1. **Purpose**

This procedure outlines the process to be followed by Snowy Hydro personnel or contractors who perform positive identification of underground cables. The document covers cable identification using a signal generator and use of specific remote cable cutting or spiking equipment.

This document DOES NOT cover spiking or cutting of liquid or gas filled underground cables.

2. **Scope**

3. **Process**

3.1. **Introduction**

Snowy Hydro’s Safe Access Rules provide specific instruction and in conjunction with this procedure, detail the requirements which must be followed in relation to positive cable identification and proving de-energised.

All persons identifying underground cables must be competent in the use of cable location / identification equipment.

**NOTE:** For use of spiking guns, persons must be licensed for the safe operation and use of Explosive Power Tools as per relevant legislative and or statutory requirements (Eg. WorkCover).

Snowy Hydro must permit only “Authorised” persons as per the Safe Access Rules with the relevant competencies to perform the work detailed within this procedure.

It is the responsibility of all staff working with underground cable to ensure that they have identified and proven cables de-energised before working on them. The challenge is to locate cables of different voltages accurately and positively, before proceeding with the work required. Cables can be difficult to locate as a result of change and reconstruction and can be difficult to identify from physical characteristics or design parameters.

3.2. **Cable Identification**

It is the responsibility of all employees to ensure a Work Method Statement is completed prior to commencing work.

Minimum Approach Distances from live electrical apparatus must be maintained at all times as specified in Snowy Hydro’s Safe Access Rules.

This procedure covers work situations (for example cutting and jointing or repair) where underground
cables are de-energised. Prior to this work being carried out, the cable must be positively identified by an approved method and then proven de-energised by remote cable cutting or spiking.

3.3. **Approved Methods for Cable Identification**

3.3.1. **De-energised High Voltage Cables**

The preferred method for identifying de-energised high voltage cables is by using signal generator to verify the correct cable prior to remote cutting or spiking of the identified cable.

Where it is not practicable to spike or cut the cable remotely, the cable must be identified either by:

- visual tracing from a point of isolation; or
- at least two independent approved methods of identification.

A high voltage cable that has been identified using a signal generator or other approved means must be assumed to be alive until it has been positively proven de-energised by cutting or spiking. No work must be carried out until this positive proof has been made.

3.3.2. **De-energised Low Voltage Cables**

The preferred method for identifying de-energised Low voltage cables is by using signal generator to verify the correct cable prior to proving de-energised by:

- remote cutting;
- remote spiking.

Refer to section 3.3.3 for other methods (least preferred).

3.3.3. **Live Low Voltage Cables**

Live Low voltage can be positively identified by any of the following methods:

- visually tracing along the entire cable length where the cable is exposed for its full length from a point of isolation to the point of work;
- physically traced by pushing extensible rods through the complete length of the conduit to verify the cable from the point of isolation to the point of work;
- tracing from official cable plans produced and maintained by the owner of the cable/s AND a physical check of cable outer sheath markings by two independent persons to verify the cable is in fact a low voltage cable;
- Identify the cable using a signal / voltage detector of proven capability to identify the cable, in situ beyond doubt.

Where none of the above methods are possible, then the low voltage cable must be de-energised and cable identified as in section 3.3.2 above.

3.4. **Cable Identification Using Signal / Voltage Detectors**

- Cable points of origin must be visually identified by verifying cable marking and labelling details against operating diagrams and/or switching sheets.
- Ensure cable to be identified via test, and any associated cables or equipment is isolated as
per Snowy Hydro’s isolation procedures.

- Ensure HV cables are earthed as per Snowy Hydro’s isolation procedures.
- Comply with signal / voltage detector instrument manufacturers’ instructions or guidelines to identify cable.
- For high voltage cables, contact the Operator in Charge and, if there is a need to come closer than the Minimum Approach Distances as listed in SP09-18, ensure an “Access Permit” is issued prior to the work.
- Erect suitable barriers and warning signs around the work area to prevent unauthorised entry of persons.
- Ensure Personal Protective Equipment such as and arc rated: safety helmet, eye / face and hearing protection is worn.
- Ensure all persons are clear of the work area, and provide a warning to other persons prior to firing spiking gun.

