McWade
Productions (Pty) Ltd

McWade Technical Catalogue

WARRANTY

McWade Productions (Pty) Ltd. will make good,

- by repair or,
- at our option, by the supply of a replacement,

defects which, under proper use, appear in the goods, within a period of 12 months from the effective date, after the goods have been delivered and arises solely from

- faulty materials or
- workmanship or
- design,

provided that defective parts have been returned to us, if we shall have so required.

DISCLAIMER

Every effort has been made to ensure that the information contained in these data sheets are correct. McWade disclaims responsibility for any action, proceedings, liabilities, claims, damages, costs, losses and expenses in relation to or arising out of incorrect utilisation of this information. McWade reserves the right to make changes to the data as and when required.

Founded in 1961, McWade Productions has progressed in line with the growth of the Electrical Transmission Industry in Southern Africa and is today a prime supplier of electrical components and accessory equipment to the African and international Transmission and Distribution Electrical Industry.

The company has developed over the years a substantial manufacturing operation based in Olifantsfontein, Gauteng, South Africa, operating to the requirements of ISO 9001-2000 and in accordance with local and international specifications. On site facilities include a non-ferrous, sand and gravity die-casting foundry, machine shop as well as tool and die-making facilities.

The company manufactures and offers a comprehensive range of equipment to meet both the market and customer's specific requirements. The products offered and detailed in this catalogue are summarised in the following product ranges:

- High Voltage Sub Station Inter Connecting Clamps up to 765kN
- Insulators
- Isolators
- Compression Tooling
- Transmission and Distribution Line Hardware

Design and consulting services are available to provide recommendations as to the most suitable type of equipment, connections and installation procedures to suit customer requirements.

The company's customer relations policy is based on giving complete satisfaction to our clients and includes for:

- In-house design
- Documentation and technical back-up
- Local and International sourcing of specialised equipment to suit the customer's requirements
- Manufacture, source and supply of full packages for sub stations and line projects

CURRENT CARRYING CLAMPS FOR USE IN ELECTRICAL SUB-STATIONS

INTRODUCTION

1. McWade Productions (Pty) Ltd manufactures and markets a comprehensive range of both aluminium and copper alloy clamps for use in all electrical conductor and/or tubular busbar applications. This range varies from small conductor termination clamps used at less than 500 volts up to large diameter tubular busbar clamps suitable for use on 250mm diameter busbars at 765kV and rated in excess of 6 500 amps. The clamps are manufactured to the company's own designs and/or to meet specific customer requirements.

2. When designing substations and, particularly when determining the type of current carrying clamp to be utilised, the maximum continuous load rating and short circuit currents are critical factors to take into account. This is particularly important with the high load factors now occurring in some power systems. Internationally, substation design now tends towards the use of tubular bus systems as opposed to overhead strung conductor type busbars where with current ratings in excess of 3 000 amps, strung busbars require more than 3 conductors per bus phase with the resultant complications arising in the connection of these bundle conductors. Bundle conductor bus systems are subject to bundle collapse under short circuit conditions which generate serious shock forces at attachment points. At voltages in excess of 88/132kV tubular bus arrangements lend themselves more towards a superior corona free design than do bundle conductor bus systems. Furthermore, the use of tubular bus systems provides for a lower profile and more aesthetically acceptable substation design. When utilising tubular busbars, short circuit forces between phases with relative small phase spacings, do present a problem and these forces must be allowed for in the mechanical strength in the clamps and the post insulators used.

3. The clamps, as detailed in this catalogue, are manufactured to comply with the requirements of the National Electrical Utility of South Africa being Eskom as well as international specifications.

   a.) Aluminium Clamps
   Aluminium alloy clamps are predominantly used for the connection of stranded aluminium conductors and/or tubular aluminium busbars to each other and to hot dip tinned copper equipment studs and terminals. Where corrosion is a prime factor, and the terminals not tinned, bi-metallic washers and/or sleeves should be fitted to the copper terminals. All aluminium alloy clamps are supplied pre-greased if required.

   b.) Copper Clamps
   Copper alloy clamps, which are hot dip tinned, are predominantly used in copper to copper applications. Where corrosion is a factor to be considered, they are also used in copper to aluminium applications. Copper clamps are supplied un-greased.

CORROSION OF INTER-CONNECTOR CLAMPS

Two factors are associated with corrosion:

1. Atmospheric action

2. Galvanic action

For atmospheric action to result in corrosion there must be moisture and oxygen present.

Galvanic action results in corrosion when two dissimilar metals in the electrolytic series e.g. aluminium and copper are in physical contact. In this case moisture acts as an electrolyte.

In such an instance the copper becomes the cathode and receives a positive charge. The aluminium becomes the anode and receives a negative charge.

The resultant current flow attacks the aluminium leaving the copper unharmed.

Both factors described above are influenced by environmental conditions.

This occurs in rural areas to a lesser extent than in urban centres and more so in heavy industry locations – steelworks, chemical plants, refineries etc.

The problem of the mechanical jointing of two dissimilar metals in physical contact with each other, such as aluminium and copper stems from their difference in electrolytic potential.

The extent, or severity, of the corrosive action is proportional to distance or separation of the metals in the list i.e. the magnitude of the difference in electrolytic potential of the two metals which, in the case of aluminium and copper is quite considerable.

Aluminium to Aluminium Connections

No problem exists in the jointing of these conductors as electrolytic action is non existent. Nevertheless, care must be taken to prevent crevice corrosion and to select an aluminium alloy connector body not liable to stress corrosion cracking.

Aluminium to Copper Conductor Connections

The best choice is an aluminium bodied connector since it is not subject to the galvanic attack of the more vulnerable element – the aluminium conductor.

Nevertheless, it is good practice to use an inhibitor grease, on the aluminium connector body or on the aluminium conductors and additionally where-ever possible to install the aluminium conductor above the copper to prevent pitting from the galvanic action of copper salts washing over the aluminium connector and conductor when in a lower position, alternatively a hot tin dipped copper alloy connector is to be utilised or an aluminium connector with a bi-metallic sleeve placed over the copper conductor.

Electrical Jointing of Aluminium

A particular phenomenon associated with jointing of aluminium conductors concerns the oxide film that forms rapidly on the surface of freshly extruded or cleaned aluminium exposed to air.

This oxide film acts as an insulating medium and must be removed with a scratch steel brush or abrasive paper in order to achieve a satisfactory and reliable electrical joint.

This problem with aluminium is that the freshly cleaned surface is liable to fast oxide formation, hence it is important to coat the surface with an oxide inhibitor immediately after cleaning.

The function of a contact/compression compound is:

a) Firstly to act as an oxide inhibitor by preventing the ingress of moisture and air and to provide for continuing protection against further corrosion of the electrical joint in its working environment.
b) Secondly, with certain compression greases under compressive force, its high content of sharp metallic particles penetrates through any remaining oxide film to provide multi contact current carrying bridges.

Inter-strand resistance

The high contact resistance due to aluminium oxide on the strands of aluminium conductors may be responsible for the poor distribution of current throughout the conductor strands. Thus some strands may carry much more than their share of the current, with consequent overheating of the conductor.

The most effective way to overcome inter-strand resistance in aluminium conductors is by the use of compression connectors filled with a compression-jointing compound.

Note: While oxide films on copper are conducting mediums, and more easily broken by contact pressure, it is a recommended practice to clean badly tarnished old copper surfaces with a scratch brush.

ALUMINIUM ALLOY BOLTED/COMPRESSION TYPE CURRENT CARRYING CLAMPS

General Features

A current carrying clamp can only satisfactorily serve the function that it is designed for, which is the transferral of current flow from one busbar to another, by the optimum design of the contact surface areas coupled with the contact pressure exerted through the clamping covers and their associated clamping systems. Intensive research both in South Africa and in Europe, has resulted in the design of the clamps detailed in this section, such clamps being designed for use at 765kV and capable of carrying current loads in excess of 3 500 amps on a continuous basis. The clamps as shown comply with the requirements of the West German specification number VDE. 0220 and the Eskom (SA) specification number NWS1671. General features of these clamps are:

1. The Compression Tube

   The SABS report number 771/8322/R46, "Testing of Line Clamps" clearly shows the best method of making electrical connections to multi-layer aluminium conductor to be the compression technique. In fact, the SABS experiments yielded the following mean percentage increase in voltage drops over the entire aging test carried out on a variety of different current carrying clamps.

Compression Tube	40.80%
Three bolted clamping covers	48.50%
Explosive wedge compression	75.63%
Single bolted clamping cover	182.60%

   The compression tube incorporated in bolted compression clamps is specially produced for this application. It is precisely dimensioned in accordance with the "compression efficiency formula" resulting from years of research in Europe. To ensure correct installation, it is indelibly marked with the appropriate conductor size, the crimping die reference number and the required points of compression. It is supplied with an internal coating of the correct compression grease.

2. Bolted Clamping Covers

   Although compression tubes should be used for stranded conductor connections wherever possible and bolted joints reserved for attachment is feasible, the nature of the tee clamp necessitates the use of a bolted connection on the "run" conductor. Thus special care must be taken with this clamp half.

   On installation, micro-contacts are formed between the clamp body and the conductor. The summated areas of these individual micro-contacts make up the total actual contact area. This area only amounts to between 1% and 5% of the apparent, or overlap, surface. Thus, if the permissible current density is 10 amps/mm², this must be interpreted as approximately 0.2 amps/mm² of overlap surface.

   The quality and life of the connection is determined by the actual contact area formed on installation and the preservation of such contact area. The contact area can reduce with time and one of the prime causes of this is creep of the conductor material – particularly for large diameter conductors with four or more strand layers. The covers fitted to these clamps are made of carefully selected alloys, gravity die cast or drop forged to yield the ideal strength and elasticity characteristics so that a high residual contact pressure is maintained. The number of clamping covers per connection depends on the current loads of the conductors and on whether stranded conductors, tubes or studs are to be connected.

3. The Clamp Body

The clamp body is provided with a large conductor seating area, machine-grooved for penetration of the conductor oxide layers and the creation of increased actual contact area. They further assist in the distribution of the bolt forces over the entire clamp length. Bolts are locked into the clamp body, thus requiring tightening of the nut only.

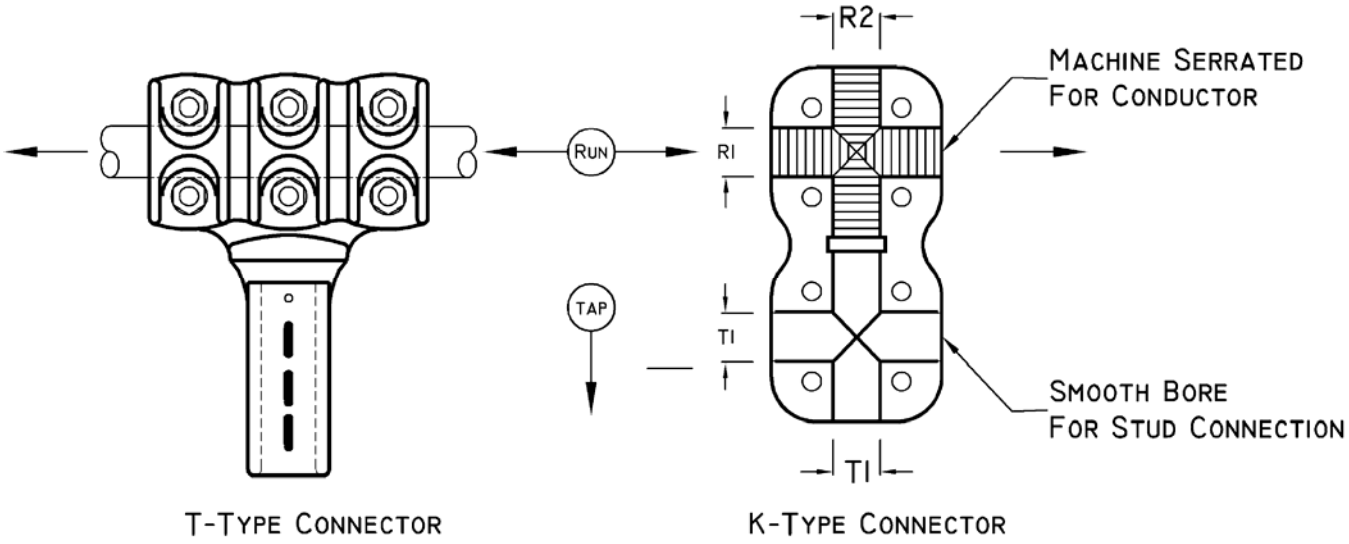
The body is indelibly marked with the clamp type number and conductor size.

