- OPERATIONS MANUAL -

MREL Specialty Explosive Products Limited
1555 Sydenham Road, RR #8
Kingston, Ontario K7L 4V4
Canada
Tel: +1-613-545-0466 Fax: +1-613-542-8029
email: VOD@mrel.com
http://www.mrel.com

MREL warrants that the product is free from Manufacturer's defects for a period of two (2) years from the date of shipment to the Customer. This Warranty covers all parts and labour.

MREL does not warrant that the product will meet the Customer's requirements or that it will operate in the combinations which may be selected for use by the Customer.

MREL does not and cannot warrant the performance or results that may be obtained by using the product. Accordingly, the product and its documentation are sold "as is" without warranty as to their performance, merchantability, or fitness for any particular purpose. The entire risk as to the results and performance of the product is assumed by the Customer.

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SPECIALTY EXPLOSIVE PRODUCTS LIMITED

1555 Sydenham Road, R.R. 8
Kingston, Ontario, Canada K7L-4V4
Tel +1 (613) 545-0466
Fax +1 (613) 542-8029

CHAPTER 1 - INTRODUCTION

1.1 INTRODUCTION

Congratulations on your purchase of the MiniTrap[II]. The MiniTrap[II] is an explosives continuous velocity of detonation (VOD) recorder which operates under the extreme temperatures, weather conditions, dust and rugged environments typical of the mining industry world-wide. It is a stand-alone portable field system providing the capability to store large amounts of VOD data. No other comparable VOD system is as easy to use as the MiniTrap[II].

The MiniTrap[II] is supplied with MiniTrap[II] Software to easily retrieve, graphically display, analyse and print the VOD data recorded by the MiniTrap[II]. The Software runs under Microsoft Windows, which allows incorporation of MiniTrap[II] graphics into Windows word-processors and/or the export of MiniTrap[II] data into Windows spreadsheets.

This Operations Manual serves as a reference for the operation of the MiniTrap[II]. The Manual details how to operate the hardware and software and describes the field applications of the system for recording the continuous VOD of explosives samples and explosives down-the-hole, as well as the procedure for recording the delay times between blastholes and explosive decks to 1 microsecond accuracy.

1.2 SAFETY FIRST

The MiniTrap[II] is easily operated. However, to monitor the VODs of explosives, its use in the field requires an operator who has been suitably trained and who is experienced in working with explosives and on blast sites. The normal rules of safety apply when working with explosives. *Persons not trained and authorized to handle explosives in blasting operations therefore should not attempt to utilize the MiniTrap[II] for explosives VOD measurements.*

The MiniTrap[II] provides a low voltage and extremely low current (less than 50 mA) to the probes within the explosives. This low excitation signal allows the MiniTrap[II] to be used without fear of initiating the explosives or detonators.

Due to the inherent hazards of blasting during electrical storms and the possibility of such electrical interference causing false trigger signals to the MiniTrap[II], it is not recommended to blast during electrical storms. This is standard policy at most blasting operations.

1.3 TECHNICAL BACKGROUND - THE RESISTIVE WIRE TECHNIQUE

The MiniTrap[II] is capable of monitoring the continuous VOD profile along the entire length of an explosives column. It can measure VODs of relatively short samples of explosives such as cast primers or sticks of explosives, and of explosives loaded down-the-hole in surface and underground blasts in single and multiple holes.

The MiniTrap[II] uses the proven *continuous resistive wire technique* for monitoring VODs. A probe of known linear resistance (ie: Ω/m or Ω/ft) is placed or loaded axially in the explosive column. For monitoring samples of explosives, the probe is a rigid PROBEROD and for monitoring explosives down-the-hole, the probe is flexible PROBECABLE or PROBECABLE-LR. The MiniTrap[II] provides a regulated constant excitation signal to the probe. It also monitors the voltage across the probe.

As the detonation head of the explosive consumes the probe, the resistance of the probe decreases in proportion to the decreasing length of the probe. The MiniTrap[II] records the resulting decrease in voltage across the probe with time. The MiniTrap[II] Software automatically converts the data to a graph of distance versus time. The slope of the distance versus time graph at any position is the VOD of the explosive at that position. The MiniTrap[II] Software has a software tool for automatically calculating and displaying the VOD of the explosive at any location chosen by the operator, as well as a software tool for automatically calculating and displaying the delay time between holes or decks of explosives chosen by the operator.

1.4 MINITRAP[II] APPLICATIONS

The MiniTrap[II] monitors the continuous VODs in explosives samples and explosives down-the-hole with unmatched cost effectiveness and ease of use. Applications include:

EXPLOSIVE SAMPLES:

- Test the quality, consistency, and reliability of explosives to meet quality control standards set for the explosive.
- Measure the continuous VOD in any charge diameter, unconfined in cardboard tubes or confined in schedule 40 steel pipe.
- Determine the critical diameter and critical density for an explosive.
- Determine the gap sensitivity of explosives.
- Measure the timing accuracy of detonators.
- Measure the continuous VOD of primers.
- Determine the minimum primer size for any explosive by measuring run-up velocities.

EXPLOSIVES DOWN-THE-HOLE:

- Measure the continuous VOD in any hole diameter.
- Measure the continuous VOD in multiple holes per blast.
- Determine whether full detonation, low order detonation or failure occurred in the explosive column and where this occurs in the explosive column.

- Check VOD against manufacturer's specifications in full scale blasting environments.
- Determine the effects of detonating cord downlines on explosives.
- Determine the minimum primer size for any explosive by measuring run-up velocities in full scale blasting environments.
- Measure the timing accuracy of detonators in full scale blasting environments.
- Measure the effects of water, drill cuttings, rocks etc... trapped within the explosive column.
- Determine the minimum length of explosive column to use as a deck considering the ingress of stemming and drill cuttings, water pick-up etc... and the explosive run-up requirements.
- Determine the correct length and type of material to use as stemming between decks of explosives to ensure that sympathetic detonation or explosive desensitization does not occur.

CHAPTER 2 - HARDWARE

2.1 MINITRAP[II] COMPONENTS

The MiniTrap[II] System is comprised of the following components:

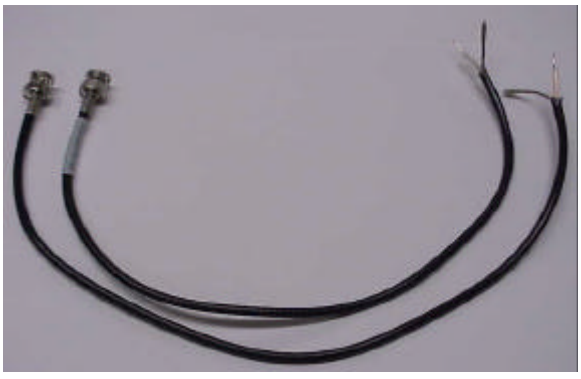
MiniTrap[II].

Carrying Case.

Charger (auto-switching 110/220 VAC).

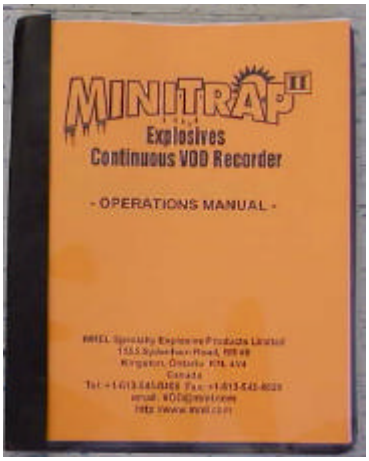
Communications Cable.

BNC Adaptors (two supplied).



200 ohm BNC Adaptor.

Operations Manual and MiniTrap[II] Software (on 3.5 in. disks).



2.2 MINITRAP[II] RESISTANCE PROBES

To test explosives in blastholes and explosives samples, the MiniTrap[II] System utilizes the following high accuracy continuous resistance probes available from MREL:

PROBECABLE: 11.5 Ω/m (3.5 Ω/ft)

PROBECABLE-LR: 3.31 Ω/m (1.01 Ω/ft)

PROBEROD 0.9 m (3 ft.) long: 322.5 Ω/m (98.3 Ω/ft)

The procedure for utilizing the MiniTrap[II] components to conduct VOD tests is contained in Chapter 3.

2.3 MINITRAP[II] BATTERY

The MiniTrap[II] has an internal NiCad rechargeable battery and is supplied with an auto-switching 110/220 VAC Charger. The MiniTrap[II] is shipped from MREL fully charged. Since some time may elapse before the MiniTrap[II] is actually put in use, the MiniTrap[II] may not be fully charged the first time it is used. Full operating time will be obtained when the MiniTrap[II] is recharged.

TESTING THE MINITRAP[II] POWER STATUS

1. Disconnect the Charger from the MiniTrap[II] at the **CHARGER/DC IN** connector on the MiniTrap[II].
2. Turn MiniTrap[II] power ON.
3. Press and hold the POWER STATUS button. This can be done at any time during the operation of the MiniTrap[II].
4. The LED display shows the energy remaining in the internal rechargeable battery. F = fully charged (approximately 24 hours of operation time remain); 9 = 90% of full charge; 8 = 80% of full charge etc...
5. When L is displayed, the internal battery requires recharging. Do not conduct any additional VOD tests. Note: If the power is left ON, within 1-2 hours the MiniTrap[II] will turn itself off to prevent complete discharge of the internal battery. The VOD data in the permanent memory are never at risk of being lost.
6. Turn MiniTrap[II] power OFF.

RECHARGING THE MINITRAP[II]

1. Turn MiniTrap[II] power OFF.
2. Connect the Charger between the **CHARGER/DC IN** connector on the MiniTrap[II] and the 110 VAC or 220 VAC mains. Full recharging takes 2 hours. The internal battery

cannot be overcharged.

3. Test the MiniTrap[II] Power Status as detailed above.

OPERATING THE MINITRAP[II] FROM AC POWER

The MiniTrap[II] can be operated from 110/220 VAC power. Contact MREL to request the optional MINITRAP[II] *AC ADAPTOR KIT*.

OPERATING THE MINITRAP[II] FROM EXTERNAL DC POWER

The MiniTrap[II] can be operated from external 12 VDC sources. Contact MREL to request the optional MINITRAP[II] *EXTERNAL DC ADAPTOR KIT*.

2.4 SPECIFICATIONS OF THE MINITRAP[II]

Number of Channels	1 channel.
Resolution	12 bits, 1 part in 4,096.
Recording Rate	1 MHz.
Recording Time @ 1 MHz	1,049 ms total recording time (262 ms pre-trigger and 787 ms post-trigger).
Trigger Modes	User selectable: Internal VOD signal level or external trigger wire.
Power	Internal rechargeable NiCad (not sealed lead/acid) battery which provides 24 hours of active operation on a full charge. The MiniTrap[II] has a non-volatile memory so that the data are stored securely, regardless of the status of the internal battery. Full battery recharging takes 2 hours. Can be operated from 110/220 VAC mains or from an external 12 VDC source with optional MiniTrap[II] accessories.
Field Settings - Menus	The MiniTrap[II] operates without the need for field settings or complex menus. The basic MiniTrap[II] operating procedure is: connect the VOD signal wire to the BNC input connector labeled PROBE, turn the MiniTrap[II] power on, press the NEXT TEST button, press the START button and walk away. When the explosive fires, the data are automatically recorded by the MiniTrap[II].
System Components Provided	MiniTrap[II], Battery Charger (auto-switching 110/220 VAC), Communications Cable, Operations Manual, Windows Software, all in one Carrying Case the size of a 35 mm camera bag.
Size and Weight	MiniTrap[II]: 23.5 x 19.7 x 11.4 cm (9.25 x 7.75 x 4.5 in.) 2.0 kg (4.4 lbs.) MiniTrap[II] System in Carrying Case: 31.8 x 26.7 x 22.9 cm (12.5 x 10.5 x 9.0 in.) 4.0 kg (8.8 lbs.)
Environmental	Operates at -40° to +80°C (-40° to +185° F). Snow, rain, dust and sand proof. System in Carrying Case is drop proof from at least a 1 m (3 ft.) height.
PC Connection	After the test, the MiniTrap[II] connects to the computer's parallel (LPT1) printer port to allow downloading of data to the computer faster than RS232 communications allow.
Software	MiniTrap[II] Software for Windows 3.1x and 32 bit Windows '95. Provides fast downloading of data from the MiniTrap[II] to the computer and automatically displays a graph of DISTANCE versus TIME. All Software operations are "point and click". Unlimited graphical zoom on graphs and creation of annotated sub-graphs. VOD and hole/deck delay time analysis of any parts of the VOD graph. Annotating, printing, saving and export of graphs and data to other Windows applications. The MiniTrap[II] Software is based upon MREL's proven DataTrap-VOD and MiniTrap Software in use around the world. User selectable: Metric or Imperial measurement units.
VOD Excitation and Safety	The MiniTrap[II] automatically adjusts its excitation voltage for the maximum 12 bit resolution across the VOD probe. All VOD operating parameters are recorded by the MiniTrap[II] with no requirement for additional instruments. The MiniTrap[II] is physically unable to output more than 50 mA of current to a VOD probe. There are no "current limiting automatic fault checking systems" to potentially fail.
VOD Probes	A complete line of VOD probes are available from MREL to record the VODs of small explosives samples to multiple holes in large opencast blasts. The MiniTrap[II] can record VODs across PROBECABLE-LR (resistance cable) lengths up to 444 m (1,457 ft.).

