# TECHNICAL SPECIFICATION

## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>GENERAL DESCRIPTION</td>
<td>3</td>
</tr>
<tr>
<td>2.0</td>
<td>OPERATING DATA</td>
<td>5</td>
</tr>
<tr>
<td>2.1</td>
<td>ACCELERATING VOLTAGE (AS PER ISO 14744)</td>
<td>5</td>
</tr>
<tr>
<td>2.2</td>
<td>POWER BEAM CURRENT (AS PER ISO 14744)</td>
<td>5</td>
</tr>
<tr>
<td>2.3</td>
<td>BEAM DEFLECTION</td>
<td>5</td>
</tr>
<tr>
<td>2.4</td>
<td>STABILITY</td>
<td>5</td>
</tr>
<tr>
<td>2.5</td>
<td>VACUUM - WORK CHAMBER</td>
<td>5</td>
</tr>
<tr>
<td>2.6</td>
<td>VACUUM - ELECTRON GUN</td>
<td>5</td>
</tr>
<tr>
<td>3.0</td>
<td>WORK CHAMBER</td>
<td>6</td>
</tr>
<tr>
<td>4.0</td>
<td>WORK HANDLING SYSTEM</td>
<td>7</td>
</tr>
<tr>
<td>4.1</td>
<td>EXTERNAL ROTARY MANIPULATOR – 2 OFF</td>
<td>7</td>
</tr>
<tr>
<td>5.0</td>
<td>ELECTRON BEAM COLUMN - EXTERNALLY MOUNTED</td>
<td>8</td>
</tr>
<tr>
<td>5.1</td>
<td>GENERAL</td>
<td>8</td>
</tr>
<tr>
<td>5.2</td>
<td>FILAMENT – DIRECTLY HEATED</td>
<td>8</td>
</tr>
<tr>
<td>5.3</td>
<td>ELECTRODE REPLACEMENT</td>
<td>8</td>
</tr>
<tr>
<td>5.4</td>
<td>ISOLATION VALVE</td>
<td>8</td>
</tr>
<tr>
<td>5.5</td>
<td>HIGH VOLTAGE UNIT</td>
<td>8</td>
</tr>
<tr>
<td>5.6</td>
<td>BEAM CURRENT CONTROL</td>
<td>9</td>
</tr>
<tr>
<td>5.7</td>
<td>BEAM FOCUS</td>
<td>9</td>
</tr>
<tr>
<td>5.8</td>
<td>DEFLECTION SYSTEM</td>
<td>9</td>
</tr>
<tr>
<td>5.9</td>
<td>FUNCTION GENERATOR</td>
<td>9</td>
</tr>
<tr>
<td>6.0</td>
<td>VACUUM SYSTEM (HIGH VACUUM)</td>
<td>10</td>
</tr>
<tr>
<td>6.1</td>
<td>D60LN ELECTRON GUN COLUMN PUMPS</td>
<td>10</td>
</tr>
<tr>
<td>6.2</td>
<td>WORK CHAMBER PUMPS</td>
<td>10</td>
</tr>
<tr>
<td>6.3</td>
<td>VACUUM INSTRUMENTS</td>
<td>10</td>
</tr>
<tr>
<td>6.4</td>
<td>LEAK DETECTION</td>
<td>10</td>
</tr>
<tr>
<td>7.0</td>
<td>CONTROL AND INSTRUMENTATION</td>
<td>11</td>
</tr>
<tr>
<td>7.1</td>
<td>GENERAL DESCRIPTION</td>
<td>11</td>
</tr>
<tr>
<td>7.2</td>
<td>CONTROL CABINET</td>
<td>11</td>
</tr>
<tr>
<td>7.3</td>
<td>OPERATION MODES</td>
<td>11</td>
</tr>
<tr>
<td>7.4</td>
<td>PROGRAM VARIABLES</td>
<td>12</td>
</tr>
<tr>
<td>7.5</td>
<td>HMI (HUMAN MACHINE INTERFACE) OVERVIEW</td>
<td>12</td>
</tr>
<tr>
<td>8.0</td>
<td>VIEWING SYSTEM</td>
<td>22</td>
</tr>
<tr>
<td>8.1</td>
<td>CCTV WITH DIGITAL CAMERA</td>
<td>22</td>
</tr>
<tr>
<td>8.2</td>
<td>BACK SCATTERED ELECTRON JOINT FINDER AND IMAGING - OPTIONAL</td>
<td>22</td>
</tr>
</tbody>
</table>
9.0 SAFETY

