UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D. C. 20555

May 7, 1980

The Honorable Victor Gilinsky
Commissioner
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Gilinsky:

Your memorandum dated March 25, 1980 asks for the Committee's thought on the feasibility and practicality of a containment concept which could withstand a core melt. In this letter the ACRS will provide some preliminary and necessarily incomplete comments on the subject.

1. The letter dated March 7, 1980 from Albert L. Latter, President, R&D Associates, to the Nuclear Regulatory Commission does not provide a technical description adequate to determine or evaluate the approach being proposed. Limited additional information was provided by R&D Associates at their meeting of April 25, 1980 with you and Chairman Ahearne. However, in the absence of considerably more information, the ACRS is unable to comment on the technical merit of this proposal.

2. The general question of the feasibility and practicability of a containment which could withstand a core melt should be examined within the context of some broad policy guidance. What cost is justifiable? Is 100% guarantee of containment integrity being sought? If not, what frequency of an uncontrolled airborne release of a large portion of the radioactive fission product inventory is acceptable? What frequency of a sudden gross release of the noble gas inventory is acceptable? What frequency of a penetration of the core through the containment foundation (or equivalent release to the ground water) is acceptable? Do the reactor site characteristics and the nation's energy supply situation bear on the definition of acceptable frequency?

   Prior to 1966, although the regulatory process did not include consideration of the probably strong correlation between core melt and containment failure, it was clearly recognized that paths existed for a loss of containment integrity concurrent with a core melt. These included the potential for large missiles arising from sudden failure of the reactor pressure vessel or other large components, as well as the possible failure of containment isolation mechanisms. Furthermore, natural events such as earthquakes and floods were known to provide a potential for a loss of containment concurrent with an accident which seriously damaged the core.

What developed in 1966 was a better appreciation that, for the medium power LWRs then under construction, containment failure was likely to be associated with core melt from whatever cause. As you know, in September, 1966 the ACRS was dissuaded by the AEC from transmitting a letter which would have recommended the development and implementation for LWRs of measures to cope with and mitigate serious accidents, and accepted as an alternate the establishment of a task force which was supposed to develop within a few months a recommended approach to pursue the core melt problem. The ACRS recommended in October, 1966 that the AEC initiate a vigorous, high priority safety research program on phenomena related to core meltdown and on design concepts to mitigate such an accident. The Committee has reiterated that recommendation many times in the ensuing years to both the AEC and the NRC with little success until the past several months.

For example, in a letter dated January 11, 1971 from R. F. Fraley to Milton Shaw, Director of the AEC Division of Reactor Development and Technology, the ACRS stated its belief that a core retention system could provide a substantial reduction in the probability of a fission product release to the environment. In addition, the ACRS noted some then-recent studies which offered encouraging results and recommended initiation of meaningful conceptual design work.

3. The response to your question depends heavily on what safety policy the NRC decides to adopt.

   (a) If the NRC policy were to become one which requires that there is no acceptable frequency for an accident involving both core melt and a loss of containment integrity, even very low power LWRs built underground would not satisfy this policy, since one can postulate scenarios, for example, involving terrorism, very large earthquakes, or a failure in an access path from containment, which could defeat any design, in principle.

   (b) If the NRC policy were to become one which requires that the design should have a very high probability of containing all core melt accidents, including those involving large internally generated missiles and should limit the maximum extent of airborne and liquid pathway release to man, some form of underground or earth-covered reactor plant may be required, with special attention given to earthquakes, floods, and groundwater conditions, and to the design of features having a high probability of successfully retaining a molten core and of retaining most of the radioactive material in case controlled containment pressure relief were called for.

(c) If the NRC policy were to become one which requires that the design should have a high probability of containing almost all core melt accidents which do not concurrently include a loss of containment integrity due to missiles, sabotage, very large earthquakes or similar postulated causes, the issue can probably be satisfactorily addresssed in terms of LWRs constructed above ground. There would still remain a policy question concerning the acceptability of design approaches which envisage the potential for deliberate venting of noble gases to prevent containment overpressure in the event of a serious accident.

(d) The NRC policy might involve a limited or selected set of additional requirements for mitigation, for example, a filtered venting system for containment to reduce the probability of containment failure due to overpressure, but no core retention within containment, relying instead upon acceptable hydrological conditions. Or, of course, the NRC policy might involve no additional accident mitigation requirements, placing all emphasis on prevention of serious accidents beyond the current design basis.

