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Foreword

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Automatic guided vehicle systems — General rules on the safety

1 Scope This Japanese Industrial Standard covers general rules to ensure safety of transporting system of automatic guided vehicles (including automatic guided tractors and automatic guided fork lift trucks), from its introducing and planning stage to installing and operating stage.

Remarks: The following standards are normative references to this Standard:

JIS D 6201 *Glossary of terms relating to fork lift trucks*

JIS D 6801 *Glossary of terms relating to automatic guided vehicle systems*

2 Definitions The definitions of main terms used in this Standard shall be as follows, in addition to **JIS D 6201** and **JIS D 6801**.

- (1) **safety checking style** The human and machine coexistence system whose starting or continuing operations are permitted only when human safety is confirmed.
- (2) **fail-safe structure** The machine system which always operates to the safety side, without losing safety and protection of human and surroundings, in the case of some abnormal situation such as machinery breakdown, in the man and machine co-existing system. A function that the system always operates to the safety side in the case of failure, damage and so on.
- (3) **brake opening switch** The switch which makes the brake of automatic guided vehicle ineffective when manually operated.

3 Basis of safety of automatic guided vehicle system The automatic guided vehicle system is an automatic transporting system to transport commodities, load and unload cargoes using automatic guided vehicles, whose working area is shared with humans.

In the human co-existing system, the important problem is to keep human safety. For this purpose, the desirable aim of system construction shall be the system formation of safety check style, and accordingly the sensor used in the interlock for the purpose of safety is desirable to be fail-safe structure.

However, there may be an impossible case to keep every system to safety check style even though the technology develops and improves. In such a case, the manufacturer and the user mutually discuss, recognize the limit of safety, treat carefully, and must keep safety, from the both sides of safe equipment which improve the safety index, and the operation regulation control in the construction field.

4 Keeping general safety at stage of design and planning

4.1 Structure and general safety

4.1.1 External form of automatic guided vehicle The external form of automatic guided vehicle shall be as follows:

- (1) The external surface of automatic guided vehicle body, excepting the part required for operation, is to be free from dangerous part such as sharp corner, protrusions, etc.
- (2) The obstacle contact bumper is to be such safe structure as to give no injury to contacting walker.

4.1.2 Confirmation of handling materials Cargo shall not only be free from deformation and collapse but also be systematically designed not to become overhanging or load-offsetting during the all movement such as transshipment, transport, etc.

4.1.3 Marking The marking shall be as follows:

- (1) **Marking** The permissible load and self-weight shall be marked on a nameplate or the like placed on an automatic guided vehicle body where the nameplate can be seen easily.
- (2) **Nameplate** The nameplate marked with the following items shall be attached on automatic guided vehicle body:
 - (a) **type** Mark the name of type designated by manufacturer
 - (b) **self-weight**
 - (c) **permissible load**
 - (d) **rated speed**
 - (e) **year and month of manufacture or its abbreviation**
 - (f) **manufacture number**
 - (g) **manufacturer's name or abbreviation**
- (3) **Safety sign** Automatic guided vehicles shall be marked with safety sign on its body to secure human safety.

Further, it shall be marked on passages and the peripheral devices, if necessary.

4.1.4 Warning devices In order to communicate the movement of automatic guided vehicles and to rouse people's attention, the following warning devices shall be provided on its body.

- (1) **Automatic driving status indicator** The indicator shall be lighted or flashed on its body while an automatic guided vehicle is automatically operated.
- (2) **Starting alarm** When an automatic guided vehicle changes from the stationary status into the travelling status, the warning shall be generated before the vehicle starts.
- (3) **Travelling alarm** Automatic guided vehicles shall actuate the warning devices continuously or intermittently which are suitable for the environment during running and automatic transferring.
- (4) **Abnormal alarm** When automatic guided vehicles fall into the abnormal status, the warning indicator shall be lighted or the warning sound alarm or the like shall be blown to inform the worker of the abnormality.

- (5) **Right and left turning display lamp** When the discrimination of right or left turning direction of automatic guided vehicle is required, the turning indicator shall be lighted.

