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**Industrial trucks—
Electrical requirements**

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Health, Labour and Welfare and the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Industrial Vehicles Association (JIVA)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14. Consequently **JIS D 6028:2012** is replaced with this Standard.

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Industrial trucks— Electrical requirements

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 20898:2008**, Edition 1, with some modifications of the technical contents, because inappropriate cross-sectional area of connection cable is included in the said **ISO**, which is specified for the rated current of battery connector used in the temperature rise test of battery connector.

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 JB.

1 Scope

This Standard specifies the electrical requirements for the design and manufacture of self-propelled industrial trucks including masted and variable reach rough terrain trucks and tow tractors with a rated drawbar pull up to and including 20 kN. This Standard applies to trucks with battery voltages of not more than 240 V.

For additional requirements of trucks with mains power, see **JIS B 9960-1**.

This Standard does not apply to:

- trucks used in potentially explosive atmospheres;
- issues related to electromagnetic compatibility.

This Standard does not repeat all the technical rules which are state of the art and which are applicable to the material used to construct the industrial truck, for which reference can be made to **JIS B 9700**.

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

ISO 20898:2008 *Industrial trucks—Electrical requirements* (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. For standards with the year indication, only the editions of the indicated year shall be applied and the revisions (including amendments) made thereafter shall not be applied. For those without the indication of the year, the most recent edition (including amendments) shall be applied.

JIS B 9700 *Safety of machinery—General principles for design—Risk assessment and risk reduction*

NOTE Corresponding International Standard: ISO 12100:2010 *Safety of machinery—General principles for design—Risk assessment and risk reduction*

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 9960-1:2008 *Safety of machinery—Electrical equipment of machines—Part 1: General requirements*

NOTE Corresponding International Standard: IEC 60204-1:2005 *Safety of machinery—Electrical equipment of machines—Part 1: General requirements*

JIS C 0920 *Degrees of protection provided by enclosures (IP Code)*

NOTE Corresponding International Standard: IEC 60529:2001 *Degrees of protection provided by enclosures (IP Code)*

JIS C 3662-1 *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V—Part 1: General requirements*

JIS C 3663-1 *Rubber insulated cables—Rated voltages up to and including 450/750 V—Part 1: General requirements*

JIS C 5101-14 *Fixed capacitors for use in electronic equipment—Part 14: Sectional specification—Fixed capacitors for electromagnetic interference suppression and connection to the supply mains*

NOTE Corresponding International Standard: IEC 60384-14:2013 *Fixed capacitors for use in electronic equipment—Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains*

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 60947-5-1:2003 *Low-voltage switchgear and controlgear—Part 5-1: Control circuit devices and switching elements—Electromechanical control circuit devices*

JIS D 6201 *Self-propelled industrial trucks—Vocabulary*

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in JIS D 6201, and the following apply.

3.1

arcing part

electrical component that interrupts current during operation

3.2

auxiliary circuit

electrical circuit that controls lights, fans and other accessories

3.3

battery compartment

compartment on the truck that houses the battery

3.4

battery enclosure

container or tray that houses the individual cells

3.5

control circuit

electrical circuitry that controls (monitors) truck movement and electrical equipment

3.6

deactivate

make inactive or ineffective

3.7

direct contact

contact of person with live parts

3.8

electrical enclosure

compartment on a truck that houses uninsulated live electrical components

3.9

electrical or electronic steering

steering in which input is connected to output through electric and/or electronic means

3.10

exposed conductive part

conductive part of electrical equipment, which can be touched and which is not normally live, but which may become live under fault condition

3.11

frame fault

accidental connection of a live part to the truck structure

3.12

indirect contact

contact of persons with exposed conductive parts which have become live under fault conditions

3.13

live part

conductor or conductive part intended to be energized in normal use

3.14

nominal current

current (A) that the electrical system is able to carry continuously without exceeding the allowable temperature indicated

3.15

nominal voltage (of the truck system)

total number of battery cells connected in series in the truck's system multiplied by the nominal cell voltage

3.16

power circuit

electrical circuitry that supplies the motors which cause truck movement, i.e. traveling, steering and lifting

3.17

rated operating current

value of current which is determined by the conditions of use of the contactor

3.18

rated thermal current

value of current which determines the temperature rise conditions of the main circuit in the absence of any closing or opening operation of the contacts (continuous energizing)

3.19

risk of fire

condition in which a device has a surface temperature greater than 175 °C or emits sparks outside of the electrical enclosure

3.20

routine test

test required for all production trucks

3.21

type test

test to verify compliance with this Standard for each truck type

4 List of hazards

Table 1 contains the significant hazards, hazardous situations and events, as far as they are dealt with in this Standard, referred from Annex B of **JIS B 9700** (No indicates the referred number), and are applicable in the situations described and could involve risks to persons if not addressed. The corresponding requirements offer guidance to limit the risk or reduce the hazard in each situation.

