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**Small solid oxide fuel cell power
systems—Part 2: General safety
codes and safety testing methods**

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Foreword

This translation has been made based on the original Japanese Industrial Standard 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 the Japan Electrical Manufacturers' Association (JEMA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

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JIS C 8841 series consists of the following 3 parts under the general title "*Small solid oxide fuel cell power systems*".

Part 1: General rules

Part 2: General safety codes and safety testing methods

Part 3: Performance testing methods and environment testing methods

Small solid oxide fuel cell power systems— Part 2: General safety codes and safety testing methods

1 Scope

This Japanese Industrial Standard specifies the necessary matters for the safety standards, safety test methods and performance maintenance management of the stationary small solid oxide fuel cell power systems (hereafter referred to as “fuel cell systems”), such as matters related to the structure, material, function, installation criteria, marking, indicator, and operation manual. The fuel cell systems covered by this Standard shall be in accordance with the following **a)** to **h)**.

- a) **Type of fuel cell** Solid oxide fuel cell
- b) **Output** Rated power transmission output of less than 10 kW
- c) **Output mode** DC output, AC output or both outputs of DC output and AC output
- d) **Output voltage** 220 V or less in the case of AC output
- e) **Operation mode** Grid-connected operation, grid-independent operation or independent operation
- f) **Raw fuel** Gaseous fuel (city gas, liquefied petroleum gas, etc.), liquid fuel (kerosene, etc.) or hydrogen
- g) **Operating pressure** Maximum working pressure of the section where fuel gas flows shall be less than 0.1 MPa. That of the section where liquid gas flows shall be less than 1.0 MPa.
- h) **System configuration** Stationary power generation dedicated system or cogeneration system stored in a package

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 8409 *Pressure type solenoid pumps for oil burners*

JIS C 1302 *Insulation resistance testers*

JIS C 8800 *Glossary of terms for fuel cell power system*

JIS C 8841-1 *Small solid oxide fuel cell power systems—Part 1: General rules*

JIS C 8962 *Testing procedure of power conditioner for small photovoltaic power generating systems*

JIS C 8980 *Power conditioner for small photovoltaic power generating system*

JIS C 9219 *Electric storage tank water heaters*

- JIS C 60068-2-30 *Environmental testing—Part 2-30: Tests—Test Db: Damp heat, cyclic (12 h + 12 h cycle)*
- JIS C 60068-2-38 *Basic environmental testing procedures Part 2: Tests Test Z/AD: Composite temperature/humidity cyclic test*
- JIS K 0151 *Non-dispersive infrared gas analyzer*
- JIS K 2301 *Fuel gases and natural gas—Methods for chemical analysis and testing*
- JIS S 2092 *General constructions of gas burning appliances for domestic use*
- JIS S 2093 *Test methods of gas burning appliances for domestic use*
- JIS S 2109 *Gas burning water heaters for domestic use*
- JIS S 3021 *Oil burning water boilers*
- JIS S 3024 *Oil burning water heaters for domestic use*
- JIS S 3027 *Oil burning bath boilers with water heaters for domestic use*
- JIS S 3030 *General rules for construction of oil burning appliances*
- JIS S 3200-1 *Equipment for water supply service—Test methods of hydrostatic pressure*
- JIS S 3200-2 *Equipment for water supply service—Test method of low temperature resistant*
- JIS S 3200-3 *Equipment for water supply service—Test method of water hammer*
- JIS S 3200-4 *Equipment for water supply service—Test method of prevention from back current*
- JIS S 3200-5 *Equipment for water supply service—Test methods of destruction by vacuum pressure*
- JIS S 3200-6 *Equipment for water supply service—Test methods of durability*
- JIS S 3200-7 *Equipment for water supply service—Test methods of effect to water quality*

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in **JIS C 8800**, **JIS C 8841-1** and the following apply.

3.1 burner

device to generate combustion by mixing air and fuel

It refers to the main burner and the pilot burner in the case of those provided with pilot burner, and to the main burner in the case of those not provided with pilot burner.

NOTE : A pilot burner is a burner to ignite the main burner, which is kept lighted at least while the main burner is burning.

4 Configuration and scope

The basic configuration of the fuel cell system shall be in accordance with clause 4 of **JIS C 8841-1**.

5 Material, structure and function concerning safety

5.1 General material

The general material shall be as follows.

