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General safety code for industrial combustion furnaces — Part 3: Protective systems

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Foreword

This Japanese Industrial Standard has been established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal for establishment of Japanese Industrial Standard submitted by Japan Industrial Furnace Manufacturers Association (JIFMA)/Japanese Standards Association (JSA) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act. This Standard partially replaces **JIS B 8415**:2008, which has been withdrawn.

Attention is drawn to the possibility that some parts of this Standard may conflict with patent rights, published patent application or utility model rights. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying any of such patent rights, published patent application or utility model rights.

JIS B 8415 series consists of the following 3 parts under the general title *General safety code for industrial combustion furnaces* —:

Part 1: General requirements

Part 2: Combustion and fuel handling systems

Part 3: Protective systems

General safety code for industrial combustion furnaces — Part 3 : Protective systems

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 13577-4** : 2014, Edition 1, with some modifications of the technical contents to corresponding to the actual situations in Japan.

The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JD. Annex JA, Annex JB and Annex JC are unique to **JIS** and not given in the corresponding International Standard.

This Standard was developed to specify the requirements of a protective system, which is a safety-related electrical control system (SRECS) of industrial combustion furnaces and associated devices (hereafter referred to as the combustion furnaces).

Mandatory safety-related control functions of combustion furnaces are specified in other parts of **JIS B 8415**.

It is intended that in designing the protective system of combustion furnaces, manufacturers of combustion furnaces choose from the four methods provided in this Standard.

This Standard is a type-C standard as defined in **JIS B 9700**.

This Standard is to be used together with the other parts of **JIS B 8415**. Since **JIS B 8415** series is a type-C standard of **JIS B 9700**, the combustion furnaces are required to be designed in accordance with the principles of **JIS B 9700**. However, there are cases in which a risk assessment according to **JIS C 0511** is more suitable for the design of a combustion furnace protective system. The machinery concerned and the extent to which hazards, hazardous situations or hazardous events are covered are indicated in the scope of this Standard.

When requirements of this type-C standard are different from those which are stated in type-A or -B standards, the requirements of this type-C standard take precedence over the requirements of the other standards for machines that have been designed and built according to the requirements of this type-C standard.

JIS C 0511 provides the option of a low-demand rate (system for permanent operation) on the protective system. **JIS B 9961** and **JIS B 9705-1** always assume high-demand rate (system for non-permanent operation) applications. Therefore, this Standard permits extended risk assessment for SRECS in which risk assessment based on **JIS C 0511** may be chosen as an alternative.

1 Scope

This Standard specifies the requirements for protective systems used in industrial combustion furnaces and associated devices.

The safety functional requirements to which the protective systems apply are specified in Part 1 and Part 2 of **JIS B 8415**.

NOTE The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 13577-4 : 2014 *Industrial furnace and associated processing equipment — Safety — Part 4 : Protective systems* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 3503 *Programmable controllers — Programming languages*

NOTE Corresponding International Standard : IEC 61131-3 *Programmable controllers — Part 3 : Programming languages*

JIS B 9705-1 *Safety of machinery — Safety-related parts of control systems — Part 1 : General principles for design*

NOTE Corresponding International Standard : ISO 13849-1 *Safety of machinery — Safety-related parts of control systems — Part 1 : General principles for design*

JIS B 9960-1 *Safety of machinery — Electrical equipment of machines — Part 1 : General requirements*

NOTE Corresponding International Standard : IEC 60204-1 *Safety of machinery — Electrical equipment of machines — Part 1 : General requirements*

JIS B 9961 *Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems*

NOTE Corresponding International Standard : IEC 62061 *Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems*

JIS C 0508 (all parts) *Functional safety of electrical/electronic/programmable electronic safety-related systems*

NOTE Corresponding International Standard : IEC 61508 (all parts) *Functional safety of electrical/electronic/programmable electronic safety-related systems*

JIS C 0511 (all parts) *Functional safety — Safety instrumented systems for the*

process industry sector

NOTE Corresponding International Standard : IEC 61511 (all parts) *Functional safety—Safety instrumented systems for the process industry sector*

