11. Insert survey tool through chuck and grippers, tighten thread to DHM. Mark the back of the survey tool to align with the mark on the DHM i.e. 12 o'clock.
12. Push DHM - Berylium Copper, Survey tool into the standpipe and attach 2nd BeCu 3 metre rod, ensuring the orientation point is still visible.
13. Transfer the mark back to the drill rod after tightening.

(Figure 19). Ensure DDM is set to 12 o'clock.

Section 1.7 OPERATING DOWNHOLE MOTOR & SURVEYING EQUIPMENT

Drilling & Branching Using DDM

1. Take rod brake off.
2. Locate bend position at 12 o'clock.
3. Open grippers.
4. Push drill string to a near face position.
5. Rotate string so that the tool face is at the chosen angle (use a chalk) e.g. 2 o'clock.
6. Apply rod brake.
7. Start water pump.
8. Open high pressure water valve to swivel.
9. Close by-pass valve.
10. Observe water pressure to determine that motor has started (pressure should be 1500 kpa at idle).
11. Establish water flow through DHM (150 to 180 l/min).
12. Reduce the feed rate to zero.
13. Operate feed control lever forward.
14. Slowly increase the feed rate to ease the cutting bit to the face.
15. Continue until the desired penetration rate is achieved.
16. Observe water pressure - 3 to 4 Mpa.
17. Drill forward a prescribed distance (6 metres nominal) and make a survey.

18. Determine the next position of the drill string to continue drilling.
19. Record all information on the appropriate sheet (Downhole Motor Drilling Data/Log Sheet).
20. Continue cycles as required to complete the hole to the required distance and direction.
21. Flush hole with water and blow out with compressed air.
22. Pull the rods out of the hole.

WARNING

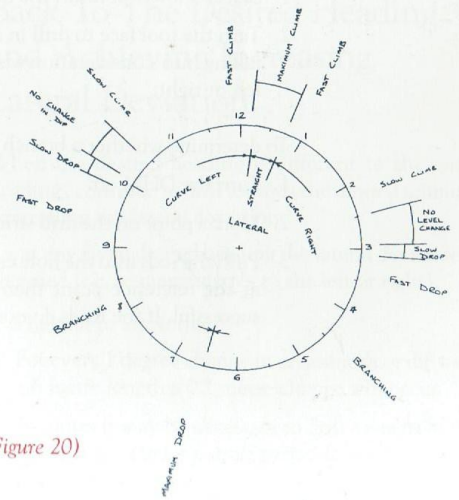
Caution is required :

- The DHM doesn't fit through the stuffing box gland.
- To prevent damage to the Be Cu rod.

Branching

Branching is when another hole is drilled away from the original hole. It is one of the advantages of downhole drilling. Branching is done if the hole hits the roof or floor, or to place another hole into a different area of the seam to affect drainage or to determine geological conditions in that new area.

It easier to branch down than to branch up due to the weight of the rods. With this in mind, if you are unsure of the position of the hole in the seam ALWAYS DRILL UP and use a slow feed rate when branching.



(Figure 20)

Branch Out Of The Floor

1. Select a higher point in the hole.
2. Select an area with sufficient coal beneath the existing hole.
3. Turn the tool face to drill in a downward direction, taking into consideration whether you want to drill left or right.
4. Turn the tool face up as soon as the branch has taken.

Branch out of the Roof

1. Select a lower point in the hole.
2. Turn the tool face to drill in a downward direction, taking into consideration whether you want to drill left or right.

To determine whether a branch has been taken:

1. Turn the DHM off.
2. Mark a point on the drill string as a reference point.
3. Push the rods into the hole carefully. If the rods stop at the reference point then the branch has been successful. If the Rods do not stop, try again.

Section 1.7 OPERATING DOWNHOLE MOTOR & SURVEYING EQUIPMENT

Computer Function To Branch.

After removing the required amount of rod to position the toolface at the branch site:

1. Press the reset button.
2. Press the F14 button and enter the "shot number" which corresponds to the amount of rod taken off.
3. Press enter.