CHAPTER 3 - FIELD OPERATIONS

3.1 TESTING SAMPLES OF EXPLOSIVES - SAFETY FIRST

Care must be taken to select a good site for detonation and VOD recording of explosive samples. If convenient, permanent test sites may be constructed. A pit surrounded by an earth wall suffices as a simple detonation site. A similarly protected shelter for the MiniTrap[II] and personnel can be constructed some distance away. The distance will depend on the amount of explosive to be detonated at one time and whether the explosives are confined in steel pipe. Ensure that the area is well demarcated and that access to the hazardous area is restricted.

If samples of explosives are to be detonated at an unprepared site then the operator must be careful when deciding upon what type of ground the charges are to be placed. Avoid placement on ground with stones, rubble or anything that is likely to turn into a projectile. The best surfaces are fines, sand or tailings.

It is always good practice to have maximum control over the time of firing of the test and therefore safety fuse initiation is not recommended. Electric or shock tube initiation is best with the detonator either initiating the sample of explosives or initiating the primer/booster in the explosives sample. For site specific recommendations, contact MREL.

3.2 TESTING SAMPLES OF EXPLOSIVES - PROBE SETUP

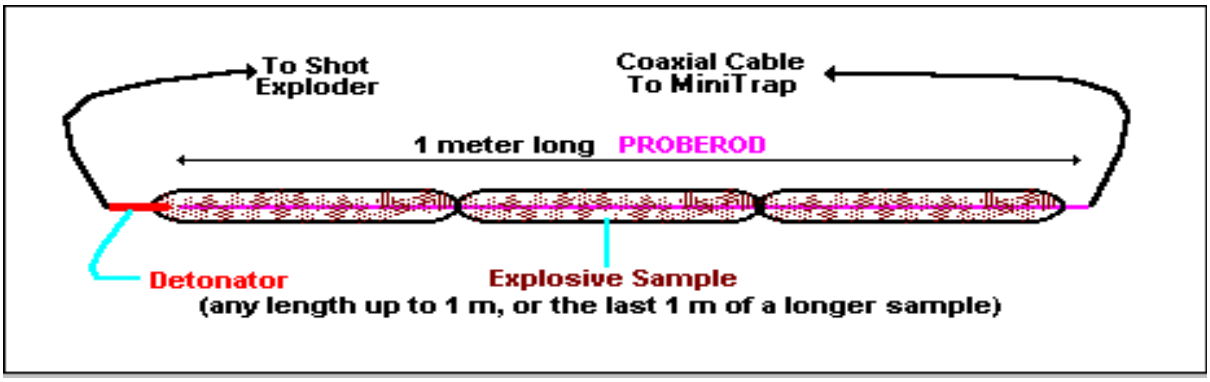
The equipment and supplies required to conduct VOD tests on samples of explosives are:

- MiniTrap[II] System.
- PROBERODs (rigid resistive probes) - one (1) per test.
- Coaxial cable (type RG-58 is recommended) - sufficient length to run between the MiniTrap[II] location and the explosives.
- Wire cutters and electrical tape.
- Explosives, detonators and shot exploder.

The procedure for preparing a VOD test is as follows:

1. Demarcate the charge detonation area.
2. Place the MiniTrap[II] in a protective shelter or at a safe distance away from the detonation area. (This distance may be closer than what is considered safe for the operator. When set up, the MiniTrap[II] does not require an operator to collect the data; it collects the data without operator assistance.)
3. Run a length of coaxial cable from the MiniTrap[II] to the detonation area with enough excess length to compensate for cable shortening or cable damage from each test. Shorter lengths of coaxial cable may be connected together using the wire cutters and electrical tape. A male BNC connector should be attached to the end of the coaxial cable at the MiniTrap[II]. A convenient **BNC Adaptor** has been supplied with the MiniTrap[II] System for this purpose. It can be connected to the coaxial cable using the wire cutters and electrical tape.

4. For quality control purposes, select and test the resistance of a rigid PROBEROD with an ohmmeter or blaster's galvanometer. *Do not use the PROBEROD if the Probe Resistance is outside the range of 295 to 305Ω. MREL will replace any out of specification PROBERODs.*



5. Insert a rigid PROBEROD axially in the sample of explosives at the opposite end from where the detonator will be placed.
   If **bulk explosives** are being tested in paper, plastic or steel pipes, and the pipes are sealed at both ends, make a small central hole to allow the PROBEROD to be inserted. If a measurement of run-up to detonation is required, ensure that the PROBEROD is pushed well into the explosives so that it reaches the position of the detonator or primer. If the PROBEROD reaches the primer or protrudes past it, the effect of the primer will be recorded by the MiniTrap[II]. The same holds true for **cartridges of explosives**.
   To test the VOD of **detonation cord**, tape the detonation cord along the entire length of the PROBEROD.
6. Note the *Unit Resistance* of the probe by reading the value in Ω/m or Ω/ft from the factory label on the PROBEROD. Note the Ω/m value if the VOD is to be reported in m/s. Note the Ω/ft value if the VOD is to be reported in ft/sec. The *Unit Resistance* will be requested later by the MiniTrap[II] Software (Section 4.3).
7. Connect the PROBEROD to the coaxial cable using the wire cutters and electrical tape. Do not be concerned with the polarity of the connection.
8. At the MiniTrap[II], connect the coaxial cable to the **PROBE** connector on the outside of the MiniTrap[II].

9. The probe setup aspects of the test are complete. The blaster can now place the detonator and connect it to the shot exploder per standard procedures. The MiniTrap[II] can now be set up to record the test (Section 3.5).

3.3 TESTING EXPLOSIVES DOWN-THE-HOLE - PROBE SETUP

The equipment and supplies required to conduct VOD tests on explosives down-the-hole are:

- MiniTrap[II] System.
- PROBECABLE or PROBECABLE-LR (flexible resistive probe).
- Coaxial cable (type RG-58 is recommended) - sufficient length to run between the MiniTrap[II] location and the explosives.
- Wire cutters and electrical tape.
- Explosives, detonators and shot exploder.

THE INITIAL PROCEDURE FOR PREPARING A VOD TEST IS AS FOLLOWS:

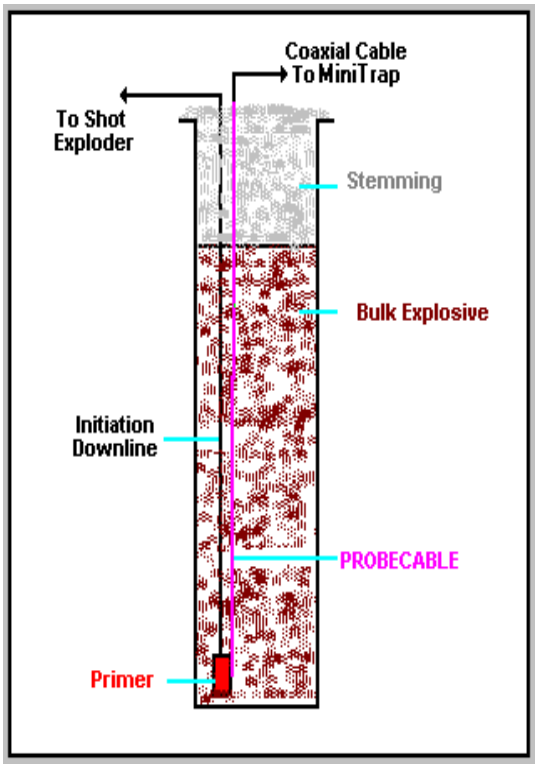
A. Demarcate the blast area.

B. Place the MiniTrap[II] in a protective shelter or at a safe distance away from the blast area. This distance may be closer than what is considered safe for the operator. When set up, the MiniTrap[II] does not require an operator to collect the data, the MiniTrap[II] collects the data automatically without operator assistance.

C. Run a length of coaxial cable from the MiniTrap[II] to the blast area. Shorter lengths of coaxial cable may be connected together using the wire cutters and electrical tape. A male BNC connector should be attached to the coaxial cable end near the MiniTrap[II]. A convenient **BNC Adaptor** has been supplied with the MiniTrap[II] System for this purpose. It can be connected to the coaxial cable using the wire cutters and electrical tape. **Somewhere along the length of the coaxial cable, loop the coaxial cable around a large rock.** When the blast is fired and the ground moves, this will stop the blast from pulling the coaxial cable and the MiniTrap[II] with the moving rock. Alternatively, leave sufficient slack in the coaxial cable to allow for ground movement.

SINGLE HOLE RECORDING MAY BE PERFORMED AS FOLLOWS:

1. Prepare the end of the PROBECABLE by using the wire cutters to remove the insulation from the end and then short the wire by connecting the shielding wire to the centre conductor wire and twist them together. Protect the connection with electrical tape.
2. Using tape or wire, attach this finished end of the PROBECABLE to the primer or to a rock and lower the PROBECABLE into the hole. Detonation cord downlines may damage the PROBECABLE or cause side initiation of the bulk explosive. When initiating with detonation cord, attach the PROBECABLE to a rock and lower it on the side of the hole opposite to the detonation cord downline.
3. The PROBECABLE can then be cut at the top of the hole.



4. Note the *Unit Resistance* of the probe by reading the value in Ω/m or Ω/ft from the factory label on the reel of PROBECABLE. Note the Ω/m value if the VOD is to be reported in m/s. Note the Ω/ft value if the VOD is to be reported in ft/sec. The *Unit Resistance* information will be requested later by the MiniTrap[II] Software (Section 4.3). When measured with a blaster's galvanometer, the *Probe Resistance* should compare favourably with the calculated resistance of the PROBECABLE which is the *Unit Resistance* multiplied by its length. If this is not the case then remove the length of PROBECABLE and reload another length into the hole.
5. The hole can now be loaded per usual procedure. Hold the PROBECABLE taut during the loading of the explosive to avoid slack in the hole. In the absence of the operator, this may be accomplished by tying the PROBECABLE taut around a hole marker stake or around a rock at the top of the hole. After loading, the operator may wish to check the *Probe Resistance* again to ensure that no probe damage has occurred. As the PROBECABLE is well protected with a thick PVC coating, there should be no problems.
6. Connect the PROBECABLE to the coaxial cable using the wire cutters and electrical tape. The connection should be shielding to shielding and centre conductor to centre conductor. Ensure that the centre conductor and the shielding connections do not short with each other.
7. At the MiniTrap[II], connect the coaxial cable to the **PROBE** connector on the outside of the MiniTrap[II].

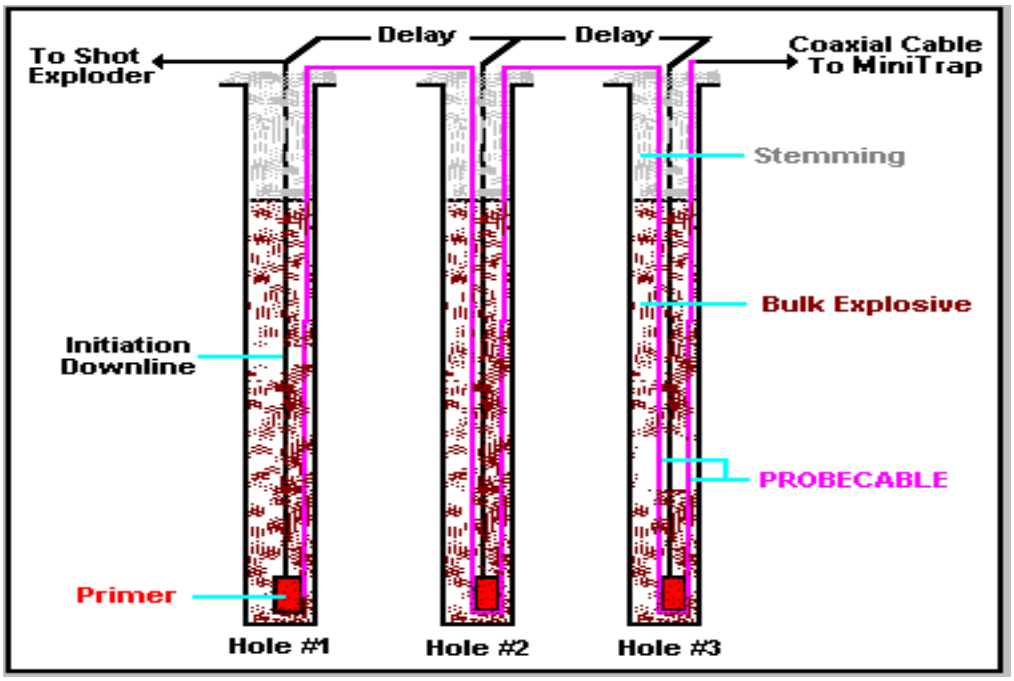
8. The probe setup aspects of the test are complete. The MiniTrap[II] can now be set up to record the test (Section 3.5).

MULTIPLE HOLE RECORDINGS MAY BE PERFORMED AS FOLLOWS:

1. Prepare the end of the PROBECABLE by using the wire cutters to remove the insulation from the end and then short the wire by connecting the shielding wire to the centre conductor wire and twisting them together. Protect the connection with electrical tape.
2. Using tape or wire, attach this finished end of the PROBECABLE to the primer or to a rock and lower the PROBECABLE into the hole that is anticipated will detonate first of all the series of holes to be recorded by the MiniTrap[II]. Detonation cord downlines may damage the PROBECABLE or cause side initiation of the bulk explosive. When initiating with detonation cord, attach the PROBECABLE to a rock and lower it on the side of the hole opposite to the detonation cord downline.
3. Run the PROBECABLE between the first hole and the second hole leaving sufficient

slack between the holes to allow for ground movement between the delayed holes.