- a) Material or coating material that is sufficiently resistant to possible corrosion under the use condition shall be used.
- b) Nonmetallic material of rubber or plastics shall be selected according to use conditions.
- c) For the metal used under highly humid environment, the corrosion-resistant material such as cast iron, stainless steel shall be used. When carbon steel is used, the coating having strong corrosion resistance shall be applied.
- d) For the electrical insulator and thermal insulator, a material which is sufficiently resistant to the temperature of the part in contact with or adjacent to it and which has small moisture absorption shall be used.
- e) For the package material of the outdoor type, a material with excellent weather resistance, such as a rust-proofed metal and a synthetic resin shall be used. Furthermore, the package material such as a synthetic resin shall be free from blisters, crazing, cracks and other abnormalities when it is left to stand for 1 h in air at $80\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ and then allowed to cool naturally.
- f) For the conductive material, copper, copper alloy, stainless steel, or iron and steel (except stainless steel) to which the plating conforming to the test requirements stipulated in “Appended Table 4 of Appendix 3 of Ministerial Ordinance on the Technical Standards for Electrical Appliances and Materials (Ordinance No. 85 of the Ministry of International Trade and Industry, 1962)”, or the material having electrical, thermal and mechanical stability that is equivalent or superior to these shall be used. However, this does not apply to materials used for the portion requiring elasticity and for other unavoidable portions in terms of structure where no danger is possibly caused.
- g) The material of components of the equipment constituting a fuel cell system (hereafter referred to as “equipment”) shall not contain polychlorinated biphenyl (PCB).
- h) For the components of the equipment, asbestos or asbestos-containing materials shall not be used.

5.2 General structure

The structure shall be as follows.

- a) All components shall have a safe structure that is resistant to distortion, strain and other damages.
- b) Components such as a removable panel and a cover shall have a structure in which a component cannot be attached to a wrong position or a wrong component cannot be attached.
- c) All components that may be touched during the normal use shall have a structure without sharp protrusions or angles in consideration of safety.

- d) All components that require periodical maintenance and inspection shall be structured in such a way that maintenance and inspection can be performed easily.
- e) The structure shall be such that a combustible gas does not remain inside the package.
- f) The structure shall be such that a leaked combustible gas does not flow into the power conditioner.
- g) The general structure of an equipment of the part in which a liquid fuel of the fuel cell system that uses the liquid fuel as fuel passes, the fuel pump in the liquid part, and the carburettor and the fuel piping of the part in which a liquid passes shall be as specified in **JIS S 3030**.

In addition, “the fuel pump in the liquid part” shall be limited to the pump specified in **JIS B 8409**, or the pump made of the equivalent material with the equivalent performance. Furthermore, “the carburettor and the fuel piping of the part in which a liquid passes” shall also include the desulfurizer.

- h) The structure of the equipment having live parts shall be such that the joint between the live parts or that between the live part and the non-live part does not generate looseness and endures use environmental conditions in the normal usage state.
- i) The structure of the equipment of which a part is attached or detached shall be such that the work of attachment or detachment can be performed surely and safely.
- j) For the plug socket attached to the equipment, the value of the maximum power or current at which the plug can be taken out safely shall be marked indelibly on itself or at a location adjacent to it.
- k) The structure shall be such that foreign materials cannot go into the inside of a package.
- l) For an equipment with a remote control mechanism, the switching of a power supply circuit shall be only possible through the operation of the equipment switch or controller. However, it may be otherwise where there is no possibility of danger.
- m) An equipment to be used by being attached to the building material shall be structured in such a way that attachment can be performed easily and firmly.
- n) The clearance and creepage distance between the live parts having different polarities, between the live part and the non-live metal part with a possibility of short-circuiting, and between the live part and the surface of the non-metal part accessible to touch by persons shall conform to the requirements specified in “1 (2) 1 of Appendix 8 of Ministerial Ordinance on the Technical Standards for Electrical Appliances and Materials (Ordinance No. 85 of the Ministry of International Trade and Industry, 1962)”.
- o) The thickness of an insulating material shall conform to the requirements specified in “1 (2) 2 of Appendix 4 of Ministerial Ordinance on the Technical Standards for Electrical Appliances and Materials (Ordinance No. 85 of the Ministry of International Trade and Industry, 1962)”.

