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MEMORANDUM FOR: Members and Staff of the APS Study Group

FROM: Christopher P. Ryder
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SUBJECT: NRC/IDCOR MEETING, 28 - 29 AUGUST 1984

The NRC and IDCOR met in Rockville, Maryland during 28 - 29 August 1984 to discuss fission product release and transport.

Enclosed is a 4 page summary of the issues that were discussed.

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Enclosure: As stated

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SUMMARY OF THE NRC/IDCOR MEETING

August 28-29, 1984

Rockville, Maryland

Models for Severe Accident Analyses

Aerosol Behavior. The NRC staff and its contractors have doubts about the IDCOR aerosol model. The IDCOR model is based on an emperical correlation. Effects and parameters known to be important for predicting aerosol behavior are not explicit in the model; they are implicit in the model.

Example: The size distribution is excluded from the correlation. Only the mass of aerosol is is predicted.

The emperical correlation coincides with some experimental data. However, the coincidence is unconvencing evidence of the predictive power of the model. Some doubts about the correlation could be dispelled by comparing its predictions to experiments of various sizes.

Revaporization. The NRC staff and its contractors agree with the IDCOR staff that revaporization phenomena are important. The IDCOR model is simplistic; the predicted time and the extent of releases from surfaces is questionable.

The environmental releases predicted by the IDCOR models are small. The predicted retention external to the reactor coolant system and the thermal hydraulics of the reactor coolant system are unrealistic.

Resuspension. Both the NRC staff and the IDCOR staff agree that aerosols in a reactor coolant system can resuspend. Because little is known about the phenomenon, it is excluded from the NRC models and the IDCOR models.

Tellurium. The IDCOR model fails to reflect experimental data about tellurium. Studies indicate that a large fraction of the tellurium inventory should remain in the core debris. During a core-concrete interaction, the tellurium should be released.

Chemical Reactions. The IDCOR staff ignore chemical reactions in their modelling. The reactions could change the form of fission products and alter their transport. The reactions involve items such as the following:

- control rod materials,
- methyl iodide,
- radiolysis,
- surfaces,
- high temperature oxidation.

Some of the reactions may have small effects. However, the small effects may be significant when small fission product releases are predicted.

Core-Concrete Interaction. The IDCOR staff is unclear in about their modelling of the releases from a core-concrete interaction. The NRC staff and its contractors believe that the release of both fission product vapors and aerosols from a core-concrete interaction is significant.

Suppression Pool. The NRC staff and its contractors disagree with the IDCOR staff. The decontamination factors selected by IDCOR are conjectural. Rigorous decontamination factors can be obtained using current data and models.

Uncertainty and Sensitivity

The NRC staff and its contractors expect the uncertainty associated with phenomena missing from the models to dominate uncertainty. The IDCOR study of uncertainty (or sensitivity) is limited. This implies that the IDCOR models are missinc parameters or the parameters are fixed. Also, the IDCOR staff may not have had the time for an extensive sensitivity study. The IDCOR study has the following attributes;

- an incomplete set of parameters,
- a failure to vary parameters based on engineering judgement, and
- only one parsmeter varied at a time.

The conclusions of the IDCOR study are difficult to accept.

Plant Analyses

When the source term estimates from the NRC and from IDCOR are compared, many differences are evident. Any agreement in the estimates may be fortuitous. The differences arise from the following;

- phenomena in the models,
- mathematical treatment of the phenomena,
- definition of an accident sequence, and
- assumptions.

Mitigative actions are treated inconsistantly by IDCOR.

The IDCOR results of the MARK-I reactor occur because the reactor building is considered to retain much fission products. The NRC has reservations about this; the integrity of the reactor building during a severe accident cannot be assured.

When the calculations from the MARCH code and the MAAP code are compared at the Battelle Columbus Laboratory, the NRC staff and the IDCOR staff will be able to discuss better than at present the differences in the estimates.

Containment Loads

In-Vessel Hydrogen Productions. The hydrogen generation predicted by the NRC and IDCOR differ by a factor of 1.4 to 10.0. This is due to differences in the modelling of items such as these;

- channel blockage,
- downward radiative heat transfer, and
- core slump and vessel failure.

The phenomenon is important because it influences containment failure.

Hydrogen Combusion. The differences the NRC modelling and the IDCOR modelling are in two areas: flame temperature and natural circulation of gases from the cavity to the containment.

IDCOR uses flame temperature criteria to determine how hydrogen ignites. Given that the hydrogen concentration is sufficient, if it can burn, it does burn. As a consequence, only low concentrations of hydrogen can develop.

The NRC has a different approach. Both a sufficient concentration of hydrogen and an ignition source all need to burn hydrogen. As a consequence, high concentrations of hydrogen can develop. This allows the NRC to use the concept of flame propagation which is not done in the IDCOR analyses.

IDCOR estimates natural circulation between a reactor cavity and a containment. These calculations predict a low hydrogen concentration and increase the oxygen concentration in compartments. Because high concentrations of hydrogen do not arise, hydrogen explosions are precluded.

The NRC does not estimate natural circulation in any of its codes. This is a drawback of the NRC codes though IDCOR estimates natural circulation because a comparison cannot be done. The quality of the IDCOR models cannot be assessed.

Melt Ejection. In the NRC model, a degraded core is ejected as a coherent melt at the time of vessel failure. In the IDCOR model, a core is sequentially relocated as regions of a degraded core slump.

The ejection mode is significant in that it influences the core-concrete interaction. The sequential relocation model predicts an inhibited ablative attack on the reactor cavity liner and a limited quantity of melt for direct heating of a containment. The coherent melt model predicts a rapid ablative attack and the possibility for directly heating the containment atmosphere.

Core-Concrete Interaction. In the NRC model, the debris crust between the core melt and the concrete is thin and relatively unstable. In the IDCOR model, the debris crust is thick, stable, and insulating.

The phenomenon is significant because, as IDCOR models it, a solid, not a molten mass of debris attacks the concrete. This influences the following phenomena;

- upward heat flux into a containment,
- gas generation from the concrete,
- fission product release from a melt,
- overhead structural degradation,
- overlying water interaction, and
- metal constituents inhibiting oxidation in a melt.

Steam Explosions. The steam explosion issue is unchanged since the 29 November - 1 December 1983 NRC/IDCOR meeting.

Steam explosion phenomena may strongly depend on scale. A poorly understood concept is how debris disperses and mixes with water in a sufficiently short time to cause an explosion. IDCOR claims that the large fragments of core debris preclude an efficient energetic energy transfer. NRC claims that the explosions can occur in stratified core debris but that the energy transfer is unknown.

A steam explosion must have the energy of about 2000 MJ to fail a containment Though such an explosion is unlikely, it has not been shown to be impossible.

Direct Heating. The NRC staff considers that direct heating is a significant phenomenon. Here, the core debris is ejected from a failed vessel at high pressure and dispersed into a containment. The debris heats the atmosphere and pressurizes the containment.

Based upon tests at the Argonne National Laboratory, the IDCOR staff considers the phenomenon unlikely. IDCOR ignores the phenomenon.

Sequence Definition. Both the NRC staff and the IDCOR staff recognize the importance of how a sequence is defined.

The predicted effects of major phenomena, such as the core melting and the containment failure, depend on how a sequence is defined.