Gas Industry Standard

GIS/ECE1:2017

Specification for

Electrofusion control boxes

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Contents

Foreword

Gas Industry Standards (GIS) are revised, when necessary, by the issue of new editions. Users should ensure that they are in possession of the latest edition. Contractors and other users external to Gas Transporters should direct their requests for copies of a GIS to the department or group responsible for the initial issue of their contract documentation.

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This standard calls for the use of procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Compliance with this engineering document does not confer immunity from prosecution for breach of statutory or other legal obligations.

Mandatory and non-mandatory requirements

For the purposes of a GIS the following auxiliary verbs have the meanings indicated:

can indicates a physical possibility;

may indicates an option that is not mandatory;

shall indicates a GIS requirement;

should indicates best practice and is the preferred option. If an alternative method is used then a suitable and sufficient risk assessment needs to be completed to show that the alternative method delivers the same, or better, level of protection.

Disclaimer

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Brief history

First published as GBE/ECE1	August 1992
Editorial update to reflect demerger November 2000	June 2001
Editorial update to reflect merger October 2002	November 2002
Editorial update to comply with GRM	July 2004
Edited by BSI in accordance with BS 0-3:1997	August 2006
Edited by GDNs to include informative annex F on Multicycle fittings	January 2008
Edited and updated by GDNs' Technical Standards Forum	March 2017

1 Scope

This Gas Industry Standard specifies requirements for construction, operation and testing of electrofusion control boxes and associated cables. The control boxes are intended for use with fittings produced in accordance with BS EN 1555-3:2002 and GIS/PL2-4.

Three ranges of welding units are specified:

The first has a maximum output of 30 amps and is designed for service installations.

The second has a maximum output of 62 amps and is designed for service and mains installations.

The third has a maximum output of 100 amps and is designed for very large diameter installations.

This standard allows for the equipment to be operated from either a nominal 110V ac supply or from a self-contained battery pack. Specification of these can be found in Annex G.

The electrofusion control boxes are intended for use in normal operating ambient temperatures of between −5 °C to +40 °C and are intended for storage at temperatures as low as −10 °C.

Due to the increased range and varied design of electrofusion fittings allowed within BS EN1555-3 and GIS PL2-4, as well as special applications within the GDN`s, the operational envelope required of control boxes has evolved such that one single design of box is often not viable. This specification is intended to provide a basic design and test criteria for control boxes to meet existing EF designs and provide scope for future requirements covering variable welding voltages between 8 and 48 volts.

This standard takes note of the international standard ISO12176 part 2, Plastics pipes and fittings — Equipment for fusion jointing polyethylene systems — Electrofusion. This standard encompasses the requirements of ISO12176-2 plus additional requirements specific to the UK market.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Formal standards

BS 6360, *Specification for conductors in insulated cables and cords*.

BS 9522 N0001, *Detail specification for multi-contact circular electrical connectors for dc and low frequency applications — Bayonet coupling with front release, rear removable crimp contacts — Full assessment level*.

BS EN 1555-3, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 3: Fittings*.

BS EN 55012, *Vehicles, boats and internal combustion engine driven devices — Radio disturbance characteristics — Limits and methods of measurement for the protection of receivers except those installed in the vehicle/boat/device itself or in adjacent vehicles/boats/devices*.

BS EN 60068-2-27, *Environmental testing — Test methods — Environmental testing procedures — Tests — Part 2.29: Test Eb and guidance — Bump*.

BS EN 60068-2-31, *Environmental testing — Test methods — Test Ed — Part 2.32: Free fall*.

BS EN 60068-2-64 Environmental testing – Test methods - Vibration, broadband random and guidance

BS EN 60204-1, *Safety of machinery — Electrical equipment of machines — Part 1: Specification for general requirements*.

BS EN 60309-2, *Plugs, socket-outlets and couplers for industrial purposes — Part 2: Dimensional interchangeability requirements for pin and contact-tube accessories*

IEC 60529 Degrees of Protection Provided by Enclosures (IP Code)

DD IEC TS 61000-1-2, *Electromagnetic compatibility (EMC) — General — Part 1.2: Methodology for the achievement of the functional safety of electrical and electronic equipment with regard to electromagnetic phenomena*.

BS EN 61558-1, *Safety of power transformers, power supply units and similar — Part 1: General requirements and tests*.

BS EN 61558-2-23, *Safety of power transformers, power supply units and similar — Part 2.23: Particular requirements for transformers for construction sites*.

BS EN 60335-1 Household and similar electrical appliances. General requirements.

BS EN 60355-2-45 Household and similar electrical appliances. Portable heating tools and similar appliances.

EN 61000-6-2 Electromagnetic compatibility. Immunity for industrial environments

EN 61000-6-4 Electromagnetic compatibility. Emission standard for industrial environments.

BS EN 50525 Electric cables

BS EN 50565 Electric cables.

ISO 13950 Plastic pipes and fittings. Automatic recognition systems.

ISO 12176-2 Plastic pipes and fittings. Equipment for fusion jointing, electrofusion.

ISO 12176-4 Plastic pipes and fittings. Equipment for fusion jointing, traceability coding.