4. There are two common methods of lowering a doubled length of PROBECABLE in the second and subsequent holes. The first method is to measure the correct length of PROBECABLE so that it reaches the bottom of the hole where the PROBECABLE has been doubled over and attached to the primer or a rock. Excess PROBECABLE between holes is not a problem. The second, and easiest method is to run the PROBECABLE through a wire loop which has been tied or taped around a rock. In this way the rock will slide along the PROBECABLE as the PROBECABLE is lowered into the hole until the rock reaches the bottom of the hole.



5. Note the *Unit Resistance* of the probe by reading the value in Ω/m or Ω/ft from the factory label on the spool of PROBECABLE. Note the Ω/m value if the VOD is to be reported in m/s. Note the Ω/ft value if the VOD is to be reported in ft/sec. The *Unit Resistance* will be requested later by the MiniTrap[II] Software (Section 4.3). When measured with a blaster's galvanometer, the *Probe Resistance* should compare favourably with the calculated resistance of the PROBECABLE which is the *Unit Resistance* multiplied by its length. If this is not the case then remove the length of PROBECABLE and reload another length into the holes.
6. The holes can now be loaded per usual procedure. Hold the PROBECABLE taut during the loading of the explosive to avoid slack in the hole. In the absence of the operator, this may also be accomplished by tying the PROBECABLE taut around a hole marker stake or around a rock at the top of each hole. After loading, the operator may wish to check the *Probe Resistance* again to ensure that no probe damage has occurred. As the PROBECABLE is well protected with a thick PVC coating, there should be no problems.
7. Connect the PROBECABLE to the coaxial cable using the wire cutters and electrical tape. The connection should be shielding to shielding and centre conductor to centre conductor. Ensure that the centre conductor and the shielding connections do not short with each other.

8. At the MiniTrap[II], connect the coaxial cable to the **PROBE** connector on the outside of the MiniTrap[II].

9. The probe setup aspects of the test are complete. The MiniTrap[II] can now be set up to record the test (Section 3.5).

3.4 PROBECABLE AND COAXIAL CABLE PROTECTION

It is important to protect the PROBECABLE and the coaxial cable from damage caused by: personnel and machinery operating on the blast; detonation of other holes and/or surface accessories such as detonating cord, detonating relays, and shock tube bunch blocks.

The cables may be protected in many ways but experience has shown that it is best to lead the PROBECABLE and coaxial cable under the detonating cord and leave a barrier of sand or drill cuttings between them where they cross. A danger point is the collar area of the holes as the detonating cord or shock tube bunch blocks that initiate the downlines may cross directly over the PROBECABLE or coaxial cable. A good procedure is to protect the area where there is a cross over for about 1.5 m (5 ft) along the length of cable. Experience has shown that a sand barrier thickness of 15-30 cm (0.5-1 ft) suffices to protect the cables.

3.5 MINITRAP[II] SETUP

Having completed the probe setup procedure detailed in Sections 3.2 & 3.3, the operator can now prepare the MiniTrap[II] to record the test using the following procedure:

1. Ensure that the coaxial cable is connected to the MiniTrap[II] signal input connector labelled **PROBE** on the outside of the MiniTrap[II].

2. Turn the MiniTrap[II] power **ON**. The red **STATUS** indicator will illuminate. If the **STATUS** indicator flashes slowly, there is (old) VOD data in the MiniTrap[II]'s memory. If you are sure that the old VOD data has been transferred to a computer and/or you wish to discard the old VOD data, press the **NEXT TEST** button to proceed. The **STATUS** indicator will illuminate and will stop flashing.

3. Look for red PROBE RESISTANCE OUT OF RANGE warning lights labelled "**HIGH**" and "**LOW**". If there <u>is</u> an OUT OF RANGE warning light illuminated then there is a problem with the probe or coaxial cable and refer immediately to Section 3.6. If there <u>is not</u> a warning light illuminated then proceed to the next step.

4. Ensure that the **TRIGGER** switch is in the **INT** position. Use of the EXT position is discussed in Section 3.7.

5. Press the **START** button. The START indicator will illuminate. The MiniTrap[II] is now monitoring the blast to be fired and personnel may leave the MiniTrap[II] unattended. When a sufficient probe length has been consumed by the blast (Section 3.8), the MiniTrap[II] is triggered and will collect the VOD data. Upon triggering, the START indicator will flash indicating that the VOD data are being saved to the MiniTrap[II]'s non-volatile memory. This takes approximately 2.5 minutes. When the data have been saved, the START indicator will turn off and the STATUS indicator will flash slowly. The data are then ready to be transferred to a computer (Section 4.3).

6. Turn the MiniTrap[II] power **OFF**.

3.6 PROBE RESISTANCE OUT OF RANGE

There are two (2) PROBE RESISTANCE OUT OF RANGE warning indicators. One is labelled LOW, the other is labelled HIGH. The **LOW** indicator illuminates when the total resistance of the probe plus the coaxial cable is less than 200 ohms. The **HIGH** indicator illuminates when this total resistance is greater than 1,500 ohms. The MiniTrap[II] is only calibrated to perform VOD tests between these two resistance values.

There can be several reasons why the total resistance may be **LOW**:
1. A short circuit somewhere in the coaxial cable and probe assembly, including BNC connector or BNC Adaptor.
2. A damaged PROBEROD.
3. An insufficient length of PROBECABLE connected in the test.

Items 1 and 2 above can be tested using a blaster's galvanometer to test the resistance/continuity of the coaxial cable and probe assembly and solved by remaking the connections and/or replacing the damaged PROBEROD. If item 3 is the cause then replace the BNC Adaptor used in the test with the supplied **200 ohm BNC Adaptor**. The 200 ohm BNC Adaptor provides an additional 200 ohms to the probe circuit and does not affect the VOD results.

There can be several reasons why the total resistance may be **HIGH**:
1. An open circuit somewhere in the coaxial cable and probe assembly, including BNC connector or BNC Adaptor.
2. A damaged PROBEROD.
3. Too long a length of PROBECABLE connected in the test.

Items 1 and 2 immediately above can be tested using a blaster's galvanometer to test the resistance/continuity of the coaxial cable and probe assembly and solved by remaking the connections and/or replacing the damaged PROBEROD. If item 3 is the cause then reduce the length of the PROBECABLE used in the test by cutting out excess

PROBECABLE between holes and remaking the connections using the wire cutters and electrical tape or reducing the number of holes being recorded by cutting the PROBECABLE and remaking the appropriate connection with the wire cutters and electrical tape.

3.7 UTILIZING THE EXTERNAL TRIGGER

In some VOD applications, it may be desirable to have the MiniTrap[II] begin to record exactly when a specific event occurs. For the specific event to start at time = 0 on the VOD graph, the **EXT TRIG** port on the outside of the MiniTrap[II] is used.

One of the **BNC Adaptors** supplied with the MiniTrap[II] is connected to this port. *Do not use the **200 ohm BNC Adaptor***. A duplex wire is connected to the BNC Adaptor. The other end of the duplex wire is prepared as follows: remove insulation from one of the wires and wrap it around the second, insulated, wire such that the circuit remains open.

Upon the duplex wire circuit becoming shorted, MiniTrap[II] will begin recording data. Any explosive event such as a detonator firing, detonating cord firing or a primer firing will short such a circuit and cause the MiniTrap[II] to collect data. Pre-trigger points will still be collected per the internal settings of the MiniTrap[II], but time=0 on the VOD graph will be the precise time when the circuit became shorted.

3.8 ADDITIONAL INFORMATION ON MEMORY AND TRIGGERING

This Section is provided for those operators interested in learning how the MiniTrap[II] is able to automatically record the VOD information when the blast is fired. This knowledge is not required to operate the MiniTrap[II] but is provided for background interest only.

MEMORY:

The MiniTrap[II] has a circular memory of 1,048,576 data points. This memory is divided into 262,144 pre-trigger data points and 786,432 post-trigger data points. The recording speed of the MiniTrap[II] is 1MHz (1,000,000 data points per second). Therefore the MiniTrap[II] has 262.144 ms of pre-trigger memory time and 786.432 ms of post-trigger memory time.

By pressing the **START** button (Section 3.5) the MiniTrap[II] begins recording VOD information into all of the circular memory at a rate of 1MHz. It continues to record information to the memory (overwriting data previously written to the memory in the previous 1.048576 seconds) until a trigger signal is received.

TRIGGERING:

When utilizing the **EXT TRIG** trigger wire, the trigger signal that the MiniTrap[II] receives is from the trigger wire being shorted by the explosives. This is time = 0 on the resulting VOD graph.

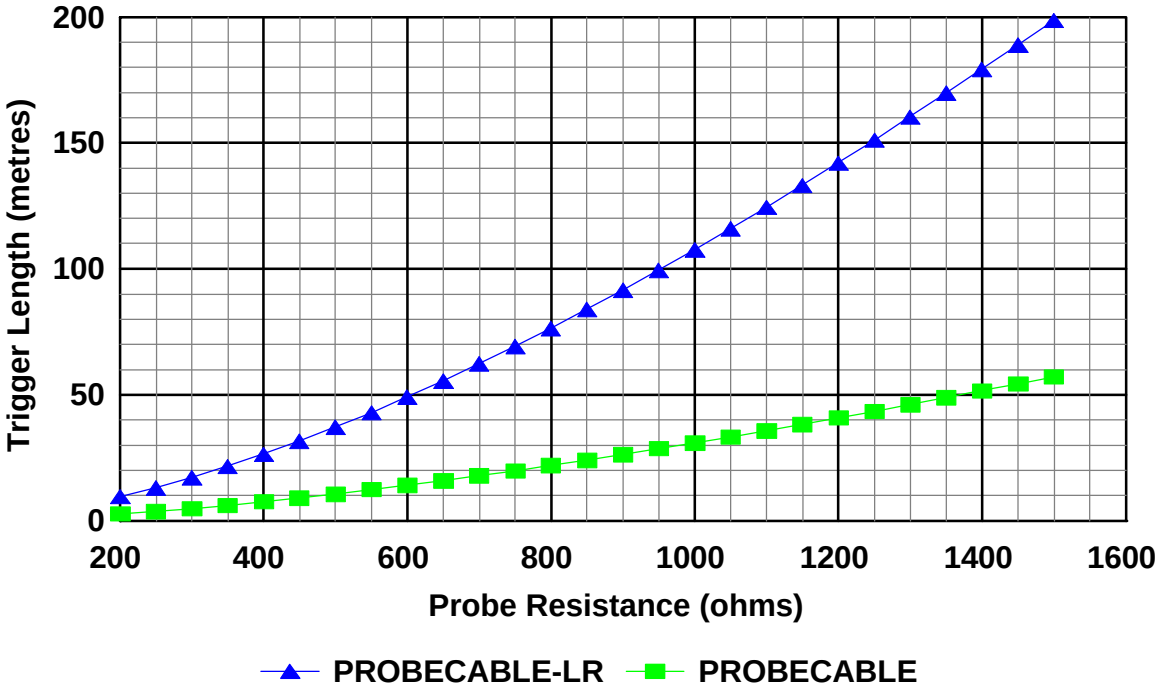
When *not* using the EXT TRIG (ie: using the **INT** TRIGGER setting), the MiniTrap[II] is triggered by the signal received from the probe in the explosives as follows: When the explosive detonates, the probe is consumed and the probe length is reduced. This reduces the resistance and thus the voltage decreases across the probe from the initial 4.95 VDC value set automatically by the MiniTrap[II]. When the voltage across the probe is reduced to approximately 4.5 VDC, the MiniTrap[II] is "triggered". This is time = 0 on the resulting VOD graph.

Having received the trigger signal, the MiniTrap[II] stores the 262.144 ms of VOD information received immediately prior to the trigger signal into the pre-trigger memory. It also records 786.432 ms of VOD information after the trigger signal is received into the post-trigger memory.