4.1.5 Maintaining of stationary status Automatic guided vehicles shall be of such structure that does not allow the vehicle to start, unless there is a starting command.

4.1.6 Operating device in an emergency The operating device in an emergency shall be as follows:

- (1) An emergency stop device which is actuated by an action of push, touch, etc. shall be provided at a position which can be reached easily on an automatic guided vehicle body.
- (2) A manual operating function for the worker to be capable of operating automatic guided vehicles when trouble emerges shall be provided.

In the case of operating the manual operating box, the operation from other devices shall be impossible.

- (3) When an automatic guided vehicle is stopped by the emergency stop button, and even the abnormality is removed, it shall not start again, if the safety of the cause of trouble is not confirmed.

4.1.7 Monitoring It is preferable that an automatic guided vehicle is provided with a monitoring function to know the situation and the cause of abnormality which has happened on the automatic guided vehicle.

4.2 Transshipping equipment

4.2.1 Confirmation of running stage and transshipping stage, and interlock The interlock shall be taken so transshipment with the ground side equipment is carried out safely and securely, and prohibit the transshipping work at the ordinary running stage.

4.2.2 Transshipping abnormality When the transshipping cannot be carried out normally, the detection of abnormalities shall be possible, and further an automatic guided vehicle shall not be started.

4.2.3 Emergency shut-down and safety confirming When the transshipping abnormality is generated and emergency shut-down of transshipping work is carried out, it shall stop transshipping until the working person resolves the abnormality, confirms the safety and restarts it.

4.2.4 Cargo holding The transshipping equipment shall be constructed to prevent cargoes from falling during the running time and even in the case of sudden stop caused by an emergency stop, with the stopper and so on.

4.2.5 Ground side transshipping equipment In the transporting system, the ground side transshipping equipments such as the ground side transporting conveyer to transship cargo to automatic guided vehicles, automatic warehouses, etc., shall be mutually interlocked so as to be capable of transshipping safely.

4.3 Peripheral equipment and associated devices

4.3.1 Charging device In the case where there is a fear of flammable gas generated from inside of battery during charging to be filled, the place set with charging devices shall be sufficiently ventilated and shall be regulated as "Caution: Flammables".

4.3.2 Safety device for running The safety devices for running shall be as follows.

- (1) For the safe running, the safety shall be secured by using warning, sign, marking, colouring, safety pole, etc. on the ground side, as required.
- (2) In order to prevent contact with a person or collision with the periphery, a device to prevent collision shall be provided also on the ground side, as required.
- (3) In the case where the sequential operation with facilities of building such as automatic door, automatic elevator, etc. is required, the interlocking shall be set so as to be capable of vehicle running, door opening and closing, elevator travelling safely.

4.3.3 Interlocking with peripheral associated devices Interlocking with each action due to the transfer of cargo or information between peripheral equipment and associated devices shall be set securely, and therefore the succeeding action can safely start and continue the action.

4.4 Obstacle contact bumper and collision prevention

4.4.1 Equipping of obstacle contact bumper In order to secure safety of working person, transshipping cargo and peripheral facilities from impact of collision, the system shall be set possible effort to keep the fail-safe structure, and the obstacle contact bumper based on the following items shall be installed.

- (1) It shall be of safe shape and structure such as not to give the workers and periphery an injury in the case of contact.
- (2) Its width shall be equal to or more than vehicle width (not including the range of transshipping motion) in travelling direction.
- (3) The reaction force, stroke and actuating points of switch of obstacle contact bumper shall be designed for automatic guided vehicle can stop safely, considering speed and distance, and shall be such mechanism as to stop automatic guided vehicle in the case of contact.

4.4.2 Equipping of obstruction approaching detector To detect the vehicle speed faster than to stop safely only by obstacle contact bumper, an obstruction approaching detector shall be equipped and the vehicle shall be reduced in speed within the permissible safety speed or shall be stopped.

The function area of obstruction approaching detector (sensor) shall be equal or more than vehicle width and height (of the main body excluding the cargo handling device), and it is preferable that the sensing area can be controlled.