The cable is now ready to be cut / spiked, refer to Section 3.7.

3.5. Proving the Cable De-energised
A cable that has been identified using a signal / voltage or other approved means must be assumed to be live until it has been positively proven de-energised by cutting, spiking or electrical testing (low voltage cables only under specific circumstances).

NOTE: No work must be carried out until this positive proof has been made.

Approved cable cutting and spiking equipment is designed to operate safely in the event of inadvertent spiking or cutting of a live cable. However, such an event can cause widespread supply interruptions and risk damage to network components, and every precaution must be taken to avoid such an action.

3.5.1. Multicore Cables
When cutting or spiking Multicore cables, earthing of the cutting / spiking equipment is not required as a phase to earth, or phase to phase protection fault will occur should the cable be energised.

Should an energised cable be inadvertently cut / spiked:

- DO NOT attempt to enter the pit or trench. Contact the Operator in Charge immediately to arrange immediate isolation
- DO NOT approach or touch the cable or cutter / spiking equipment until tested and proven de-energised
- DO NOT isolate without contacting the Operator in Charge unless there is a threat to human life.

3.5.2. Electrical Testing – Low Voltage Cables
Where it is not practical to cut or spike a low voltage cable or two or more single core low voltage cables cannot be cut or spiked simultaneously the following method should be adopted provided that the cable can be positively identified as per clause 3.3.3

NOTE: Technology is available to accurately and positively identify LV cables beyond doubt. This must be done before this section can be used. For any reason that the cable cannot be positively
identified, then testing using 2.7.2 cannot be adopted and 2.5 must be used:

1. position and stand on LV ground mat;
2. wear insulating gloves and remove small section of insulation from cable;
3. check operation of voltage detection device at a known source;
4. test between phases and to known earth point (install temporary earth where required) to prove cable de-energised, then;
5. check operation of voltage detection device at a known source.

3.6. Operation of Cutting / Spiking Equipment

3.6.1. Electrical Testing – Low Voltage Cables

Single or multi core cables can be spiked or cut in accordance with the operating instructions of the various equipment.

The method of cable configuration and spacing in the jaws of the equipment must follow the manufacturer’s guidelines. Single core cables may require spacers to protect the equipment from damage.

Cutters or spiking equipment must be earthed as appropriate. HV cables are generally screened and the cutting or spiking equipment must still be bonded to earth as required by the manual.

If single cored non earth sheathed cable (particularly LV) is to be cut or spiked the gun or spiker must be bonded to an earth of a satisfactory capacity to operate any protection equipment. It is therefore prudent if intending to cut or spike cables to ensure that protection equipment on nearby circuitry is operational and the earthing is solid enough to operate the protection equipment and disconnect supply. Tandem spiking / cutting can be set up using multiple items of equipment to undertake the actions on individual cores simultaneously.

3.6.2. Operation of Hydraulic Cable Cutting Equipment

Prior to using any hydraulic cable cutting equipment, visually check the condition of the equipment and that it is within any specified test date.

Ensure no oil leaks exist and that any battery or generator operated pump units and corresponding hoses contain fire resistant hydraulic fluid (e.g. Plantoflux 68 AT-S).

Ideally, hose length should be greater than 8m and be operated from the extent of the outstretched hydraulic hose.

If using a battery operated pump, it is recommended to have a second charged battery available as backup.

3.6.2.1 Position and Operate Hydraulic Cable Cutter

Identify / verify cable to be cut or spiked, then:

- install cutter head around the identified cable;
- attach hydraulic hose to cutter head. Roll out hose to its maximum length;
- ensure the on/off switch on pump is in OFF position before connecting the hose to pump;
- cover the cables and hydraulic hose in the immediate vicinity with suitable protective covers where appropriate;
• ensure barricades are in place and all persons are clear of the work area;
• operate the pump by switching the pump to ON position.