- p) For a movable part accessible to touch by persons in the normal usage state, a suitable protective frame or protective net shall be provided so that there is no possibility that people will easily touch it. However, this does not apply to movable parts which need to be exposed for functional reasons, or those, even when touched, are not expected to cause electric shock or injury.
- q) For an equipment of the double rating with the mechanism that is capable of switching the rated input voltage or the rated frequency, the voltage and frequency that are switched shall be able to be easily identified. This does not apply to equipment having a mechanism of automatically switching.
- r) The allowable temperature of each part when the temperature rise test is performed in accordance with **10.5** shall be as specified in table 1 and table 2.

Table 1 Specified values of temperature rise under normal condition

Item		Specified value
Temperature of the portion that is touched by a user's body at the time of operation of knobs or others.	Metals, ceramics and glasses	60 °C
	Other objects	70 °C
Surface temperature of the part accessible to touch by hands	Enclosures ^{a)} of the object that corresponds to electric facilities for general use	95 °C
	Other objects	140 °C
Outside surface of the part of the body of a fuel shutoff valve ^{b)} through which fuel passes		85 °C or the temperature that conforms to the requirement of airtightness of gas passage and at which it is confirmed that there is no abnormality in operation in accordance with clause 16 of JIS S 2093 .
Surface of an ignition device ^{c)}		85 °C or the temperature at which it is confirmed that there is no trouble in use in accordance with clause 16 of JIS S 2093 .
Outside surface of the part of the appliance governor through which gas passes		70 °C or not more than the temperature that conforms to the requirement of airtightness of gas passage and at which it is confirmed that the change of adjustment pressure is not more than $(0.05 p_1 + 30)$ Pa in accordance with clause 16 of JIS S 2093 . p_1 : adjustment pressure before test (Pa)
Winding ^{d)}	Heat resistance class A	100 °C
	Heat resistance class E	115 °C
	Heat resistance class B	125 (120) °C
	Heat resistance class F	150 (140) °C
	Heat resistance class H	170 (165) °C
Rectifier cell ^{e)}	Made of selenium	75 °C
	Made of germanium	60 °C
	Made of silicon	135 °C

Table 1 (concluded)

Item	Specified value
Back surface and side surface of the power generation unit, and surface of the wooden wall of upper ceiling face, and surface of the wooden table ^{f)} of under surface of power generation unit	100 °C
The surface of the wooden wall around the exhaust terminal or the vent terminal and the surface of the wooden frame of the wall penetration part of the supply and exhaust tube	
Exhaust temperature	260 °C
The reference ambient temperature shall be 35 °C.	
Notes ^{a)} Excluding an exhaust outlet. ^{b)} Including an appliance valve ^{c)} Including piezoelectric element ^{d)} The value in parentheses applies to the winding of a rotating machine. ^{e)} Limited to that used for an AC side power supply circuit. ^{f)} Limited to a floor type.	

Table 2 Specified values of allowable temperature under abnormal conditions

Item	Specified value
Back surface and side surface of the power generation unit, and surface of the wooden wall of upper ceiling face, and surface of the wooden table ^{a)} of under surface of power generation unit	100 °C
Surface of wooden wall around the exhaust terminal or the vent terminal and the surface of wooden frame of the wall penetration part of the supply and exhaust tube	
The reference ambient temperature shall be 35 °C.	
Note ^{a)} Limited to a floor type.	

5.3 Fuel cell stack

The fuel cell stack shall be as follows.

- It shall have a structure capable of enduring the stress generated by the assumable pressure, vibration, heat, etc.
- It shall have corrosion resistance in the assumable use environment.
- It shall have electric safety in the assumable use environment.

5.4 Fuel reformer

The fuel reformer shall be as follows.

- a) It shall have a structure capable of enduring the stress generated by the assumable pressure, vibration, heat, etc.
- b) It shall have corrosion resistance in the assumable use environment.

5.5 Fuel system piping and reformer system piping

The piping of the part through which raw fuel, a reformed gas and an exhaust gas pass shall be as follows.