Gas Industry Standards

GIS/PL2-4, *Specification for* p*olyethylene pipes and fittings for natural gas and suitable manufactured gas — Part 4: Fusion fittings with integral heating elements*.

3 Terms and definitions

For the purposes of this standard the following term and definition applies.

3.1 conformal coating
impervious coating which conforms to the irregular surface of components mounted on a printed circuit board (PCB)

4 Construction

4.1 The mass of the control box, frame (if supplied) and associated input cable shall be marked on the control box to enable appropriate risk assessment for manual handling.

The control box shall be designed and constructed in accordance with BS EN 60204-1. The control box shall be designed and constructed to allow its safe use in normal field conditions and shall be CE marked against the following specifications and EC directives:

2006/42/EC Machinery Directive

BS EN 60204-1 Safety of machinery. Electrical equipment of machines. General requirements.

ISO 12100-2 Safety of machinery. Basic concepts, general principles for design. Technical principles.

2014/35/EU, Low Voltage Directive

BS EN 60335-1 : Household and similar electrical appliances – General Requirements

BS EN 60335 -2-45 : Household and similar electrical appliances – Portable heating tools and similar appliances

2014/30/EU, Electromagnetic Compatibility Directive

IEC TS 6100-1-2 Electromagnetic compatibility – Part 1-2 General

EN 61000-6-2 : Electromagnetic compatibility (EMC) – Immunity for industrial environments

EN 61000-6-4 : Electromagnetic compatibility (EMC) – Emission standard for industrial Environments

4.2 The control box may have the facility for logging and retrieval of data in accordance with Annex A.

4.3 The control box enclosure shall afford a minimum environmental protection to IP54 in accordance with IEC 60529 with any socket-outlet exposed. All PCBs shall be conformal coated to protect against the effects of condensation.

4.4 An instruction manual shall be supplied which should include basic information on machine operation, troubleshooting, maintenance and guidance on machine calibration.

NOTE The control box should be designed to allow ease of calibration and maintenance.

4.5 The input cable shall be permanently attached to the control box, and its nominal length shall be between 3 and 10 m.

The input cable shall be constructed from flexible 3-core HO7RN-F cable or equivalent. The input cable assembly shall conform to BS EN 60204-1, BS EN 50525 and BS EN 50565. The earth core shall be bonded to all metal parts (excluding the mounting frame, provided it is completely isolated and/or insulated from the control box) and any input transformer interwinding screen (if appropriate). The input cable supply source end shall be terminated at a plug meeting and shall be in accordance with BS EN 60309-2. (Table 1)

Table 1 Plug Requirement

Plug Current Rating	Output Power		
	≤ 48V (3kW)	≤ 80V (6kW) & ≤ 40V (Transformerless)	≤ 80V (Long Fusion Time) & ≤ 80V (Transformerless)
32A	✓		
63A		✓	✓

A facility for input cable winding, storage and protection during handling shall be available on the control box. Trailing flexible cables shall be protected against stresses encountered during normal service.

Note: If the welding unit is designed to operate from a self-contained battery pack then it will not have an input lead so this section 4.5 is not applicable. However, the battery charger will have an input lead so the type of input lead specified in section 4.5 is applicable to the charger.

4.6 Control boxes conforming to GIS/ECE1 shall be permanently marked with the following information:

a) the name or trademark of the manufacturer or their appointed agent;

b) the manufacturer's contact details;

c) serial number;

d) input voltage;

e) output voltage;

f) input current;

g) output current;

h) degree of protection;

i) the number and date of this standard, i.e. GIS/ECE1:2017 [1)];

j) power supply minimum power requirements;

k) Unit weight including output leads

l) CE mark

m) where authorized, the product conformity mark of a third-party certification body, e.g. BSI Kitemark.

[1] Marking GIS/ECE/1:2017 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is therefore solely the responsibility of the person making the claim. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

4.7 The "start" push button shall be coloured green and may have a visual legend such as 1, GO or Start.

4.8 The control box shall be fitted with a "stop" push button, which isolates both poles of the output. The "stop" push button switch shall be coloured red and may have a visual legend such as 0 or Stop.

4.9 Any transformers incorporated into the design shall be safety-isolating transformers in accordance IEC 61558-1 and IEC 61558-2-23.

4.10 The output current shall be continuously monitored for the duration of the fusion cycle. Any increase in current greater than 10 % during any 4 s period shall cause the control box to terminate the weld and indicate a fault condition.

4.11 Combined electrofusion control and power generation systems shall be in accordance with **B.1**. Combined electrofusion control and power generation systems shall be tested in accordance with **B.2**.

4.12 Control boxes may be fitted with a barcode reader which shall be capable of reading barcode formats specified in ISO13950 and ISO12176 and suitably robust to cover on-site conditions.

4.13 The equipment shall be constructed so that no damage occurs to any critical electrical/electronic component when it is stored between -20C and +70C.

5 Output cable

5.1 All materials used in the construction of output cable shall be suitable for use at ambient temperatures in the range −5 °C to +40 °C. The insulation materials used shall be weather proof and robust for cable protection but shall be flexible enough to permit repeated coiling and uncoiling. Flexible conductors shall be in accordance with BS 6360. Output cables shall be in accordance with BS EN 60204-1, BS EN 50525 and BS EN 50565.