Bringing the Entry Heading Back To The Desired Heading, and Achieving Increasing Lateral Deviation.

When the desired heading is different to the entry heading , continue to drill towards the desired azimuth, controlling the lateral deviation.

So, at any given desired heading the lateral deviation is obtained (i.e. so many metres to the left or right).

It is helpful to know that:

- For every 1 degree change in an azimuth or dip over a 6 metre length a 0.1 metre change will occur.
- At times it may be necessary to drill away from the desired heading for a short period to get the desired lateral deviation.

Locating Roof Profiles

This can be done in two ways:

1. Slowly bring the hole up until the roof is touched and then drill downwards.
2. Bring the hole up rapidly, then when the roof is touched, pull back to a suitable place and branch.

The advantage of plotting roof profiles is that a line can be projected forward from these points and the operator can direct the motor to follow.

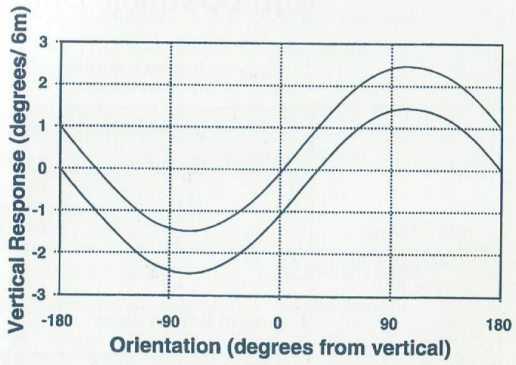
- If the plotted hole goes through the projected line, then the roof profile has reduced in dip. Continue to drill up until the roof has been touched.
- If the roof has been touched before the projected line, the seam profile has gained in dip.

After every profile is found, use this information to update the line being projected forward.

Section 1.7 OPERATING DOWNHOLE MOTOR & SURVEYING EQUIPMENT

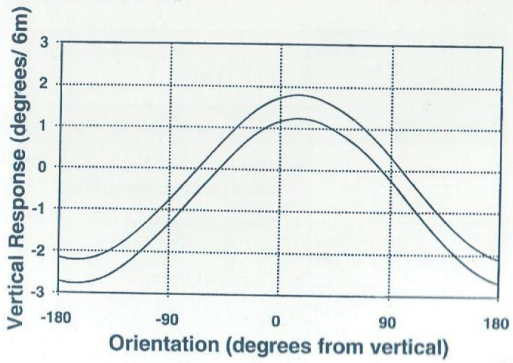
(Figure 21)

Lateral Response of Down-Hole Motor



(Figure 22)

Vertical Response of Down-Hole Motor



Problems that may be Encountered with Downhole Drilling

1. Gas coming back through the drill string

• DHM may be damaged	Check DHM operation
• Rods may be broken	An indication of either of these will also result in low bit pressure, thus the rods or DHM have to be withdrawn

2. Loss of Return water

• H.P. water pump failure	Check pump status
• The hole being drilled has intersected another hole	Check planning sheet for proximity of the other holes, turn off hole that is taking the water

3. Rods Bogged

• Build up of fines in the hole	Flush hole
• Hole collapsed where stone has been intersected	Pull back to remove area and branch off
• Too many directional changes	Keep hole straight, hole may not be able to progress further, apply forward rotation and traverse back simultaneously
• Geological structure	
• Undersigned	

Section 1.7 OPERATING DOWNHOLE MOTOR & SURVEYING EQUIPMENT

4. Motor will not start

• Bit blocked	Remove and unblock
• Motor damaged	Remove and check
• H.P. pump not running	Check pump
• No apparent cause	Pump the bit to the face, with the H.P. water valves set to start DHM, rotate rods and pull back

5. High Bit Pressure

• Drilling in stone	Pull back and branch
• Approaching a structure	Log all changes
• Build up of fines	Flush hole
• Feed rate too high	Reduce feed rate
• Partially blocked bit	Remove bit and clear
• Damaged Bit	

