



# The Evolution of

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## **Mines Rope Rescue** in Mines Rescue Services South Africa



# Implementation

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After completion of different courses, techniques and equipment selected have been implemented in

- training
- on ore-pass entries
- rescues underground



# Implementation

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- original techniques used were sporting or surface orientated
- not suitable for underground rescue in S.A.



# Implementation

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- a proper needs analysis was conducted
- associated dangers and risks were identified and adequately dealt with



# Implementation

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- decided to develop, combine and adapt the best suited systems and equipment to meet our mining industries needs



# Safety

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- rescuer, patient, incident commander and assistant must be in close proximity to point of entry
- assisting personnel under the direct guidance of the incident commander must be observed at all times



# Systems

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- every system must be double.
- backed up by an independent system
- simple – the minimum amount of equipment and components
- tried and tested in training and rescues
- reliable, effective, fail proof, safe and adaptable



# Systems





# Equipment

- equipment checked and certified
- vehicle proceeds fully equipped to the scene.
- second vehicle with lifting and cutting equipment if required





# Research & Development

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- after every incident we objectively look at the systems and equipment
- if there are shortcomings or systems don't fulfill the need we then redesign, source, simulate, test and implement to cater for a similar situation in the future



# Research & Development

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- a shaft accident where our proto teams were underground for up to 5 days, 150 people were brought to safety
- during this incident the **skyjack** was introduced to speed the operation up



# Skyjack



# Mines Rope Rescue Technician



- trained current brigadesmen
- 3 day initial training
- biannual refresher
- understanding of systems
- require 8 to 12 MRR technicians



# Incident Commander & Assistant



- managerial skills
- knowledge, leadership
- qualified BAA
- ability to evaluate, identify and overcome dangerous situations
- gain the trust of the MRR team
- self confidence
- be able to take control





# Scribe

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- scribe to be competent MRR technician
- be familiar with all terms, mining, BAA and MRR
- ability to record comprehensive minutes of the complete operation



# Rescuer

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- Volunteer
- should not have worked a shift in hot conditions prior to the callout
- BAA
- correct physical size, strength, mental state
- knowledge to be able to continually assess the situation



# Rescuer

- Rescuer entering through grizzly into ore pass.





# Site Assessment

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- first MRR technician on site must do a quick assessment and determine the magnitude of the problem
- try to communicate with the person to be rescued to reassure him that help is on it's way
- raise the alarm and call for help
- provide a list of equipment requirements suitable to execute the rescue



# Site Assessment

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- set up control center
- place a guard at the point of entry to prevent any tipping
- drop a compressed air hose down that is opened up slightly to minimize dust but ventilate the area.
- push a compressed air hose into the box-front from the bottom and place a guard



# Site Assessment

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- extend communication as close as possible to the incident
- clear the access ways for quick entry of men, equipment and evacuation of the injured
- clear any loose rock or material away from the hole ensuring that persons are secured and nothing falls down the hole



# Site Assessment

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- consider changes to ventilation to improve conditions of rescue site
- is it necessary to hang up the blast?
- minimize the number of persons in the area to unions, safety and health and persons directly involved in rescue
- rescue can only be effected by a full team, but preparation and planning can commence immediately with one or two Mines Rope Rescue Technicians.



# Equipment

- simple in design
  - easy to use, reliable, durable, light, safe, compact, robust, versatile
  - easy to wash and maintain
  - material packed in bags for ease of transport to site
- Rescuer and 2<sup>nd</sup> rescuer equipment





# Equipment

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- initial assessment will determine the system to be used, with the determining factor being the access to the area
- bags are packed so the technician can select required length of rope and bag to complete a component of a system



# Equipment

- patient extraction and transport
- immobilux, kendricks, scoop and basket stretchers