4. The Welded Joint

Intensive research into welding techniques, both hand and machine methods, has resulted in joints of high quality. Tests in South African and European laboratories show the connection to be physically, electrically and mechanically sound. On-going quality assurance procedures adopted by McWade Productions guarantee that no problems will arise in this area, or for the unit as a whole.

5. Run And Tap Configuration

International understanding is that the RUN conductor (immaterial whether stranded or tubular conductors) is always in the horizontal plane and that the TAP conductor (whether stranded or tubular conductor) is in the vertical plane – see sketch below.



The K type cross clamp is specifically designed for use with a SOLID EQUIPMENT STUD and STRANDED CONDUCTORS. The K clamp is manufactured in compliance with the Eskom NWS 1671 specification, which specification calls for one half of the clamp having both the horizontal and vertical cross grooves smooth bored to suit 26 or 38mm dia equipment studs – with the other half of the clamp having the horizontal and vertical cross grooves either machined or cast serrated to suit stranded conductors of 16.3, 19.0, 21.0, 26.5 and 38.5mmdia. These are the standard Eskom stud and conductor diameters and the McWade manufactured K clamps are manufactured to suit these stud and conductor sizes where in all instances the stud is normally classified as the tap side of the clamp, immaterial of whether the stud is vertically or horizontally mounted.

Where a standard K clamp is required to be used with either different conductor or stud sizes, the standard K clamp as manufactured requires to be modified to suit these different stud/conductor sizes. It is required that customers specify both the RUN size and the TAP size in each specific case.

6. Preferred South African Substation Conductors

A.) ASCR Conductors to BS.215

Code Name	Reference Area Aluminium/Steel	No. & of ∅ of Wires Aluminium/Steel	Nominal Diameter	Mass per	Current Rating Amps	
	mm²	mm	mm	kg	70°C	90°C
Wolf	160/40	30/7/2.59	18.13	7.28	371	482
Bear	250/40	30/7/3.35	23.45	1219	504	665

B.) AAC Conductors to BS.215

Code Name	Reference Area	No. and Diameter of Wires	Nominal Diameter	Mass per km	Current Rating Amps	
	mm²	mm	mm	kg	75°C	90°C
Hornet	150	19/3.25	16.25	433	365	470
Centipede	400	37/3.78	26.46	1150	647	860
Bull	800	61/4.26	38.34	2397	986	1353

NB.: Above current ratings are based on a wind speed of 1.6 kms per hour and at an ambient temperature of 40°C (the 75 and 90°C temperatures in the above table refer to the conductor temperature).

INSTALLATION PROCEDURE

All inter-connector clamps as manufactured by McWade Productions are designed to suit both the electrical transfer current carrying capacity of the stranded/tubular busbar it is to be utilised with and the mechanical strengths associated with the rated short circuit current.

All international manufacturers' inter-connector clamps can only perform to their designed electrical and mechanical functions subject to the correct on-site installation procedures being adhered to which are:

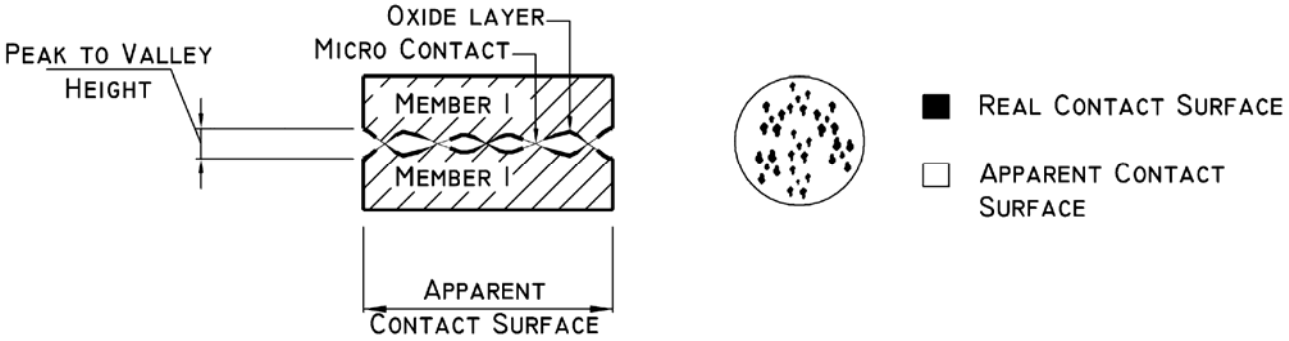
1. Clamp Selection

   The first step is to ensure that the clamp to be utilized is suited to the application in question. McWade clamps are all stamped with both Type Number and Conductor sizes and these can be compared to those specified on the installation drawings. It should be noted that types KC and YC are to be used solely for the compression connection of conductors to equipment terminals. The only time a bolted connection is made to stranded Conductors is in the case of TEE joints or tap-off where the clamp types T, TC or K are utilised.

2. Cleaning Procedure

   All clamps are supplied ex-factory in heavy duty heat-sealed plastic bags and the clamps should only be removed from these plastic bags immediately prior to installation and after correct cleaning and preparation of the installation connection area.

   Aluminium alloys as utilised in stranded or tubular conductors are prone to immediate oxidisation after extrusion. This oxide layer can achieve a maximum thickness of 500 – 1000nm and acts as an insulating medium. The dynamics of an oxidised aluminium connection results in a very high resistance interface and causes thermal instability leading to connection failure. To ensure proper contact between the busbar and clamping contact areas, it is necessary to clean away the layer of aluminium oxide in the contact areas.



Preparation of Contact Surfaces

ALL CONTACT SURFACE AREAS must be strongly brushed with a steel-wire brush alternatively with an aluminium oxide emery cloth grade 80 – 180 and then wiped clean with a dry cloth. Immediately thereafter the contact surfaces of the stranded/tubular busbar and inter-connector clamp are to be greased with a high-melting point non-oxidant grease to a 0.25 – 0.5mm minimum thickness. This greasing process must be immediately followed up with the application of the inter-connector clamp to the respective busbars.

Care should be taken that the contact surfaces, which have been cleaned and greased, are kept free of sand and other foreign matter. In the case of accidental pollution these surfaces shall be cleaned with a suitable solvent and the cleaning and greasing process repeated.

Equipment terminal studs and palms whether of aluminium or plated copper are to be cleaned in accordance with the above procedure.

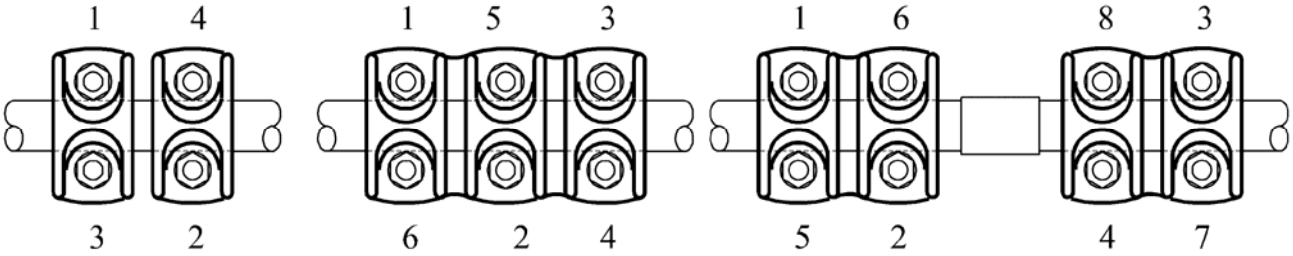
Certain compression compounds contain an aluminium grit and upon compression of the conductor sleeve on conductor, the compressive force drives the grease, containing sharp metalgrit particles, between the conductor strands, at the same time forcing the conductor strands into a semi hexagonal shape, this effect breaking down the oxide film around the inner conductor strands and providing for a point-point contact.

3. Clamp Installation

When installing the inter-connector clamp, ensure that the conductor seating areas match those of the busbar that the clamp is to be fitted to. In cases where the aluminium tubular busbar is slightly beyond the tolerances for diameter and ovality, the clamp can be accurately bedded onto the tube by hammering around the outside of the clamp body shell with a rubber hammer. This can only be done whilst the clamp is clamped onto the tubular basbar and the bolts are to be re-set afterwards with a torque wrench.

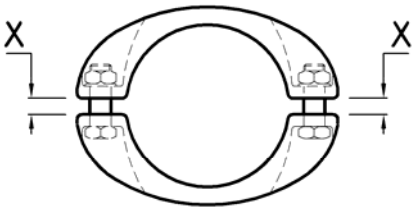
4. Clamping Sequence

Once the caps are correctly positioned, final bolt tightening is to take place according to defined sequences in order to apportion correct stresses to the conductor/tubes as well as the inter-connector bodies.

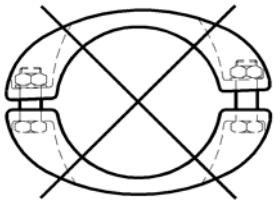


5. Positioning of the Caps

It is imperative that the clamping covers are tightened down in a parallel sequence so that the gap between the clamp's body and the clamp's cover is equal on both sides.



CORRECT
DISTANCE 'X' TO BE EQUAL



INCORRECT

6. Bolt Tightening Torques

All clamps are fitted with bolts, nuts and washers of either:

a) 8.8 grade high tensile steel bolts (HDG),
b) Stainless steel grade A2/A4,
c) Aluminium alloy grade 7075 – P60.

All inter-connector clamps are designed to provide a maximum effective contact surface between the busbar and the inter-connector clamp for the efficient transfer of electrical current. This maximisation of effective contact surfaces can only be achieved by the correct contact pressures of >6N/mm² being applied to the clamp. This can only be achieved by all bolts being tightened with a torque wrench to the required torque as stated below:

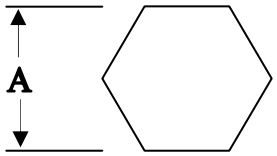
Bolt Thread	Spanner Width	Bolt Tightening Torque (Nm)				
		Steel (HDG)		S/Steel	Bronze	Alum
		5,6	8,8	A2	F60	7075 (p.60)
M8	13	-	15	20	15	10
M10	17	13	26	35	26	21
M12	19	23	45	60	45	36
M14	22	35	60	80	70	55
M16	24	56	75	110	-	70

7. Compression Joints

The conductor size to be compressed must correspond to the conductor diameter stamped on the compression tube. The conductor is to be cleaned as stated above and then cut to the required length. It is inserted into the pre-greased compression tube until the end is firmly against the clamping body stop. Compression is to be undertaken using a suitable 30/45-ton rating power operated compression tool. Compression dies are to be checked to meet with the following sizes:

Hexagon Type Crimped Connections

Conductor Type	Die Ref. No.	Tube O/D (mm)	Die Size (mm)	Dimension "A" (mm)	Die Bite Width
Bull	58	58	49	Max 51 Min 48	25
Centipede	42	42.5	36	Max 37.5 Min 35.2	40



Note: These are the commonly used Conductors in Sub-stations in South Africa. For all other connections, information is available on request.

