Exothermic welding manual

KALweld® graphite moulds and weld powder: step by step, with quality and safety tips



37 joint types in 7 groups
Conductor, tape, earth rod, reinforcing bar and steel plate

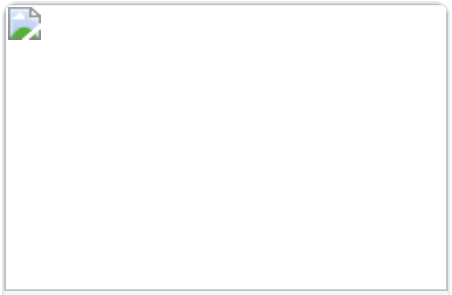
12 illustrated steps
From heating the mould to cleaning it

Tested to IEEE 837 and UL 467
At the Power and Water University of Technology (Shahid Abbaspour): freezing, thermal cycling, short circuit

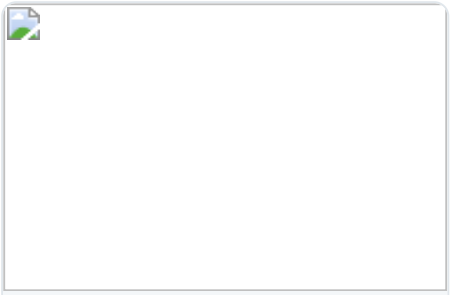
What is exothermic welding?

exothermic welding (also called thermite welding) makes permanent joints between the conductors of earthing, bonding and lightning protection systems. The heat-releasing reaction of the weld powder (copper oxide and aluminium) inside the graphite mould produces molten copper that melts the conductor surfaces and, once cooled, leaves a single solid joint: no bolts, no electricity and no contact surface that can loosen or oxidise over time.

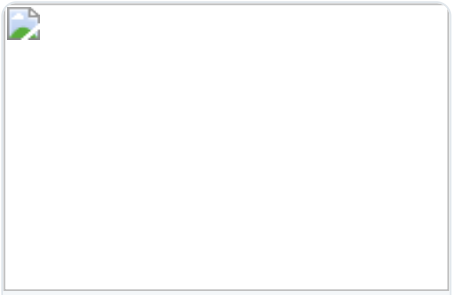
KALweld® system components



Two-part graphite mould, stainless steel lid and handle



KALweld® weld powder: box, cartridges, discs and powder



Complete exothermic welding kit: mould, handle, powder, discs, tools and safety gear

Graphite mould

Made from high-grade, semi-permanent graphite; each mould is machined for one joint type and one conductor size, and it sets the direction, speed and final shape of the molten metal. The mould code and the matching powder are marked on the mould lid. Used correctly and in line with this manual, each mould is good for **50 to 60 welds** .

KALweld® weld powder

Code	Powder weight	Qty per box
KWD 025	25 g	20
KWD 032	32 g	20
KWD 045	45 g	20
KWD 065	65 g	20
KWD 090	90 g	10
KWD 115	115 g	10
KWD 150	150 g	10
KWD 200	200 g	10
KWD 250	250 g	10

The discs come in a separate bag inside each box, one disc per weld. The starting powder is packed into the bottom of each cartridge.

Handles

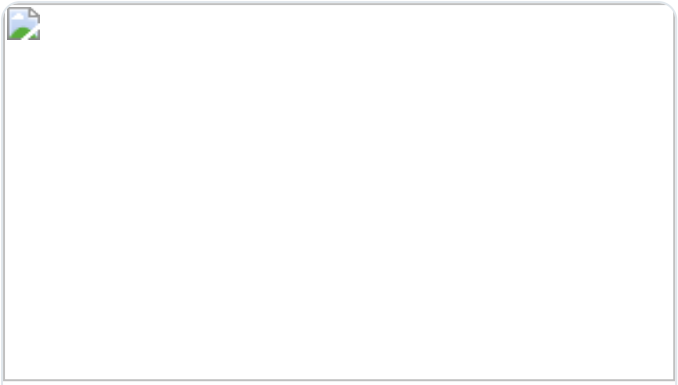
Code	Description
HC 01	Standard handle
HC 02	Medium handle
HC 03	Large handle
HC CH	Chain handle for pipe and reinforcing bar
HC AC	Mould holder stand

