

# Gas Industry Standard

GIS/ECE1:2008

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Specification for

**Electrofusion control boxes**

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nationalgrid

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## 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

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## 1 Scope

This Gas Industry Standard specifies requirements for construction, operation and testing of electrofusion control boxes and associated cables, with a maximum output current of 62 A. The control boxes are intended for use with fittings produced in accordance with BS EN 1555-3:2002 and GIS/PL2-4.

The electrofusion control boxes are intended for use in normal operating ambient temperatures of between  $-5\text{ }^{\circ}\text{C}$  to  $+40\text{ }^{\circ}\text{C}$  and are intended for storage at temperatures as low as  $-10\text{ }^{\circ}\text{C}$ .

## 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 4884 (all parts), *Specification for technical manuals*.

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

BS 7540-1, *Guide to the use of cables with a rated voltage not exceeding 450/750V — Part 1: General guidance*.

BS 7655-3.1, *Specification for insulating and sheathing materials for cables — PVC insulating compounds — Part 3.1: Harmonized types*.

BS 7655-3.2, *Specification for insulating and sheathing materials for cables — PVC insulating compounds — Part 3.2: Hard grade types*.

BS 7919, *Electric cables — Flexible cables rated at up to 450/750V for use with appliances and equipment intended for industrial and similar environments*.

BS 9522 N0001, *Detail specification for multi-contact circular electrical connectors for d.c. 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 60068-2-29, *Environmental testing — Test methods — Environmental testing procedures — Tests — Part 2.29: Test Eb and guidance — Bump*.

BS EN 60068-2-32, *Environmental testing — Test methods — Test Ed — Part 2.32: Free fall*.

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*

BS EN 60947-1, *Specification for low-voltage switchgear and controlgear — Part 1: General rules*.

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

### **Gas Industry Standards**

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

### **National Grid standards**

T/SP/EL11:2005, *Specification for fixed standby generators and transportable generator sets.*

T/PM/EL3, *Management procedures for the selection, protection, maintenance and operation of electrically operated portable and transportable tools, equipment and associated appliances.*

## **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 no more than 25 kg. The design shall allow for the control box to be carried by one person.

The control box shall be designed and constructed in accordance with BS EN 60204-1, DD IEC TS 61000-1-2 and BS EN ISO 12100-2.

If required by the gas transporter, the control box shall have the facility for logging and retrieval of data in accordance with Annex A.

NOTE Attention is drawn to the following EC Directives:

- 89/392/EEC, Machinery Directive [1];
- 73/23/EEC, Low Voltage Directive [2];
- 89/336/EEC, Electromagnetic Compatibility Directive [3].

**4.2** The control box enclosure shall afford a minimum environmental protection to IP54 in accordance with BS EN 60947-1 with any socket-outlet exposed. All PCBs shall be conformally coated to protect against the effects of condensation.

**4.3** An instruction manual shall be supplied in accordance with BS 4884. Maintenance shall be in accordance with T/PM/EL3.

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

**4.4** The input cable shall be permanently attached to the control box, and its nominal length shall be 10 m. The maximum voltage drop shall be 2.75 V ac rms (lead and return) when measured at maximum input current (see **5.1**).

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 7919 and BS 7540.

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 inter-winding 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.

NOTE 1 For compliance with CE marking requirements it would be expected that the current rating of the input power plug should encompass the maximum current input of the control box. However for practical reasons it has become custom and practice, proven by good operation for many years, to fit 40 V, 3 kW transformer boxes with a 16 A plug and 80 V 6 kW transformerless boxes with a 32 A plug. This practice has probably been successful because control boxes are not used for continuous power control and current is not normally interrupted by disconnecting at the plug. Purchasers and suppliers may agree to continue this option as a concession provided they have evidence from development testing or previous long term usage that operational safety and reliability is not compromised.

NOTE 2 40V transformerless control boxes should not be fitted with a 16 A plug but should be regarded similarly to 80 V control boxes.

NOTE 3 Where it is anticipated that an 80 V control box may be required to provide long periods of power at a high current level, for instance where pre-heating is to be applied to large electrofusion fittings, as well as the long fusion time for such fittings, then a 63 A plug is necessary.

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.

**4.5** The output cable socket-outlet shall be fixed to the control box panel.

**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/ECE1:2006 <sup>1)</sup>;
- j) generator minimum power requirements;
- k) where authorized, the product conformity mark of a third party certification body, e.g. BSI Kitemark.

NOTE Attention is drawn to the advantages of using third party certification of conformance to a standard.

A label shall be attached indicating that the control box shall only be used in conjunction with generator sets conforming to T/SP/EL11.

**4.7** The "start" push button shall be coloured green.

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<sup>1)</sup> Marking GIS/ECE/1:2006 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.