Dies reference numbers are to be checked to the number stamped on the compression tube. Compression of the tube and conductor should commence from the conductor end towards the clamp body and compression must be effected over the compression marks detailed on the tube.

Compression tools are to automatically bypass on complete compression and under no circumstances should the die pressure be released before bypass is reached. After full compression the die numbers 42 or 58 will be imprinted onto the tube and serve to indicate both satisfactory and complete compression.

Compression tools are to be treated strictly in accordance with the operating instructions supplied. A light film of pure white Vaseline should be applied to the compression die faces after every 5 – 10 compressions in order to extend die life and facilitate die slide over the compression tube surface. Any compression die flashes should be removed with a file.

Upon completion of the clamp installation and checking that all bolts are correctly torqued surplus grease should be wiped away.

TUBULAR BUSBAR CLAMPS IN ALUMINIUM ALLOY

INTRODUCTION

The aluminium alloy tubular bus current carrying clamps depicted in this section are manufactured in certified aluminium alloys, namely aluminium alloy grade LM-6 as a standard, alternatively in aluminium alloy LM-25 heat treated to a T6 temper where a clamp is required to comply with a higher strength rating.

Tubular Busbar

Standard South African busbar tubes are supplied in either the alloys 6101-A and/or 6261-TF which are both suitable for electrical purposes. The 6261-TF alloy has better mechanical properties, but somewhat poorer electrical properties than the 6101-A. However, for application of HV yards, where long spans are essential, the 6261-TF alloy with superior mechanical properties is preferred. All imported Aluminium Alloy Tubular Busbar are in the grade 6101-BT6.

Alloy Type	Max Yield Strength MPa	Electrical Resistivety at 20°C in mm^2/m
6101-A	170	0.03133
6261-TF	240	0.037
6101-BT6	160	0.0333

Standard Tubular Busbar

Outer Diameter	Wall Thickness	Cross Section	Weight	Permanent Electrical Load		± Tolerance in outer diameter incl. deviation from roundness	Max. Length which can be supplied	Maximum sag (cm) due to own weight, 2 supports, (for 3 supports multiply listed values by 0.415)												
				Busbar Temp.				Support spacing (m)												
mm	mm	mm²	kg/m	65°C A	85°C A	mm	m	6	8	10	12	14	16	18	20	22	24	26	28	30
80	4	955	2.58	1,400	1,860	0.6	19	0.9	2.8	6.8	14.1	26.1								
	5	1,178	3.18	1,560	2,070	0.6		0.9	2.9	7.0	14.4	26.8	45.6							
	6	1,395	3.77	1,690	2,240	0.6		0.9	3.0	7.1	14.8	27.5	46.8							
	8	1,810	4.89	1,920	2,550	0.6		1.0	3.1	7.5	15.5	28.8	49.1							
	10	2,199	5.94	2,110	2,790	0.6		1.0	3.2	7.9	16.4	30.3	51.8							
100	4	1,206	3.26	1,690	2,240	0.7	25	0.6	1.8	4.3	8.9	16.4	28.0							
	5	1,492	4.03	1,880	2,490	0.7			1.8	4.3	9.1	16.7	28.5	45.6						
	6	1,772	4.78	2,040	2,710	0.7			1.8	4.4	9.2	17.1	29.1	46.6						
	8	2,312	6.24	2,320	3,070	0.7			1.9	4.6	9.6	17.8	30.3	48.75	73.9					
	10	2,827	7.63	2,540	3,360	0.7			2.0	4.8	9.9	18.4	31.4	50.3	76.7					
120	4	1,458	3.94	1,950	2,580	0.7	25	0.4	1.2	2.9	6.1	11.3	19.2	30.8						
	5	1,806	4.88	2,170	2,880	0.7			1.2	3.0	6.2	11.4	19.5	31.2	47.6					
	6	2,149	5.80	2,370	3,140	0.7			1.2	3.0	6.3	11.6	19.8	31.7	48.3					
	8	2,815	7.60	2,700	3,580	0.7			1.3	3.1	6.5	12.0	20.4	32.7	49.9	73.1				
	10	3,456	9.33	2,960	3,920	0.7			1.3	3.2	6.7	12.4	21.1	33.9	51.6	75.6				
	12	4,072	10.99	3,130	4,150	0.7			1.4	3.3	6.9	12.8	21.8	35.0	53.3	78.0				
150	4	1,835	4.95		2,900	1.0	25			1.9										
	6	2,714	7.33		3,500	1.0				1.9										
	8	3,569	9.64		4,000	1.0				2										
160	4	1,960	5.29	2,520	3,330	1.0	25	0.2	0.7	1.6	3.3	6.2	10.6	16.9	25.9	37.8				
	5	2,435	6.57	2,790	3,700	1.0				1.6	3.4	6.3	10.7	17.2	26.2	38.3	54.3			
	6	2,903	7.84	3,060	4,050	1.0				1.7	3.4	6.4	10.9	17.4	26.5	38.3	55.0			
	7	3,365	9.08	3,270	4,330	1.0				1.7	3.5	6.4	11.0	17.6	26.8	39.3	55.6			
	8	3,820	10.31	3,490	4,630	1.0				1.7	3.5	6.5	11.1	17.8	27.2	39.8	56.4			
	10	4,712	12.72	3,830	5,070	1.0				1.7	3.6	6.7	11.4	18.3	27.9	40.8	57.8			
	12	5,579	15.06	4,060	5,380	1.0				1.8	3.7	6.9	11.7	18.7	28.5	41.8	59.2			
200	4	2,463	6.65	3,030	4,010	1.2	25	0.1	0.4	1.0	2.1	3.8	6.7	10.8	16.4	24.0	34.0			
	5	3,063	8.27	3,410	4,520	1.2			0.4	1.0	2.1	4.0	6.8	10.9	16.5	24.2	34.3	47.3		
	6	3,657	9.87	3,720	4,920	1.2			0.4	1.0	2.2	4.0	6.8	11	16.7	24.5	34.6	47.7	63.8	
	8	4,825	13.0	4,270	5,660	1.2			0.4	1.1	2.2	4.1	7.0	11.2	17.0	24.9	35.3	48.6	65.4	86.1
	10	5,969	16.1	4,680	6,200	1.2			0.4	1.1	2.3	4.2	7.2	11.4	17.4	25.4	36.0	49.6	66.8	88.0
	12	7,087	19.1	4,990	6,610	1.2			5.0	1.1	2.3	4.3	7.3	11.6	17.7	25.9	36.7	50.6	68.0	89.6
250	5	3,848	10.4	4,140	5,490	1.5	25	0.1	0.3	0.7	1.4	2.5	4.3	6.9	10.5	15.4	21.8	30.0	40.3	53.1
	6	4,599	12.4	4,520	5,990	1.5	25				1.4	2.5	4.3	6.9	10.6	15.5	21.9	30.1	40.5	53.4
	8	6,082	16.4	5,190	6,870	1.5	25				1.4	2.6	4.4	7	10.7	15.7	22.2	30.6	41.2	54.3
	10	7,540	20.4	5,700	7,560	1.5	25				1.4	2.6	4.5	7.2	10.9	16.0	22.7	31.2	42.0	55.4
	12	8,972	24.2	6,100	8,080	1.5	25				1.4	2.7	4.5	7.3	11.1	16.2	23.0	31.6	42.5	56.1
	14	10,380	28.0	6,420	8,500	1.5	23				1.5	2.7	4.6	7.4	11.3	16.5	23.3	32.1	43.2	57.0
	16	11,762	31.8	6,640	8,800	1.5	19				1.5	2.8	4.7	7.5	11.5	16.8	23.8	32.7	44.0	58.0

INSTALLATION PROCEDURE

When installing full or half expansion inter-connector clamps, care must be taken for the allowance of the thermal expansion of the relevant basbar tube, be it aluminium or copper. An estimate of the expansion of various tubes due to thermal expansion at various temperature changes is given in the tables below:

1. Calculation of Thermal Expansion in Aluminium Tubes in mm

Length of Tube in Meters	Temperature Difference △T. in °C									
	10	20	30	40	50	60	70	80	90	100
2.5	0.6	1.2	1.8	2.4	3.0	3.6	4.2	4.8	5.4	6.0
5.0	1.2	2.4	3.6	3.0	6.0	7.2	8.4	9.6	10.8	12.0
10	2.4	4.8	7.2	9.6	12.0	14.4	16.8	19.2	21.6	24.0
20	4.8	9.6	14.4	19.2	24.0	28.8	33.6	38.4	43.2	48.0
30	7.2	14.4	21.6	28.8	36.0	43.2	50.4	57.6	64.8	72.0
40	9.6	19.2	28.8	38.4	48.0	57.6	67.2	76.8	86.4	96.0
50	12.0	24.0	36.0	48.0	60.0	72.0	84.0	96.0	108.0	120.0

Temperature Co-efficient of Linear expansion (temp. range -20° + 200°C
Aluminium: 23 x 10^{-6} (0,000023 per centigrade degree)

Example of the Calculation of Thermal Busbar Expansion:

Aluminium basbar tube, length = 10m

Temperature difference t = Max. Op. Temperature – Min. Op. Temperature
= (+80°C) – (-20°C)
t = 100°C
Assembly temperature = +20°C

For complete expansion length refer to table = 24.0mm.

Temperature difference between the final temperature (+80°C) and the assembly temperature (+20°C) is therefore 60°C. Referring to the above table, the corresponding expansion difference will be 14,4mm. The clamp must therefore be mounted in such a way that a shift of at least 14,4mm in the direction of the clamp centre is guaranteed. A shift in the opposite direction in accordance with the temperature difference of (+20°C) assembly temperature and (+20°C) being the lowest final temperature - 40°C. Referring to the above tables, this value is given as 9.6mm.

2. Short Circuit Forces on Clamps

Tube Size	Current Rating	Phase * Spacing	Short Circuit	Transverse Short Circuit Forces on Clamps and Post Insulators
mm	Amp	m	kA	kN
80 x 8	2 300	2.3	16	4
100 x 8	2 800	2.3	25	6
120 x 8	3 300	2.3	25	6
150 x 8	4 000	4.5	50	16
200 x 8	5 200	4.5	50	16
250 x 8	6 300	4.5	50	20

*Notes: * Indicates the phase spacing at which maximum short circuit forces occurs.*
Clamps are designed to have a factor of safety of 2:1 with respect to the specified load. Unless the min. mechanical load is specified, the standard strength LM-6 alloy clamp, is supplied.

3. Busbar Tube Vibration Damping

Aluminium tubular busbars are subject to wind-generated vibration and oscillation. Because of the low self-damping of tubular busbars very slight excitation forces will suffice to excite the tubes to vibrations amplitudes of the order of the tube diameter, when there is a resilience of the excitation force with a natural frequency of the tube. These high amplitudes produce additional dynamic stresses inside all structural parts and it is often necessary to dampen this tube oscillation by the insertion of AAC conductor into the busbar. The increased self damping provided by the insertion of damping conductor delays the onset of resilience build-up and this limits the maximum amplitudes created by a given excitation force.

As a rule it is normally sufficient to insert one conductor into a tube, but in order to increase the safety and to maintain maximum damping effect it is advisable to insert two conductors into the tube (one at each end running for 2/3 of the tube length). The following table shows recommended damping conductor sizes. A drain hole of 10mm diameter should be drilled at bottom centre point of tubes to facilitate drainage of condensate moisture.