10.0 INSTALLATION AND SERVICES
  10.1 ELECTRICAL SUPPLY
  10.2 POWER CONSUMPTION (APPROX)
  10.3 WATER
  10.4 AIR
  10.5 EXHAUST
  10.6 AMBIENT
  10.7 EARTH-POINT

11.0 TESTING
  11.1 GENERAL PHYSICAL INSPECTION
  11.2 LEAK TESTING
  11.3 WATER SYSTEM
  11.4 PNEUMATIC SYSTEM (VALVE OPERATION)
  11.5 INTERLOCKS
  11.6 VACUUM PERFORMANCE
  11.7 HIGH VOLTAGE SYSTEM
  11.8 TOOLING
  11.9 ELECTRON GUN
  11.10 TEST DATA

12.0 DOCUMENTATION

13.0 MANUFACTURING STANDARDS
  13.1 QUALITY MANAGEMENT SYSTEM
  13.2 MANUFACTURING STANDARDS
1.0 GENERAL DESCRIPTION

Materials to be welded:

➢ Stainless steel and SS based alloys
➢ Titanium and Titanium based alloys
➢ Copper and Copper based alloys
➢ Aluminium and Aluminium alloys

Depth of Penetration:

➢ Stainless steel: 10mm
➢ Aluminium: 10mm < At a welding speed of 1000mm/min.
➢ Titanium: 10mm

➢ Stainless steel (non-magnetic) welding chamber with nominal internal dimensions 350 x 350 x 350 mm with wall thickness designed to block X-ray radiation in accordance with international regulations (<1μSv/h measured 100mm from the walls).
➢ One electron gun positioned horizontally to the right side with provision of linear movement of +/- 50mm in Z direction (vertically up and down).
➢ Front access door with hinged movement opening to left of vacuum chamber
➢ Viewing port of Ø 150mm shielded with lead glasses located centrally on the front door. Suitable vapour protective removable glasses shall be provided.
➢ Sealing system comprising door, access ports and pumping system having compatible “O” ring seals. All interfaces to maintain an ultimate vacuum level of 5 x 10^{-5} mbar
➢ Fully automatic high vacuum chamber pumping system for operation in the 10^{-4} mbar range
➢ Two rotary manipulators, CNC controlled, mounted externally, one to left side of chamber and one on bottom side of chamber.
➢ 4 kW switched mode power supply (one off)
➢ One off filament alignment jig, second grid cup & one off tool kit included
➢ Down beam illumination and CCTV viewing system on the EB column
➢ Programmable focus control, X-Y deflection & function generator
➢ PC based HMI operator interface
➢ Spares and consumable for 2 years operation - OPTIONAL

The system is fully integrated within a robust steel framework with securely fitting covers and access panels.

The services required are cooling water, electricity, compressed air and a suitable exhaust line. All services are closely grouped together for simple and convenient installation.

The unit, unless otherwise specified, is finished with RAL 9001/9002 framework and panels.
CW 604 with 300mm cube chamber and gun mounted vertically (for reference only)
2.0 OPERATING DATA

2.1 ACCELERATING VOLTAGE (AS PER ISO 14744)

Range (in steps of 1kV) 10 to 60 kV

2.2 POWER BEAM CURRENT (AS PER ISO 14744)

Maximum beam power 4 kW
High current range 0 – 66 mA (in steps of 0.1mA)
Low current range 0 – 10 mA (in steps of 0.1mA)
Slope in and slope out adjustable up to 1250mA/sec.

2.3 BEAM DEFLECTION

X direction ± 3°
Y direction ± 3°

2.4 STABILITY

Voltage and Beam Current 1%
Reproducibility 1%
Ripple 5% (peak to peak)

2.5 VACUUM - WORK CHAMBER

Vacuum level 10⁻⁴ mbar range
Ultimate vacuum level 5 x 10⁻⁵ mbar range
Duration less than five minutes (nominal)
Pump down time in a clean, dry and empty chamber to beam-on 40 secs

2.6 VACUUM - ELECTRON GUN

Ultimate vacuum level 10⁻⁵ / 10⁻⁶ mbar range
Vacuum level 10⁻⁵ mbar range
Duration less than 3 minutes
3.0 WORK CHAMBER

3.1 Nominal internal dimensions

350 mm “X”
350 mm “Y”
350 mm “Z”

3.2 The work chamber is a fully welded construction manufactured from non-magnetic stainless sheet and sections.

3.3 Hinged chamber access door with viewing window.
Door opens to the left.

3.4 Flanged “O” ring seals to door, access ports and pumping system to maintain an ultimate vacuum level of $5 \times 10^{-5}$ mbar.