# Equipment

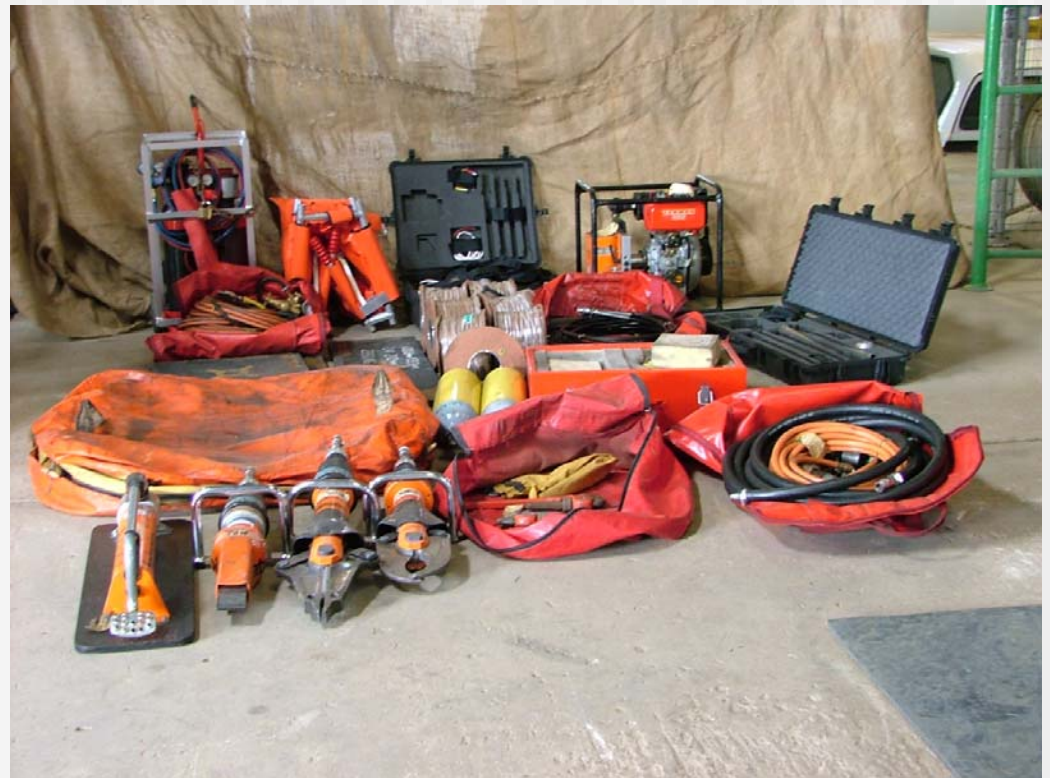
- rescuer PPE
- food
- water
- suntan lotion
- disinfectant





# Equipment

- lifting and cutting equipment
- trapped person locating device



# Equipment: Communications





# Equipment: Cooling



# Equipment: Ore Consolidation





# Equipment: Rigging



# Equipment: Documentation, Gas Monitoring, Comms, Distomat and Camera





# Equipment: Ropes





# Equipment: Ladders





# Equipment: Additional



# Equipment: Remote Rigging



# Equipment: Remote Rigging



# Equipment: Incident Commander





# Equipment: Accessory Line





# Equipment: Patient Bag





# Equipment: Belay Bag

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# Equipment: Skyjack Bag





# Equipment: Mainline Bag





# Equipment

- equipment is housed in a trailer with 4 access points for unloading
- trailer is towed by a LDV that transports the stretchers, communication, documentation and other required materials





# Systems

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- systems designed in the interests of safety and health
- basic system is adaptable to meet all the challenges of the past
- raising and lowering is effected by the technicians manning the respective systems on direct instruction from the Incident Commander through the communication systems installed



# Systems

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- the complete system must be in place before a man is lowered
- all systems are checked by the incident commander and MRR technician in charge prior to the rescuer being lowered



# Systems

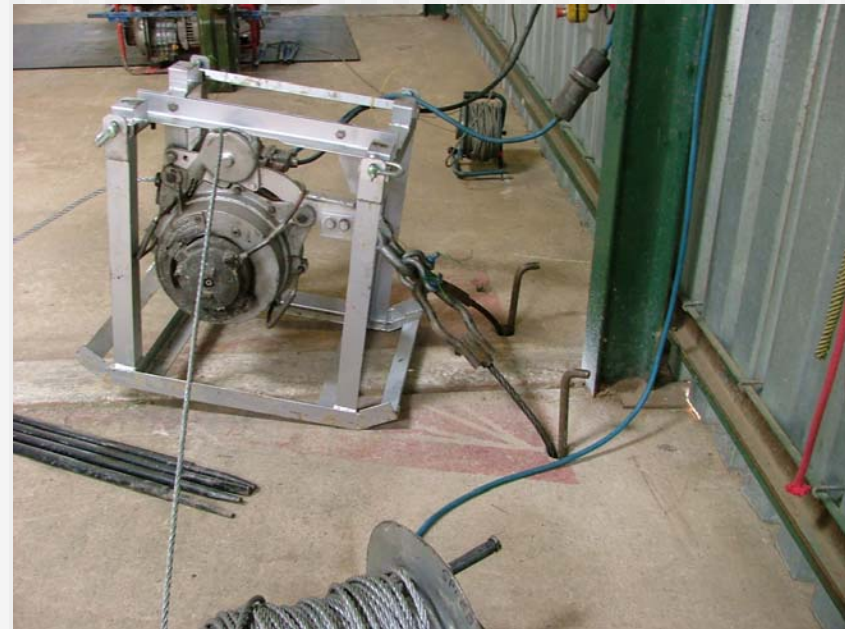
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- if communication between incident commander and the rescuer is lost **the rescuer to be raised immediately**
- at no stage from descent to ascent should the rescuer be detached from the main or belay line



# Anchors

- all anchors to be at least 2 independent anchor points
- critical angles for loading to be taken into consideration
- suitably elevated and aligned to accommodate the system





# Mainline

- the mainline will consist of:
- skyjack with applicable length of 9mm steel rope, or
- griptech with applicable 11mm static kernmantle rope and mechanical advantage in place





# Mainline

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- systems should preferably be in direct sight and hearing distance of the incident commander, if not then communication is to be installed
- adequate re-set distance required for the mechanical advantage needs to be taken into consideration



