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Plastics pipes and fittings — Automatic recognition systems for electrofusion joints

Tubes et raccords en matières plastiques — Procédés de reconnaissance automatique d'un assemblage par électrosoudage

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13950 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 4, *Plastics pipes and fittings for the supply of gaseous fuels*.

This first edition of ISO 13950 cancels and replaces ISO/TR 13950:1997, of which it constitutes a technical revision.

Plastics pipes and fittings — Automatic recognition systems for electrofusion joints

1 Scope

This International Standard specifies the characteristics of automatic recognition systems (numerical recognition by means of bar codes or magnetic cards, electromechanical recognition using implanted-resistor connectors and self-regulation systems) that enable the energy supply to be delivered automatically to the thermoplastic electrofusion fittings used in pipe jointing.

It is applicable to electrofusion fittings intended to be used for plastics piping systems for the conveyance of gaseous fuels, water for human consumption (including raw water prior to treatment) and for general purposes, or of other fluids.

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.

ISO/IEC 7810:2003, *Identification cards — Physical characteristics*

ISO/IEC 7811-2:2001, *Identification cards — Recording technique — Part 2: Magnetic stripe — Low coercivity*

ISO/IEC 7811-6:2001, *Identification cards — Recording technique — Part 6: Magnetic stripe — High coercivity*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
fitting
accessory for the connection by fusion of thermoplastic pipes and/or other accessories

3.2
socket
female part of a fitting in which the fusion is performed

3.3
coupler
fitting constituted by two sockets

3.4
monofilar coupler
fitting constituted of two sockets for which fusion is performed in a single operation

3.5
bifilar coupler
fitting constituted of two sockets for which fusion is performed separately

3.6
saddle
electrofusion fitting for by-passing, branching, ballooning or other operations

3.7
reduction
electrofusion fitting for the assembly of two pipes and/or male terminating fittings of different dimensions

3.8
elbow
electrofusion fitting with two sockets with an angle

3.9
tee
electrofusion fitting with three electrofusion sockets or two sockets and one male end

3.10
plug
electrofusion fitting with one socket for plugging tubes and other accessories

3.11
connector
end of the cable connecting the electrofusion accessory to the fusion machine

3.12
terminal
fixed part of the heating element located on the outside of the fitting to enable electrical connection to be made with the fitting

3.13
terminal shroud
part of the fitting enabling the connector to be mounted externally

3.14
nominal fusion time
fusion time, in seconds, specified by the fitting manufacturer at the reference temperature and for the electrical parameters, such as nominal resistance, voltage and current, specified by the manufacturer

3.15
real fusion time
fusion time, in seconds, used in reality, taking account, if necessary, of the ambient temperature and/or the real electrical parameters

3.16
fusion voltage
voltage, in RMS AC volts, applied to the fitting during the fusion cycle

3.17
fusion current
current, in amperes, flowing in the fitting and its supply circuit during the fusion cycle

3.18
nominal fusion energy
energy, in kilojoules, specified by the fitting manufacturer at the reference temperature and for the electrical parameters whose values fall within the tolerance ranges specified by the manufacturer

3.19
real fusion energy
energy, in kilojoules, consumed by the fitting at a given ambient temperature and for electrical parameters whose values fall within the tolerance ranges specified by the manufacturer

3.20 Resistance of the heating element

3.20.1
nominal resistance
ohmic resistance of the heating element at 23 °C used in the basic design calculations for the electrofusion fitting, as specified by the manufacturer

3.20.2
identification resistance
ohmic resistance of the heating element at 20 °C measured on any electrofusion fitting

3.20.3
measured resistance
ohmic resistance at the ambient temperature measured on any electrofusion fitting

3.21
resistivity
reciprocal of the conductivity of the heating element, in ohm metres

3.22
temperature coefficient of the heating element
gradient of the change in resistance versus temperature, in reciprocal degrees kelvin

3.23
digit
whole number from zero to nine

3.24
character
whole number from zero to nine or a letter or a sign

4 Description of procedures

4.1 Numerical recognition

4.1.1 Principle

Methods for numerical recognition are based on systems such as bar codes and magnetic cards. Fusion parameters are recorded in code form on the data medium. At the manufacturer's initiative or in response to user request, other information for fitting identification, identification of test data, fusion cycle optimization, additional safety measures, etc. can also be encoded

For a heating cycle, the system reads, processes and memorizes the information recorded on the data medium.

