EXOWELD®

INSTRUCTION MANUAL

A guide for the safe use of exothermic connections

The parameters and criteria set out in this handbook are based on the experience gained over the years of using Exoweld© products for installation work, as well as our ongoing research and development at our manufacturing plant, to develop better exothermic technology.

The exothermic welding process is a simple, self-contained method of forming high quality electrical connections. The compact process requires no external power or heat source, making it completely portable.

Connections are made inside a semi-permanent graphite mould, using the high temperature reaction of powdered copper oxide and aluminium.

An exothermic connection is actually a molecular bond formed between two metals such as copper to copper, copper to steel and steel to steel. Copper oxide and aluminium are combined and ignited. The result is an exothermic reaction that produces molten, super-heated copper and aluminium oxide slag. The melting or fusing temperature rating of the finished joint is 2000°C +. The molten, super-heated copper melts the objects being connected together, forming the molecular bond.

This bond will not loosen over time or deteriorate with age. The connection's current carrying capability is to that which it is being connected. In other words, there is no increase in resistance in an exothermically welded connection as there is in most pressure connections.

The majority of exothermic connections have at least twice the cross sectional area of the conductors being joined, and an equivalent or greater current carrying capacity. Because the connection is a fusion of high conductivity, high copper content alloy, it will withstand repeated fault currents, and will not loosen in the way that mechanical connections can.

Corrosion resistance too, is exceptional, due to the alloy's very high copper content, which is in excess of 90%.

This instruction manual offers and provides training for personnel to make a variety of different types of exothermic connections, covering the required safety aspects as laid down in the OHS act of 1998. Training courses are accredited by Energy Seta.

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TYPICAL EXOTHERMIC CONNECTIONS

CABLE TO CABLE

MCCX MCCT MCCO MCCV MCCV1 MCCH MCCH1 MCCS

CABLE TO EARTH ROD

MERT MERL MERX MERX1 MERBT MER3

CABLE TO STEEL SURFACE AND PIPE

MCS1H MCPT MCS45 MCS3V MCS1P MCPS MCS2P MCS2H

CABLE TO BAR

MCB MBCT MCBT

BAR TO EARTH ROD

MEBR MEBT

BAR TO BAR

MB1B MB2B MB3B MB4B MB5B MB6B MB4BFW MB9BV

BAR TO STEEL

MB1S MB2S MB3S

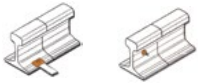
STUD TO STEEL SURFACE

MSVS MSHS

CABLE TO RAIL

MRC MRF MRW-L/R

BAR AND STUD TO RAIL



MBF90 MWS

CABLE TO REINFORCING BAR

MCRH MCR1X MCRV MCRP MCRT

The moulds are manufactured from graphite as it is found to be one of the best materials to withstand the very high thermal and mechanical shocks present in the exothermic welding process. The heat obtained in the weld process is in excess of 2000°C.

Graphite lends itself to easy machining so as to accommodate the various sizes and shapes required for welded connections.

The graphite mould is designed to last for an average of 50 to 60 connections. This will vary according to the care given to the mould during use, cleaning, storage and transportation. Worn-out or damaged moulds should never be used as the joint will be sub-standard and it may pose serious risk and danger to staff.

Mounted on the side of the mould is the name plate indicating the size of the conductors, type of connection and the size of the weld metal to be used.

NB: always refer to the mould name plate.

TAKE NOTE:

- No alteration whatsoever may be done to the mould
- Alterations may only be made by the factory
- Mould must be absolutely dry before use
- The mould, when dropped or hit, will break
- Water or moisture are dangerous in a molten metal environment

Weldmetals consist of copper oxide, aluminium and flux in powder form. The powders are packed into plastic containers and the quantity is pre-determined by the factory for specific connections. The weldmetal powders are marked in numbers, e.g. 15, 25, 32, 45, 65, 75, 90, 115, 150, 200 and 250g (Fig. 1).