4.4.3 Execution of countermeasures for prevention of mutual collision In the case of

operating plural automatic guided vehicles, the countermeasures to prevent mutual collision shall be executed considering following each item, as required.

- (1) The interval time to the succeeding automatic guided vehicle
- (2) The confluent timing of automatic guided vehicle running in confluence
- (3) The opening left by each other automatic guided vehicles passing in opposite directions
- (4) The entering timing of automatic guided vehicles mutually crossing at a cross point

4.5 Running speed

4.5.1 Running speed At the passing road occupied by both automatic guided vehicle and a person, the running speed of automatic guided vehicle shall not exceed the speed capable of stopping quickly by detecting obstacle. Automatic guided vehicles shall be equipped with the speed selecting function which can run safely according to the situation of surrounding. Except the automatic guided vehicles of which running speed is fixed at a speed low enough to be safe in the vehicles' working environment.

4.5.2 Slow down At the specified place or when the obstruction approaching detector is actuated, automatic guided vehicles, for securing safety, shall slow down.

4.6 Emergency stop

4.6.1 Meaning and types of emergency stop Emergency stop means to stop quickly the operating action, such as running, transship, etc., of automatic guided vehicle, and it brakes power source and stops the vehicle emergently, when operated or functioned any of the following items.

- (1) **emergency stop button**
- (2) **obstacle contact bumper**
- (3) **out of track**
- (4) **overspeed**

4.6.2 Emergency stop devices and function Automatic guided vehicles shall be provided with the following emergency stop devices and function, and, when any one of them is operated or actuated, shall stop the vehicle emergently.

- (1) **Emergency stop button** The emergency stop button or the like shall be provided at a position where a person can operate easily. The emergency stop button shall be red colour and marked with letters such as emergency stop button.

And, when the ground side control box controls the guide track, the function that can immediately stop automatic guided vehicle in the case of emergency shall be provided.

- (2) **Obstacle contact bumper** Automatic guided vehicles shall be provided with an obstacle contact bumper without such strong pressing force as to injure the human body at the time of actuation.

- (3) **Out of track** The function that automatically gives an emergency stop, when an automatic guided vehicle runs out of the guide path or guiding the vehicle becomes impossible, shall be provided.
- (4) **Overspeed** The function that stops the vehicle in emergency, when the running speed exceeds the specified limit and may interfere the safety operation, shall be provided.

4.6.3 Marking of emergency stop The fact that it is in the situation of emergency stop shall be marked by means of sound, light, etc. on the body of automatic guided vehicle that is able to be recognized easily by a person.

4.6.4 Resetting after emergency stop When the emergency stop is actuated, it shall be reset after the causes are removed and safety is confirmed.

5 Safety keeping in the stage of introduction preparing and operating

5.1 Introduction preparing stage

5.1.1 Confirmation and arrangement of working environment Confirmation and arrangement of working environment shall be as follows.

- (1) The possibility that workers, observers and the like may intrude the track of automatic guided vehicle, and that automatic guided vehicles use the passing road jointly with the other vehicles such as a fork lift or a platform car, shall be checked, and the counter-measures shall be taken beforehand.

The place where those persons have some possibility suddenly to contact with automatic guided vehicle because of the poor visibility should preferably be installed an access alarming device on ceiling, wall and so on to alarm the access of automatic guided vehicle previously.

The crossing of heavy traffic volume, where the other vehicle such as a fork lift or a platform car cross with automatic guided vehicle, should preferably be installed a traffic signal, a crossing gate and so on.

- (2) In the case where a building has an auto-door, an elevator and so on which interlock with the running of automatic guided vehicle, the countermeasure shall be taken beforehand.
- (3) There may be some possibility of influence by disturbance into automatic guided vehicle and its peripheral equipments from the environmental condition of structural equipment such as plant, illuminating equipment, lighting equipment and so on. Therefore, check on the environmental condition concerning the noise shall be taken beforehand, and the measure to reduce disturbance and to prevent intrusion shall be taken.

5.1.2 Arrangement of the track and the road surface Arrangement of the track and the road surface shall be as follows.

- (1) When the track of automatic guided vehicle uses the public track in common, the space for the pedestrian to refuge shall be maintained.