NOTE: The time taken could be one minute or more depending upon length of hose, cable size and type.
• Wait until the maximum pressure has been reached and the pump automatically switches off.
• Reverse the operation of the pump to retract the cutter blade.
• Switch OFF the pump.
• In the event of arcing, do not attempt to enter pit or trench, notify the Operator in Charge immediately and do not approach or touch the cable, cutting or spiking equipment until tested and proven de-energised.
• Lastly, inspect the cable to see if desired cut has been achieved.

3.6.3. Operation of Cable Spiking Equipment

WARNING: Operation of the spiking guns must be undertaken by remote means only, and by persons appropriately trained and licensed in the use of explosive power tools.

Cable spiking equipment must be operated in accordance with manufacturers’ instruction or guidelines and ensuring compliance with the Snowy Hydro’s Safe Access Rules.

All cable spiking equipment must be maintained and stored in accordance with manufacturers’ recommendations.

3.7. Operation – Acvoke Cable Gun
3.7.1.1  Assemble, Position and Operate Cable Gun

Numbers shown in parenthesis () depict Part numbers.

- Clamp the barrel base (7) and cable clamp (9) securely to the cable using the tube spanner.
- Tighten the clamp bolts (26) evenly so that the cable clamp (9) remains parallel to the barrel base (7).
- If the cable has a small diameter then lead packing should be used as shown below. However, if the cables to be spiked are HSL cables then the cable clamp must be used in an inverted position as shown.

**NOTE:** Adequate and correct lead packing is essential for trouble free stabbing of small diameter cables.

- First wrap a single layer of sheet lead completely round the cable then pack further lead strips underneath and at sides to give at least 90mm of solid resistance essential to absorb the full thrust of the piston punch or spike.
- Equally tighten the two clamp bolt nuts.

Correct tightening of bolt nuts and proper lead packing will ensure that the barrel base is satisfactorily aligned with and spaced at least a safe 38mm from the cable clamp.

- Ensure the barrel base fibre stop washer (3) is in good condition and located on top of the locating spring (36). Place the barrel base steel washer (2) on top and align its slot in line with the locating spring.
- Insert the piston punch (chisel) (35) into the barrel (1).
- Insert the barrel (1) into the barrel base (7) making sure the “V” marks on the barrel and barrel base are aligned.
- Push in the barrel base taper pins (8) and tap them home securely.
- Choose the appropriate cartridge and place in the top of the barrel. The cartridges come in sizes depicted by colour – Red, Green, Silver, and Yellow. See Section 4.3.3 – Cartridge Selection and Application.
- Screw the breech cap (14) on top of the barrel, ensure the breech cap latch (15) trips past the extractor (5) and drops alongside the stop screw (33).
- Place the firing bracket (41) on the barrel below the breech cap but above the gas exhaust vent. The eye of the firing bracket must be in line with the hammer release pin (27).
Unwind and lay the lanyard (34) or firing string out to the remote firing location. Feed the lanyard through the eye of the firing bracket, this gives a straight pull on the hammer release pin. The firing bracket allows the lanyard to be pulled from any direction and allows the operator to move as far away from the trench as possible.

The spiking gun must be remotely operated at a minimum distance of 8m from the gun.

Pull back the hammer (20) and insert the hammer release pin sufficiently to retain the hammer in a cocked position.

Ensure all personnel and the public are clear of the work area.

Depress the safety catch button (31).

The gun is now ready for firing. Indicate that you are about to fire (yell “Firing”) and fire the gun with a sharp pull on the lanyard (firing string). The safety catch returns to the safe position after firing.

Wait 30 seconds before approaching the gun in case a live cable was inadvertently stabbed and an automatic reclose were to occur.

Lift up the breech cap latch and unscrew the breech cap one turn. Now using the brass hammer, tap up the extractor level. This will release any pressurised gas in the combustion chamber.