5.2 The nominal length of the cable shall be 3 m. The cable can be fixed or demountable to the box at one end, however if the cable is fixed then the fitting terminal connectors should be replaceable without the need to remove the cable. The connection to the electrofusion fitting shall be in accordance with shroud configurations specified in BS EN 1555-3:2002 and/or GIS/PL2-4. Connector types shall be in accordance with Table 2 and BS 9522 N0001. It shall not be possible to connect a 40 V fitting to an 80 V output, and vice versa, even with a fault in any single system element.

5.3 The power cores shall be rated with a higher current capacity than the fittings to be welded.

5.4 For 80 V operation, and 40 V controllers without a transformer, the control box and the output cable shall be protected by a 30 mA RCCB within the control box which shall be easily accessible for resetting.

Note: If the welding unit is designed to operate from a self-contained battery pack, and has a feature to allow welding whilst the battery is being charged, then electrical isolation between the output and input must be provided or the charger must be protected by a 30 mA RCCB.

5.5 The cable/box connectors shall have an enclosure rated at a minimum of IP54 to IEC 60529.

5.6 The connectors shall be designed with a relief mechanism to prevent straining of the cables within the harness.

5.7 The fitting connector shall be designed to prevent the engaging end of the connector from splaying out (i.e. increasing in diameter) when the connector is separated from the fitting by pulling at an angle of not less than 20°.

The connector and protective sleeve shall be designed so as to cause no interference with the function of fusion indicators (such as “pop-ups”) in fittings designed in accordance with GIS/PL2-4.

Table 2 — Connector types

Connectors in accordance with BS 9522 N0001 F0032		
Voltage V ac rms	**Connector type**	**Reference**

40 / 48	Socket Plug	C2758 2412 SCN C2528 2412 PCN
80	Socket Plug	C2758 2412 SCX C2528 2412 PCX

6 Operation

6.1 The control box shall be designed to operate from a nominal 110 V, 50 Hz sinusoidal supply with either one pole or the mid-point earthed, or from a self-contained battery pack.

The control box shall be suitable for use with power sources conforming to Annex G.

NOTE 1 Supply sources of sufficient power should be provided in accordance with Annex C.

Residual current circuit breakers (RCCBs) may be fitted to the input service supply and shall not be derated by any component or circuitry used in the operation of the control box.

Overload protection shall be fitted to the input side of the control unit in an accessible position.

When the control box is delivering maximum output at minimum input voltage (103 V) from the power source, the input current shall not exceed the values specified in Table3.

Note: The input current values do not apply to equipment powered from internal battery packs.

Table 3 — Operating parameters

Nominal output voltage	**Actual output voltage**		**Nominal input current** [a)]	**Output current**		**Initial duty cycle**	**Subsequent cooling and heating period**
V ac rms	V ac rms		A	A		min	min
	Min.	**Max.**		**Min.**	**Max.**		
40	39	40	30	5	30	10	5
40	39	40	62	5	62	30	10
40	39	40	100	5	100	60	20
80	78	80	62	10	62	45	15

a) The nominal input current does not include losses.

6.2 The output from the control box shall be stabilized to give the output voltage specified in Table 3 when delivering the corresponding range of output currents. The stable voltage shall be achieved within 2 s from start of applied voltage.

The control boxes with detachable leads the circuitry shall use the voltage sensed by separate connectors, other than the power connectors, onto the fitting terminals to monitor the voltage to the electrofusion fitting. Where the output voltage limits and the output voltage control circuitry are derived from the same voltage reference, an independent means of checking this reference shall be provided.

For control boxes with fixed leads local voltage sensing from within the box is optional.

6.3 At an ambient temperature of 40 °C, the control box shall be capable of undergoing the duty cycle specified in Table 4.

Table 4 — Duty cycle

Maximum output voltage	**Minimum output current**	**Initial cycle**		**Subsequent cycles**		
		"on" duration	**"off" duration**	**Number of cycles**	**"on" duration**	**"off" duration**
V ac rms	A	min	min		min	min
40	30	10	24	5	5	5
40	60	30	10	5	10	10
48	80	60	15	5	20	20
80	60	45	15	5	15	15

6.4 The control box shall be capable of providing a current 25% above the minimum output current for a minimum of 20 seconds.

6.5 The control box shall check the continuity of the fusion coil and the integrity of the output circuit, before switching the main power on to the fitting. The continuity circuit shall be powered by not more than 12 V. The control box shall not operate when attached to resistances above 200 Ω. The control box circuit shall measure continuity across voltage sense pins on the output socket. The continuity of this circuit shall be continuously monitored during the fusion cycle. Any break in the circuit shall switch off the control box and indicate a fault condition.

6.6 The control box shall display as a minimum the following information:

a) Output voltage indication.

b) fusion cycle time — decrementing in seconds to zero;

c) fusion complete;

d) fault (see **6.7**).

6.7 Each of the following faults shall be uniquely identified when it occurs:

a) output voltage outside the tolerance band: these trips shall be set as in Table 5 and shall operate in less than 6 s;

b) break in circuit;

c) interrupted fusion cycle;

d) input voltage in excess of 120 V or less than 103V;

e) partial short circuit of fusion coil (as per clause 4.10).

f) Stop button pressed or weld terminated by operator

g) Power cut off in previous weld.

