

# Operating Manual

## Tube to Tubesheet Weld Head RBK 20



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## 1. GENERAL INFORMATION

This welding head automatically performs tube to tube sheet weldings with TIG or TIG + filler wire.

For TIG welding without filler wire you may remove the rear machine group. In this way size and weight of the welding head will be reduced and allows welding operations on tubes of minimum diameter and of minimum wall thickness.

### 1.1 Technical Specifications

Positioning of weld head:	pulse emitter
Welding position:	horizontal, vertical
Welding process:	TIG and/or TIG + filler wire
Welding current:	max 200 A
Welding diameters:	10 - 70 mm 10 - 26 mm electrode inclined at 30° 70 mm electrode parallel to the tube
Welding geometries:	recessed, flush and protruding tubes
Current transmission:	lamellar coupling
Gas and water transmission:	rotating coupling
Support on tube sheet:	three point support
Torch and wire nozzle:	adjustable on three axis according to welding geometry
Centering of torch:	by means of a series of spring loaded centering cartridges and mandrels
Cooling of torch:	water cooled up to electrode holder
Torch inclination:	max. +/- 45°
Rotation and filler:	18 V DC standard motor (tacho on rotation on request)

Rotation speed:	min. 0,33 rpm max 6,00 rpm
Wire speed:	min. 0.15 m/min max 1.50 m/min
Filler wire spool:	1 Kg Midget spool, diam. 100 mm, mounted on machine body
Wire diameter with rollers:	min. 0,6 mm max 0,9 mm

Dimensions:

- Machine body 70 mm

Length:

- Without wire group 325 mm

- With wire group 470 mm

- Weight:

(without centering devices and  
connection cable)

- Without wire group 5,0 Kg

- With wire group 10,0 Kg

## 2. DESCRIPTION OF THE WELD HEAD

- A) The weld head can rotate indefinitely as current, cooling water and gas are supplied to the torch by means of a special designed rotating coupling. In this way cable connections from the power supply to the weld head remain fix.
- B) Electrode and wire nozzle are both completely moveable towards the tube axis. In this way the electrode and the wire nozzle inclination can be easily optimized.
- C) All normal work operations and small maintenance jobs can easily be performed directly by the operator (replacement of spool, electrode, wire hose, etc.).

The weld head is composed of these groups:

- Central body and rotating coupling: assembly drawing 20.01.01.00
- Wire group: assembly drawing 20.02.01.00
- Front body and torch: assembly drawing 20.03.00.00

On request can be supplied:

- Cage with support ring for welding of flush tubes
- Internal bore welding torch (L= up to 400 mm), tube diam 9,5 to 80 mm
- Front dual flow cage for second gas (for titanium welding e.g.), at request with three point support.

We would like to remind you that our staff is able to design special torches for special applications or welding geometries as well as prolonged torches for welding in hardly accessible areas.

## 2.1 Main Body and Rotating Coupling (drawing 20.01.01.00)

This group is composed of the following main items or subassemblies:

- Connection block (pos. 34) to the main cable for cooling water, welding current and protection gas.
- Electric socket for connection to the welding programmer (pos. 38).
- Rotation joint spindle (pos. 25) and main distributor (pos. 23) for cooling water, protection gas and welding current. The electrical contact between the parts is obtained by means of a lamellar joint (pos. 52).
- Self-lubricating bearings (pos. 12; 13) for supporting the rotation joint spindle.
- Standard rotation gear-motor (pos. 19). (On request with tachometer feedback pos. 20)
- Coupling between crown wheel-pinion (pos. 22; 30) for transmission of rotation from the gear-motor to the welding head.
- Electro mechanic pulse-counter for controlling the welding cycle with respect to the torch position. The microswitch (pos. 61) is actuated by a wheel with 20 cams which supplies 60 impulses during a 360° rotation of the torch.
- External body (pos. 02) with hook (pos. 37). (Standard for welding in horizontal position)
- Mandrel support vessel (pos. 01) machined out of stainless steel.
- Ball bearing (pos. 49) which allows the rotation of the mandrel support vessel and the front group for external and internal bore welding.
- Socket (pos. 31).
- Start/Stop button (pos. 59) for starting the welding cycle or act the emergency stop (if pushed during the cycle).