Successive messages are displayed, or signal tones emitted, to request the operator to follow a procedure, defined by the fitting manufacturer, specific to the fitting in question and including its recognition.

4.1.2 Field of application and limits

Numerically controlled fusion machines capable of reading fusion parameters can be used for all electrofusion and electro-heating assembly techniques.

The limits of this type of fusion control unit shall be detailed by the manufacturer in terms of

— the maximum energy to be delivered,

— the fusion programmes incorporated,

— the fusion adaptations incorporated, and

— the limits of the programmable parameters.

4.1.3 Bar codes

4.1.3.1 General

The system for entering data using bar codes offers a number of different user possibilities, both for the fitting supplier and the manufacturer of the fusion machine:

— the fitting manufacturer records on the bar code the data he considers will be needed to ensure correct assembly, the amount of data depending on factors such as particular requirements or new technical developments;

— the control unit manufacturer is free to develop his own software and the technical design of the unit, and can choose which data to display, which commands will be available, the criteria for fusion cycle emergency stop, and the display and recording of the various faults, the memorization method for fusion data, etc.

4.1.3.2 Format of bar codes

The format of bar codes shall one or the other of the following.

a) The 24 digit “2-in-5” interleaved type. The ratio between the width of the thicker bar and the thinner bar shall be 2,5. The bar code content is summarized in Annex A.

b) The 32 digit “2-in-5” interleaved type, including traceability coding as summarized in Annex B. The ratio between the width of the thicker bar and the thinner bar shall be 2,5.

4.1.3.3 Bar code structure

The bar code structure shall have a predetermined overall length of either 24 digits or 32 digits. One of these digits is composed by a control character (checksum). A complementary character set can be added if further data is required. The content of each digit shall be in accordance with Annex A or Annex B, as applicable.

4.1.4 Magnetic cards

4.1.4.1 General

The system of data insertion by means of magnetic cards offers different possibilities for the fitting supplier, as well as for the user and control unit manufacturer.

— The fitting manufacturer records on the card the number of items of data necessary for the completion of an optimal fusion joint. In order to establish the fusion programme, he can choose between the functions described in Annex C, and adapt the data according to his wishes using nominal or real values. A fusion programme can contain up to 90 characters.

— The control unit manufacturer is completely free to develop his own software as well as the technological concept of the unit. He can choose, among others, the data appearing on the display, the different commands, the emergency stop of the fusion cycle, as well as the display and recording of the different faults, the fusion data storage mode, etc., unless these are already prescribed in other standards.

— With respect to the quality assurance of every fusion, a record containing all or part of the fusion process data can be stored either on the magnetic card or in the control box memory. When the fusion has been completed successfully and recorded on the magnetic card, the same magnetic card shall not be used again to carry out another fusion.

4.1.4.2 Description of technique

Use of a magnetic card for the transmission of data to a fusion control unit requires the following information:

- the card format;
- the magnetic tracks to be used;
- the recording technique;
- the data storage mode;
- the variables and the units in which they are expressed.

4.1.4.3 Physical characteristics of magnetic card

The magnetic card (ID-1) specified in this International Standard is in accordance with ISO/IEC 7810, ISO/IEC 7811-2 and ISO/IEC 7811-6. The magnetic card shall not contain embossed characters. The three tracks according to ISO/IEC 7811-2 and ISO/IEC 7811-6 may be used to store data (fusion programme: tracks 1 and 2 only, and a fusion record: tracks 1, 2 and 3) on the card.

