



臻善圈決賽隊伍提案摘要 Project Summaries of WIT Finalists

改善單向導通裝置消除鋼軌絕緣節打火問題

Improving Unidirectional Conductive Device- Eliminating The Problem of Arcing in Rail Insulation Joints



圈員資料 Team's Information

成立日期 Date of Team Formation 01/2015

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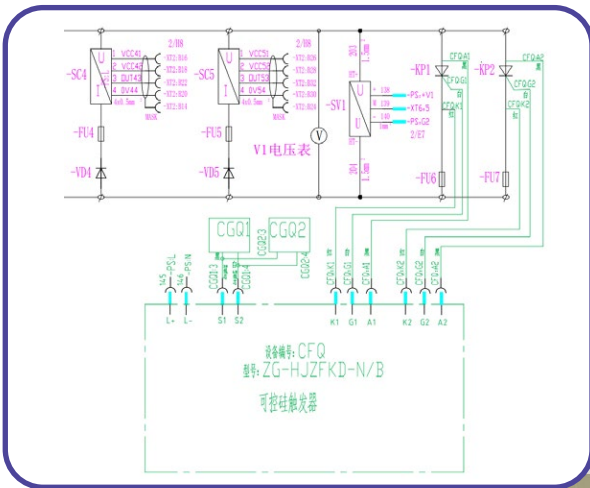
問題剖析 Problem Analysis

- 國標規定車輛段與正線鋼軌的交界需設絕緣節，實現電氣隔離。這導致絕緣節兩側出現電壓，位於停車場及車輛段出入段線處的單向導通裝置用於消除電壓差。
- 目前，京港地鐵14號綫的單向導通裝置，僅能在鋼軌絕緣節兩側電壓差大於10V的條件下觸發，且其觸發方式較為單一。
- 列車車輪瞬間通過鋼軌絕緣節時，由於無法提前觸發單向導通裝置消除電壓差而產生打火現象，會造成鋼軌損傷，甚至影響人身、設備安全與運營。
- National standards stipulate that insulated joints are required between depot and mainline tracks to achieve electrical isolation. This creates a voltage difference on both sides of the insulated joint, which can be eliminated by installation of a unidirectional conductive device at the access line of the stabling area and the depot.
- Currently, the unidirectional conduction devices on Beijing MTR Line 14 can only be triggered when the voltage difference on both sides of the rail insulated joint is greater than 10V, and the triggering method is relatively simple.
- When train wheels pass through the rail insulated joint instantaneously, the unidirectional conduction device cannot be triggered in advance to eliminate the voltage difference. The resulting arcing can cause rail damage and even affect personal safety, equipment safety, and operations.