3.5 The electron gun is mounted horizontally on the right hand side of the chamber with provision to mount the gun on the top side of the chamber.

3.6 Motorised CNC gun adjustment is provided, stroke is 100 mm (+/- 50mm) and is available to carry out dynamic welding under CNC control.

3.7 Mounting holes on the inside bottom face of the chamber will be incorporated and a feedthrough port will be supplied as a provision for a future XY table requirement.
4.0 WORK HANDLING SYSTEM

To manipulate the work piece under the electron beam the following work handling equipment is supplied.

4.1 EXTERNAL ROTARY MANIPULATOR – 2 OFF

- Fully hardened and ground “super grip” collet clamping assembly
- Precision angular contact bearings
- Non-magnetic high precision 70 mm, 3 jaw self-aligning chuck
- 25 mm diameter x 450 mm long hardened non–magnetic shaft
- < 0.02mm run out at 50 mm from the mounting plate
- Rotational speed continuously adjustable between 1 and 60 rpm
- Speed stability ±1% of the set speed
- Externally mounted to left and base of the chamber
- Drive system by servo motor (CNC controlled)
- Loading capacity 20kg
5.0 ELECTRON BEAM COLUMN - externally mounted

5.1 GENERAL

Triode type, rated for maximum operating conditions. The column has its own high vacuum system and valve to isolate it from the chamber when vented. Mounted externally in Z axis with dedicated mechanical sealing system under static and dynamic conditions. (During gun movement and gun in operation mode). Allows work with highest vacuum levels (in the range of $10^{-5}$ mbar) inside the welding chamber and can be used with CNC gun movement system.

- Viewing/beam alignment shall comprise of a video device with a colour CCD/Digital camera designed to achieve a magnification of approximately 10X at a shooting distance from 50-300mm inside the chamber.
- Provisions for aligning the joint with beam before welding and during welding.
- 19" Flat screen monitor (LED) with adjustable cross line.
- Cross hair superimposed over the image to allow the position of the beam on the joint to be precisely adjusted before welding.
- Seam tracking by teach in & replay
- External gun carriage stroke on Z axis is 100 mm (+/- 50mm) and is available to carry out dynamic welding.
- Drive system by servo motor with CNC control.

5.2 FILAMENT – DIRECTLY HEATED

Filament type - ribbon
Filament (consumable) secured in re-useable mounting

5.3 ELECTRODE REPLACEMENT

Grid (bias) cup and filament assembly positively located in electron beam column. Assembly accessed via a port on the front of the column.

5.4 ISOLATION VALVE

Maintains the electron beam column at high vacuum when the chamber is vented. Slide valve: Pneumatically operated and automatically sequenced.

5.5 HIGH VOLTAGE UNIT

The switched mode unit provides the high voltage for the formation of the electron current, variable bias supply for the control of beam current with an adjustable and stabilised supply for filament heating.

An oil filled tank containing the bias and filament supplies is provided. For maintenance purposes the top lid of the tank is removable.
- Anti- flash protection is provided
- Less power dissipation
- High voltage proof
- Short circuit proof (supply does not switch off to avoid mis-welding and loss of expensive work piece).
- Zero beam current during HV recovery (defocussing of beam to avoid mis-welding of expensive workpiece).
- Oil filled tank and top lid easily removable for maintenance.
➢ 10 to 60 kV (in steps of 1 kV)
➢ Ripple 2% (peak to peak value)
➢ Stability 1%
➢ Reproducibility 1%

5.6 **BEAM CURRENT CONTROL**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>High current range</td>
<td>0 to 66 mA</td>
</tr>
<tr>
<td>Low current range</td>
<td>0-10 mA (in steps of 1 mA)</td>
</tr>
<tr>
<td>Ripple</td>
<td>5% (peak to peak)</td>
</tr>
<tr>
<td>Stability</td>
<td>1%</td>
</tr>
<tr>
<td>Reproducibility</td>
<td>1%</td>
</tr>
<tr>
<td>Beam power</td>
<td>4 kW</td>
</tr>
<tr>
<td>Slope in</td>
<td>adjustable up to 1250 mA/sec</td>
</tr>
<tr>
<td>Slope out</td>
<td>adjustable up to 1250 mA/sec</td>
</tr>
</tbody>
</table>

5.7 **BEAM FOCUS**

Focus Coil - lens type mounted in the lower section of the gun column enables beam to be focused between 50 to 300 mm from the roof of the chamber.

