

# **Michiephone Handset**

## **Instruction Manual**

**Speleonics**

**December 2002**

## **Speleonics Michiephones**

Thank you for purchasing the Speleonics Michiephones. If there are any questions you have on the operation of your Michiephones, suggestions for improvements or if you require service on them please contact Speleonics at the address below.

### **Your Michiephones Serial Number**

All Speleonics Michiephones have a serial number engraved on the back of the speaker, inside the Michiephone.

### **Electromagnetic Compatibility Note**

The Michiephone Handsets and the Michiephone Base Station transmits audio frequency radiation from the long Michiephone Line which may interfere with other electronic equipment. The Michiephone Line may may also pickup radio interference from local radio stations. Michiephones and Base Stations should only be used in the cave environment for which they were designed.

Michael Lake

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# 1 Introduction

Michiephones are two-way communication units specifically designed for use in caves. The original Michiephone was designed in Australia by N. Michie in 1974. They are used by cave rescue squads in Australia, New Zealand and the UK. The Speleonics' Michiephones are a modern, improved version, yet still retain the original design philosophy of a pocket sized, reliable, simple to use communication system. They have many advantages over conventional telephone or intercom systems:

- Small size – measuring 110 x 58 x 30 mm – a unit will fit into your top pocket and weighs 250g including battery.
- Low power requirement – lasts hundreds of hours on a single battery.
- Designed and built to be used in a cave environment. Reliable circuit housed in a rugged metal diecast box.
- Single wire operation – significantly reduced the quantity of wire reels that must be carried into a cave.

## 2 Brief Description of the Michiephones

The Michiephone handsets are powered by an internal 9 volt battery. Each handset has a power Off/On switch labelled 0/1 and a small red LED to indicate that power is switched on. The LED intensity has been kept low so that it is not too bright in a cave. The other button, labelled PTT, is a Push-To-Talk switch which is depressed when you wish to transmit and released when you wish to receive.

Throughout these instructions we will be referring to Michiephone cable and Michiephone line. The Michiephone cable is the short cable coming out of the Michiephone handset with an alligator clip at the end. This is used to attach to the Michiephone line which is the long wire line laid out along the ground and along which the signal travels.

The Michiephone box is rugged diecast metal which provides a good earth contact to the operator's hand. This is essential for the operation of the system which will be described later.

## 3 Quick Use Instructions

The following is a quick run-down on how to use the Michiephones. More detailed instructions and tips for establishing a reliable and efficient communication system are covered later.

You will need two Michiephones, a long length of Michiephone line and another person with whom to communicate. The system works best in a cave as the ground is always moist but usually the surface ground is adequate, especially after some rain.

Take a Michiephone and attach the alligator clip to a bared end of the Michiephone line. Switch this unit ON via the switch labelled 0/1. Give this Michiephone to the other person and instruct them to hold the unit in one hand, place their other hand on the ground and listen. Take the second

Michiephone and the roll of Michiephone line and move away, unrolling the Michiephone line as you go. When you're around 20 metres away connect your Michiephone to the line at a bared section.

Holding the Michiephone in your hand, switch it on, place your other hand on the ground and push the Press-To-Talk button (labelled PTT). Speaking in a normal level voice, ie not loud, ask the other person if they can hear you then release the PTT button so your unit can receive their reply. Remember that the other persons needs to press their PTT button to transmit. You should now be able to strike up a conversation.

## 4 How they Work

### 4.1 A simple two Michiephone communication system

The simplest Michiephone system consists of two Michiephone handsets attached to a single Michiephone line. Electrical contact to the line is made by clipping the alligator clip to a section of the line which has had its electrical insulation carefully removed, exposing the bare wire.

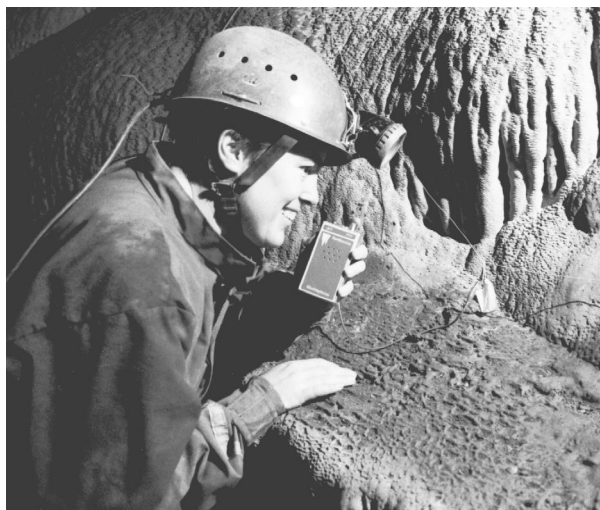


Figure 1: Operator using a Michiephone. Note that the operator is earthing herself by touching the ground with her hand.