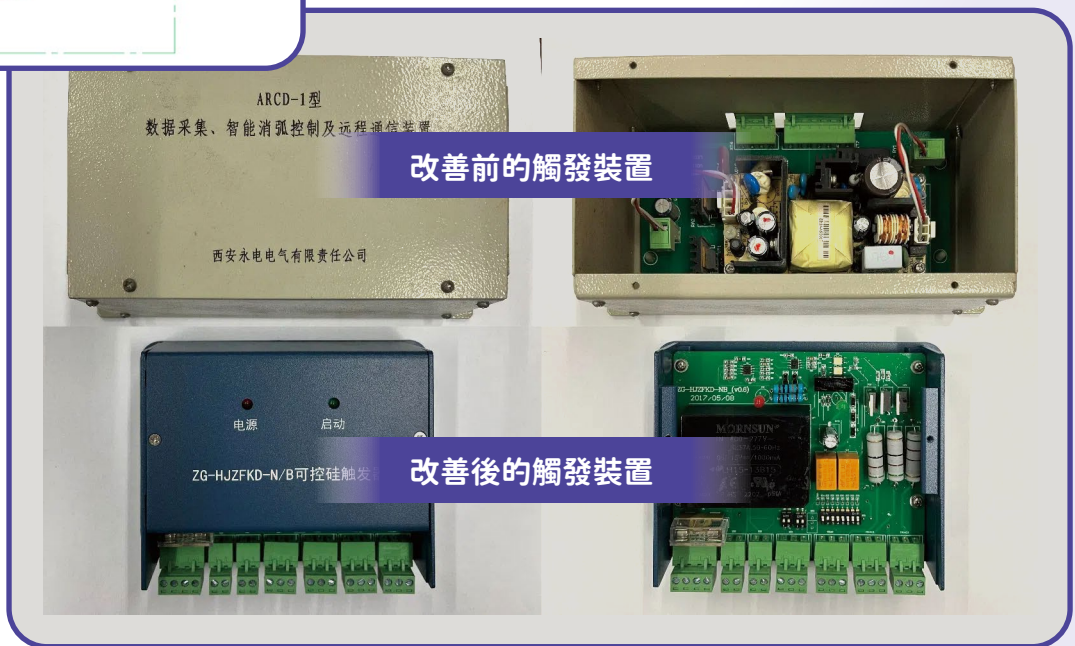


改善方法 Improvement Methods

- 圈組首先深入研討單向導通裝置工作原理，充分瞭解其外部改善成本，通過思維工具分析後，確定自行對裝置進行改善。
- 組員先剝離裝置內原有的脈衝輸出盒、智慧消弧控制及遠端通訊裝置，並將其更換成更先進的可控矽觸發器，同時增設紅外感測器，以便提前獲取列車行進位置資訊。
- 通過多次現場實際踏勘，線下搭建工裝測試平台等方式進行上百次驗證後，最終實現在保留原有電壓差觸發的前提下，解決鋼軌絕緣節打火問題。
- The group began by conducting an in-depth study of the unidirectional conductive device's working principle to fully understand the costs of external improvement. Following a thorough analysis with various thinking tools, the group decided to improve the device themselves.
- We first remove the original pulse output box, intelligent arc suppression control and remote communication device and replace them with the advanced thyristor trigger. An infrared sensor is also added to easily obtain the information of train position ahead of time.
- After hundreds of verifications through on-site inspections and setting up an offline tooling test platform, the arcing problem of the rail insulation joint is solved while preserving the original voltage difference trigger.



改善後單向導通裝置設計原理接線圖
Wiring Diagram of the Improved Device's Design Principle



改善前後的觸發裝置對比
Comparison of Trigger Devices Before and After Improvement



改善前的鋼軌



改善後的鋼軌

改善效果對比
Comparison of improvement effects



總結成果 Summary of Achievements

有形得益

- 自主改造單向導通裝置後，14號綫節省更新改造費用逾80萬元，既有綫全部設備升級可節省近206萬元。
- 大幅降低鋼軌的絕緣節打火的頻率，降低絕緣材料損壞率，並提升出入段線4台裝置的可靠性、安全性、有效性，為鋼軌提供更好的保護。

Tangible Benefits

- By renovating the unidirectional conductive device in-house, Line 14 saved more than 800,000 yuan in renovation costs, with a potential saving of nearly 2.06 million yuan if the improvement is extended to all existing lines.
- It significantly reduced the occurrence of arcing from insulated joints, and lowered the damage rate of insulating materials, thereby improving the reliability, safety and effectiveness of the four devices installed at the entry and exit section lines, and providing better protection to the rails.

無形得益

- 在考慮安全性及成本的基礎上，圈員利用現有設備進行改造，將原理論與現場試驗相結合，多角度分析問題，大幅提升專業技能和業務水準。
- 圈員從對設備的被動監測改進為主動操控，不僅防患於未然，更可提升設備安全性。
- 透過共同探索、嘗試、複盤，增強了圈員們的團隊協作能力，為今後更多工作改進積累經驗。

Intangible Benefits

- Based on the considerations of safety and cost, the team members renovated existing equipment, combined theoretical principles with on-site tests and analyzed problems from multiple perspectives, thereby significantly enhancing their professional skills and proficiency.
- Shifting from passive monitoring to active control of the equipment, the team members not only prevented potential issues but also enhanced the equipment's safety.
- The team enhanced their collaboration skills and accumulated valuable experience for future improvement work through cycles of joint exploration, experimentation, review.