HOLTEC INTERNATIONAL

Holtec Center, 555 Lincoln Drive West, Marlton, NJ 08053
Telephone (856) 797-0900
Fax (856) 797-0909

November 13, 2002

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: USNRC Docket No. 72-1014
HI-STORM 100 Certificate of Compliance 1014
Report Pursuant to 10 CFR 72.242(d)

References: 1. Holtec Project 5014
2. Holtec Corrective Action Report No. 88

In September of this year, Southern Nuclear Operating Company (SNC) was experiencing difficulty achieving acceptable liquid penetrant (PT) examination results on a Holtec HI-STORM 100 System Multi-Purpose Canister (MPC) lid-to-shell (LTS) weld at Plant Hatch. Based on the circumstances of this issue, we hereby submit this report pursuant to 10 CFR 72.242(d) pertaining to a fabrication deficiency affecting MPC lid material that was manufactured by a Holtec vendor and certified for use under a 10 CFR 72 general license.

ABSTRACT

Holtec International fabricated and certified MPC-68 Serial Numbers 40 and 25 to SNC for use in the HI-STORM 100 dry spent fuel storage system at the Plant Hatch Independent Spent Fuel Storage Installation (ISFSI). The MPC functions as the confinement boundary in the HI-STORM 100 dry storage system. Subsequent to fuel loading in MPC-68 Serial Number 40, welding was performed on the MPC LTS joint in accordance with the normal welding procedures used for other MPCs. Unacceptable liquid penetrant (PT) indications were found on the root weld layer and repaired. Additional weld layers were made and additional unacceptable PT indications were found. While continued grinding and welding could potentially have been performed until the full weld depth was completed, SNC, with Holtec's concurrence, decided to remove the lid and replace it with a new lid. As part of an extent-of-condition evaluation, the lid for MPC-68 Serial Number 25, also at Plant Hatch but not yet loaded with fuel, was found to have similar welding difficulties when test welds were applied. Therefore, the lid supplied for MPC Serial Number 25 will not be installed on an MPC.

NARRATIVE DESCRIPTION

Description of Deficiency

The stainless steel lid forging for MPC-68 Serial Number 40 was fabricated by a supplier to Holtec (Gulf Coast Machine and Supply Company) and Holtec's MPC fabricator (UST&D) performed final machining on the lid per the design drawings. Holtec International certified and delivered MPC-68 Serial Number 40, including the lid, to SNC for use in the HI-STORM 100 dry spent fuel storage system at the Plant Hatch ISFSI. Subsequent to fuel loading, welding of the ¾-inch (min.) partial penetration groove weld that joins the MPC lid to the MPC shell commenced. Similar LTS welding has been successfully performed using the same mechanized weld process (Gas Tungsten Arc

NMSS01

HOLTEC INTERNATIONAL
Holtec Center, 555 Lincoln Drive West, Marlton, NJ 08053
Telephone (856) 797-0900
Fax (856) 797-0909

Welding - GTAW - with hot wire option) on eight previous MPCs currently in service at Plant Hatch's ISFSI and over 20 additional MPCs at other nuclear plants.

The HI-STORM 100 CoC (72-1014) requires, for the MPC LTS weld, a liquid penetrant (PT) examination of the root and final weld layers, and each approximately 3/8 inch of intermediate weld depth. The PT examination of the LTS weld root layer of MPC-68 Serial Number 40 revealed surface indications that were deemed rejectable by the NDE inspector using the ASME Code acceptance criteria of NB-5350. These indications were located in the toe of the weld at the interface with the MPC lid. The indications had the appearance of porosity and were distributed along the entire length of the weld around the circumference of MPC lid. There were no rejectable indications found at the interface between the LTS weld and the MPC shell.

These indications were ground out and re-welded using the mechanized welding process. Subsequent PT examinations of the root layer once more revealed unacceptable indications in essentially the same locations. After several unsuccessful attempts were made to repair the root weld using the mechanized welding process with different weld parameters (e.g., wire feed rate, amperage) and consumables, a segment of the root weld was successfully repaired using a manual Flux Core Arc Welding (FCAW) process.