The output circuit shall be switched off automatically if a fault occurs.

Note: For equipment powered by an internal battery pack, the maximum and minimum supply voltages shown in (d) should be modified according to the design of the battery.

Table 5 — Trip settings for output voltage

Maximum output voltage V ac rms	**Trip setting** A	
	Low	**High**
40	38.9 to 39.0	40.0 to 40.1
8 – 48 (variable)	-0.5 of set voltage	+0.5 of set voltage
80	77.8 to 78.0	80.0 to 80.2

6.8 A means for the manual selection of fusion times (in increments of one second) shall be provided appropriate to the group.

A means for the automatic selection of fusion parameters (in accordance with ISO 13950) may be provided.

Both shall be suitable for operation by a gloved operator, shall be robust enough for normal site conditions and shall be inactive during the fusion operation.

6.9 A means for measuring the ambient temperature may be provided to allow compensation of the welding parameters in accordance with ISO13950 in section 6.8. This measurement shall be accurate to +/- 2 degrees Celsius. The temperature sensing element shall not be influenced by the heat produced by the welding unit and it shall be protected from physical damage

6.10 All displays shall be clearly visible both in bright sunlight and in subdued lighting conditions.

7 Testing

7.1 General

Type approval testing of control boxes shall carried out in accordance with **7.2** followed by batch acceptance testing in accordance with **7.3**.

7.2 Type approval testing

7.2.1 The schedule of type approval tests shall be in accordance with Table 6. Following a successful approval testing program, a successful field trial shall be carried out in order to obtain type approval.

7.2.2 The output cable and fitting connector shall withstand an axial pull of 100 N without failure or deterioration, and the fitting connector shall be in accordance with IEC60529, IP54.

7.2.3 The control box shall be tested at 23 ˚C+/- 2C under the conditions specified in Table 7.

The output voltage shall be measured and shall be in the range 39 V ac rms to 40 V ac rms (see **6.2**).

Table 6 — Schedule of type approval tests

Control box		
Description of test/check	**Test conditions specified in**	**Requirement clause**
Tests to be carried out on same unit		
Weight	—	**4.1**
Enclosure protection	IEC 60529	**4.3**
Free fall test	BS EN 60068-2-31	**8.1**
Bump test	BS EN 60068-2-27	**8.2**
Vibration test	BS EN 60068-2-24	**8.3**
Inductance-latching current test	**7.2.6**	**6.1**
Output voltage	**7.2.4**	**6.2**
Heating effects	**7.2.5**	**6.3**
Continuity test	—	**6.5**
Insulation test	—	**8.4**
RCCB test	—	**7.2.6**
Electrical voltage test	—	**8.5**
Output cable		
Description of test/check	**Test conditions specified in**	**Requirement clause**
Axial pull test	—	**7.2.2**

Table 7 — Test conditions at 23 °C

Input voltage V ac rms	**Frequency** Hz	**Output current** A	
		40 V	**80 V**
120	52.5	5	10
120	52.5	30/62/100*	62
103	47.5	5	10
103	47.5	30/62/100*	62

* Depending on maximum output current of unit.

Note: For equipment that is powered from an internal battery pack, the test conditions in table 7 should be carried out at nominal battery voltage.

7.2.4 The self-heating of the control box shall be tested under the conditions specified in Table 8. The temperature of the critical electrical/electronic components shall be continuously

monitored during the test and shall not go above the maximum temperature specified by the component manufacturer. The maximum case temperature should not exceed +60C.

Table 8 — Self-heating test conditions

Duty cycle	**Input voltage** V ac rms	**Frequency** Hz	**Output current** A		**Ambient temperature** 0 C
			40 V	**80 V**	
See **6.3**	120	52.5	30/62/100*	62	+40

* Depending on maximum output current of unit.

Note: For equipment that is powered from an internal battery pack, the test conditions in table 8 should be carried out at nominal battery voltage.

7.2.5 In standard operating conditions, as defined in the manufacturer's data sheet, the control box shall supply power to a load current at the maximum of the appropriate control box group, when powered by any power source, conforming to Annex G. Using a transient recorder, or similar fast recording device, the output voltage waveform shall be monitored during the start of the fusion cycle. No missing half cycles should be detected during this period.

7.2.6 With the control box operating under full-load conditions and an RCCB connected to the input supply, a fault current equal to the rated trip current of the RCCB shall be introduced. The RCCB shall operate within the rated trip time.

7.3 Batch acceptance testing

7.3.1 Once type approval to this standard has been granted, the production batches of control boxes shall be tested in accordance with Table 9.

A batch shall be a maximum of 100 control boxes.

7.3.2 Control boxes shall be tested under both of the conditions specified in Table 10, when testing for output voltage and timer accuracy.

7.3.3 The control box shall be operated for 30 min at minimum rated output current.

7.3.4 10 % of every batch shall be operated for 10 min at maximum rated output current before dispatch.

7.3.5 All boxes shall be checked to ensure they are fully functional prior to release, this should include all types of weld data entry that the box is capable of i.e. manual, automatic pin, barcode.

