Review of the Optimization Strategies with respect to the Technical Issues for a Long Term Spent Fuel Storage

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1. Introduction

Cask design for a long term storage needs continuous improvements until the closure of a final repository system since the durations, burnup and storage quantities are not defined as yet. Optimization which considers various technical issues for a cask design is expected to provide a better cask design. Also an optimization is needed because the cask designed for a disposal will include assumptions of an excess conservatism that result in the cask designs having reduced capabilities and cask performances such as assembly performance capacity. By implementing an optimization, a burnup capability can be improved in spite of fixed cask safety limits such as external dose rates and fuel temperature limits. In this sense overall procedures of an optimization and specific optimization issues under various technical areas with respect to the circumstances of Korea are reviewed for beneficial results.

2. Optimization Process

2.1 Conceptual Optimization of a long term dry storage system

Optimization is a part of a design process in which a combination of application objectives, safety limits, design, regulatory practices, and costs is evaluated. And each of these several technical disciplines should be innovatively addressed and judiciously balanced in the final design.

As shown in fig 2.1, an optimization is divided into two parallel stages, each with design, fabrication and operation phases. Practice stage proceeds with a prototype design using the existing tools in four principal technical areas, an optimization within each area, and then proceeding to prototype fabrication using the established methods to test the ease of fabricating the design, and then to the test for a

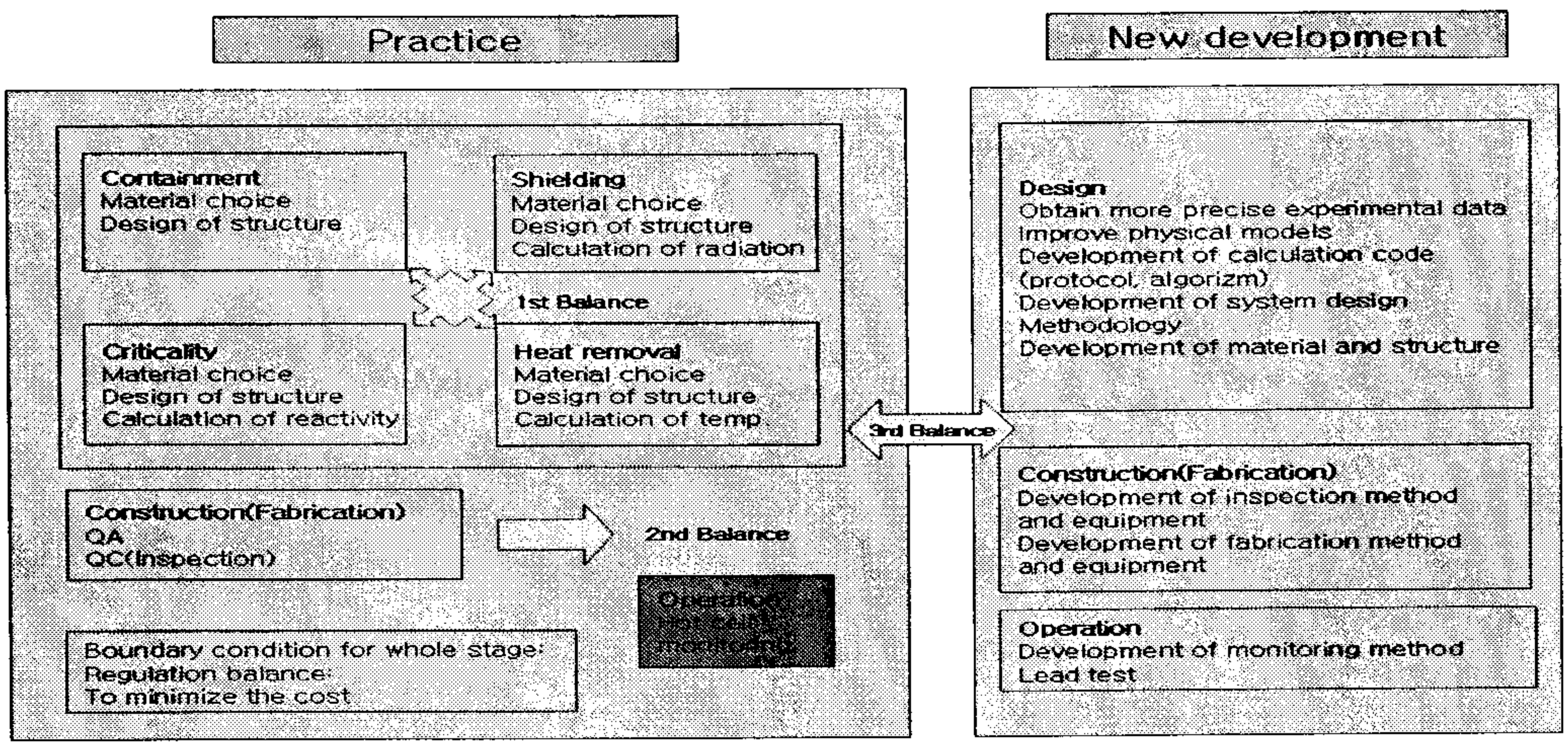

Fig 2.1 Optimization stages for a long term dry storage

design operability and a ease of monitoring. Then the new development stage proceeds in parallel without interfering in the parallel prototype design activity, but it develops improved fabrication approaches and a new test and monitoring approaches.

3. Optimization Issues

3.1 Cask type selection

The continuing trend of increasing fuel element burnups and specific powers leads to an increase of the decay thermal power and source term, especially the additional decay heat and neutron production in MOX elements. At the same time, cladding temperature criteria and limits for fuel elements become more and more stringent.

Optimization consists of a selection of materials with appropriate combinations of a high performance in multiple technical areas, such as their shielding, thermal conductivity, and strength attributes, so as to be more efficient for an overall safety function. This may require an aggressive development and demonstration of new materials. An additional goal of an optimization of a material performance is an identification of the material performance margins that lead to the simplification of a safety analysis and to the related simplification of a license.

3.2 Thermal performance

There are two aspects to be considered when dealing with an optimization of the thermal performance of casks: optimization of the loading itself and an optimization of the cask design to accommodate a higher thermal load. The zoning approach which is the simplest method of a non-homogeneous cask loading is a clear example of the first consideration. The use of better shielding materials with higher allowable temperature limits and the employment of more accurate or less conservative computational models and tools are examples of the second optimization route of accommodating higher thermal loads.

3.3 Radiation source terms, shielding, and dose limits

The overall optimization challenge is to undertake realistic reductions in the conservatisms in the shielding regulatory practices, to make improvements in the current shielding safety analysis methods and in their supporting data, and to achieve the best among and within the alternative potential shielding design performance tradeoffs. Another principal optimization challenge is to best balance in the tradeoff between the largest practicable assembly capacity of a cask and a cask's burnup/age radiological capability relative to the spectrum of fuel types and characteristics in an intended application.

4. Conclusion

Overall procedures of an optimization for a long term spent fuel storage and optimization issues under a few technical areas are reviewed for a better cask design of a conceptual disposal system in Korea. A primary result of a successful design optimization is expected to be a licensed cask of a superior assembly and burnup/age capacity that minimizes the total number of cask loadings required to manage a given SNF inventory over a long term. An equally important and parallel benefit is that an optimization also results in a reduced overall radiation exposure, thereby contributing to the ALARA objectives for reducing all radiation exposures. More issues under technical areas need to be studied for a more detailed optimization until the final closure of a repository system.

REFERENCES

[1] IAEA, Optimization Strategies for Cask Design and Container Loading in Long Term Spent Fuel Storage(2006)