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MEMORANDUM FOR: Edson G. Case, Acting Director
Office of Nuclear Reactor Regulation

FROM: Saul Levine, Director
Office of Nuclear Regulatory Research

SUBJECT: RESEARCH INFORMATION LETTER #21, CRITICAL REVIEW OF SODIUM HYDROXIDE AEROSOL TOXICITY

This memorandum transmits the results of completed research entitled: "A Critical Review of Sodium Hydroxide Aerosol Toxicity." This work was performed by Dr. D. W. Cooper, et al, at the Harvard School of Public Health under the direction of and funded by the Probabilistic Analysis Staff of RES. This work consisted primarily of a review of relevant literature (with some preliminary supportive analysis) pertaining to the toxicity of NaOH. It is noteworthy that one insight from this work has been that sodium in the hydroxide form, following an incident involving sodium release, may not exist in sufficient amounts to warrant further attention. In addition, the chemical species that would be present in appreciable quantities (Na_2CO_3) may not be of concern in terms of health effects. A final report which more fully discusses this work is attached.

The principal findings which substantiate the above insights are:

(a) For relative humidities exceeding 35% RH, it appears that NaOH droplets in the atmosphere will be transformed to sodium carbonate decahydrate ($Na_2CO_3 \cdot 10H_2O$) in less than a minute if the NaOH aerosol concentration is less than or equal to about 100 mg/m^3. This transformation will take longer if the humidity is less than 35% RH.

(b) The alkalinity of a sodium carbonate solution will be substantially less than that of a sodium hydroxide solution of the same normality; thus, carbonate aerosols will be less hazardous, per sodium atom, than hydroxide aerosols.

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(c) Using the current definition of the respirable fraction* of the aerosol, the transformation from the sodium hydroxide to sodium carbonate decahydrate increases the aerodynamic diameter by approximately 40%. This increase in diameter shifts some of the aerosol out of the respirable range and thus lowers the respirable fraction of the aerosol. Hydroxide or carbonate particles entering the upper respiratory tract will absorb water and grow so the respirable fraction will decrease.

Based on their assumption of the need for further analysis of incidents involving sodium aerosols, Dr. Cooper and colleagues recommended the following areas for further research:

(a) Analysis of the chemical transformations which sodium aerosols undergo as they are transported; in particular, consideration of the dependency of chemical composition on temperature, humidity, particle size distribution and concentration, and time.

(b) Analysis of the particle size distribution which results from such chemical transformations, with emphasis on the effect of humidity.

(c) Analysis of the effects of chemical transformations and changes in particle size distribution on scavenging of the aerosol.

(d) Analysis of dose-response relationships for humans; possibly involving the formulation of mathematical models of effects on humans and on animals, with subsequent testing of the model by experimentation on animals.

These recommendations will be considered in the Advanced Reactor Safety Research Program.

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* This definition (see Lippman, M., "Respirable Dust Sampling," American Industrial Hygiene Association Journal, Volume 31, pp. 138-159, March-April, 1970) assumes that the respirable fraction decreases montonically as particle size increases.

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If you have any questions with regard to this report and its analysis, please contact Dr. Michael C. Cullingford of my staff (telephone #492-8377).

Original Signed by
Saul Levine

Saul Levine, Director
Office of Nuclear Regulatory Research

Enclosure:
Report entitled, "A Critical Review of Sodium Hydroxide Aerosol Toxicity," by Dr. D. W. Cooper, et al.

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