Interlock Control System for New 7000 Series Rail Cars Access Platforms

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Abstract *— New 7000 Series Rail Cars bought have the A/C units located on top and access platforms have been built and installed at each Shop in order to access these units for maintenance purposes. With this, a safety issue of fall risk has been identified from either, by leaving swing or sliding gates unintentionally opened. As a result, a complete assessment has been developed including going through the proper problem solving and decision making processes in order to provide the best solution and path forward for solving the safety issue. Therefore, after a complete analysis, it has been determined to install an automation system to control swing and sliding gates for different scenarios associated to whether the train is present or not. Consequently, based on the plan, this will establish the required controls to mitigate the fall risk hazard in order to provide the employees a safe work environment.*

Key Terms *— Assessment, analysis, control system, design, safety*

INTRODUCTION

Washington D.C. Metropolitan Area Transit Authority has purchased new 7000 Series Rail Cars as part of the new upgrade made to replace old rail cars within the Metrorail system, which service Maryland, Virginia and Washington D.C. With this, one important difference of these new trains is that the new rail cars have the A/C units located on top instead of the bottom location like the old ones. Therefore, in order to provide maintenance to new A/C units, access platforms have been built and installed in multiple shops located in the yards within the Metrorail system. So, because of the installation of these access platforms, a safety concern was brought up to the attention of engineering and other disciplines as part of the responsibility of the employer to provide a safety work environment to all workers.

Furthermore, since access-platforms are elevated and there are swing and sliding gates, and if any of these are left behind opened accidentally or unintentionally, there would be a risk of falling off the platform.

After identifying the issue, a technical evaluation took place in order to provide options to solve the safety concerns as indicated previously. As a result, an assessment was performed by reviewing the structural drawings and walking through the shop as part of the process of gathering the information. The following information was obtained:

- The number of swing and sliding gates in question.
- Possible locations of all field devices like solenoid gate locks, open/close sensors, swing gates operators, etc.
- Electrical power requirements.
- Existing Programmable Logic Controller (PLC) including its conditions.

Subsequently, after having accurate information, a problem solving process was put in place in order to provide feasible solutions to solve the safety issue. So, based on a complete analysis of the overall assessment, it was determined that automatizing the access platforms was the best option to mitigate the problem. The following are established method to accomplish this:

- Locking sliding gates when train is not present in order to avoid any worker to be able to open the gate by accident and fall off the platform. This includes disabling swing gates operators so these cannot be functional as a safety precaution when the train is not present.

- Workers being able to open sliding gates and close swing gates when train is present so they can work safely on the maintenance of the A/C Units located on top of the train.

TOPICS OF DISCUSSION

The following are the key areas of discussion directly associated to the development process to assess and review the information including the implementation of the most feasible option to solve the safety issue that has been identified:

- Evaluation of access platforms built and installed for shop employees to work on the maintenance of the A/C Units located on top of the new 7000 Series Rail Cars.
- Assessment of installed access platform including existing conditions.
- Field survey to identify existing conditions of power and controls.
- Implementation of the Decision Making and Problem Solving techniques in order to identify potential solutions to solve the safety issue.
- Based on the outcomes obtained from previous topics included here in this section, project objective or goal is to provide a safe work environment to all workers.
- Risk of falling off the platform has been identified as a potential "safety issue". Accordingly, all the details shown previously are required to be evaluated and implemented as part of a final resolution and determination to meet the objective of the project.

METHODS AND ANALYSIS

Typically, engineering problems are worked through by using many different tools and procedures in order to get to the most feasible solution related to the problem-solving process. In this section, the approach used to select the most practical option to addressing the safety issue is shown.

Survey and Assessment

As part of the collection of information from a complete assessment and the development of the plan to works towards meeting the objective of solving the safety issue through using the problem solving technique, the following are some of the tools or methods utilized:

- Organization's safety policies and standards.
- Power meter to check space capacity from existing electrical panels.
- Outlook for coordination and email communication including the effective use for scheduling progress and discussion meetings as well.
- Digital camera and computer used to document existing site conditions to be included in the data collection process.
- Adequate journal and progress reports as part of good documentation practice and technique.
- Search engine to look for parts and equipment.

