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Research of EMC Management Plan Optimized for Fuel Cell Electric Vehicle(FCEV)

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Abstract

The electromagnetic characteristics of FCEVs(fuel cell electric vehicles) are much different from the existing combustion engine cars due to the high voltage/current generated by a fuel cell stack which uses a compressed hydrogen gas reacted with oxygen. Moreover, FCEV are equipped with high voltage systems such as motors, inverters, and converters in addition to ordinary electric systems used in existing combustion engine cars. However, there is neither a reference nor a standard for the evaluation of potential hazards due to the safety errors in electric systems of FCEV. Therefore, EMC(Electromagnetic compatibility) management plan for FCEV systems is the most important element to prevent the possible electric functional safety errors. In this paper, a systematic approach in applying the EMC standard for FCEV system is proposed. Firstly, the EMC(Electromagnetic compatibility) management plan optimized for FCEV is suggested. Subsequently, evaluation procedure and consideration for the EMC management plan is introduced.

Keywords: fuel cell, EMC, hydrogen, safety

1 Introduction

The necessity of cleaner and energy efficient vehicles has been glowing rapidly due to great concerns on carbon dioxide(CO_2) reduction and energy shortage. To meet such demands, many car companies have investigated alternative vehicles such as H_2/CNG driven engine and hybrid electric vehicle. Although emissions from new combustion vehicles and hybrid cars are reduced, air quality regulations are not fully satisfied in many counties in the world [1-2].

One of alternative vehicles widely discussed to replace the current internal combustion engine vehicle is FCEV (Fuel Cell Electric Vehicle). This vehicle type is very promising not only for clean operation up to zero emission operation but also for high energy efficiency.

Unfortunately, the electromagnetic characteristics of FCEVs are much different from conventional combustion engine cars due to the high voltage/current generated by fuel cell stack which uses a high pressure hydrogen gas reacted with oxygen. For this reason, optimized procedure and technology for EMC evaluation of FCEVs to

ensure the safety have been regarded as important issues.

However, there is neither a reference nor a standard for the evaluation of potential hazards due to electric safety errors between high voltage/current systems and subsystems or in electric systems of FCEV. Therefore, analysis of electromagnetic characteristics and guidelines for evaluation and safety deign of FCEV are essential to ensure safety and to curtail the development period.

In this paper, the EMC(Electromagnetic compatibility) management plan optimized for FCEV is suggested and then evaluation procedure and consideration for the EMC management plan is introduced

2 The EMC management plan for FCEV

In this paper, the EMC management plan for FCEV is suggested on the basis of the Electromagnetic Compatibility Interference Management of Railway Electrification System [3]. Also, standard documents and technical recommendation, such as ISO [4-7], SAEJ [8-9], and CISPR 12/25 [10-11] are referred. Figure 1 shows suggested the EMC management plan for FCEV.

The first step to ensure the successful practice of the EMC management plan is to set up the technical strategy by clearly defining the category of interference as intra, inter, or extra system interference. And then, EMI/EMS characteristic of each system or subsystem has to be analyzed both by simulation and measurement according to the relevant standard documents

3 The evaluation procedure and consideration for the EMC management plan

To set up the EMC evaluation procedure correctly, the operational environment of vehicle should be understood clearly. Also, the procedure has to be systematic and logical.