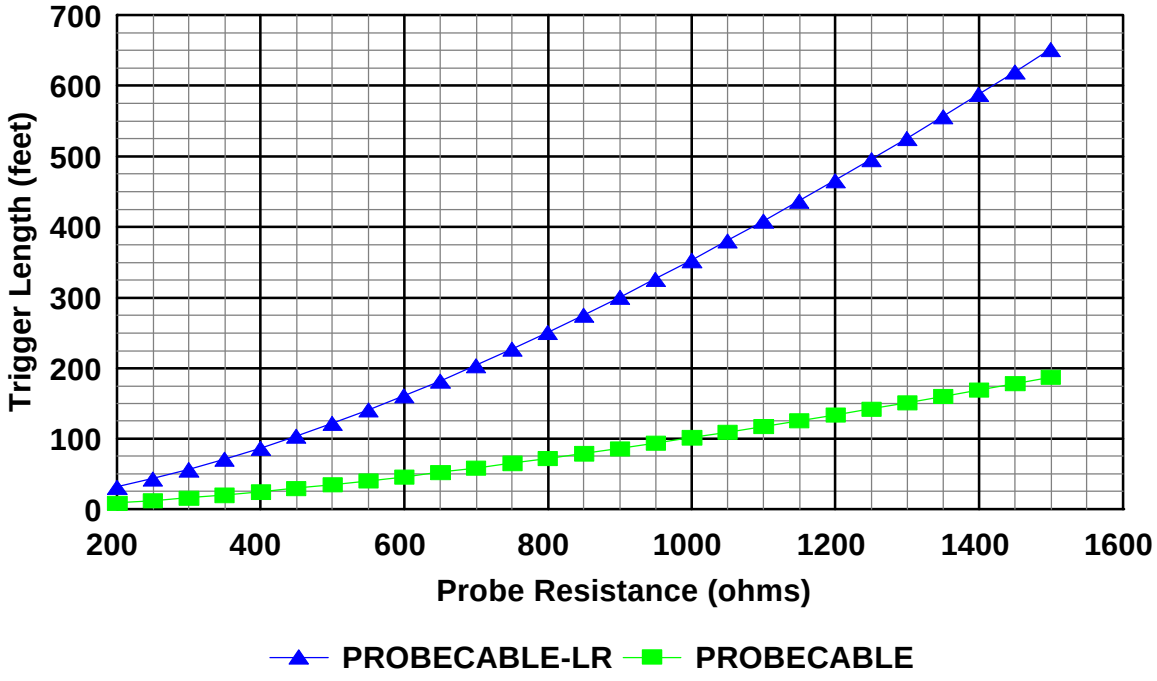
The graph on the following page shows the amount of PROBECABLE that must be consumed for the MiniTrap[II] to receive the trigger signal, given the *Probe Resistance* of the test. Two lines are shown, one for PROBECABLE (R/L = 11.5 Ω/m, 3.5 Ω/ft) and one for PROBECABLE-LR (R/L = 3.31 Ω/m, 1.01 Ω/ft). PROBECABLE-LR should be used for tests involving several holes where if PROBECABLE was used it would result in the *Total Resistance* exceeding 1500 Ω.

Notice on the graph that if a large resistance (such as 1300 Ω) is used in a test then 50 metres of PROBECABLE (or approximately 175 metres of PROBECABLE-LR) must be consumed to trigger the MiniTrap[II] to record. If the first hole does not consume a sufficient length of PROBECABLE to trigger the MiniTrap[II] to record, then all of the VOD data for the first hole will be before time = 0. The Operator should ensure that a sufficient length of PROBECABLE is consumed at least 262.144 ms after the first hole in the test begins to detonate. This will ensure that no data from the first hole are lost.

MiniTrap II
Trigger Length Determination



MiniTrap II
Trigger Length Determination



CHAPTER 4 - SOFTWARE

4.1 COMPUTER REQUIREMENTS

The MiniTrap[II] Software for Windows has been provided on 3.5 inch computer disks. This software can be installed on any PC system with the following minimum specifications:

1. 386 or higher processor.
2. 8 Mb RAM.
3. 12 Mb hard drive space. (Windows '95 - 30 Mb free).
4. Windows 3.x or Windows '95. Windows NT is not supported at this time.

4.2 INSTALLATION

To install the MiniTrap[II] Software, start Windows and insert the first installation disk (Disk 1) in to the 3.5 inch drive (usually A:). Windows users should start File Manager, then choose File-Run from the menu and type **A:\install**. Windows '95 users should choose Start-Run, then type **A:\install**. Follow the instructions on the screen. When the installation is complete, re-boot Windows. The MiniTrap[II] icon will be visible. To start the MiniTrap[II] Software, double click on the MiniTrap[II] icon.

4.3 RETRIEVING DATA

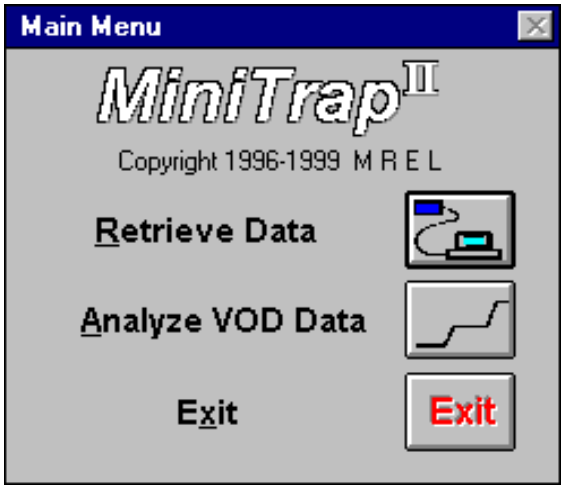
WARNING: DO NOT PRESS THE NEXT TEST BUTTON OTHERWISE ALL VOD DATA WILL BE ERASED FROM THE MINITRAP[II]'S INTERNAL MEMORY. The procedure to retrieve data from the MiniTrap[II] to a computer is as follows:

1. Connect the communications cable, supplied with the MiniTrap[II], between the LPT1 (parallel printer port) on the computer and the **LPT COM** port on the face of the MiniTrap[II]. Do not connect to a "pass through" port such as on a ZIP drive or a "dongle" - incorrect data will result. Connection to a printer switching box will not cause a problem.

2. Turn the MiniTrap[II] power ON.

3. Start the MiniTrap[II] Software by double clicking on the MiniTrap[II] icon or Start-Programs-MiniTrap[II].

4. At the Main Menu click on the Retrieve Data button or with the keyboard press Alt-R. Data retrieval can be accomplished without the use of a computer mouse by pressing "tab" to move between data entry fields.

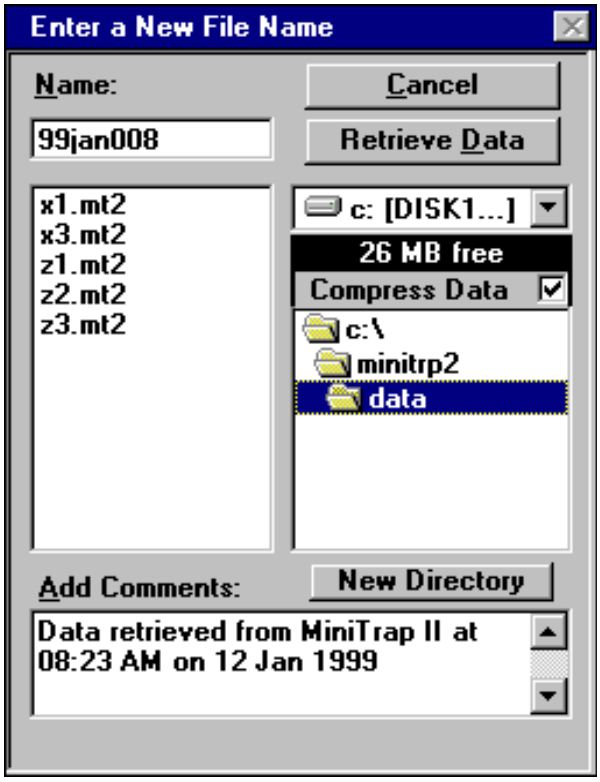


5. Choose a drive, directory and file name in which the MiniTrap[II] data will be stored. Also add comments about the data so that the file can be easily recalled.

   The directory defaults to C:\minitrp2\data. The file name defaults to the year, month and test number for that month.

   Comments default to the time and date of data retrieval from the MiniTrap[II]. Other MiniTrap[II] files already stored in the directory are also displayed.

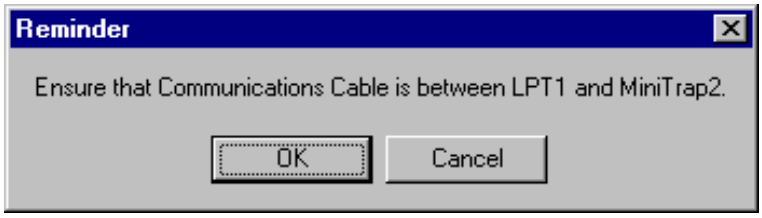
   Clicking on the Compress Data tick box turns the file compression on or off. With Compress Data on, the retrieval from the MiniTrap[II] takes longer for some computers but the file size is reduced conserving computer disk space and allowing the file to fit on a floppy disk.



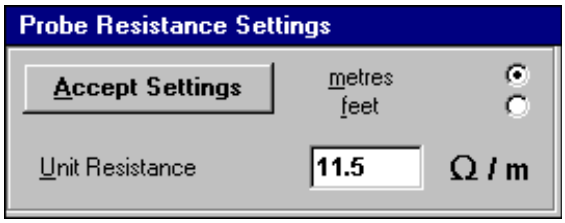
New directories can be created from this window using the New Directory button.

When all information is entered, click on the Retrieve Data button. Otherwise click on the Cancel button to return to the Main Menu.

6. A reminder and two message windows are then displayed in sequence. Click on OK.



7. The operator can click on the preferred units of measurement (metres or feet). The *Unit Resistance* of the probe used in the VOD test must be entered. This value was noted in the field (Sections 3.2 and 3.3). Click on the Accept Settings button when the resistance information has been entered.



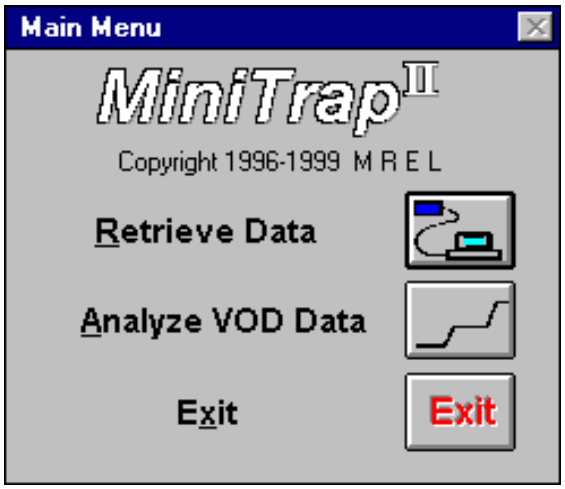
8. The MiniTrap[II] VOD data have been saved under the file name specified by the operator in Step 4. The software returns to the Main Menu and the data can now be analysed.

9. The communications cable can be detached from the computer and the MiniTrap[II] and the NEXT TEST button may be pressed if another VOD test is to be conducted.

4.4 SELECTING DATA FOR ANALYSIS

The procedure to select a MiniTrap[II] file is as follows:

1. From the Main Menu, click on the Analyse VOD Data button or press Alt-A.

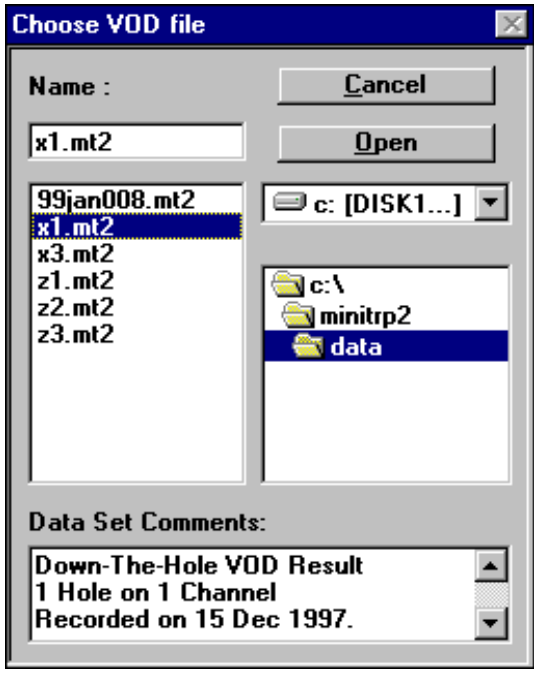


2. Click on the file name of interest, use the Data Set Comments box as a guide to each file's contents.

   Click on the Open button when a file has been selected, otherwise click on the Cancel button to return to the Main Menu.

   For this example **X1** is chosen to illustrate the results of a down-the-hole test on one hole. X1, X3, Z1, Z2 and Z3 are data files which have all been included as examples with the MiniTrap[II] Software.

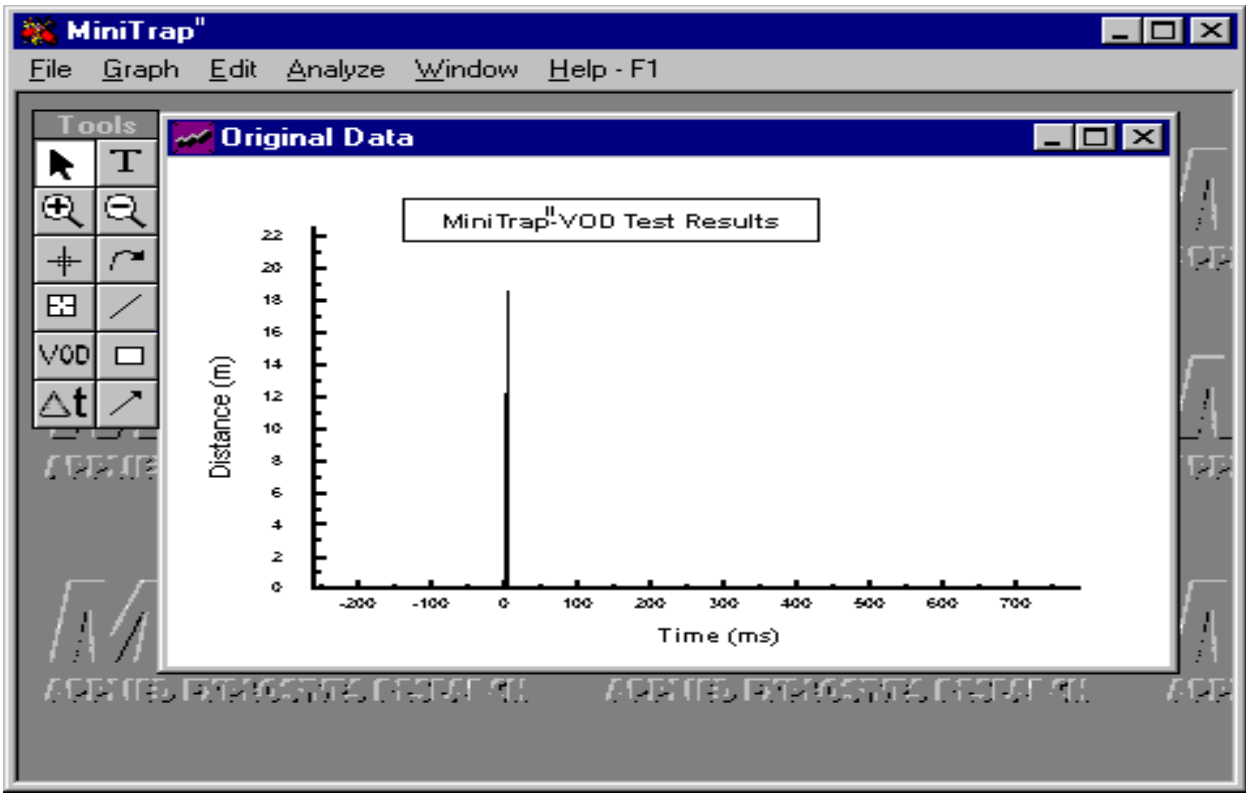
   Chapter 5 provides the detailed procedures for analysing the data in each of these files.