Recommended Damping Cables		
Tube-Ø mm	**Al-cable mm**	**Permissible spacing between supports without damping cables m (nominal values)**
63	120	3.0
80	150	3.5
100	240	4.5
120	300	5.5
160	500	7.5
200	625	9.5
250	625	12.0

4. Nominal Linear Expansion of Tubular Busbars

Temperature °C	Expansion in mm/Per Meter	
	Aluminium	Copper
20	0.69	0.51
30	0.92	0.68
40	1.15	0.85
50	1.38	1.02
60	1.61	1.19
70	1.84	1.36
80	2.12	1.58

INTRODUCTION

The copper current currying clamps as depicted in this section are manufactured from the material grade LG 2 in accordance with BS 1400.1969. All clamps are supplied hot tin dipped and can be supplied silver plated if required.

1. Calculation of Thermal Expansion in Copper Tubes in mm

Length of Tube in Meter	Temperature Difference △T. in °C									
	10	20	30	40	50	60	70	80	90	100
2.5	0.42	0.85	1.3	1.7	2.2	2.6	3.0	3.4	3.9	4.4
5.0	0.85	1.7	2.6	3.4	4.3	5.2	6.0	6.8	7.7	8.6
10	1.7	3.4	5.1	6.8	8.5	10.2	11.9	13.6	15.3	17.0
20	3.4	6.8	10.2	13.6	17.0	20.4	23.8	27.2	30.6	34.0
30	5.1	10.2	15.3	20.4	25.8	30.6	35.7	40.8	46.2	51.6
40	6.8	13.6	20.4	27.2	34.0	40.8	47.6	54.4	61.2	68.0
50	8.5	17.0	25.5	34.0	42.5	51.0	59.5	68.0	76.5	85.0

Temperature Co-efficient of Linear expansion (temp. range -20° + 200°C
Copper: 17 x 10^{-6} (0,000017 per centigrade degree)

2. Nominal Linear Expansion of Tubular Busbars

Temperature °C	Expansion in mm/Per Meter	
	Aluminium	Copper
20	0.69	0.51
30	0.92	0.68
40	1.15	0.85
50	1.38	1.02
60	1.61	1.19
70	1.84	1.36
80	2.12	1.58

Electrical Jointing of Aluminium

A particular phenomenon associated with jointing of aluminium conductors concerns the oxide film that forms rapidly on the surface of freshly extruded or cleaned aluminium exposed to air.

This oxide film acts as an insulating medium and must be removed with a scratch steel brush or abrasive paper in order to achieve a satisfactory and reliable electrical joint.

This problem with aluminium is that the freshly cleaned surface is liable to fast oxide formation, hence it is important to coat the surface with an oxide inhibitor immediately after cleaning.

The function of a contact/compression compound is:

c) Firstly to act as an oxide inhibitor by preventing the ingress of moisture and air and to provide for continuing protection against further corrosion of the electrical joint in its working environment.

d) Secondly, with certain compression greases under compressive force, its high content of sharp metallic particles penetrates through any remaining oxide film to provide multi contact current carrying bridges.

Inter-strand resistance

The high contact resistance due to aluminium oxide on the strands of aluminium conductors may be responsible for the poor distribution of current throughout the conductor strands. Thus some strands may carry much more than their share of the current, with consequent overheating of the conductor.

The most effective way to overcome inter-strand resistance in aluminium conductors is by the use of compression connectors filled with a compression-jointing compound.

Note: While oxide films on copper are conducting mediums, and more easily broken by contact pressure, it is a recommended practice to clean badly tarnished old copper surfaces with a scratch brush.

Section Lengths Available

McWade strain and suspension insulators are available in lengths appropriate for 11kV through 132kV. Longer or shorter lengths can be produced for special projects. Length increments are approximately 38mm.

Insulation Co-ordination

The operating performance of a transmission line depends on its insulation level. It must not flash over under practically any operating condition. Several methods of co-ordination of line and station insulation have been proposed. Generally, the best method is to establish a definite common insulation level for all the station insulation and then match that level with the line insulation. With this approach, the task is limited to three fundamental requirements:

1. selection of Basic Insulation Level (BIL),
2. specification of insulation with flashover characteristics equal to or greater than the selected BIL and
3. the application of suitable over voltage surge protection.

Satisfactory performance is generally achieved with an insulator which has a dry 60Hz flash over of three to five times the phase-to-ground voltage and a leakage distance approximately twice the shortest air gap (strike) distance.

Corona Performance

McWade suspension and strain insulators are RIV and corona free through 132kV, by the use of integral Stress Distribution Disk (SDD). The table below details the rings necessary for voltages equal to or exceeding that listed in the column header.

Insulator	Orientation	SDD Up to 66kV	66kV – 132kV
Strain/ Suspension	Top Bottom	None None	None SDD
Line Post	Top Bottom	None None	None None

INSTRUCTIONS FOR HANDLING, STORAGE AND CLEANING OF POLYMER INSULATORS

Handling

While these insulators are remarkably resistant to damage, care should always be taken to avoid dragging on the ground, or against structural numbers.

The insulators will accept moderate bending or twisting, but severe bending or torsional loading should be avoided. Bending loads are sometimes easily applied to ball or socket fittings, watch especially for ball shank bending and/or socket cotter crushing.

If rings are to be added, follow manufacturer's recommendations for position and orientation. This information is provided by a small drawing/tag attached to each ring.

Installation

Always examine insulators for handling and shipping damage.

Install insulators so that moisture will drain from the sheds, the shed angles make this easy in standard line construction. If unique construction requirements – e.g. "uphill deadends", result in sheds which will not drain, reverse the insulators or use special insulators with inverted sheds. A good rule when the insulator must be installed with upward-sloping sheds is to make sure the insulator position is within 45 degrees of horizontal.

For safety reasons and to prevent insulator damage, crews MUST AVOID climbing on, walking on, or hanging ladders from the insulator surfaces.

Storage

Store insulators in an area free of standing water. Avoid direct contact with transformer oil, hydraulic oil, or other similar petroleum derivatives.

The light weight of the insulators permits storage on light duty floors and foundations. Suspension insulator design encourages vertical storage (hanging or standing), reducing the floor area required. For long units standing vertically, a simple rack may be useful to provide support.

Cleaning

McWade Insulators normally require no cleaning, washing, or other routine maintenance. Chalking of the rubber weathersheds surfaces that are exposed to sunlight is normal and helps protect the polymer surface from the sun's UV rays. Thus, chalky white surface film need not be removed by cleaning.

Washing or cleaning may be required if the insulators are installed in areas of severe environmental contamination and where there are indications of abnormal leakage currents or scintillation on the insulator surface due to fog, mist, or other conditions of light wetting.

In the event that washing or cleaning is required, the procedures are outlined in ANSI/IEEE 957 "Guide for Insulator Cleaning".

INSULATOR PART NUMBER MAKE UP

Example, Part No.: **7 0 0 6 0 2** [ ]

Suffix on insulator codes indicates type of rubber used for weather sheds
Blank - ESP
W – Silicon

70	06	0	2

1.
50 – 120Kn Earth Wire & Arch Horn
60 – 70kN Earth Wire & Arc Horn
70 – 40kN
80 – 2 Disc Equiv.
81 – 70kN
82 – 120kN
83 – 1-1/4 Post

0, 1 or 2
Number of large weathersheds (Alternating)
For 31mm/kV creepage Insulators – first two Digits indicate number of large dia. w/sheds

2.
70, 81 or 82
Total number of Weathersheds

3.
0 – No SDD < 66kV
2 – SDD > 66kV
4 – Steel fittings for Post Insulators
6 – Twin SDD

4. (40/70kN)
1 – Socket/Ball 16mm
2 – Clevis/Tongue
3 – Clevis/Tongue-Twisted

82 = (120kN)
1 – Socket/Ball 20mm
3 – Y Clevis/Tongue
4 – Socket/Ball 16mm
8 – Clevis/Tongue in-line
9 – T-Top Long
0 – T-Top Short

A – Clevis/Tongue 90 Deg
I – Ball/Socket 16mm

(reverse duty)
K – Y-Clevis/Tongue (in-line)
L – Tongue/Clevis

83 = Post Insulators
1 – 2 Hole Stress Base/F-Neck
4 – 2 Hole Stress Base/Clamp-Top
5 – 2 Hole Stress Base/2 Hole Blade
6 – M20 Stress Base/F Neck

GLASS DISC – COUPLED PERFORMANCE

Flashover and Withstand values on Insulator Strings, tested in accordance with SABS 177, B.S. 137 and I.E.C. 383.

U70 – 80 & 100 BL;U70CL & U120BS/20

All these insulators have a nominal connecting length of 146mm and a shell diameter of 254mm

Insulators per string	Power-frequency voltage				Impulse Voltage			
	Dry		Wet		Positive		Negative	
	Flashover	Withstand	Flashover	Withstand	Flashover	Withstand	Flashover	Withstand
2	130	118	82	72	206	194	220	208
3	188	173	120	107	300	286	316	300
4	244	220	158	144	384	368	402	388
5	292	264	196	180	465	450	490	465
6	340	306	232	214	545	525	570	550
7	390	352	264	248	625	605	650	625
8	438	394	300	282	700	680	735	705
9	484	434	336	316	770	750	815	780
10	530	475	370	346	845	820	890	855
11	575	515	405	380	920	890	965	930
12	615	555	440	410	990	960	1 040	1 005
13	660	595	475	440	1 060	1 030	1 110	1 080
14	700	630	505	470	1 130	1 100	1 190	1 150
15	740	665	540	500	1 200	1 170	1 260	1 230
16	780	700	570	530	1 260	1 230	1 340	1 300
17	820	740	605	560	1 330	1 300	1 410	1 370
18	860	775	635	585	1 400	1 360	1 480	1 440
19	895	810	670	615	1 470	1 430	1 560	1 510
20	935	845	700	640	1 530	1 490	1 630	1 580
21	970	880	735	670	1 600	1 560	1 710	1 650
22	1 010	915	765	700	1 660	1 620	1 780	1 720
23	1 040	945	800	730	1 720	1 680	1 850	1 790
24	1 080	980	830	755	1 790	1 740	1 920	1 860
25	1 120	1 010	860	785	1 850	1 810	1 990	1 920

All the above values were determined at an altitude of 1 400 meters above sea level, at the South African Bureau of Standards Laboratory – Pretoria and are given as Correct to Standard Atmospheric conditions (kV n.t.p.).

Generally, correction factors for air density and temperature are of the order of d – 0.85 @ 1 400m and d = 0.81 @ 1 800m.

Information, with regard to the co-ordination of insulation in South Africa may be found in SABS 0120 insulation Co-ordination".

The values above 750kV R.M.S. and 1 800kV Impulse, were obtained by extrapolation, using the empirical formula U = U◦ xnУ

COMPRESSION FITTINGS

BIMETAL 4 CRIMPING TOOL

State of the Art – No Dies Required

Double Acting Hydraulic 4 way Indentation Compression Tool -
for use on Aluminium, Copper and Bimetal Compression Fittings for
Electrical Over-Head Transmission & Distribution Lines

Aluminium head rotates through 180 degrees
for ease of use, with Rapid closing, 9 pump action

Aluminium conductor sizes: Squirrel, Fox, Rabbit, Mink, Hare and Hornet

Copper conductor sizes: 16, 25, 35, 50, 70, 95, 120, 150, 185mm²

Fitting Sizes: 10mm – 33mm out-side diameter
Bimetal Copper & Aluminium Connectors

Round Shaped Oblong C Connectors

Yellow Hot-Line (live line) handles, tested to 22kV

Total weight: 4kg

Black Rubber Grips

Handle rotates for releasing jaws

2 YEAR GUARANTEE

Extra: Compression head can also be rubber lined for
380 volt live line work

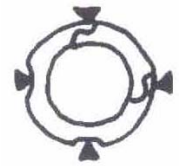
Bimetal Crimper
Supplied in Steel carry case

Pressure Gauge
10, 500 PSI 700 Bar
for maintenance and
checking hydraulic
oil pressure
Type: High Spin 32

By Pass cartridge
for setting pressure
to be applied to
connectors

Quick Release

DEFINITIONS

STATE OF THE ART	- The most up-to-date method of manufacture, material and testing.
NO DIES REQUIRED	- The tool has a 4 way indention. Nibs are always concentric, on fitting. No loose dies to lose or replace.
DOUBLE ACTING	- These tools have a low and high pressure valve to enable the tool to close rapidly on low pressure and to exert high pressure at the nib face.
MATERIALS TO CRIMP	- Aluminium, Copper or Bimetal fittings, manufactured to suit “Bimetal 4 E” system.
TYPES OF FITTINGS TO BE CRIMPED	- Round, shaped, oblong and C connectors – Aluminium or Copper
APPLICATION IN TOOL 	- The Bimetal 4 E system is designed with locating grooves down the length of the fitting to enable the operator to align the tool head.
YELLOW HOT-LINE HANDLES	- These handles are made of fibre glass and tested to 40kV DC. The crimping head may also be insulated with rubber.
PRESSURE (OPERATING)	- All tools operate at 10, 500 PSI or 700 bar. or 64 kPA. and can be checked by means of a pressure gauge.
OIL	- All tolls use hydraulic oil high spin 32.
BY PASS CARTRIDGE	- The method of setting the pressure is unique and carries a worldwide patent. Situated externally for easy access.
CARRY CASE	- All tools are supplied in a steel carry case for extra protection and safe keeping.

