UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

JUN 13 1979

The Honorable Lawrence Coughlin
United States House of Representatives
Washington, DC 20515

Dear Congressman Coughlin:

The staff has reviewed the suggestion of Dr. Aristid Grosse that nuclear power plants mark the release of radioactive gases with colored smoke or an odorous substance. Our evaluation shows that there are many factors involved in the production of smoke or an odorous substance that limit their potential effectiveness, including the dispersion of these substances in the atmosphere, the perception of these substances by members of the public, and difficulties with the generation of the material. Based on these limitations, we conclude that the suggestion has too many limitations to be effective; however, we wish to thank Dr. Grosse for his thoughtful recommendation. Our evaluation is enclosed.

Sincerely,
(Signed) T. A. Rehm

Lee V. Gossick
Executive Director
for Operations

Enclosure:
Evaluation of Smoke or Odorous Substance Release with
Radioactive Plumes

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EVALUATION OF SMOKE OR ODOROUS SUBSTANCE RELEASE WITH RADIOACTIVE PLUMES

Dr. Grosse's suggestion of adding colored smoke or an odorous chemical to a radioactive plume is subject to limitations in its practical application. Our evaluation is presented below.

A. Since the average number of daylight hours is 12 out of 24, colored smoke would be readily visible only half of the time, reducing its potential effectiveness as a visual marker by 50%. The addition of an odorant to the colored smoke would have the advantage of extending detection capability into the nighttime hours, but other considerations limit the value of such action. For example, odors could not be depended upon to rouse persons from their sleep.

B. A smoke or odor dispersing system is subject to several engineering, chemical, and physiological limitations, all of which contribute to reducing its effectiveness. Some of these are:

(1) The smoke generating material or odorous substance must be chemically stable for periods up to several years. Since the colored smoke or odorous substance would have to be released simultaneously with the radioactive plume, the smoke generating material or odorous substance would have to be stored in some manner as a component of an aerosol generating device. Many chemical compounds used to generate colored smoke or produce odors may be chemically reactive or unstable and are not suitable for long periods of storage. Further, the requirement for immediate release after the detection of a radioactive release would eliminate from consideration many commercially available aerosol generating devices which are dependent on time-consuming preparatory actions such as mixing, pressurization, burning or heating of the smoke generating substance. Satisfactory smoke generating materials or odorous materials may be available or could be developed if needed; however, it is likely a development program would be required.

(2) The smoke generating material or odorous substance must not be toxic. Since the material must be stored at some location in the plant, the possibility of leakage, accidental release within a building, or fire must be considered. Procedures to mitigate the consequences of an accident would be necessary, or the material must have a toxicity rating such that accidents like those described above do not result in production of concentrations which could be injurious or lethal to plant personnel.

(3) Preferably, the material should not be produced from an exothermic reaction, i.e., the material should not generate heat when released. Many of the commercially available smoke generators produce exothermic reactions and have the potential for starting in-plant fires. Another draw-back has to do with adding hot gases to the plume; in most cases, there will not be sufficient time for mixing of hot gases with the air in the vent or stack prior to exit, so that it is probable that the hot gases containing the smoke or odor would rise to a higher elevation than the actual radioactive gas plume and may be subject to a different wind pattern.

(4) The concentration of smoke or odor should be proportional to the severity of release. This represents a criteria which can probably never be achieved, since aerosol generator systems typically operate at a single rate of generation. It would serve no useful purpose to use the same quantity of smoke or odor for a minor release as for a release from a major accident. One should consider the individual psychological response factors involved. Too frequent emissions of smoke or odor used to mark releases of small environmental impact would dull the response to a significant release, while a panic-type response could lead to injuries and accidental deaths from a release of no radiological consequence.

(5) An odorant, for identification purposes, would have to be unique, in order that it not be confused with other natural or industrial odors. It would be necessary for local residents to become familiar with such an odor, since not all persons relate in the same manner to descriptive comparisons of other odors. For example, descriptions of chemical warfare gases as smelling like new-mown hay, garlic, or bitter almonds were found to be of limited value since many persons did not relate the odor of the gases to the natural odor. Such a familiarization program would be extremely expensive and time-consuming and would have to be repeated every few years.

(6) In an outdoor environment, smokes and odors are quickly dispersed. Dense clouds of smoke emitted from vents or stacks with small volumetric flow rates are typically dispersed within a few hundred yards of the point of release under meteorological conditions which normally prevail. Without unrealistically increasing the flow rates of such stacks by adding large quantities of smoke and air, there appears to be little that can be done to make plumes visible over longer distances.

From the above discussion, we conclude that there are many factors which limit its potential effectiveness and which preclude its use in the manner contemplated by Dr. Grosse. Principal among these factors are engineering problems in the generation of aerosol smokes and odors in a time frame compatible with the actual releases, the relative toxicity of the smokes and odors themselves, difficulties in familiarizing the public with the nature of the emissions, and the rapid dispersion of smoke plumes under normal meteorological conditions. In sum, we do not consider the generation of smoke and odor aerosols to be a practicable method of defining plant releases of noble gases under accident conditions.