5.8 **DEFLECTION SYSTEM**

X and Y deflection coils mounted in the lower section of the gun column. Amplitudes of X & Y deflection set via the operator console.

X deflection angle +/- 3°
Y deflection angle +/- 3°

5.9 **FUNCTION GENERATOR**

Output to deflection coils to allow control of the fusion zone to improve quality. Each output has specific uses:

➢ Two axes sine wave outputs for deflecting the beam in a circular pattern
➢ Two axes DC deflection for positioning of the electron beam
➢ Sine, square, triangle, circle, ellipse, saw tooth and ∞ forms
➢ Two axes sine wave outputs for deflecting the beam in a circular pattern
➢ Square wave forms of different workspace ratio selectable (1:1; 2:1; 3:1; 4:1). Useful when more power is required in one side of the joint than the other. Examples include the joining of dissimilar metals or different thicknesses. Mark space variation ensures the energy of the electron beam is precisely shared between the components
➢ Sine wave generation can be adjusted in the following ways:
  ▪ Frequency range 0.1 to 2000 Hz – digital selection of frequency is provided
  ▪ X and Y amplitudes may be independently set
  ▪ DC deflection may be superimposed on the AC outputs to provide a means of centering the circle while the module is being set up for the welding operation
Effectively, two ranges of use exist:

- low frequency (0.1-100Hz) beam deflection in a circular path to produce the weld
- high frequency (10-2000Hz) usually at a lower amplitude for producing a “stirring” action to the molten weld pool during welding
  
  The heat input may be varied to minimise porosity in welds – particularly in low alloy and mild steels

DC Deflection
- Two separate DC outputs, independently variable to provide a fixed offset to any of the AC patterns or to the static beam

6.0 VACUUM SYSTEM (HIGH VACUUM)

The machine has two separate pumping systems for the work chamber and the electron column. Provision is made to operate the chamber in either high vacuum (10^{-4} mbar range) or low vacuum (10^{-2} mbar range).

6.1 D60LN ELECTRON GUN COLUMN PUMPS

- Turbo-molecular pump
  - Leybold TURBOVAC TMP151
  - 145 l/sec
- Rotary pump
  - Leybold Scrollvac SC7
  - 7 m³/hr

An isolating valve is incorporated in the gun column so that the gun is maintained at high vacuum when the chamber is vented.

6.2 WORK CHAMBER PUMPS

- Turbomolecular Pump
  - Leybold TURBOVAC 1000C
  - 850 l/sec
- Rotary pump
  - Leybold Sogevac SV120
  - 110 m³/hr
- Roots Blower
  - Leybold WAU501
  - 500 m³/hr
- Rotary back up pump for turbo molecular pump
  - Leybold Scrollvac SC7
  - 7 m³/hr

6.3 VACUUM INSTRUMENTS

Wide range gauge head fitted to the electron beam column for high and low vacuum measurement, wide range gauge fitted to the chamber. Vacuum levels are displayed on the PC

6.4 LEAK DETECTION

Provision is made for a leak detector (not included) to be connected in the pumping line.
7.0 CONTROL AND INSTRUMENTATION

7.1 GENERAL DESCRIPTION

The electron beam equipment is controlled by an industrial PLC, a set of electronic interface printed circuit boards and an industrial HMI (human machine interface) PC. The PC is equipped with 4 USB and 2 Ethernet ports. The operating system is based on a Windows platform and suitable for network operation.

7.2 CONTROL CABINET

Incorporated within the machine frame are:

- Main switchgear
- Ancillary power equipment including pump starters
- Voltage regulators and filament current power control
- Beam control system
- Vacuum control equipment

7.3 OPERATION MODES

- SUPERVISOR (manual)
  For development and new programs, allowing the operator to dynamically change any of the parameters while viewing the process. The program data can then be stored under a unique program number. Allows safe machine operation with full control of all electron beam parameters, operation and monitoring of the vacuum system and control of the tooling. Allows both automatic and manual operation along with the facility to edit existing recipes, create new recipes and processes (up to 1000). Existing recipes can be renamed or deleted.