These in turn are packed in a number of either 10 or 20, in a larger plastic container with a lid, metal discs and silica gel which serves as a moisture absorber and an Exoweld© leaflet, which contains the following information (Fig. 2):

- Quantity of powder
- Size
- Batch number (very important)

The weldmetal is packed under the white cap of the container, and the ignition powder is packed under the red cap (Fig. 3).

The ignition temperature of the weldmetal powder is in the vicinity of 1000°C. This high ignition temperature is difficult to achieve, hence we use ignition powder.

This ignition powder is similar to the weldmetal, with the exception that it is much finer, allowing ignition at about 450°C by using a flint gun (igniter). This cannot be ignited with a normal flame i.e. matches, cigarette lighters etc. (Fig. 4).

Under no circumstances must half the quantity of weldmetal stipulated be used and neither must the quantity be doubled up, if not stipulated. Each weldmetal size quantity is for a specific type of connection only.

Should any fault be experienced with the weldmetal, the batch number on the Exoweld© leaflet must be referred to when logging the complaint, as without it, no cross-referencing can be done.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

HANDLE CLAMPS

Mould securing clamp and screw

Adjusting eye bolt. Used to tighten/loosen the handle clamp when the mould doesn't close properly.

TAKE NOTE:

- Handle clamps have a vice grip type locking arrangement which allows the operator to free their hands while making connections
- When repetitive welding takes place, the mould becomes far too hot to handle. Wear safety gloves and always use a handle clamp
- Mould securing clamps hold hot mould parts to the handle clamp securely, allowing easy cleaning

THREE TYPES OF MOULDS WITH HANDLE CLAMPS

1.

Four pre-drilled holes for handle clamp prods.

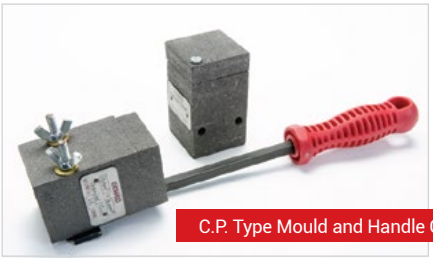
2.

Because the mould gets very hot during the welding process, the securing clamp and screws secure the mould to the handle clamp.

3.

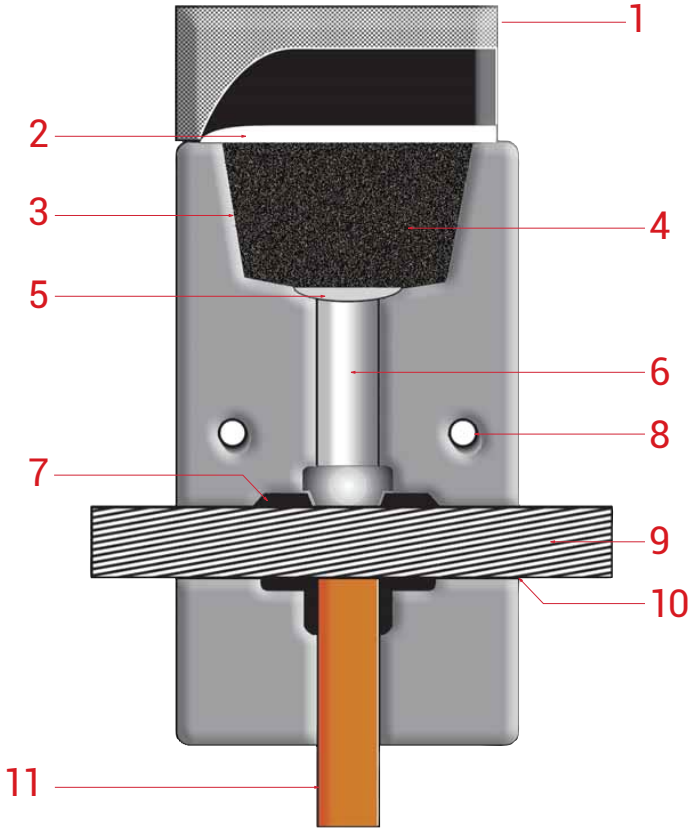
Push the handle clamp prods down into the mould and secure clamping screws.