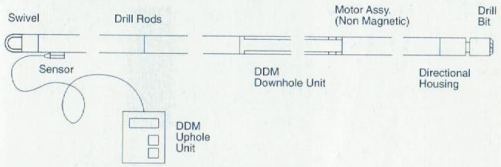
6. Low Bit Pressure

• Damaged or broken motor	Remove and check
• Broken rods	Replace as necessary
• Rods uncoupled	

7. Drill not responding

• Drill continues to go in the opposite direction to where you wish to drill.	Bend and bit size are incompatible, use a smaller bit
	Azimuth correction has not taken effect
	Geological features interfering e.g. cleat direction

Directional Drilling System Overview of DDM Upgrade



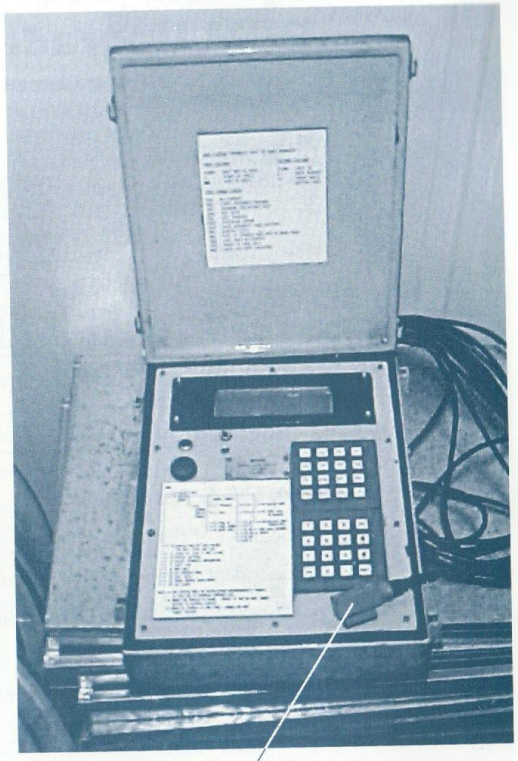
DDM-Upgrade

The DDM-OIA System itself consists of the following components:

1. Downhole Unit - brass instrument pipe with electronics
   - Downhole Battery Pack
   - Sounder or Sounder Chamber
   - Sounder Chamber Sleeve on the Drill Motor Side
   - Thread Saver Sub on Uphole Side

2. DDM 01A Acoustic Pickup Sensor
3. Uphole Monitor Unit
4. Battery Charger Unit *
5. Battery Charger Leads *
6. Downhole Battery Stand *

Upgrade Uphole Monitor



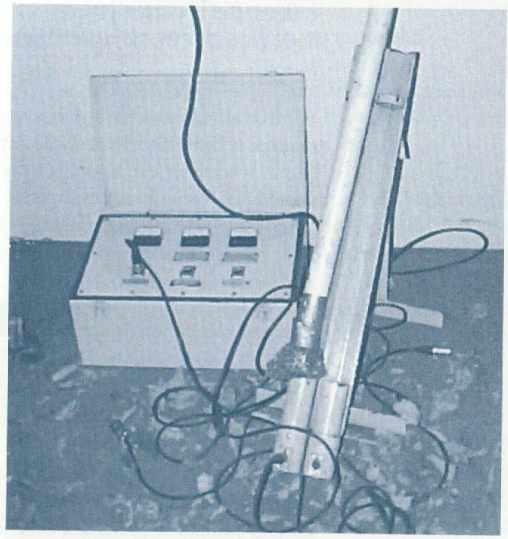
Magnetic Acoustic Pick-Up Sensor

(Figure 23).

Section 1.8 DIRECTIONAL DRILLING SYSTEM OVERVIEW OF DDM UPGRADE

Upgrade

Battery Charger Unit with Downhole Battery & Stands



(Figure 24).

