Design Concepts of Re-verification System on the MACSTOR/KN-400

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1. Introduction

The MACSTOR/KN-400 module is based on the MACSTOR- 200 design but has twice the capacity and thus twice the number of storage cylinders. In all, the new module contains 40 dry fuel storage cylinders, each of which houses 10 spent fuel baskets. The storage cylinders are arranged in 4 rows of 10, with 24 located close to periphery of the module and 16 located internally at some distance from the peripheral walls.

Re-verification is an IAEA safeguard requirement to measure the gamma dose rate and spectrum of each irradiated fuel basket once the storage cylinders are filled with spent fuel. This is required to monitor the presence of spent fuel in the storage cylinders. To achieve this on the existing MACSTOR-200, a re-verification tube, running inside the module walls, is provided for each storage cylinder. The gamma profile is read by lowering a detector inside the tube so that it can be registered at the level of each basket. For the 24 peripheral storage cylinders this method of measurement is retained on the MACSTOR/KN-400 module. However, an alternate method is required for the 16 internal dry fuel storage cylinders since they are located some distance from the module walls and thus surrounded by storage cylinders[1].

The focus of this paper is to describe a new re-verification system that can be used to measure the gamma profile of each cylinder.

2. Methods and Results

2.1 Design Motivation and Requirements

The IAEA needs to be able to insert appropriate gamma detector along the containers so that the resulting radiation trace would have characteristics as follows[2]:

- The radiation trace must be reproducible, which means the detector location relative to the container must be reproducible for instance by use of a tube guiding the motion of the probe along the container.
- The radiation recorded in the radiation trace must originate from the container and the background originating from surrounding containers must be negligible or at least can be corrected.
- The presence of irradiated fuel in the container must reflect in the radiation trace so that a pattern indicating actual presence of all loaded baskets in the container is visible.
- The radiation traces should be changed when significant change occurs in loading(i.e. retrieval of spent fuel from the basket must result in decrease of the recorded signal).

2.2 Measurement Principles

The re-verification system can be divided in to three main components: the gamma detection system, the position sensing system, the data acquisition system.

As the gamma detection system ascends the verification tube, it sends pulses to the MCA. The MCA processes the pulse information while at the same time passing all the raw data. The MCA sends the raw and processed data to the data acquisition software onboard the laptop where it is recorded to a data file.

An encoder, located on the wheel next to the speed controlled motor, is used to determine the angular velocity of the wheel. The signals of the encoder are received by the data acquisition software and used to derive the detector's linear velocity and position as a function of time.

The data acquisition software receives and compiles the gamma and position data. The gamma and position are all parametric functions (functions of time). These parametric functions are combined to give count rate as a function of detector position, also known as the radiation profile.

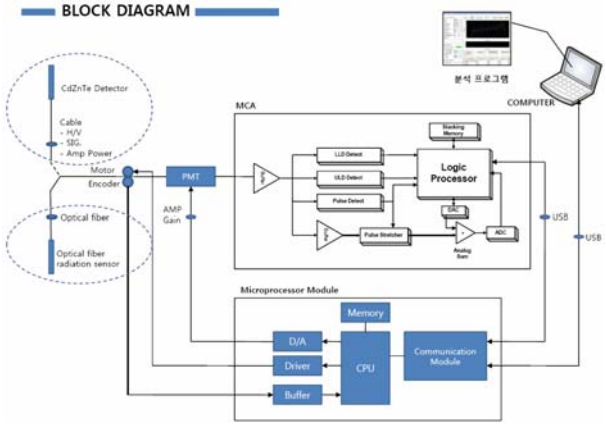

Fig. 1. Schematic diagram of conceptual re-verification system design

2.3 Operation and Use

The operation, data acquisition, and will be limited to a single software that will be developed. The operation procedure is illustrated in Fig. 2.

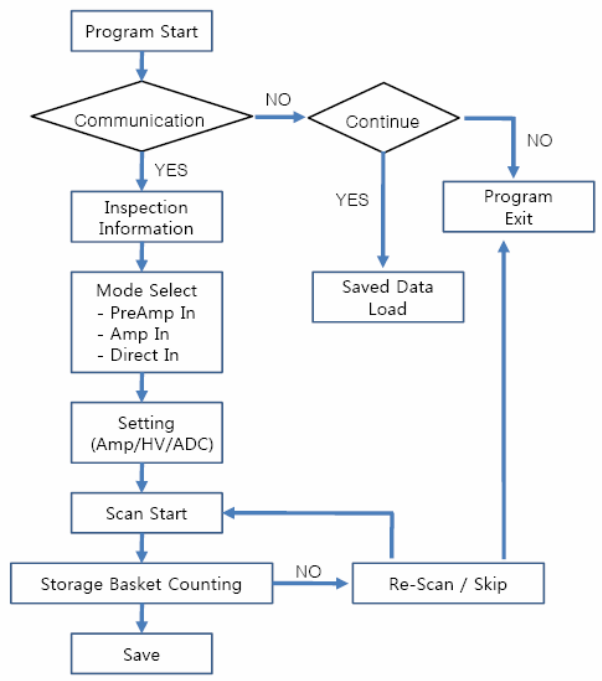

Fig. 2. Flowchart for measurement procedure of re-verification system.

2.4 Current Status

The conceptual design for the re-verification system was shown in Fig. 1. Some decisions have already been made regarding specific components and functions of the re-verification system. The prototype of re-verification system has been manufacturing for field trial. All components of the hardware except computer will be encased in an electromagnetic-shielded box. The gamma detection system will consist of a CdZnTe detector or plastic scintillation fiber and UCS-20 MCA.

3. Summary

We are in the process of manufacturing a prototype of re-verification system of MACSTOR/KN-400 to measure the gamma profile. The final goal is to construct a reliable system that shall be miniaturized, whenever appropriate to enhance transportability, to improve the inspectors' working conditions in the field, and to increase equipment utilization and have long life cycle before component obsolescence due to the introduction of replacement technologies.

REFERENCES

[1] Seung Sik Park, Jang Soo Shin, and Jin Kyun Yeo, *Safeguards Approach to the MACSTOR KN-400 Type Dry Storage at the Wolsung Facility*, 49th INMM annual Meeting, 2008.
[2] Letter of the IAEA on the subject of *MACSTOR/KN-400 dry storage*, Jul. 2005.