Table 1 Example of significant hazards, hazardous situations and hazardous events

No	Hazard	Corresponding requirements in this Standard	
1	Mechanical hazards	5.1.11	Slack and/or broken chains
	Crushing hazard	5.1.12	Low voltage
	— between truck components	5.1.14	Controls — General
	— between truck and obstacles	5.1.15	Controls — Travel
	Impact by collision	5.1.16	Controls — Load handling
	— when driven by the operator	5.1.17	Controls — Steering
	Loss of machine stability/overturn	5.1.18	Contactors
	— from excess speed	7.1	Minimum marking for electric trucks
	— from faulty battery mass	7.3	Minimum marking for IC trucks
2	Electrical hazards	5.1.1	Traction batteries
	Touch to live part (direct contact)	5.1.2	Battery cables
	Overloading	5.1.3	Battery connectors
	— All voltages	5.1.4	Battery charging
		5.1.5	Emergency switching off requirements (disconnection) and connections for batteries
		5.1.6	Design construction
		5.1.8	Wiring and wire construction
		5.1.9	Electrical shock protection [direct contact and indirect contact (spacing)]
		5.1.13	Overcurrent protective devices
		5.2.1	Battery
		5.2.2	Circuit protection
		5.2.3	Control systems
		5.2.4	Wiring and wire construction
		5.2.5	Electrical shock protection [direct contact and indirect contact (spacing)]
		6.2.1	Abnormal operation test
	— 120 V < voltages ≤ 240 V	5.1.1	Traction batteries
		5.1.7	Trucks with nominal voltage exceeding 120 V dc
3	Thermal hazards	6.2.2	Temperature test

Table 1 (concluded)

No	Hazard	Corresponding requirements in this Standard	
7	Material/substance (and compositions) hazards Battery electrolyte Fire or explosion hazard — All voltages	5.1.1	Traction batteries
		5.1.2	Battery cables
		5.1.3	Battery connectors
		5.1.4	Battery charging
		5.1.5	Emergency switching off requirements (disconnection) and connections for batteries
		5.1.6	Design construction
		6.1	Insulation resistance testing (routine test)
		6.2.1	Abnormal operation test
		6.2.3	Arc rupture testing
		6.2.5	Connector testing
		6.2.6	Contacting testing
	— 120 V < voltages ≤ 240 V	5.1.7	Trucks with nominal voltage exceeding 120 V dc
		7.1	Minimum marking for electric trucks
		7.3	Minimum marking for IC trucks
8	Ergonomic hazards Human error	7.1	Minimum marking for electric trucks
		7.3	Minimum marking for IC trucks
—	Hazards due to functional disorders Failure of energy supply Failure/disorder of control system Loss of machine stability/overturn	5.1.12	Low voltage
		5.1.14	Controls — General
		5.1.15	Controls — Travel
		5.1.16	Controls — Load handling
		5.1.17	Controls — Steering
		5.1.18	Contactors
		5.2.2	Circuit protection
		5.2.3	Control systems

5 Requirements

5.1 Electrical requirements for battery powered trucks

5.1.1 Traction batteries

5.1.1.1 All trucks shall be equipped with an insulated battery.

5.1.1.2 Cells assembled in metal containers shall be insulated from each other.

5.1.1.3 The cell connections shall be such that the potential between any two adjacent cells cannot be more than 24 V dc nominal.

5.1.1.4 For battery terminals, measures shall be taken to reduce risk of a connection coming loose causing overheating or arcing.

5.1.1.5 On trucks equipped with an on-board battery charger, the battery terminals shall be protected by insulating boots or covers.

Exception 1: A terminal that is intentionally connected to ground on the truck frame need not be provided with a boot or cover.

Exception 2: This requirement does not apply to on-board battery charger complying with **5.1.1.6** equipped with a ground-fault circuit interrupter or an isolated output.

5.1.1.6 When trucks are fitted with an on-board battery charger, the requirements in **6.3.1**, **6.3.2**, **7.2.1**, **8.1** and **8.2** of **JIS B 9960-1** shall apply. The enclosure containing on-board battery charger connected to the mains supply shall be IPXXB specified in **JIS C 0920**. However, for top surface, the minimum degree shall be IPXXD.

5.1.1.7 For batteries with nominal voltages exceeding 120 V dc, the battery enclosure shall be lockable or facilities shall be provided so that the battery compartment can be secured to prevent unauthorized access to the battery if a lockable cover is not present on the battery enclosure.

5.1.1.8 For batteries with nominal voltages exceeding 120 V dc, one of the following protective measures against indirect contact shall be selected:

- a) protective electrical insulation;
- b) protection by earth-free equipotential bonding;
- c) protection by automatic disconnection or signalling.

5.1.1.9 A battery enclosure where the battery nominal voltage exceeds 120 V dc shall be:

- a) metal and lined with a material bonded to the metal that is impervious to the electrolyte;
- b) constructed of an insulating material.

5.1.2 Battery cables

5.1.2.1 A battery cable where the battery nominal voltage is up to and including 120 V dc shall be:

- a) that of which cross-sectional area of wires and thickness of insulation are specified in **JIS C 3662-1** and **JIS C 3663-1**;
- b) insulated with a suitable material rated for the temperatures and voltages of the truck;
- c) resistant to the electrolyte;
- d) able to withstand flexing, handling, and impact at temperatures referenced in **5.1.3.2**;
- e) average insulation thickness shall not be less than 1.5 mm for a wire less than or equal to 35 mm² and shall not be less than 2.0 mm for a wire greater than 35 mm².

5.1.2.2 A battery cable where the battery nominal voltage exceeds 120 V dc shall meet the requirements of **JIS B 9960-1**.