Data is transmitted by the Downhole Unit via acoustic transmission systems (sound pulses). These coded sound pulses are picked up by the Sensor which is connected to the Uphole monitor unit. The Uphole monitor unit collects the raw data, processes it back to meaningful data, processes the data and displays it on the Uphole Monitor screen.

Whilst all efforts have been made to design and construct both the Downhole unit and the Uphole Monitor to meet the rigours of the mining industry, it should be remembered that both units are sensitive precision electronic equipment.

REMEMBER

The Uphole Monitor should not be treated like a tool box. Throwing it around will result in damage to the display screen and/or electronics.

The Downhole unit is a robust tube but it does contain sensitive electronic components. Dropping it to the ground instead of placing it on the ground could lead to serious and expensive damage. The Sounder Chamber is protected from damage to its threads by two thread saver subs, one is mounted on the drill motor side of the Sounder Chamber and the other on the Uphole side of the Sounder Chamber. These thread savers are only to be removed from the Sounder Chamber if they have to be replaced.

There are no user serviceable parts within the Downhole unit or Uphole Monitor.

Section 1.8 DIRECTIONAL DRILLING SYSTEM OVERVIEW OF DDM UPGRADE

Battery Charging and Maintenance

The Uphole Monitor and the Downhole unit are both powered by rechargeable batteries and these will have to be recharged. The recharging should only be performed in a non- hazardous environment.

The Uphole Monitor has a 2 pin socket on the right-hand side. This socket is both for battery charging and RS232 data transfer to a computer.

The Battery Charger has an output lead with a plug that is compatible with the socket on the Uphole Monitor on one side and a 5 pin plug on the other side.

Plug the lead into the Uphole Monitor and the appropriate socket on the Battery Charger and turn on the 240 volt supply to the Battery Charger.

The Downhole battery has a stand which is attached to the Battery Charger via a 3 pin cable. Slide the battery into the Battery Charger Stand with the ring connector first and ensure you do not short the terminal rings on the battery pack or battery damage will result. Connect the Downhole battery charger lead between the Battery Charger Stand and the Battery Charger and turn the 240 volt power on.

The Battery Charger is fully automatic and will look after charge rates and determine when each battery is fully charged and will maintain this charge.

It should be remembered that the batteries used in both units are typical of all rechargeable NiCd batteries and as such will lose charge gradually if just left on the shelf.

Whilst this is not a problem in day to day use, it should be noted that if either unit is fully charged and then left in storage for 30 days then approximately 30% of the charge will be lost.

With this in mind if a battery pack has been stored for a period of time it should be placed on charge for a few hours prior to use.

A fully discharged battery will take 12 hours to reach full charge.

The Downhole battery pack is a non serviceable item as it has been designed to accommodate the harsh environment in which it is required to be used.

Failed battery packs should be returned to AMT for appropriate disposal.
Batteries in the Uphole Monitor are replaceable. Due to requirements with respect to intrinsically safe operation and reliability. The unit should be returned to AMT for battery maintenance.

It is advisable to fully replace the Downhole and Uphole batteries after one year in service as the batteries have a limited life and number of recharge cycles. This will ensure the best performance from the DDM 01A system.

Section 1.8 DIRECTIONAL DRILLING SYSTEM OVERVIEW OF DDM UPGRADE

Battery replacement in the Downhole Unit

Removal of Downhole battery pack for recharging can only be done in a non- hazardous clean environment.

1. Place the Downhole brass instrument pipe on a bench, so that the Sounder Chamber is not resting on the bench.

2. Rotate the brass pipe so that one of the locking or bottle pins, which secure the Sounder Chamber to the brass pipe is facing up. Remember that only the locking pins that hold the Sounder Chamber in the brass pipe are to be undone. Do not touch any of the other locking pins in the system.