Table 9 — Schedule of batch acceptance tests

Description of test/check	Frequency of test	Test conditions specified in	Requirements clause
Burn-in	Every box	—	**7.3.3**
Output voltage	Every box	7.3.2	**6.2**
Continuity test	Every box	—	**6.5**
Insulation test	Every box	—	**8.4**
Electrical volt test	Every box	—	**8.5**
Full load test	10% of batch	---	**7.3.4**
Functionality	Every box		**7.3.5**

Table 10 — Test conditions

Input voltage V ac rms	**Frequency** Hz	**Output current** A
103	47.5	Max & Min
120	52.5	

Note: For equipment that is powered from an internal battery pack, the test conditions in table 10 should be carried out at nominal battery voltage.

8 Performance

8.1 Free fall test

The control box shall withstand one free fall test from a height of 1 m on to level concrete or steel, as specified in BS EN 60068-2-31, without changing the performance of the control system.

After testing, the control box shall conform to **4.3** and **6.2**

8.2 Bump test

When the control box is tested in accordance with BS EN 60068-2-27, it shall withstand:

a) 1 000 bumps at 10 g, 16 ms.
b) 18 bumps at 25 g, 6 ms.

After testing, the control box shall meet the requirements of **6.2**

8.3 Vibration test

8.3.1 The assembled control box and individual PCB shall be capable of withstanding the vibration test specified in Annex D and carried out in accordance with BS EN 60068-2-64.. When tested in accordance with **D.3**, no cracking of the PCB, nor loosening of the components

mounted on the PCB, shall be evident. The unit shall perform satisfactorily after completion of the test.

8.3.2 When tested in accordance with **D.3**, the control box shall meet the requirements of this standard.

8.4 Insulation test

When tested in accordance with Annex E the insulation resistance thus measure shall be not less than 1 MΩ .

8.5 Electrical Voltage Test

When tested in accordance with Annex H the equipment must undergo a high voltage test with no disruptive discharging occurring.

Annex A (normative) Data logging and retrieval (optional)

It is highly recommended that control boxes have the facility for logging and retrieval of jointing data for quality assurance purposes. A minimum of 2000 joints should be stored in the box with the minimum information required being as follows:

- Control box identification number
- Joint number
- Date and time the joint were made
- Fusion time, target and achieved times
- Status of the joint, complete or incomplete
- power profile of weld (at least 10 points during fusion cycle) and total energy delivered
- Any fault condition

However this version of ECE1 seeks to ensure that the equipment used within the UK Gas Industry has the ability to meet emerging standards, and several GDN/IGTs now use real-time quality assurance procedures for PE jointing.

The below provides a list of data and features required to support this real-time process:

Control boxes should have the facility for the logging and real-time retrieval of the following data in an agreed format for each joint:

- operator information, including EUSR references
- client details, project and supervisor
- control box serial/identification number
- control box calibration status
- joint number
- date and time joint made
- resistance of connected fitting
- fusion time: target and achieved times
- status of joint (complete or incomplete)
- power profile of weld (at least 10 points during fusion cycle) and total energy delivered
- ambient temperature
- any fault condition (fault codes may be used)

Minimum features of each control box:

- capable of storing a minimum of 2,000 weld records and a warning given when the memory is 95% full, if the warning is ignored the oldest joints shall be overwritten.
- wireless means of data communication to improve real time quality assurance processes and data security – including external smartphone connection.
- ability to scan and collect fusion barcodes (ISO13950) – this can be app based.
- ability to scan and collect material traceability barcodes (ISO12176-4) – this can be app based.

Annex B (normative) Specific requirements and testing for combined electrofusion control and power generation systems

B.1 Performance

B.1.1 The power generation system shall be in accordance with Annex G.

B.1.2 For all units, a changeover method shall be provided to select either electrofusion (40 V) or 110 V, 16 A output.

For a 2.5 kW unit, a changeover method shall be provided to select electrofusion (40 V) or 110 V, 16 A or 110 V, 32 A output.

For a 5 kW unit, a changeover method shall be provided to select either electrofusion or 110 V, both 16 A and 32 A, output. If appropriate, a further changeover method shall be provided to select either 40 V or 80 V electrofusion output.

Note: Changeover may be defined as any means to block the use of 110 V sockets while welding is occurring.

NOTE The generation unit may be directly connected to the control box.

B.1.3 If a remote portable start/stop unit with a means of inputting and displaying the fusion time and any other information is supplied, the remote unit shall be attached to the control box by means of a H07RN-F compliant cable. The cable length shall be 6 m. The remote “stop” button shall be in series with the main “stop” button on the control box (see **4.8**).

B.1.4 The mid-point of the 110 V and 80 V (as appropriate) windings shall be taken to a zero potential earth, i.e. centre-tapped earth outlets.

NOTE One side of the 40 V winding may be earthed.

B.1.5 The nominal length of the electrofusion output cable shall be 6 m.

B.1.6 The power cores of the electrofusion output cable shall be rated with a higher current capacity that the fittings to be welded.

B.1.7 The control box shall be in accordance with BS EN 55012 for radio frequency interference suppression.