JIS C 8201-4-1 *Low-voltage switchgear and controlgear — Part 4-1 : Contactors and motor-starters : Electromechanical contactors and motor-starters*

NOTE Corresponding International Standard : IEC 60947-4-1 *Low-voltage switchgear and controlgear — Part 4-1 : Contactors and motor-starters — Electromechanical contactors and motor-starters*

JIS C 8201-5-1 *Low-voltage switchgear and controlgear — Part 5-1 : Control circuit devices and switching elements — Electromechanical control circuit devices*

NOTE Corresponding International Standard : IEC 60947-5-1 *Low-voltage switchgear and controlgear — Part 5-1 : Control circuit devices and switching elements — Electromechanical control circuit devices*

JIS C 9730-2-5 *Automatic electrical controls for household and similar use — Part 2-5 : Particular requirements for automatic electrical burner control systems*

NOTE Corresponding International Standard : IEC 60730-2-5 *Automatic electrical controls — Part 2-5 : Particular requirements for automatic electrical burner control systems*

ISO 13574 *Industrial furnaces and associated processing equipment — Vocabulary*

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in **ISO 13574**, and the following apply.

3.1

automatic shut-off valve

valve that opens when energised and closes automatically when de-energized to shut off the fuel supply

NOTE See **2.194** of **ISO 13574**.

3.2

final element

part of a protective system which implements the physical action necessary to achieve a safe state

NOTE 1 Valves, switchgears, motors including their auxiliary elements, for example, a solenoid valve and actuator if involved in the safety function.

NOTE 2 The definition in **3.2.22** of **JIS C 0511-1** is partially modified, and “safety instrumented system” is changed to “protective system”.

3.3

flame detector device

device by which the presence of a flame is detected and signalled

NOTE 1 It can consist of a flame sensor, a flame detector amplifier and a relay for signal transmission.

NOTE 2 The definition in **2.65** of **ISO 13574** is modified, and NOTE is added.

3.4

functional safety

capability of a protective system or other means to reduce risk, to execute the actions required for achieving or maintaining a safe state for the process and its related equipment

NOTE See **2.73** of **ISO 13574**.

3.5

logic function

function that performs the transformations between input information (provided by one or more input functions or sensors) and output information (used by one or more output functions or final elements)

NOTE 1 Logic functions are executed by the logic solver (**3.6**) of a protective system.

NOTE 2 The definition in **3.2.35** of **JIS C 0511-1** is modified, and "input functions" is changed to "input functions or sensors" and "output functions" is changed to "output functions or final elements".

3.6

logic solver

portion of a protective system that performs one or more logic function(s)

NOTE 1 For example, electrical systems, electronic systems, programmable electronic systems, pneumatic systems and hydraulic systems are available. Sensors and final elements are not part of the logic solver.

NOTE 2 NOTE 1 in **3.2.36** of **JIS C 0511-1** is deleted, and "either a BPCS or SIS" in the definition is changed to "a protective system".

3.7

manual reset

action after a lockout of a safety device (e.g. automatic burner control) carried out manually by the supervising operator

NOTE See **2.107** of **ISO 13574**.

3.8

performance level PL

discrete level used to specify the ability of safety-related parts of control systems to perform a safety function under foreseeable conditions

NOTE See **3.1.23** of **JIS B 9705-1**.

3.9

product standard

standard for products and components which are listed in all parts of **JIS B 8415** except this Standard

NOTE See **2.135** of **ISO 13574**.

3.10

programmable logic control (PLC)

digitally operating electronic system which uses a programmable memory for the internal storage of user-oriented instructions for the implementation of specific control function as the control of various machines and processes through digital or analogue inputs/outputs

NOTE See **2.125** of **ISO 13574**.

3.11

protective system

instrumented system used to implement one or more safety-related instrumented functions, which is composed of any combination of sensor(s), logic solver(s), and final elements (see Figure 2)

NOTE 1 The protective system can include either safety-related instrumented control functions and/or safety related-instrumented protection functions.