3. Undo the locking grub screw in the locking pin facing upwards, always put downward pressure on the Allen key and special bottle pin tool. While undoing the second grubscrew, still applying downwards pressure on the bottle pin, observe that the bottle pin is slowly going down. If the locking pin itself rotates, use the special tool supplied with the DDM to prevent the pin from rotating. After removal of the second grub screw the bottle pin will push all the way in. Rotate the unit to allow the ball bearing to fall out. If the ball does not come out, jiggle the brass pipe until the ball comes out. Only after removal of the ball can the locking pin be pushed all the way in. Remember that the locking pin is a fail-safe design and therefore you must be

patient when removing the grubscrews and stainless steel balls. The ball might not come out the first time, but it must be removed before trying to push the bottle pin in.

4. Repeat item 2 and 3 until all 3 sets of grub screws and balls have been removed.

5. Push all the locking pins in until they clear the brass pipe and pull out the Sounder Chamber and battery pack slowly and carefully.

6. Remove the Sounder Chamber from the battery pack by unplugging the two brass connector pins and charge the battery pack in the Battery Stand. Insert the battery pack with the rings end downward in the Battery Stand being careful not to short circuit the rings. Connect the Battery Stand to the Battery Charger and turn on the Battery Charger.

7. Follow the next instructions to reassemble the Downhole unit. Insert a fully charged battery pack, rings end first, into the Downhole instrument pipe.

8. Before Connecting the Sounder Chamber to the Downhole battery pack, make sure that the 'O' ring on the Sounder Chamber is not damaged. Replace the 'O' ring immediately if any damage has been detected. This 'O' ring protects the Downhole electronics from water, and if damaged can cause severe damage to the electronics inside the brass instrument tube, so be sure to check the 'O' ring

Section 1.8 DIRECTIONAL DRILLING SYSTEM OVERVIEW OF DDM UPGRADE

every time the Sounder Chamber is reassembled to the brass instrument tube.

9. Insert the 3 locking pins into their respective holes in Sounder Chamber and push the Chamber and battery slowly and carefully into the brass instrument pipe. Make sure that the locking pins are aligned with the holes in the brass pipe.

10. Put one of the holes in the brass instrument pipe at the top and drop 1 stainless steel ball into the hole in the locking pin.

11. Insert a grubscrew into the locking pin and screw it in until the locking pin is protruding from the brass pipe and the grub screw is tight. Remember to always apply continued pressure on the grubscrew whilst locking the screw. If the locking pin itself rotates, use the special tool, supplied with the DDM, to prevent rotation.

12. Rotate the brass pipe until the next locking pin is at the top and repeat 10 and 11 until all three locking pins are in place.

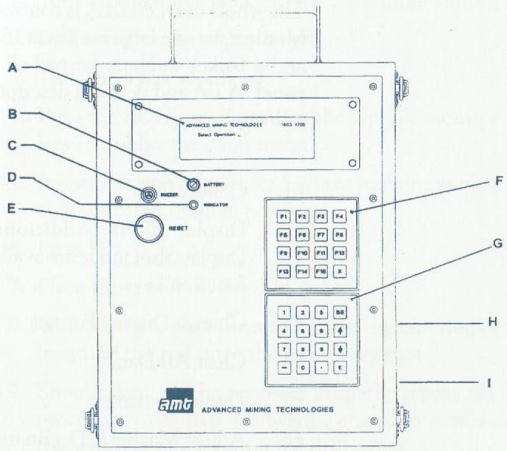
13. Now insert and tighten a second grubscrew into all three locking pins. If the locking pin itself rotates, use the special tool, supplied with the DDM, to prevent rotation. If the unit is exposed to heavy vibration you can put a medium lock-tite on the second grubscrew to prevent them accidentally unscrewing.

14. The Downhole unit is now ready for operation.

15. To test the Downhole unit before being used underground or on site, rotate the Downhole unit clockwise for one and a half turn to start the Downhole unit. The Sounder chamber should transmit a short burst of sound followed by a long burst of clicking sounds of approximately 80 seconds long. This will indicate whether or not the Downhole unit is working correctly.

Section 1.8 DIRECTIONAL DRILLING SYSTEM OVERVIEW OF DDM UPGRADE

Uphole Monitor Unit Layout Diagram *(Figure 25)*.