4.1.4.4 Description of encoding

ISO/IEC 7811-2 specifies the characteristics of the magnetic stripe. The structure of the information on tracks 1, 2 and 3 is given in Annex C.

4.1.4.5 Data storage

For the data storage, the basic rules given in Annex C shall be followed.

4.2 Electromechanical recognition

4.2.1 Principle

The primary function of the electromechanical recognition method consists of converting the measured value of an identifying resistance into a fusion time.

Other functions may be carried out, such as fitting identification by the implanted resistance method.

4.2.2 Field of application and limits

Electromechanical recognition may be used when fittings are provided with the correct terminal housing and terminal pin configurations.

4.2.3 “Implanted resistor” connector

4.2.3.1 General

A resistor is implanted in one of the terminal pins of an electrofusion fitting. The value of this resistor is read by the control unit and the fusion time is determined automatically by the control box from stored data.

4.2.3.2 Description of system (see Annex D)

A resistor is placed in the fitting terminal as shown in Figure D.1. This terminal is moulded into the fitting together with a second plain terminal in the other fitting connector (see Figure D.2).

The preferred values of the dimensions versus the voltage of the system are given in Table D.1, by way of example.

The preferred values of the implanted resistor together with the equivalent fusion times are given in Table D.2, by way of example.

The connector (see Figure D.3) from the control box to the fitting is used to recognize the resistor value and to supply power to fittings. The fusion control unit determines the fusion time from the recognized resistance value using stored data.

4.3 Self-regulation

4.3.1 Principle

This fusion control process operates using the physico-chemical state of the material at the fitting/pipe interface. It automatically incorporates variations in fit, assembly temperature, supply voltages and the electrical resistance of the fitting.

During the fusion of a fitting to a pipe, the energy supplied causes an increase in temperature in the area around the heating element: the thermoplastic material therefore passes from the solid to the liquid state. This change in state is accompanied by a volume expansion which increases the pressure in the fusion zone. The quality of the fusion is essentially governed by the triple set (P = pressure, T = temperature, t^* = time during which the temperature of the material is less than the fusion temperature). The principle of self-regulation is to use the data terms P and T to govern the fusion time and thus to calculate the optimum t^*.

This requires no adjustment or fusion time correction. The pressure built up in the melted material interrupts the supply circuit.

4.3.2 Field of application and limits

The automatic regulation system enables fittings equipped with the appropriate terminal shroud to be processed.

The limits of this recognition system are either

- specific to the system (fixed value for the fusion parameter “fusion voltage”), or
- specific to the machine (maximum available energy).

4.3.3 System description (see Annex E)

Each fitting has two calibrated wells positioned above the fusion zone. When the voltage is applied, the heating wire melts the material in the well, firstly at the level of the wire itself, then over a greater area. Figure E.1 shows the melted zone at a given moment: this zone continues to spread in time (in Figure E.1, from zone limit a to zone limit b at the end of fusion). The wells are designed with the optimum dimensions and geometry for each fitting, ensuring that the melted material in the well bottom rises only when the correct physico-chemical state has been attained at the interface. A sensor located in the connector and an integral part of the supply cable is fitted over each well. It detects the rising level of molten material and transmits a signal to the fusion control unit which cuts the electricity supply. A diagrammatic representation of the whole detection process is given in Figure E.2 for a flat-bottomed well.

4.3.4 Dimensional characteristics

The terminal shroud shown in Figure E.3 is universal and can be used with all self-regulating fittings.