B.2 Testing

B.2.1 Approval tests

B.2.1.1 *Principle*

The suitability of the combined electrofusion control and power generation systems for deployment in typical gas distribution sites is determined.

B.2.1.2 *Apparatus*

B.2.1.2.1 *Combined electrofusion control and power generation system. True-rms test meter.*

B.2.1.3 *Procedure*

The power generation unit shall comply with Annex G

Note: For low and high temperature tests the power and control sections should already have been tested separately in accordance with GIS ECE1 and Annex G respectively. Evidence must

be shown of this. Further to this they also require testing together. The temperature of the combined unit shall either be lowered to -10 ± 1°C and then brought into an ambient temperature of no more than 20 ± 5 °C, or the unit may be tested outside at an ambient temperature of -10 ± 2.5 °C Following this, the temperature of the combined unit shall either be raised to +40 ± 1°C and then brought into an ambient temperature of no less than 20 ± 5 °C, or the unit may be tested outside at an ambient temperature of +40 ± 2.5 °C

B.2.1.4 *The combined unit shall meet the requirements of the following tests:*

a) bump test in accordance with **8.2**;

b) vibration test in accordance with **8.3**;

c) weather protection in accordance with **4.3**.

B.2.1.5 *Test report*

The test report shall include the following information:

a) reference to this standard, i.e. GIS/ECE1:2006:

b) results of the test specified in **B.2.1.3** and **B.2.1.4**;

c) any additional factors which may have affected the results of the test.

Table B.1 — Test conditions for approval testing

Ambient Temperature	Off-Load Voltage	Minimum Current Draw A			Duty Cycle Test Times
		1.5kW*	2kW*	4kW*	
20 ± 5	+125V	30	60	100	As per Table 3
	+103V	30	60	100	
-10 ± 2.5	+125V	30	60	100	30
	+103V	30	60	100	
+40 ± 5	+125V	30	60	100	30
	+103V	30	60	100	

* Output power of control box

B.2.2 ***Acceptance tests***

Combined units shall be batch tested in accordance with 7.3

Annex C (informative) Matching controller, generator and fittings

It is essential that purchasers and users of electrofusion control boxes should become aware of the need to provide electrical generators of sufficient quality and power for their control boxes and fittings. They should appreciate in particular the differing requirements of 40 V controllers according to whether they are transformer based or are of the transformerless type.

NOTE 1 The latter are becoming favoured by some users because of their compact, lower weight, construction. However because of their inefficient use of the available power, it is necessary to match them to a larger generator of much higher power output.

NOTE 2 A transformer based controller converts 110 V input to 40 V output at higher current with relatively little loss of power. Hence a fitting requiring 60 A at 40 V (2.4 kW) can be provided by a 3 KVA generator.

NOTE 3 A transformerless box works by electronic chopping of the 110 V ac waveform. Essentially the input and output currents are almost equal and the effective ac output voltage is achieved by wastage of the excess power, mostly as heat in the windings of the generator.

Hence a 2.4 kW fitting supplied by a 40 V transformerless control box requires a 6.5 KVA generator that can give an input current of 60 A at 110 V. Furthermore the generator needs to be of good quality to accept the heat loss in its windings.

NOTE 4 The step-down from 110 V to 80 V is less severe and so less heat is wasted in 80 V transformerless boxes.

Hence a 6.5 KVA generator can supply an 80 V controller with an output of 60 A, which powers a fitting of 4.8 kW, and with less heat lost in the generator windings. Controller, generators and fittings should be matched in accordance with Table C.1.

Table C.1 — Matching controller, generator and fittings

Generator continuous power rating (minimum)	**Electrofusion control box Voltage (type)**	**Maximum fitting**	
		Current	**(Power)**
3 kVA	40V(8-48) Transformer	30 A	1.5 kW
4 kVA	40V(8-48) Transformer	62 A	2.5 Kw
5 kVA	40V(8-48) Transformer	100 A	5 Kw
7.5 kVA	40V (8-48) Transformerless	62 A	2.5 kW
7.5 kVA	80V Transformerless	62 A	2.5 kW

Annex D (normative) Vibration test

D.1 Principle

The capability of the control box to withstand vibration is determined by applying a random frequency to the PCBs in isolation and as part of the complete unit.

D.2 Apparatus

D.2.1 *Signal generator*, capable of applying a frequency 20 Hz to 2 kHz and a resonant sine wave 20 Hz to 2 kHz.

D.3 Procedure

Test 1. Circuit boards only, in normal working orientation.
Resonant search between 20Hz and 2000Hz, 1 sweep at 1g
Record resonant frequencies.

Test 2. Circuit boards only, in normal working orientation.
Random endurance between 20Hz and 2000Hz, 0.002 g^2/Hz for 60 minutes.
Check correct operation of circuit boards.

Test 3. Circuit boards only, in normal working orientation.
Resonant search between 20Hz and 2000Hz, 1 sweep at 1g
Record resonant frequencies and check to see if they have changed.

Test 4. Complete unit, in normal working orientation.
Resonant search between 20Hz and 2000Hz, 1 sweep at 1g
Record resonant frequencies.

Test 5. Complete unit, in normal working orientation.
Random endurance between 20Hz and 2000Hz, 0.002 g^2/Hz for 60 minutes.
Check correct operation of unit.

