Efficient Management Strategies for Nuclear MMIS Engineering Deliverables

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1. INTRODUCTION

To satisfy the technical standards in the field of Man-Machine Interface Systems (MMIS) for the Czech new Nuclear Power Plant (NPP) project, systematic requirements analysis and management activities are essential. In particular, IEC 61513, a key technical standard for Instrumentation and Control (I&C) systems in European NPPs, has rarely been applied to domestic nuclear projects. Therefore, a comprehensive review of this standard and the establishment of an efficient management scheme for MMIS deliverables are crucial [1].

This paper systematically examines the documentation and maintenance requirements for MMIS deliverables specified in IEC 61513. Furthermore, the latest systems engineering standards, ISO/IEC/IEEE 15288 and ISO/IEC/IEEE 15289, are analyzed to facilitate effective documentation during the operation, maintenance, and repair phases [2,3]. By comparing and analyzing these international standards with current domestic nuclear operating practices, this study derives an optimized management scheme for MMIS deliverables suitable for the new NPP project.

2. Documentation Requirements for Operation, Repair, and Maintenance

2.1. Documentation Requirements in IEC 61513

Section 8.3 of IEC 61513 specifies that chronological documentation regarding operation, repair, and maintenance must be maintained. It also mandates that operating records undergo periodic reviews to evaluate adverse performance trends and unacceptable degradation of I&C equipment, ensuring that appropriate corrective actions are executed.

These requirements imply that the operating conditions of the system must be periodically identified and recorded. Through rigorous review of operational records, any system impacts or defects resulting from operation must be identified, and a structured documentation system must be established and maintained to evaluate and mitigate faults that may affect normal plant operation. Additionally, Clause 6 of IEC 61513 specifies documentation throughout each system development phase; most development deliverables required in this clause are actively produced during the MMIS design and manufacturing stages.

2.2. Domestic Technical Standards

The domestic technical standards corresponding to IEC 61513—namely IEEE Std 603 and IEEE Std 7-4.3.2—do not explicitly define the operational, repair, and maintenance documentation requirements set forth in IEC 61513 [4,5].

2.3. Supplementary International Standards

To bridge this standard gap, supplementary systems engineering standards were analyzed. ISO/IEC/IEEE 15288 defines a comprehensive set of processes across the system life cycle, providing a foundation for establishing system environments comprising methods, procedures, techniques, tools, and training. Complementing this, ISO/IEC/IEEE 15289 provides requirements for identifying and planning specific information items (documents) to be developed and revised throughout the system and software life cycle.

3. Review of Operating Procedures in Domestic NPPs

3.1. Procedures for Operation, Repair, and Maintenance

In domestic APR1400 NPPs, system operating procedures are established and implemented for major MMIS systems. In addition, alarm response procedures are operated for the Main Control Room (MCR). Regarding repair and maintenance, core operating procedures, preventive maintenance procedures, and periodic test procedures are developed and managed for primary MMIS subsystems.

3.2. Evaluation of Existing Procedures

An evaluation of domestic NPP practices confirmed that documentation encompassing operation, repair, and maintenance is well executed through the current operating procedure architecture. These procedures encompass most of the provisions outlined in ISO/IEC/IEEE 15288 and ISO/IEC/IEEE 15289 [2,3].

Specifically, the system operating procedures describe detailed operating sequences for major MMIS systems. The maintenance procedures specify personnel qualification requirements, maintenance protocols, post-maintenance system restoration, and required test equipment. Furthermore, periodic and routine test procedures outline surveillance testing, periodic inspections, and calibration protocols essential for continuous system operation. Inspection results are formally recorded and maintained using standardized log sheets.

4. Conclusions

To address the operation and maintenance documentation requirements of IEC 61513 [1], the latest international standards, ISO/IEC/IEEE 15288 and ISO/IEC/IEEE 15289, were reviewed. An analysis of operating procedures in domestic APR1400 NPPs confirmed that existing procedures closely align with international requirements, properly supporting the operation and maintenance of MMIS systems [2,3].

However, compared to ISO/IEC/IEEE 15288 and 15289, certain areas—such as system performance monitoring during operation/maintenance and dedicated user manuals—require further enhancement in domestic procedures. Therefore, by developing supplemented procedures that incorporate these missing elements, the Czech new NPP project can fully satisfy both IEC 61513 and ISO/IEC/IEEE 15289 documentation mandates while meeting owner requirements.

Furthermore, to achieve efficient management of MMIS life cycle deliverables, the current vendor-dependent documentation scheme must transition toward an operator-driven Configuration Management System (CMS). Korea Hydro & Nuclear Power (KHNP) currently conducts configuration management utilizing Configuration Management Information System (CMIS) and SAP enterprise systems. To maximize operational efficiency, configuration management must systematically incorporate operating experience and plant design changes. Establishing standardized identification numbering and naming conventions will ensure seamless configuration linkage across all plant units. This systematic enhancement will serve as a strategic foundation to strengthen plant operational safety, system reliability, and regulatory compliance.

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