## 2.2 Filler Wire Group (drawing 20.02.01.00)

- Filler wire gear-motor (pos. 43).
- Pair of wire feed rollers (pos. 20; 21). On the machine usually are mounted rollers for wire 0,6 - 0,9 mm.
- Wire spool support (pos. 11). Standard spool has following dimensions:
  - external diameter: 100 mm
  - min. wire coiling diameter: 40 mm
- Elastic (spring loaded) blocking device which avoids by a clutch-disc (pos. 37; 38) system the unrolling of the spool.
- Filler wire arrival group which is composed of:
  - guide nozzle (pos. 40)
  - wire exit guide (pos. 08)
  - wire entry guide (pos. 39) and rear entry nipple (pos. 16)
  - rear wire guide hose (pos. 09)
  - front wire guide hose (pos. 04)
  - shaft with insulating bushing (pos. 28)
  - shaft support (pos. 29)

## 2.3 Front Body and Torch (drawing 20.03.00.00)

- Brass slide body (pos. 11) with sliding guide for the torch support. Inside the brass body is running the cooling water and the protection gas. Three Viton hoses (pos. 13; 15) start from here to the torch.
- Torch body (pos. 12) with threaded hole for the gas diffuser (gas lens). The torch is covered by a special insulating painting in order to insulate the piece against high frequency.
- Torch support (pos. 01) with split for adjusting the welding distance. The support is insulated like the torch body. Attached to the support is the shaft for supporting the filler wire arrival group.
- Radial torch position adjustment device (pos. 07) by special screws.
- Insulating body (pos. 03).
- Three point support (pos. 08; 26; 27).
- Mandrel support vessel (pos.14)

At request front cage with stainless steel support ring (drawing 20.05.00.00)

## 2.4 Centering Feature for External Tube Sheet Weldings

Is needed in order to maintain the welding gun perfectly in axis with the tube to be welded.

It consists of a spindle which is mounted by means of 5 screws on the support vessel. On this spindle (mandrel) are mounted the centering cartridges which will be located into the tube to be welded (bayonette attachment and blocked by a spring loaded ball).

The centering cartridge is equipped with four rows of spring loaded balls guaranteeing in this way a perfect centering of the welding head.

All mandrels and centering cartridges must be chosen with respect to the internal diameter of the tube to be welded.

Centering Device Type	Internal Tube Diameter		Mandrel Type
	min.	max.	
01	10	10.5	A
02	10.5	11	A
03	11	11.5	A
04	11.5	12	A
05	12	12.5	A
06	12.5	13	A
07	12.8	14	B
08	13.8	15	B
09	14.8	16	B
10	15.8	17	B
11	16.8	18	B
12	17.8	19	B
13	18.8	20.5	B
14	19.8	22.5	B
15	22.3	25	C
16	24.5	27	C
17	26.5	29	C
18	28.5	31	C
19	30.5	33	C
20	32.5	36	C
21	35.5	39	C
22	38.5	42	C
23	41.5	45	C
24	44.5	48	C
25	47.5	51	C
26	50.5	54	D
27	53.5	58	D
28	57.5	62	D
29	61.5	66	D
30	65.5	70	D

## 2.5 Connections (drawing 20.01.01.00)

Together with weld head RBK 20 is supplied a connection cable L=8m which allows the connection to the welding programmer/power supply.

The cable contains the following tubes:

- cooling water in hose (blue)
- water return and current hose (red)
- protection gas hose (yellow)
- gas 2 (eventually to be used for double gas)
- plug of the electrical signals from welding programmer to the welding head

### **3. ACCESSORIES AND MODIFICATIONS**

#### **3.1 Internal Bore Welding without Filler Wire**

A modification kit for the standard welding head can be supplied in order to perform internal bore welding (TIG process) without filler wire for the following dimension:

- Length std < 400 mm
- Minimum tube internal diameter 9,5 mm

ORBITEC can supply even torches longer than 400 mm and corresponding to special welding geometries.