- a) The passage of a piping system shall be airtight and structured such that airtightness is not lost in the normal transportation, installation, use, etc. However, this does not apply to the open part (aeration, a fuel chamber, etc.) in the passage of a liquid fuel.
- b) The piping system shall be provided in a location not subjected to excessive heat or corrosion, or some measures for protection, etc. shall be taken.
- c) Connection parts of the piping shall be connected surely by means such as welding, screwing, unions, flanges or other methods of equivalent connection capability.
- d) The seal part of piping system shall be of a structure and material that are resistant to deterioration.
- e) In the case of a gaseous fuel, the structure shall be such that a raw fuel passes two or more automatic closing valves provided in series. The automatic closing valves, irrespective of the type of fuel, shall be fail closed valves which close when a driving source is lost.
- f) When burner combustion air is mixed with a fuel gas, an effective means for preventing the back flow of air to the fuel gas piping and the inflow of fuel gas to an air supply part shall be provided.
- g) The material of the part through which exhaust gas passes shall be a noncombustible material that does not melt at the operating temperature. This does not apply to air sealing materials such as packing materials and sealants.
- h) The piping system for a liquid fuel shall normally use a corrosion-resistant metallic conduit. However, when it is not suitable for structure or use to use the metallic conduit, conduit of a material other than metal, which is not affected by the fuel to be used may be used.
- i) The material of the part through which a gaseous fuel including a vaporized liquid fuel and a reformed gas pass shall be a noncombustible material or a flame retardant material. This does not apply to air sealing materials such as packing materials and sealants.
- j) The lagging material, heat insulating material, etc. used near a gas passage, a combustion part and an electric component part shall not burn out and shall be extinguished within 10 s when the test is performed in accordance with item 5 of table 19 of **JIS S 2093**. This requirement does not apply to lagging materials and heat insulating materials which, when burnt, generate no risk of causing electric shock, fire, etc.

k) The connection of each device and external pipes shall be as follows.

- 1) The piping shall have a suitable bore diameter according to the purpose of use and location of use.
- 2) The end connection shall normally be exposed to the outside, or provided at a position where it is easily visible from the outside.
- 3) The piping shall be resistant to various stresses generated by vibration, self weight, internal pressure, earthquake load, load due to temperature variation, etc., and shall be supported at suitable locations with a supporting material.
- 4) For the piping, material of which the durability is considered shall be used.
- 5) The piping shall have a carefully considered function and layout, which allow easy maintenance and checks.

5.6 Water system piping and hot-water system piping

The water system piping and hot-water system piping shall be as follows.

- a) The passage of a piping system shall be airtight and structured such that airtightness is not lost in the normal transportation, installation, use, etc.
- b) The piping system shall be provided in a location not subjected to excessive heat or corrosion, or some measures for protection, etc. shall be taken.
- c) Connection parts of piping shall be connected surely by means such as welding, screwing, unions, flanges or other methods of equivalent connection capability.
- d) The seal part of piping system shall be of a structure and material that are resistant to deterioration.
- e) The connection of each device and external pipes shall be as follows.
 - 1) The piping shall have a suitable bore diameter according to the purpose of use and location of use.
 - 2) The end connection shall normally be exposed to the outside, or provided at a position where it is easily visible from the outside.
 - 3) The piping shall be resistant to various stresses generated by vibration, self weight, internal pressure, earthquake load, load due to temperature variation, etc., and shall be supported at suitable locations with a supporting material.
 - 4) For the piping, material of which the durability is considered shall be used.
 - 5) For the piping, function and layout shall be carefully considered, and maintenance and checks shall be easy.
- f) The structure of water system piping and hot-water system piping shall be as follows.
 - 1) The position of the mounting opening to the water distributing pipe shall be separated from the mounting opening of other water supply devices by 30 cm or more.

- 2) The bore diameter of the water supply pipe in the mounting opening to the water distributing pipe shall not be remarkably oversized compared with the amount of water used by the water supply device concerned.
- 3) The piping shall not be connected directly to the pump which may affect the hydraulic pressure of a water distributing pipe.
- 4) The piping shall be sufficiently resistant to hydraulic pressure and other loads, and shall not contaminate or leak water.
- 5) The suitable measures for preventing freezing, destruction, corrosion, etc. shall be taken.
- 6) The piping shall not be directly connected to the water pipe of other than the water supply device concerned or other equipment.
- g) The test method of the water supply device of a fuel cell system shall be in accordance with **JIS S 3200-1** to **JIS S 3200-7**.

5.7 Burner and other combustion parts

5.7.1 Common matters

The burner and the other combustion parts shall be as follows.

- a) The caulking part, welded part and other locations shall be free from defects that are detrimental to use.
- b) The flame hole shall be free from deformation that affects combustion.
- c) The burner and the other combustion parts shall be stably attached to the specified position, their relative positions with the related portions such as a nozzle, a combustion chamber, an electric ignition device, a safety device shall be surely maintained, and they shall not move or come off in the normal usage state.
- d) The burner and the other combustion parts shall be attached to a position where they do not heat or damage unnecessary parts of the power generation unit.
- e) The burner and the other combustion parts shall not backfire.