   Clicking on the Open button automatically starts the MiniTrap[II] VOD Analysis Software with the chosen data file. The following section outlines the capabilities of the Analysis Software.

4.5 INTRODUCTION TO ANALYSIS

The following screen is displayed when a VOD file has been chosen for analysis:



The screen contains three main areas which are summarized below and discussed in more detail in Chapter 5:

Desktop: the area having the MREL logo as background. It is the area in which one or more graphs can be displayed in maximized, normalized or minimized size states.

Menu Bar: located across the top of the screen. It includes pull down menus for File, Graph, Edit, Analyse, Window and Help.

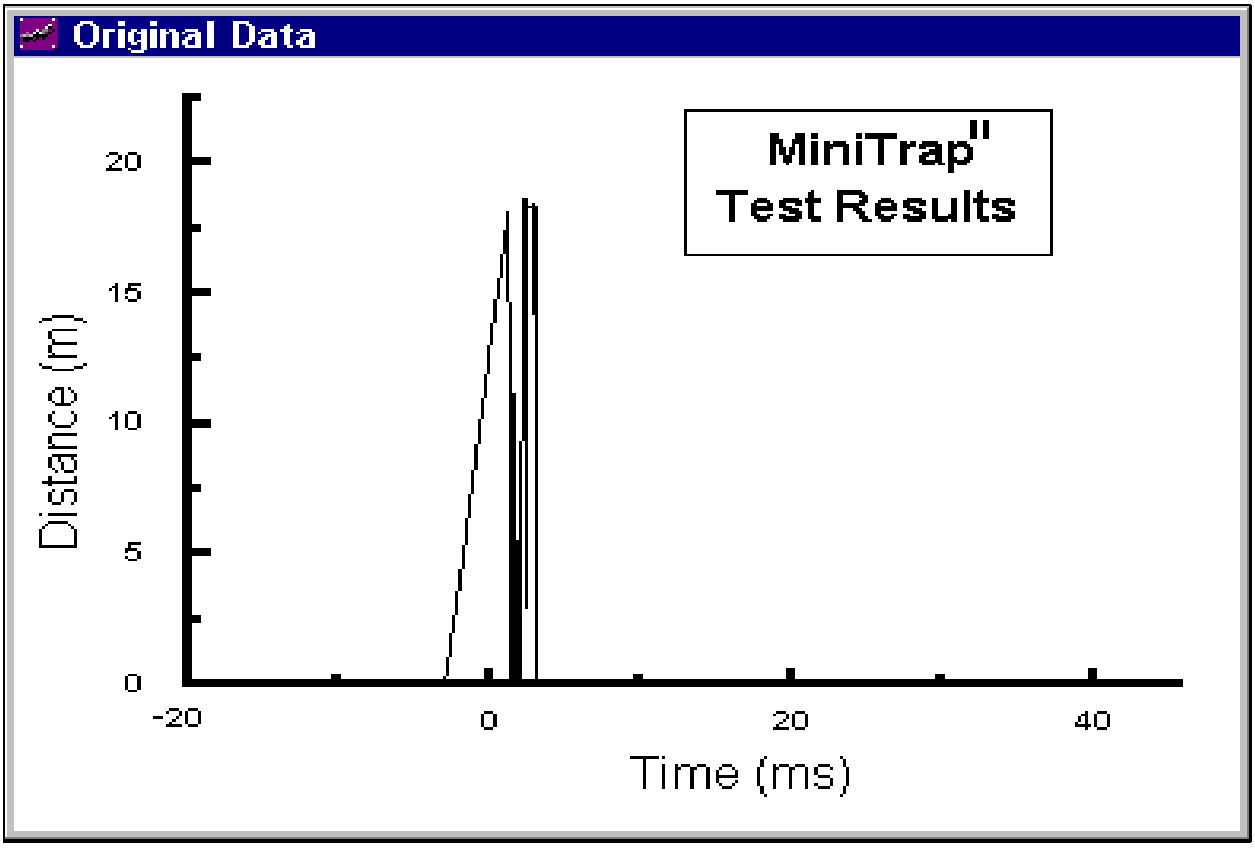
Tools Bar: a moveable menu of icons which allows the operator to easily access analysis and graphics tools.

4.6 DESKTOP

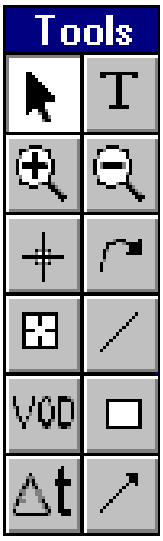
When a data file is initially opened, the Desktop area of the software, which has as a background the MREL logo, shows the **Original Data** graph in a normalized state. For every VOD file there is one **Original Data** graph collected during the VOD test. The data and graphics on this **Original Data** graph can not be changed and is saved under the graph name **Original Data**. New graph names must be given to the modified graphs (or **sub-graphs**). In this way the original data for the VOD test can never be lost. In the above example, the X1 data file at this point in the analysis has only 1 graph, which is the **Original Data** graph.

From this original graph, other graphs, known as sub-graphs can be made and saved by the operator under new graph names. These sub-graphs can include some or all of the data in the original graph and can include graphics, text and analysis information as added by the operator. The next time the data file is chosen for analysis, the original graph and all sub-graphs will be opened. There is no limit to the number of sub-graphs which can be created from an original graph. Each sub-graph requires about 4K of disk memory. The procedure for creating sub-graphs is discussed in Chapter 5.

By clicking on either the normalize icon or on the maximize icon on any minimized graphs (per normal Windows procedures), the data can be viewed and analysed. In the example below, the **Original Data** graph has been maximized. Items in the Tools Bar can now be used to analyse the data.



4.7 TOOLS BAR



The Tools Bar contains a selection of twelve (12) tool buttons used to add or modify the graph's characteristics, text and graphics and to apply analysis procedures to the data in the graphs to calculate VODs and delay times between holes. The Tools Bar can be moved anywhere on the Desktop. The basic functions of each of the tool buttons are outlined below:

The **Select Tool** has many functions including:
- selecting, moving, minimizing, maximizing and normalizing graphs;
- selecting and modifying any component of the graphs by double clicking on the component (ie: x-axis, y-axis, data, text, titles).

The **Text Tool** allows the operator to add new text/titles/comments to graphs.

The **Curve Tool** allows the operator to add a curved line/pointer to graphs.

The **Line Tool** allows the operator to add a straight line to graphs.

The **Arrow Tool** allows the operator to add a straight arrowed line/pointer to graphs.

The **Box Tool** allows the operator to add a box to graphs.

The **Zoom In Tool** allows the operator to zoom in on any part of the data and graph.

The **Zoom Out Tool** restores the data to the range before zooming in was performed.

The **Position Tool** displays the digital x, y (time, distance) position of any part of the graph's area.

The **Data Value Tool** displays the digital x, y (time, distance) value of any data point on the graph.

The **VOD Tool** allows the operator to automatically calculate the VOD for any part of the graph by linear regression on all of the data between any two points on the graph.

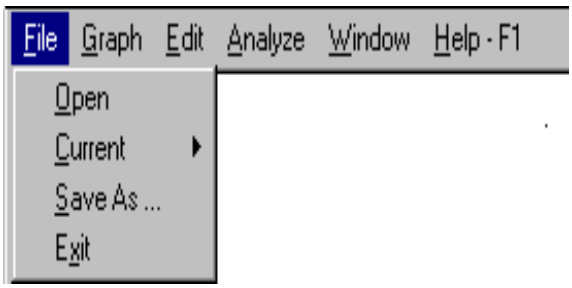
The **Delay Tool** allows the operator to automatically calculate the delay time between any two data points on the graph.

4.8 MENU BAR

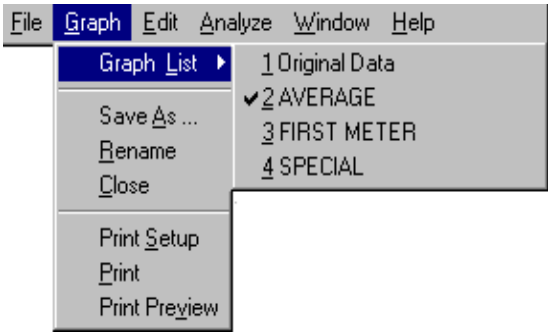
The Menu Bar contains a selection of six (6) pull down menus used to open data files and their associated graphs, save sub-graphs, print graphs, export data and graphics, move

and erase bad data points, arrange graphs on the Desktop and provide access to the online Help. The Menu Bar is always located at the top of the Desktop. The basic functions of each of the pull down menus are outlined below:

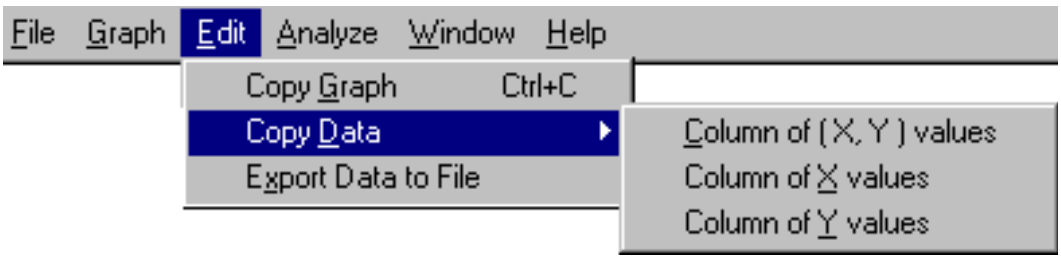
The **File** menu allows the operator to **Open** data files, display the name of the **Current** data file, **Save** the current data file including the associated graphs and **Exit** the Analysis section of the software.



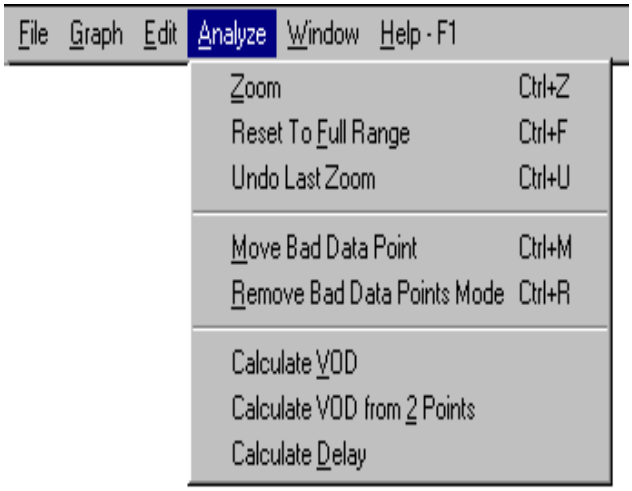
The **Graph** menu allows the operator to **List** the graphs associated with the current data file, **Save** and **Rename** the sub-graphs, **Close** the sub-graphs for the current analysis session, **Delete** the sub-graphs, **Setup** the printer, **Preview** how the graph will appear when printed, and **Print** the graph.