The standard torches cover the diameter range from 9,5 -80 mm.

Referring to the diameter the torches are subdivided into 5 groups:

- Group "A" : I.D. 9,5 - 13 mm
- Group "B" : I.D. 13,1 - 18 mm
- Group "C" : I.D. 18,1 - 30 mm
- Group "D" : I.D. 30,1 - 50 mm
- Group "E" : I.D. 50,1 - 80 mm

(On request even larger diameters)

Each group is composed of the following components:

- Water cooled torch with front centering bushings (ceramic), gas nozzle (ceramic), electrode holder with gas diffusor. Ceramic nozzle and electrode holder are fixed to the torch by means of a threaded bush. The electrode is fixed by a screw.
- Front cage with stainless steel centering bush to support the weld head on the tube plate.

It is possible to mount distance rings on the torch in order to reduce the length of the torch in case there are several welding depths with the same internal diameter. These distance rings are available on request in all dimensions.

In any case we recommend to attach with the order for an internal bore welding torch the drawing of the welding geometry in order to fit out the torch the best way possible.

### 3.2 Front Cage for Dual Gas Flow

For welding special material (e.g. titanium) it is necessary to obtain a completely inert environment. For this reason it is possible to fit on welding head RBK 20 a front cage with a transparent glass which allows to create an inert environment around the electrode. This cage can be equipped with a three point support to render easier the positioning of the weld head on the tube plate in case of slightly protruding tubes.

The accessory is supplied complete with:

- Front cage with stainless steel front ring
- Pyrex glass
- Gas hose
- Nipples
- Upon request three point support

## 4. USE AND MAINTENANCE

### 4.1 Use of Weld Head RBK 20

The high technology achieved with welding head RBK 20 puts this model as response on top of the international market demands. This welding head is extremely simple and allows easily to perform all necessary adjustments for a proper welding, guaranteeing a high standard of reproducibility.

Anyhow it is recommended, before starting production, to prepare a sufficient number of welding samples (about 50) which correspond the later welding geometry. We recommend to adjust the wire arrival about 0,5 - 1,0 mm below the electrode. The wire should arrive perpendicularly to the electrode and tangentially to the tube.

The welding head should be hooked up with an elastic balancer.

The orbital welding RBK 20 allows to perform a great number of high quality weldings. In order to take advantage of this feature it is recommended to organize in advance the welding position:

- Be sure to have enough gas bottles.
- Be sure to have enough electrodes (pre-cut and shaped ).
- Prepare ceramic nozzles, wire nozzles, gas lenses, collets and wire spools.

The most important point to achieve a perfect weld is a perfect cleaning of the tubes and the joints to be welded. Be sure that there is no oxide, chips, grease or any impurities.

### 4.2 Positioning of the Welding Head

The low weight and the efficient centering devices allow an easy and economic way of using the welding head.

Hook up the welding machine on a balancer (size up to 15 Kg).

In order to obtain an efficient support on the tube sheet it is recommended to have to rope about 2 meters long and that it may be angled 15 - 20° towards the tube sheet. In this case the welding head is slightly pressed on the tube plate.

4.3) Starting of the Welding Heads  
(drawing 20.01.01.00)

In case the welding head is connected to a PRAI controller, pushing start / stop button {pos. 59} the welding cycle will start (real cycle or simulation) .Pushing a second time the same button the welding will be stopped (cycle end with downslope)