- OPERATOR (automatic)
  The operator can select a complete program from memory and complete the process without changing any parameters. Allows basic machine operation with selection of recipes, operation and monitoring of vacuum system and basic control of tooling. Allows both automatic and manual operation with limited operator control of electron beam parameters

- MAINTENANCE (security)
  Allows authorised personnel to access the machine for modification and testing purposes. Allows full manual control of the vacuum pumping system and individual control of all valves and pumps. Access to the machine set points with the facility to edit them is provided with additional information concerning vacuum gauge feedback and gauge selection.

Note: In maintenance mode there are no interlocks. Improper use can damage the machine!
### 7.4 Program Variables

A basic program will consist of the following parameters:

- Accelerating voltage \( (kV) \)
- Tracer beam current \( (mA) \)
- Main beam current \( (mA) \)
- Filament current \( (A) \)
- Focus \( (mA) \)
- Slope in \( (mA/s) \)
- Slope out \( (mA/s) \)
- Speed \( (rpm) \)
- Beam duration \( (s) \)
- X deflection \( (mA) \)
- Y deflection \( (mA) \)

Programs can be linked to build up a fully automatic program consisting of tacking, penetration, cosmetic pass, deflection, stirring, etc.

### 7.5 HMI (Human Machine Interface) Overview

The following section gives a guide to the PC screen display for an operator to enter a programme combined with tooling movement. It also shows typical mimic displays, alarm status and quality recording.

19” (nominal) flat screen LED colour monitor
240GB SATA HDD
8GB RAM
COM1, COM2
Visual Graphic Array (VGA)
Suitable keyboard and mouse
2 Ethernet ports
4 USB ports
- **Start Screen**

This screen is displayed on initial power-up of the machine. It shows your company name, the CVE logo, auto-start information, date when next service is due and the CVE software reference name.

To access further screens the operator is required to log in. If the machine is left unattended or if the operator logs off, this screen becomes the default.

- **Screen Navigation**

Using a Mouse or Keyboard

Following a successful log-in, the screen selection menu will be activated.

By clicking on the appropriate button the screen will change to show the desired information. The number of different screens available is dependent on the access level of the operator.
Operating Screen - Vacuum

Function Keys

**Auto/Manual**
Toggles the state ‘Auto’/’Manual’ and refers to weld sequence only. When selected a complete weld sequence is initiated by the ‘Timed Weld’ function key on the weld screen. This includes all linked recipes.

**Start Pumps**
Initiates the automatic pump start sequence.

**Chamber Pump**
Initiates the automatic valve sequence to pump the chamber down to the ‘Chamber Ready’ vacuum level.

**Electron beam column Pump**
Initiates the automatic valve sequence to pump the electron beam column down to the ‘Electron beam column Ready’ vacuum level.

**Chamber Vent**
Initiates the automatic valve sequence to vent the chamber to atmospheric pressure.

**Electron Beam Column Vent**
Initiates the automatic valve sequence to vent the electron beam column to atmospheric pressure.

**Shutdown**
Initiates the automatic pump shutdown sequence. It concludes when all pumps are stopped, turned off and, in the case of diffusion pumps, are cold.
Note: Shutdown does not vent the electron beam column or chamber.
Vacuum Status Messages
The top indicator shows the current status of the vacuum system, i.e. pumping, venting, shutting down etc. When the electron beam column and chamber have reached a state such that welding can take place the indicator turns green and displays ‘Vacuum Ready’. Below the large indicators are status indicators for each individual pump and valve. The states indicated are open or closed, for valves, on or off, for pumps and fault.

Vacuum Pressure Display
Two vacuum pressure levels are displayed, one for the electron beam column and one for the chamber. The gauge type being read is identified and next to it is the actual reading (default display is mBar). Below each digital display is an analogue indication for rapid appreciation of trending.

Mimic
Provides a graphical representation of the particular machine. It shows the vacuum pumping line with the relative positions of pumps and valves. Pumps and valves have coloured indicators to represent their state. This may vary depending on the machine specification.