# Mainline

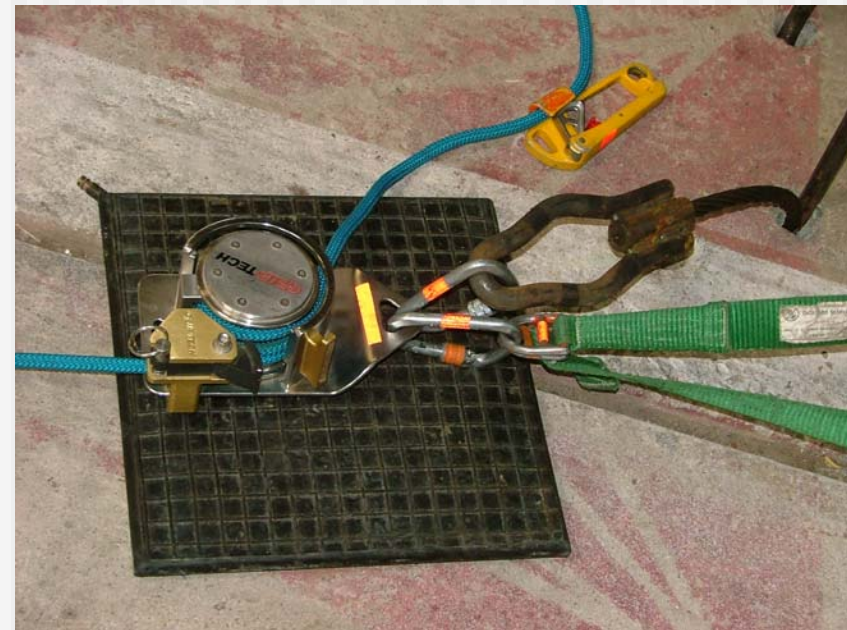
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- men, material and systems must be protected from rolling stock
- electrical power, water and compressed air should be isolated
- consideration should be given to stopping conveyances in the shaft if in close proximity, as well as hanging up the blast if required



# Belay Line

- belay line will consist of:
- griptech with the applicable length of 11mm static kernmantle rope
- in the case where the skyjack is used on the mainline a mechanical advantage must be in place





# Belay Line

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- rope on the belay line should be a different colour to the mainline rope
- system setup should not cross the main line and preferably be in the opposite direction to the mainline but in sight and hearing distance of the incident commander



# Environmental Conditions

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- equipment for the measurement of temperature and the testing of flammable gas, carbon monoxide and oxygen deficiency must be used
- in the case of a hazardous environment, long duration self rescuers should be available
- the area should be ventilated if possible to cool the area down and dilute gas or fumes



# The Rescuer

- must have a full body harness on at all times
- when applicable the full body harness must be used in conjunction with the trapeze and spreader bar





# The Rescuer

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- be attached to the main line and belay at all times
- have at least two effective means of communication between himself and the incident commander
- be lowered and raised on request working through the incident commander
- will rest, hydrate himself and inspect the systems before commencing with the task

# Discussion of 2 Underground Rescues

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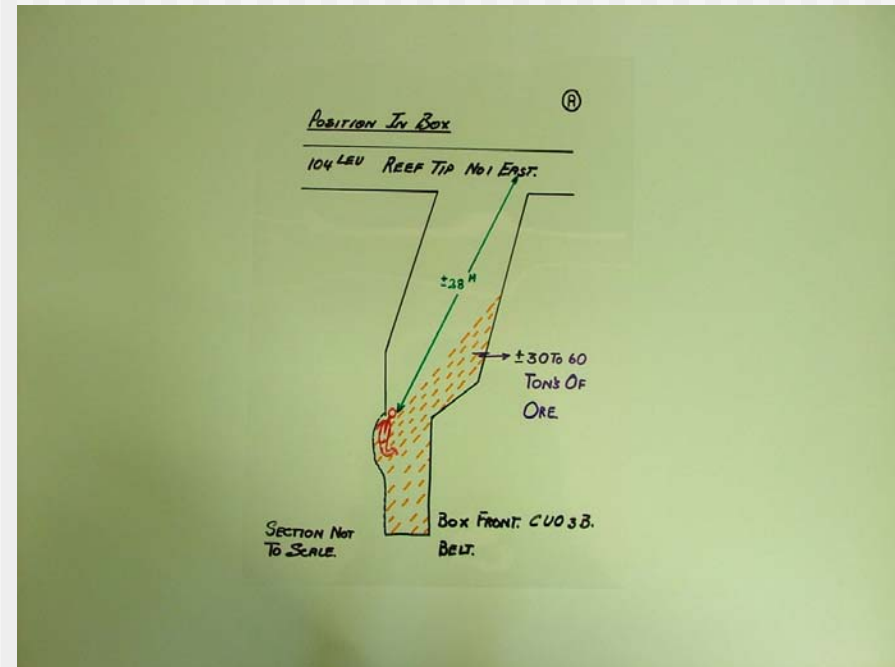


- an employee fell into an underground silo and was trapped by ore
- problems that we faced and the decisions made, were by all present, including the trapped person