Tools and safety gear (TK1 toolbox)

GLV	Gloves	DMM	Mask
GLS	Safety glasses	FIG	Flint igniter
WRB	Wire brush	MCB	Mould brush
MSC	Mould cleaner (scraper)		

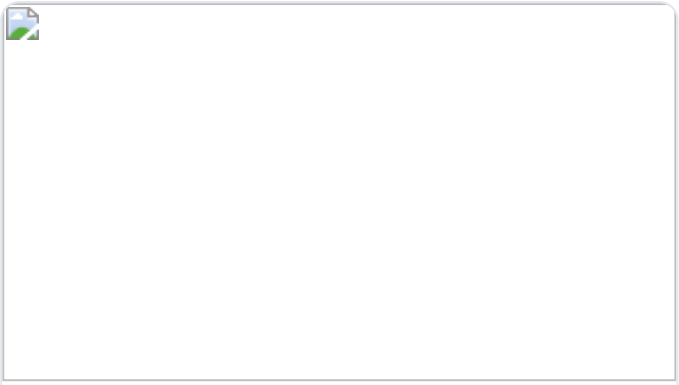
Plus a small gas torch for drying and preheating.

Exothermic welding steps (1 to 6)



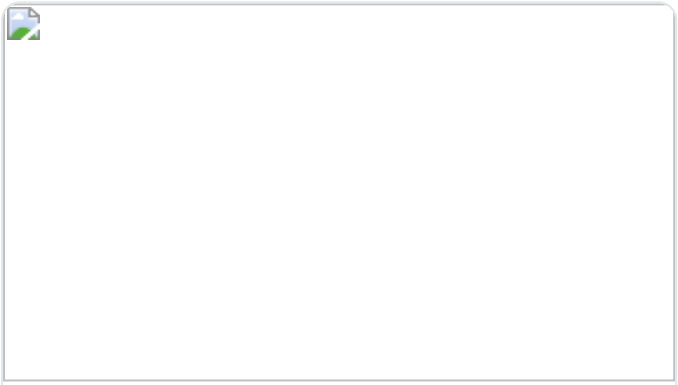
1 Heating the mould

Before the first weld, heat the cold mould with a gentle torch flame until a drop of water sizzles on it. Graphite absorbs moisture from the air, and moisture is the main cause of porosity in the weld.



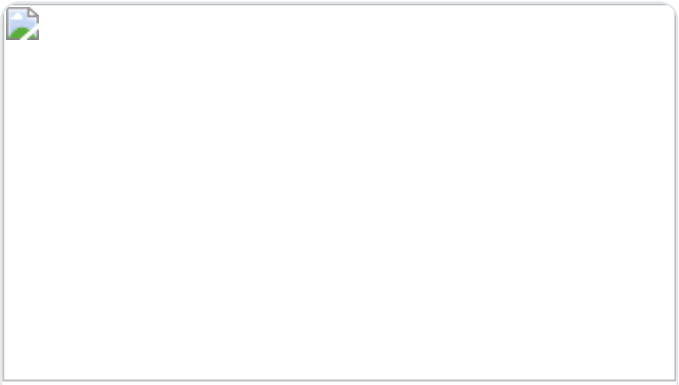
2 Cleaning the conductors

Clean the conductor ends with a wire brush down to bright metal; no oil, mud, paint or oxide should remain. Bring steel surfaces and reinforcing bar to bright metal with a grinder or file.



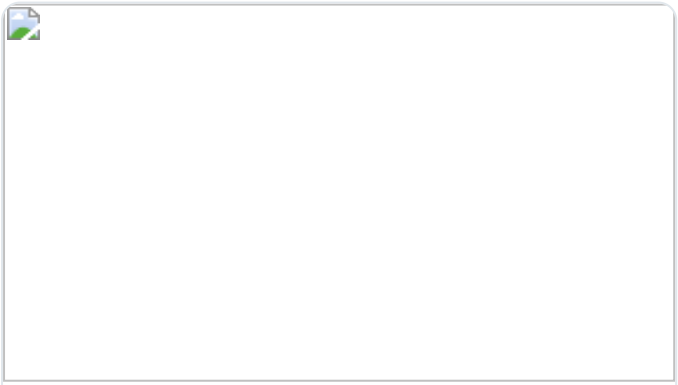
3 Drying and heating the conductors

Dry the conductors with the torch flame. A wet or damp conductor gives a porous weld and may make the molten metal spatter.



