April 11, 2005

MEMORANDUM TO: John N. Hannon, Chief
Plant Systems Branch
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

FROM: Michele G. Evans, Chief **/RA/**
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SUBJECT: TRANSMITTAL OF LOS ALAMOS NATIONAL LABORATORY'S SCREEN PENETRATION TEST REPORT

The attached subject report is provided to support regulatory activities associated with GL2004-02. It should be noted that while this LANL technical report is completed and can be publically disseminated, a NUREG/CR report is being prepared that will address outstanding comments from RES and NRR staff review. This NUREG/CR report will contain significantly more supporting technical detail and will also have an associated foreword which will summarize this work and provide recommendations on its applicability to ongoing regulatory activities. When this NURE/CR report is completed and transmitted, it should replace the attached document for all activities. In the meantime, a preliminary summary and recommendations about the use of this information in regulatory activities is provided as follows.

Generic Safety Issue (GSI-191), "Assessment of Debris Accumulation on PWR Sump Performance," was established by the U.S. Nuclear Regulatory Commission (NRC) to assess, following a loss of coolant accident, if debris transported to and accumulated on the sump screen in a Pressurized Water Reactor (PWR) containment would impede or prevent the proper operation of the emergency core cooling and containment spray systems during recirculation. It was recognized, however, that some of the debris transported could potentially pass through the screen and be transported to systems downstream of the screen. Debris passing through the screen may then degrade or impede the proper operation of small-clearanced equipment downstream of the sump screen, such as the high pressure safety injection (HPSI) throttle valves or pumps. This concern is referred to as the "downstream effect" in GSI-191.

This report documents a NRC-sponsored experimental project, conducted by the University of New Mexico under the supervision of Los Alamos National Laboratory. The primary objective of this study was to develop test data for assessing the potential of PWR insulation debris for passing through passive sump screens (termed "screen penetration" in this report). This study is the first step in evaluating concerns associated with the downstream effect. The test matrix consists of 44 tests using combinations of representative screen opening sizes, debris sizes and shapes, and approach velocities. Screen openings of 1/4", 1/8" and 1/16" were evaluated. Insulation debris consisting of NUKON^{TM} fiberglass, calcium silicate (CalSil), and stainless steel reflective metallic insulation (RMI) were individually tested. The approach velocity ranged from 0.2 ft/s to 1.0 ft/s. These screen openings, insulation materials, and sump pool velocities are representative of expected PWR conditions.

This study was conducted parametrically. Replicate tests were not conducted to understand the uncertainty associated with the results at any single test condition. Rather, single tests were performed over an appropriate range for each variable to identify those factors which most contribute to the ability of insulation debris to pass through the screen. While the uncertainty associated with individual test results is unquantified, some indication of its magnitude is possible by comparing test results for those parametric variable changes which are of secondary importance for a specific debris type.

The principal finding of this study is that the amount of debris passing through the sump screen in general is a function of the following variables: debris type, debris size, screen opening size, flow velocity at the screen, and whether the debris reaches the screen along the floor or in the flow. Tests showed that the fraction of debris that penetrate the screens can range from trivial to significant amounts, depending on all of these variables. It was observed that a significant amount of particulate CalSil insulation can pass through a screen opening of any size that was tested. However, higher flow velocity breaks up more of the larger CalSil clumps and allows more CalSil to both be transported to and pass through the screen. For example, close to 70% of the CalSil passed through a 1/4" screen opening size for the test conducted at 0.5 ft/s approach velocity. A significant amount of fibrous NUKON™ debris arriving at the screen in finely separated fibers can also pass through the screens. Up to 90% passed through a 1/4" screen opening size in the test using 0.5 ft/s approach velocity. However, if the NUKON™ debris arrives at the screen in larger, agglomerated pieces, only a small amount may pass through the screens. Less than approximately 5% of the NUKON™ in this configuration passed through a 1/4" opening size for the test at 1 ft/s approach velocity. Lastly, for RMI debris transported to the screen along the floor, less than 15% passed through the screen in all tests when the debris size was approximately the same as that of the screen opening. More RMI debris, up to 20%, passed through the screen in tests where the debris was somewhat smaller than the screen opening. However, a significant percentage (up to 75%) of the RMI passed through the screen in a test with an approach velocity of 0.5 ft/s when the debris was somewhat smaller than the screen opening, and when it was introduced directly into the flow instead of being transported along the floor.

The results of this report provides NRC and the industry with test data to support the assessment of “screen penetration” of debris. This information can be used to support performance assessment of components downstream of the sump strainer screen. A follow-on NRC-sponsored study is underway to assess the potential of debris which passes through the sump screen on the operation of HPSI throttle valves downstream. The results from that study will be summarized in a follow-on report once those activities have been completed.

Attachment: LANL Technical Report LA-UR-04-5416

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