Annex A
(normative)

Structure of bar code

A.1 Digits 1 to 8 — Name/Trademark — Accessory type — Energy correction — Cycle type — Cooling time

A.1.1 Basic alphabetic codes

The coding of characters shall be in accordance with Table A.1

Table A.1 — Basic alphabetic code

Code					
A = 01	F = 06	K = 11	P = 16	U = 21	Z = 26
B = 02	G = 07	L = 12	Q = 17	V = 22	+ = 27
C = 03	H = 08	M = 13	R = 18	W = 23	“blank” = 28
D = 04	I = 09	N = 14	S = 19	X = 24	“black” = 29
E = 05	J = 10	O = 15	T = 20	Y = 25	
If the name/trademark of the accessory manufacturer has to be shortened, use code + (27), space (28) or black (29). 00 is an invalid code and may cause error messages for some decoding systems.					

A.1.2 Symbols/abbreviations for accessory types

The symbols, corresponding to the accessory types, used for fusion equipment are given in Table A.2.

Abbreviations according to Table A.2 may be chosen instead of the symbols. However, a software change should not be requested.

Table A.2 — Symbols for accessory types

Type	Symbol	Abbreviation
Tapping tee or saddle	.†.	SAD
Coupler	I	CPL
Single socket	[	SKT
Cycle with a flip-flop type dividing box	*	FFP
Electro-thermo-retractable sleeve	<	ERS
(TDW) tapping tee	J	TDW
Reduction	Y	RED
Tee	T	TEE
Elbow	C	BOW

A.1.3 Principle

Digits 1 to 8 are used to describe

- the name/trademark (logo) of the accessory manufacturer by contraction to two or four letters, as applicable,
- the type of the accessory,
- the energy correction applicable to the nominal fusion time,
- the type of the fusion cycle,
- the indication of the cooling time of the fusion cycle, and
- the cooling time, if applicable.

If the cooling time is not expressed (Case A), the name/trademark of the accessory manufacturer is expressed by four alphabetic characters, coded under digits 1 to 8 in accordance with Table A.1.

If the expression of the name/trademark requires fewer than four alphabetic characters, then the signs "+", blank or black should be used to complete it.

If the cooling time is expressed (Case B), the name/trademark of the accessory manufacturer is expressed by two alphabetic characters, coded under digits 3 to 6, in accordance with Table A.1.

Each odd digit, i.e. 1st, 3rd, 5th and 7th, controls additional information.

A.1.4 Digit 1

For Case A, accessory type information is added to digit 1. The offset value shall be in accordance with Table A.3.

Table A.3 — Offset for accessory type information

Accessory type	Offset
Tapping tee or saddle	+0
Monofilar coupler	+3
Single socket	+6

For Case B, the value of digit 1 is 9.

A.1.5 Digit 2

For Case B, accessory type information is given in digit 2, according to Table A.4.

Table A.4 — Codes for Case B accessory type

Accessory type	Code for digit 1	Code for digit 2
Cycle with a flip-flop type dividing box	9	0
Electro-thermo-retractable sleeve	9	1
(TDW) tapping tee	9	2
Reduction	9	3
Tapping tee	9	4
Coupler	9	5
Single socket	9	6
Tee	9	7
Elbow	9	8
Not to be used [a]	9	9

[a] Current display ERROR.

A.1.6 Digit 3

Digit 3 controls the energy correction.

The offset value for the energy correction shall be in accordance with Table A.5.

Table A.5 — Offset for energy correction

Control type	Offset
Mode U or mode I controlled with time or energy correction (depending on digit 7) related to the value given in digits 19 to 21.	+0
Mode U or mode I controlled with U or I power correction related to the value given in digits 13 and 14.	+3
Mode U or mode I controlled with time or energy correction (depending on digit 7) related to the value given in digits 19 to 21, with: — digit 18 controlling the independent expression of the temperature coefficient and of the manufacturing tolerance in per cent grouped in K or K′; — 10 available levels of manufacturing precision; — 10 available temperature coefficients.	+6
When non-active, display ERROR.	

A.1.7 Digit 5

The offset value for the fusion cycle (heating cycle) type shall be in accordance with Table A.6.