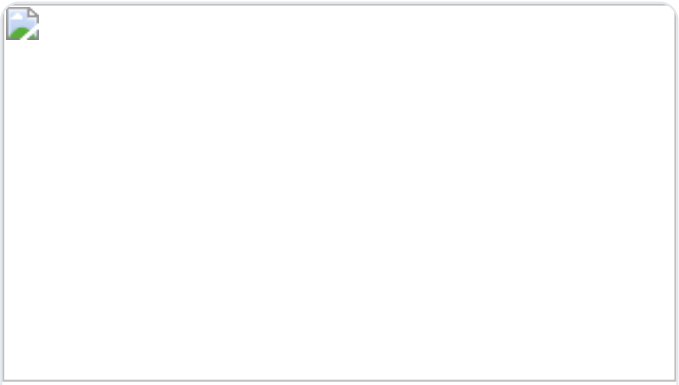
4 Fitting the handle to the mould

Fit the handle that suits the mould (HC 01, HC 02 or HC 03) onto the two mould halves and adjust it.



5 Placing the first conductor in the mould

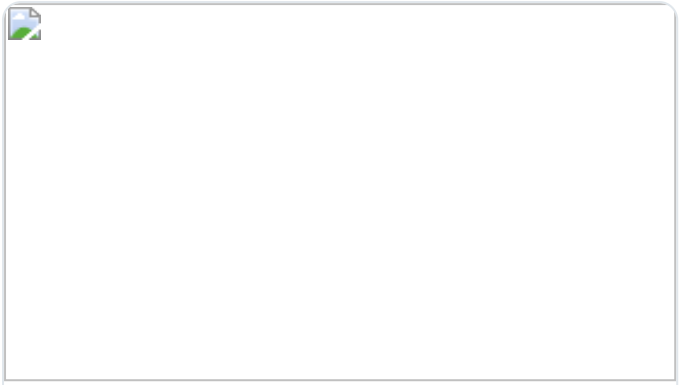
Lay the first conductor in its groove without forcing it, exactly in the middle of the weld cavity.



6 Placing the second conductor and locking the mould

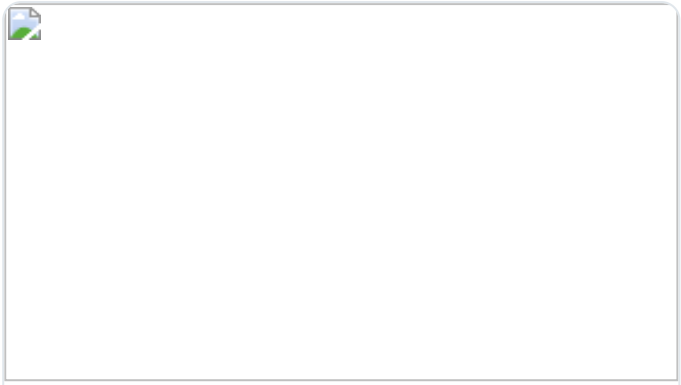
Lay the second conductor crosswise in the other groove and squeeze the handle until the two mould halves lock fully together.

Exothermic welding steps (7 to 12)



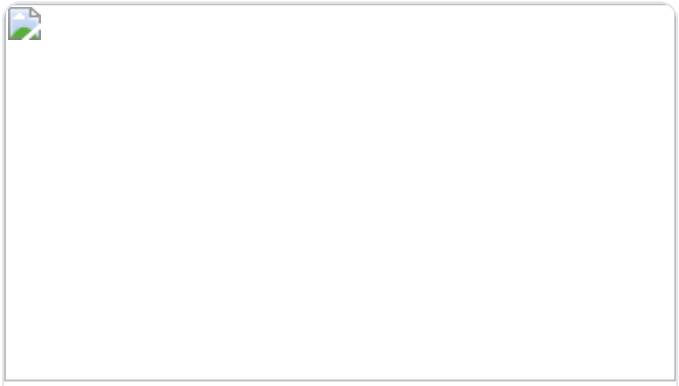
7 Placing the steel disc

Open the lid and place one disc, concave side up, on the floor of the reaction chamber over the tap hole.