A. *Alpha Numeric Liquid Crystal Display (Display screen)*
B. *Battery Power Meter - Battery Condition*
C. *Buyer*
D. *Indicator Light (LED)*
E. *Reset Button*
F. *16 Key Keypad Function Keys*
G. *16 Key Keypad Numeric, Scroll and Enter Function Keys*
H. *Battery Charger and Data Transfer*
I. *Downhole Data signal Input Connector*

Uphole Monitor Operation Procedures

The Uphole Monitor is a sophisticated computerised data collection, data processing and data display Unit. The whole of DDM 01A is controlled from the Uphole Monitor via one large button, a 16-key function keypad and a 16-key numeric keypad all located on the front panel. A list and detailed description of each function follows:

F1. Collect Shot

F2. Display Shots. Additional functions in the Display Shot mode are available by pressing other function keys.

F3. Change Display Format

F4. Clear All Data

F5. Display Setting

F6. Adjust Magnetic Declination

F7. Reset Tool/Bend

F8. New Hole

F9. Set Standard Rod Length

F10. Self Test

F11. Data Transfer (Not used)

F12. RS232 Data Transfer

F13. Set Clock

X. Escape Key

Section 1.8 DIRECTIONAL DRILLING SYSTEM OVERVIEW OF DDM UPGRADE

Fl - Collect Shot

A typical cycle consists of:

1. Turn on the water supply to the Downhole motor.
2. Drill a drill string of any length.
3. Turn the water supply off.
4. Press the Red Reset button on the Uphole monitor box to display the main menu.
5. Rotate the string slowly for 3 - turns stopping as near as practical to original position.
6. Press Fl.
7. Place the sensor on the drill rod.
8. Wait for the Uphole unit to request the entering of length of the rod since the last survey shot.
9. Should data not be received properly, repeat the procedure from step 4 onwards, ensure to remove the sensor before rotating the drill string.

After rotating the Drill string clockwise for 3 - 4 turns, the Downhole electronics will start. A short burst of sound indicates that the unit has been started. Practice the turning of the Downhole unit to start the collection of the survey data. Place the Sensor on the drill rod and ensure the sensor cable is connected to the Uphole Monitor. Then press the Fl button within approximately 5 seconds when the main display is in "Select Operation mode", to take a survey shot.

If it is the first shot in a hole the unit will request the desired heading in degrees. If no heading is entered a default of 0 degrees is assumed. It will then request the entry heading.

After receiving the raw data, the Uphole Monitor will ask for the pipe length. The length can be put in via the Numeric Keypad the X key, which will automatically put in the Standard Pipe Length (6m). The Uphole Monitor will now calculate all the data and display the results on the Display screen. For more information on the display of data see function F2.

If however a message was received but somehow has been corrupted, the Display screen will display a Checksum error

F2 - Display shots

To go to the Display Shot mode and display the shots taken, press the F2, when the main display is in "Select Operation:" mode.

After F2 has been pressed the last 10 survey shot data will be displayed on the screen. The data on the Display screen is formatted as follows:

"# S m Azm Pt TL L/R U/D G Gd dt tm"

In which:

= Shot number

S = Shot status

Section 1.8 DIRECTIONAL DRILLING SYSTEM OVERVIEW OF DDM UPGRADE

m = Total drill string length in metres

Azm = Azimuth in degrees

Pt = Pitch in degrees

TL = Position of Toolface/bend in degrees

L/R = Left / Right deviation in metres

U/D = Up / Down deviation in metres

G = Gamma - not used

Gd = Gamma direction - position of gamma sensor not used

dt = Date when survey shot was taken

tm = Time when survey shot was taken

The Shot status has the following meaning:

first column

blank - Shot not included in hole

* - Start of hole

- Shot included in hole

second column

blank - Shot OK

* - Data suspect

F3 Change Display Format

When in the Display Shot mode and F3 is pressed the Display format will change to:

"# S m Cx Cy Cz Mx My Mz G fl tm"