The Michiephone is usually held in one hand while your other hand touches either the cave wall or the ground. You can see the operator touching the ground to earth herself in Figure 1. Another person somewhere else along the line does the same. When you press the Push-To-Talk (PTT) button and speak your Michiephone converts the speech into an electrical signal, amplifies it to several volts and transmits it down the Michiephone line. The other Michiephone further down the line picks up the signal and powers its speaker.

As in all electrical circuits the signal must return to where it began, that is, an electrical current must be able to flow. In the Michiephone this return path is via the ground. The signal received by the other Michiephone came from your Michiephone via the line. This signal then travels from the Michiephone diecast box via the operator's hand to the cave ground or wall, back through the ground, and finally back to your Michiephone via its diecast case and your hand. That is why the case of the Michiephone is metal – it must make electrical contact to the operator's hand.

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This system is called a “single wire, earth return communications system”. Compare this to a conventional intercom system which requires twin-cable wire – one to send the signal down and another for the return path for the signal. This at least doubles the quantity of wire to carry into the cave and doubles the cost of the wire used.

## **4.2 More complex systems – branches**

*There are no constraints on the number or arrangement of lines in a Michiephone communication system.* Branch lines can be added by electrically connecting the new branch line to the main Michiephone line. You can add branches to this branch also.

## **4.3 Loops – even more reliable communications**

The Michiephone line can be joined back to itself creating loops. This makes the communications system more reliable because if there is a break in the line anyone on the loop can still communicate with anyone else on the loop.

## 5 Detailed Use of The System

### 5.1 Laying the line

The Michiephone line can be laid fairly quickly by a small line-laying team of two people. Once laid the line provides a guide for others entering or exiting the cave.

The line should be laid so that it is clearly visible but not in the way of teams moving along the cave passage. For this reason it is usually laid along the side of the passage. Allow sufficient slack so that people don't trip over it. As the line is laid out visually inspect any bared sections or joins in the line to check there is no obvious break in electrical contact along the line.

The line can be secured by tying around "jug handles" or looping it around projections on the wall or floor of the cave as in Figure 2 and Figure 3.

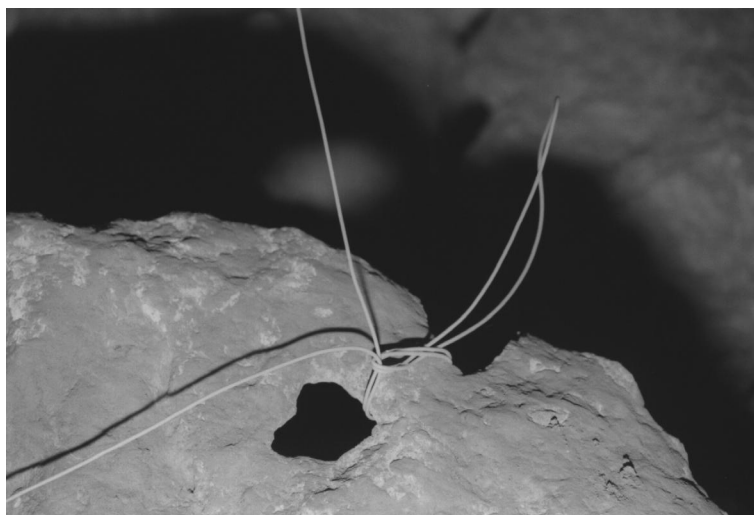


Figure 2: Michiephone line tied to a jug handle.

Alternatively the line might be able to be wrapped around loose rocks to hold it in place as in Figure 4.