Test 6. Complete unit, in normal working orientation.
Resonant search between 20Hz and 2000Hz, 1 sweep at 1g
Record resonant frequencies and check to see if they have changed.

D.4 *Test report*

The test report shall include the following information:

a) reference to this standard, i.e. GIS/ECE1:2006;

b) results of the vibration test, including any evidence of cracking of the PCB or loosening of the components mounted on the PCB;

c) any additional factors which may have affected the results of the test.

Annex E (normative) Insulation test

Note: For equipment designed to operate from an internal battery pack, the insulation test (Annex E) is not applicable.

E.1 Principle

The insulation properties of the control box and input cable are determined by applying a voltage to the control box and measuring the insulation resistance.

E.2 Apparatus

E.2.1 *Control box*.

E.2.2 *Input cable*.

E.3 Procedure

Subject the control box and input cable to an insulation test to earth with the 110 V primary circuit connected as follows.

a) all terminals of active control elements (e.g. thyristors or triacs) are shorted together.

b) Where applicable, close switches, circuit breakers, contactors, and ensure fuses are in place.

c) Connect together both poles of the supply.

Apply a nominal test voltage of 250 V dc between supply poles and earth.

E.4 Test report

The test report shall include the following information:

a) reference to this standard, i.e. GIS/ECE1:2006;

b) the measured insulation resistance;

c) any additional factors which may have affected the results of the test.

Annex F (Informative)

Multi-cycle fittings eg Large Diameter Electrofusion Couplers

It should be noted that in the case of certain large diameter electrofusion fittings then these shall only be welded using an ECE1 approved electrofusion control unit that is also compliant with the requirements of this annex.

Normally a fitting requires only a single time to be entered into the electrofusion control unit (ECU) but in some cases multiple times must be entered. To facilitate this, the following practice has become the norm:

- At a suitable point in the menu selection, a choice is made between manual entry of data for a single cycle fitting, OR manual entry of data for the multi-cycle fitting. Established ECU manufacturers have used specific designations e.g. “EasiGrip 450+” within their menu selection to allow the correct information to be entered for these fittings
- Three pieces of timing information should be entered, the purpose of which is described below:
    - Warm up time; During this time the box shall output a nominal 80V fixed voltage across the terminals of the fitting, immediately followed by
    - Soak time; During this time the box shall act as a time counter and shall have no output across the terminals of the fitting, immediately followed by
    - Fusion time; During this time the box shall output a nominal 80V fixed voltage across the terminals of the fitting. It should be noted that provision is required for 4 digit time entries (seconds)

All boxes that have been adapted to work with multi-cycle fittings and proven to be compatible with these fittings shall be labelled with a sticker denoting compatibility.

Such a sticker shall be agreed in conjunction with the fittings manufacturer to ensure acceptable use of trademark information and shall be compliant with the requirements of the main laying manuals to ensure operator recognition.

An example of a compliant sticker is shown in figure 1.

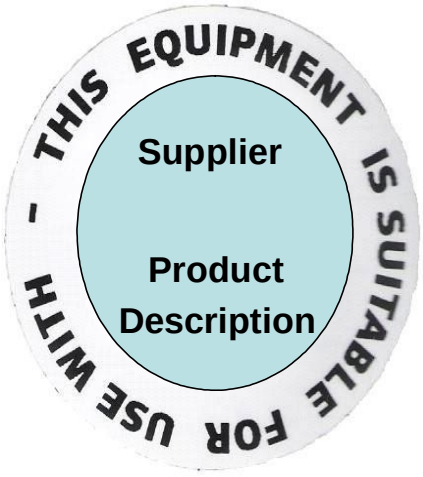

Fig 1: Compliant Sticker

Annex G. (Informative) Power supply requirements

1 PORTABLE TRANSFORMERS

1.1 General

These types of transformers are used for the supply of electrofusion welding equipment during maintenance and construction activities.

1.2 Rated output power

The transformer output rating shall be based on a unity power factor.

The transformer shall have a power rating for continuous use and a power rating for intermittent use.

1.3 Output phase configuration

The transformer output shall be single phase and shall be electrically isolated from the input. The transformer output shall be centre tapped to earth to reduce the risk of shocks.

1.4 Earthing

The transformer shall be class one earthed with all exposed metalwork being earthed. The output earth shall be connected to the input earth. All socket outlet earths shall be connected to the supply earth.

1.5 Output waveform characteristics

The output voltage waveform of the transformer shall be sinusoidal with a maximum of 20% distortion. No spurious zero crossovers shall occur.

1.6 Output voltage

The nominal output voltage shall be 110 V ac. The output voltage of the transformer shall not be less than 103 V at any kW loading between no load and full load.

1.7 Electrical protection

Protection against overload of the transformer socket outlets should be provided by circuit breakers to BS EN 60898 rated to trip at not more than 120% of the full load current of each socket, in less than 2 hours.

1.8 Socket outlets and switches

The 110 V output shall be provided with yellow socket outlets to BS EN 60309-2 (2 pole and earth), as listed below.