5.7.2 Ignition operation (general)

The ignition operation shall be as follows.

- a) In order to carry out the fuel gas substitution, before ignition is tried, the air purge of the amount of at least 4 times the capacity concerned shall be automatically performed inside each burner housing
- b) It shall be possible to confirm with a combustion sensing means that the burner and the other combustion parts have been ignited.
- c) The combustion sensing means shall be held so that the positional relation with the burner and the other combustion parts does not change in the normal usage state.
- d) When the combustion cannot be detected with the combustion sensing means after a series of the specified ignition operations, the supply of fuel to the burner and the other combustion parts shall be automatically shut off.

- e) When the combustion sensing means breaks down, the supply of fuel shall be automatically shut off.

5.7.3 Ignition using discharge spark

The ignition using a discharge spark shall be as follows.

- a) The electrode part shall be located at a position which a yellow flame always does not touch.
- b) The electrode shall be fixed so that the electrode interval does not change in the normal usage state.
- c) For the space between the live part of a high-voltage conductor and the non-live metallic part, the sufficient clearance of not less than the electrode spacing shall be kept or effective electric insulation measures that do not cause electric leakage at the time of the ignition operation shall be taken.
- d) The electrical insulator used for a portion with a possibility that a discharge spark reaches shall be free from any changes in quality such as harmful deformation and harmful deterioration due to discharge spark.
- e) In the case of normal use, parts of high-voltage conductor accessible to touch by human hands shall be provided with an effective insulation covering.

5.7.4 Ignition using ignition heater

The ignition using an ignition heater shall be as follows.

- a) The ignition heater shall be held so that the attached position does not change easily.
- b) Consumables such as an ignition heater shall be easy to exchange.

5.8 Equipment using electronic control device

The equipment using an electronic control device shall be as follows.

- a) In the normal usage state, the equipment shall be free from malfunction, such as operation from open to close in a power supply circuit, operation from a standby state to an operation state and discharge of combustible gas, etc.
- b) In the normal usage state, when a part of control circuit is short-circuited or disconnected, there shall be no trouble in safety such as abnormal overheating of equipment or discharge of combustible gas.

5.9 Equipment equipped with motor

The equipment equipped with a motor shall be as follows.

- a) The motor shall be able to start irrespective of the position of the rotor.
- b) Operation shall be able to be continued without trouble.
- c) At the time of electric power interruption and also at the subsequent restoration of power, there shall be no trouble in safety.

5.10 Electric apparatus and wiring

5.10.1 Common matters

The electric apparatus and wiring shall be as follows.

- a) The electric apparatus and wiring shall be installed at the position where thermal affects are small and shall have thermal endurance at the time of operation.
- b) The actuation of the electric apparatus shall be performed smoothly and surely.
- c) The insulation resistance between electric wires of the low-voltage cable way that connects a power generation unit and between the cable way and the ground shall be not less than the values given in table 3 for each cable way that can be divided by a switch or a circuit breaker.

Table 3 Insulation resistance value of cable way that connects fuel cell

Division of working voltage of cable way		Insulation resistance value MΩ
300 V or under	In the case of voltage to ground ^{a)} of 150 V or under	0.1
	In other cases	0.2
Over 300 V		0.4
Note ^{a)} It refers to the voltage between electric wire and ground for the grounded cable way, or the voltage between electric wires for the non-grounded cable way.		

- d) The power generation unit except the fuel cell stack shall endure the AC voltage of 1 000 V for the rated voltage of 150 V or less or 1 500 V for the rated voltage of exceeding 150 V when this voltage is applied between the live part and the ground continuously for 1 min.
- e) The fuel cell stack shall endure the DC voltage 1.5 times the maximum working voltage or the AC voltage 1 time the maximum working voltage when this voltage is applied between the live part and the ground continuously for 10 min. When this DC voltage or AC voltage is less than 500 V, the fuel cell stack shall endure 500 V.
- f) The power conditioner shall endure the DC voltage 1.5 times the maximum working voltage or the AC voltage 1 time the maximum working voltage when this voltage is applied between the live part and the ground continuously for 10 min to perform the test of dielectric strength. When this DC voltage or AC voltage is less than 500 V, the power conditioner shall endure 500 V.
- g) In the cable way of the power generation unit, live parts of the relay terminal box, plug connector (water proof connector) and other joints shall not be exposed.
- h) Equipments such as a relay terminal box that are installed at a location accessible to people shall have a structure which will not easily allow unnecessary operation.