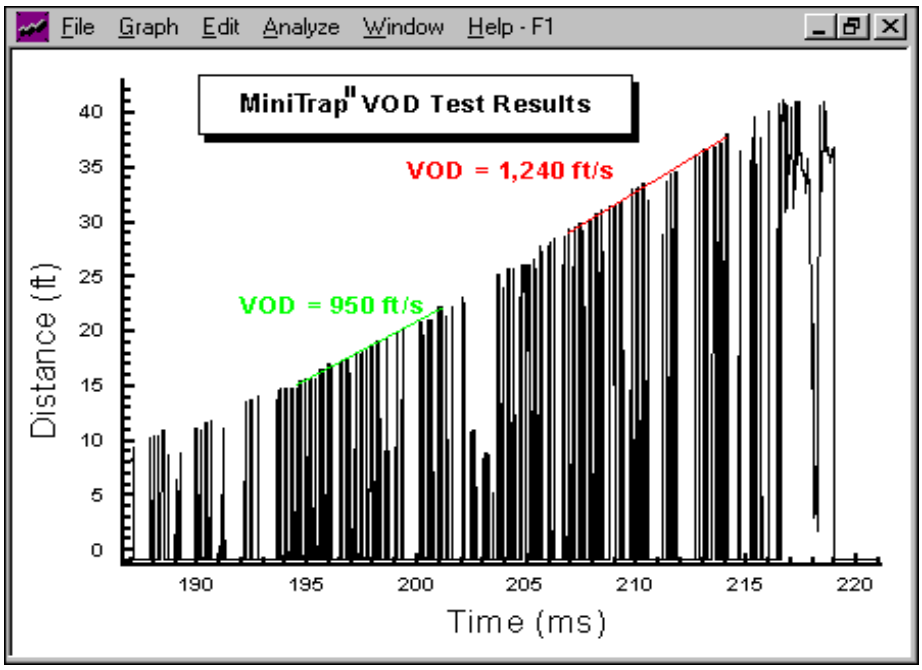
The **Edit** menu, shown below, allows the operator to **Copy** the **Graph** to the computer's memory for pasting into other Windows applications such as word-processors, **Copy** the **Data**, which comprises the graph, for subsequent pasting into Windows spreadsheets, and **Export** the data to an ASCII file for use by other graphics/analysis software.



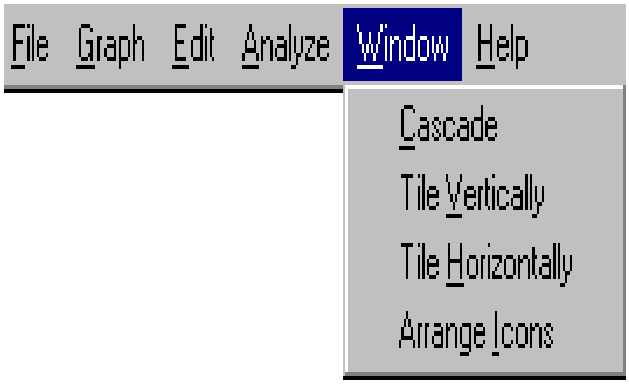
The **Analyse** menu allows the operator to **Zoom** in on the graph, **Reset** the graph to full range, **Undo** the last Zoom, **Move** a bad data point, **Remove** bad data points, calculate a **VOD** using a linear regression, calculate a **VOD from 2 Points** on the graph, and calculate a **Delay**. The **Remove** and **Move** menu items can be used on data points that sometimes result from inefficient shorting of the probe, causing downward spikes in the data.
Note that these menu items, except for **Remove**, **Move**, and **VOD from 2 Points** are also available on the **Tools Bar**.



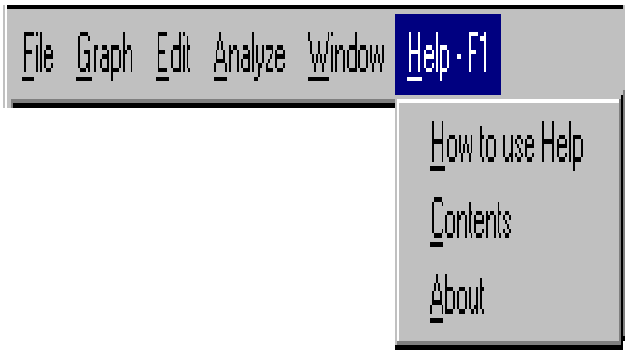
When explosives react very slowly, there may be inefficient shorting of the probe. This may result in a graph similar to that shown below. The trend of the VOD is apparent, however there are many downward spikes on the trace which make the normal **Calculating VOD** using the regression inaccurate. In such cases the operator should **Calculate VOD from 2 Points** from the **Analyse** menu.



The **Window** menu allows the operator to automatically arrange the non-minimized graphs on the Desktop in three (3) ways: **Cascade**, tile **Vertically**, and tile **Horizontally**. This menu also allows the operator to automatically **Arrange** the minimized graph icons.



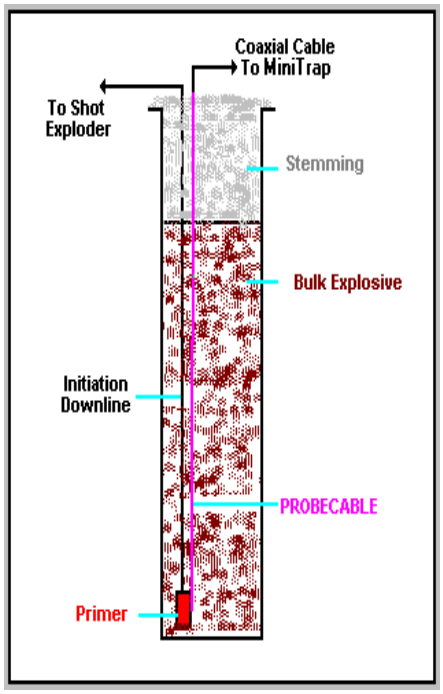
The **Help** menu provides the operator with instructions on **How** to use the online help manual, provides the operator access to the online help manual through the **Contents** of the manual and displays information **About** the MiniTrap[II] Software including contact information for MREL.



CHAPTER 5 - ANALYSIS EXAMPLES

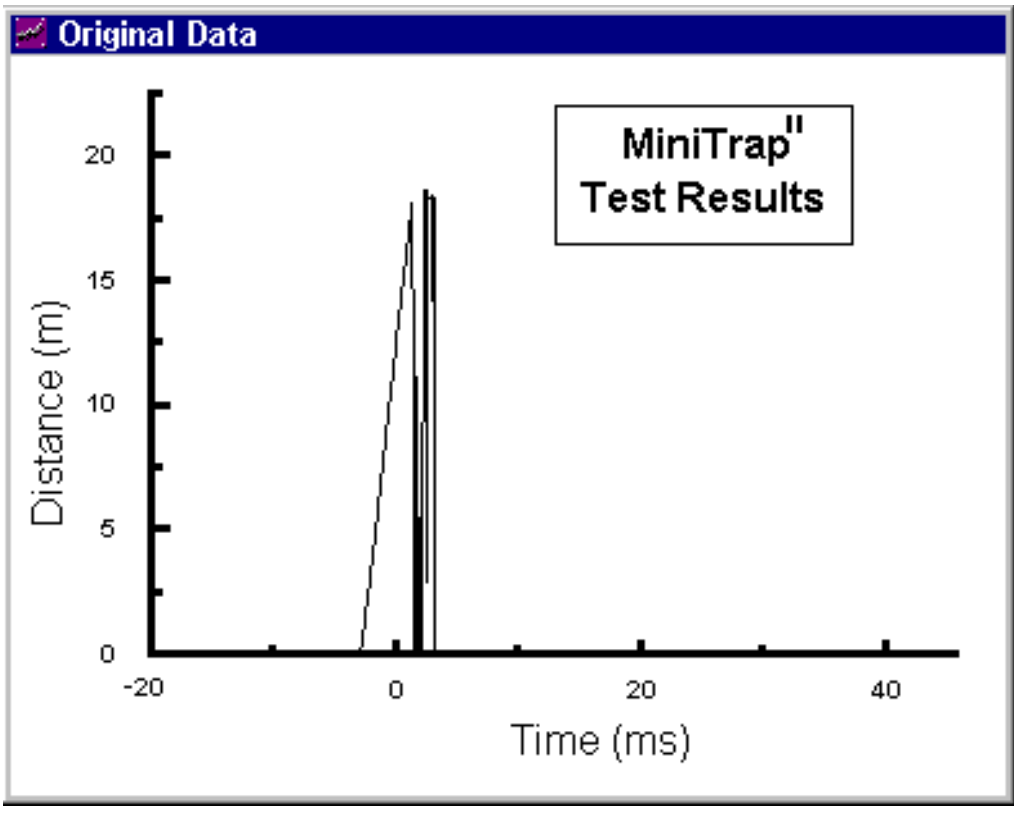
5.1 ONE HOLE (X1)

From the Main Menu, select the Analyse VOD Data button (Section 4.4), open the X1 file, and maximize the Original Data graph. Moving the graph's title and the Tools Bar results in the screen shown below:



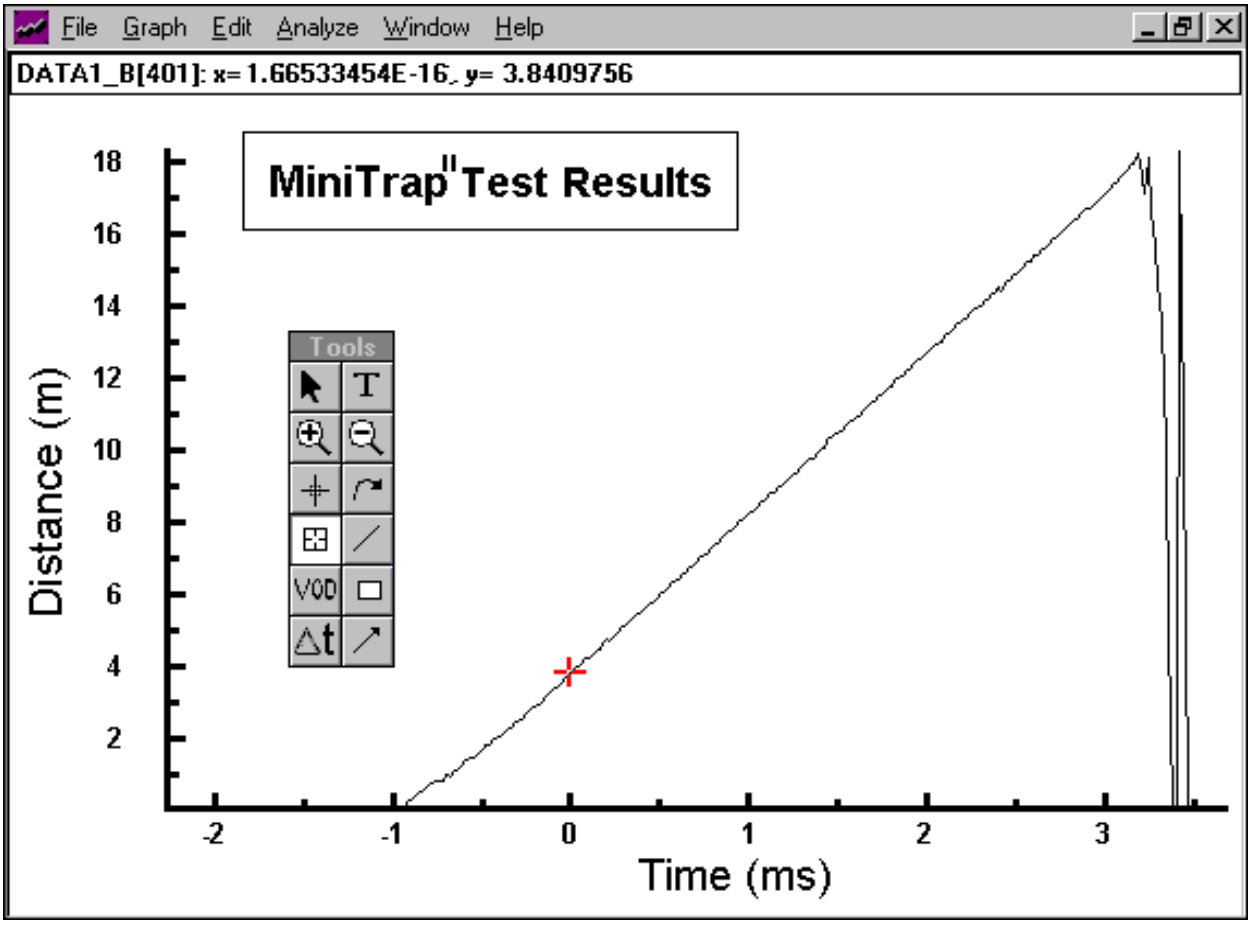
The graph shows a line plot of distance versus time for the complete duration of a VOD test of similar configuration to that of the one hole test set up shown above. The length of the explosive column is approximately 18 m.

The graph has two time areas: before time = 0 (pre-trigger time) and after time = 0 (post-trigger time). In all VOD tests, the MiniTrap[II] is triggered to begin recording at time = 0 but has a resident memory of 262ms before time = 0 (Section 3.7). This allows the MiniTrap[II] to record the information from the probe as it is being consumed to the probe length at which the MiniTrap[II] will trigger. The MiniTrap[II] records 787ms after time = 0.



Since only one hole was tested, and the time for the explosive to detonate (approximately 5ms) is far less than the 1,049ms that the MiniTrap[II] records, a large amount of extra data was recorded after the detonation in the hole was complete. Using the **Zoom In Tool** (Section 4.7), the operator can focus on the area of interest: the part of the graph that shows the explosive detonating.

The following screen shows results from zooming in on the data of interest. If the wrong area is chosen, use the **Zoom Out Tool** to undo the Zoom In. On the graph, for interest only, the **Data Value Tool** has been used to click on the graph to find the distance at which time = 0. The x, y (time, distance) coordinates of this point are shown just under the Menu Bar.

