Docket File

JUL 17 1979

Mr. Kevin A. Belanger
13032 Durham Drive
Warren, Michigan 48093

Dear Mr. Belanger:

In response to your letter to Mr. Denton of May 25, 1979, we are happy to provide answers to your questions concerning the Three Mile Island Reactor accident.

QUESTION:

1. What would have happened if the hydrogen bubble in the Three Mile Island reactor exploded?

ANSWER:

1. Hydrogen by itself does not explode, or even burn; it must be mixed with oxygen. In the Three Mile Island bubble, apparently insufficient oxygen was present for either burning or explosion to take place.

   This was not known with certainty at the time, as there was thought to be a potential source of oxygen from the radiolytic decomposition of water. A more detailed examination of the conditions in the reactor showed that, with ample hydrogen present both in the bubble and in solution in the water, this decomposition reaction is driven in reverse; i.e., any oxygen released immediately recombines with dissolved hydrogen to form water, and there is no accumulation of free oxygen. Nevertheless, the following brief calculation estimates the damage potential of a hydrogen explosion.

   About 5-6% oxygen on a molecular basis (that is, 5 molecules of oxygen for every 95 molecules of hydrogen) must be present in hydrogen for ignition to take place, and 9-12% oxygen is required for an explosion. (An explosion releases the same amount of energy as a fire of the same quantity, but the explosion releases the energy extremely rapidly and would generally be more damaging).

   It was estimated that about 35000 g moles of hydrogen were in the bubble. If oxygen had been present in the amount of 3500 g moles (10%), its complete burning would release about 2000 megajoules of energy. An explosion of this amount in a dry atmosphere is equivalent in chemical energy to about 450 kg (1000 lb) of TNT. This is enough to severely damage the primary system and could conceivably make it impossible to provide further substantial cooling to the core.

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In hindsight, it appears that such a situation was not possible, because of the lack of oxygen.

Note also that in the presence of large amounts of steam, as in the reactor vessel, the reaction of hydrogen and oxygen would not be as complete as assumed in the above calculations.

QUESTION:

2. What would the extent of the damage be?

ANSWER:

2. As noted above, the composition of the hydrogen bubble was not such that an explosion could occur. If oxygen had been present in an amount sufficient to permit an explosion (about 10%) and if an ignition source had been present, the hydrogen explosion in the presence of steam would probably have been equivalent to several hundred kilograms of TNT (500-1000 lbs TNT). Core damage (dispersal) would have been extensive within the reactor vessel. The reactor vessel or primary system could have suffered major failures. Core coolability could have been rendered impossible. In this event, meltdown of the core with the molten material penetrating the reactor vessel would have been a possibility. Containment coolers and spray systems were in functional condition throughout the Three Mile Island accident, and their operation would probably have prevented failure of the containment system, either by overpressure or by penetration of the concrete basemat.

QUESTION:

3. How can a meltdown be prevented once the core has been exposed?

ANSWER:

3. At Three Mile Island, it is believed at this time that a large part of the core was exposed for several hours, and the entire core may have been exposed for a short while. By exposed, we mean that the level of liquid water in the reactor was below the level of the fuel. Apparently, sufficient water was present below the exposed region, however, so that the exposed region was cooled to some extent by rising steam. This seems to have prevented major melting of the uranium oxide fuel, although the fuel cladding, a zirconium alloy, was severely damaged under these conditions.

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In general, however, provisions are made to reflood a core that is exposed before fuel melting takes place. This is done using one of several emergency pumps and reserve supplies of water that are kept in readiness for such an event. These supplies and equipment make up the Emergency Core Cooling System (ECCS).

The after-heat, or decay-heat, in a reactor that has been operating for some days, is sufficient to melt the core if the core is exposed, but only if none of these emergency cooling measures is provided.

Further analysis of the events at Three Mile Island is underway by task groups of the NRC, of the President's investigating committee and others. The conclusions I have presented above are subject to modification as the results of these more complete investigations unfold.

We hope that these answers will furnish the information you need in connection with the Three Mile Island accident.

Sincerely,

Original Signed by
F. Schroeder

Frank Schroeder, Acting Director
Division of Systems Safety
Office of Nuclear Reactor Regulation

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