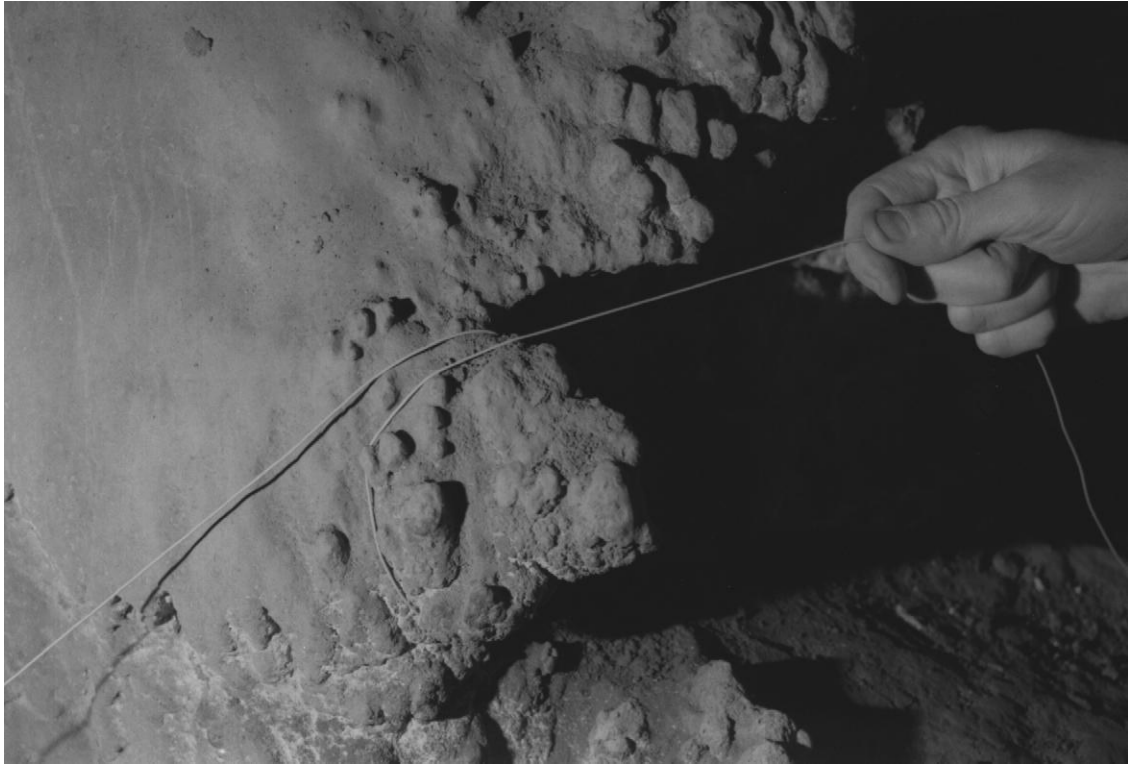
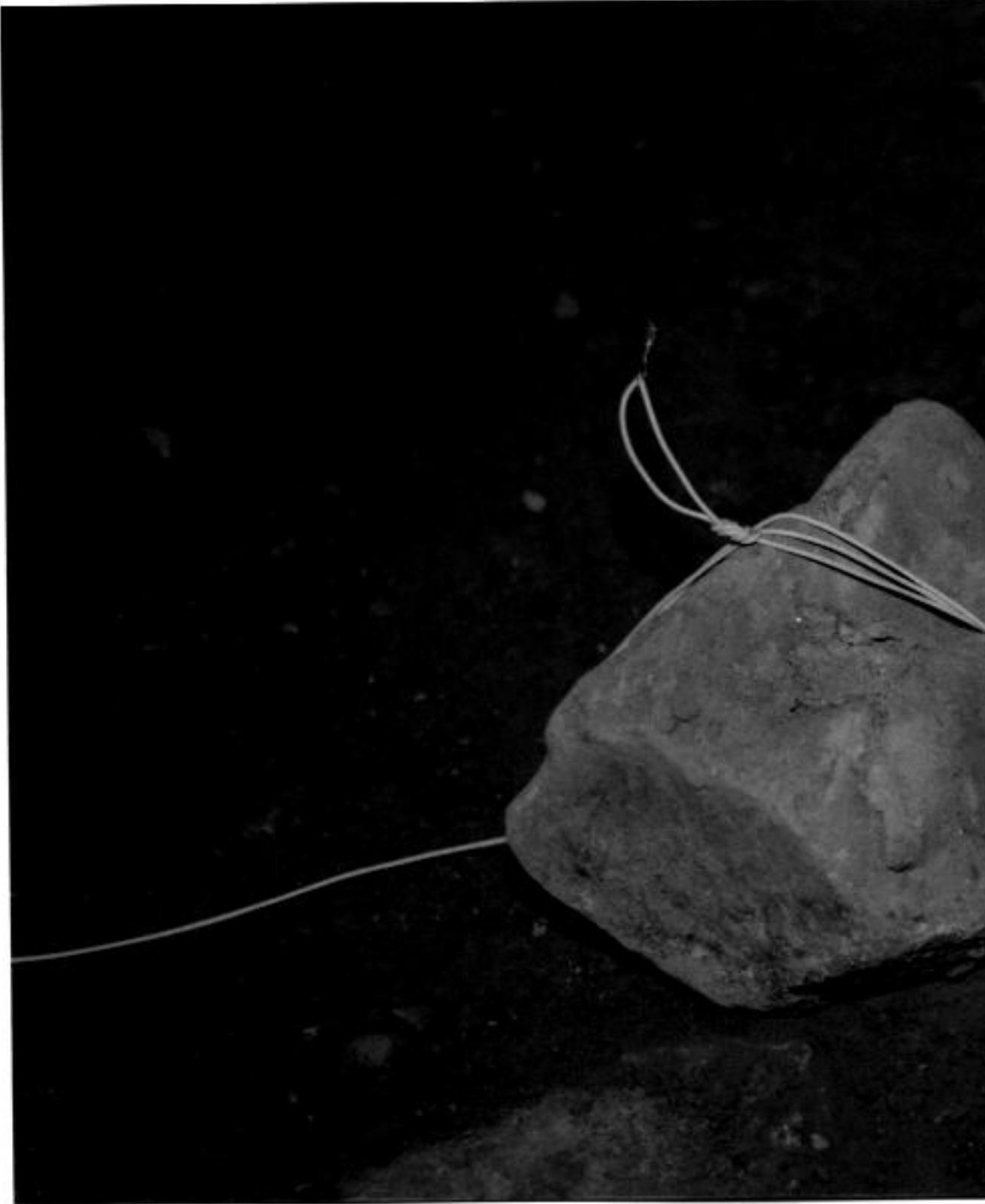