Up to 1 kW	1x 16A
1 kW to 3 kW	2x 16A and 1x32A
3 kW to 6 kW	2x 16A, 1x 32A, 1x63A

2 PORTABLE GENERATOR SETS, VAN-MOUNTED POWER TAKE OFF UNITS AND INVERTERS

2.1 General

These types of generators, PTOs and inverters are used for the supply of electrofusion welding equipment during maintenance and construction activities.

2.2 Rated output power

Their output rating shall be based on a unity power factor.

They shall be rated for continuous running duty, S1 in accordance with BS EN 60034-5.

2.3 Output frequency

Their set output frequency shall be 50 Hz ±5%.

2.4 Output phase configuration

Their output shall be single phase with the mid-point brought out for the provision of the socket outlet earth and earthing all metalwork associated with the generator set.

2.5 Earthing

A 10mm earth stud connected to the mid-point of the generator output shall be provided to permit the connection of an external earth conductor.

2.6 Output waveform characteristics

The output voltage waveform shall be sinusoidal with a maximum of 20% distortion. No spurious zero crossovers shall occur.

2.7 Sub-transient reactance limits

Their sub-transient reactance shall not exceed 11 ohms at any angle of rotation of the rotor.

2.8 Output voltage

The nominal output voltage shall be 110 V ac via a centre-tapped earth. The output voltage shall not exceed 120 V and shall not be less than 103 V at any kW loading between no load and full load.

2.9 Electrical protection

Protection against overload should be provided by:

a) Temperature element embedded within the alternator winding

b) Circuit breaker to BS EN 60898 rated to trip at not more than 120% of the full load current in less than 2 hours.

Over-current protection circuit breakers shall be fitted to all socket outlets at their rated value. i.e. 16A, 32A, 63A.

2.10 Socket outlets and switches

The 110 V output shall be provided with yellow socket outlets to BS EN 60309-2 (2 pole and earth), as listed below.

Up to 1 kW	1x 16A
1 kW to 3 kW	2x 16A and 1x32A
3 kW to 6 kW	2x 16A, 1x 32A, 1x63A

3 BATTERY PACKS

3.1 General

These types of battery packs are custom made specifically for the equipment they are to be used with, the output voltage of the battery being matched to the requirements of the electrofusion welder.

They must have a sealed battery technology and they must be constructed in a way to avoid damage to the battery pack when used to supply welding equipment carrying out maintenance and construction activities.

If the battery pack is to be replaceable during normal operation, then it must be environmentally protected to at least IP54.

3.2 Rated output power

The battery pack output rating shall be based on a unity power factor.

The battery pack shall have a power rating for continuous use and for intermittent use.

3.3 Earthing

If the battery pack is designed to allow operation while being charged, then all exposed metal parts of the battery pack must be earthed to the incoming supply earth.

3.4 Output voltage

The output voltage shall remain within 10% of the nominal rating and have less than 10% total distortion for any kW loading between no load and full load.

If the output voltage of the battery pack is designed at a nominal 110V ac then it must comply with all of Annex G, section 1, Portable Transformers.

3.5 Electrical Protection

Protection against short circuit of the battery terminals shall be provided.

Protection against over-heating of the batteries during charging and discharging shall be provided.

Protection against overload of the battery pack outlet shall be provided by circuit breakers to BS EN 60898 rated to trip at not more than 120% of the full load current, in less than 2 hours.

If the battery pack is designed to have an output voltage greater than 80V dc or 110 V ac then protection must be provided to avoid electric shock to the operator in case of fault.

If the battery pack is designed to allow operation while being charged, then electrical isolation must be provided between the output of the battery pack and the supply input.

3.6 Socket outlets and switches

The voltage output shall be provided through a female (socket) connector that is rated with a higher voltage and current rating than the maximum designed output of the battery pack.

All switches must also be rated with a higher voltage and current rating than the maximum designed output of the battery pack.

ANNEX H. (Normative) Electrical voltage test

The following verification test should be carried out to show compliance with BS EN 60204-1 section 18.4, Voltage Tests.

Note: For equipment designed to operate from an internal battery pack, the voltage test (Annex H) is not applicable.

H.1 Principle

The strength of the condition of the insulation of the control box and input cable are determined by applying a voltage to the control box and measuring the current.

H.2 Apparatus

H.2.1 Control box with input cable attached

H.2.2 High voltage tester

H.3 Procedure

The phase and neutral connectors should be shorted together and the test run between these and the earth.

The test shall be at a nominal frequency of 50 Hz.

The maximum test voltage shall have a value of twice the rated supply voltage of the equipment or 1000V whichever is greater. The maximum test voltage shall be applied between the power circuit conductors and the protective bonding circuit for a period of approximately one second. The requirements are satisfied if no disruptive discharge occurs.

Components and devices that are not rated to withstand the test voltage shall be disconnected during the testing.

Components and devices that have been voltage tested in accordance with their product standards may be disconnected during testing.

After the testing, the functions of the control box shall be tested and the functions of any circuits for electrical safety (for example earth fault detection) shall be tested.

H.4 Test report

The test report shall include the following information:

a) Reference to this standard i.e. GIS/ECE1:2017
b) The applied voltage
c) The duration of the test
d) The measured current
e) Any disruptive discharges that occurred
f) Any additional factors that may have affected the results of this test

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