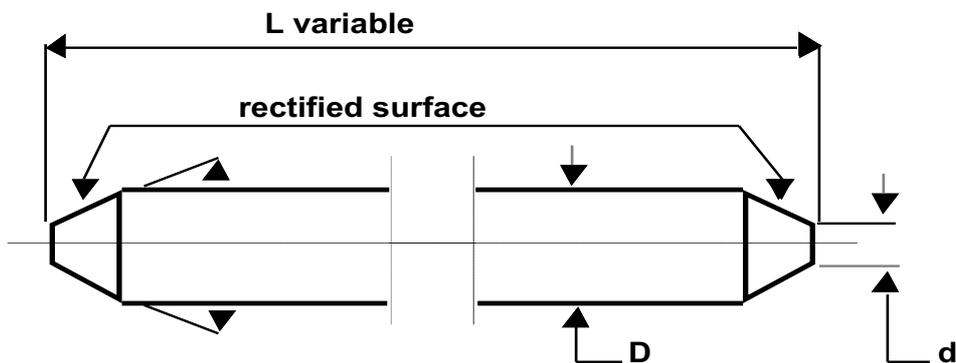
4.4) Preparation and Replacement of the Electrode  
(see drawing 20.03.00.00)

A correct geometry of the electrode is very important in order to guarantee a good quality of the welding. This geometry depends on the current you have chosen. For your reference see the enclosed table.

The electrode must be replaced every time you can see differences from the original geometry. In this case the welding parameters will change and the reproducibility is no longer guaranteed.

For the replacement of the electrode unscrew the cover the collet and collet body. In this way you can extract the electrode to be replaced.

Electrode collets for the following diameters are available: 1; 1,6; 2; 2,4 mm.



Electrode Diameter	Top Diameter	Angle	DC Current max. val.	Pulsed Current range
D	d	in °	A	A
mm	mm	°		
1.0	0.12	12	15	2 - 25
1.0	0.25	20	30	5 - 60
1.6	0.50	25	50	8 - 100
1.6	0.75	30	70	10 - 140
2.05	0.75	35	80	10 - 160
2.4	0.75	35	90	12 - 180
2.4	1.1	45	150	15 - 250
3.2	1.1	60	200	20 - 300
3.2	1.5	90	250	25 - 350

NOTE: The protrusion of the electrode from the ceramic nozzle geometric value to guarantee the reproducibility of the welding. It influences as well the distance electrode-workpiece.

We recommend to prepare a certain number of electrodes already cut and sharpened as soon as you have determined the electrode size.

#### 4.5 Adjustment of welding diameter (drawing 20.03.00.00)

The welding diameter can be adjusted by means of the screw (pos. 7) with the key supplied together with the tool box

#### 4.6 Adjustment of the Arc Distance (see drawing 20.03.00.00)

The distance electrode-workpiece can be defined after having determined the protrusion of the electrode from the ceramic nozzle.

Rotating the counter-ring (pos. 10) of the three-point-support you may change the distance electrode-workpiece.

Unscrewing the screw (pos. 35) on the torch support you may move the torch forwards or backwards parallel to the machine's axis. the stroke is 6 mm.

#### 4.7 Adjustment of the Filler Wire Arrival

The wire arrival group is assembled on the torch support following this way all radial and axial movements. To move the wire nozzle you just have to untighten the M3 screws on the hinges.

While adjusting the nozzle position you must keep in mind that the wire should pass about 0,5 - 1,0 mm under the electrode and that the wire arrival should be perpendicular to the tube axis and tangentially to the tube to be welded.

#### 4.8 Replacement of the Wire Nozzle (see drawing 20.02.01.00)

It is necessary to replace the wire nozzle when the exit hole has become ovaly due to the wear or if you want to change the filler wire diameter.

In this way exact guiding of the wire to the welding bath is no longer guaranteed.

Nozzles for wire diameter 0,6 ; 0,8 ; 1.0 mm are available.

For the replacement unscrew screw {pos. 51}, extract the nozzle and remove the nozzle from the wire liner.

#### 4.9 Replacement of the Wire Spool (drawing 20.02.01.00)

Act as follows:

- Cut the wire left on the spool.
- Press the wire forward button on the remote control in order to push forward the wire.
- The wire will advance until it has passed the wire feed rollers. Take a pair of pliers and tear the remaining wire out of the liner.
- Unscrew handle {pos. 33} and remove the spool.
- Take a new spool and round off the top of the wire with a file in order to prevent cutting of the Teflon wire liner.
- Remove the wire exit nozzle near the torch.
- Introduce the wire into the guide until it arrives to the wire feed rollers.