Figure 3: Michiephone line looped around a projection.



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Figure 4: Michiephone line wrapped around a loose rock.

The most important point is to make sure that any bare wire doesn't touch the ground or lie in a pool of water.

Where there is a join in the wire or a bared section attach reflective or brightly coloured tape. This assists users in finding a connection point for their Michiephone. It is important to make regular checks back to Base as the Michiephone line is being laid out, around every 15 minutes or so. This checks that there is no break in the Michiephone line between you and Base.

## 5.2 Baring the Michiephone line

If you wish to communicate and there is no bare section of wire in the Michiephone line near you then you will have to bare the line and prepare a connection. Using a pocket knife cut about 2 cm of insulation off the line, taking care not to cut the strands of wire underneath. Bend the line in two and twist the metal strands together. Tie an overhand knot in the insulated part below the bared wire as in Figure 5. This helps prevent the bared wire from undoing if tension is applied to the line. Tie some brightly coloured tape (eg. pink flagging tape) around the bared section so that other users can easily find the connection point. Keep the bared wire from touching the ground by placing it in a dry, visible place.



Figure 5: An overhand knot in the line secures the newly made join..

## 5.3 Using the handsets

### 1. Find a bared section of Michiephone line

You may have to search up and down the Michiephone line until you come to a bared section.

(If one is not found within a reasonable distance you may have to make one (see “Baring the Michiephone Line”))

## **2. Clip the Michiephone cable onto the line**

Clip the alligator clip onto the bare metal of the line. Make sure that your connection point to the line is not touching the ground or is in water.

## **3. Turn on the handset**

Turn the handset on by switching the toggle switch towards the centre of the handset; the LED indicator should light. If it doesn't the battery may be flat. Remember that in bright sunlight the LED may be faint.

## **4. Earth yourself**

Ensure that your hand holding the Michiephone is making good contact to the diecast box. Place your other hand on the cave wall or floor to earth yourself like the operator in Figure 1. If you are in a very dry cave you may have to moisten your finger with a little water to get a better earth contact. In damp caves you may not need to touch the cave wall or floor as there may be sufficient conduction through your boots to the ground.

## **5. Listen / Talk**

To listen the PTT button should be released ie not depressed. You should be able to hear any messages from other transmitting Michiephones. When there is a gap in the conversation, press the PTT button and call the person to whom you wish to speak. Remember, the Michiephone uses the PTT system so you cannot receive while you transmit.

## **5.4 Rolling the line up when finished**

Carefully wind the line back onto its spool, trying to keep the line spooling neatly, without kinks. If a spool has to be moved up or down a pitch the entire spool should be placed in a pack which can then be raised or lowered. Do NOT haul up the spool by the line. The wire and insulation may be damaged.

# **6 Recommended Procedures**

## **6.1 Checking Michiephones as they are handed out**

Rescue Leaders are usually provided with a Michiephone for their team at the cave entrance. These should be checked that they are working as they are handed out. You can test the handset being handed out by using a second handset. Connect the two handsets together via the alligator clips on the cables. Turn both handsets on and hold one handset in each hand. On one unit depress the PTT button and speak. The other handset should pick up your voice. Note that when two Michiephones are connected together, switched ON, and one is set to transmit the receiving unit will “howl” if they are close together. This is due to feedback overdriving the units. It will not damage them.

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## 6.2 Calling into Base regularly

During lengthy cave rescues a Base Station is often set up close to but outside the cave entrance. This Base would have Michiephone communications into the cave and radio communications for outside the cave. Rescue personnel inside the cave should regularly call into Base and inform them of the group's location and situation. This keeps those in command on the surface informed and up to date. A suitable time between calls is about 15 minutes. This procedure also provides a regular check that there is no break in the Michiephone line between you and Base.

## 6.3 Establish listening watches

A handset kept in the pocket and not used is a waste of equipment. There are many occasions when obstacles like climbs, pitches or squeezes slows down the team moving through the cave. Take this opportunity to attach to the Michiephone line for a *listening watch*. To do this take a Michiephone, attach it to the line, switch it on, and sit it on the ground. You will be able to hear all messages on the line. This will keep everyone informed as to what is going on. Regularly call into Base and provide a situation report. Remember if the cave ground is very dry, one may have to place a little water on the ground to ensure good contact between the ground and the Michiephone case.