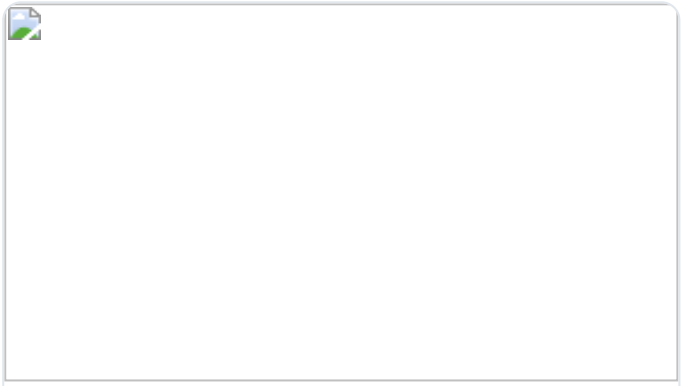
8 Pouring the weld powder

Pour the powder marked on the mould lid gently into the chamber without moving the disc.



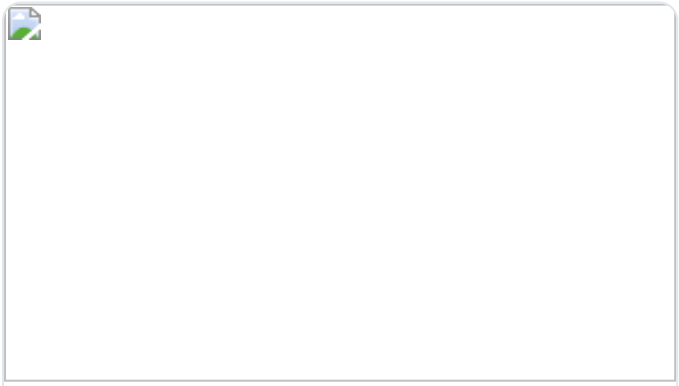
9 Adding the starting powder and closing the lid

Tap the bottom of the cartridge a few times to free the starting powder, spread it over the powder and the mould lip, and close the lid.



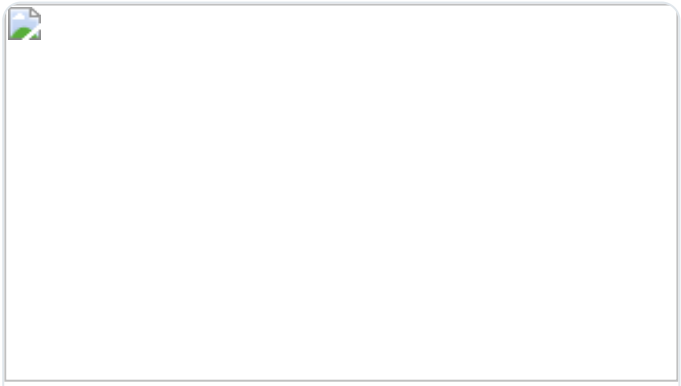
10 Igniting with the flint igniter

Strike a spark with the igniter at the side of the lid and step back at once. Never light the starting powder with a match, gas lighter or flame.



11 Opening the mould after one minute

Wait at least one minute for the molten metal to solidify; then open the mould carefully, take out the weld and inspect it.



12 Cleaning the mould

Clean the slag from the chamber and tap hole with a bristle brush and scraper. Never clean the mould with a wire brush.

Key points for a sound weld

Do

- ✓ Use the mould and powder that match the joint type and the conductor size.
- ✓ Heat a cold mould before the first weld; in back-to-back welds a hot mould needs no reheating.
- ✓ Clean the conductors to bright metal and dry them fully.
- ✓ Cut the conductor end square with cable cutters so the strands do not open.
- ✓ Lock the two mould halves fully and hold the conductor in a clamp.
- ✓ Wait at least one minute before opening the mould.
- ✓ Clean the mould after every weld with a bristle brush and scraper.