- i) For the iron table and metallic outer case of machinery and appliances installed at the cable way of the power generation unit, the Class D grounding work or the Class C grounding work shall be performed.

In addition, the grounding conductor shall be the IV wire or CV cable of 1.6 mm or more diameter.

5.10.2 Electric wiring in electric apparatus

The electric wiring in an electric apparatus shall be as follows.

- a) In the normal transportation, installation, use, etc., damage, etc. of a covering shall not occur.
- b) The lead wire to be used for wiring shall be as short as possible, and the measures for insulation, thermal insulation protection, fixation, etc. shall be provided for a required location.
- c) For the wiring with a possibility of contacting the hot area when a force of 2 N is applied to it, abnormalities shall not occur at the time of contact.
- d) The wiring, when a force of 2 N is applied to it, shall not contact a movable part.
- e) In the case where an electric wire with a covering is fixed or is passed through a through-hole, or in the case where it contacts other parts when a force of 2 N is applied to it, the covering shall not be damaged.
- f) The wiring connected with a connector shall not be removed when a force of 5 N is applied to the connected part.
- g) When a lead wire, a terminal, etc. that can be exchanged without rework are erroneously attached, the electric apparatus shall not operate, or shall actuate normally.
- h) The lead wire, terminal, etc. shall be identifiable by numerals, letters, symbols, colours, etc. except when:
 - 1) they have the physical shape that prevents improper connection; or
 - 2) there are only two lead wires or terminals and even if the two are exchanged, no effects on operation will be caused.
- i) The chamfering or other suitable protection workings shall be applied to the through-hole of the power cable, the electric wire connecting the instruments, the electric wire functionally required to be exposed to the outside of the instrument body so that the power cable etc. are not damaged, except when other suitable protective device such as a protection bushing is used.
- j) The fuse, overcurrent protective device or other protective devices that operate when abnormalities such as short circuit and overcurrent of the electric wire connecting the instruments occur shall be provided.
- k) The electric insulator used for the part which may be reached by an arc shall not produce deterioration such as harmful deformation or harmful reduction in insulation resistance due to the arc.

5.10.3 Live part

The live part shall be as follows.

- a) The live part shall not be reached by a test finger after removing all the parts that can be easily removed without the use of tools such as a driver, a spanner or a dedicated key or a coin for maintenance inspection. However, live parts falling under any of the following are exempted from this requirement.
 - 1) A live part of which the attachment surface is not easily accessible to touch by persons in the state that it is attached.
 - 2) A live part that is at a distance of 40 cm or more from the opening of the bottom surface of the instrument body with a mass of exceeding 40 kg.
 - 3) Live parts that are unavoidably exposed due to the structure of the equipment, further falling under the following:
 - 3.1) in the case of AC, a live part in which the voltage to ground and line voltage of the secondary circuit connected to the insulating transformer are 30 V or less;
 - 3.2) in the case of DC, a live part in which the voltage to ground and line voltage of the secondary circuit connected to the insulating transformer are 45 V or less;
 - 3.3) when the resistor of 1 k Ω is connected against the ground and between the lines, a live part in which the current passing through the resistor is 1 mA or less except when there is no possibility of causing the danger of short circuit at a frequency of not less than the commercial frequency.
- b) For the equipment having the portion in which the peak voltage between the live parts of which polarity is different or between the live part and the non-live metal part accessible to touch by persons exceeds 600 V, the cautions for high voltage shall be marked indelibly on the vicinity or on the conspicuous location of the package.

5.10.4 Grounding

The grounding shall be as follows.

- a) The terminal for grounding shall be indelibly marked with its identity (terminal conductor), on the terminal itself or in its vicinity.
- b) The grounding conductor shall be able to be easily and surely attached, and the nominal diameter of the terminal screw for grounding shall be 4 mm or more (for the presser foot thumb screw type, 3.5 mm or more).
- c) The grounding mechanism shall be completely electrically connected to the metal part which is accessible to touch by persons, and firmly attached so that it is not easily loosened.
- d) The material of the terminal for grounding shall have the sufficient mechanical strength and resistance to rust.
- e) The lead wire for grounding shall conform to any of the following.