4. Policy alternative 3(c) above is examined briefly in this section for technical feasibility. The technical questions would, of course, be more complex if accidents such as pressure vessel rupture were also to be addressed per policy alternative 3(b).

. containment designed to withstand a core melt must consider both the problem of molten core retention and cooling, and the prevention or limitation of a significant atmospheric release of radioactive material. If one establishes a reasonable reliability goal for measures intended to protect against both the atmospheric and liquid release pathways, and the potential need for pressure relief of the containment with a resultant release of radioactive noble gases through a filtered, venting system, it appears that, for the large volume, high-design-pressure type of containment, core melt retention is probably feasible. Its practicality will depend on the cost, the reliability goals sought, and the benefits assigned to the accomplishment.

The attached, recently issued documents by Messrs. I. Catton, C. Kelber, A. Marchese and T. Speis, R. DiSalvo, and A. Benjamin and H. Walling provide some current thinking on the problems, prospects and issues involved in molten core retention. These documents have not yet been reviewed by the ACRS; an ACRS subcommittee meeting on the general subject is scheduled to be held this month.

It is clear that problems remain, for example, from the potential for an excessively large, sudden pressure rise within containment due to hydrogen deflagration or a very rapid thermal energy exchange between the molten fuel and water. Measures appear to be possible to cope with these and similar questions, but comprehensive and sufficiently detailed studies to evaluate and choose from various design approaches are not available.

Recent work suggests that steam explosions are not a likely source of a loss of containment integrity in a large, high-design-pressure containment. However, steam explosions may be locally disruptive to features intended to help retain a molten core. The decision as to whether it would be better to keep the region below the vessel dry or flooded with water cannot be readily made with the limited design and risk evaluation information now available.

The ACRS believes that, given reasonable reliability goals, goals which do not pose so unrealistic a demand that they cannot be confirmed either experimentally or theoretically, it should be technically feasible to design an LWR containment to withstand a core melt.

The Committee wishes to note that whatever policy the NRC adopts, thought has to be given to the approach which would be taken to recover the site and dispose of a nuclear plant which had been subjected to a core melt accident.

5. The ACRS believes that the issue of what protection is to be required to contain or mitigate accidents involving core melt in LWRs yet to be designed and constructed should be decided expeditiously. The NRC Staff has recently augmented its previously modest research efforts related to this issue. However, in view of the essential nature of this issue to any decision process regarding the design of future LWRs, the ACRS believes that the current efforts by the Staff are inadequate.

   If the NRC concludes that future LWRs will require protection to contain or mitigate serious accidents involving core melt, the Committee believes that the DOE should be requested to undertake, as soon as possible, the necessary research and development work. The DOE effort should be adequately funded from the very start in order to develop an effective and reliable protection system within a time frame that will not delay the design of future plants which would incorporate this system.

6. The ACRS believes that resolution of this general issue should be given high priority by the Commissioners themselves. The Committee believes that such a policy decision should be part of an overall NRC safety philosophy. The safety philosophy should also provide siting guidance for future reactors and reliability goals for design measures intended to prevent core melt accidents. It should also provide risk-based guidance to both the Staff and industry for the wide spectrum of possible accidents.

The ACRS believes that such a policy decision by the Commission should be made with recognition of the comparative risks from other energy sources and from other technologies, and in the light of the societal, economic, and political factors which bear significantly on the complex issues involved.

Sincerely,

Milton S. Plesset

Milton S. Plesset
Chairman

Attachments:
1. I. Catton, ACRS consultant, memo to D. Okrent, ACRS, dtd. 4/25/80 re. Breach of Containment by a Core Melt

2. C. Kelber, RSR, memo to G. Quittschreiber, ACRS, dtd. 4/22/80 re. Input to Response to Commissioner Gilinsky's Questions on Core Melt

3. A. Marchese and T. Speis, NRR, memo to D. Okrent, ACRS, dtd. 4/25/80 re. "General Feelings on Containing a Core Melt"

4. R. DiSalvo, RSR, memo to G. Quittschreiber, ACRS, dtd. 4/24/80 re. Request for Input to Commissioner Gilinsky's Questions on Core Melt

5. A. Benjamin and H. Walling "Development and Analysis of Vent-Filtered Containment Conceptual Designs," SAND80-0887

cc:
Chairman Ahearne
Commissioner Kennedy
Commissioner Hendrie
Commissioner Bradford