Manual welding using the FCAW process was performed to bring the LTS weld up to a thickness of approximately 5/8 inch. The first intermediate PT inspection was successful after a minor amount of grinding and re-welding. A second intermediate PT inspection revealed some rejectable indications. After removal of these indications, a Shielded Metal Arc Welding (SMAW) process was used for a cover pass, which resulted in indications along the majority of the weld in the lid base metal material. While continued grinding and welding could potentially have been performed until an acceptable full weld was completed, the decision was made to replace the lid on MPC-68 Serial Number 40 with a new lid.

During the investigation as to the cause of the welding difficulties on MPC-68 Serial Number 40, test welds were performed on the lid for MPC-68 Serial Number 25, also delivered to Plant Hatch but not yet placed in service. These test welds revealed rejectable indications similar to those experienced on the MPC-68 Serial Number 40 lid. Multiple welding processes with varying welding parameters were applied to the MPC-68 Serial Number 25 lid with results similar to MPC-68 Serial Number 40. It was decided that the MPC-68 Serial Number 25 lid would also be replaced.

Date and Approximate Time of Discovery

Difficulties with MPC-68 Serial Number 40 lid welding were first encountered on September 18, 2002. The decision was made to replace the MPC-68 Serial Number 40 lid on October 16, 2002. The latter date was used as the starting date for the 30-day reportability "clock."

HOLTEC INTERNATIONAL
Holtec Center, 555 Lincoln Drive West, Marlton, NJ 08053
Telephone (856) 797-0900
Fax (856) 797-0909

Cause of Deficiency

The root cause analysis has not been finalized at the time of this report. However, from the causal evaluation work completed to date (which included third party input from metallurgical consultants), weld wire material contamination and inappropriate weld technique have been ruled out. The apparent cause of the weld indications is large grain size combined with residual elemental impurities concentrated in the grain boundaries of the MPC lid base metal. The average grain size of the subject lid forging was found to be coarser than 00 (per ASTM E-112), while still meeting all ASME Code requirements for Section III, Subsection NB, Class 1 material, including chemical and mechanical properties.

The MPC-68 Serial Number 25 lid was found to have similar grain size as the MPC-68 Serial Number 40 lid. Test welds were performed on the Serial Number 25 lid using low heat input GTAW and SMAW parameters and high heat input GTAW parameters. Samples were taken from the test welds and unwelded lid base metal for metallurgical examination. The results of the examination confirmed that the indications were liquation cracks of the form of "hot cracking" in the lid base metal heat affected zone in all three test welds. The micro-fissures were very small and limited in length to 400 microns (roughly the grain size). Many smaller crack lengths were also observed where partial grain diameters were fissured.

"Hot cracking" can be defined as grain boundary cracking formed at high temperatures near the solidus of the metal, where the metal has coherence but has low strength and ductility. It can occur in either the weld metal or the heat-affected zone of the base metal. Almost all metals may, on any scale, suffer this defect. The lack of ductility at high temperatures, which causes the cracking condition near the solidus, is usually due to the formation of an intergranular liquid film of an impurity (typically sulfur and/or phosphorous) in the metal. Both of these impurities combine with the matrix elements to form low-melting point (lower than that of the matrix) compounds, thereby reducing intergranular cohesion at high temperatures. The lack of cohesion between grain boundaries, in turn, initiates cracks aided by tensile stresses resulting from the contraction of the weld. Hot cracking occurs in two forms. It is known as "solidification cracking" when it occurs in the weld metal as the molten weld metal freezes and "liquation cracking" when it occurs in the heat-affected zones of the base metal or previously solidified weld metal as the solid metal cools. The cracks in these lids were determined to be the liquation cracking type.

Impurities are typically located at the grain boundaries. Metals with a very large grain size have less grain boundary area than metals with a very fine grain size. Consequently, the impurities are more concentrated in metals with large grain size. Therefore, metals with large grain sizes are more susceptible to liquation cracking.

Failure Mode, Mechanism, and Effect

There was no failure of a component important to safety and, therefore, no effect on safe ISFSI operations at Plant Hatch. The unacceptable weld indications were discovered during the normal inspection process conducted at the time of LTS welding on MPC-68 Serial Number 40. Therefore,

HOLTEC INTERNATIONAL
Holtec Center, 555 Lincoln Drive West, Marlton, NJ 08053
Telephone (856) 797-0900
Fax (856) 797-0909

the MPC-68 Serial Number 40 was never placed into service with the subject lid. Similarly, the large grain size and corresponding lack of weldability on MPC-68 Serial Number 25 was discovered prior to the commencement of fuel loading activities.

