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 TECHNICAL REPORT ON CHARACTERIZATION AND HEAD-LOSS TESTING OF LATENT DEBRIS FROM PRESSURIZED-WATER-REACTOR CONTAINMENT BUILDINGS

The attached subject report is provided to support regulatory activities associated with GL2004-02. It should be noted that while this 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. The NUREG/CR report will also have an associated foreword which will summarize this work and provide recommendations on its applicability to ongoing regulatory activities. When this NUREG/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.

Dirt, fiber and other foreign materials that normally can be found in nuclear power plant containment buildings are referred to as “latent debris.” Latent debris, along with debris generated by a loss-of-coolant accident (LOCA), may be present in a pressurized-water reactor (PWR) containment pool during the operation of the emergency core cooling system (ECCS). Some of this debris could be transported to the sump screen and cause pressure drop (head loss) which could degrade ECCS performance after a LOCA in a PWR plant. Other studies have evaluated the transportability and head loss characteristics of LOCA-generated debris. This study was undertaken to understand those relevant physical and hydraulic characteristics necessary to assess the potential contribution of latent debris to recirculation-flow head loss.

This report documents the results of NRC-sponsored research that was performed by Los Alamos National Laboratory. Latent debris samples were obtained from five PWR plants. Sieving, optical microscopy, scanning electron microscopy, energy-dispersive spectroscopy, and nitrogen adsorption tests were used to fractionate and measure the fiber-to-particulate mass ratio and particulate size distributions. Specific surface area (SSA) and porosity were measured by testing surrogate particulate debris in a vertical-flow test loop at the University of New Mexico. Surrogate particulate debris was generated by dry-sieving soil and sand to match the size distributions measured in the plant latent debris samples. Microflow conductivity measurements were used to confirm the appropriateness of using surrogate latent debris.

All latent debris samples contained measurable fiber mass fractions. Based on comparative evaluation of the fiber sizes and densities, this study concludes that hydraulic parameters of latent fiber are conservatively represented by fiberglass insulation parameters. Furthermore, the additional head loss contribution of latent fiber is predicted to be inconsequential. The latent debris samples contained particulates over a wide size range, from less than 10 μm to greater than 2 mm in diameter. The size distribution appears to be a function of collection methods and sample locations along with plant-specific debris differences. Therefore, the distributions based on five volunteer plants may not fully capture the variability present within the nuclear power plant population. The report also provides practical recommendations about assessing latent debris inventory and plant-specific head loss contributions using the default distributions provided in the report. However, because of the limited sample population, these recommendations may not be applicable to all operating PWR plants and plant-specific debris characterization may be preferable.

A conservative hydraulic SSA was determined for a range of sump flow velocities and particulate-to-fiber mass ratios by iteratively applying the NUREG/CR-6224 head loss correlation until the results envelop observed behavior. However, several deficiencies in the head loss testing apparatus, testing procedures, and application of the NUREG/CR-6224 head loss correlation have been identified by both the NRC Office of Nuclear Regulatory Research (RES) staff and the Advisory Committee on Reactor Safeguards (ACRS). These deficiencies cloud the interpretation and applicability of these head loss measurements. Therefore, these measurements do not solely provide a technical basis for utilizing the NUREG/CR-6224 head loss correlation with the above SSA parameters. The RES staff is pursuing additional research to substantiate both the head loss evaluation and the hydraulic properties recommended for use in this report for the evaluation of latent debris.

Attachment: LANL Technical Report LA-UR-04-3970

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Publicly Available? (Y or N) Y DATE OF RELEASE TO PUBLIC 4/13/05 SENSITIVE? N
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