NOTE 2 See **2.138** of **ISO 13574**.

3.12

safety bus

bus system and/or protocol for digital network communication between safety devices, which is designed to achieve and/or maintain a safe state of the protective system in accordance with **JIS C 0508** (all parts) or **JIS C 9730-2-5**

NOTE See **2.164** of **ISO 13574**.

3.13

safety device

device that is used to perform protective functions, either on its own or as a part of a protective system

NOTE For example, sensors, limiters, flame supervision devices, burner control systems, logic systems, final elements and automatic shut-off valves are available.

3.14

safety integrity level (SIL)

discrete level (one out of four) corresponding to a range of safety integrity values

NOTE 1 Safety integrity level 4 has the highest level of safety integrity and safety integrity level 1 has the lowest.

NOTE 2 The target failure measures for the four safety integrity levels are specified in Table 2 and Table 3 of **JIS C 0508-1**.

NOTE 3 Safety integrity levels are used for specifying the safety integrity requirements of the safety functions to be allocated to the E/E/PE safety-related systems.

NOTE 4 A safety integrity level (SIL) is not a property of a system, subsystem, element or device. The correct interpretation of the phrase "SIL*n* safety-related system" (where *n* is 1, 2, 3 or 4) is that the system is potentially capable of supporting safety functions with a safety integrity level up to *n*.

NOTE 5 See **3.5.8** of **JIS C 0508-4**.

3.15

sensor

device that produces a signal based on a process variable

NOTE For example, Transmitters, transducers, process switches and position switches are available.

3.16

system for permanent operation

system intended to remain in the operating state for longer than 24 h without interruption

NOTE In this Standard, the meaning of "permanent operation" is "continuous operation" commonly used in the field of industrial combustion furnaces, which is different from that specified in **2.5.101** of **JIS C 9730-2-5**.

3.17

system for non-permanent operation

system intended to remain in the operating state for less than 24 h

NOTE In this Standard, the meaning of "non-permanent operation" is "non-continuous operation" commonly used in the field of industrial combustion furnaces, which is different from that specified in **2.5.102** of **JIS C 9730-2-5**.

3.18

systematic capability

measure of the confidence that the systematic safety integrity of an element meets the requirements of the specified SIL, in respect of the specified element safety function,

when the element is applied in accordance with the instructions specified in the compliant item safety manual for the element

NOTE 1 Expressed on a scale of SC1 to SC4.

NOTE 2 Systematic capability is determined with reference to the requirements for the avoidance and control of systematic faults (see **JIS C 0508-2** and **JIS C 0508-3**).

NOTE 3 What qualifies as a relevant systematic failure mechanism depends on the nature of the element. For example, for an element comprising solely software, only software failure mechanisms will need to be considered. For an element comprising hardware and software, it is necessary to consider both systematic hardware and software failure mechanisms.

NOTE 4 A systematic capability of SC*n* for an element, in respect of the specified element safety function, means that the systematic safety integrity of SIL*n* has been met when the element is applied in accordance with the instructions specified in the compliant item safety manual for the element.

NOTE 5 See **2.183** of **ISO 13574**.

4 Design requirements for equipment in a protective system

4.1 General

Electrical equipment shall comply with **JIS B 9960-1** and withstand the hazards identified in the risk assessment required at the design stage. Electrical equipment shall be protected against damage. In particular, it shall be robust to withstand damage during continuous operation.

Devices shall be used in accordance with the manufacturer's instructions including safety manuals. Any device used outside of its published technical specification shall be verified and validated to be suitable for the intended application.

Devices of a protective system shall withstand the environmental conditions and fulfil their intended function.

Sensors (e.g. pressure transmitters, temperature transmitters, flow transmitters) used in the protective system shall be independent from the process control system.

Figure 1 is provided as an aid to understanding the relationship between the various elements of combustion furnaces and their ancillary equipment, the heating system, the process control system, and the protective system.