## **7 Maintenance**

### **7.1 Care of the Michiephone line after use**

Unroll the line onto another spool, looking for kinks and damaged sections. Any dubious section should be cut and rejoined. Check the condition of all bared sections. Sections of the line which have been bared in the cave should be soldered and the section tied with an overhand knot to relieve strain on the join. Mark the location of bared sections with brightly coloured flagging tape.

### **7.2 Replacing the Michiephone line**

If the Michiephone line becomes corroded or brittle from use the line will need to be replaced. Additional line may be required to reach the end of large caves. The Michiephone line is generally 1.2 mm diameter PVC coated multi-strand (7 strands / 0.2 mm) copper wire, usually supplied on 100m reels. Any other wire similar to this can be used. The wire should be tinned as it is less likely to corrode and is easier to solder. It is readily available from the larger electrical equipment suppliers and is often called “Equipment wire” or “Hook-up wire”.

Choose a colour which shows up well in a cave. YELLOW is excellent. Avoid dull colours like reds and blues etc.

### **7.3 Care of the Michiephone handsets after use**

To ensure a long life for your Michiephones care of the handsets after use is essential. The following points should be observed:

- Batteries should not be left in the handsets for long periods of time.
- Store the handsets in a dry location.
- If the Michiephones have become wet or muddy inside they should be disassembled and cleaned to prevent corrosion occurring. Disassembly and assembly is relatively simple.

### **7.4 Disassembly**

1. Make sure the handset is switched OFF
2. Undo the four screws from the back of the handset using a small Posidrive screwdriver (note, not Philips).
3. Carefully remove the battery from its connector being careful not to pull on the battery connector wires.
4. Carefully remove the foam packing – noting which way it was placed in.

- 
5. Using pliers carefully grip the switch bezels and loosen them by unscrewing them anticlockwise a half turn or so. The bezels can then be unscrewed further by hand. The red PTT button will come off as its bezel is lifted.
  6. The circuit board and speaker can be gently manoeuvred out of the diecast box. Grasp the circuit board by the top edge and the speaker screws and slide it back towards the strain relief pad. There will then be just enough clearance for the switches and LED to clear their holes in the diecast box as you lift out the circuit board. The cable and battery wires can remain attached to the strain relief pad as in Figure 6.
  7. Finally the felt under the speaker can be easily lifted out as it is not attached.

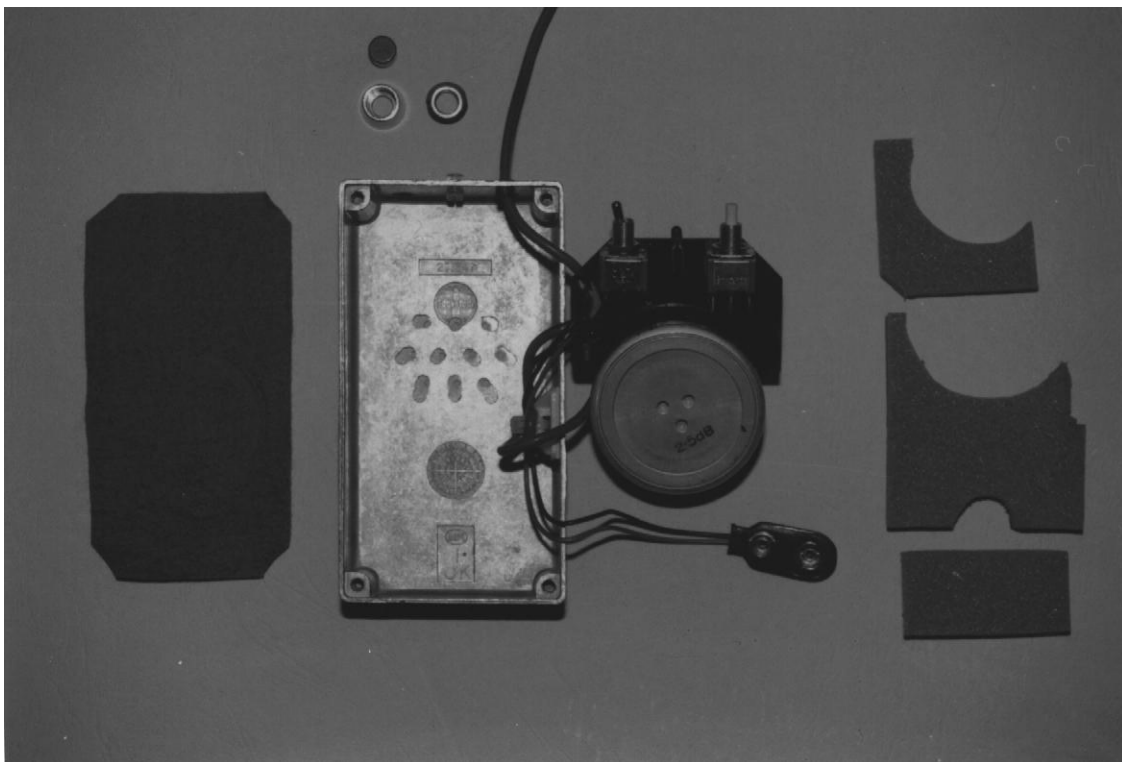


Figure 6: The disassembled Michiephone.

