Application Discussion and Inspection on the Unintended Car Movement Protection System

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Abstract. As the amount of using elevators and annual elevators grows, the injury accidents still happen frequently every year under the circumstances of elevator manufacture and maintenance available. Most accidents result from the failure of door system and breaks which causes shearing and crushing. The Unintended Car Movement Protection System (UCMP) is listed into the national mandatory criteria to prevent injury accidents. In this paper, the composition of UCMP is simply analyzed, and inspection method is discussed.

1. Introduction
With the development of the economy, elevators are widely used in modern buildings and provide great convenience to the residents in daily life. But the increasing injury accidents follows on account of unintended car movement according to the investigation and pose a threat to the safety of human life and property which may cause social fears. So it is imperative to add the unintended car movement protection system in the elevator to ensure the normal use of the vertical space of the building and the safety of residents.

Last year, an injury accident happened in Qingdao. An old lady took the elevator upstairs in the hotel with her granddaughter, but they fell into the elevator well and died instantly. Investigators found that the clearance between the brake drum and the brake linings was too small due to the maladjustment. After a long time of high-speed rotation and intense friction, the surface of the brake linings was worn out and the friction factor of the brake drum reduced which caused low breaking torque. The car couldn’t remain stationary because of the lack of the breaking force and it fell down by the gravity of the counterweight even though the hall door and the car door opened after the elevator leveled to the station.

2. Unintended Elevator Car Movement
2.1. Definition of Unintended Car Movement
Unintended car movement refers to a extremely dangerous circumstance that the elevator car leaves the stop station in the unlocking area without receiving any instructions when the hall door and the car door are unlocked [1, 2]. Most unintended car movement may cause crushing injury shown in Fig.1 and shearing injury shown in Fig.2.
2.2. Cause of Unintended Car Movement

The causes of Unintended Car Movement can be listed as follows: failure of breaking system, short circuit of door system, lack of traction force and so on.

At present, elevator is working under traction driving mode. When the traction sheave rotates, the car moves up and down by the traction force created by the friction between the traction sheave groove and the wire ropes. The traction force will lessen when the traction sheave groove has been seriously worn out so that the wire ropes will slip in the traction sheave groove which causes unintended car movement [3].

When an elevator stays static state, the brake linings cling closely to the surface of the brake drum without any slide. But the breaking system cannot hold static if the brake linings have been seriously worn out or some grease is left on the surface of the brake drum which may cause unintended car movement [4].

The door system is damaged most in all systems for its high frequent usage. The door lock device may be short circuit to ensure elevators operation by the maintenance personnel and they will often forget to remove the short wires form the door lock device after repairing which may cause elevators moving while the door system is opening.

2.3. Solutions

The unintended car movement protection system is written into the Elevator Manufacture and Secure Installation Standards (GB7588-2003+XG1) to prevent unintended car movement from happening. The elevator car can be stopped timely and reliable by this device to avoid shearing and crushing injury which can improve its safety performance and protect passengers [5].

3. Unintended car movement protection device

The protection device that can stop the elevator car when unintended car movement caused by the failure of any unit of tractor or control system happens under the circumstance of the hall door and the car door unlocked [6]. The device is consist of detecting subsystem, breaking subsystem and self monitoring subsystem.

3.1. Detecting Subsystem

Detecting subsystem is a signaling device that can detect the risk of unintended car movement and whether it happens, and send breaking orders. The standard requires that electrical safety devices correspond to the standard requirement can detect unintended car movement at the latest of the car leaving the unlocking area on the premise of the door system unlocked [7].

Detecting subsystem includes sensor detecting unintended car movement and arithmetic circuit logic operating the signal detected. The most common detecting sensors can be listed as follows:
position signal switch fixed on the top of the car, centrifugal type of over speed governor detecting unintended car movement, absolute position sensor in the well etc.