**4.8** The control box shall be fitted with a “stop” pushbutton, which completely interrupts the output. The “stop” pushbutton switch shall be coloured red.

**4.9** Any transformers incorporated into the design shall be safety-isolating transformers in accordance with BS EN 61558-1:1998 and BS EN 61558-2-23:2001.

**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 switch off 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**.

## **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  $-5\text{ }^{\circ}\text{C}$  to  $+40\text{ }^{\circ}\text{C}$ . The insulation materials used shall be weather proof and robust for cable protection but shall be flexible enough to permit repeated coiling and uncoiling. PVC shall be in accordance with BS 7655-3, Type T11 with a Type TM1 PVC cable sheath. Flexible conductors shall be in accordance with BS 6360. Output cables shall be in accordance with BS EN 60204-1, BS 7919 and BS 7540.

**5.2** The nominal length of the cable shall be 3 m. Terminations shall be fitted for de-mountable connection to the control box at one end and to the electrofusion fitting at the other. 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 1 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 contact resistance of the power contacts after 10 000 mating cycle operations shall be not greater than 10 m $\Omega$ .

**5.4** The power cores shall have a maximum voltage drop of 2.0 V ac rms (lead and return) when measured at a maximum current of 60 A.

**5.5** 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.

**5.6** The cable/box connectors shall have an enclosure rated at a minimum of IP54 to BS EN 60947-1.

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

**5.8** 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  $20^{\circ}$ .

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 1 — Connector types**

<b>Connectors in accordance with BS 9522 N0001 F0032</b>		
<b>Voltage</b> V ac rms	<b>Connector type</b>	<b>Reference</b>
40	Socket	C2758 2412 SCN
	Plug	C2528 2412 PCN
80	Socket	C2758 2412 SCX
	Plug	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.

The control box shall be suitable for use with generators conforming to T/SP/EL11.

NOTE 1 Electrical generators of sufficient power should be provided in accordance with Annex C.

NOTE 2 Typically, a transportable 110 V generator output will be 103 V to 120 V ac rms having a sinusoidal waveform with not more than 20 % distortion and within the frequency limits of not less than 47.5 Hz and not greater than 52.5 Hz. The sub-transient reactance of a generator may be as high as 11  $\Omega$ . The generator's minimum rate of rise of current may be assumed to be 2000 A/s.

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 generator, the input current shall not exceed the values specified in Table 2.

**Table 2 — Operating parameters**

<b>Nominal output voltage</b> V ac rms	<b>Actual output voltage</b> V ac rms		<b>Nominal input current</b> <sup>a)</sup> A	<b>Output current</b> A		<b>Initial duty cycle</b> min	<b>Subsequent cooling and heating period</b> min
	<b>Min.</b>	<b>Max.</b>		<b>Min.</b>	<b>Max.</b>		
40	39	40	62	5	62	30	10
80	78	80	62	10	62	45	15

<sup>a)</sup> 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 2 when delivering the corresponding range of output currents. The stable voltage shall be achieved within 2 s from start of applied voltage.

The control box 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.

**6.3** At an ambient temperature of 40 °C, the control box shall be capable of undergoing the duty cycle specified in Table 3.

**Table 3 — 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	60	30	10	5	10	10
80	60	45	15	5	15	15

**6.4** The fusion cycle times shall be set in increments of one second and shall be controlled to an accuracy of  $\pm 0.5\%$  for any setting over an ambient temperature range of  $-10\text{ }^{\circ}\text{C}$  to  $40\text{ }^{\circ}\text{C}$ . The timing system accuracy shall be maintained within these limits without adjustment for a period of at least 12 months.

NOTE The frequency variation of the generators may be between the limits of not less than 47.5 Hz to not greater than 52.5 Hz.

**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  $\Omega$ . 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 the following information:

- a) input voltage “on”;
- b) initial 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 4 and shall operate in less than 6 s;
- b) break in circuit;
- c) fusion time not on preferred list of times;
- d) interrupted fusion cycle;
- e) input voltage in excess of 120 V;
- f) partial short circuit of fusion coil.

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

**Table 4 — 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
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) to at least 999 s shall be provided. This shall be suitable for operation by a gloved operator and shall be inactive during the fusion operation.

**6.9** 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 be 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 5. Following a successful approval testing program, a successful three month 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 BS EN 60947-1, IP67.

**7.2.3** The control box shall be tested at 23 °C under the conditions specified in Table 6.

The output voltage shall be measured and shall be in the range 39 V ac rms to 40 V ac rms (see **6.2**). The timer accuracy shall be measured during each test and shall be within 0.5 % of set point (see **6.4**).

