Experimental research of the application of turning method in the non manipulative reverse protection of VVVF escalator

Jun Ou1, Aiguo Liu1,2, Xinmin Dong3*, Yang Zhao4, Changjie Li1, Peng Cai1,2
1Henan Institute of Special Equipment Safety Inspection and Testing, Zhengzhou, China
2National Center for Quality Supervision and Inspection of Overhead Gantry Cranes and Lightweight Hoists, Xinxiang, China
3Zhengzhou University, Zhengzhou, China
4University of New South Wales, Sydney, Australia

*Corresponding author e-mail: 289326660@qq.com

Abstract. Of escalators and moving sidewalks manipulation reversal protection device, the regular inspection and test is a standard, safety technical norms and requirements, is the important way to verify its validity function. Barring method applied in the field of frequency conversion of escalators and moving sidewalks reversal protection device for validation test, need to interrupt the motor running, because some automatic frequency conversion electric control system of escalators and moving sidewalks and protection function of frequency converter, cause in the process of test control system will automatically stop the escalator running, thus make barring method test cannot continue. Based on the analysis of frequency conversion control principle, design of ac electronic load circuit, to replace the inverter output load motor way, without changing and adjusting the original escalator and frequency converter control system, under the condition of on-site test is an effective method. Results show that using ac electronic load circuit, parts for frequency conversion escalators and moving sidewalks manipulation reversal protection device, technical measures for barring method test is feasible and solves the part of detection frequency escalators and moving sidewalks than manipulation reversal protection device, in stop problems in application of barring method test.

1. Introduction
Escalators and inclined automatic walkways (hereinafter referred to as escalators), due to their special structure and arrangement, will directly cause the upward escalator to suddenly reverse due to faults, overloads, and other causes during the normal operation. Accidents such as accumulation, extrusion, and stamping caused injuries or injuries[1]. In order to prevent such accidents from occurring, the escalator is provided with a non-manipulation reverse protection device, and whether the non-manipulation reversal protection device provided for the escalator can effectively prevent non-manipulation reversal accidents is an important content of the inspection.

The installation supervision and periodic inspections conducted at the construction site and the use site are important systems for verifying the effectiveness of non-manipulation reversal protection devices for escalator equipment. However, in the current standards and safety technical specifications, no specific test method has been given for the inspection of the escalator non-manipulation reversal
protection device. In recent years, relevant domestic scholars have conducted intensive and meticulous research on the test methods for non-manipulation reversal protection of escalators. Zhang Yun[2] discussed the inspection methods of three different modes of non-manipulation reversal protection devices; Xia Yanxia[3] analyzed six inspection methods for non-manipulation reversal protection devices. All of them have also analyzed and explored the method of using the crank method. Because of its simple and convenient operation, the disc brake method is a star-triangle (Y-△) drop in the direct drag mode of a three-phase AC asynchronous motor. Pressure activated escalators are widely used.

2. Existing test methods existing problems and solutions
At present, among the several testing methods that perform on-site testing and verification of the escalator non-manipulation reversal protection device, the disc brake method is widely used. It is a manual test method that drives the detected escalator to reverse the working conditions to verify the effectiveness of the escalator non-manipulation reverse protection. When the test method is used for testing and testing, the first part of the operating procedure is to normally start the escalator up, and then manually cut off the power supply of the escalator drive motor to drive the motor to stop running. At this time, the vehicle is first to be rotated in a selected direction (e.g., upward), and the response status of the tested escalator device is observed. Then, the vehicle is reversed according to the reverse direction (for example, downward). At this time, the escalator to be tested should have a corresponding response status, and the result of this response state is determined, so as to determine the non-manipulation reverse protection of the tested escalator device (device). Whether the function is effective and meets the requirements[4].