Table A.6 — Offset value for fusion cycle type

Fusion cycle	Offset
Uniform cycle	+0
Sequential cycle (available, waiting for a definition)	+3
Temperature cycle	+6
For +3 and +6, when non-active, display ERROR.	

A.1.8 Digit 7

Digit 7 controls either the heating time, when digits 19, 20 and 21 are expressing the time values, or the energy regulation, when digits 19, 20 and 21 are expressing the energetic values. Digit 7 shall be in accordance with Table A.7.

Table A.7 — Code for indication of cooling time

Case	Function	Code
A	Without cooling time indication	0, 1 or 2 [a]
B	With indication of cooling time)	3
	Regulation with energy where energy is expressed as (digit 19, digit 20) × $10^{\text{digit 21}}$ (joules) EXAMPLE 123 = 12 × 10^3 J or 12 000 J	4
	Case B (with indication of cooling time) or message referring to external table Energy control N · 10^x joules; Expression of the exponent in accordance with 10^x 5 = 10^1, 6 = 10^2, 7 = 10^3, 8 = 10^4, 9 = 10^5 (Digits 19, 20 and 21 are expressing the energy N value. Digit 8 refers to cooling time) Where non-active, display ERROR.	5, 6, 7, 8, 9

[a] According to the basic alphabetic code. See Table A.1.

A.1.9 Digit 8

For Case B, the code related to the cooling time shall be in accordance with Table A.8.

Table A.8 — Cooling time codes

Cooling time min	Code
5	0
10	1
15	2
20	3
30	4
45	5
60	6
75	7
90	8
	9 [a]

[a] Message with indication from the manufacturer.

A.2 Digits 9, 10, 11 — Accessory diameter(s)

A.2.1 Principle

Digits 9 to 11 express the diameter(s) of the accessory corresponding to the external diameter of the pipe on which it is fitted.

A.2.2 Electro-heating accessories

Code 000 is used for accessories not described by their diameter.

Codes 001 to 014 are reserved for fusion equipment manufacturers.

A.2.3 Accessories whose diameter is expressed in millimetres

Codes 015 to 799 are used to express the diameter as follows:

— digit 9 corresponds to the figure indicating the hundreds of millimetres;

— digit 10 corresponds to the figure indicating the tens of millimetres;

— digit 11 corresponds to the figure indicating the units of millimetres.

EXAMPLE 1 d_n = 20 mm, code: 020.

EXAMPLE 2 d_n = 63 mm, code: 063.

EXAMPLE 3 d_n = 110 mm, code: 110.

A.2.4 Accessories whose diameter is expressed in inches with IPS or CTS precision

Codes 800 to 999 are used to express the diameter as follows:

— digit 9 corresponds to the figure indicating the tens of inches;

— digit 10 corresponds to the figure indicating the inch units;

— digit 11 corresponds to the figure indicating the fraction of an inch according to Table A.9.

Table A.9 — Codes for inch fractions

System			
Iron pipe size (IPS)		Copper tube size (CTS)	
Fraction	Code	Fraction	Code
Whole inch	0	Whole inch	5
1/4 inch	1	1/4 inch	6
3/8 inch	2	3/8 inch	7
1/2 inch	3	1/2 inch	8
3/4 inch	4	3/4 inch	9

A.2.5 Reduction or monofilar tapping tee (two diameters)

In the case of a reduction or a monofilar tapping tee (corresponding to code 9 for digit 1 and code 3 or 4 for digit 2), the following coefficients are used for the calculation of the code value D:

— Coefficient C_1 for the first diameter, D_1;

— Coefficient C_2 for the second diameter, D_2;

where C_1 and C_2 are as given in Table A.10.

Select D_1 as being the greater diameter from the two diameters. Then, D is given by Equation (A.1):

$$D = (C_1 \times 31) + C_2 \tag{A.1}$$

EXAMPLE Reduction with D_1 = 110 mm and D_2 = 63 mm ; $D = (8 \times 31) + 5 = 253$.