

# Challenges for CGD Implementation

kweonwoo SOHN<sup>a\*</sup>, changwhan CHO<sup>a</sup>, sungjong KIM<sup>a</sup>,

<sup>a</sup> *MIRAE-EN Co., Ltd., Disruptive engineering, D403 Daedeok Biz Center, Daejeon, Korea*

*\*Corresponding author: kweonwoo.sohn@mirae-en.co.kr*

\*Keywords: Reverse engineering (RE), RE-based Digital Transformation (REDiX), NQA, CGI(D)

## 1. Introduction

From 1970~1980, the obsolescence of parts and components of mother equipment in operating nuclear power plants(NPPs) has sharply increased. The phenomena have several reasons such as limited market to supplier, small quantity with diverse type of products, the cost of maintaining nuclear quality assurance program [1], and then it became too difficult to find and maintain even the supply chain.

This forces us to explore approaches to reverse engineering and dedication of commercial grade items by investigating modernized and digitized alternatives for the same parts(s) or item(s). For this reason, reverse engineering has become an important field and method for dealing with obsolescence and deterioration, particularly in NPPs [2, 3]. For reference, the reverse engineering infrastructure is being built under the name RE-based digital transformation (REDiX) from both a technical and quality assurance perspective.

In the same context as above, this paper describes the main challenges of dedication and reverse engineering performed in the field. REDiX is the infra structure platform for reverse engineering using agentic AI by MIRAE-EN Co. Ltd.

## 2. Challenges for CGD Implementation

### 2.1 Standard cutoff date and its revision

If the same product cannot be purchased, and some product specifications have changed (required confirmation) as the standard for the existing product (IEC 269) has been revised to IEC 60269 fuse, physical characteristics such as dimensions and materials must be evaluated according to the applicable standard in addition to design characteristics.

### 2.2 Delay of purchasing raw materials

Delays in purchasing raw materials affect the manufacturing and assembly process of target parts/devices, taking a lot of time (advance purchase is required).

### 2.3 The possibility of CoC (Certificate of Conformance) issuance and in-stock lifetime assessment

Even if the same model is confirmed to be in stock, it may not be possible to issue a CoC or the stock lifetime (expected to be confirmed in the product technical specifications) may be an issue.

### 2.4 Parts/devices applicability in mother equipment through original supplier consultation

In case of using alternative parts and/or devices where purchasing the same part is not possible, a technical equivalence assessment must be conducted. In this case, in addition to the technical equivalence assessment, it might be necessary to obtain technical advice/applicability advice from the manufacturer of the device in mother equipment.

### 2.5 SDDR (Supplier Deviation Disposition Report) issuance

If the purchase of an identical part/device is not possible due to differences in certain criteria, SDDR may be required to demonstrate the technical acceptability of using a substitute part(s) or device(s).

### 2.6 Supplier's denial of witness point designation

If supplier is reluctant to be involved in witness of manufacturing process, best efforts to gain the evidences corresponding and supplementing to factory witness such as CoC, manual, technical specification, manufacturing procedure and others may be deemed necessary.

### 2.7 Equipment qualification (EQ) concerns

For examples in case of power supply system, there are typically two types of power supply of linear power supply (LPS) and switch mode power supply (SMPS). SMPS is available in the market with bigger share. But this general type of power supply fails in equipment qualification especially in EMC. This kind of challenge in qualification should be considered in advance to conduct reverse engineering and dedication.

### 2.8 QVDL regarding CGID

When preparing a quality verification document list, you should consider and include at least the following:

- Procurement specification
- Receipt inspection sheet
- CGID plan and reports
- Sampling plan and reports
- Non-CFSI certificate
- Test equipment calibration sheets
- QP and its reports

### 2.9 Deviation and its resolution

During the manufacturing process, product physical properties do not conform to standards, and acceptance criteria vary depending on the manufacturer, intended use, and standard. In practice, unless a significant deviation occurs, compliance with the standards must be achieved by selecting one of the relevant agency's decisions.

## 3. IEE (Item Equivalency Evaluation)

While the goal of reverse engineering is to obtain the same essential elements as the original, the design and manufacturing of the new item are inherently altered. Therefore, such substitutes are generally not considered exact replacements and are in most cases subject to IEE[4].