With the above-described test method for the disc brakes, when the non-manipulation and reverse protection of the escalator and the moving walk of the AC direct drag mode is tested, the operation of the driving motor can be interrupted at any time, and there is no problem. For escalators and moving walks driven by frequency converter technology, when testing the non-manipulation reversal protection with the disc brake method, the fault protection starts due to the open circuit output of the inverter[5], i.e., the inverter's no-load fault protection. As a result, the entire escalator equipment will be automatically shut down, and the test for the next step will not be possible. Because, according to the characteristics of the escalator's variable frequency operation mode, when the power supply to the driving motor is cut off, the load circuit of the frequency converter is disconnected, then the output of the frequency converter is in the state of “open or phase loss” and the frequency converter will start. Output the under-phase fault protection, the inverter will display “external” fault and stop[6-8]. At the same time, the inverter's control circuit will feedback this signal to the escalator control system. The escalator control system will start fault protection due to the open circuit of the motor[9], cut off the control circuit and safety circuit of the escalator, and force the escalator to stop operation. At this time, if you insist on the use of disc brakes to conduct inspection tests, it is often very easy to cause misjudgment of the test results, interfere with and affect the correct judgment of the non-manipulation reverse protection (device) test results. Therefore, it is difficult to test, test and test the non-manipulation reversal protection (function) of frequency conversion escalator by field application of disc brakes.

In order to make the car rolling method be applied on the frequency-variable driving escalator, the design of the circuit using AC electronic load[10],[11] is studied to solve the problem of inverter's no-load fault protection. This scheme uses AC electronic loads to simulate different combinations of resistors, inductors, and capacitors, as well as certain characteristics of non-linear loads[12] to simulate the drive motor of an escalator to replace the protection problem of the open-circuit load of the inverter and thus to provide frequency conversion. Driving the escalator to use the disc brake method to realize the non-manipulation reversal protection field test verification has opened up a convenient test route.

3. Principle of experiment using AC electronic load circuit
By analyzing the working principle of the frequency conversion control and the reference materials related to the application of the frequency converter, the author proposes a technical scheme of using
an AC electronic load device to replace the electric motor equivalently, and studies the equivalent circuit DX shown in FIG. Simulate the escalator's AC motor and successfully complete the verification test of the escalator's non-manipulation reversal protection site. The application of this technical solution also solves the problem of the old frequency-variable-driven escalators being missing and missing technical data and unable to adjust their procedures for testing, and does not require the use of a programmer or debugger to adjust the program parameters in the escalator control cabinet. Field testing is convenient, safe and easy to implement.

3.1. The composition and working principle of the test device
The test device for AC electronic load circuit is mainly composed of circuit breaker Q, AC contactor C and equivalent motor AC electronic load circuit DX. The control circuit is mainly composed of circuit breaker Q, single-phase switch K and AC contactor C control coil[13]. The main circuit input terminals are U21, V22, W23, the output terminals are U11, V12, W13, and the power input terminals are A11, A12, as shown in the dashed box circuit in FIG.

The principle of applying AC electronic load circuit to test is: when it is necessary to disconnect the motor power supply during the test, the AC electronic load circuit is connected to the main circuit of the inverter, and the AC drive is operated under analog conditions through the AC electronic load circuit. The control circuit of the escalator continues to operate, so that the next step of the test can continue.

Its working process[13] is: closes the circuit breaker Q in the control circuit, the alternating current contactor C attracts, the C main contact conducts, the main circuit input terminal U21, V22, W23 and the output terminal U11, V12, W13 conducts C The auxiliary contacts are open, terminals L21, L22, L23 are disconnected from T21, T22, T23, and the main circuit input terminals are disconnected from the equivalent motor load circuit DX. When the single-phase switch K is disconnected, the AC contactor C is released in the control circuit, and the main circuit input terminals U21, V22, W23 are disconnected from the input terminals U11, V12, W13; the C auxiliary contacts are conducting, and the terminals L21, L22, L23 and T21, T22, T23 conduction, the main circuit input terminal and the equivalent motor load circuit DX connected.

3.2. Connection between the test device and the tested escalator equipment
Disconnect the detected escalator main power switch, disconnect the three-phase power supply line at the input end of the drive motor, and connect the escalator control cabinet inverter INV output terminal with the drive motor M1 three-phase power input terminal.

The input terminals U21, V22, W23 of the test device[13] are connected to the corresponding terminals of the three-phase power output terminals U1, V1, W1 of the main circuit of the frequency converter driven escalator control cabinet; the output terminals U11, V12, W13 It is connected with the corresponding terminals of the three-phase power input terminals U1’, V1’ and W1’ of the detected variable-frequency drive escalator motor M1; the power input terminals A11, A12 are taken from the power supply L1, L3 of the detected variable-frequency drive escalator or are transformed The other power supply. The connection circuit diagram is shown in Figure 1.