4.



C.P. Type Mould and Handle Clamp

Slide mould onto handle clamp screws and lock with wing nuts.



1. Mould Cover
2. Starting Powder
3. Mould Crucible/Cup
4. Weldmetal Powder
5. Steel Retaining Disc
   (plays an important role)
6. Tap Hole
7. Weld Cavity
8. Locating Pin
9. Cable (Conductor)
10. Conductor Area
11. Earth Rod

The heat generated in a mould when a connection is made is in excess of 2000°C. Regular, thorough inspection of all moulds is very important to avoid uneccessary burns or accidents.

1. Mould Parts

- The machined area and interfaces of the mould must be kept clean. Only the Exoweld© poster paintbrush must be used. No wire brush must come near the mould
- If the moulds are placed together with locating pins, the two sides must be square to one another
- Mould faces should seal (no gaps)
- There should be no chipping or gouges on the machined contours

2. Mould Cover

- Make sure that each mould has a lid that has been secured

3. Mould Cup and Disc Seat

- The disc seat should look good
- The disc seating area must have no chips or cracks
- Make sure that the disc seals the tap hole. This is to prevent the powder passing into the tap hole prior to ignition

4. Weld Chamber

- The cavity should be well defined
- There should be no chips or gouges

5. Conductor Area

- The conductors should have a 3mm gap between them where possible. This allows the flow of weldmetal
- The area must not be chipped or worn out

For the purpose of this demonstration, we have used a vertical opening mould and a bare copper earth wire (BCEW) to be connected to an earth rod type “T” connection, Exoweld© code MERT.

Step 1

Graphite is brittle and can break when dropped or hit. Please handle with care. Clean conductors using a conductor cleaning brush with a wooden handle and steel bristles (see above).

NB: This brush must only be used on conductors and not on the mould.

Step 2

Select the correct mould by checking all the details on the mould name plate.

- Connection type
- Conductor Sizes
- Weldmetal Size

MERT Type Mould

Step 3

- Fit the conductors into the mould
- Close the mould with the handle clamp and lock
- Ensure the two mould faces seal (with no gap)
- Ensure that the conductors have a 3mm gap between them

Fig. 1

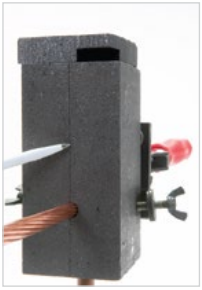


Fig. 2

Step 4

- Slide the mould lid open (Fig. 3)
- Take the disc and place it into the mould cup making sure that it sits properly
- The disc plays a very important role in sealing the tap hole (see page 8), preventing any weldmetal passing into the weld chamber. Should weldmetal run past the disc, further procedures must be discontinued, as it will result in an unsatisfactory connection (Fig. 4)

Fig. 3

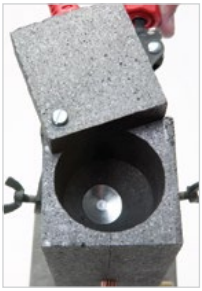


Fig. 4

Step 5

- Check the mould name plate for the correct weldmetal powder (Fig 5)
- Remove the white cap from the weldmetal container, holding it over the cup of the mould, as spillage will fall into the mould cup
- Slowly pour the weldmetal powder (copper oxide and aluminium) into the cup, making sure not to upset the disc (Fig. 6)
- Only the full contents of the container will be filled into the cup. If less, or more is used, it will seriously affect the results

Fig. 5

Fig. 6

Fig. 7

Fig. 8

Step 6

- During transportation, the ignition powder becomes lumpy in the red container
- Tap the container against a hard surface to loosen any lumpy powder content
- This action allows for easy sprinkling of the starting powder on the mould lip and over the weld metal (Fig.7)
- Check where the opening on the mould cover is located when in a closed position (Fig. 8)