\* If the circuit needs to be removed further then small wire cutters can be used to snip the cable tie from the strain relief pad. Note how the cable tie was installed.

## 7.5 Cleaning

- Remove any mud and grit from the interior of the diecast box by wiping with a damp cloth.
- A soft brush can be used to remove any mud from the circuit board and around the speaker. Be careful not to brush anything into the speaker holes.
- Allow the entire unit including felt and foam inserts to dry before assembly.

## 7.6 Assembly

Assembly is the reverse of the above but there are some points to note.

- There are two washers which act as spacers. Both go over the PTT switch before it is inserted into the diecast box. There is no washer on the On/Off switch.
- When sliding the circuit board back into the diecast box make sure that the red LED slides into the clear LED cover. The leads of the LED can easily be bent.
- If installing a new cable tie on the strain relief pad make sure that it effectively constrains the Michiephone cable and battery wires.

## 7.7 Changing the battery

- Make sure the handset is switched OFF
- Undo the four screws from the back of the handset using a small Posidrive screwdriver.
- Carefully remove the old battery from its connector being careful not to pull on the battery connector wires.
- Look to see what way around the battery terminals connect to the connector. Connecting the battery incorrectly, even momentarily, may damage the Michiephone.
- Clip the new battery into the connector.
- Replace the back of the handset.

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| Only use batteries which are guaranteed not to leak. |
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## 8 Finding and Fixing Communication Problems

Occasionally when using the Michiephones the received signal may seem faint or there may be no signal at all. This indicates a communications problem. Most communication problems are usually due to:

- poor earthing of either the sender or the listener's hand with the cave wall or floor,
- poor connection of either sender or the listener's hand to the diecast box of the Michiephone,
- a break in the Michiephone line,
- there is nobody on the line.



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## 8.1 Faint or low signal

If the signal you receive is very low or sounds noisy then you should check the following in this order:

1. Are you earthed? You should be touching the ground or some rock with your other hand. In very dry caves you may need to moisten your finger with a little water to get a good contact with the ground.
2. Are you holding the diecast case of the handset in your hand? Moisten your fingers to improve the electrical connection then try again.
3. Check that your Michiephone's alligator clip is connected to a bare section of the Michiephone wire and that this section is not touching the ground and shorting out the Michiephone.
4. Call another handset to see if communications to another group is OK.

Another reason for a faint signal is if the Michiephone line is shorting out to ground between the station that is calling and you. If the person you are transmitting to often asks for you to repeat the message they may be receiving a faint signal. Ask them if the signal is strong and clear. If not go through the above check list yourself and get them to go through this check also.

## 8.2 No signal at all

If you cannot hear any communications on the line and nobody responds to your call then you should check the following, in this order:

1. Is the red LED power indicator light on? If not check the power switch is turned on. If the LED is still not on replace the Michiephone battery.
2. Go through the checklist for "**Faint or low signal**".
3. Check to see if you can call any other handset. The person you wish to speak to may not be connected.
4. Check for a break or poor join in the line or a short from line to ground.

There may be a break in the line between you and whoever you are trying to call. If it is convenient, you may wish to go back to the last point at which you were able to communicate, checking the line along the way. If Base suspects there is a break in the line (because a person or team are not responding), then they should send one or two people (depending on the cave) to check the integrity of the line, calling back regularly.

## 8.3 Noisy or buzzing signal

Although the Speleonics Michiephones have been designed to reject very low frequency (less than 200 Hz) and very high frequency noise (greater than 20 kHz), some will get through. Low frequency noise can come from portable electrical generators if they are close to the Michiephone line. Usually

the only solution is to move either the generator or the Michiephone line. High frequency noise can come from power lines, radio stations or faulty electrical equipment. This noise is more likely to be picked up if the Michiephone line extends for some distance along the surface. If this is a problem keep the Michiephone line inside the cave entrance.

## 9 Operating Procedures

The Michiephone is a “party line system”. This means that when you transmit, everyone can receive you and when anyone transmits, you can receive them. With only a few team leaders or teams this isn’t a problem. If there are several teams or if the Michiephone “traffic” is very busy then some form of voice procedure must be used in order to prevent messages from being misunderstood. The following are some suggested procedures that can be used to ensure efficient communications. Of course your organisation may have its own procedures for radio type communications. In this case the procedures with which you are familiar can be used with the Michiephone system.