**Table 5 — Schedule of type approval tests**

<b>Control box</b>		
<b>Description of test/check</b>	<b>Test conditions specified in</b>	<b>Requirement clause</b>
<b>Tests to be carried out on same unit</b>		
Weight	—	<b>4.1</b>
Enclosure protection	BS EN 60947-1	<b>4.2</b>
Free fall test	BS EN 60068-2-32	<b>8.1</b>
Bump test	BS EN 60068-2-29	<b>8.2</b>
Vibration test		<b>8.3</b>
Inductance-latching current test	<b>7.2.6</b>	<b>6.1</b>
Output voltage	<b>7.2.4</b>	<b>6.2</b>
Heating effects	<b>7.2.5</b>	<b>6.3</b>
Timer accuracy	<b>7.2.4</b>	<b>6.4</b>
Continuity test	—	<b>6.5</b>
Insulation test	—	<b>8.4</b>
RCCB test	—	<b>7.2.6</b>
<b>Output cable</b>		
<b>Description of test/check</b>	<b>Test conditions specified in</b>	<b>Requirement clause</b>
Contact resistance	—	<b>5.3</b>
Axial pull test	—	<b>7.2.2</b>

**Table 6 — Test conditions at 23 °C**

<b>Input voltage</b> V ac rms	<b>Frequency</b> Hz	<b>Output current</b> A	
		<b>40 V</b>	<b>80 V</b>
120	52.5	5	10
120	52.5	62	62
103	47.5	5	10
103	47.5	62	62

**7.2.4** The self-heating of the control box shall be tested under the conditions specified in Table 7. 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.

**Table 7 — Self-heating test conditions**

Duty cycle	Input voltage V ac rms	Frequency Hz	Output current A		Ambient temperature °C
			440 V	80 V	
See 6.3	120	52.5	62	62	+40
	103	47.5	5	10	-10

**7.2.5** With the minimum trigger pulse width applied, as defined in the manufacturer's data sheet, the control box shall supply power to a 62 A load, when powered by any generator, conforming to T/SP/EL11. Using a transient recorder, or similar fast recording device, the output voltage waveform shall be monitored during the start of the fusion cycle.

NOTE 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 8.

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 9, 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 30 min at maximum rated output current before dispatch.

**Table 8 — Schedule of batch acceptance tests**

Description of test/check	Frequency of test	Test conditions specified in	Requirements clause
Vibration test	One per batch	—	<b>D.3.3</b>
Burn-in	Every box	—	<b>7.3.3</b>
Output voltage	Every box	7.3.2	<b>6.2</b>
Timer accuracy	Every box	7.3.2	<b>6.5</b>
Continuity test	Every box	—	<b>6.5</b>
Insulation test	Every box	—	<b>8.4</b>
Full load test	10% of batch	—	<b>7.3.4</b>

**Table 9 — Test conditions**

<b>Input voltage</b>	<b>Frequency</b>	<b>Output current</b>
V ac rms	Hz	A
103	47.5	63
120	52.5	61

## **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 60068-2-32, without changing the performance of the control system.

After testing, the control box shall conform to **4.2**, **6.2** and **6.4**.

### **8.2 Bump test**

When the control box is tested in accordance with BS EN 60068-2-29, 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** and **6.4**.

### **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. When tested in accordance with **D.3.1**, no cracking of the PCB, nor loosening of the components mounted on the PCB, shall be evident. When the PCB is included in a control box, the unit shall perform satisfactorily.

**8.3.2** When tested in accordance with **D.3.2**, the control box shall meet the requirements of this standard.

**8.3.3** When tested in accordance with **D.3.3**, 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 M $\Omega$ .

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

If required by the gas transporter, the control box shall have the facility for the logging and retrieval of the following data in an agreed format:

For every box:

- a) control box identification number;
- b) a minimum of 500 entries.

An alarm facility and display information shall be provided to indicate when the log memory is 95 % full to prompt the operator to down-load the data to a printer or approved recording device.

If the alarm is ignored, the data entries shall be overwritten commencing with the oldest entry.

For every joint the following shall be included:

- a) joint serial number;
- b) date and time joint made;
- c) fusion time: target and delivered times;
- d) status of joint;
- e) ambient temperature;
- f) any operator input data;
- g) any fault condition.

**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 T/SP/EL11.

**B.1.2** For a 2 kW unit, a changeover switch shall be provided to select either electrofusion (40 V) or 110 V, 16 A output.

For a 3 kW unit, a changeover switch shall be provided to select electrofusion (40 V) or 110 V, 16 A or 110 V, 32 A output.

For a 6 kW unit, a changeover switch shall be provided to select either electrofusion or 110 V, both 16 A and 32 A, output. If appropriate, a further changeover switch shall be provided to select either 40 V or 80 V electrofusion output. The lighting output (fused at 5 A) shall be continuously available.