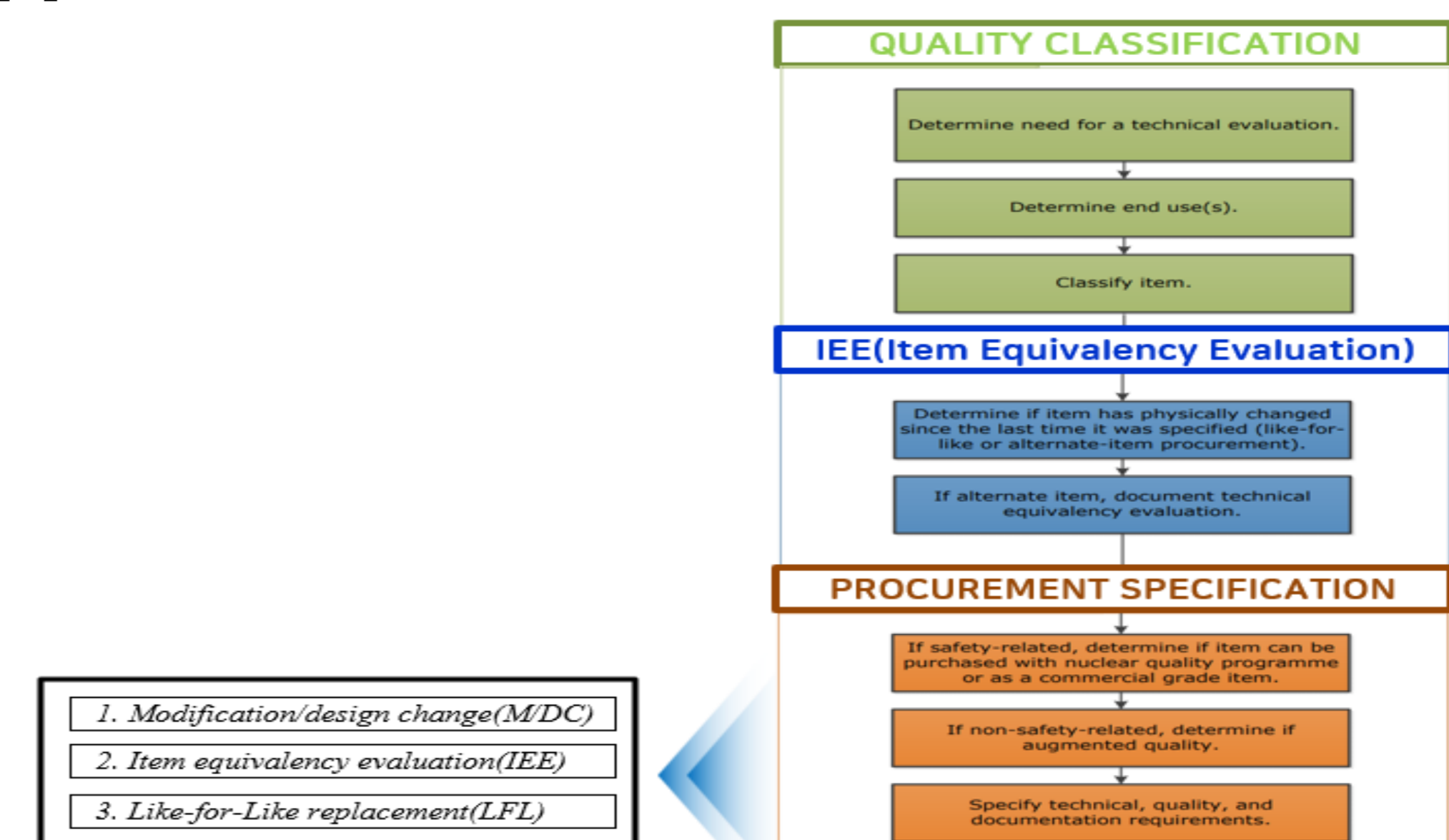


Figure 1 IEE for replacement items

Therefore, IEE must be performed in a sophisticated manner covering technical areas such as physical, design and performance characteristics, quality assurance and procurement engineering as in Figure 1.