When equipment in FCEV are defined as EMC

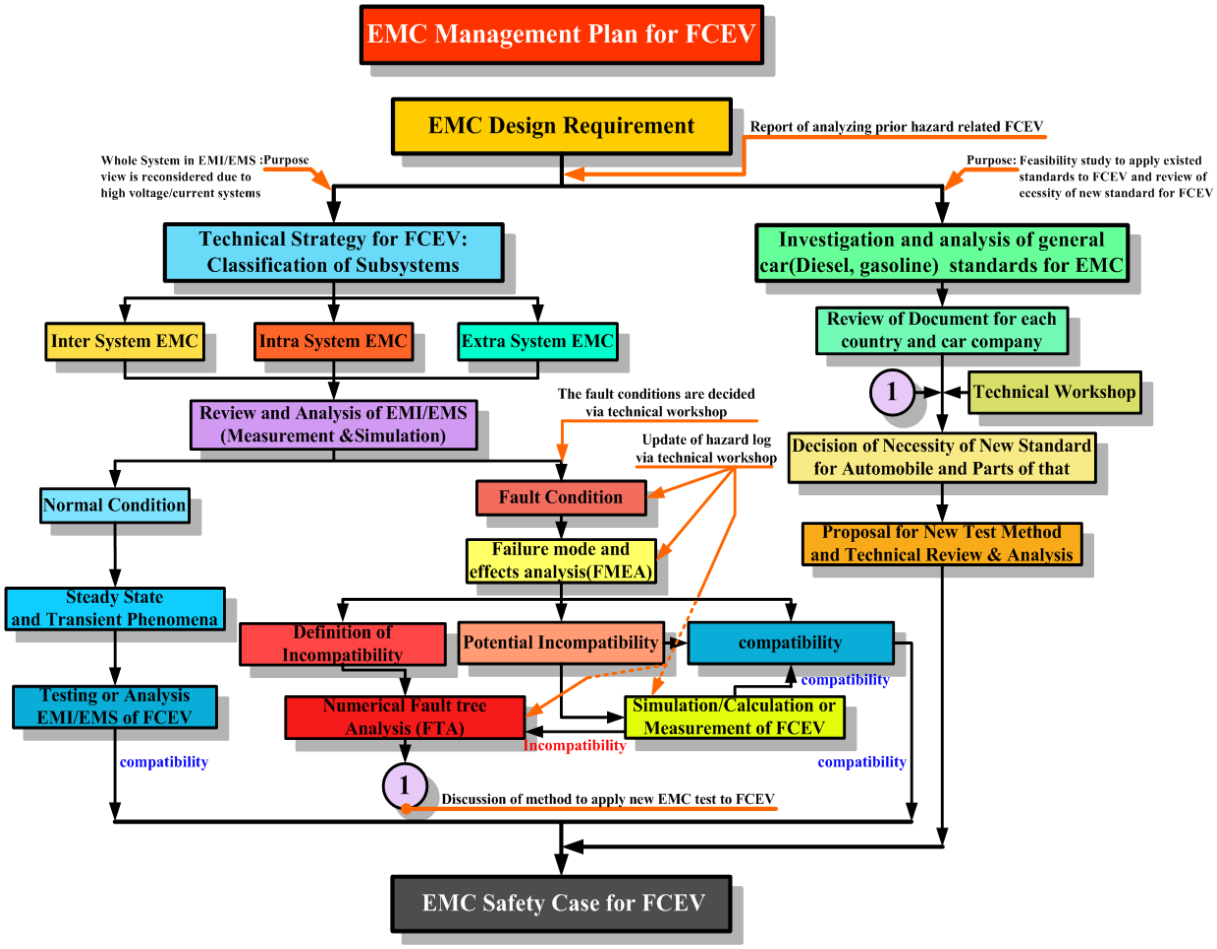

Figure 1: The EMC management plan suggested for FCEV

ensured parts, they need to be categorize as intra, inter, extra, or interface system(or subsystem). The evaluation of equipments associated with normal and fault operation should be executed by using the methods in [4-7]. accompanied with hazard analysis for FCEV. The possible hazard identified through EMC evaluation need to be solved. Some important aspect of EMC evaluation are explained in following sections

3.1 Classification of system EMC in FCEV

All systems in FCEV should comply with international EMC standards and/or applicable regulations. EMC evaluation related to FCEV should include followings;

- The mutual compatibility between components with a designate system(Intra System EMC)
- The mutual compatibility two systems of FCEV(Inter System EMC)
- The radiation from surrounding load, portable wireless transmitter, power line, airport navigation system, underground, train, and local industry as well as the third radiation source outside of FCEV.

Some examples of system EMC of FCEV are listed in Table 1.

3.2 The list of equipments for EMC evaluation

The critical list of equipment related to EMC

Table1: Arrangement of intra, inter, and extra systems for EMC evaluation

	Arrangement of Intra, Inter, and Extra systems for the EMC evaluation							
	Engine management system	Security system	Electric blower controller	Electrical Transmission system	Speed control system	Electric management system	AV instrument package controlled by electric	Extra System of FCEV
Engine management system	Intra system	Inter system	Inter system	Inter system	Inter system	Inter system	Inter system	Extra system
Security system		Intra system	Inter system	Inter system	Inter system	Inter system	Inter system	Extra system
Electric blower controller			Intra system	Inter system	Inter system	Inter system	Inter system	Extra system
Electrical Transmission system				Intra system	Inter system	Inter system	Inter system	Extra system
Speed control system					Intra system	Inter system	Inter system	Extra system
Electric management system						Intra system	Inter system	Extra system
AV instrument package controlled by electric							Intra system	Extra system

safety of FCEV for EMC evaluation is as following;

- Engine management system
- Security system
- Electric blower controller
- Speed control system
- Electric management system
- AV equipment package controlled by electric
- Electrical transmission system
- Traction control system
- Collision avoidance system
- Navigation system
- Steering wheel system
- Communication system
- Tire pressure monitoring system
- Memory system for seats and mirrors
- Stability control system

The data obtained through the EMC evaluation of above listed equipment are critical to analyze the prior hazards of FCEV. They can also provide outline to distinguish equipment among systems, subsystems, and intra subsystems as well as interface of subsystems and to system level design. The list of equipment can be added through EMC management plan.

Figure2: The list of equipment for FCEV

3.3 Categorization of equipment for EMC testing

Equipment can be categorized into two depending on the necessity of obligatory EMC testing

3.3.1 The standard equipment

This type of equipment needs to be tested according to EMC regulation and certification should be submitted

3.3.2 The equipment untested by EMC

The manufactures guarantee the compatibility of designated equipment through their own testing.

3.4 General guideline

Guideline generally applied for automotive EMC design are;

- The isolation and unification of cable system.
- Cable routing and crosstalk rules.
- Shielding condition requested for connector and cable.
- Shielding and architectural shielding of special part of FCEV
- Filter and suppression

4 Conclusion

The major issues associated with the successful integration of electrical system to be used within the fuel cell electric vehicle environment have been reviewed. The EMC management plan very important from the begging stage of a FCEV development to ensure that EMC level is in compliance with relevant regulation.

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