FITTINGS FOR BIMETAL 4 E SYSTEM

1) All raw material is checked for hardness, elongation, malibility before any fittings are manufactured.

2) All fittings are locally made with 100% local content.

3) All fittings are de-oxidized and cleaned before being dispatched, to remove an oxidation in and outside the tube.

4) All fittings are marked as follows:

   a) Manufactures name-CCL
   b) Type of material
      - Aluminium
      - Copper
      - Bimetal
   c) Fitting type
      - Non tension joint
      - Tension joint
      - Angle tap connector
      - Tee tap connector
      - Lugs (1 hole lugs)
      - Jumper terminal (2 hole lugs)
      - Tee flag connector
      - Repair sleeve
      - C Connector
      - Bi-metal lugs & Ferrols
      - Dead ends

   d) All fittings are designed exclusively to fit and operate the "Bimetal 4" Compression system. With the following sizes-

	Range of Conductors
0 = Squirrel	4,0-7,0
1 = Fox	6,0-8,5
2 = Mink/ Pine	8,0-11,3
3 = Hare/ Oak	10,0-14,00
4 = Hornet	12,0-16,00

   e) Size of tap connector
   f) What tooling to be used and where to crimp

5) All fittings have a manufacturers code build-up from the above description. i.e.: VCAT 1.2 (code 1022)

Aluminium	tension joint	for mink
1	02	2

6) All fittings are pre-greased with 159 grit grease before being capped and packed in see-through plastic packages, hermetically sealed to prevent air and moisture gaining access to the fittings.

APPLICATION OF CONNECTOR ON CONDUCTOR

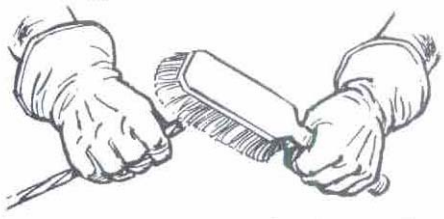
Check list

1) Hydraulic tool (No leaks, in good working order)
2) Fitting (Size is correct)
3) Conductor size
4) Wire brush
5) Grit grease 159 G
6) Cable cutter

1) The conductor should first be cut off square and clean, then straightened by hand (no hammer etc.) as all conductors have a curve built-in, due to it being placed on a drum. Should you not straighten the conductor it will lead to this curving (bananing) when crimped.

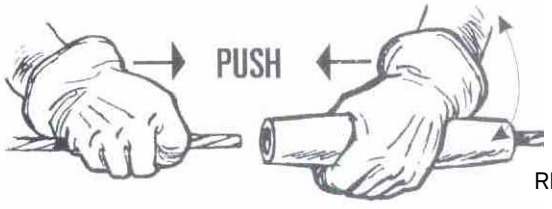
To make a perfect joint
CUT the conductor leaving a clean square end.

2) Now clean the area where the fitting is to be attached by means of the wire brush, even if the conductor is new, it will already have oxidized and it is for this reason that the grease is applied, to prevent oxidation. Apply grit grease after cleaning.



CLEAN the conductor

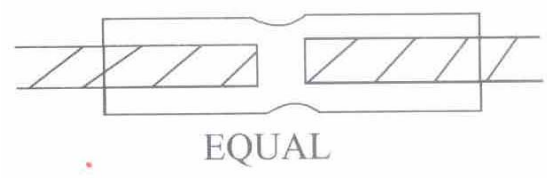
3) Select compression fitting, remove from packaging and remove plastic caps insert conductor, and revolve fitting to apply grit grease to both surfaces.



PUSH the conductor fully into the connector and revolve fitting.

REVOLVE FITTING

4) Now follow instruction on fitting with regard to crimping procedure and how many crimps. (Crimp between lines) all fittings which are required to join two conductors in line will have a center stop, so that the operator will not over crimp one and under crimp the other. CCL fittings are crimped in the middle for this purpose and to act as a guide as to how deep the indent should be, if a conductor is inserted and crimped. Should the conductor be able to pass through the indents, the conductor diameter is in fact too small for that particular fitting.



OPERATING "BIMETAL 4 E" HYDRAULIC TOOL

1) Remove tool from case checking there is no oil leaking in the case (if oil is present check pressure with gauge).

2) Hold unit in both hands, and pump handle 9 times, at this stage all 4 nibs should be touching each other, release pressure by rotating pump handle anti clockwise and closing handles together, this action will engage the release mechanism at the base of the handle and the 4 nibs will open. "Repeat twice"

3) Now we are ready to exert high pressure on the tool with all the operating parts and "O rings" lubricated.

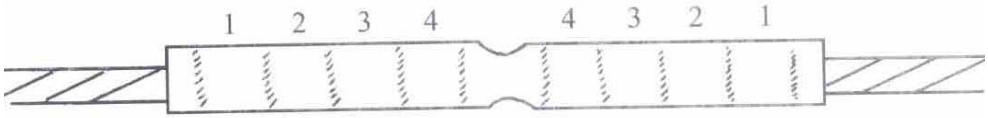
4) Pump unit to close nibs (9 pumps) pressure will automatically change over to high pressure with a high pitched sound, now 2½-3 pumps should enact by-pass valve and the pressure will fall away, should the tool not reach by-pass stage, do not crimp any fittings as they will be under crimped. If in fact the tool takes 4-6 pumps to by-pass it will over crimp.

5) All tools should be checked by an appointed representative (i.e. safety office) every six months for oil leakages and general tightening up (Screws etc.) All tools must be serviced every 12 months. (Oil changed and pressure set) by the supplier.

6) **Danger:** Do not engage in repairs and services without first-hand knowledge of hydraulic tools as this could lead to a very expensive repair at a later stage.

7) Placing the fitting in the tool pump handles until the fittings is firmly held in place, making sure that the fitting is held by all 4 nibs and that the fitting has not slipped between two nibs.

8) On all joints, crimp from the outside towards the middle-stop, making sure you do not crimp that extreme ends.



9) Remove cap and insert or apply fitting to conductor (after cleaning and straightening) now pump handles until tool by-passes, you will first feel resistance to your pressure applied and at by-pass, no resistance to you pumping the handles together. Move tool to next set of marks and repeat operation, until all demarcations have been crimped.

10) If you have not straightened your conductor before you crimp it, and it does banana, do not try to straighten it by hitting it with a hammer, or the like, leave it alone. You will only do more harm than good.

11) Always make sure that the opening of the fitting throat faces out of the crimping head towards the line so that the line can enter straight in.

Open throat connectors

All OPEN THROAT connectors are located in the tool head as shown in the adjacent illustration. The tool nibs are advanced to lightly grip the connector profile at the position where the first crimp is to be made. Subsequent compressions are made by sliding the tool head along the connector.

12) The "Bimetal 4 E" Hydraulic tool has been designed exclusively for overhead line fittings, to let it help you take a rest when up the ladder. Hang the tool on the conductor over the fitting when resting.

13) After completing crimping your compression fitting onto the line "Do not drop" the tool onto the ground, but let it down slowly or carry it down the step ladder.

14) Always replace the crimping tool in the steel carry case after use.

Training courses for the correct operation of the tools as well as installation procedure of Crimp Fittings can be arranged either on site or at our offices. Please liaise with your sales representative to schedule this training.

ISOLATING SWITCHES

The Isolating Switches as detailed in this catalogue are designed for use in sub-station and distribution lines and categorised as either outdoor 3 phase rocking type and single phase isolators or three phase centre rotating double side break isolating switches.

1. OUTDOOR THREE PHASE ROCKING TYPE AND SINGLE PHASE ISOLATORS

The following switches are manufactured in accordance with IEC 60265-1 and are used in the voltage ranges 11, 22 and 33kV. For each voltage range manufactured we are able to supply a switch with a current rating of 400A up to 1200A depending on the customer's requirements. The short time (3 second) current ratings for these switches are as follows: 13kA up to 600A & 7.5KA for 800A & 1200A.

These switches can be mounted either horizontally or vertically and are normally supplied with manual insulated operating mechanisms. Motorised or spring operating mechanisms are available on request.

The main characteristics and components of these switches are as follows:

Current Carrying Components

Contacts
Manufactured from high conductivity copper. Fixed contacts are spring backed to ensure high contact pressure. Surfaces on both fixed and moving contacts are nickel plated. (Silver plating is an optional extra up to 600A and standard for 800 and 1200A).

Current Transfer
Current paths with flexible cables which carry current from the fixed insulator (load end) to the tilting centre insulator are supported within a mild steel pantograph.

Main Terminals (connector pads)
Comprise copper pads for acceptance of conductors as specified. The complete assembly is nickel or silver plated depending on the current rating.

Saddle type clamps are provided as standard up to 600A. For 800A and 1200A, pads are drilled to accept compression or bolted type terminals (optional extra).

Arcing Contact
The main moving contact (isolator blade) incorporates an arcing tip which serves to protect the main contacts from burning on closing the isolator, i.e. the arcing contacts close before the main contacts are engaged. The arcing contacts do not carry current when the isolator is fully closed.

Hinge
The centre tilting insulator assembly hinge which is designed to run dry for long periods of maintenance free operation, comprises non-ferrous bearing points and galvanised ferrous surrounds.

Base
Each phase base is manufactured from mild steel channel which is hot dip galvanised to ISO 1461 after fabrication. Mounting holes to suit standard mounting arrangements are provided.

Operation Mechanism
An operating handle of the reciprocating type is supplied. Adjustment of the vertical connecting pipe is easily accomplished by means of a turnbuckle.
Facilities exist for padlocking the isolator either in the open or closed position. Interlocks can be fitted.
The vertical rod between the operating mechanism and the isolator inter phase operating tube is supplied in suitable lengths to facilitate installation, with insulating insert.

Installation Instructions
See the technical section for the installation and operating instruction.

Optional Extras

- Flicker arc horns for interrupting small load currents.
- Arc interrupter heads for interrupting full load current.
- Compression and bolted connectors
- Auxiliary contacts.
- Silver plated contacts.
- Earth switch.
- Interlocks

2. 3 PHASE CENTRE ROTATING DOUBLE SIDE BREAK ISOLATING SWITCHES

A range of centre rotating switches is manufactured from 11 – 66kV. These switches can be supplied with a current rating up to 1600A. The short time (3 seconds) current rating for these switches is 25kA.

These switches are mounted horizontally and are normally supplied with manual operating mechanisms. Motorised operating mechanisms are available on request.