• Operating Screen - Tooling

Function Keys
Tailstock Enable (If Fitted)
Toggles selection of the tailstock tooling. Green indicates enabled, grey disabled
N.B. The Function Key information related to tooling may differ depending on the machine specification.
• Operating Screen – Welding

Function Keys

**Hi Voltage (HV)**
Enables the high voltage power supply. Green indicates enabled. When selected the high voltage apply will ramp up to its demanded value.

**Filament**
Enables the filament power supply. Green indicates enabled. When selected the filament current will ramp up to 10% less than the demanded value (hot but not emitting).

**Function Generator**
Select the function generator. Green indicates selected, grey not selected. The function generator superimposes a pattern onto the spot position. For example, if pattern ‘0’ is selected then a circular pattern is superimposed, provided X and Y gains are the same. By using dissimilar gains an ellipse is produced.
Note: If the function generator is selected then deflection is automatically selected.

**Deflection**
Select static deflection. Green indicates selected. This provides a constant offset to the beam spot position.

**Tacking**
Select Tacking (either positional or timed).

**Lock**
Facility to enter and lock a value for deflection, focus and filament settings that overrides the stored recipe values.
Recipe
This displays the recipe selection screen.

Process
This displays the process selection screen.

Manual Link + / -
This de-selects the current weld recipe and in its place loads the next or previous recipe as defined in the process.

Main Beam/Tracer
Selects the electron beam mode. ‘Main Beam’, indicated by yellow, selects the high power demand. ‘Tracer’, indicated by green, selects a low power beam.

Timed Weld
Initiates a single weld in manual or a sequence of welds if ‘Auto’ and ‘Link Enable’ are selected. Bright green indicates that a weld is in progress.

Print Screen
 Produces a hard copy of the currently selected weld recipe (requires the addition of a suitable printer)

Weld Parameter Display
For each weld parameter there is a display of demanded and actual values. The parameter label also displays the status of that parameter (e.g. ‘HV On’, green, ‘HV Off’ yellow, ‘HV Fault’, red). For parameters that have no real-time feedback only the demand is displayed.
Note: The key symbol indicates parameters that are not editable for the current access level.
Operating Screen - Recipes

The default weld recipe is '0' 'START-UP'. This has default settings for all of the weld parameters. To use another recipe press 'Recipe Select'.

The operator may select a previously saved user recipe. To select a user recipe click on 'LOAD' and an alphabetical list of all the available recipes will be displayed.

Click on the recipe required. To confirm the selection press 'Load'. The chosen recipe will be displayed at the top of the screen. The recipe name can be up to 32 characters long. The maximum number of recipes available is 1000 by default, although this number can be increased if necessary.
Operating Screen - Process

A process is defined as a group of weld recipes that will execute in their given order from a single start command. A process can have any number of recipes up to a maximum of 127. Recipes or groups of recipes may be repeated.

Warnings

The display panel shows up to 32 warning messages. The warning window can be called manually from the screen selection menu but will also appear automatically on the change of state of any one of the messages.
Alarms

On the occurrence of any alarm condition the alarm indicator panel is automatically displayed. The machine enters its automatic shutdown procedure. The machine will shutdown in a safe ordered manner. The speed at which the machine shuts down is dependent on the severity of the alarm condition.
7.6 DATA LOGGING PACKAGE

The data logger allows viewing of historical weld data automatically recorded. The data may be displayed in a graphical form. The user may specify which parameters are displayed and the time scale displayed. Values may be read from the graph and the scaling may be dynamically adjusted. Areas of particular interest may be saved as file in a format compatible with Microsoft Excel.

Real-time data can be graphically displayed. All beam parameters and vacuum levels are available.
8.0 VIEWING SYSTEM

8.1 CCTV WITH DIGITAL CAMERA
- Down beam illumination provided using variable brightness LED
- Viewing prism mounted in the column may be rotated for viewing
- Closed circuit television Digital camera mounted to the gun column
- 19" flat screen monitor (LCD) with adjustable cross hairs
- Image magnification approximately x10
- Manual focus facility

8.2 BACK SCATTERED ELECTRON JOINT FINDER AND IMAGING - OPTIONAL
- Detector mounted in the chamber collects back-scattered electrons reflected from the surface of the work-piece
- When the beam is scanned across the joint the intensity of electrons reaching the collector plate decreases and enables the system to determine the joint position with respect to the free-falling beam.

