Establishment of the Design and Testing Methods of Lid Welds as the Confinement Boundary for Spent Nuclear Fuel Storage Canister

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1. Introduction

This paper describes the design and testing methods of lid welds as the confinement boundary for austenitic stainless steel storage canisters. This canister must be designed to protect the release of radioactive materials during the dry storage period [1]. At present, the storage canister developed by KORAD (Korea Radioactive Waste Agency) applies redundant lid and closures that are using the multi-pass weld. We also investigated and analyzed the integrity test methods for the confinement boundary.

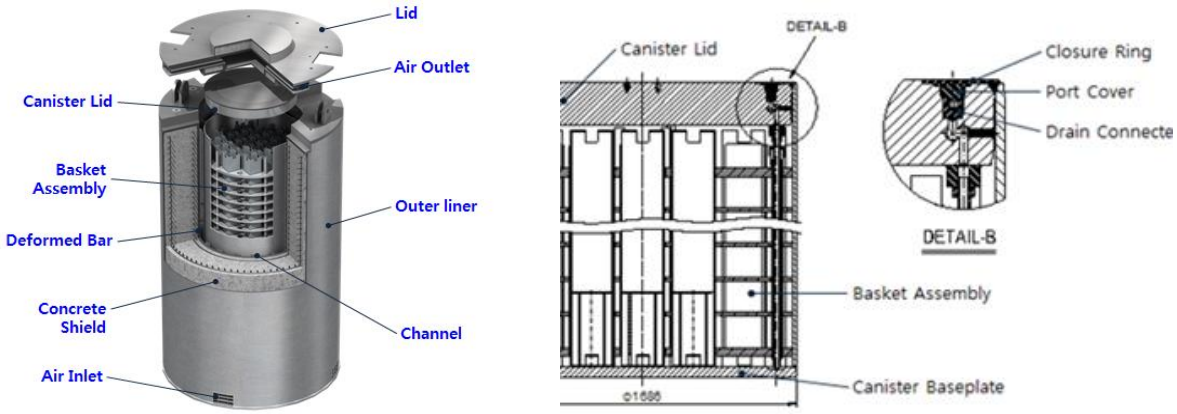

Fig. 1. Conceptual drawing of the concrete storage cask and its canister.

2. Design and testing of lid welds

2.1 Description of storage canister

The storage canister developed by KORAD consists of fuel basket, canister shell, lid and closure plate (Fig. 1). The major components of this canister are made of 2 types austenitic stainless steel (inner parts; SA 204 TP 304 and outer parts; SA 204 TP 316L) considering corrosion and environmental impacts. After spent fuel assemblies are loaded, the canister lid and closure ring plate are sealed by remote welding.

2.2 General Requirements

This storage canister must rely on weld integrity to assure continued confinement effectiveness. The redundant welded closures must be helium leakage tested per the method of ANSI N14.5 [2] or exempted from the helium leakage test according to the "large weld exception criteria design" [3]. In order for closure weld to be exempt from the helium leakage test, all of the following conditions are satisfied;

1) The weld must be multi-pass, with a minimum weld depth comprised of at least 3 distinct weld layers.
2) Each layer of weld may be composed of one or more adjacent weld beads.
3) The layer must be complete across the width of the weld joint.
4) If only three weld layers comprise the full thickness of the weld, each layer must be PT examined.
5) The weld cannot have been executed under conditions where the root pass might have been

subjected to pressurization from the helium fill in the canister itself.

2.3 Test of the Confinement Boundary

This storage canister design meets the "single lid with cover plate" concept(refer to fig. 2). The confinement integrity test should be performed with the following steps;

The first closure boundary(fig. 2, the dotted line marked ①) maintains confinement integrity because one weld meets the large weld exemption criteria and the other(drain and vent port) weld was He leakage tested. Thus, this first closure boundary meets the guidance by ensuring at least one of the two redundant closure boundaries is leakage tested or conforms to the large weld exemption criteria.

The second boundary(fig. 2, the dotted line marked ②) continues through the cover plate to the fillet weld joining the cover plate to the canister lid. The weld joining the cover plate to the canister wall and lid cannot be helium leakage tested since there is no feasible means to do so. Since this second boundary does not meet all the criteria for a confinement boundary.

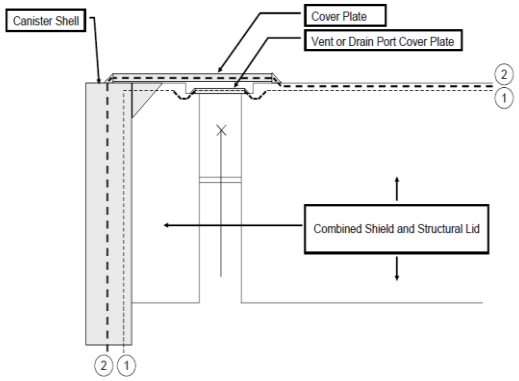

Fig. 2. Configuration of leakage testing a single lid with cover plate design.

3. Conclusion

The storage canister developed by KORAD has redundant lid and closures using the in situ multi-pass weld after fuel loading at the domestic PWR NPPs. The integrity test of the storage canister meets the safety requirements by applying the large weld exception criteria in accordance with the exceptional provisions of the He leakage test. Other parts of the integrity confirmed the He leakage test.

In this way, we also established and confirmed the confinement integrity test methods for the storage canister.

ACKNOWLEDGEMENT

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REFERENCES

[1] U.S. Nuclear Regulatory Commission (NRC), 10CFR72, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radio-active Waste and Reactor Related Greater than Class C Waste (2012).

[2] ANSI N14.5, Leakage tests on packages for shipments (1997).

[3] U.S. Nuclear Regulatory Commission (NRC), NUREG-1536, Revision 1, Standard Review Plan for Dry Cask Storage Systems (2010).