ELECTRIC POWER RESEARCH INSTITUTE

EPRI

January 21, 1980

Mr. Joseph M. Hendrie
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Joe:

It is always difficult to step back in the middle of a stampede and ask why we are going where.

The enclosed memo of mine is an early thought along these lines. While it obviously needs some expansion, I thought you might be interested in the thought. It really isn't completely new, just a good idea that has been lost in history.

Sincerely,

Milt

Milt Levenson
Director
Nuclear Power Division

ML:pb
Enclosure

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J—uary 21, 1980

MEMORANDUM

TO: Planning File

FROM: M. Levenson

The knee jerk reaction to TMI that says "plan to evacuate" may·well be very wrong. Lets review and possibly expand the following ideas:

IS EVACUATION THE SAFEST POLICY

An accident at a Nuclear Power Plant always raises the question of possible risk to those people in its close vicinity. The prevalent concept for emergency preparedness in such an event focuses on evacuation of the area surrounding the plant to mitigate possible consequences of the accident to the general population. Although recent federal policy has placed some considerable emphasis on evacuation as a primary option following a nuclear plant accident, little thought has been given to the criteria for ordering such an evacuation, or, even more importantly, the conditions under which the decision not to evacuate will better serve the health and safety of the public.

Inadequate recognition is being given to the safety margin provided by sheltering and controlled respiration - by this is meant nothing more complicated than staying indoors and closing the doors and windows. The relative merits of evacuation versus sheltering depend greatly on the particulars of a given accident including such parameters as severity, site location, meteorological conditions, etc. A precise answer to the questions of whether to evacuate, when to evacuate, and how far to evacuate are not attempted here. Instead we want to make the point that for the vast majority of reactor accidents that actually might occur, including the most serious, mass evacuation is probably a sub-optimal safety strategy, and that sheltering (perhaps in conjunction with the evacuation of a few individuals from close in locations) will result in a lower risk to the population. One of the most significant lessons of the accident that occurred last year at Three Mile Island is that too much time and resources have been devoted to planning for and analyzing the biggest conceivable although highly improbable accident, while other lesser although much more likely accidents, such as occurred at TMI itself, did not receive as much attention as warranted. Simply stated, accidents unlikely to ever occur but with high consequences received all the attention, at the expense of more realistic accident scenarios. If we are to take the TMI experience to heart, then we must rethink not only our concepts of what types of accidents to plan for, but also factor this thinking into our emergency preparedness planning. If we were to do that, then we should look to the technical input from our historical experience with accidents at nuclear reactors, as well as probabilistic risk assessment models typified by the WASH-1400 report.

To date there have been three western world reactor accidents with significant radioactive releases. They happened at Windscale (U.K.) in 1957, at the SL-1 reactor in Idaho in 1961 and at Three Mile Island in 1979. All three events resulted in major damage to the reactor core. Both Windscale and SL-1 occurred in non-commercial reactors. Even though neither of these two plants had reactor containment buildings, a safety system which all commercial reactors have, radiological releases were quite limited for the size of the accidents involved. These two plus TMI pretty well bracket the range of consequences we should expect from reactor accidents. Although more serious events may be possible, and should be prudently planned for, the WASH-1400 methodology indicates that the radiological releases from these three accidents are not atypical of the most likely reactor accidents, the most common ones that emergency planning should be designed to address. In fact, the combination of its high solubility in water plus its very high chemical activity assures that in future accidents, as in TMI and SL-1, the release of iodine will be smaller than Windscale, the most serious of the historical events.

What then should be our strategy for action if a reactor accident does occur? We must recognize that during an accident, decisions will have to be made in the face of considerable uncertainty. In this context, time is an asset, in that it allows decisions to be based on more information and less guess work. The popular wisdom that if an accident occurs, immediately run for the hills, is not a good course of action, because it deprives us of time to more carefully evaluate the situation, does not recognize that even a quite serious accident is most likely to result only in a small radioactive release in terms of its health consequences and that evacuation may in fact expose the public to greater risk than less drastic measures such as sheltering. Let us examine these ideas more closely. During an accident, the severity and status of the situation is difficult to determine, even if all lines of communication functioned perfectly. Decisions must nevertheless be made. Under such conditions, the principle of "Decisions of Minimum Regret" should be applied, whereby one assumes that the known information is incomplete and probably wrong, so that the best course to pursue is the one that, if wrong, results in the least harm. In this regard, time is extremely important, because each increment of time provides an increment of information. It allows more valid information to accumulate, and bad information to be filtered out. Fortunately the nature of reactor accidents helps out in this matter of time. Hazards to the public from even the most severe accident would evolve over a period of hours and days.

There are two radioactive sources that pose health concerns. The first are radioactive noble gases, such as Xe and Kr, which form a plume and are carried down wind. The second are the volatile and solid fission products which may become suspended in the plume and carried partially along with it.

The gases, being chemically non-reactive, mix and dilute in the air. The main concern for these sources is whole body dose as the plume passes over a populated area. The solid and condensed volatile fission products, however, may be deposited on various surfaces or be washed out by rain or snow resulting in a "ground" dose to the population. In some accidents it may be the particles which pose the greatest potential long term health threat. The radioisotope ^{131}I has been identified as being the one of greatest concern because of its affinity for being concentrated in the human thyroid once it enters the body. Potassium iodide, a salt in the form of tablets, has been suggested as a prophylactic measure to prevent uptake of radioiodine by the thyroid. However, the mechanism that results in ~~it~~ the iodine entering the body in the first place is not so apparent. Because they are chemically active and physically dense, most of the volatiles and solids are adsorbed or plated out in or on equipment and on the inside of the containment building even if a containment breach should exist. Additional fallout occurs within the reactor site. For instance, during the TMI incident, 10-20 curies of Iodine 131 were released out of a TMI inventory of 60 million curies. At Windscale, around 20,000 curies of ^{131}I (1,000 times TMI) escaped into the atmosphere, but aside from precautions taken to mitigate its concentration in milk, no other actions were necessary. Even this was not due to direct exposure of the cows, but rather due to their eating contaminated grass.

The maximum dose rate (from all fission products) measured off-site was 4 mr/hr in the plume one mile from the Windscale reactor. In this case, as in SL-1 and TMI, the dose from the plume represented the largest potential health effect. The EPA Protective Action Guide currently establishes a permissible dosage of 500 mr whole body and 1500 mr to the thyroid. Clearly much time was available, several weeks even in the Windscale event, before these dose limits would have been reached, with the combination of decay and dilution making it many times longer, if ever. Equally important is the question of taking advantage of simple protective measures. Closing the windows greatly reduces potential radioparticulate inhalation. The shielding ability of structures is another. Even a simple frame wood house reduces the dose rate from a passing cloud by a factor of 2. A masonry structure may give dose rate reductions up to a factor of 10 on the first floor, 50 or more for a person staying in the basement. These values are for isolated structures. A town where 35% of the area is covered with building provides another factor of 3 protection. The buildings in a major city would provide quite substantial protection. In fact, the greater the concentration of people the more protection is afforded by the environment, and the more difficult is evacuation. Evacuation, on the other hand, is likely to expose people to increased risks, due either to changes in meteorological conditions or to the fact that evacuation may be in the direction of the plume travel. The risks due to travel and to panic must be added.

Clearly the decision to evacuate or not evacuate is a complex one. There may be certain of the low population areas within one or two miles of the plant where evacuation, even early evacuation, is the best course of action. But equally clearly, massive evacuations can only add to the risk, with little probability of having any tangible benefits.

Evacuation of the population around nuclear sites is not obviously the safest policy.

ML:bg

January 18, 1980