- Using correct sample pieces the Back Scattered Joint Finding system is accurate to ± 0.02 mm.
- To verify the accuracy and repeatability of the Joint Finding System for a specific application it is best to do test samples for verification
9.0 SAFETY

9.1 Measurement of radiation levels is performed in accordance with the requirements of ISO14744. The approved code of practice is observed as laid down in the Ionising Radiation Regulations of the UK Government.

9.2 The maximum annual whole body dose limit is 50mSv.

9.3 The chamber shielding will ensure radiation levels of less than $1\mu$Sv/hour, measured at a distance of 50 mm from any external surface, when a defocused beam of maximum power is struck on a tungsten target.

9.4 Once the machine is installed the customer must arrange for regular checks to be made on radiation levels particularly after service periods when vacuum joints have been disturbed.

9.5 To meet X-radiation safety requirements a red warning light will be sited in a prominent position and will be illuminated when the high voltage to the gun is on.

9.6 Water flow, water temperature and air pressure switches are fitted to protect the vacuum pumping system against supply failure. Audible warning of failure will be provided.

9.7 All rotary drives will be fully protected by safety guards.
10.0 INSTALLATION AND SERVICES

The equipment is constructed as an integral unit, requiring only a sound level load bearing floor for installation. All service connections are terminated at a conveniently positioned panel at the rear of the unit.

10.1 ELECTRICAL SUPPLY

415V 50 Hertz
3ph 4 wire neutral & earth

Alternative supply voltages may be accommodated if required.

10.2 POWER CONSUMPTION (APPROX)

<table>
<thead>
<tr>
<th>Component</th>
<th>KVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pumping System</td>
<td>12</td>
</tr>
<tr>
<td>Control &amp; Motors</td>
<td>3</td>
</tr>
<tr>
<td>Beam Power</td>
<td>6</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>21</strong></td>
</tr>
</tbody>
</table>

10.3 WATER

The supply is required to be filtered, clean and neutral
Inlet temperature 2-3 bar gauge
Inlet temperature 15-20°C

Suitable Water Chiller: Not included in scope of supply
2.5kW 15 degrees
5.7l/min
3bar
45 ambient
LC 2500

10.4 AIR

Filtering and lubricating are fitted in the unit
Consumption is minimal and intermittent 5-8 bar gauge

10.5 EXHAUST

An exhaust line should be attached to the rotary pump exhaust. The exhaust line should discharge clear of the working area. An external U-trap with drain should be fitted by the customer.

10.6 AMBIENT

Temperature 10 to 30°C
Humidity up to 70%

10.7 EARTH-POINT

The customer must provide a suitable earth point in close proximity to the machine with an impedance of less than 2 ohms. If this is not possible, please contact CVE for advice.
11.0 TESTING

The electron beam equipment is completely assembled and tested prior to shipping. When the assembly is complete, the system is turned over to our Quality Department for the pre-shipment test procedures. The tests will consist of (but not be limited to) the following steps:

11.1 GENERAL PHYSICAL INSPECTION

The beam equipment will be inspected to check the overall system for proper fit-ups, alignment and general appearance.

11.2 LEAK TESTING

Individual components will have been leak tested prior to assembly. After assembly, the entire system will be thoroughly leak checked, utilizing a helium mass-spectrometer. Any discovered leaks will be corrected.

11.3 WATER SYSTEM

The water system is tested for suitability and leaks. Any discovered leaks will be corrected.

11.4 PNEUMATIC SYSTEM (VALVE OPERATION)

A full air pressure test of the entire air system is carried out. Any discovered leaks will be corrected. All air-operated functions are tested for proper operation.

11.5 INTERLOCKS

All safety interlocks and alarm functions will be activated and checked for proper functioning.

11.6 VACUUM PERFORMANCE

The system will be evacuated to the ultimate vacuum obtainable as determined by the size of the chamber and pumping system.

All vacuum functions activated by the control system and all other vacuum components will be tested.

Vacuum pump down times and ultimate vacuum levels will be checked against the agreed specification.

11.7 HIGH VOLTAGE SYSTEM

The functionality and performance of the high voltage system will be checked. Penetration and profile will be measured against standard performance data.
11.8 **TOOLING**

Tooling performance, operation, accuracy and repeatability will be tested as appropriate for the system supplied. Where appropriate customers will be asked to supply sample components in order to fully check tooling functionality.