The operating procedure is slightly different depending on whether the Michiephone system is a directed net or an undirected net. A directed net is one where all requests for transmitting are required to be directed to a specific person in charge of the communications network. An undirected net is one where you can directly transmit with whom you wish to speak. The following are suggested procedures to be used to transmit and receive messages in these situations:

### 9.1 Procedure for an undirected net

1. Attach the Michiephone to the line and switch it on.
2. With one hand make good contact to the case of the Michiephone and with the other hand ground yourself well by placing your finger onto the moist ground or the cave wall.
3. Listen for a short time to check if anyone else is currently transmitting.
4. • If there is no other transmission on the line, send a short message stating who you are and who you wish to speak to.  
• If there is someone transmitting wait until they have finished or until there is a suitable pause in the transmission, then transmit your message as above.
5. Wait for the reply.
6. When the person you called answers send your message.

### 9.2 Example for a undirected net

Scenario: The rescue is small scale and all members of the rescue squad know each other. The rescue team with the patient wish to know if a ladder being rigged is ready yet. They are in a good, safe location and don’t want to move the patient then have to wait at the bottom of a ladder pitch. Standard pro-words are shown in **bold**.

TODO

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Rescue Team with Patient Leader is Bill Michiephone 1 Ladder Rigging Team Leader is John Michiephone 2 "John, this is Bill, over."

"John here. Go ahead Bill, over"

"We're about ten metres from the bottom of the ladder pitch now. Is the ladder rigged yet, over"

"No Bill, we are having some trouble. We will be another 15 minutes, over."

"OK. We're in a good place here so we will wait until you're ready. Let us know when the ladder is rigged, over."

"Will do, John out "

John then waits about 10 seconds or so before disconnecting to ensure there are no further messages directed to him.

There are a few things to note from this communications example:

- First names were used because everyone involved in the rescue knew who was who and what they were doing. For a small rescue this informal communications procedure is appropriate and efficient.
- John, who was rigging a ladder, replied because he had set up his Michiephone on the ground and switched it on for a listening watch, and so heard Bill's message directed to him. When Bill's team took a short break from moving the patient they left their Michiephone switched on for a listening watch. This way John could contact them when the ladder was rigged.

### **9.3 Procedure for a directed net**

1. Attach the Michiephone to the line and switch it on.
2. With one hand make good contact to the case of the Michiephone and with the other hand ground yourself well by placing your finger onto the moist ground or the cave wall.
3. Listen for a short time to check if anyone else is currently transmitting. If there is no other transmission on the line, send a short "request to speak" message to the Net Controller.
4. If there is someone transmitting wait until they have finished or until there is a suitable pause in the transmission. Then transmit your "request to speak" message as above.
5. Wait for a reply from the Net Controller.

The "request to speak" should be short and directed to the Net Controller. Don't send messages directly to other persons, bypassing the Net Controller.

### **9.4 Example for a directed net**

Scenario: The rescue is large scale and many rescue squads are involved. There are around twenty rescuers with Michiephones. A directed net has been set up and all communications are to go via

“Base” located just outside the cave entrance. The rescue team with the patient wish to know if a ladder being rigged is ready yet. Standard pro-words are shown in **bold**.

Rescue Team 1 with Patient

Michiephone 1 Base at Entrance or Ladder Rigging Team Michiephone 2 There is a lot of traffic on the line. The Rescue Team 1 waits until there is a break.

”Base this is Rescue Team 1, over.”

”Rescue Team 1 this is Base go ahead, over.”

”Permission to speak to Ladder Team, over”

”Rescue Team 1 this is Base. You are clear to contact the Rigging Team directly, go ahead, out.”

The ladder Rigging Team would probably have heard this message and will be expecting a call.

”Ladder Rigging Team this is Rescue Team 1, over.”

”Rescue Team 1 this is Rigging Team, go ahead over.”

”Yes, this is Rescue Team 1, We’re about ten metres from the bottom of the ladder pitch now. Is the ladder rigged yet, over”

”Yes Bill, the ladder is rigged and the haul team is ready, over.”

”OK. We’ll be there in around 15 minutes, Rescue Team 1 out.”

”Rigging Team out ”

Rescue Team 1 then calls Base to let them know that they will be out of contact for a short time while they transport the patient.

”Base this is Rescue Team 1, we are going off-line. We will call in again at 11:30am, out.”

Rescue Team 1 this is Base. Expect you at 11:30am, out.

The comms person in Rescue Team 1 then waits about 10 seconds or so before disconnecting to ensure there are no further messages directed to them.

