H2scan APPLICATION NOTE

WELDING OF DRY CASK STORAGE CONTAINERS

Application

Detection of hydrogen during the dry cask storage welding process in a nuclear facility. The storage containers are used to store *spent nuclear fuel* without immersion in water.

Background

The cask body is a one piece cylindrical structure composed of ductile cast iron in modular graphite form. This material exhibits good strength and ductility, as well as providing effective gamma shielding. The external dimensions of the cask body can be (16 ft.) high and 2385 mm (8 ft.) in diameter.

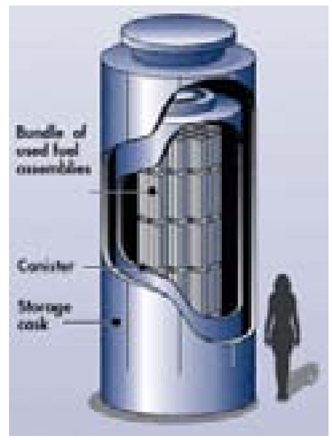

Figure 1: Dry cask storage vessels used to store spent nuclear fuel

Each cylinder is surrounded by additional steel, concrete or other material to provide radiation shielding to workers and members of the public. The steel cylinder provides a leak-tight containment of the spent fuel. Some of the cask designs can be used for both storage and transportation.

Casks are either welded or bolted closed once the spent fuel is transferred. The fuel (discharged from a boiling water reactor) is cooled in a storage pool for at least 5 years prior to the welding. The fuel assemblies are selected and transferred underwater into a shielded storage cask. The cask is removed from the fuel storage pool and set in a scaffold tower where a lid is welded into the fuel containing the cask. It takes about 14 hours to weld in the lid. During this time the fuel, sitting in its cask full of water, is turning water molecules into hydrogen gas and oxygen ions. The hydrogen, if left to collect at the top of the cask where the welding is in progress, could burn in the presence of atmospheric oxygen and heat from the automatic welder, so the hydrogen is purged out of the cask by feeding and bleeding argon through the air space below the weld area.

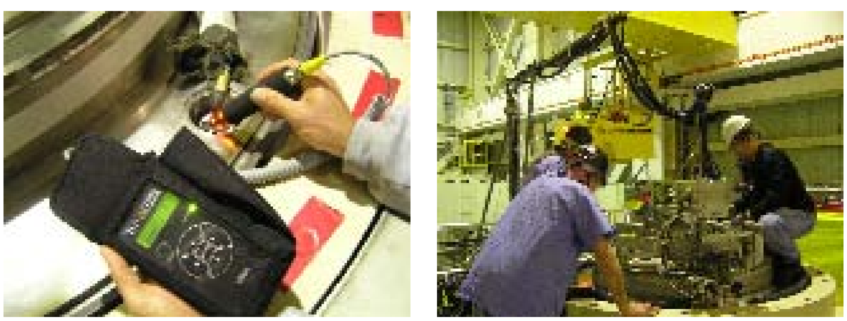

Figure 2: Hydrogen specific leak detection (left) during welding process (right)

Argon purging begins 1 hour before the welding is started, and continues until the lid-to-shell weld is 100% complete.

Advantages

The argon purge (To eliminate any oxygen from the process) is the result of a recent procedural change, requiring nuclear facilities to purge with an inert gas during the welding operation (within the US). As almost all combustible gas sensing technologies require oxygen to operate correctly, they cannot be implemented in the argon purged/inert environment, required for this application.

Prior to using the argon purge, hydrogen detection was done by exhausting, however exhausting only diluted hydrogen allowed an ample supply of oxygen allowing for combustion; hydrogen ignition can occur from a hot surface, not just an arc. Conversely, argon purge flow rate is easy to read; purging hydrogen out with argon eliminates both the combustible material and the oxygen required for combustion (addressing two legs of the "fire triangle," not just one re: exhausting); there's nothing that can be done to eliminate a source of ignition - the welding must be completed.

The implementation of H2scan's HY-ALERTA™ 500 Hand Held Leak Detector and the HY-OPTIMA™ 1700 Process Hydrogen Monitor are ideal choices for monitoring the hydrogen during the welding process.

> **Reference Users**
> Energy Northwest, Entergy, PCI Westinghouse

- The HY ALERTA™ Model 500 has been used to sample for hydrogen every 10 minutes from the start of purging until the lid-to-shell weld is 100% done. The purge goes into a 100 gallon void space under the lid.
- The HY OPTIMA™ 1700 is inserted into the outlet purge stream; if the hydrogen concentration rises above 50% LEL for air, end users will typically stop welding and continue purging as necessary until the hydrogen is back below 25% LEL.

Model HY-OPTIMA™ 1700

Model HY-ALERTA™ 500

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