The main components of these switches are as follows:

Current Carrying Components

Contacts

Manufactured from high conductivity copper. Contacts are spring backed to ensure high contact pressure. Contact surfaces on both fixed and moving portions are nickel plated. (Silver plating is an optional extra up to 600A and standard for 800 and 1200A).

Main Terminals (connector pads)

Comprise copper pads for acceptance of conductors as specified. The complete assembly is nickel or silver plated depending on the current rating.

All pads are drilled to accept compression or bolted type terminals (optional extra).

Base

Each phase base is manufactured from mild steel channel which is hot dip galvanised to ISO 1461 after fabrication. Mounting holes to suit standard mounting arrangements are provided.

Operation Mechanism

An operating handle of the rotational type is supplied. Adjustment of the vertical connecting pipe is easily accomplished by means of a turnbuckle.
Facilities exist for padlocking the isolator either in the open or closed position. Interlocks can be fitted.
The vertical rod between the operating mechanism and the isolator inter phase operating tube is supplied in suitable lengths to facilitate installation.

Installation Instructions

See the technical section for the installation and operating instruction.

3. GENERAL

Metal Treatment

All ferrous components are hot dip galvanised to ISO 1461. Current carrying non-ferrous components are nickel plated, alternatively silver plated where applicable.

Type Designation

A metal nameplate detailing the isolator type and rating is affixed to each isolator base.

Packing

Each isolator is suitably packed in wooden crates to protect against damage during transport and storage.

Type Test

To substantiate ratings, type test reports are available on request.

3-Phase Formula

1. Voltage drop = 1.72 x 1 x R
   Where 1 = Line current per phase
   R = Resistance of one core only
   NB: For large 3-core cables carrying high alternating currents, the increased AC resistance due to skin effect must be allowed for.

2. $kW = kVA \times \text{Power Factor}$

$$kW = \frac{\text{Line Amps} \times \text{Line Volts} \times 1.73 \times \text{Power Factor}}{1\,000}$$

$$kW = \frac{\text{Horse Power} \times 746}{1\,000 \times \text{Efficiency}}$$

3. $$kVA = \frac{kW}{\text{Power Factor } \theta}$$

$$kVA = \frac{\text{Line Amps} \times \text{Line Volts} \times 1.732}{1\,000}$$

$$kVA = \frac{\text{Horse Power} \times 746}{1\,000 \times \text{Efficiency} \times \text{Power Factor}}$$

4. $$\text{Line Amps} = \frac{kW \times 1\,000}{\text{Line Volts} \times 1.72 \times \text{Power Factor}}$$

$$\text{Line Amps} = \frac{kVA \times 1\,000}{\text{Line Volts} \times 1.732}$$

$$\text{Line Amps} = \frac{kW \times 1\,000}{\text{Line Volts} \times 172 \times \text{Power Factor} \times \text{Efficiency}}$$

kW = KiloWatt kVA = KiloVolt Amps Power Factor = Cos θ

Physical Constants

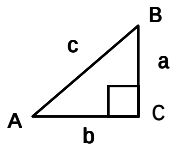
Acceleration of gravity	=	32.2ft/sec²
	=	9.8m/sec²
Atmospheric pressure	=	14.7psi
	=	760mm Hg = 101.3 kilopascal
Avogadro's number	=	6.024×10^{23}/gm mol
British thermal unit	=	1 054.8 joules
Curie	=	3.7×10^{10} disintegrations/sec
Faraday	=	9.65×10^{4} coulombs
Gas Constant (air)	=	8.32×10^{7} ergs/°C gm mol
Gram-calorie	=	4.19 joules
Gram-mole of gas	=	22.4 litres @ 0°C and 1 atm
	=	24.45 litres @ 25°C and 1 atm
Planck's constant	=	6.626×10^{-27} erg sec
Velocity of light	=	2.9978×10^{10}cm/sec

Geometric Formula

Circle	Sphere
$C = \pi D$	$S = 4\pi r^2$
$A = \pi r^2$	$V = (4/3)\ \pi r^3$

Trigonometric Functions

sin A	=	a/c
cos A	=	b/c
tan A	=	a/b
cot A	=	b/a



Mechanics

F	=	μN
F_1d_1	=	F_2d_2
v	=	$v_o + at$
s	=	$v_ot + (at^2)/2$
v^2	=	$v_0^2 + 2as$
KE	=	$(mv^2)/2$
PE	=	$mgh = (kx^2)/2$
p	=	mv
F	=	ma
W	=	mg

Gas Law

PV = nRT

TWA's

TWA = $[T_1C_1 + T_2C_2 + ... + T_nC_n]/T_{total}$

Electricity

E	=	IR
P	=	EI
R_{series}	=	$R_1 + R_2 + ... + R_n$
$1/R_{parrallel}$	=	$1R_1 + 1/R_2 + ... + 1/R_n$

Ventilation

Q	=	AV
V	=	$4005\ (VP)^{1/2}$
V	=	$4005C_e\ (SP_h)^{1/2}$
TP	=	SP + VP

Radiation

S=6CE

$I_2 = I_1 x\ [(d_1)^2/(d_2)^2]$

Noise

L_I	=	10 log (I/I_0) dB
L_p	=	20 log (p/p_0) dB
T	=	$8/\ (2^{[L-90)/5]})$

Heat Stress

WBGT	=	0.7WB + 0.3 GT
WBGT	=	0.7WB + 0.2 GT + 0.1 DB

Unit Conversions

Temperature			Angles		
t_k	=	$t_c + 273.16$	1 radian	=	$180°/\pi$
t_c	=	$(t_f - 32)/1.8$			
			Concentrations of Vapours and Gases		
Density of Water			ppm	=	mg/m^3 x 24.45/MW
$1gm/cm^3$	=	$1.94\ slugs/ft^3$			
(weight density = $62.4lbs/ft^3$)			Light		
			1 lumen	=	1 candela
Radiation			1 footcandle	=	$10.76\ candela/m^2$
1 Curie	=	3.7×10^{10} Becquerel		=	10.76 lux
1 Rad	=	10^{-2} Gray			
1 Rem	=	10^{-2} Sievert	Magnetic Fields		
			1 Teasla	=	10, 000 Gauss

CONVERSION FACTORS

Great care must be exercised in the use of units as the application of incompatible units probably constitutes the major cause of errors in calculation. This section gives some conversion factors to facilitate the expression of units on a common correct base.

Use of the International Standard (SI) units has become mandatory in the R.S.A. in terms of the Measuring Units and National Measuring Standards Act No. 76 of 1973 from the 5th of July 1974 as noted in Government Gazette No. 4326. This system must, therefore, be adhered to on all drawings, specifications, enquiries, contracts and orders.

The SI units consist of:

a.) Base units
b.) Supplementary units
c.) Derived units

Base Units

Quality	Name	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol.
Luminous intensity	candela	cd

Supplementary Units

Quality	Name	Symbol
Plane angle	radian	rad
Solid angle	steradian	sr

Delivered Units

Some of the relevant derived units are:

Quality	Name	Symbol	Expressed in terms of SI Units
Capacitance	farad	F	C/V
Conductance, Admittance, Susceptance	Siemens	S	A/V
Electric charge	coulomb	C	A.s
Electric resistance, Impedance, Reactance	ohm	Ω	V/A
Electric potential	Volt	V	W/A
Force	newton	N	kgm/s^2
Frequency	hertz	Hz	S^{-1}
Inductance	henry	H	Wb/A
Magnetic flux	weber	Wb	V.s
Magnetic induction	tesla	T	Wb/m^2
Power	watt	W	J/S
Pressure, stress	pascal	Pa	N/m^2
Work, energy	joule	J	N.m.
Area	-	m^2	m^2
Density	-	Kg/m^3	Kg/m^3
Kinematic viscosity	-	m^2/s	m^2/s
Second moment of area	-	m^4	m^4
Speed	-	m/s	m/s
Volume	-	m^3	m^3
Dynamic viscosity	Pascal second	Pa.s	Pa.s
Torque	-	N.m	N.m
Permeability	-	H/m	H/m
Permittivity	-	F/m	F/m
Resistivity	-	Ωm	Ωm

Specific heat	-	J/kgK	J/kgK
Thermal conductivity	-	W/mk	W/mk

Conversion Factors

Multiply by ← to convert from			To convert from → to → Multiply by
(i) Area			
0,155	sq. inches	sq. centimetres	6,4516
0,00155	sq. inches	sq. millimetres	645,16
10,7639	sq. feet	sq. metres	0,0929
43560	sq. feet	acres	0,00002296
0,40469	hectare	acres	2,471
0,0001	hectare	sq. metres	10 000
1,196	sq. yard	sq. metres	0,83613
0,00197	circular mil	µm²	506.707
(ii) Bending Moment			
0,7376	pounds feet	newton metre	1,3558
8,851	pounds inch	newton metre	0,113
0,102	kilogram metre	newton metre	9,807
0,102	kilopond metre	newton metre	9,807
1000	newton millimeter	newton metre	0,001
(iii) Density			
0,06243	pounds/cu.ft.	kilogram/cu.metre	16,018
0,036128	pounds/cu.inch	grams/cu.cm.	27,679
(iv.) Energy, Power			
1,341	Horsepower	kilawatts	0,7457
56,879	BTU/min	kilowatts	0,01758
3,4129	BTU	Watt-hrs	0,2930
0,9863	Horsepower	metric horsepower	1,0139
0,000948	BTU	joules	1054,6
1,0	watt seconds	joules	1,0
0,948	BTU	kilojoules	1,0546
0,2387	calories	joules	4,19
0,102	kg metre	joules	9,807
0,2778	kilowatt hour	mega joules	3,6