Don't

- ✗ Don't clean the mould with a wire brush, knock it or drop it.
- ✗ Don't substitute powder meant for another mould or of another size.
- ✗ Don't weld on a wet, oily or muddy conductor or mould.
- ✗ Don't light the starting powder with a flame or match; use only the flint igniter.
- ✗ Don't open the mould before one minute is up.
- ✗ Don't use mud or unsuitable materials to seal leaks.

Preparation for each joint type

Joint	Note
Conductor to earth rod / tape to earth rod	Cut off the thread at the top of the earth rod before welding and dress the flattened end; moulds CE1, CE2, CE3 and TE are made for copper-bonded earth rods.
Conductor to reinforcing bar	Clean rust and mill scale to bright metal, and seal around the ribbed reinforcing bar with the heat-resistant packing supplied in the box so the molten metal does not leak.
Conductor to steel plate	Clean the weld area to bright metal with a grinder or file; remove paint, rust and galvanising, and after welding coat the surrounding surface with anti-rust paint or zinc spray.
Tape to tape / conductor to tape	Cut the tape ends square and flatten them so they sit in the mould with no gap.

Welder safety and health

- **Personal protective equipment:** Heat-resistant gloves, safety glasses, mask, long-sleeved clothing and safety shoes; move a hot mould only by its handle.
- **Fumes and ventilation:** Step back after ignition, stand with your back to the wind and do not breathe the fumes; ventilate enclosed spaces.
- **Moisture:** Molten metal touching water causes sudden steam and spatter; keep the mould and conductor dry at all times.
- **Fire:** Remove combustible materials, keep an extinguisher or dry sand to hand, and do not smoke while

Weld inspection and troubleshooting

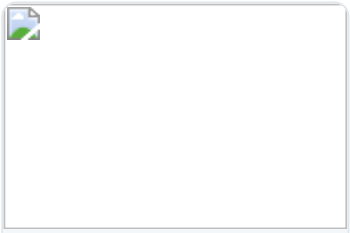
Sound weld

It fills the mould cavity completely and covers the conductors fully, its slag comes away easily, and after cleaning it has a golden to copper colour. A deep cavity, an unmelted conductor under the slag or an incomplete weld means the weld must be redone.

Fault	Common cause	Solution
Voids and porosity	Moisture in the mould or conductor; oil and grease; galvanised coating	Heat the mould; dry and clean the conductor; remove zinc
Excess slag	Disc not seated; damaged disc seat; raw powder spilled	Place the disc correctly; replace the damaged mould
Molten metal leakage	Worn mould; conductor smaller than mould; mould not fully locked	Adjust the handle; correct-size mould; heat-resistant packing for reinforcing bar
Conductors not fused	Moisture and oxide; wrong positioning; wrong powder	Clean thoroughly; conductors centred in the cavity; powder as marked on the mould lid
Large weld bulge	Wrong powder; moisture in the mould or conductor	Correct powder; dry the mould and conductor
Early mould wear	Wire brush; impact; back-to-back welds and overheating; opening too early	Bristle brush; keep it in its box; wait one minute

Tested to IEEE 837 and UL 467

KALweld® four-way and three-way welds on 120 mm² copper conductor were tested to IEEE 837 and UL 467 (reports 95/4221 and 95/4220, 1395/12/24). Every test was passed:



Four-way copper conductor weld

Test	Test conditions	Result: four-way (report 95/4221)	Result: three-way (report 95/4220)
Freeze-thaw cycle	10 cycles: more than 2 hours below -10 degrees in water and more than 2 hours above +20 degrees	No cracks or breaks; resistance 176 to 179 µΩ/m: passed	No cracks or breaks; resistance 179 to 184 µΩ/m: passed
Thermal cycle (resistance change)	25 cycles at a current above 1100 amperes; reference conductor up to 350 degrees	Largest change in weld resistance 2.8%: passed	Largest change in weld resistance 3.0%: passed
Weld temperature in the thermal cycle	Thermometer on each weld and on the reference conductor (350 degrees)	286 to 306 degrees; cooler than the conductor: passed	287 to 309 degrees; cooler than the conductor: passed
Short circuit (up to melting point)	Circuit of 120 square millimetre copper conductor, 20 kA current	Withstood 12 kA for 8 seconds with no defect; then at 20 kA the copper conductors melted and the welds stayed intact: passed	At 20 kA the copper conductors melted and the welds stayed intact: passed