# Situation 1 Sketch A

- the profile of the ore, the width of the underground silo and the volume of ore made it logistically impossible to consolidate the ore, and concentrate the efforts around the trapped person





# Sketch A

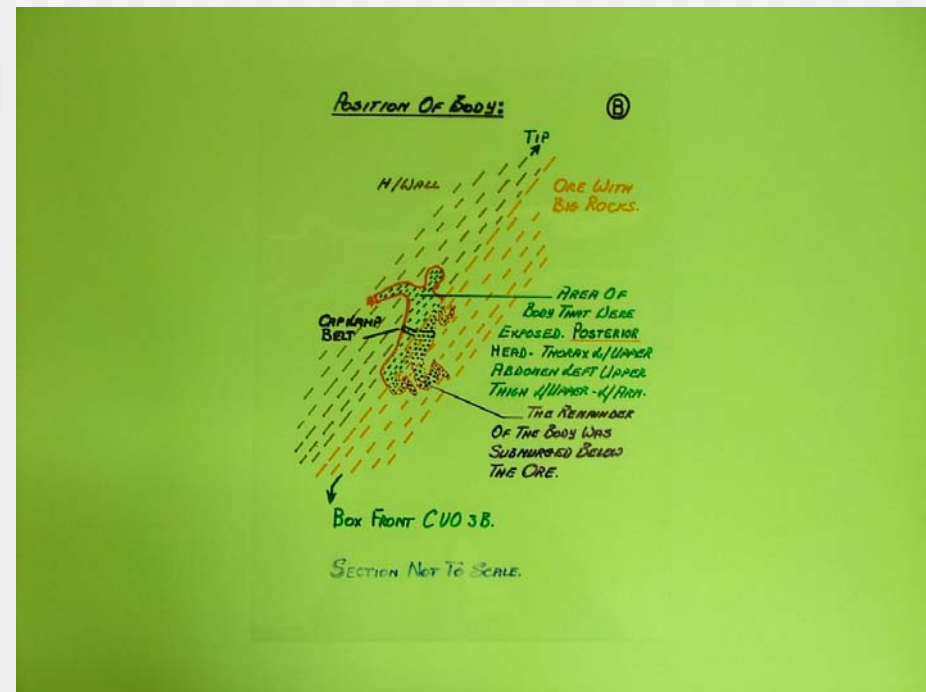
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- a certain amount of loose ore gravitated down to the trapped person as rescuers gained access to free him
- the estimated 30 - 60 tons of ore to be taken out would have taken in excess of 8 days to remove using bags
- further complications were large rocks within the ore



# Sketch B

- any spillage or rolling rocks could injure the trapped person
- he would have to be protected by constructing a cage around him





# Sketch C

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- consideration was given to use a vacuum cleaner
- not possible as no vacuum cleaners were readily available
- large rocks and vertical distance of between 15 and 30 meters
- breathing protection was required due to dust