Fig. 9

Fig. 10

- Now remove the red cap from the weldmetal container and sprinkle some starting powder on the lip of the mould where the opening of the cover was (Fig. 9)
- Then sprinkle the remainder of the starting powder over the weldmetal cup (Fig. 10)

Fig. 11

Fig. 12

- Slowly slide the cover into the closed position, taking care not to wipe off any of the ignition powder (Fig. 11 and Fig. 12)

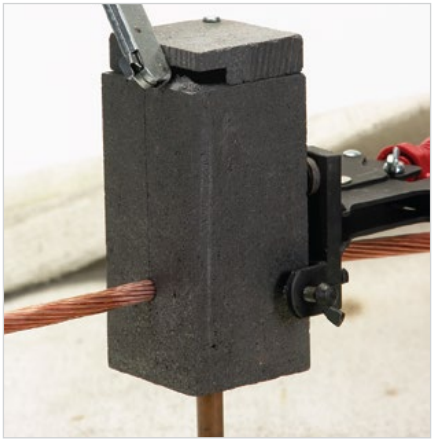


Fig. 13

Step 7

Ensure the following prior to ignition:

- Don all safety gear (gloves, goggles, etc.)
- Be well clear of all flammable goods
- Flammable goods or other non-essential personnel to be two meters clear of the area
- Operators should be behind the opening in the mould cover
- Be careful of starting veld fires
- Rest the flint igniter at approximately 60° on the lip of the mould where the ignition powder was deposited (Fig.13)
- Pull the trigger (ignite) and move hand away from the mould

Step 8

- After ignition, wait ±15 seconds before opening the mould with the handle clamp (Fig. 14 and 15)
- Remove the mould and handle clamp from the connection (Fig. 16)

Fig. 14

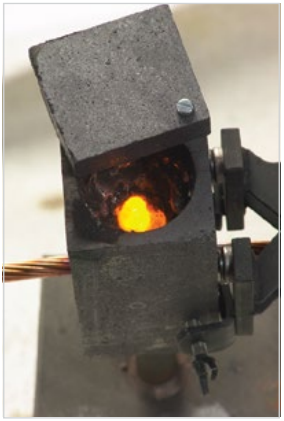


Fig. 15

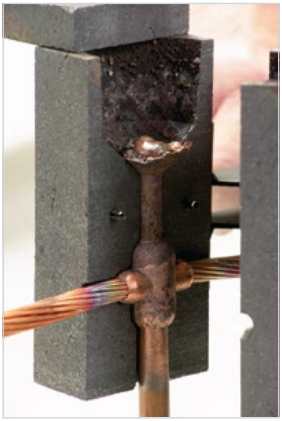


Fig. 16

NB: The smoke coming from an exothermic weld has been tested and found to be non-toxic

Fig. 17

Step 9

- Once the mould has been removed from the conductor, clean the mould using the poster paintbrush (Fig. 17)
- This brush is used on all moulds (vertical and horizontal)
- Remove all remaining slag

Fig. 18

Step 10

- Use the mould cup scraper to clean up. By using this cup scraper, it ensures minimum damage to the disc seat (Fig. 18)

TAKE NOTE:

The scraper is used for cleaning the cup and tap hole only on the horizontal opening mould

