

## Safety Review related to Commercial Grade Digital Equipment in Safety System

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### 1. Introduction

Nuclear utilities are upgrading selected Instrumentation & Control (I&C) equipment because of obsolescence and increasing maintenance costs. Typically, the upgrades include changes from analog to digital technology, and in many cases nuclear utilities consider commercial software-based equipment as practical solution. The upgrades or replacement of I&C systems on safety system typically involve digital equipment developed in accordance with non-nuclear standards. However, the use of commercial grade digital equipment could include the vulnerability for software common-mode failure, electromagnetic interference and unanticipated problems. Although guidelines and standards for dedication methods of commercial grade digital equipment are provided, there are some difficulties to apply the methods to commercial grade digital equipment for safety system. This paper focuses on regulatory guidelines and relevant documents for commercial grade digital equipment and presents safety review experiences related to commercial grade digital equipment in safety system.

### 2. Regulatory Guides and Relevant Documents

KINS(Korea Institute of Nuclear Safety) regulatory guides, KINS/RG-N8.13, 8.15, 8.20 and 17.12[1~4] required that the dedication process of commercial grade digital equipment in safety system meet the requirements and/or guidelines described in KEPIC ENB 6370 [5] (equivalent with IEEE std. 7-4.3.2 [6]) and EPRI TR-106439 [7]. The dedication process shall entail identification of the physical, performance and development process characteristics to provide reasonable assurance that the commercial grade digital equipment will perform its intended safety function. KINS regulatory guides (KINS/RG-8.15, 8.20 and 17.12) endorse KEPIC ENB 6370 and EPRI TR-106439 as a method satisfying the KINS's regulations with respect to the evaluation and acceptance process of commercial grade digital equipment.

These endorsed documents require that the dedication involve all aspects of hardware and software. These endorsed documents provide the dedication process including 1) Identification of the safety

function of commercial grade digital equipment, 2) Identification of critical characteristics, 3) Evaluation of critical characteristics for acceptance criteria, 4) Demonstration for acceptance criteria. The critical characteristic evaluations are divided by physical, performance and development process characteristics as shown in Figure 1. The physical characteristic is hardware aspect and the performance is functional aspect for both hardware and software. The development process is the critical characteristics of software aspect including V&V activities and software life cycle activities. To evaluate and demonstrate acceptability of the critical characteristics, four methods are addressed in EPRI TR-106439 as shown in Figure 1 which is referred method in EPRI NP-5652 [8]. To verify the development process, the characteristic cannot be verified through alone method, should be used in combination of methods.

Furthermore, the dedication process should be controlled in a configuration management process to provide traceability and conducted by qualified dedicicator.

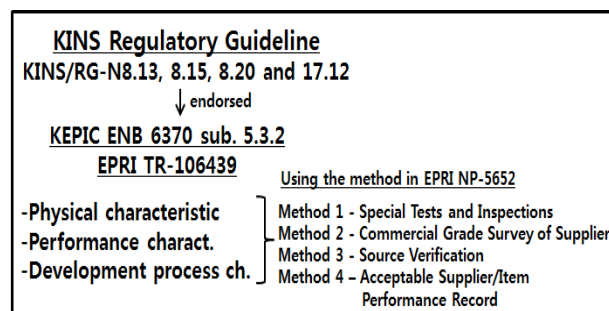


Figure 1. Regulatory guides and relevant documents about the Dedication

### 3. Experience of AC160 dedication

The AC160 platform is used in the Digital Plant Protection System and the Digital Engineered Safety Features Actuation System in Ulchin NPP Unit 5 and 6. The AC160 already produced by ABB as part of their standard product requirements not in accordance with nuclear standards. To use the AC160 on safety system, WEC (Westinghouse Electric Company), as an approved nuclear safety class supplier and has nuclear quality assurance programs including dedication

procedure, conducted dedication for the AC160. WEC issued dedication plan which addressed identification of the safety classification, required acceptance criteria and established evaluation methods. The dedication report by WEC addressed the evaluation review and review for acceptability for some open findings.

#### 4. Safety review of G60

Recently KHNP (Korea Hydro and Nuclear Power) submitted an amendment of Final Safety Analysis Report for replacing the EDG (Emergency Diesel Generator). According to the attached documents, the digital undervoltage relay G60, produced by GE as shown in figure 2, is used to perform the safety function in the local control panel of the EDG and the G60 is a generally used commercial grade digital protection relay in other industry. KINS required the dedication report of G60 and informed the regulatory position as like below

1. Dedication shall be conducted by qualified dedicicator.
2. Dedication including 3 critical characteristics shall be performed in accordance with KEPIC ENB 6370 subsection 5.3.2 and EPRI TR-106439.
3. Dedication shall be controlled in a configuration management process.

After KHNP submit the dedication report and relevant documents, these documents will be reviewed.

provided to verify acceptability of the commercial digital equipment used for safety function.

#### REFERENCES

- [1] KINS/RG-N8.13, Criteria for Use of Computers in Safety Systems of Nuclear Power Plants, 2011.
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- [3] KINS/RG-N8.20, Developing Software Life Cycle Processes for Digital Computer Software used in Safety Systems of Nuclear Power Plants, 2011.
- [4] KINS/RG-N17.12, Quality Verification for Alternating of CGIs in Nuclear Safety-Related Application, 2011.
- [5] KEPIC ENB 6370, Digital Computers in Safety Systems of Nuclear Power Generating Stations, 2000.
- [6] IEEE Std. 7-4.3.2, IEEE Standard Criteria for Digital Computers in Safety Systems of Nuclear Power Generating Stations, 2003.
- [7] EPRI-TR 106439, Guideline on Evaluation and Acceptance of Commercial Grade Digital Equipment for Nuclear Safety Applications, EPRI, 1996.
- [8] EPRI NP-5652, Guideline for the Utilization of Commercial Grade Items in Nuclear Safety Related Applications, EPRI, 1988.

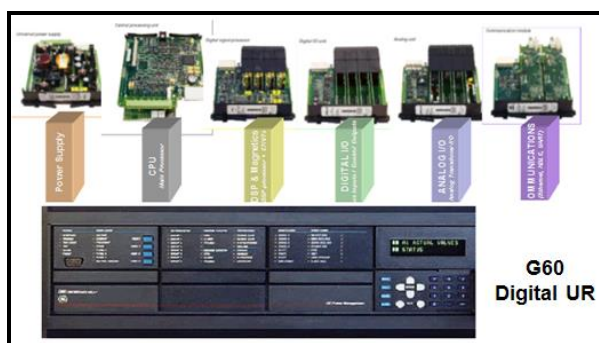


Figure 2. Compositions of the digital undervoltage relay G60

#### 3. Conclusions

This paper focuses on KINS regulatory guides and relevant documents for dedication of commercial grade digital equipment and presents safety review experiences related to commercial grade digital equipment in safety system. Dedication including critical characteristics is required to use the commercial grade digital equipment on safety system in accordance with KEPIC ENB 6370 and EPRI TR-106439. The dedication process should be controlled in a configuration management process. Appropriate methods, criteria and evaluation result should be