11.9 **ELECTRON GUN**

The electron gun are fully tested for operation and performance. The guns are aligned and set up to obtain optimum characteristics.

11.10 **TEST DATA**

All in-house test data will be recorded on the appropriate Test Sheets along with all detailed checking of beam equipment functions and components.

These forms are kept on file at CVE and are available to the customer upon request.

The above tests, together with any additional tests or trials agreed with the customer, will be repeated during the presence of a customer's representative and will form the basis for the acceptance to ship.
12.0 DOCUMENTATION

12.1 At the time of acceptance at CVE, three sets of documents are provided. These include:
  ○ General arrangement drawing indicating service requirements, unit weights and sizes
  ○ Electrical, pneumatic and water schematics

12.2 At the time of commissioning (unless otherwise indicated) three sets of the following are provided:
  ○ Operator instruction manuals
  ○ Maintenance instruction manuals

12.3 One soft copy of all the manuals and diagrams in pdf format as well as the specific programs PLC and man-machine interface).
One re-installation CD for the PC.
Licensed version software CD and replaceable hard disc installed with all the software is included.
Calibration certificates for all the vacuum gauges will be provided.
Technical documentation for the main components purchased
Original software licence for the software which is purchased.

The documentation will be provided in the English language.
13.0 MANUFACTURING STANDARDS

13.1 QUALITY MANAGEMENT SYSTEM

Cambridge Vacuum Engineering operates a Quality Management System which complies with the requirements of BS EN ISO 9001:2015.

13.2 MANUFACTURING STANDARDS
(for Vacuum Furnaces and Electron Beam Equipment as appropriate)

<table>
<thead>
<tr>
<th>Item</th>
<th>BSI Number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>BS 8888:2013</td>
<td>Technical Product Documentation</td>
</tr>
<tr>
<td>5</td>
<td>BS EN 61000-6-2:2005</td>
<td>Generic Standards for immunity for industrial environments</td>
</tr>
<tr>
<td>6</td>
<td>BS EN 61000-6-4:2007 + A1:2011</td>
<td>Generic Standards for emission for industrial environments</td>
</tr>
<tr>
<td>7</td>
<td>BS EN 61508:2008 Parts 1-7</td>
<td>Functional Safety of Electrical / Electronics</td>
</tr>
<tr>
<td>9</td>
<td>BS EN ISO 12100:2010</td>
<td>Safety of Machinery Basic Terminology</td>
</tr>
<tr>
<td>10</td>
<td>BS EN ISO 12100:2010</td>
<td>Safety of Machinery Technical Principles</td>
</tr>
<tr>
<td>11</td>
<td>BS EN ISO 12100-1: 2003 + A1:2009 Inc.</td>
<td>Corrigendum 1</td>
</tr>
<tr>
<td>13</td>
<td>BS EN ISO 13849-1: 2015</td>
<td>Safety of machinery – Safety related parts of control systems.</td>
</tr>
<tr>
<td>16</td>
<td>BS EN ISO 13853:2008</td>
<td>Safety of machinery (Safety distances to prevent danger zones being reached by the lower and upper limbs). Safety of machinery – Safety distances to prevent hazard zones being reached by upper and lower limbs.</td>
</tr>
<tr>
<td>17</td>
<td>BS EN ISO 13857:2008</td>
<td>Acceptance Inspection of Electron Beam Welding Machines</td>
</tr>
<tr>
<td>18</td>
<td>BS EN ISO 14744-1:2008</td>
<td>Internal lighting of machine.</td>
</tr>
<tr>
<td>20</td>
<td>2014/30/EU</td>
<td>Simple Pressure Vessel Directive</td>
</tr>
<tr>
<td>21</td>
<td>2014/29/EU</td>
<td>Machinery Directive</td>
</tr>
<tr>
<td>22</td>
<td>2006/42/EC</td>
<td>Low Voltage Directive</td>
</tr>
<tr>
<td>23</td>
<td>2006/95/EC</td>
<td>Pressure Vessel Standards</td>
</tr>
<tr>
<td>24</td>
<td>PD 5500</td>
<td>Safety of machinery – General requirements for the design and construction of guards (fixed and moveable)</td>
</tr>
<tr>
<td>25</td>
<td>PR BS EN 953: (1993)</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>The supply of Machinery (Safety) Regulations 2008</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>All machines are supplied with CE certification</td>
<td></td>
</tr>
</tbody>
</table>