



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

*Parley
Copies to
GF, Bandwidth, ERM,
George Lohse, Pickens*

September 27, 1979

MEMORANDUM FOR: Commissioner Gilinsky
FROM: Bernie Snyder, OPE *B Snyder*
SUBJECT: TMI ACCIDENT - HIGH TEMPERATURE READINGS FROM CORE THERMOCOUPLES

In response to your question, I have taken a brief look at the possible significance of reported high temperature readings from TMI-2 core thermocouples. I understand that some readings were reported to be as high as 4000°F during the period when the TMI core was assumed to be uncovered.

As you pointed out, data for voltage vs. temperature for chromel-alumel (Cr-Al) thermocouples is not available above 2500°F. Based on my conversations with experts at the National Bureau of Standards (Drs. Schooley and Burns), data above 2500°F is not available in standard handbook references because use of Cr-Al thermocouples is not recommended above this temperature. The oxidation and embrittlement of Cr-Al above 2500°F is severe and results in a shortened service lifetime. However, this does not preclude the validity of voltage readings corresponding to temperatures somewhat above 2500°F.

The real limitation in the use of Cr-Al is reached at slightly above 2700°F which is the approximate melting point of the thermocouple material. Under normal circumstances it appears that Cr-Al thermocouples would be useless above 2700°F. However, there are some postulated mechanisms which could explain the reported voltage readings which correspond to 4000°F, recognizing that no true temperature readings are physically possible above the melting point.

I briefly pursued two possibilities suggested to me by ORNL (R. Shepherd, Program Manager, I&C Division). One possible explanation is that during uncovering and heat-up of the TMI core a number of the Cr-Al thermocouples failed due to excessive temperature (there were 51 separate thermocouple assemblies operating in the core just prior to the accident -- located at varying radial positions). At some distance away from the hottest areas at positions along the failed thermocouple leads, a number of separate junctions could have been formed by fusing the leads together. Each of these junctions would generate a voltage which is additive and results in a high reading. Also, even in a failed thermocouple with an open circuit, the high radiation field might produce enough ionizing of materials to result in a voltage potential across the leads. According to Shepherd, both of these mechanisms can result in fairly high voltage readings which falsely indicate high temperatures and this has been observed by ORNL in their research reactor (HFIR).

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The second possible explanation is that the combination of high temperature, radiation and chemical reactions among the Cr-Al thermocouple materials and the stainless steel sheath around the thermocouple resulted in changes to the base alloys of the thermocouples. If this occurred, then the thermocouples would no longer be Cr-Al, but rather some inhomogeneous mixture of alloys. Under this scenerio, it may be possible to get high temperature indications.

I understand that the few very high millivolt meter readings obtained by technicians were in the range of about 75 mv. This is far in excess any tabulated data for Cr-Al thermocouples (2500°F is the maximum figure which corresponds to about 55 mv). Apparently the technician just extrapolated above 55 mv and obtained the 4000°F value, without recognizing at the time, that the thermocouples melt at about 2700°F.

The bottom line here is that true temperature indications above about 2700°F are physically impossible for Cr-Al thermocouples.

However, there may be some useful further investigations by instrumentation and thermal-hydraulic experts. The above possible explanations could be checked out both by careful analysis of the data obtained during the accident and thermal analysis of the conditions which existed along each of the thermocouples which read high. This could be important to attempt to provide data to assess the condition of the fuel subassemblies nearest these thermocouples. Valid information here would be invaluable in any recovery operations. However, any definitive conclusions on the significance of high voltage readings from these thermocouples will probably have to await removal of fuel and examination of instrumentation.

cc: Chairman Hendrie
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Commissioner Bradford
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Leonard Bickwit
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