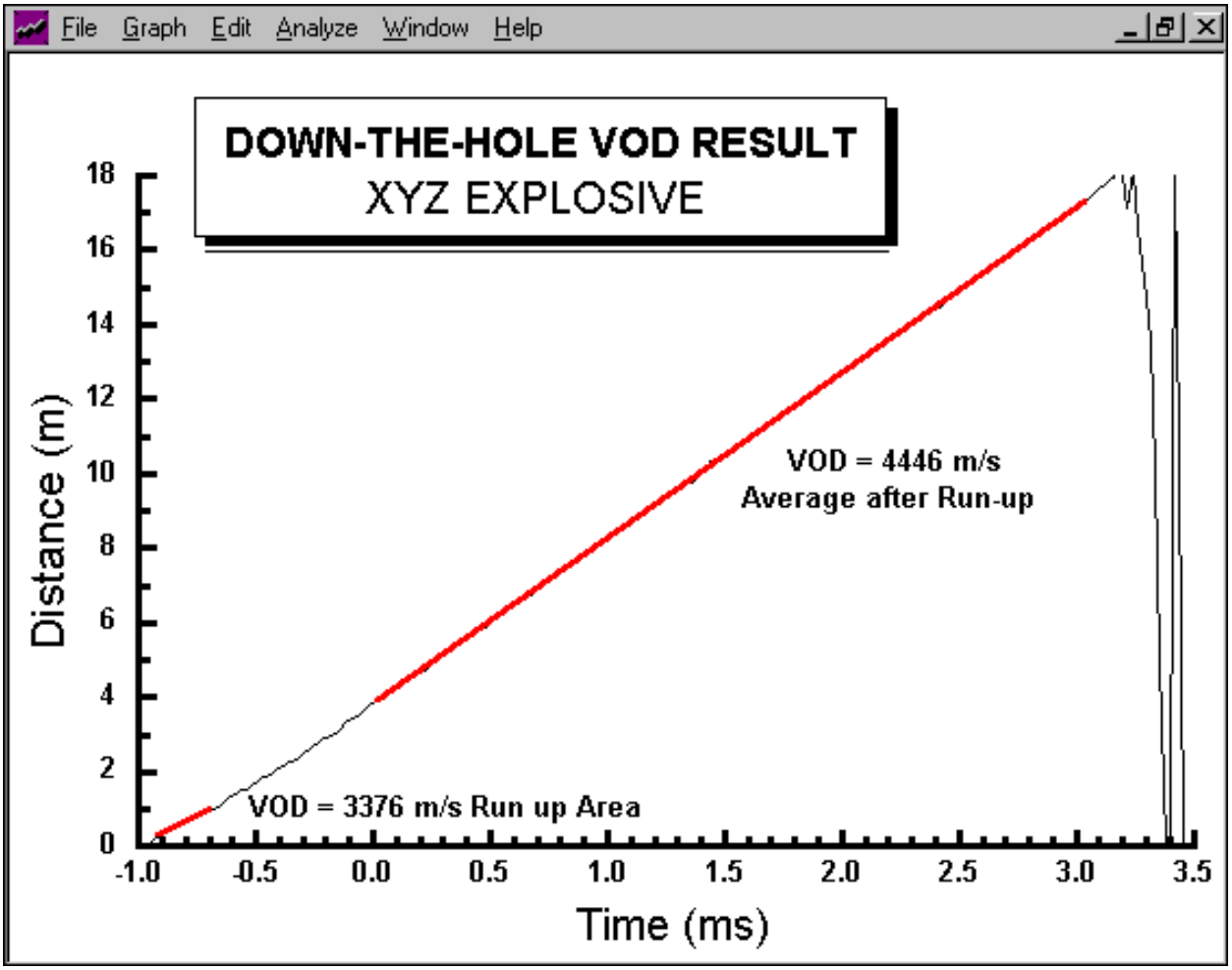


To change the format of the Distance and Time axes, use the **Select Tool** to double click on them. Double clicking with this tool on the axis labels, axis titles, graph title box and on the data allows the operator to change the attributes of these items. The **Text Tool** can be used to add additional comments on the graph.

To analyse the data for VODs, choose the **VOD Tool**. The software calculates the VOD by conducting a linear regression on the data contained between two data points chosen by the operator. The software prompts the operator to click on the “first” data point and

then on the "second" data point, thus defining a data range for the VOD calculation. The VOD result is automatically shown with a coloured straight VOD line over the data range of interest. The operator can perform an unlimited number of VOD analyses on a graph. The VOD text and line can be chosen with the **Select Tool** for moving or deleting. The colours and properties of these items can be changed by double clicking with the **Select Tool**.

VODs for two regions of the hole are shown on the graph. The axes properties, labels and the title have been modified using the procedures detailed above.



When the graph has been annotated to the satisfaction of the operator, using the Menu Bar, the graph can be saved as a sub-graph. The operator cannot overwrite the Original Data graph name which contains the original data and graphics. The operator chooses **Graph-Save As** and then types in a name for the sub-graph. This sub-graph will be stored with the X1 file and will be automatically opened along with the Original Data graph the next time the X1 file is chosen for analysis.

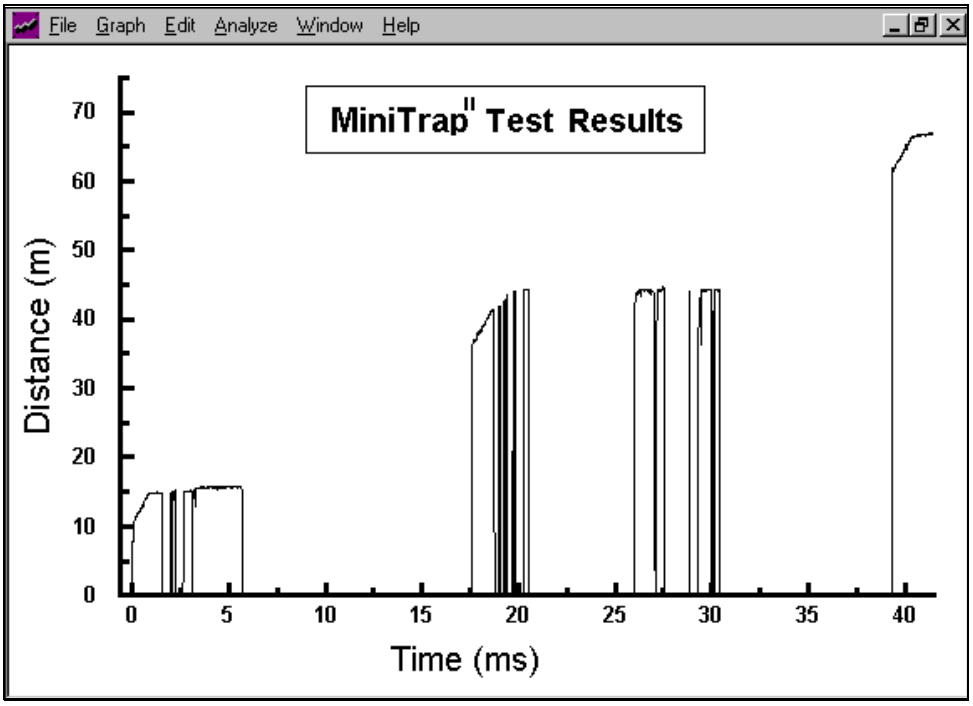
The operator may wish to copy the graph into a Windows word-processor for a report. To do this the operator chooses **Edit-Copy Graph** from the Menu Bar. The operator can then minimize the MiniTrap[II] Software, open the word-processor and Paste the graph.

To print directly from the MiniTrap[II] Software, the operator must select the printer and paper by choosing **Graph-Print Setup** from the Menu Bar. It is useful to activate a print preview mode to ensure that all of the graph components fit on the paper in the correct position. To start the preview mode, the operator chooses **Graph-Print Preview** from the Menu Bar. Graph elements can be moved and modified in this mode until they are correct for printing. The operator then chooses **Graph-Print** from the Menu Bar to print the graph. To exit the print preview mode, the operator chooses **Graph-End Print Preview** from the Menu Bar.

The operator is encouraged to experiment with analysing, formatting and printing the data and graphs contained in the X1 file. No matter what changes are made to the data in the sub-graphs, the Original Data graph cannot be changed and will always be available for subsequent analysis.

5.2 THREE HOLES (X3)

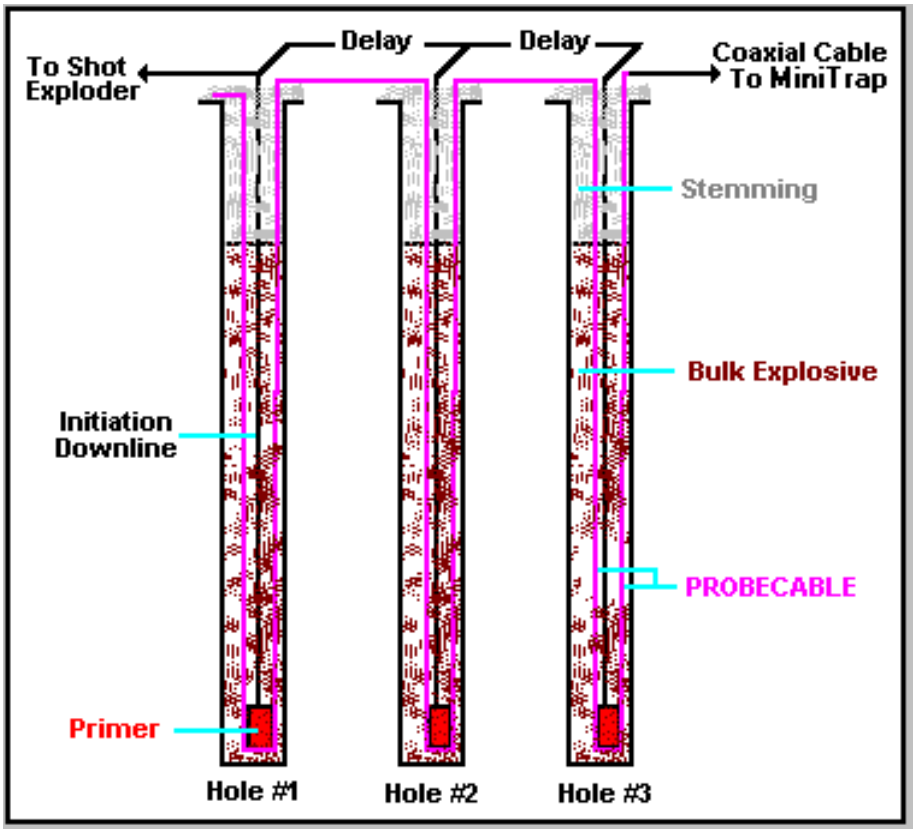
From the Main Menu, select the Analyse VOD Data button (Section 4.4) or, if continuing from the previous example (Section 5.1), choose **File-Open** and open the X3 file. Maximize the Original Data graph. Moving the graph's title and the Tools Bar results in the screen shown.



The graph shows a line plot of distance versus time for the complete duration of a VOD test. The test was of similar configuration to that of the three hole test shown on the next page.

Three 10m deep holes were monitored. Each hole contained a column of approximately 5m of explosives and the blast was tied in with a 17ms delay between holes.

Notice on the diagram that the PROBECABLE in Hole 1 was not terminated at the primer but was run down and out of the hole in a method similar to Holes 2 and 3. In this way, the detonation of the primer in Hole 1 immediately cuts off or shortens the PROBECABLE by 10m thereby assuring that the MiniTrap[II] will be triggered to record (time = 0) upon the primer in Hole 1 firing. This is evident on the graph. Also notice that if Hole 2 fired before Hole 1 then approximately 35m of PROBECABLE (comprised of 20m in Hole 1 + 5m spacing between holes + 10m in Hole 2) would have been cut off. Of course in that case no data would have been recorded for Hole 1, only for Holes 2 and 3.

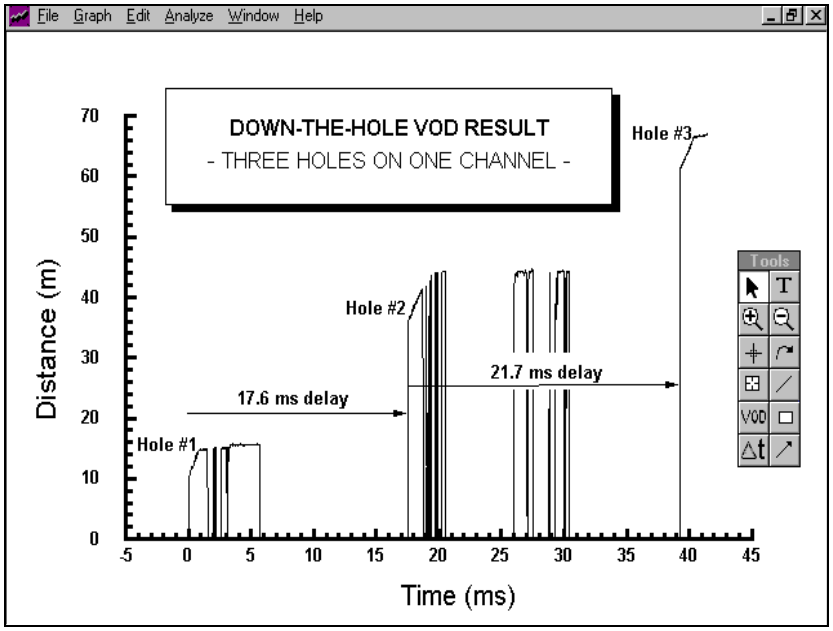


The data can be analysed to determine the actual delays between holes and the VODs of the explosives in each of the holes.