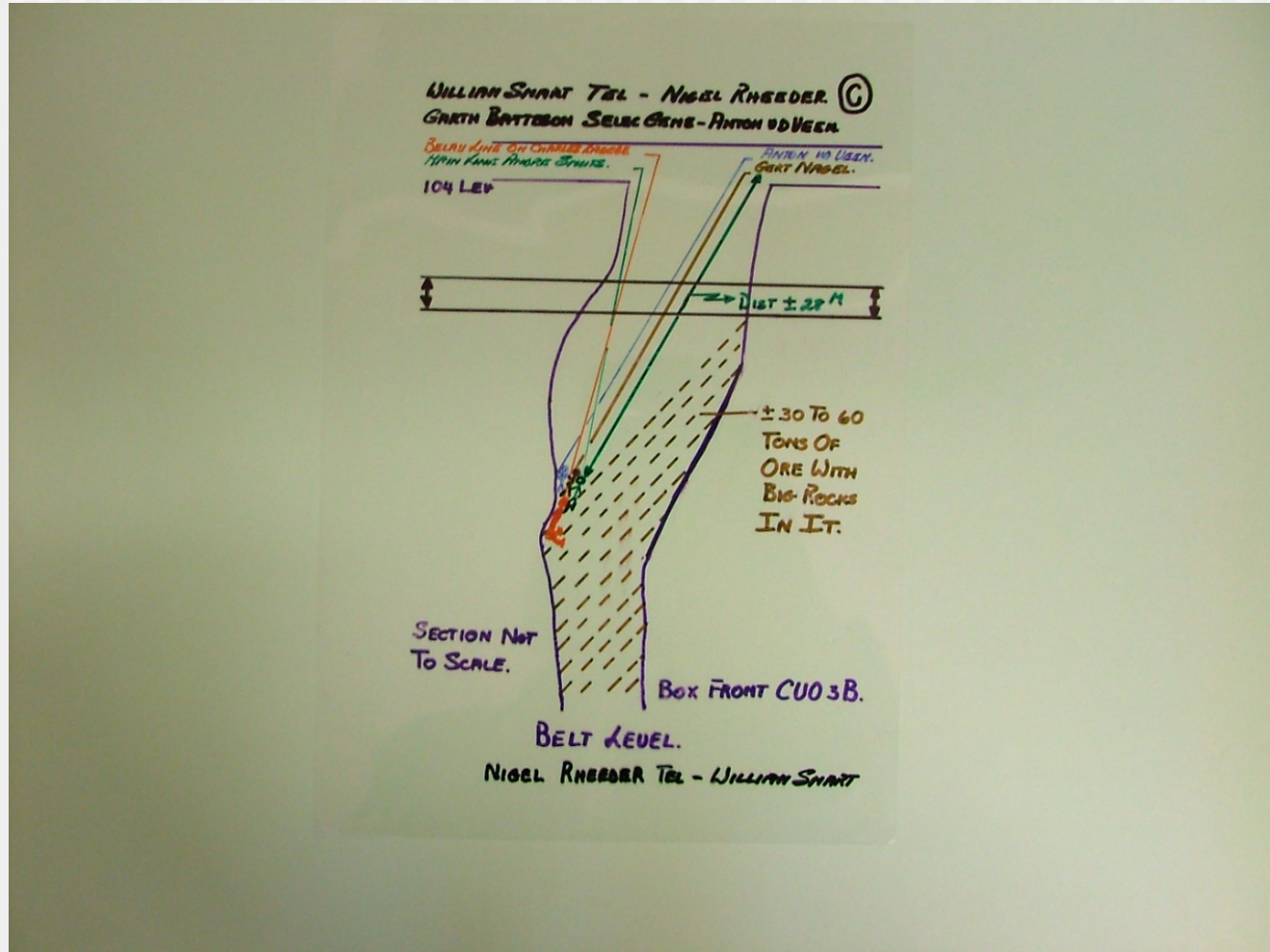


# Sketch B & C

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- the anterior portion of the patient was against the hanging wall and he said it felt as if his legs were not straight but trapped in the ore
- the patient had lost a lot of blood and although in a state of shock, was conscious and could communicate with us

# Sketch C





# Sketch B & C

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- the rescuers freed the patients left arm
- he managed to assist them in attaching pickoff straps onto his cap lamp belt and an open harness around his thorax and left thigh
- numerous attempts were made to pull him from the ore by means of a mechanical advantage with no success



# Sketch B & C

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- the patient found this very painful and this confirmed that his legs were trapped in the ore below him
- very little progress had been made in freeing the patient
- the patients condition was deteriorating and he was becoming despondent
- he requested to pull the CV03B box in an attempt to free him from the ore



# Sketch D

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- it was decided to pull the box after deliberation with all parties present, including the trapped person
- communication between underground control and CV03B box was established and an open line maintained



