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

JAN 11 1980

Mary G. White, ANS Technical Program Chairman
Attn: Ruth Farmakes
American Nuclear Society
555 North Kensington Avenue
LaGrange Park, Illinois 60526

Dear Ms. White:

In accordance with instructions provided to me by the Chairman of the ANS Reactor Physics Division, I have enclosed four copies of a paper summary entitled "Lessons Learned from TMI In-Reactor Instrumentation: An NRC Viewpoint." Summary Cover Sheets for this paper are also included. This paper is being submitted for presentation at the 1980 ANS Annual Meeting.

Sincerely yours,

John C. Voglewede

John C. Voglewede
Core Performance Branch
Division of Systems Safety

cc: R. C. Kryter, ORNL

SUMMARY COVER SHEET

CONTRIBUTED PAPER ☐ INVITED PAPER ☒

ORIGINAL AND THREE COPIES REQUIRED

TITLE: Lessons Learned from TMI In-Reactor Instrumentation: An NRC Viewpoint

AUTHOR(S): (List authors in the proper order and exactly as they are to be published. PLACE AN ASTERISK AFTER EACH AUTHOR WHO IS AN ANS MEMBER; AN "S" AFTER STUDENT AUTHOR.)

1. John C. Voglewede *
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AFFILIATION(S): (List corresponding author's affiliation and complete mailing address.)

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2. Washington, D.C. 20555
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Title of Summary Lessons Learned from TMI In-Reactor Instrumentation: An NRC Viewpoin

This is to acknowledge receipt of your summary. Please use the log number above in future correspondence.

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Thank you for submitting this summary.

Sincerely,

Mary G. White
ANS Technical Program Chairman
1980 Annual Meeting

LESSONS LEARNED FROM TMI IN-REACTOR INSTRUMENTATION

AN NRC VIEWPOINT

John C. Voglewede
Division of Systems Safety
U.S. Nuclear Regulatory Commission

During the TMI-2 accident, a condition of inadequate core cooling existed and was not recognized for many hours. This resulted from a combination of factors including insufficient indicating range for existing instrumentation, unfavorable location of instrument readout, and perhaps insufficient instrumentation. The Nuclear Regulatory Commission staff has analyzed each of these perceived deficiencies and has made a number of new regulatory requirements and technical recommendations.

The regulatory viewpoint of the lessons learned from the in-reactor instrumentation at TMI-2 is similar to that of the owner, the reactor vendor, and the nuclear industry as a whole. That is, the in-reactor instrumentation played a prominent role during the first few hours of the accident as well as the period of time leading to cold shutdown of the plant. Because of this, the NRC Lessons Learned Task Force concluded that the as-designed and field-modified instruments at TMI-2 provided sufficient information to indicate reduced reactor coolant level, core voiding, and deteriorated core thermal conditions.

Three Mile Island was one of the best instrumented reactors in operation because of the large number of in-core thermocouples and other features. Unfortunately, these positive features did not result in the prompt recognition of, and the rapid recovery from, a condition of inadequate core cooling.

In response to this and other findings from the Three Mile Island accident, the NRC staff initiated a number of short-term requirements, based on "TMI-2 Lessons Learned Task Force Status Report and Short-Term Recommendations" (NUREG-0578). The status of the industry response concerning in-reactor instrumentation is

summarized in this presentation, and the Metropolitan Edison Restart Submittal on Three Mile Island Unit 1 is used as an example of the industry response.

Metropolitan Edison, like other utilities, is required to review its present in-reactor instrumentation to determine how the condition of reduced coolant level and core voiding can be detected. The existing instruments examined by Metropolitan Edison measure coolant temperature, flow, and pressure as well as neutron flux and motor current of the coolant pumps. The staff supports such diversity. However, these instruments existed at TMI-2 at the time of the accident. New instruments, such as the PWR vessel coolant level detector, have also been required and long-term improvements in other areas are being actively pursued by the staff. The results of these efforts, however, have not yet been implemented.

With regard to existing instrumentation, the staff has noted that many instruments at TMI-2 lacked sufficient range of indication. A notable example was the range of the core exit thermocouples. As a result, Metropolitan Edison has extended the indicating range of these thermocouples as well as the indicating range of the reactor outlet resistance temperature detectors (RTDs) in the Unit 1 facility. This was done without replacing the sensors. Access to the in-core thermocouple signals from outside of the containment building has also been provided. This feature did not exist on Unit 1 at the time of the Unit 2 accident. The indicating range of these instruments now encompasses the physical limitations of the sensor rather than the expected response of the device during normal operation. The change from expected to extended instrument range reflects the staff position in the proposed revision to Regulatory Guide 1.97, "Instrumentation for Light Water Cooled Nuclear Power Plants to Access Plant Conditions During and Following an Accident" issued December 4, 1979.

All PWR owners are also required to install a saturation meter in the control room to provide an indication of the degree of subcooling in the primary coolant. However, the use of in-core thermocouples, extended range reactor outlet temperature RTDs, and the new saturation meter are enhancements of existing instruments. The staff previously concluded that reduced coolant level and the existence of core voiding could be determined with these instruments. Longer term improvements in the instrumentation will make this determination easier, provided the operator is aware of the available information and interprets it correctly.

An important lesson learned from TMI-2 on the subject of in-reactor instrumentation is that the operator must be made aware of the available information and must know how to interpret it correctly. Marked improvement in an operator's ability to quickly recognize a condition of inadequate core cooling, and his ability to act upon this information, will, in my judgement, lie more with improvement to the operator's training and instruction than with improvement of the instrumentation. However, both approaches have been required by the NRC to ensure that conditions of inadequate core cooling do not go undetected in the future.