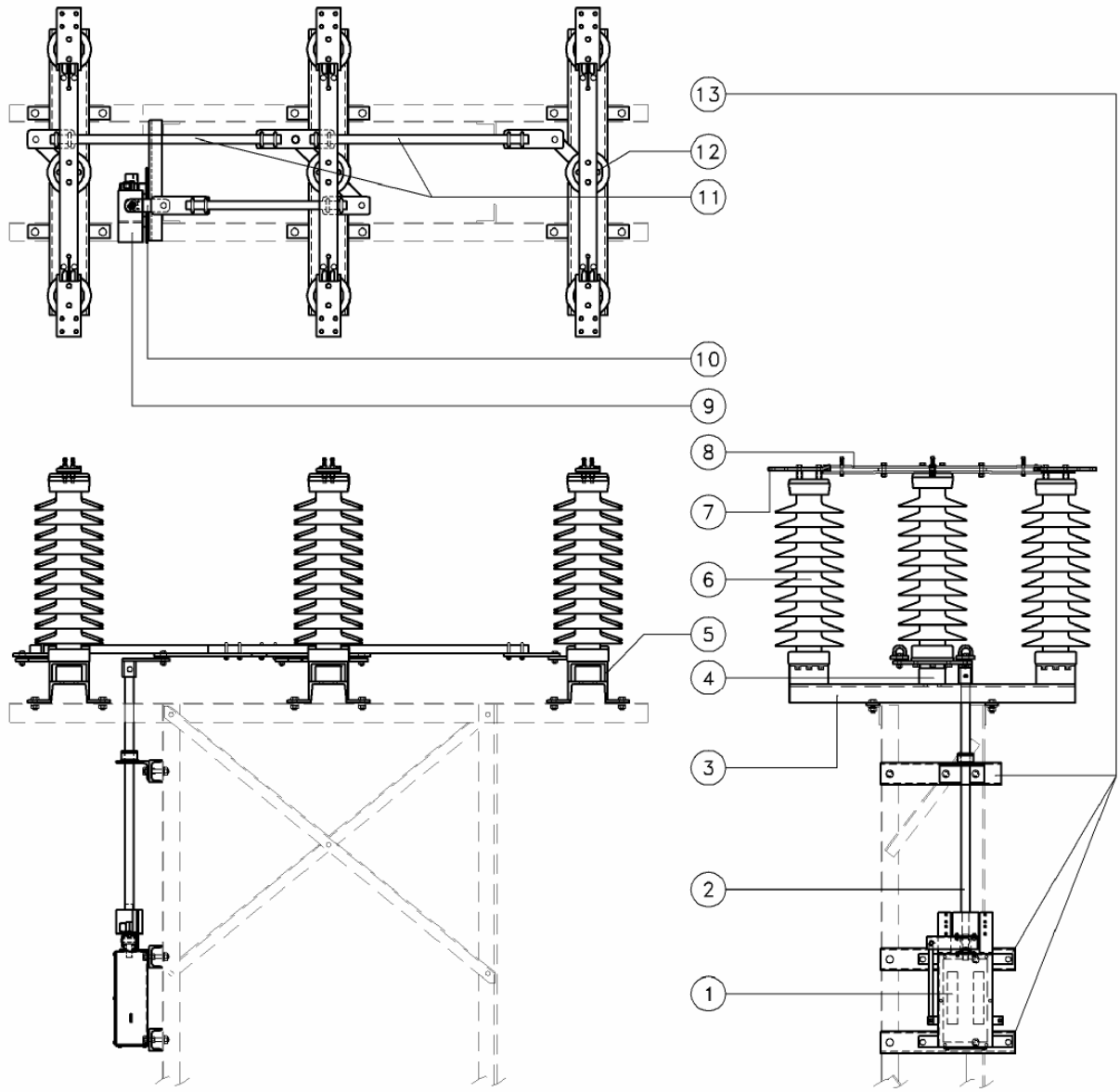
Multiply by ← to convert from			To convert from → to → Multiply by
(v) Force			
100000	Dyne	Newton	0,00001
0,102	Kilogram force	Newton	9,807
0,102	Kilopond	Newton	9,807
0,2248	Pound force	Newton	4,448
(vi) Torque			
0,7376	Foot pounds	Newton metres	1, 3558
8,8507	Inch pounds	Newton metres	0,113
0,102	Kilogram metres	Newton metres	9,807
0,102	Kilopond metres	Newton metres	9,807
1000	Newton mm	Newton metres	0,001
(vii) Length			
0,3937	inches	centimetres	2,54
39,37	inches	metres	0,0254
0,03937	inches	millimetres	25,4
3,2808	feet	metres	0,3048
0,62137	miles	kilometres	1,60934
1×10^{7}	angstrom unit	millimetres	1×10^{-7}
1000	micron	millimetres	0,001
1×10^{6}	millimicron	millimetres	1×10^{-6}
39,37	thou	millimetres	0,0254
39,37	mil	millimetres	0,0254
1,0936	yards	metres	0,9144
(viii) Mass			
0,035275	ounces (av)	grams	28,349
0,03215	ounces (troy)	grams	31,103
2,20462	pounds	kilograms	0,45359
2204,62	pounds	metric tonnes	0,0004536
2000,0	pounds	short ton	0,0005
2240,0	pounds	long ton	0,0004464
0,001	metric tonnes	kilograms	1000,0
15,432	grains	grams	0,0648

Conversion Factors Continue

To convert from ● ⟶ to ● ⟶ Multiply by Multiply by ⟵ ● to ⟵ ● to convert from			
(ix) Pressure			
2,242	cm. mercury	ft. water	0,4461
1	atmospheres (metric)	kg/sq.cm.	1
0,06805	atmospheres (std)	pounds/sq. inch	14,6959
0,96784	atmospheres (std)	kg/sq.cm.	1,03323
14,2233	pounds/sq.inch	kg/sq.cm.	0,0703
0,01	bars	kilopascals	100
10,0	bars	newtons/sq.mm.	0,1
0,0075	mm. mercury	pascals	133,322
0,102	mm.water	pascals	9,8064
0,145	pounds/sq. inch	kilopascals	6,8948
0,001	newtons/sq.mm	kilopascals	1000
(x) Volume			
0,061	cubic inches	millitres	16,387
0,0353	cubic feet	litres	28,31
35,3145	cubic feet	cubic metres	0,02832
0,2642	gallon (U.S.)	litres	3,7853
0,22	gallon (imp.)	litres	4,5456
0,00176	pint	millilitres	568,261
1,7598	pint	litres	0,5683

SI Prefixes and Symbols for Multiples and Submultiples of SI Units

Numerical Factor	Verbal Factor	SI Prefix	SI Symbol
10^{12}	Billion	tera	T
10^{9}	Millard	giga	G
10^{6}	Million	mega	M
10^{3}	Thousand	kilo	k
10^{2}	Hundred	hecto	h
10	Ten	deca	da
10^{-1}	Tenth	deci	d
10^{-2}	Hundredth	centi	c
10^{-3}	Thousandth	milli	m
10^{-6}	Millionth	micro	µ
10^{-9}	Milliardth	nano	n
10^{-12}	Billionth	pico	p
10^{-15}	Billiardth	femto	f
10^{-18}	Trillionth	atto	a



ITEM	QTY	DESCRIPTION
13	3	SPACERS
12	3	CENTRE PIVOT ASSEMBLIES
11	2	INTER-PHASE COUPLING RODS
10	1	COUPLING ASSEMBLY AND DRIVE ROD
9	1	BEARING SUPPORT PLATE
8	3	MOVING CONTACTS-DOUBLE BLADES
7	6	FIXED CONTACT TERMINAL PADS
6	9	INSULATORS
5	6	INSULATOR SUPPORT SPACERS
4	3	TURNTABLES
3	3	PHASE CHANNEL BASES
2	1	VERTICAL COUPLING PIPE
1	1	HAND OPERATED MECHANISM

List of Components – HK Isolators

Description	Quantities
1. Hand Operating Mechanism *NB.: The box may contain an auxiliary switch and/or captive key lock(s).*	1
2. Vertical Coupling Pipe	1
3. Phase Channel Bases	3
4. Turntables	3
5. Insulator Support Spacers	6 (66kV – 24)
6. Insulators	9
7. Fixed Contact/Terminal Pads	6
8. Moving Contact/Double Blades	3
9. Bearing Support Plate	1
10. Coupling Assembly and Drive Rod	1
11. Inter-phase Coupling Rods	2
12. Centre Pivot Assembly	1

NB.: Due to development modifications, the details may vary slightly from the drawing.

Unpacking

The isolators are packed in sub-assemblies, one complete isolator per skeleton crate. The 3-phase sub-assemblies consist of Items 3, 5, 6, 7 and 8, mounted on their phase channel bases (3). In addition items 1, 2, 9, 10 and 12 are strapped to the side of the crate.

Inspect and check the existence of all the above parts and advise supplier immediately of any shortages or damage (see addendum for any additional optional parts).

Installation

1. The contact pressure is factory set. Open moving contacts and close again until contacts just touch. Check that the fixed contact blade is positioned in the centre of the two moving contact blades. If not satisfactory, slacken off M8 screw with spring nearest to the centre insulator. Adjust blades up or down to suit and re-tighten the M8 screw.

2. Mount and align each phase sub-assembly in position on the structure (supplied separately or by others) at the phase centres indicated on the drawing and secure.

3. Position the hand operating mechanism (1) on the structure.

4. Position the bearing support plate (9) on the structure.

5. With the isolator phases in the closed position, fit the inter-phase coupling rods (11) between the centre phase centre pivot assembly (12) and the outer phases turntable levers (4). Adjust their length to ensure simultaneous opening and closing of all 3 phases.

6. Fit the vertical coupling pipe (2) in position through the bearing.

7. Fit the coupling assembly and drive rod (10) between the coupling pipe crank and centre phase lever.

8. With the phase contacts closed and the hand operating mechanism (1) in the CLOSED position, couple the vertical coupling pipe (2) to the hand operating mechanism (1) by means of the M10 set screw and lock in position.

9. Operate the switch and check that the contacts are fully closed with the handle in the fully CLOSED position. If necessary, adjust by slackening the u-bolts on the drive rod (10), adjust length and re-tighten the u-bolts.

10. Open and close isolator a number of times to ensure smooth and correct operation.

11. After the conductors have been secured to the terminal pads, check contact alignment.

12. All contacts will have been cleaned and greased before despatch. Only if necessary, clean contact surfaces and apply recommended contact paste.

13. Check any secondary wiring, terminals and fixing screws for tightness.

14. Note spaces, item 13 to mount items 1 and 9 to the structure as supplied as standard 76 x 38 channel.

Maintenance

These isolators require very little maintenance. However, it is recommended, dependant upon the environmental conditions, to attend to the following, once in 3 to 5 years.

1. Grease all bearing points via nipples provided.

2. Clean main contacts with transformer oil and recoat with recommended contact paste.

3. Operate isolator several times to check smooth operation and operation of auxiliary contacts. Only re-adjust settings if found to be necessary.

Polymer Insulators

Elbroc polymer insulators have been ergonomically designed and shaped to make use of the environment and its changing conditions to create insulators that are:

Self washing
Light weight
Easy to use

There are more of this design of composite insulators in service than all other makes combined.

Elbroc polymer insulators were first installed in SA on a 132kV line in the Nelspruit area in 1979. Some of these were subsequently taken down for examination and testing, and were found to be in perfect working order. Random checking over the years has confirmed the reliability of Elbroc polymer insulators.

This reliability helps you to satisfy your customer's need for uninterrupted power supply.

Field use has proved that Elbroc composite insulators are the cost effective, high performance solution to the ongoing maintenance and construction problems encountered in the distribution of power.

Elbroc polymer insulators, which are marketed under the trade name "Thiel-Lite", are manufactured under licence to the world-renown Ohio Brass Company of America who are leaders in polymer technology. Our licence agreement ensures that all new product developments are immediately incorporated into the local product.

Our manufacturing and marketing policy includes a quality assurance programme that is in accordance with our listing in terms of SABS ISO 9001 code of practice, ensuring that our products conform to the high standards demanded by the industry we serve.

More than 500 000 units sold in the first 14 years.

Basic Construction

The insulators consist of three basic components:
1. Weathersheds
2. Fibreglass rod
3. Metal end-fittings

The weathersheds are assembled over the fibreglass rod, the centre hole in the weathersheds being smaller than the rod to ensure a tight fit. The inner surface of the weathersheds hole forms two O-rings per centimetre and the reservoirs between these O-rings are filled with a special silicone grease to produce a continuous, permanent "living" seal.

The end fittings are attached by crimping them to the fibreglass rod.

When assembled, the end-fittings maintain the entire stack of weathersheds under axial compression, which adequately compensates for the slight elongation of the fibreglass rod under tension or when temperature changes occur.

A wide range of products for 11 to 765kV are available to fit all existing hardware. Applications stretch from the sub-zero temperatures of Alaska to the harsh UV conditions of the Namibian desert.

Local manufacture gives you:

- Custom design. We manufacture to your needs (all configurations from 11 to 20mm socket/ball and clevis/tongue).
- Better deliveries because there are no long shipping times.
- Superior local knowledge of polymer insulator design and construction.
- Price flexibility.
- Production flexibility.
- Direct replacements for existing strings.
- No change in ground clearances.
- Reduced down time and fewer outages.
- Less fault tracing.
- Cheaper transportation.
- Improved productivity.
- No repetitive line inspections. Once a McWade insulator is installed you never need worry again. "Put it up and leave it".
- Maintenance down time is costly. McWade polymer insulators help you save money.

