

## **(12) Title**

Safety Assessment of Closed-Loop Level Crossing Control Systems by Means of Systems-Theoretic Accident Model and Processes (STAMP)

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## **Abstract**

There have been a large number of accidents at level crossings of railways and this has been considered to be a significant issue to be solved for the realization of safe and stable railway transport. Conventional level crossing control equipment consists of two types of level crossing controllers; one detects a train approaching to a level crossing section and the other then detects the train having left the level crossing. By contrast, closed-circuit level crossing control systems in which level crossing controllers and train-borne equipment communicate with each other have been advocated and are expected to serve as an effective solution to the abovementioned issue. This paper describes the following three types of closed-circuit level crossing control systems: decentralized control system, fully-centralized control system and semi-centralized train-based sequential control system. This paper then assesses the safety of these systems in comparison to the conventional level crossing control equipment. For the purpose of the assessment of their safety, a new accident analysis model called STAMP (Systems Theoretic Accident Model and Processes) that is suitable for software intensive systems is used to clarify the advantage of the proposed three types of level crossing control systems in terms of safety.

## **Keywords**

- (1) Level crossing control
- (2) Railway signaling
- (3) closed loop control method
- (4) safety assessment
- (5) STAMP