WARNING: Failure to observe this precaution could result in the cartridge becoming a missile when the extraction lever is operated. Never have your head over the top of the gun during this operation.

- Remove the breech cap and disassemble the gun in the reverse manner as it was assembled.

Stab Cable with Chisel Rotated 90 Degrees

At times it may be required to stab a cable with the chisel turned 90 degrees so that the chisel hits the cable lengthways rather than crossways.

This is only to be done on cables if a parallel branch joint is to be performed on the cable and the cores would be badly damaged.

NOTE: Since the gun was not designed to operate in this manner it should be avoided wherever possible, discussions with supervisor must occur prior considering adoption of this method.

- To effect this method, the only change required is to remove the guide spring (36) in the barrel base and replace it with one that has been re-designed to guide the chisel 90 degrees from the manufacturer’s design.
- The cartridge used should be a smaller charge (i.e. Silver) as it does not have to cut the armouring as a sideways spike would.

Monitor Resistance to Earth While Spiking Cable.

- Where cable ends are earthed in convenient locations (i.e. Ground Substations) the responsible officer may prefer to monitor the cable resistance to earth value during the cable stabbing process, to confirm an effective earth has been achieved.
- This is done by removing all earths; and, at one end, short the cores together and measure their resistance to earth. This should be greater than 10 Meg ohms and drop to less than 10 ohms upon stabbing.
The person operating the gun and the person watching the ohmmeter should maintain communication (eg. radio, mobile phone) during the operation.

Precautions When Stabbing Near to Cable Ends

NOTE: When stabbing a cable near to its end, since the length is short, there is a possibility the chisel may miss the conductors.

To successfully perform this operation, mount two guns (chisel crossways), one right on the end of the cable and, the second far enough along and back from the cable end, to ensure hitting of cable cores if fired.

- Use an ohmmeter to monitor resistance.
- Fire the gun at the cable end first.
- If successful earthing achieved, disarm and remove second gun.
- If unsuccessful earth after firing first gun, the second gun will have to be fired.

Requirements for use on 11KV Aluminium Sheathed Cables using Cable Gun Conversion Kit

Cable Gun Conversion Kit for use with 11KV Aluminium Sheathed Cables

Cable Conductor Area - 95mm², 185mm², 300mm²

The conversion kit consists of a special cable clamp part number 1430/9S, which must only be used with the standard cable gun, replacing the standard cable clamp part number 1430/9. See above diagram.

The clamp is designed so that one side is marked 185 and 300 which takes both the 185mm² and 300mm² conductor area cables. Providing only the “Light” cartridges are used (See below – Cartridge Selection and Application), no packing of this size of cable is required.
The clamp is reversible to take 95mm2 conductor area cables (see above diagram). Packing is necessary when spiking cables of size 95mm2.

**WARNING:** DO NOT attempt to stab a 95mm2 cable without packing as detailed below, as this will result in serious damage to the gun.

- A short length (approx 100mm long) of scrap 95mm2 cable should be used as packing and placed under the cable to be stabbed as shown above. It will be found that the scrap length of cable can be used as packing more than once, by moving it to a new position
- If preferred, packing can be in the form of a rolled or cast billet of lead of similar diameter.

**CARTRIDGE SELECTION AND APPLICATION**

“**RED**” STRENGTH (HEAVY) for use with older types of steel wire armoured cables over 85mm (3 3/8”) outside diameter, in the Standard gun, and up to 150mm (6”) outside diameter in the Heavy Duty gun.

“**GREEN**” STRENGTH (MEDIUM) for lead covered and all armoured cables up to 85mm (3 3/8”) outside diameter.

“**SILVER**” STRENGTH (LIGHT) for aluminium sheathed cables up to 300mm2 and the modern small diameter plastic covered cables.

“**YELLOW**” STRENGTH (EXTRA LIGHT) for small polymeric type cables having no outer metallised sheath.