Points to note from this communications example are:

- Team names appropriate to their function are used, not first names.
- The Network Controller gave permission for Rescue Team 1 to contact the Ladder Rigging Team directly. This is up to the Network Controller. Don’t bypass the Network Controller without their permission.
- Rescue Team 1 informed Base that they would be off-line and when they would call in again.

Remember, if your organisation has its own procedures for radio type communications your members will be readily able to use the Michiephone system with those same procedures.

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## 10 Common Questions

### **Can the Michiephone line be run through water?**

Yes. Michiephone line can be run through water, even sumps, as long as the wire's insulation is not broken where it is in the water.

### **How long can the wire be left in the cave?**

It is recommended that the wire not be left in a cave permanently. The wire should only be in the cave for a few days during an exercise or an authentic rescue.

### **How long can the Michiephones be left in the cave?**

The air in caves is usually at 100% humidity and this means that water will eventually get inside the Michiephones. The Michiephones should be removed from the cave after completion of the exercise or rescue. They should be cleaned and dried, if necessary, before storage.

### **Are the Michiephones waterproof?**

The Michiephones are splashproof, not waterproof. If they get wet they should be cleaned and dried before storage.

### **Can another Michiephone line be branched off the main Michiephone line?**

Yes. Any number of lines in any arrangement can be connected up. Michiephone handsets can be connected at any point along the line. Lines can even be connected in loops.

### **How far can I communicate using the Michiephones?**

At least a couple of kilometres and possibly several depending on the electrical conductivity of the ground, how well the user contacts both the case of the Michiephone handset and the ground with their hand and how many Michiephones are connected to the line.

### **How long should the batteries last in a Michiephone handset?**

A fresh, nine volt, alkaline manganese battery should give at least a hundred hours of continuous use and probably much longer. In very cold conditions alkaline batteries will deliver less power and will not last as long.

### **Can operating a Michiephone effect my Pacemaker?**

No. Any part of the Michiephone or Michiephone line can be safely handled – so long as no one has connected any high voltage equipment to the Michiephone line.

### **Can I connect the Michiephones to my Army Field Telephone system?**

No. Ex-Army Field Telephones use very high voltages. Connecting either Michiephones to the Field telephone lines or Field telephones to the Michiephone line will damage the Michiephones.

### **What are the limits to the Michiephone system?**

- With a Michiephone line many kilometres long the received signal strength will start to decrease.
- As the number of Michiephones connected to the system increases the received signal strength (ie the loudness from the speaker when receiving) becomes weaker. In practice you are unlikely to notice this effect because it requires a lot of Michiephones and for them all to be connected at once.

## 11 Important Notes on Michiephone Use !

### 11.1 Michiephones and the telephone system

Michiephones must NOT be connected to any Telephone system as this is illegal in most countries and it is likely that damage to the Michiephone will occur.

### 11.2 When changing the battery

When changing the battery be careful to connect the battery in the correct way. Connecting the battery incorrectly, even momentarily, may damage the Michiephone.

### 11.3 When laying Michiephone line

When laying the Michiephone line avoid placing the line across paths where personnel may trip over it. If this is unavoidable include plenty of slack and mark it with bright flagging tape so that it is less likely that someone will be tripped up.

## 12 Michiephone Handset Specifications

### 12.1 General Michiephone Specifications

These are typical values. Some variation will occur due to component tolerances and operating conditions.

|   |                          |
|---|--------------------------|
| Operating voltage:                          | 9 Volts nominal          |
| Current drain in receive (typical):         | 3 to 4 mA                |
| Current drain on transmit (typ.):           | 1 mA                     |
| Quiescent current (typ.):                   | 0.8 mA                   |
| Battery life, using alkaline manganese:     | at least 100 hours       |
| Exterior dimensions of case:                | 60 mm x 32 mm x 112 mm   |
| Weight (excluding batteries):               | 200 gm                   |
| Weight (including batteries):               | 244 gm                   |
| Low frequency -3dB point:                   | 200 Hz                   |
| High frequency -3dB point:                  | 20 kHz                   |
| Operating temperature range of electronics: | 0°C to 70°C <sup>1</sup> |

Table 1: Base Station Specifications

### 12.2 Typical Battery Specifications

PP3 Can Style

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|                             | Capacity (mAh) | Temperature range (°C) |
|-----------------------------|----------------|------------------------|
| Alkaline manganese          | 550            | 0 to 50                |
| Lithium manganese           | 1,200          | -40 to +70             |
| Nickel cadmium <sup>2</sup> | 150            | unknown                |

Notes:

1. Operating temperature range of the electronics is based on the temperature range of the amplifier chip. The type of battery used will also determine the useful temperature range.
2. The nickel cadmium PP3 battery has a voltage of 8.4 volts not 9.0 volts. This may result in a slightly lower volume level from Michiephones using nickel cadmium batteries.

## **Your Notes**