- Act on screw {pos. 65} in order to adjust the pressure of the rollers for feeding the wire.
- The right pressure is achieved when the wire is feeded regularly and without interruptions.
- Excessive pressure on the rollers will lead to an early wear. In order to adjust the pressure on the rollers it is necessary to act as follows:
  - \*\* Switch on the welding equipment.
  - \*\* In case the wire as stopped in front of the rollers which are too closed act on screw (pos. 65) in order to open the rollers.
  - \*\* Press the manual wire button on the remote control and tight screw (pos. 65) until the wire starts to be pushed. Now tight screw {pos. 65} half turn. The pressure will be correct now.
  - \*\* Place the spool on the shaft and put handle {pos. 33} on it.
  - \*\* Push the manual filler wire button until the wire gets out on the top.
  - \*\* Place again the wire end nozzle on the liner and fix it on its support.

Please Note: The wire group is equipped with a special friction which allows to keep the filler wire tight on the spool.

#### 4.10 Removement or assembly of wire group (drawing 20.02.01.00)

As mentioned before, the RBK 20 welding head allows to perform Tig weldings with or without filler wire. In case you intend to perform only TIG weldings you may remove the filler wire group in order to reduce dimensions and weight of the welding head. Hereafter are explained all operations to assemble the wire group on the welding head.

- assemble the front wire group fixing it by means of screw (pos. 57)

Note : the insulating bushing must not be removed when disassembling the wire unit.

- remove rear tap ( pos. 04 drawing 20.01.01.00)
- put into position the wire unit paying attention to :
- the front wire liner (pos. 04) must be inserted into the hole on the welding head and pushed through

- connect the electric sockets for feeding the wire motor ( pos. 55 , 56 )
- fix the wire unit to the machine body by means of screws ( pos. 51 , 62 )
- add the wire spool as described before and adjust the front wire nozzle

#### 4.11 Replacement of the Wire Liner

This operation is necessary due to the wear of the wire liner itself. The wear depends on the roughness of the wire surface. This operation can be programmed periodically after about 10-15 wire spools. As the cost of the wire liner is very low it is recommended to forecast the replacement before the liner is actually damaged.

Hereafter will be described the necessary replacement of the wire liner.

##### 4.11.1 Replacement of the Front Wire Liner (drawing 20.02.01.00)

Act as follows:

- Cut the wire left on the spool.
- Press the button on the remote control in order to push forward the wire.
- The wire will advance until it has passed the wire feed rollers. Take a pair of pliers and tear the remaining wire out of the liner.
- Remove the wire nozzle {pos. 40} from the support and remove it from the liner.
- Loosen screws ( pos. 51 , 62) disconnect electrical connectors (pos. 55, 56) and remove the whole wire unit. This way the front wire liner will be extracted from the welding head.
- Remove the liner from nozzle ( pos. 03)
- With the help of a pencil-sharpener round off the extreme parts of the liner and screw it again on nozzle (pos. 03).
- Proceed as described in par. 4.10

##### 4.11.2 Replacement of the Rear Wire Liner (drawing 20.02.01.00)

Act as follows:

- Cut the wire left on the spool.
- Press the button on the remote control in order to push forward the wire.
- The wire will advance until it has passed the wire feed rollers. Take a pair of pliers and tear the remaining wire out of the liner.
- Remove the spool as illustrated in the previous paragraph.
- Unscrew the liner to be replaced from its guiding nozzle {pos. 39}.
- Remove nozzle {pos. 16}.
- With the help of a pencil-sharpener round off the extreme parts of the liner.
- Screw nozzle {pos. 39} on the new liner ( the liner is self-threading)
- Place again the new liner in its guiding nozzle