- 1) The annealed copper wire of 1.6 mm diameter or the metal wire that has the strength and thickness equivalent or superior to this and is resistant to corrosion.
 - 2) The single-core code or the single-core cabtyre cable having a nominal cross sectional area of 1.25 mm² or more
 - 3) The two-core code having a nominal cross sectional area of 0.75 mm² or more, of which two conductors are braided at both ends and brazed or crimped
 - 4) The multi-core code having a nominal cross sectional area of 0.75 mm² or more (except a braided code) or one of conductors of a multi-core cabtyre cable
- f) The lead wire for grounding shall be marked indelibly with its identity (lead wire for grounding), on the wire itself or in its vicinity.

5.11 Equipment provided for transfer of air and fluid

The equipment provided for transfer of air and fluid shall be as follows.

- a) For the fan, turbocharger and blower, they shall be selected so as to be suitable for use and able to be easily inspected.
- b) The bearing shall suit the operational temperature range in the normal operation. Furthermore, the means of grease supply shall be provided as necessary.

5.12 Electric components and accessories

The rated voltage of electric components and accessories shall be not less than the maximum voltage that is applied to them. Furthermore, the rated current and allowable current shall be not less than the maximum current that flows into them.

5.13 Exhaust heat recovery equipment

The exhaust heat recovery equipment shall be as follows.

- a) In the heating medium system, the air escape mechanism shall be provided at the location where air is hard to escape structurally.
 - b) When the heat exchanger that does not correspond to any of 1) to 6) below is used, the use condition, material, structure and test method shall be in accordance with “Boiler and Pressure Vessel Safety Regulations (Ordinance No. 33 of the Ministry of Labour, 1972)” or “Structure Standards of Small-sized Boilers and Small-sized Pressure Vessels (Ordinance No. 84 of the Ministry of Labour, 1975)”.
- 1) The steam boiler used at a gauge pressure of 0.1 MPa or less of which the heat transfer area calculated as specified in “Boiler and Pressure Vessel Safety Regulations (Ordinance No. 33 of the Ministry of Labour, 1972)” (hereafter referred to as “heat transfer area”) is 0.5 m² or less, or of which the inside diameter of the shell is 200 mm or less and the length of the shell is 400 mm or less
 - 2) The steam boiler used at a gauge pressure of 0.3 MPa or less of which the internal volume is 0.000 3 m³ or less
 - 3) The steam boiler with a heat transfer area of 2 m² or less to which the steam pipe opened to the atmosphere of 25 mm or more inside diameter is attached,

or in which the U-shaped vertical pipe having a gauge pressure of 0.05 MPa or less and an inside diameter of 25 mm or more is attached to the steam part

- 4) The hot-water boiler having a gauge pressure of 0.1 MPa or less of which the heat transfer area is 4 m² or less
- 5) The once-through boiler used at a gauge pressure of 1 MPa or less of which the heat transfer area is 5 m² or less except the multi-pipe boiler of which the pipe header diameter exceeds 150 mm. However, for boilers with a steam separator, the inside diameter of the steam separator concerned shall be 200 mm or less and the internal volume shall be 0.02 m³ or less.
- 6) The once-through boiler having an internal volume of 0.004 m³ or less of which the product of the numeric value, expressed in MPa, of the maximum gauge pressure to be used and the numeric value, expressed in m³, of the internal volume is 0.02 or less. This once-through boiler shall be without either a pipe header or a steam separator

5.14 Hot-water storage unit

The hot-water storage unit shall be as follows.

5.14.1 Hot-water storage unit with gas burning auxiliary heat source equipment

The gas burning auxiliary heat source equipment installed in the hot-water storage unit shall be as specified in **JIS S 2092** and **JIS S 2109**.

5.14.2 Hot-water storage unit with oil burning auxiliary heat source equipment

The oil burning auxiliary heat source equipment installed in the hot-water storage unit shall be as specified in **JIS S 3030**, **JIS S 3021**, **JIS S 3024**, and **JIS S 3027**.

5.14.3 Hot-water storage unit with electric auxiliary heat source equipment

The electric auxiliary heat source equipment installed in the hot-water storage unit shall be as follows.

- a) The structure of the hot-water storage tank shall be in accordance with “Structure Standards of Small-sized Boilers and Small-sized Pressure Vessels (Ordinance No. 84 of the Ministry of Labour, 1975)”. Furthermore, for the hot-water storage tank in which the hydraulic head pressure exceeds 20 m or the heat transfer area is 2 m² or less, Article 37 of the Industrial Safety and Health Act (Act No. 57, 1972) shall be observed.
- b) The test method of the water supply device shall be in accordance with **JIS S 3200-1** to **JIS S 3200-7**.
- c) The electric auxiliary heat source equipment categorized as the push-up type and of which the maximum working pressure (gauge pressure) is 100 kPa or less and the rated electric power consumption is 10 kW or less shall conform to the structure and the test method specified in **JIS C 9219**.

