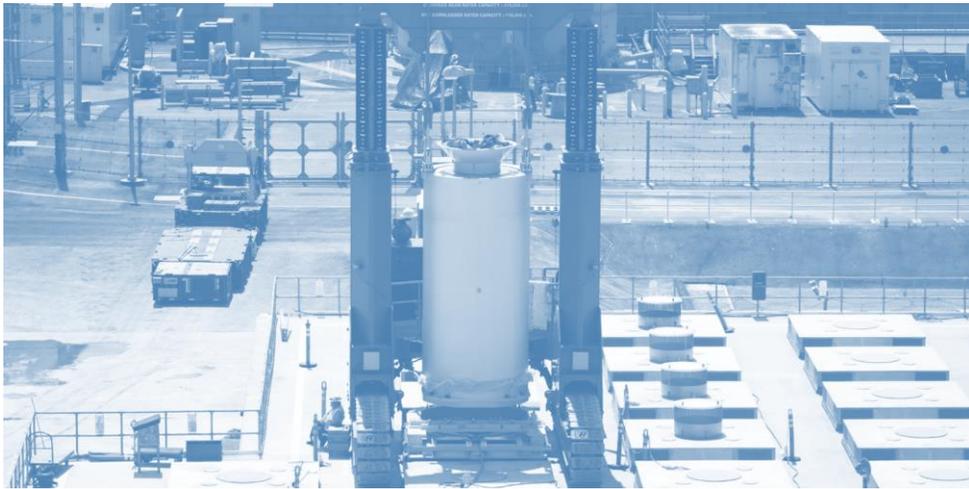


Evaluation of Downloading Effects on Multi-Purpose Canister Integrity



Prepared by Southern California Edison
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Introduction

The Holtec UMAX System is designed for seismic support and for radiation shielding such that there is minimal clearance between the Multi-Purpose Canister (MPC) outer diameter and the inner diameter of the below-grade Vertical Ventilated Module (VVM) - in particular, the VVM divider shell shield ring and seismic restraints. Thus, considering the potential for minor variations in vertical alignment during centering of the download, it is likely that the MPC shell will make some amount of contact with the divider shell sub-components during the downloading process. On August 3, 2018, during the download of a Holtec UMAX MPC-37 design spent fuel dry-storage MPC (Serial Number 067) into its associated VVM, the MPC became misaligned and wedged allowing for the full weight of the loaded MPC to rest on the divider shell shield ring. The purpose of this paper is to describe the analyses and evaluations performed to determine the acceptability of surface effects resulting during download activities.

Worst-Case Predicted Scratch

Holtec performed an evaluation to demonstrate that the worst-case scenario of interaction between the wedged MPC and divider shell sub-components (i.e., the divider shell shield ring and MPC seismic restraints) could produce a scratch that is up to 0.010 inches deep and 0.125 inches wide. Other possible scratches due to incidental lateral rubbing of the other MPCs during downloading into the VVMs are less of a concern than this worst case scratch condition.

Worst-Case Baseplate Dent

An additional Holtec evaluation considered the full weight of an MPC resting on the divider shell shield ring guides (gussets). This evaluation demonstrated that the worst-case dent to the chamfered edge of the MPC baseplate would be 0.20 inches deep. Normal lateral forces or momentary bumps during downloading of other MPCs into their VVM storage cavities are less of a concern than the MPC Serial Number 067 due to lower possible loads against rubbing surfaces.

Holtec Manufacturing Acceptable Limits

In general, during the fabrication process of metal components, minor dents, scratches, and other handling marks are to be expected. Similarly, the manufacturing and handling process for an MPC can produce minor scratches and dents on the surface. Holtec has performed evaluations to determine maximum allowable levels of scratches and dents that would ensure applicable ASME code requirements are still met. The maximum allowable pre-approved depth of scratch for a SONGS MPC is 0.0625 inches and the maximum allowable pre-approved depth of dent to the MPC baseplate is 0.25 inches. The worst-case predicted scratch (0.01 inch) and dent (0.20 inch) that could have occurred on MPC Serial Number 067 are within the pre-approved limits and therefore ASME code requirements are maintained.

Susceptibility to Chloride Induced Stress Corrosion Cracking (CISCC)

In order for CISCC to occur to the Type 316L stainless steel canister containment boundary, a buildup of chloride contaminants, water, and tensile stresses must be present. The primary areas of concern for stress corrosion cracking for the shell wall of an MPC-37 design are the heat affected zones (HAZ) of MPC shell welds. This is because a through-wall tensile stress could exist adjacent to welds and this is one of the necessary factors to potentially permit CISCC to penetrate the wall and challenge the confinement integrity.

As a preventive measure for the initiation of CISCC in the MPC shells, SCE directed Holtec to laser peen all MPC closure welds and their associated HAZs. This was performed at Holtec's Manufacturing Division. Laser peening induces a compressive stress layer covering the underlying weld tensile stresses, preventing penetration of the layer by CISCC. The minimum depth of compressive layer achieved by Holtec was greater than 0.030 inches. Therefore, if a worst case scratch of 0.010 inches were to occur across the peened protective compressive stress layer, it would not completely remove the protective layer that prevents through-wall CISCC.

Protective Oxide Layer

The manufacturing process for stainless steel introduces a protective oxide layer. A scratch to the MPC surface would temporarily remove the oxide layer. In a dry, heated, storage environment in air (an MPC during initial storage period within the VVM), Type 316L stainless steel will re-passivate and redevelop its protective oxide layer in a short time (< a month). By the time that the MPCs will be cool enough to enable a potential corrosive environment to develop somewhere on the canister surface by absorbing sufficient moisture from the circulating air to cause wetting of accumulated dry deposits (several decades after storage begins), any temporary effect of localized scratches will be repassivated. Any localized residual stresses associated with the scratch will be very shallow (< 0.010 inches) and not a driver for through-wall cracking.

Industry Operating Experience

On May 24, 2017 the Sacramento Municipal Utility District (SMUD) performed an inspection of a canister with a known scratch in support of ISFSI license renewal. This canister was selected for inspection based on being the longest in-service canister (over 15 years). Upon inspection, the scratch showed no signs of degradation.

Aging Management Program

As part of the NRC License Renewal process to extend the service life of the Holtec HI-STORM UMAX System at SONGS beyond the initial license period, MPCs must be inspected in accordance with an Aging Plan Program. In addition, SCE has committed to providing an Inspection and Maintenance Program to the California Coastal Commission for the period of initial operation by October 2020. MPC Serial Number 067 has been identified as

having a surface condition that will be considered when selecting which MPCs to inspect at SONGS.

Conclusions

- Holtec's analyses have demonstrated that the worst-case scratch and dent are within acceptable limits that maintain compliance with applicable ASME code requirements.
- The calculated worst case scratch associated with the wedging of MPC Serial Number 067 temporarily in its VVM during initial downloading would be shallower than the depth of a protective peening layer over the containment boundary welds and would not negate this protective design feature.
- Possible disturbances (e.g., scratches) of passive stainless steel films during MPC downloading will be repassivated in a short time after entry into its dry-fuel storage VVM,
- Potential scratches and dents to MPC Serial Number 067 will be a consideration in determining which MPCs will be inspected as part of the Aging Management Program. These inspections will confirm the continued adequacy of the scratched and dented locations or identify any further actions required.