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 is supplied, the remote unit shall be attached to the control box by means of a polyvinyl chloride (PVC) metal-screened 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 shall have a maximum voltage drop of 4.0 V ac rms (lead and return) when measured at a maximum current of 62 A.

**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.****B.2.1.3 Procedure**

Carry out approval testing of the 110 V system in accordance with T/SP/EL11:2005, **6.2**. Condition the combined unit at ambient temperature in accordance with Table B.1 for 1 h before testing. Adjust the engine governor to give the engine speed specified in Table B.1 when the generator is on load. Measure the output voltage in increments of approximately 20 % of full load up to the maximum rating. The output voltage shall be in accordance with 6.1. Measure

the timer accuracy during each test. During the evaluation of the electrofusion system, a 110 V, 5 A load shall be connected to the lighting circuit (see **B.1.2**).

NOTE For low temperature tests the power and control sections should be separated from each other. The power section should be conditioned for 1 h at  $-15^{\circ}\text{C}$  and then removed to an ambient temperature of  $20 \pm 5^{\circ}\text{C}$  for the tests. The control section should be conditioned for 1 h at  $-10^{\circ}\text{C}$  and remain in a  $-10^{\circ}\text{C}$  environment through the tests.

**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 **4.2**.

**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 $^{\circ}\text{C}$	Engine speed rev/min	Minimum resistive load			Min. test time min
		kW			
		1.5	2	4	
$20 \pm 5$	3 300	1 to 40	0.8 to 40	1.6 to 8	30
	2 700	40 to 1	40 to 0.8	8 to 1.6	
$-10$	3 300	40 to 1	40 to 0.8	8 to 1.6	
	2 700				

**B.2.2** *Acceptance tests*

**B.2.2.1** *Principle*

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

**B.2.2.2** *Apparatus*

**B.2.2.2.1** *Combined electrofusion control and power generation system.*

**B.2.2.3** *Procedure*

Carry out acceptance testing of the 110 V system in accordance with TS/P/EL11:2005, **6.3**. Condition the unit at ambient temperature in accordance with Table B.2 for 1 h before testing. Adjust the engine governor to give the engine speed specified in Table B.2 when the generator is on load. Measure the output voltage in increments of approximately 20 % of full load up to the maximum rating. The output voltage shall be in accordance with **6.1**. During the evaluation of the electrofusion system, a 110 V, 5 A load shall be connected to the lighting circuit (see **B.1.2**).

**B.2.2.4 Test report**

The test report shall include the following information:

- a) reference to this standard, i.e. GIS/ECE1:2006;
- b) results of the acceptance tests;
- c) any additional factors which may have affected the results of the test.

**Table B.2 — Test conditions for acceptance testing**

Ambient temperature °C	Engine speed rev/min	Minimum resistive load kW			Minimum test time min
		1.5	2	4	
20 ± 5	3 300	1 to 40	0.8 to 40	1.6 to 8	10
	2 700	40 to 1	40 to 0.8	8 to 1.6	

### 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	40 V (Transformer)	62 A	(2.5 kW)
6.5 KVA	40 V (Transformerless)	62 A	(2.5 kW)
6.5 KVA	80 V (Transformerless)	62 A	(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.

#### **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**

**D.3.1** Subject all PCBs to a random frequency search from 20 Hz to 2 kHz at 1 g. Test the PCBs in the plane of normal transportation when fitted into the complete control box. Identify the resonant frequencies. Subject the PCBs to a random endurance sine wave resonant search from 20 Hz to 2 kHz at 1 g, for 60 min, in the plane of normal transportation.

**D.3.2** With the assembled control box and input cable in the plane of normal transportation, subject them to a random frequency range of 20 Hz to 2 kHz with an auto spectral density (ASD) of  $0.002 \text{ g}^2/\text{Hz}$  for 90 min. Identify the frequency giving the largest resonance.

**D.3.3** Further subject the assembled control box and input cable to a single frequency vibration test in the frequency range 20 Hz to 2 kHz with an auto spectral density (ASD) of  $0.002 \text{ g}^2/\text{Hz}$  for 90 min.

#### **D.3.4 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**

#### **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 500 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.

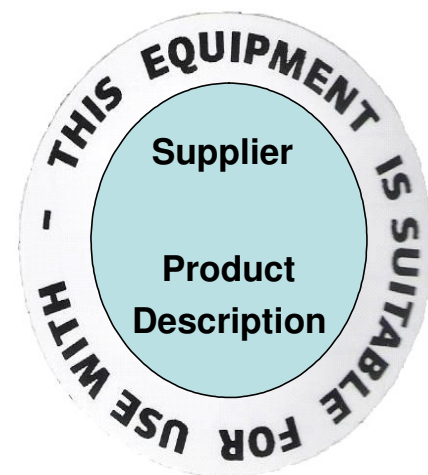


Fig 1: Compliant Sticker

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