## 4. Measuring effectiveness of RE

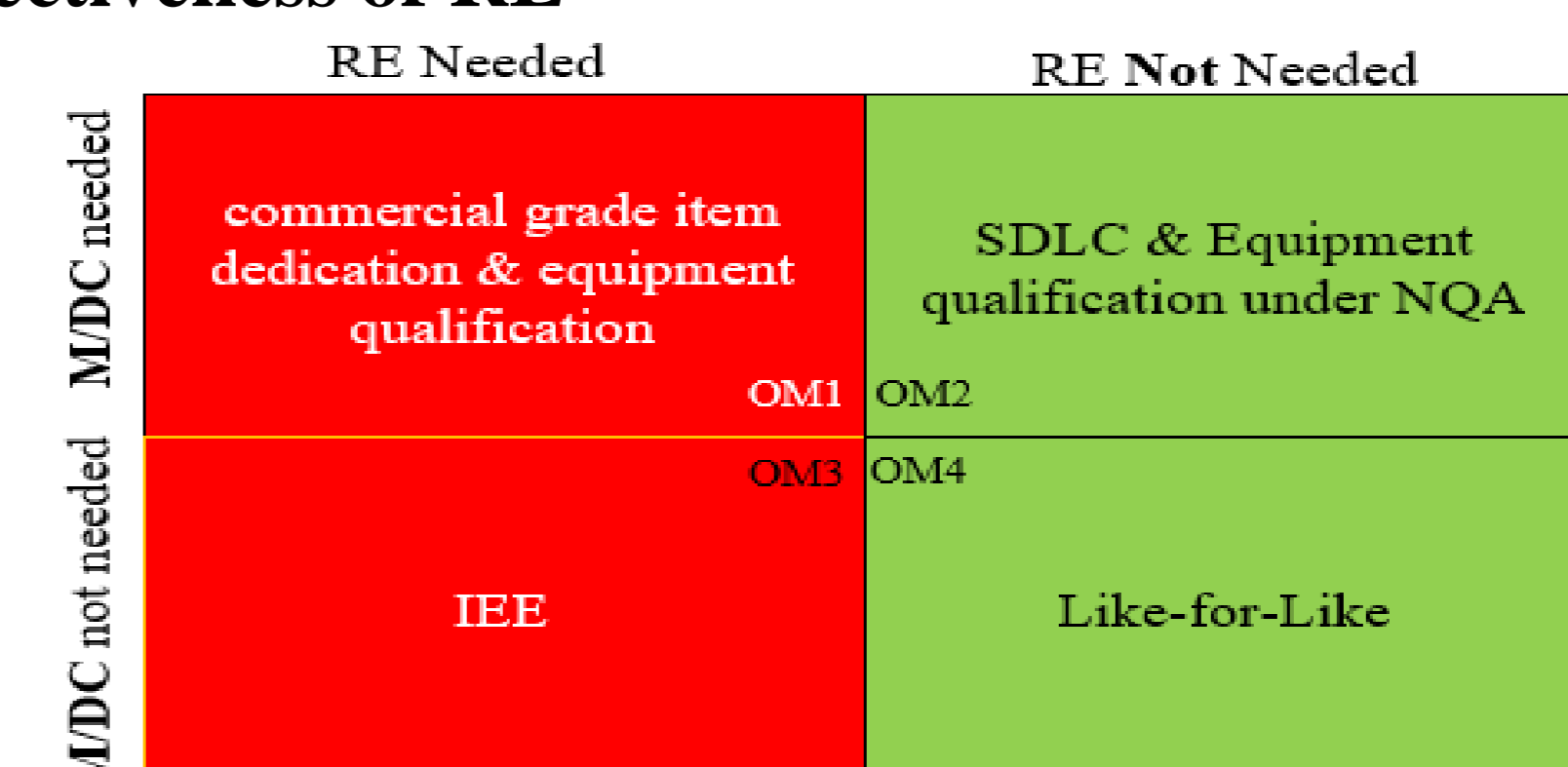


Figure 2 Effective metric for RE

Modernization programmes in part to address obsolescence concerns, include parts substitutions or major modifications.

As one of the major modifications, digital upgrades, for example, often involve replacing multiple individual analog components with a single digital multi-function controller. Therefore, it's advisable to evaluate the effectiveness of reverse engineering and modification/design change (M/DC) for the replacement components as in Figure 2.

## 5. Legal implication

Reverse engineering does have legal implications in the areas of patent protection, intellectual property, trade secrets, copyright protection and theft. When performed ethically, reverse engineering is legal in most jurisdictions and is not considered to be a form of design infringement or theft. Legal concerns about reverse engineering should be addressed on a case by case basis with the legal administration department, and proprietary data and intellectual property rights need to be respected[4, 5, 6]. In case by case, there might be engagement of legal administration department.

## 6. Conclusion

In some cases, commercial grade item dedication and reverse engineering performed in the field cannot be standardized due to the outdated technical data packages and contingency. The case presented in this paper is one of such examples. To ensure technical validity of replacement device(s) or item(s), it is desirable to develop diverse and flexible methodologies and decision-making methods such as through quality grade reclassification and interpretation of technical criteria.

In the case of discontinuation of parts due to long term operation (LTO), it is necessary to remember once again that the technical review and purchase of discontinued parts in the early stages are important factors that determine the success or failure of CGD.

## ACKNOWLEDGEMENTS

This work was supported by the Korea Institute of Energy Technology Evaluation and Planning (KETEP) and the Ministry of Climate, Energy & Environment (MCEE) of the Republic of Korea (No. RS-2022-KP002857).

## REFERENCES

- [1] ANSI N45.2.11, Quality Assurance Requirements for the Design of Nuclear Power Plants
- [2] EPRI 3002011678(EPRI TR-107372, Rev.1), Guidance for the Use of reverse engineering Techniques
- [3] NRC Information Notice 2016-09, Recent Issues Identified When Using Reverse Engineering Technologies in The Procurement of Safety-Related Components
- [4] ISO/IEC/IEEE 24641:2023 Systems and Software engineering — Methods and tools for model-based systems and software engineering
- [5] IAEA Safety Standards SSG-48, Ageing management and development of a programs for Long Term Operation of Nuclear Power Plants
- [6] IAEA Safety Reports No. 82(Rev 2), Ageing Management for Nuclear Power Plants: International Generic Ageing Lessons Learned (IGALL)

<sup>1</sup> REDiX is the infra structure platform for reverse engineering using agentic AI by MIRAE-EN Co. Ltd