BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.
Upton, New York 11973

Department of Nuclear Energy

(516) 345-7690

March 20, 1980

Mr. Robert L. Ferguson
Plant Systems Branch
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Bob:

During the past 6 months part of my effort in fire safety entailed evaluations of fire detector analyses submitted to the Nuclear Regulatory Commission by three utilities; namely, Wisconsin Electric Power Company for their Point Beach facility, Omaha Public Power District for their Fort Calhoun facility, and the smoke simulation prototypic tests conducted by NUTECH Corporation at the Yankee Rowe nuclear plant. My evaluation of each of these approaches were sent to you by letters respectively dated March 3, 1980, February 12, 1980 and November 30, 1979.

The purpose of this letter is to provide a concerted summary of the above approaches. Recall, that each of my appraisals of the licensee's approach had been based upon their responses to (1) the need for specifying the environment to which fire detectors are exposed, and (2) their development of means to predict the response of fire detectors to particular combinations of environmental properties generated by a fire, which includes assessment of the effects of

- ceiling height and configuration
- potential fire development and growth
- detector sensitivity to liberated combustion products
- room congestion
- ventilation
- stratification
- detector selection

At the outset, I must state that even with present day state-of-the-art technology in smoke detector siting, engineering judgement by responsible engineers is still required. Of course, advances have been made which alleviate to some extent the need for total qualitative assessment. Suggested guidelines as to the effect of ceiling height, combustible material, detector type,

A006
S
1/0

fire size and growth rate, and response time alluded to in various codes (e.g. NFPA 72E) can now be quantified due to the recent efforts of the Fire Detection Institute. Indeed, more research is required especially to assess the effects of ventilation, stratification and congestion; studies involving smoldering type fires involving electrical cables is also imperative.

The need for further research in this area notwithstanding, of the three submitted approaches, we consider the approach adopted by Wisconsin Electric Power Company in their report "Fire Detection System Selection Criteria" transmitted to NRC by letter dated December 20, 1979 to be the most suitable. We have found the approach adequate since it contains a viable mix of sound engineering judgement, present day state-of-the-art smoke detector siting technology, and the use of visual smoke for siting assessment. All of the factors listed above are either considered directly or their consideration is inferred. This indicates to us that well informed individuals, congizant of the problems associated with detector siting technology, have prepared the noted document. Also, their fire detector location plan and the procedures used for generating such a plan, should be instituted by other utilities that are contemplating a fire detector analysis.

The Omaha Public Power District submittal entitled "Fire Detector Analysis, Fort Calhoun Station, Unit 1," transmitted to NRC by letter, dated January 8, 1979 is also noteworthy in the effort used to generate their detector location scheme. However, when compared to the Point Beach Approach, it is not as comprehensive. Its documentation and added comments lack the detail that is portrayed in the latter approach. And, it utilizes guidelines in some areas we consider as outdated when compared to those recently presented by the Fire Detection Institute. Indeed, their guidelines of detector location in beamed ceiling areas may be questionable. The effect of ceiling height on detector spacing has not been explicitly addressed in this analysis as well as possible effects of stratification.

The NUTECH approach described in their report "Smoke Simulation Prototype Test Conducted at Yankee Rowe Nuclear Plant" and submitted to NRC by letter dated October 3, 1979 is, of the three, a truly in situ test scheme. The use of a tracer gas, e.g., SF_6, as a surrogate smoke, and the subsequent measurement of its concentration with time at select locations within the test enclosure (switchgear room at the Yankee Rowe facility) indeed can provide, with proper interpretation of the data collected, a more cogent picture of how smoke may disperse. Thus effects of congestion, ventilation, and possibly stratification, (although this has not been fully tested) on smoke movement may be implicitly assessed if the correspondence between gas movement and aerosol movement has been established; however, the implementation of the approach is considered impractical. Possibly its feasibility may become more attractive if sample collections could be automated thereby requiring less individuals for the conduction of the tests. Also the translation of the data recorded for direct application for smoke detector siting must be performed by individuals knowledgeable in the operations and problems associated with detector siting. The idea of siting detectors where "smoke" is first registered is tantamount to the idea that the convective flow in the proposed area is high. However, high flow velocity affects detector performance and hence strictly using maps of gas concentration with time may be insufficient.

Indeed, we feel that a practical in situ scheme is still required. And we also concur that the SF_6 tracer gas technique which has found wide application for the determination of the gross movement of smoke is a viable approach. There is still lacking a quantitative correlation between the measurements provided by this technique with the actual quantity and movement of smoke from actual fires that triggers a given detector.

In closing, we suggest that the NRC initiate efforts to study the effects of congestion, ventilation/stratification on detector performance. We further suggest that tests should be undertaken to establish whether the tracer gas technique (still considered as viable) can provide reliable and practical field data on the movement of smoke within a single large compartment. Differences between smoldering and flaming fires resulting from fuels indigenous to a reactor facility, notably electrical cables, must also be made and factored into existing test standards design to assess individual detector performance.

Yours truly,

John Boccio

Dr. John Boccio
Reactor Engineering Analysis

JB:sd
cc.: R. Hall
W. Kato
M. Levine
E. MacDougall
V. Panciera
E. Sylvester