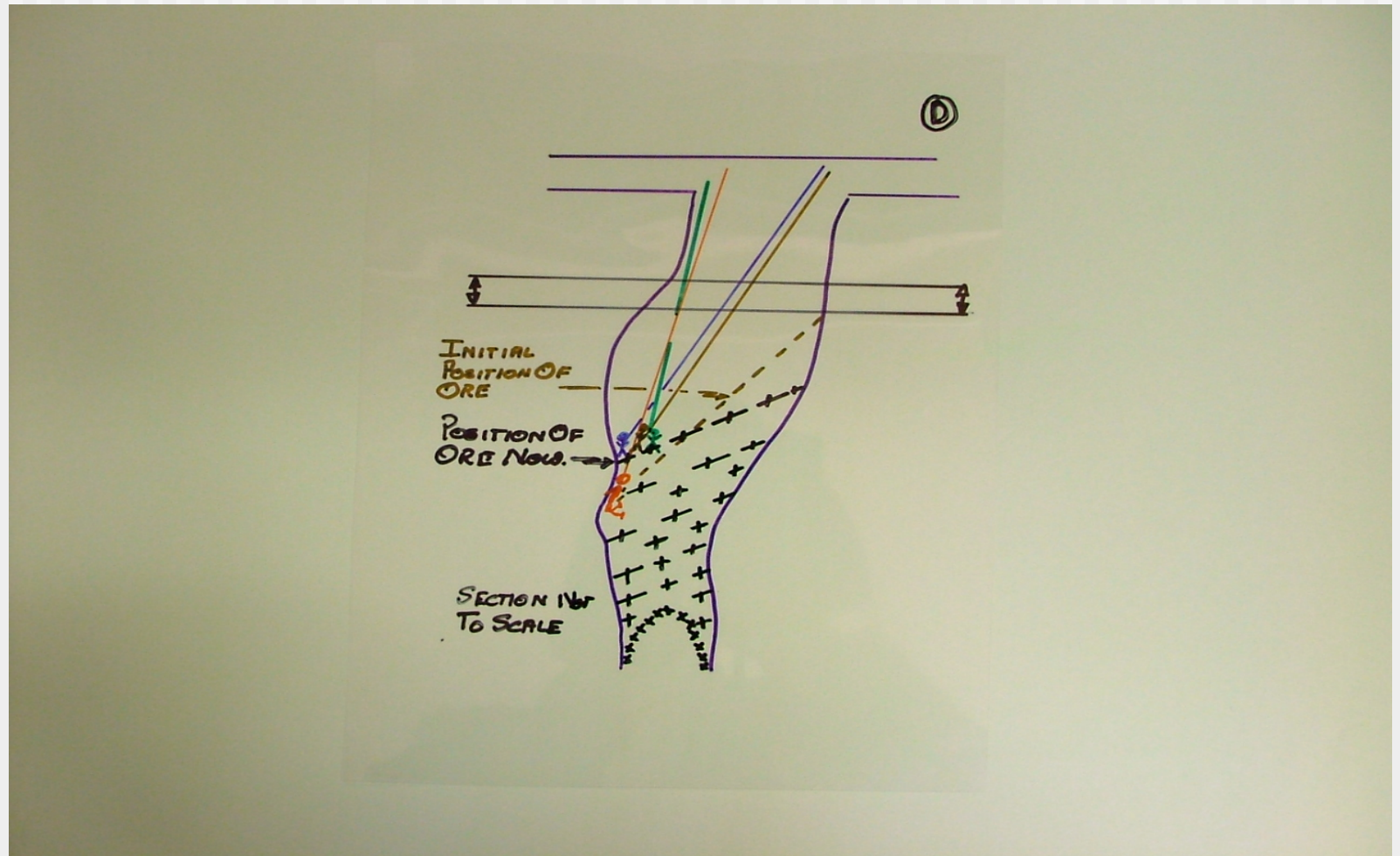
# Sketch D

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- the box front was bled slowly and no movement of ore was reported by the rescuers
- suddenly a movement occurred and the profile of the ore changed dramatically trapping the legs of one rescuer and totally engulfing the trapped person



# Sketch D





# Sketch D

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- slack on the ropes attached to the rescuers was taken up and communication lost with the trapped person
- in an attempt to save his life it was then decided to pull the box to free the rescuers legs and possibly expose the engulfed person



# Sketch D

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- unfortunately we lost the trapped person as he was drawn into the ore
- his body was recovered out of the box on the belt level
- a workshop was held to design, develop and construct a rescue cage to overcome problems experienced should a situation like this occur in the future



# Rescue Cage

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- this cage would enable us to concentrate our efforts to free the trapped person from the ore and offer a certain amount of protection to the trapped person
- the cage segments would be erected around the trapped person and air bags or props would push and hold the cage against the hanging wall



# Rescue Cage

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- ore loaded can then be deposited on the sides of the rescue cage
- the inner sections are then lowered as the rescuers dig down
- had this cage been available we could have saved the life of the trapped person



# Rescue Cage

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- unique situation as the area inside the silo was vast, the ore profile was unpredictable and in excess of the angle of repose
- other options was to dig the trapped person out
- but after a period if he showed no vital signs we would recover the body
- or if alive would he survive the crush syndrome



# Rescue Cage

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- Criticism made
- best decisions made