## 5. SPARE PARTS LIST

ASSEMBLY DRAWING 20.01.01.00

CENTRAL BODY AND  
ROTATING COUPLING

VALID FROM SERIALNR : 9810359

POS.	DESCRIPTION	PART-NO
1	VESSEL SHELL SUPPORT	20.01.00.01
2	MACHINE BODY	20.01.00.02
3	INSULATING BODY	20.01.00.03
4	COVER	20.01.00.04
5	DISC	16.01.00.10
6	PLUG	04.04.00.03
7	NUT	04.04.00.20
8	NUT	04.04.00.21
9	WRENCH NUT	06.06.00.02
10	SPRING	10.01.00.41.00
11	PROTECTION FOR PUSH BUTTON	10.01.00.70
12	BEARING	13.01.00.24
13	BEARING	13.01.00.29
15	GAS CONNECTION	13.01.00.41
16	BASE	13.01.00.46
17	PLATE	13.01.00.49
19	ROTATION GEARMOTOR STANDARD	16.01.07.02
20	ROTATION GEARMOTOR WITH TACHO	16.01.07.05
21	SPACER	19.01.00.07
22	CONICAL WHEEL	19.01.00.08
23	DISTRIBUTOR SPINDLE	19.01.00.10
24	PLATE	19.01.00.11
25	DISTRIBUTOR	19.01.00.12
26	RING	19.01.00.14
27	SPACER	19.01.00.16
28	INSULATING PROTECTION	19.01.00.17.00
29	GEARMOTOR SUPPORT	20.01.01.01
30	PIGNON WITH TOPS COUNTER	19.01.00.19
31	SOCKET	20.01.01.05
32	CONNECTION PLUG	19.01.00.21
33	FUNNEL RING	20.01.01.03.00
34	BLOCK	20.01.01.02.00
35	WATER HOSE	19.01.00.24
36	WATER / GAS HOSE	19.01.00.25
37	EYEBOLT	19.01.00.26
39	CONECCTION CABLE	19.01.00.28
41	INSULATING PROTECTION	19.01.00.30
42	CLAMP BLOCK	33.01.00.30
43	CABLE CLAMP	33.01.00.31

ASSEMBLY DRAWING 20.01.01.00

CENTRAL BODY AND  
ROTATING COUPLING

VALID FROM SERIALNR : 9810359

POS.	DESCRIPTION	PART-NO
44	INSULATING SHELL	89.01.00.38
48	O-RING	56.40.01.40.02
49	BALL BEARING	55.19.55.32.25
52	LAMELLAR COUPLING	68.60.00.39.03
53	O-RING	56.40.00.40.02
59	START/STOP BUTTON	63.62.00.39.01
61	MICROSWITCH	62.25.01.39.02
66	SPACER	16.01.07.06
67	KNOB	20.01.01.06
68	FLANGE	20.01.01.07
69	WIRE FLANGE	20.01.01.08
70	WIRE BUSH	20.01.01.09
71	KNURLING KNOB	16.01.00.29
74	HOSE	19.01.00.06

VALID FROM SERIALNR : 9703286

POS.	DESCRIPTION	PART-NO
4	WIRE GUIDING HOSE	20.02.00.04
5	FLANGE	20.02.00.05
6	FLANGE	20.02.00.06
7	GEARMOTOR SUPPORT	20.02.01.01
8	WIRE EXIT NOZZLE	20.02.00.08
9	REAR GUIDING HOSE	20.02.00.09
10	COVER	20.02.00.10
11	SPOOL SUPPORT	20.02.00.11.00
12	SPACER	20.02.00.12
13	MOTOR COVER	20.02.00.13
14	KNOB	20.02.00.14
15	BEARING	20.02.00.15
16	REAR WIRE INLET	03.04.00.29
17	DOWEL	04.05.00.01
18	BUSH	04.05.00.02
19	DOWEL	04.05.00.03
20	WIRE FEEDING WHEEL 0,6-0,8	04.05.00.04
21	WIRE FEEDING WHEEL 0.6-0.8	04.05.00.05
22	FEMALE THREAD BOLT	04.05.00.06
23	SPACING WASHER	04.05.00.07
24	BOLT	04.05.00.08
25	STIRRUP	04.05.00.11
26	WIRE PUSH ASSY BODY	04.05.00.12
28	WIRE SHAFT	16.03.01.45.00
29	SHAFT SUPPORT	04.05.00.15
31	GEAR	20.02.00.16
32	MOTOR PIGNON	04.05.00.21.00
33	KNOB	04.05.00.27
34	NUT	04.05.00.28
35	SPRING	04.05.00.29
36	WASHER	04.05.00.30
37	CLUTCH DISC	04.05.00.31
38	CLUTCH	04.05.00.32
39	WIRE ENTRY NOZZLE	04.05.00.35
40	WIRE END NOZZLE	33.06.01.08
42	GEARED SPINDLE	16.02.00.12
43	FILLER WIRE GEARMOTOR STANDARD	16.02.00.14
44	WASHER	16.02.00.15
46	BALL BEARING	55.19.55.32.69
47	BALL BEARING	55.19.55.32.55
55	MALE OIN	86.73.01.39.84
56	FEMALE PIN	86.73.01.39.85
60	BALL BEARING	55.19.55.32.63
61	ROLLER CAGE	55.49.55.61.02
62	RING	53.20.11.25.03