**NOTE:** ONLY USE “Green” or “Silver” cartridges when stabbing small diameter cables.

**STEPS TO BE TAKEN SHOULD THE GUN MISFIRE**

If the cartridge fails to fire instantaneously when struck by the firing pin, it is unlikely that a delayed explosion will occur.

- DO NOT touch anything.
- Wait 3 minutes.
- Ensure that safety catch is in “safe” position.
- Ease breech cap one full turn only and then lift extractor to free cartridge rim from chamber.
- Completely remove breech cap and lift out cartridge by hand.

The probable cause of the failure will be:

- a. Weak hammer spring.
- b. Hammer tight on bush.
- c. Firing pin eroded.

The cartridge can safely be used or fired again once the firing mechanism of the gun has been checked.

If the cartridge still does not fire, then remove and safely dispose of the cartridge.
CLEANING THE ACOVEK CABLE GUN

- Disassemble the gun.
- Insert the cleaning tool (40) carefully into the barrel bore, pushing it right home and rotate it with a firm clockwise pressure to remove any powder deposits at the breech.
- Using the Hilti lubricating and cleaning fluid, spray the barrel bore and wipe with a clean cloth. Store, wrapped in a clean cloth.
- Spray the inside of the breech cap and wipe clean. Store, wrapped in a clean cloth.
- Spray the chisel with Hilti spray and wipe clean.
- Remove and clean the barrel base fibre and steel washers. Spray and clean the barrel base and replace the barrel base washers.
- Spray and wipe clean the rest of the components and store for future use.

WARNING: Neglecting to properly clean the gun after each use and before storage will lead to corrosion from the acidic products of combustion.

3.8. Approved Methods of Cable Identification

3.8.1. Electrical Methods

Audio Frequency Signal Generator

Injection at a point of isolation of an audio frequency signal between two cable cores and by the use of a sensing device detecting the signal at the work site (this requires the cores to be shorted together at the remote end).

Current Injection

- Direct current injection at a point of isolation and detection of the current at the worksite by the use of a direct current tong ammeter.
- A low voltage alternating current can be injected at a point of isolation into single core cables or one core of a Multicore cable and measured at the worksite.

Pulse Injection

A pulse or ramp of direct current injected into a conductor at a point of isolation and detected at the worksite by the use of a receiver and a polarity-sensitive indicating instrument (the return current is via cable sheaths and earth).

Interrupted Earth

Meggering an insulated sheath or screen of a cable at a point of isolation to detect an applied interrupted sheath earth fault connected at the point of work.

Fault Location

A cable fault test which by applying a test voltage or pulse at a point of isolation produces a positive indication at the point where the work will be done (the indication will normally be a visible and audible explosion at the fault).
3.8.2. Non-Electrical Methods

Visual

Visually tracing along the entire cable length where the cable is exposed for its full length from a point of isolation to the point of work.

Tracer Gas

Where a gas-filled cable is leaking gas at the worksite and the presence of a tracer gas, injected at a point of isolation, can be detected at the worksite.

Caution: Use of this method alone is not an acceptable means of identification.

Pressure Loss

Where an oil-filled cable is leaking at the worksite and the pressure loss is monitored at a point of isolation.

Caution: Use of this method alone is not an acceptable means of identification. Other cables in the vicinity must also be checked for pressure loss.

Rodding of Conduit

Where a cable in a conduit is physically traced by pushing extensible rods through the complete length of the conduit to verify the cable from the point of isolation to the point of work.

Cable Plans

Tracing from official cable plans produced and maintained by the owner of the cable/s.

Caution: Use of this method alone is not an acceptable means of identification.

4. Accountabilities

<table>
<thead>
<tr>
<th>All persons authorised to identify and or spike cables</th>
<th>Compliance with this Practice</th>
</tr>
</thead>
</table>

5. Records

Records, or forms, that are generated by the procedure should be listed.

6. Associated Forms and Documents