Decision Making and Problem Solving

Establishing the correct techniques and methods is always vital for solving problems. In this case, Decision Making and Problem Solving processes were used in order to perform a complete analysis to determine the best solution. As a result, the following problem solving process was established:

- Identify the problem, which has been confirmed as a "Safety Issue".
- Analyze the problem based on the information gathered which was the result of a complete assessment and field survey performed.
- Establish possible feasible options that would be available to solve the problem. In this case, the most acceptable option was the installation of a new interlock control system for swing and sliding gates. See that gates will be controlled through a new PLC system based on different scenarios regarding whether the train is present or not. The other option, which was not acceptable, was more focused on retraining the employees on safety while working on

access platforms at the Shop. However, since humans commit accidents unexpectedly, this did not ensure a considerable minimization of the safety risk.

- Select the most feasible option. As mentioned before, it was determined to install a new interlock control system for swing and sliding gates.
- Implementation of the chosen option. With this, a complete electrical and control design has been developed and produced as part of the access-platform automation process.
- Verification of the implemented option chosen. In this case, a comprehensive design review was completed. Afterwards, once the installation stage is finished, installation verification and inspection works will take place including final system commissioning.

Gates Interlock Control System Design Tools and Methods

It is important to use tools, methods, and standards available at the time a design under development. This will help to ensure the complete design and final plan meet construction, installation and testing standards, applicable code, and specifications. Therefore, the following are methods, tools, and standards utilized to develop the plan and design for this project:

- Organization's Design Criteria and Specifications for design development and final implementation.
- ACAD Software to develop the electrical and control design.
- Design review process as part of the methods utilized to revise and correct preliminary designs.
- The use of codes, standards, and guidelines as part of developing and coordinating the plan for testing and final commissioning.
  - Utilization of applicable codes and standards, which are required in order to perform a correct and accurate implementation of the design [1].
  - Testing codes and standards to ensure all electrical testing are accurately performed in order to provide a reliable system to be put in service once the installation process is complete [2].
- Books and guidelines used to develop and complete the project in association with the planning, design, installation and system testing:
  - Automation and protective relays guidelines for controls in order to design a system that goes aligned with the correct control logic [3].
  - Gates' operators manual which provide information on how the system would be incorporated into the design as well as including all operational components and functions to be part of the sequence of operation and control logic [4].
  - Guidelines and standards for correct Grounding and Bonding as part of the safety requirements of the design [5].

Control System Design

As part of the automation process, a comprehensive and logic plan has been put in place in order to satisfy the requirements to control adequately the access platforms gates including sensors. The following are general guidelines established for the operation:

- Based on the proposed design, all gates will be controlled in coordination with train presence/absence status.
- By establishing an automated control system, the access to the platforms will be safer since workers will be able to operate the gates only under certain conditions.
- By establishing an accurate sequence of operation through programming the PLC Control System, it would support the safety protocols associated to control the gates in a way that the personnel is safe.

System Implementation and Installation

Implementation and testing would be the final stage on the process and the most critical one. At this point, the plan and design have to be carried out in an accurate way in order to have a correct and reliable installation. With this, the following are several details regarding information used to ensure quality and the stages of construction and installation:

- High quality installation with the use of guidelines and procedures in order to obtain an acceptable installation of the new proposed control system in accordance with applicable codes, organization's design criteria and specifications including safety standards.
- Coordination of the supervision and inspection of the new control system implementation includes but is not limited to the following:
  - Installation Verification
  - Inspection.
  - Field Acceptance Test.
  - Commissioning.
  - System Turn Over (including turn over package).
  - As-Built Drawings.

Safety

Safety is the focus and main objective of this project. With this, the following represent the expected outcomes after the system is finally completed and in service:

- By the implementation and installation of the proposed gates interlock control system for new 7000 Series access platforms, workers will have a safer work environment.
- Workers will have a complete training regarding the full operation and automation associated with the new interlock control system in order for them to be familiar with it and to follow correct procedures while working at the Shop. In addition, extra safety training would be provided to reinforce the safety mindset and culture within the workplace.

CONCLUSION

It has been established the main objective and purpose of this project which is providing a safe work environment to all employees. That is why it has been developed a complete assessment and analysis including going through the adequate problems solving and decision making processes in order to determine the correct path forwards to solve the safety issue that has been identified.

There have been several gaps where options have been adjusted and modified due to field conditions. However, as part of the complete analysis performed, it has been recognized ways to implement the proposed design by considering alternate solutions and options identified during the problems solving stage. For example, installing a new PLC Panel instead of reusing an existing one so spare I/O Signals can be provided for future applications.

Finally, by using the adequate problem solving technique based on the information gathered, it has been promising to make correct decisions in order to provide a feasible option including reliable path forward with the implementation of the proposed plan. As a result, it was possible to choose the best option to achieve the established objective or goal in order to satisfy the project focus on safety.

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