ASSEMBLY DRAWING : 20.03.00.00

FRONT BODY AND TORCH

VALID FROM SERIALNO : 9703286

POS.	DESCRIPTION	PART-NO
1	SLIDE TORCH SUPPORT	20.03.00.01.00
2	SLIDE RADIAL ADJUSTMENT	20.03.00.02
3	INSULATING BODY	20.03.00.03
4	SPECILA SCREW	20.03.00.04
5	PLATE	20.03.00.05
6	INSULATING PLATE	20.03.00.06
7	SHAFT SCREW	20.03.00.07.00
8	FOOT	20.03.00.08.00
10	GEAR	20.03.00.10
11	SLIDE BODY	20.03.00.11.00
12	SLIDE TORCH	20.03.00.12.00
13	WATER / GAS HOSE	20.03.00.13
14	SPINDLE SUPPORT VESSEL	20.03.00.14
15	GS HOSE	20.03.00.15
16	GEAR	20.03.00.16
17	GEAR	20.03.00.17
18	BUSH	20.03.00.18
19	INSULATING BUSHING	04.06.00.09
20	GAS LENS DIFFUSOR	04.06.00.10
21	TORCH GASKET	04.06.00.15
22	SCREW	04.06.00.18
23	WRENCH NUT	06.06.00.02
24	ARC IGNITION CLIP	16.03.00.11.00
25	O-RING	56.40.00.40.02
32	GAS NOZZLE	64.20.03.39.10
34	COLLET	64.20.02.39.11
40	RING	53.40.39.22.03

## 6. GENERAL SAFETY RULES

These rules apply to AC and DC welding generators, AC transformers, AC/DC welding machines and DC transformer welding rectifiers.

In arc welding operations, where electrically charged parts are exposed, the following rules should be observed to assure maximum safety and protection to operator and surroundings.

Failure to observe these safety precautions may expose, not only the operator himself, but also fellow workers, to serious injuries. Once these rule are studied and well kept in mind, proceed, in any case with maximum care.

**Welding Cables:** DO NOT overload cables.

DO NOT use welding cables at excessive current rates compared to their capacity. It will cause overheating and rapid deterioration of their insulation. It is certainly uneconomical.

DO NOT use worn-out or poorly connected cables.

INSPECT cables frequently. Repair immediately all breaks in insulation with rubber and friction tapes. Tighten and adequately insulate all cable connections. It is dangerous when exposed sections of cable come in contact with grounded metallic objects causing an arc. Unprotected eyes may be injured and fire may result if combustible materials such as oil or grease are in the vicinity.

**Binding Code:** Welding machines must be installed and maintained in accordance with the local National Electric Code.

**Polarity Switch:** DO NOT operate the polarity switch under load.

The polarity switch, when supplied, is provided for changing the electrode lead mutually from positive to negative. Operate this switch only while the machine is not in use and the welding circuit is open. Potential dangers of opening the circuit while charged with current are the following:

- An arc could form between contact surfaces of the switch.
- The person using the switch may receive a severe burn from this arc.