# Rescue Cage



# Rescue Cage



# Rescue Cage





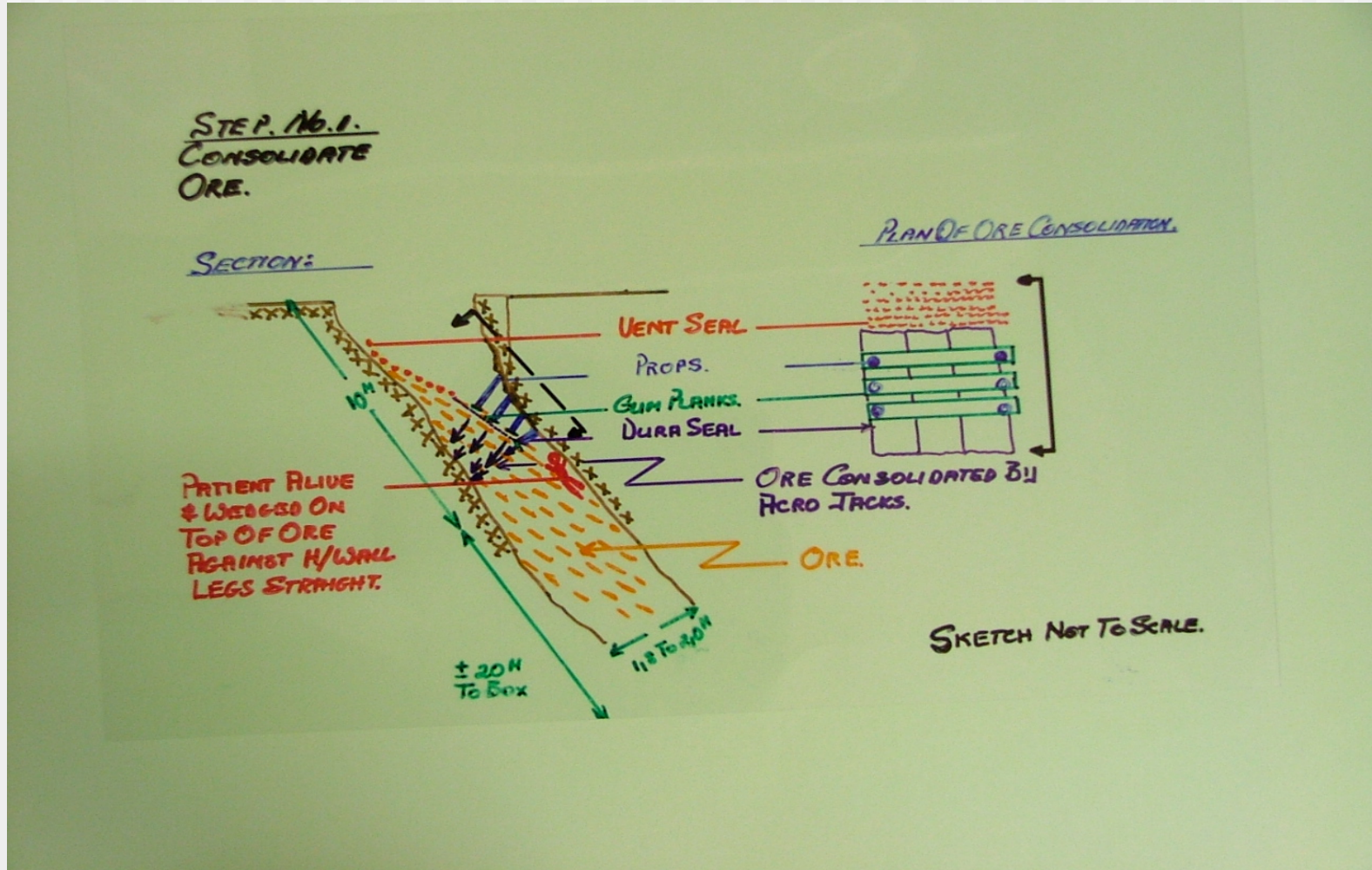
# Situation 2

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- a person was drawn into an ore-pass by loose ore and was totally engulfed
- rescued after 12 hours of digging
- compare this situation to the previous rescue, the ore could be consolidated and the area made safe as we progressed with the rescue



# Step 1





## Step 2

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- human chain could be formed
- ore only had to be transported for ten meters
- approximately four tons of ore was taken out of the ore-pass

# Step 2



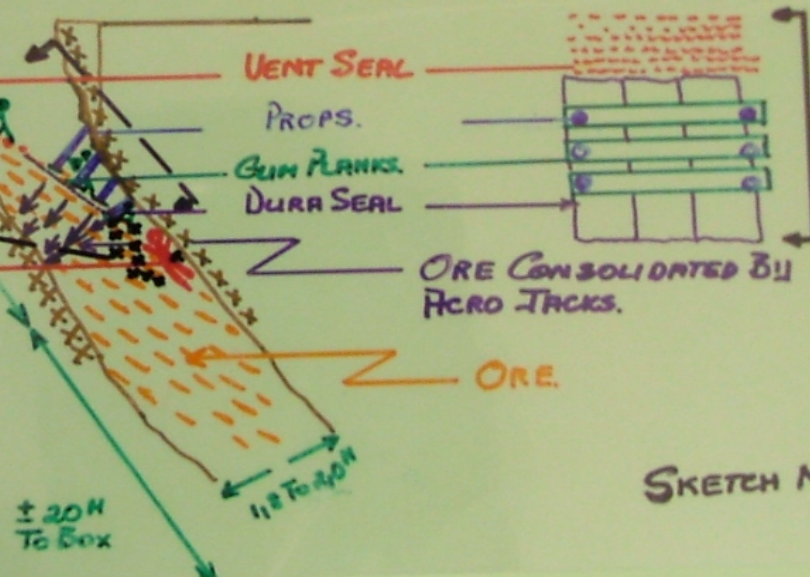
STEP No. 1.  
CONSOLIDATE  
ORE.

SECTION:

ORE IN  
BUCKETS  
HUMAN CHAIN  
REMOVE ORE  
FROM BACK & SIDES  
OF PATIENT.  
± 4 x TON  
PATIENT ALIVE  
& WEDGED ON  
TOP OF ORE  
AGAINST H/WALL  
LEGS STRAIGHT.

STEP No. 2.  
EXPOSE PATIENT  
OPEN - REMOVE ORE  
MED ASSISTANCE.  
HUMAN CHAIN - ORE  
OUT BUCKETS.

PLAN OF ORE CONSOLIDATION.



SKETCH NOT TO SCALE.