Systems or Secondary Functions Affected

None

Method of Discovery

This deficiency was discovered through the normal weld inspection process for MPC LTS welding.

Manufacturer and Model Number of Deficient Component

Manufacturer: Gulf Coast Machine and Supply Company (Gulfco)
Interstate 10 West at Smith Rd
6817 Industrial Rd.
Beaumont, TX, 77720-6002
Phone: 1-800-842-3032

Forging Nos. 1322V – MPC-68 Serial Number 40
5341V – MPC-68 Serial Number 25

Model and Serial Number of the Affected Spent Fuel Storage Cask

HI-STORM 100 System, MPC-68 Serial Number 40.
HI-STORM 100 System, MPC-68 Serial Number 25.

ASSESSMENT OF SAFETY CONSEQUENCES

There are no safety consequences because the affected lids were replaced before the storage systems were placed in service. The subject MPC lids passed all chemistry tests, mechanical tests, and NDE (ultrasonic and liquid penetrant) requirements of the ASME Code for a Section III, Subsection NB, forging. The mechanical test coupons were taken directly from the as-forged component. The components were forged with protrusions that were removed after forging to be used as the test coupons. Therefore, had the lid been welded into place with all rejectable indications removed by weld repair, these lids would have satisfactorily performed their safety function.

HOLTEC
INTERNATIONAL

Holtec Center, 555 Lincoln Drive West, Marlton, NJ 08053
Telephone (856) 797-0900
Fax (856) 797-0909

CORRECTIVE ACTIONS AND ACTIONS TO PREVENT RECURRENCE

1. The MPC-68 Serial Number 40 lid was replaced with another lid, which was successfully welded. The MPC-68 Serial Number 25 lid is also being replaced.

2. Lids on MPCs already in service are unaffected based on the acceptable results of welding and associated PT inspections on those LTS welds prior to placing the MPC into service.

3. Holtec issued a Holtec Information Bulletin (HIB) and discussed this issue on the Holtec Users Group weekly fabrication committee conference call to ensure all users were informed. One other licensee (Energy Northwest (EN)) was involved in an active dry cask loading campaigns at the time the deficiency was discovered. Holtec immediately recommended to EN that they perform weld tests on all lids not in service prior to their use. This was communicated to EN verbally and in writing via the HIB.

4. Three other MPC lids delivered to SNC at Plant Hatch were tested for their grain size and weldability via the application of test welds, which were inspected using the same criteria as the MPC LTS weld. The other three lids at Plant Hatch were found to have grain sizes between 0.5 and 4.5, passed the weldability tests, and were deemed acceptable for use.

5. MPC lids already delivered to other clients will be tested for their grain size. Lids found to have unacceptable grain size will be subjected to weldability tests to ascertain their acceptability. Any lid forging that has large grain size and fails the weldability tests will be replaced.

6. All remaining undelivered lids at the UST&D shop are being evaluated for grain size. For those with unacceptable grain size, test welding will be performed on the lids to determine their status. Any lid forging that has large grain size and fails the weldability tests will be replaced.

7. All forged lid material historically has been required to meet the chemical, mechanical, and NDE requirements of ASME Section II for ASME III Class 1 service. The low-temperature service condition for the stainless steel forgings did not require additional restrictions on grain size to be established in the procurement specification. However, to prevent recurrence, all future MPC forged lid material procurement documents will include an appropriate limit for grain size in the material in addition to the ASME Section II chemical, mechanical, and NDE requirements.

PREVIOUS SIMILAR DEFICIENCIES

None.

HOLTEC INTERNATIONAL
Holtec Center, 555 Lincoln Drive West, Marlton, NJ 08053
Telephone (856) 797-0900
Fax (856) 797-0909

CERTIFICATE HOLDER'S POINT OF CONTACT

Brian Gutherman
Licensing Manager, Holtec International
(856) 797-0900, Extension 668

Sincerely,

Brian Gutherman P.E.
Licensing Manager

emcc: Mr. M. W. Hodges, USNRC
Dr. C. Miller, USNRC
Mr. P. Narbut, USNRC
Mr. C. Regan, USNRC
Mr. M. Rahimi, USNRC
Mr. S. O'Connor, USNRC
Holtec Groups 1, 2, and 4
HUG Licensing Subcommittee
NRC Correspondence Distribution

Document ID 5014470