Forged steel end-fittings	• Superior quality • Consistent strength
Hot dip galvanized	• Non-corrosive • Long lasting
Weathersheds	• Specially formulated silicone alloy material • Hydrophobicity of silicone • Strength and electrical superiority of EPDM
Hydrophobicity	• Surface water breaks up into droplets • Broken conductive pathways • Reduced leakage currents
Pollution	• Sediment forms on insulator, silicone molecules migrate through sediment causing water film to break up into droplets and so break conductive path
Smooth aerodynamic profile	• Allows for wind cleaning and water run-off • Suitable for vertical and horizontal installation
Vandalism	• Silicone alloy weathersheds – no breakages • High mechanical strength • Absorbs impact • Flexible weathersheds combat vandalism
Compact design	• Allows for increased creepage without increasing the coupling length
O-rings	• Filled with silicone grease, forming a continuous seal along the insulator • Eliminates the risk of puncture
High strength fibreglass ring	• Glass content exceeds 70 per cent • Continuous strands of fibre • As strong as 070M55 (En9) steel
Integral corona ring	• Prevents corona on rubber surface • Insulators are RIV and corona free up to 161kV
Long rod style insulator (class A type)	• No metal between end-fittings • Longer creepage • Less chance of flashover • Puncture-proof

HARDWARE

McWade Productions manufactures and supplies a comprehensive range of hardware fittings utilised in the make-up of complete insulator string sets for both LV/HV transmission lines and substations up to an operational voltage of 800kV.

All forged steel hot dipped galvanised fittings are manufactured in compliance with IEC specification number IEC120.

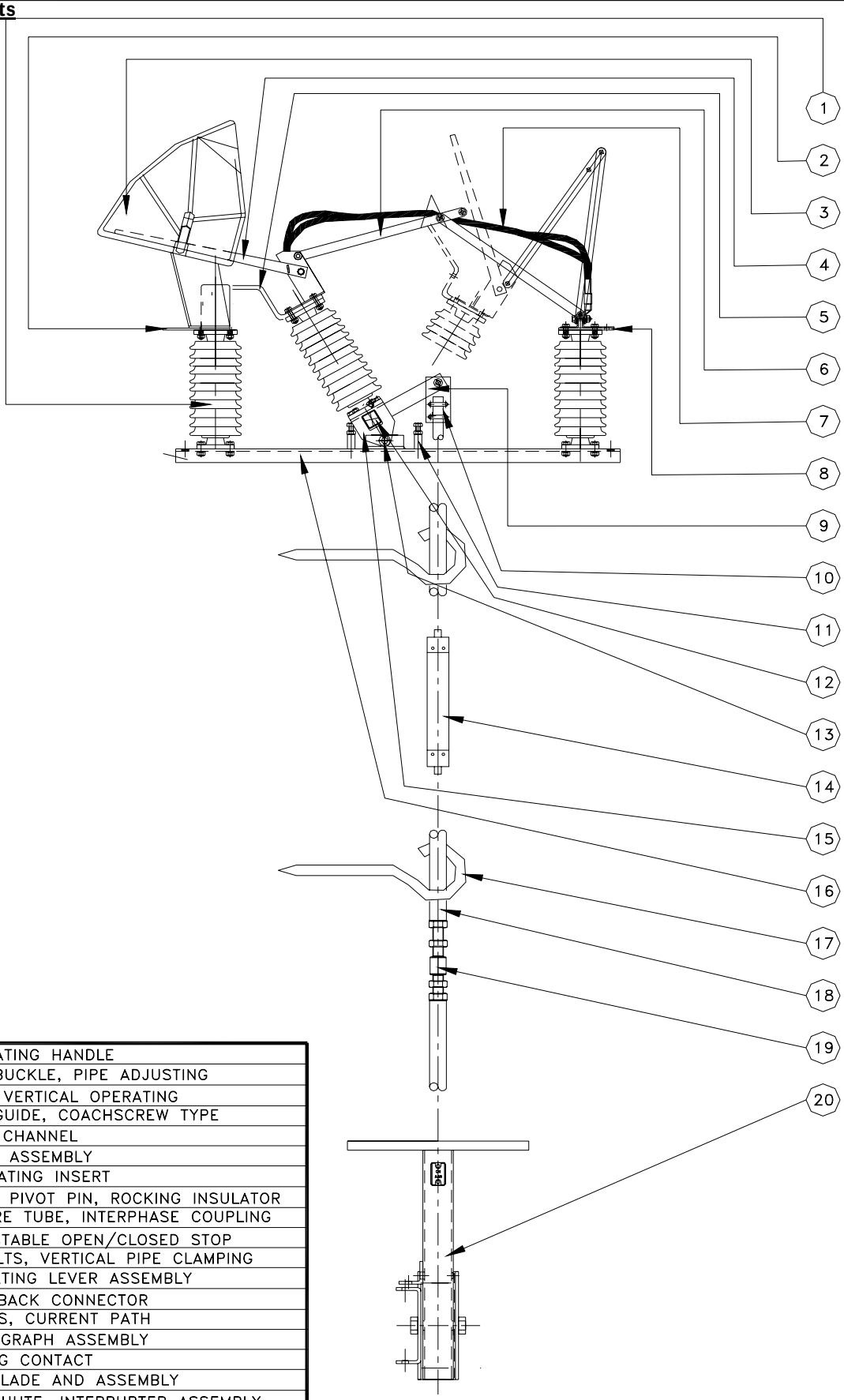
The catalogued range of compression connectors provides for service and heavy duty "T" connections from Main Lines. Connectors are available for COPPER ALUMINIUM and BI METAL interconnections between Main Line conductors and branch cable. Live Line bails are included in the range, since these provide for disconnectable features at Overhead Line section points, or any situation where live clamp tapping of the conductor is desirable.
The types of connector designs available ensure the complete requirements of HV and LV tapping are catered for with a minimum number of "Range Taking" compressed with the "Bimetal 4" No Die Crimping Tool.

Accessory equipment such as:

- Tensioning Machines
- Lifting Apparatus
- Hot Line Working Tools
- Grounding/Earthing Equipment
- Cover up equipment
- Working Platforms

etc. are sourced from both local and internationally recognised suppliers.

List of Components



ITEM	QTY	DESCRIPTION
20	1	OPERATING HANDLE
19	1	TURNBUCKLE, PIPE ADJUSTING
18	3	PIPE, VERTICAL OPERATING
17	1	ROD GUIDE, COACHSCREW TYPE
16	3	BASE CHANNEL
15	3	HINGE ASSEMBLY
14	1	INSULATING INSERT
13	3	HINGE PIVOT PIN, ROCKING INSULATOR
12	1	SQUARE TUBE, INTERPHASE COUPLING
11	6 (2)	ADJUSTABLE OPEN/CLOSED STOP
10	2	U-BOLTS, VERTICAL PIPE CLAMPING
9	1	OPERATING LEVER ASSEMBLY
8	3	PAD, BACK CONNECTOR
7	6	CABLES, CURRENT PATH
6	3	PANTOGRAPH ASSEMBLY
5	3	MOVING CONTACT
4	3	ARC BLADE AND ASSEMBLY
3	3	ARC CHUTE, INTERRUPTER ASSEMBLY
2	3	PAD, FRONT CONNECTOR
1	9	PORCELAIN INSULATOR

On receipt of equipment compare components against the following checklist. Notify supplier immediately of shortages or damage.

Description	Quantities
1. Complete isolator as per drawing	Three phases per unit
2. Interphase coupling tube – 38mm square tube	1 length
3. Vertical operating rods: 20mm bore pipe x 2m lengths	3 lengths
4. Operating lever assembly	1
5. Operating rod insulating insert	1
6. Reciprocating operating handle assembly	1
7. Flexible earthing strap	1
8. Rod Guides	1

Note: In cases where arc chutes have been removed for transportation, refit one to each Phase as described under load break units.

Installation

Each isolator is factory aligned before dispatch, but to ensure years of trouble free operation, follow these instructions carefully: -

1. Place individual phases in position on the mounting framework. In the case of 11kV and 22kV isolators, ensure that the isolator pole fitted with adjustable hinge stops is mounted in the center phase position. This is important as the open and closed positions for all three phases are set by this phase.
2. Holding down bolts can be inserted, but not secured.
3. Loosen U-bolts on center hinge assemblies on each phase – removal is not necessary.
4. Position interphase coupling tube through square apertures in hinges, ensuring alignment with operating handle position and/or equal overlap through outer phase hinges.
5. Tighten U-bolts finger tight.
6. Open isolator, i.e. separate the main moving contact and the fixed contacts by pulling upwards on the main contact blade. All three contacts will open.
7. Close slowly, letting the moving contacts rest in the fixed contacts. Do not close completely.
8. Leaving the phase coupling tube free, align the three phase bases, and tighten the holding down bolts.
9. Tighten U-bolts on all phases.
10. Close isolator until the center phase moving contact is parallel to the base. Adjust the appropriate stop if necessary. Lock in position. At this point, ensure that the interrupter moving contact (Load break head, item 4) is not making contact with the arc chute internal contacts. It should not be necessary to adjust the open position stop.
11. Open the isolator slowly, checking that the arcing moving contacts have properly latched below the arc chute contacts, and remain below them until the main moving contacts are well clear of their fixed contacts.
12. Close the isolator slowly, checking that the arcing contacts on all phases latch below the arc chute contacts and once fully closed, do not touch them or the bottom of the arc chute. This setting is made by means of the eccentric stop.
13. Clamp the operating lever in the desired position on the phase coupling tube.
14. Place the operating mechanism handle in position, screw up bolts finger tight.
15. Fit rod guide in position on the structure
16. Attach one length of vertical operating pipe to the operating mechanism turnbuckle. Fit insulating insert to operating pipe.
17. Close operating mechanism.
18. Fit remaining operating rods, cutting top section to suit if necessary. Use pipe sockets and U-bolts on operating lever to secure.
19. Align operating mechanism handle and tighten fixing bolts.

20. With isolator in closed position and operating handle in the “ON” position, check that the center hinge is against the closed stop.
21. Tighten the operating mechanism turnbuckle until the operating pipe is taut. Secure in position with lock nuts.
22. Check all fasteners for tightness.
23. By means of operating mechanism, open and close the isolator a number of times to ensure a positive action exists.
24. Secure the operating mechanism earthing strap to the mechanism mounting base.
25. Secure incoming and outgoing conductors as required.

Maintenance

- At approximately 6-monthly intervals – particularly if the isolator has not been operated for an extended period, the isolator should be opened and closed several times to “wipe” the contacting surfaces, verify that the operation is correct, and ensure that the isolator and operating mechanism remain in good condition.
- Every two years – or shorter intervals under adverse atmospheric conditions, remove the isolator from service and perform the following operations: -

1. Visually examine all contacts and replace damaged components if required.
2. Clean all contacts, removing all dirt and old grease. Regrease the main contact surfaces only – arcing contacts should be left clean and dry.
3. Lubricate operating mechanism and isolator hinge points.
4. Clean the insulators.
5. Check alignment of contacts, following the procedure set out in items 10, 11 and 12 of the installation procedure.

Load Break Units

When load break heads are fitted, these are pre-set before dispatch from the factory and should require no further adjustment. However, it is possible that the settings could be upset as the result of knocks received during transportation or unpacking. In this event, checks and adjustment should be carried out as follows after assembly of the three phases of the isolator on its structure: -

- Ensure that all cardboard separation pieces are removed from the arc chute slot.
- If any of the stainless steel arcing blades have been bent, carefully straighten them by hand, or disassemble them for repair.
- Slip the blade into the arc chute, and using the M8 stainless steel setscrews supplied, fasten the arc chute to the pre-assembled galvanized bracket, with one flat washer under the setscrew head, and the other underneath the spring washer and nut, against the bracket.
- Ensure that the blades are centred within 3mm of the centerline of the arc chutes as they enter the chamber.
- With the isolator fully closed, ensure that the blades have properly latched below the chamber contacts, but do not touch them or the bottom of the chamber. This setting is made by means of the eccentric blade stop.
- Minor differences in the opening time of the three blades are permissible. If adjustment is necessary, slacken the insulator to base mounting channel mounting bolts and set as required, ensuring that the main moving contact remains centred between the main fixed contacts.