3.2. Breaking Subsystem
Breaking subsystem can distinguish the instructions from the remote control platform and stop the elevator car from running away to protect the passengers [8]. The breaking component is one of the important part of the breaking system. There are two triggered ways according to the trigger mode. Over speed governor switch, photoelectric position signal, electromagnetic induction signal and absolute position sensor signal can be triggered by electric device while counterweight safety gear, wire rope gripper and gearless machine break can be triggered by mechanical device.

The breaking subsystem acts on the counterweight or the car to stop the car by triggering the counterweight safety gear or the bidirectional safety gear, acting on the wire rope to stop the car by triggering the wire rope gripper, acting on the traction sheave to stop the car by triggering the machine break.

3.3. Self Monitoring Subsystem
It is necessary for synchronous tractor configured with self monitoring subsystem when the break is taken as breaking unit. The subsystem should contain the device that can monitor whether the break releases or not and the system that can monitor the breaking torque cyclically [9]. The subsystem can close the door system when monitoring abnormal data and prevent the elevator from normal operation.

4. The inspection of unintended car movement protection system

4.1. The Method of Detecting
In the newly published Regulation for Lift Supervisory Inspection and Periodical Inspection, it is written that move the car up at the testing speed according to the certificate of type test when the car is in the upper well with no load. The breaking unit can be activated after the car moving up and the car can be stopped by the break merely. Judge the distance whether it is out of the range according to the certificate of type test after measuring the movement. If the redundant break is used as the breaking unit, the door system can be locked and the elevator car stays static when the failure of the break releasing or the lack of the breaking torque is detected [10].

4.2. Test Procedure of UCMP of Elevator with Machine Room
The tested elevator is a 1000kg passenger elevator and the running speed is 1.0m/s.

Set up barrier at the testing floor or arrange exclusive people to watch the floor otherwise unauthorized person may come into the car.

Move the car to the testing floor and make sure that the locking signal lamp of the door system is on after the hall door and the car door close.

Use dedicated server to enter menu and set parameter to activate the UCMP function.

Check the parameter setting again and enter testing menu to choose moving direction.

Confirm the load of the car, and make sure that the car with no load when going up while with full load when going down.

Remove the UCMP plug-in unit which means the locking signal lamp of the door system is off and start the test of UCMP.

Move the car up and measure the vertical distance between the car door sill and the hall door dill after the car stops

Insert the UCMP plug-in unit and return the elevator back to normal service.

The procedure of the test in shown in Fig.3.
Figure 3. Test Procedure of UCMP.

The measurement is shown in Fig.4, and we can see the distance is 0.063m.

Figure 4. The Distance of two Door Dills.

According to the parameter configuration of breaking subsystem shown in Table 1, the distance of this test is less 0.315m which means the function of UCMP of this elevator meets the requirements of the Regulation for Lift Supervisory Inspection and Periodical Inspection.
### Table 1. Parameter Configuration of Breaking Subsystem.

| Parameter                        | Value                  |
|----------------------------------|------------------------|
| System capacity range            | 3200~12400kg          |
| Breaking system type             | Break                 |
| Forced component                 | Traction sheave       |
| Testing speed                    | 0.15m/s               |
| Highest speed before slowing down| 1.098m/s              |
| Working environment              | Indoor                |
| Load capacity range              | 750~2000kg            |
| Lift driving mode                | Traction mode         |
| Trigger type                     | Electrical triggering |
| Response time                    | ≤300ms                |
| Permissible distance at the testing speed | ≤0.315m             |
| Trigger device                   | Controller            |

5. **Conclusion and Expectation**

The unintended car movement protection system can effectively protect the passengers from unintended car movement injury. There are just inspecting rules for the UCMP breaking subsystem and self-monitoring subsystem in the newly published regulation without any for the detecting subsystem. So it is of great necessity for the detecting subsystem to be inspected, and the breaking subsystem could not be activated if the detecting subsystem could not detect the unintended car movement when it happens. More resource should be invested in further research of UCMP and detecting methods should also be improved gradually. Only in this way can the safety performance of elevator be improved and the sense of security for passengers be guaranteed.

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