4. The mechanism and procedure for conducting the test
4.1. The mechanism of the car test
The AC electronic load circuit device is connected to the escalator control cabinet according to the connection of FIG. And check the reliability and insulation of the wiring, and confirm the correctness before testing. The action mechanism of the non-manipulation reversal protection test by the disc brake method[13], [14] is:

(1) When the escalator is operated in the selected direction, the trigger mechanism of the non-maneuvre reverse protection device shall not trigger a "reverse" signal detection sensor (or microswitch), or (and) the non-manipulation reverse protection device detection system should not output "Reverse" signal.

(2) When the escalator is reversed, the triggering mechanism of the.
Figure 1. Connection diagram of AC electronic load circuit and escalator control cabinet.

non-manipulation reverse protection device shall trigger the 'reverse' signal detection sensor (or microswitch), or (and) non-manipulation reverse protection device detection system output "reverse" signal. At this time, the service brake and the additional brake (if any) should be braking and the escalator should be stopped. At this time, the control system of the escalator emits an audible and visual warning signal, and displays the fault code (if any), and the fault displayed by the escalator is locked (if any), and the next operation operation cannot be performed.

(3) When the "reversal" signal detection sensor (or micro switch) triggered by the triggering mechanism of the non-manipulation reverse protection device is in the triggering state, or when the non-manipulation reverse protection device detects the output "reverse rotation" signal of the system, then the selected signal is selected. When the escalator is started in the direction, the escalator shall be unresponsive, or after the escalator is started, the service brake and the additional brake will immediately generate a braking effect, and the escalator will stop operating.

(4) Manually reset the fault lock (if any) of the detected escalator, the sound and light alarm signal stops, and the fault code disappears (if any).

4.2. Test procedure
The flow chart of the application of the AC electronic load circuit to the field test of the car rolling method[13] is shown in Fig. 2.

Specific test procedures[13], [14] are as follows:

(1) For the "reversal" signal input of the reverse protection device, the escalator with "zero speed (or underspeed)" protection principle is used. The field test should confirm in advance whether the distinction is "zero" of the escalator control system itself during the test. The speed (or underspeed) protection function is active; otherwise, the "zero speed (or underspeed)" protection function of its escalator control system should be released.

(2) Cut off the total power supply of the detected escalator. Between the escalator inverter and the drive motor being tested, connect the AC electronic load circuit test device according to the corresponding wiring sequence.

(3) Select a running direction of the detected escalator and start the detected variable-frequency driving escalator, for example, in the upward direction. After running for a period of time, disconnect the single-phase switch K in the AC electronic load circuit test device.

(4) Operate the manual disc brake device to drive the detected escalator with a manual disc brake and rotate in the direction of the operation (such as the upward direction). The relative distance of disc
movement should be overridden by the non-manipulation and reversal detection device of the detected escalator. The location of the role.

(5) operating the manual disc brake device to drive the detected escalator (for example, in the downward direction) in the reverse direction of the selected direction, so that the detected escalator passes the position where the non-manipulation reversal detection device triggers in the reverse direction, and automatically The escalator working brake brakes, the system issues a fault alarm, shows the acousto-optic signal, and the fault is locked (if any).

(6) Manually reset the fault lock of the detected escalator (if any), and the fault alarm is released.

(7) Repeat the test twice (3) to (6).

(8) Remove the AC electronic load circuit test device, restore the normal escalator wiring and protection functions, and the escalator can operate normally.

5. Conclusion
Using the AC electronic load circuit equivalent to replace the motor makes the escalator complete system in a normal state, so that the test of the non-maneuvering reverse protection device function of the escalator can be verified on-site. This scheme not only solves the problem of “open circuit” of the motor winding. In the following, the inverter's "idling" protection may cause damage to the inverter module, and is not limited by the type and setting method of the non-manipulation reverse protection device of the detected escalator equipment. The test method has wide applicability and operability, and is suitable for testing, testing and testing of various types of frequency-variable driven escalators. It does not change the control system function of the escalator itself, which is detected by the variable frequency drive, and provides an easy and quick method for the inconvenience of obtaining technical data or the difficulty of on-site debugging of the frequency converter when the old frequency-changing

![Test program flow chart](image-url)
escalator and the automatic sidewalk are encountered. The test scheme has made up for the inadequacy of the prior art in applying the disc brake method for verification tests.

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