To determine the delays between holes, choose the **Delay Tool** (Section 4.6). The software calculates the delay time by measuring the difference in time between two data points chosen by the operator. The software prompts the operator to click on the “first” data point and then on the “second” data point, thus defining a data range for the delay calculation. The delay result is automatically shown with a coloured straight delay line over the data range of interest. The operator can perform an unlimited number of delay analyses on a graph. The delay text and line can be chosen with the Select Tool for moving or deleting. The colours and properties of these items can be changed by double

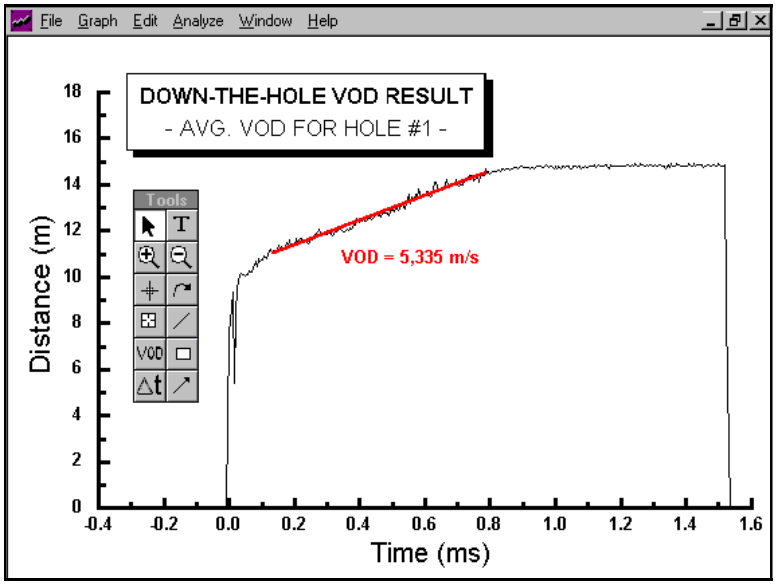
clicking with the **Select Tool**.

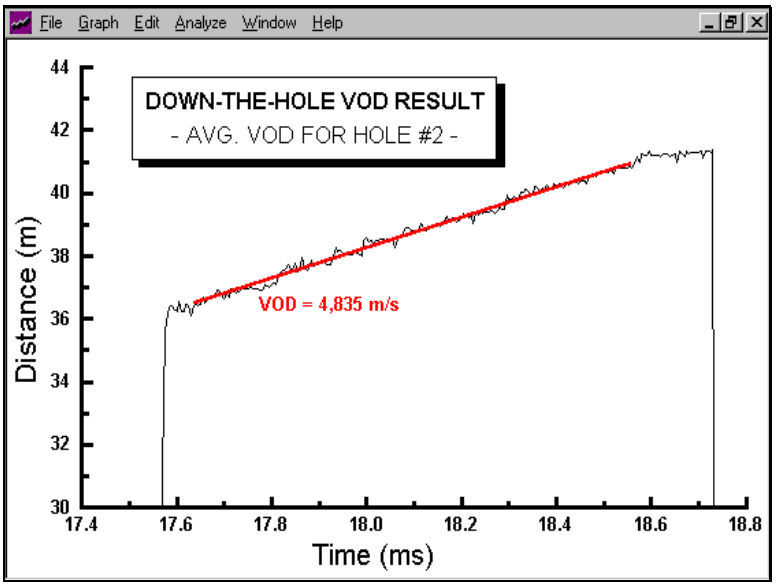
Delay times between Holes 1 and 2, and 2 and 3 are shown on the graph. The axes properties, labels and the title have been modified using the procedure detailed in Section 5.1.

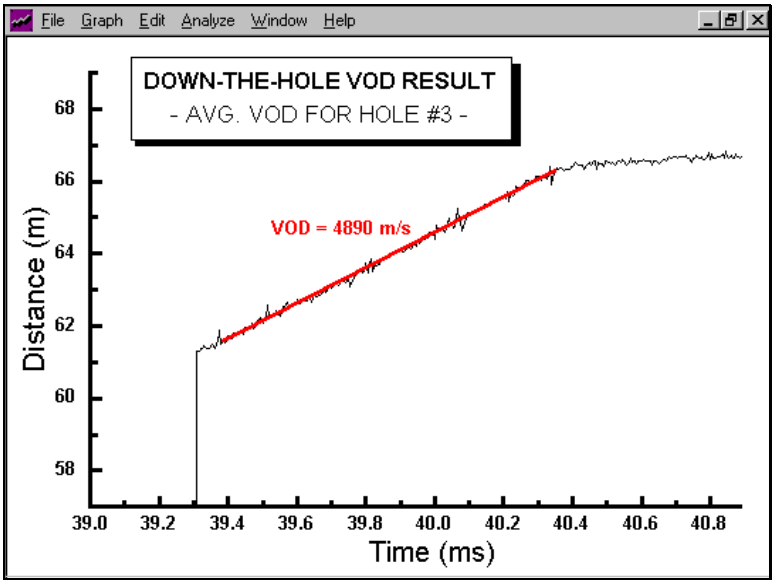


When the graph has been annotated to the satisfaction of the operator, using the Menu Bar, the new graph can be saved as a sub-graph and printed per the procedures in Section 5.1.

The operator can zoom in on each of the three holes to calculate the VODs in each hole per the procedures in Section 5.1 and save the zoomed VOD results for each hole as sub-graphs as illustrated below:



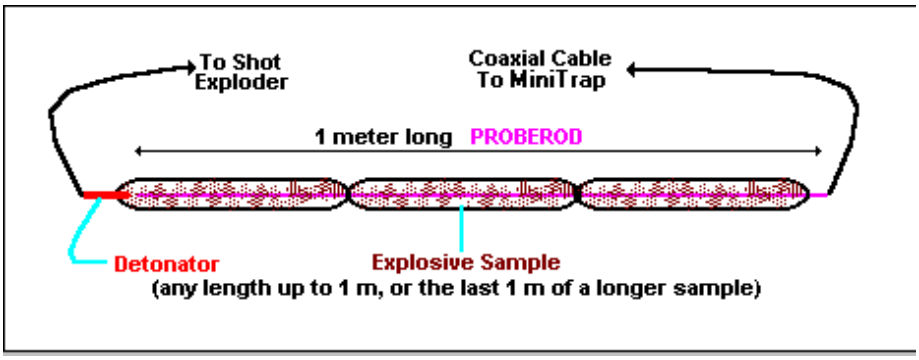




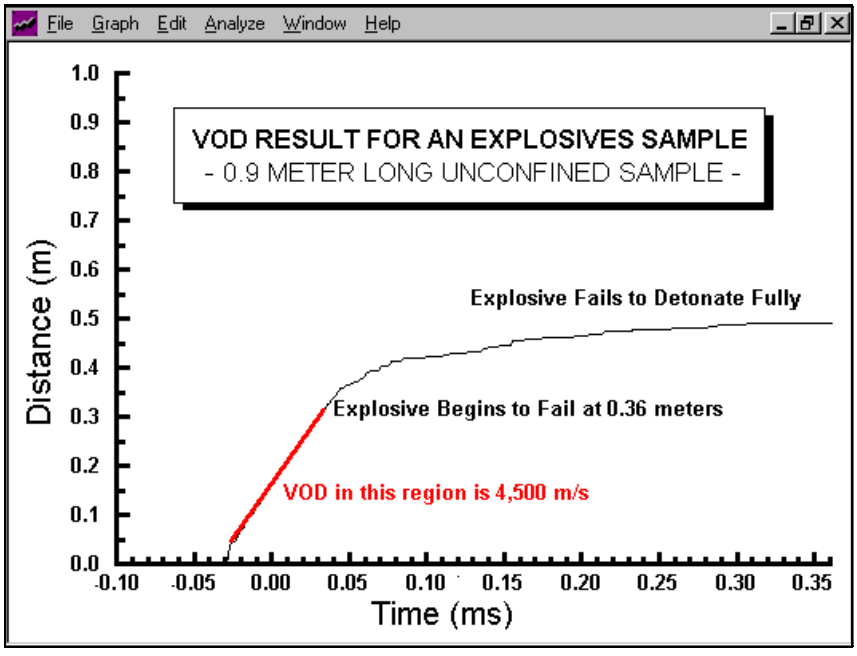
The operator is encouraged to experiment with analysing, formatting and printing the data and graphs contained in the X3 file. No matter what changes are made to the data in the sub-graphs, the Original Data graph cannot be changed and will always be available for subsequent analyses.

5.3 EXPLOSIVES SAMPLES (Z2, Z3, Z1)

As detailed in Section 3.2, a typical VOD test of an explosives sample is shown below.



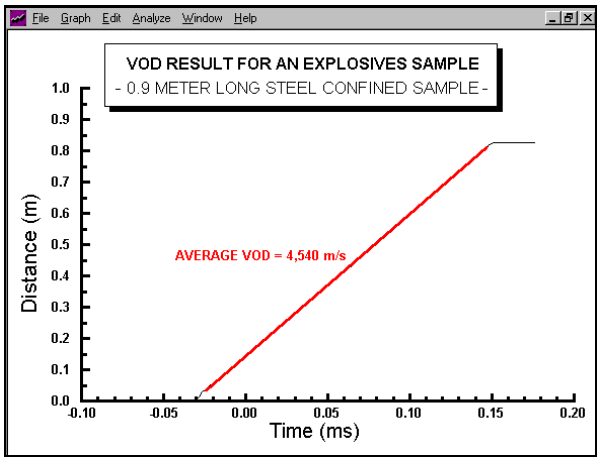
From the Main Menu, select the Analyse VOD Data button (Section 4.4) or, if continuing from the previous example (Section 5.2), choose File-Open and open the Z2 file. The figure below shows the result of zooming on the Original Data graph, conducting a VOD analysis, and performing some graphics editing.



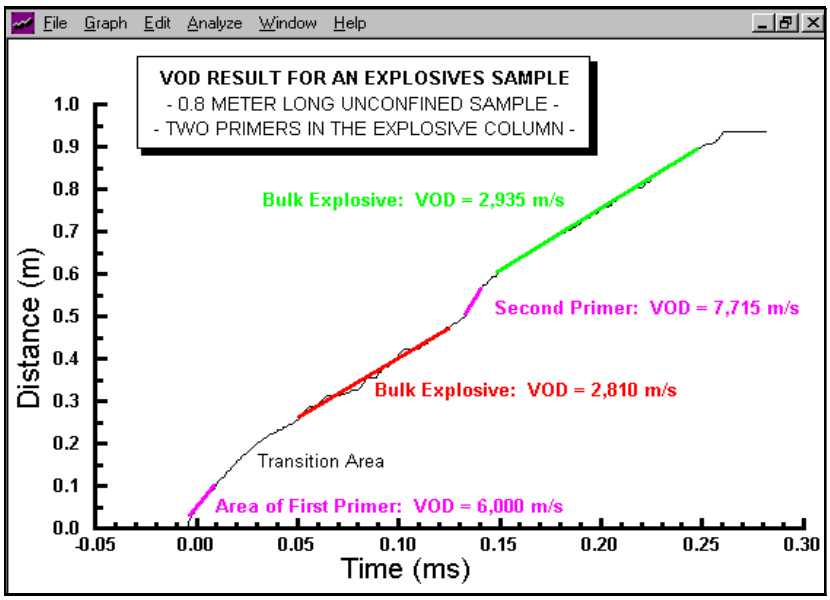
This result is typical for an unconfined explosive failing to detonate completely.

The figure on the right is the result of analysing and editing the Original Data graph of the Z3 file.

This result illustrates the effect of confining the explosive in Schedule 40 steel pipe (a standard substitute for rock). The explosive detonates fully when loaded in steel pipe but fails when unconfined as shown in the previous graph.



The Z1 file contains a sub-graph which is an extreme illustration of the MiniTrap[II]'s ability to record changes in VOD along the length of an explosive column. It is the result of a VOD test on unconfined bulk explosive. It can be observed that a second primer was placed in the explosive column which had not been tied into the shot exploder. As can be seen, the operator can determine the VOD anywhere along the 0.8 m long unconfined sample.



The operator is encouraged to experiment with analysing, formatting and printing the data and graphs contained in the Z1 file. No matter what changes are made to the data in the sub-graphs, the Original Data graph cannot be changed and will always be available for subsequent analyses.

5.4 EMAILING MINITRAP^{II} FILES

It is straightforward to send a MiniTrap^{II} file for analysis/review by another operator who also has the MiniTrap^{II} Software.

When a file is saved on a computer, the file name takes the form of **filename.filetype**, otherwise known as root.extension. When a MiniTrap^{II} file is saved using a name chosen by the operator (for example: *test*), several files with different filetypes are automatically created by the MiniTrap^{II} Software all with the same filename, *test*.

To email a MiniTrap^{II} file of *test*, attach all the MiniTrap^{II} files with the same filename to the email.

For example:

test.mt2	(the MiniTrap^{II} settings file, which is a readable text file)
test.raw	(the MiniTrap^{II} data file if the data were not compressed)
test.cmp	(the MiniTrap^{II} data file if the data were compressed)
test.e1, *test*.e2 etc...	(the series of sub-graph files the operator saved during VOD analysis)
test.r1, *test*.r2 etc...	(the data points removed from a sub-graph by the operator)
test.m1, *test*.m2 etc...	(the data points moved in a sub-graph by the operator)

As part of MREL's ongoing commitment to Customer Satisfaction, MREL VOD Specialists will be pleased to review your analysis of your VOD data. If you would like to have a "second opinion" from MREL on your analysis of a specific test, send an email to VOD@mrel.com with a brief description of the test and attach all of the files.