## Step 3

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- after 12 hours of digging and rotating positions of rescuers in the human chain to optimize efficiency the trapped person could be brought to a point of safety

# Step 3

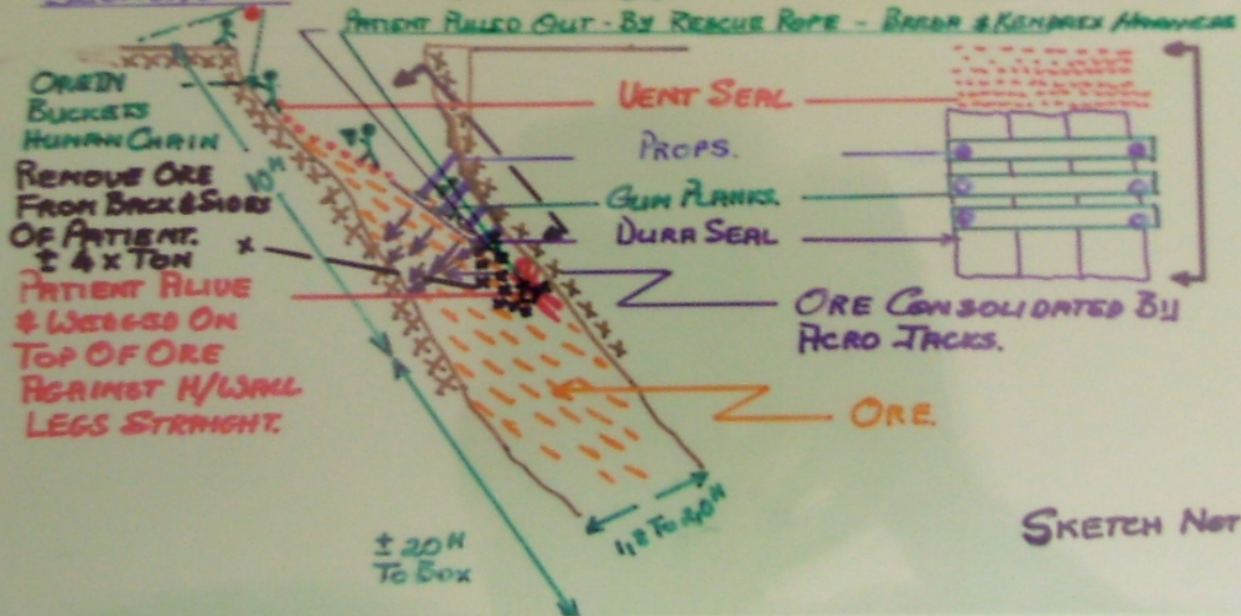


STEP No. 1.  
CONSOLIDATE  
ORE.

STEP No. 2.  
EXPOSE PATIENT  
OPEN - REMOVE ORE & GUIDED OUT BY MRR  
MED ASSISTANCE.  
HUMAN CHAIN - ORE  
OUT BUCKETS.

STEP No. 3  
PATIENT IMMOBILIZED SECURED  
& GUIDED OUT BY MRR

SECTION:



ORIGINAL  
BUCKETS  
HUMAN CHAIN  
REMOVE ORE  
FROM BACK & SIDES  
OF PATIENT.  
± 4 X TON  
PATIENT ALIVE  
& WEBS ON  
TOP OF ORE  
AGAINST H/WALL  
LEGS STRAIGHT.

PLAN OF ORE CONSOLIDATION.



# Practical Training

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- where possible refresher training is done underground
- for example:  
using 12 MRR technicians ore-pass examinations are conducted checking for self mining, scaling and buildup of mud or fines
- all required documentation is completed and safety precautions are taken



# Practical Training

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- simulated a full conveyance that has been pulled into the jack catches with the evacuation of injured persons
- simulated an accident in a sinking shaft with the evacuation of patients in a kibble
- rescue winch has been used to examine redundant and ventilation shafts to a depth of 900 meters



# Practical Training





# Practical Training



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# Practical Training





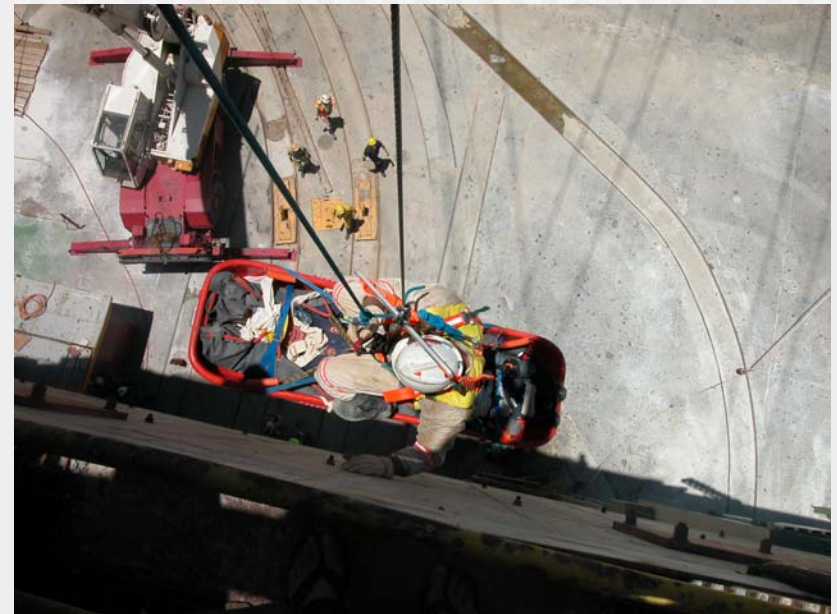
# Practical Training

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# Practical Training



# Rescue Winch





# Questions?



# Thanks and God Bless!

