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Comparison of Nuclear Fuel Management at U.S. Nuclear Utility and KHNP

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1. Introduction

Changes of reload core design for economic efficiency, such as extended reload cycle, power uprate and license renewal, can cause the changes in safety margins, peak power and burn-up trends in the core. The changes of reload core design can increase the risk of various kinds of unusual core power distribution such as AOA (Axial Offset Anomaly) and, at worst, CILC (Crud Induced Localized Corrosion). In short, because the importance of reload fuel change management is emerging as a major configuration management issue, nuclear utilities should have an appropriate self-review and work process for reload design or reload fuel change management. From this background, this study will be conducted by choosing the US utility Exelon as a leading fuel management organization and comparing their fuel change package and reload design management know-how with our core group.

2. Comparison of Core Operation at U.S. Nuclear Utility and KHNP

2.1 Reload Core Design Process

Normally both factors decided upon by vendor (supply assembly design and fabrication method, etc.) and those decided upon by utility (enrichment setting, cycle length, design input, burnable poison, water chemistry, operating strategy, etc.) are considered as the key components of core design plan. At Exelon, engineers develop their own core shuffling strategy. After seeking PLP (Preliminary Loading Pattern), Exelon develops a final CLP (Candidate Loading Pattern) with their vendor (Westinghouse) design group by co-location. Also, Exelon collaborates with vendor using an E-Room, which is a web-based enterprise contents management system (ECMS), and shares all documents needed or produced during the reload design process. On the contrary, KHNP had only the review process of PLP developed by vendor (KEPCO NF), and did not have the technical capacity of reload design review or its own design capacity for the 10CFR50.59 configuration management. However, from 2010, KHNP began a study for the development of an optimal reload design and fuel change management process. And, while implementing the self-design and comparing the results with those of the vendor, KHNP is also seeking a working process that will allow it actively to participate in core design in order to fit it to the purpose of the utility and the regulatory body's configuration change and reload safety management.

2.2 Related Procedure

The procedures are very important in forming the rules and operations of the utility's task because these procedures standardize the area, responsibility and performance methods for prescribed tasks and play an important role as a training document for successors. Exelon NF (Nuclear Fuel division) has many procedures such as corporate procedures, T&RM (Training & Reference Materials) and procedures for specific sites, etc. Our utility has a 'Standard Technical Administration Procedure', but more specific and systematic procedures will be needed and have to be implemented thoroughly for the overall design process.

2.3 Management of reload fuel design configuration change

The management of reload fuel design configuration change is very important because various reload inputs would change cycle by cycle according to the changes of plant status and the utility's plans for design improvement, maintenance, license environment change, equipment deterioration, and so on. Especially, the review process or capacity of the core design input and its loading pattern risk assessment are highly significant because such procedures can find the configuration (input) errors and operating risks that cannot be evaluated during the vendor design process. Exelon developed a cooperative working process and has been operating a verification process for various aspects of configuration change management through FCP (Fuel Change Package), RDOT (Reload Design Overview Team), SMDI, RRB, etc. to prevent various design errors. Also, the risk of design error can be prevented in advance through reload design risk assessment, which evaluates the various operating core risks of the cycle. During this risk assessment, the utility can find AOA prevention loading pattern, RCS water chemistry adjustments for CILC prevention, power distribution feedback for the next cycle, and so on. KHNP lacks this working process, especially, and therefore our utility needs a specific plan to develop optimized reload configuration change management and risk assessment processes and procedures.

Table I: Comparison of core operation between KHNP and Exelon

	KHNP	Exelon
Core operation	▪ LP development by vendor ▪ Review LP result from vendor ▪ Weak risk assessment ▪ Using UCMS for reload configuration management	▪ PL developed by co-location ▪ Robust detailed procedures ▪ Risk assessment by vendor and utility ▪ Using e-room for reload configuration management
Relations with vendor	▪ Private contract ▪ Design verification by vendor	▪ Not private contract ▪ Share all processes for common profit ▪ Cooperative verification of PLP
Advantag-es	▪ Effective communication by small group ▪ Effective distribution of responsibility and authority	▪ Leading role in core design ▪ Strong reload risk assessment procedure ▪ Cooperation for safety and economic efficiency of full fuel cycle
Disadvan-tages	▪ Difficulty to build up ability of professional engineer ▪ Passive role in core design and lack of verification	▪ Complicated process ▪ Deficiency of flexibility in operating experts

3. Conclusions

Establishing a process of configuration management for reload core design and investigating reload core risk in advance with accumulated operating experience are very important. For this reason, this study compared the working process of an advanced utility in the US with our operation. Particularly, we are now in the final stage of development of the KARMA-ASTRA code, our first unique brand core design code. So, now it is very important to develop a process of optimized core design and configuration/risk management. Especially, the cooperation of utility and vendor is important for efficient and safe reload design. And, the developed process should facilitate informational exchange and cooperation activities between utility's operation and vendor's design experience. The development of risk assessment procedures has become an urgent assignment to decrease various deviations between design and operation, such as AOA, CILC, RCS temperature stratification, error of estimated critical boron value, and so on.

REFERENCES

[1] Exelon "NFM(Nuclear Fuel Management) Operation Procedure"
[2] Exelon "FCP(Fuel Change Package) Procedure"
[3] "Westinghouse Performance Indicators" written by Exelon
[4] "Exelon Reverse Feedback" written by Westinghouse
[5] KHNP Operation Procedure
[6] KHNP "Standard Technical Administration Procedure"