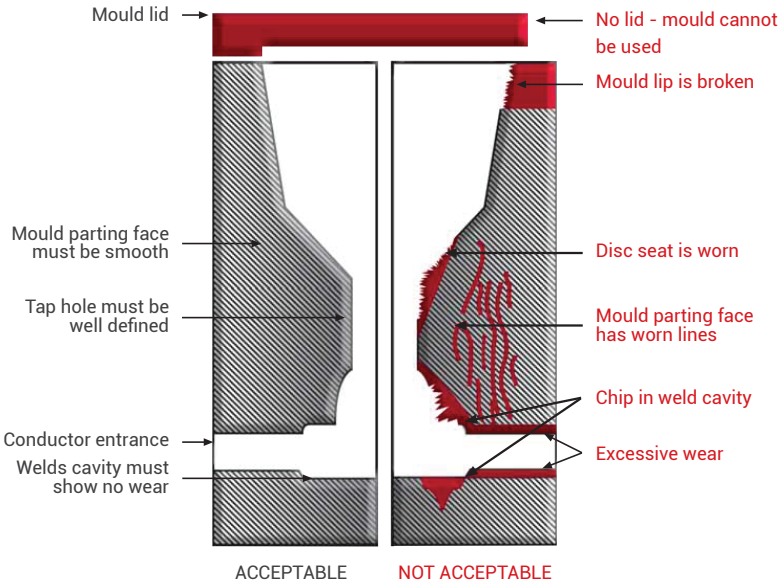
The Exoweld© connection has the following advantages:

- A current carrying capacity greater than that of the conductor
- It will last indefinitely and will not age
- It has a lower electrical resistance than a mechanical joint
- It will not corrode or loosen as it is a permanent atomic bond
- Saves time with no external source of heat or power required, which lends itself to fieldwork
- Low labour costs (no special skills are needed and minimal training is required)
- Exothermic welded connections are superior to any known mechanical or pressure type connection

The Exoweld© exothermic welding process is not only applicable to copper to copper, copper to steel or steel to steel connections, but also has been successfully used on materials listed below:

- Brass and bronze
- Cast iron, commercially pure steel and copper clad steel
- Galvanized steel
- Stainless steel, silicon bronze and steel rail
- Wrought iron

VERTICAL SPLIT MOULD



The Exoweld© mould are designed to complete 50 - 60 connections, depending on the care given to the mould during usage, transport and storage.

Regular checks of the following will determine if moulds are fit for use:

- Mould must be dry and have a lid
- Mould face must be smooth, so when closed it seals properly
- Mould disc seat must show no signs of chips, cracks, gouges or wear
- The steel retaining disc must seal properly. No powder must fall into the weld cavity prior to weld
- Tap hole must be well defined
- Weld cavity must have no chips or signs of wear
- Conductors must fit snugly and not be loose in the mould
- The correct mould cleaning tools must be used (e.g. poster paintbrush and cup scrapers)
- Moulds must be handled carefully to avoid damage and excessive wear

1. Toolkit

- Plastic tool box (51cm)
- Standard handle clamps
- Mould scraper 34
- Mould scraper 55
- Mould scraper 65
- Mould cleaning brush
- Conductor cleaning brush
- Flint ignitor gun
- Spare flints
- Mould support clamp
- Safety glasses
- Safety gloves
- Safety apron (leather)
- Mini burns kit
- Sealing putty

2. Safety Equipment

- Safety goggles
- Safety gloves
- Safety apron

3. Additional Tooling Equipment

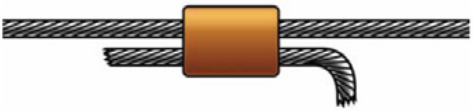
- Rod bender
- Chain clamp

When designing systems, it is recommended that connections are standardised as far as possible. The following is an example of this.

NORMAL STRAIGHT THROUGH CONNECTION (MCCS)

PARALLEL TYPE CONNECTION (MCCV)

PARALLEL TYPE CONNECTION (MCCV)



PARALLEL TYPE CONNECTION (MCCV)

PARALLEL TYPE CONNECTION (MCCV)

TAKE NOTE: All connections made with a single mould

Exothermic Welding Course

This course covers all safety aspects, storage, transport and making of good quality exothermic welded connections.

Sub-Station Earthing

Exothermic weld connection to:

- Steel galvanized structures
- Fence poles
- Buried earth mats
- Substitution of copper tape with earth electrodes in high theft areas
- Distribution and transmission tower earthing

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