- d) The electric auxiliary heat source equipment categorized as the push-up type and of which the maximum working pressure (gauge pressure) is 100 kPa or less and the rated electric power consumption is 80 kW or less shall be as follows.
 - 1) The structure shall be in accordance with “Structure Standards of Simplified Boilers and so forth (Ordinance No. 65 of the Ministry of Labour, 1975)”.
 - 2) The escape valve that actuates promptly after maximum pressure is reached shall be provided except those valves equipped with an escape pipe.
 - 3) When the hydraulic test is performed at a gauge pressure of 200 kPa, there shall be no abnormality.
 - 4) When the rated consumption power is 10 kW or less, **JIS C 9219** shall be applied.
 - 5) When the rated consumption power exceeds 10 kW, **JIS C 9219** should be applied.
- e) For the push-up type, the hot-water storage tank of which the maximum working pressure (gauge pressure) is over 100 kPa up to and including 200 kPa and the rated consumption power is 40 kW or less shall be as follows.
 - 1) The structure shall be in accordance with the “Structure Standards of Small-sized Boilers and Small-sized Pressure Vessels (Ordinance No. 84 of the Ministry of Labour, 1975)”.
 - 2) **JIS C 9219** should be applied.
- f) The electric auxiliary heat source equipment not categorized as the push-up type shall be as specified in **JIS C 9219**.
- g) The equipment into which the closed type electric water heater is diverted shall conform to the “Electrical Appliance and Material Safety Act (Act No. 234, 1961)”.

NOTE : In “Boiler and Pressure Vessel Safety Regulations (Ordinance No. 33 of the Ministry of Labour, 1972)”, “maximum power facility capacity” is used as a term corresponding to “rated power consumption”.

5.15 Power conditioner

The power conditioner shall be as follows.

5.15.1 General

The power conditioner used for a power generation unit shall have performance specified in **JIS C 8980**.

5.15.2 Input voltage of power conditioner

The input voltage of the power conditioner shall be as follows.

- a) The power conditioner shall satisfy the rated values such as the output voltage and frequency in the input operation voltage range, and shall be able to be operated safely.
- b) The power conditioner shall be free from abnormal operations or failures in the range of input voltage.

5.15.3 Output capacity of power conditioner

The output capacity of a power conditioner shall be as follows.

- a) At the time of the grid-connected operation, in general, the power conditioner that is capable of converting the maximum output power assumable from the operation condition of the power generation unit shall be selected.
- b) At the time of the grid-independent operation, the power conditioner that has the grid-independent operation capacity sufficient for the full load capacity to be required shall be selected.
- c) For the output electric system, a single phase two-wire system, a single phase three-wire system and a three phase three-wire system shall be taken as the standard.

5.16 Protective device

In the power generation unit, not only the marking that enables the confirmation of operating condition shall be provided, but also the protective devices that can automatically stop the system safely when trouble occurs in continuation of operation shall be installed. These protective devices shall be able to respond whether the control device is full-automatic, semi-automatic or manual, and even at the time of startup and stop of the power generation unit.

5.16.1 Protection from ground fault, short circuit accident, etc.

The protection from a ground fault, a short circuit accident, etc. shall be as follows.

- a) When the ground fault of the cable way in the power generation unit side occurs, the protection function that detects this ground fault, separates an accident part and separates interconnection, etc. shall be provided. However, this is unnecessary when the cable way of the fuel cell is grounded in circuit architecture and the suitable protection is performed.
- b) For the power generation unit having an electric storage device, a fuse, a molded-case circuit breaker, etc. that protect a DC circuit shall be provided.
- c) For the load short circuit at the time of grid-connected operation and grid-independent operation, the function that stops safely or protects the power generation unit shall be provided.
- d) The current shall not be made to flow into the fuel cell stack from the external device.

5.16.2 Safety device

The power generation unit shall be provided with the device to automatically stop in occurrence of the following conditions.

- a) When the pressure or temperature of fuel gas in the fuel system and reforming system rises remarkably.
- b) When the fire of the burner of the reformer goes out.
- c) When leakage of fuel gas is detected.
- d) When abnormalities occur in the control device.