**Ground Power Circuit:** DO NOT use welding machine without grounding frame of case.

GROUND every power circuit to prevent accidental shock by stray current.

DO NOT ground to pipelines carrying gas or inflammable liquids and lines carrying electrical conductors.

BE SURE that conductors can safely carry the ground current.

**Welding Operations:** NEVER weld pieces without cleaning or inerting materials which, when heated, give off inflammable or toxic vapors.

USE steam to clean superficial material.

USE a strong cleaning solution to clean out heavy oils or grease.

BE SURE to remove any residues of inflammable gas or liquid.

NEVER use oxygen to ventilate the welding piece.

CAUTION when cleaning with steam or caustic soda.

WEAR goggles and gloves.

DO NOT clean where there is poor ventilation.

Ventilation is necessary to divert harmful or explosive vapors.

DO NOT clean in the presence of open flames or arc.

USE a wet tool to avoid sparks, when scaring or hammering to remove heavy sludge or scale.

KEEP head and arms distant from work as possible.

**Explosion Hazards:** NEVER weld in or near explosive atmospheres. Such atmospheres can be created by inflammable gas leaks or by vapors from inflammable liquids or by combustible dusts.

**Ventilation:** DO NOT weld in enclosed spaces without adequate ventilation.

When welding in enclosed spaces always provide adequate ventilation with fans, air pipes, etc.

NEVER use compressed oxygen.

Heat and fumes from welding could cause severe discomfort or serious illnesses.

When toxic fumes from lead or cadmium content materials or any other substances are present in proportions that could be harmful always use a gas mask.

**Solvents:** DO NOT weld in the presence of even a small amount of vapor from solvents such as perchloroethylene or trichloroethylene.

Ultraviolet light from the electric arc can decompose the vapors forming phosgene, a poisonous gas.

**Fire Hazards:** DO NOT weld near inflammable or combustible materials.

Fire can be caused by the arc, on contact with heated metal, by slag or sparks.

KEEP combustibles at least 10 m from the arc, on the contrary they should be suitably protected by a flame-proof shield.

**Dangers of Electric Shock:** OPEN power circuits before checking machines.

DO NOT touch electrically heated parts.

NEVER touch any exposed or insulated part of the cables, cable connectors, electrodes, etc. to avoid harmful or fatal electric shock or burns.

NEVER work in a damp area without suitable insulation.

KEEP hands, feet and clothing dry at all times.

Salt in perspiration or sea water dangerously lowers contact resistances.

**Face Protection:** DO NOT use cracked or defective helmets or shields.

KEEP helmet and hand and face shield in good condition.

If cracks occur in fibre material, replace shield, since leakage of arc rays may cause serious burns.

**Eye Protection:** DO NOT under any circumstances, view an electric arc without eye protection.

MAKE sure that flash goggles are used under the welding helmet at all times.

In some types of arc welding, such as TIG welding, ultra-violet and infrared radiation from the arc is particularly intense and requires constant attention to avoid arc flashes reaching weldor or other exposed persons.

NEVER use cracked, ill-fitting or defective filter plates.

Eye burns from the arc, though not generally permanent injuries, are exceedingly painful.

Such burns, frequently referred to as flashes, feel like hot sand in the eye.

For eye burns, consult your first aid station or doctor.

**Clothing:** DO NOT use inadequate or worn-out clothing.

Proper and dry, oil-free clothing is essential for weldors protection.

Clothing must not only keep off sparks and molten particles, but must also obstruct the rays from the arc.

They must insulate the body from harmful electric currents.

Wear leather or asbestos gloves at all times to protect hand and wrists.

Dark coloured shirts are preferred to light ones since arc rays readily penetrate light-coloured fabrics.

In case of gas-shielded arc welding, light colours are more reflective and may cause eye burns due to intense ultra-violet rays given off by the process.

Avoid cotton fabrics with gas shielded arc welding.

**Hot Metals Burns:** DO NOT touch hot metals.

DO NOT touch pieces of metal which have just been welded or heated.

DO NOT substitute electrodes or centering cartridges immediately after welding.