69 – 8 = 61

Documentation of Official Discrepancy

Concerning the number of control rods inserted into the Three Mile Island Unit-2 reactor core during the scram sequence on March 28, 1979

Coalition for Independent Investigation

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INSTRUCTIONS FOR DETECTION OF OFFICIAL DISCREPANCY CONCERNING THE NUMBER OF CONTROL RODS INVOLVED IN THE TMI-2 SCRAM SEQUENCE

The purpose of this package is to provide official documentation concerning the number of control rods that fell into the core to stop the fission chain reaction during the accident at Three Mile Island Unit-2 on March 28, 1979.

Document A contains information from the Report of the President's Commission on the Accident at Three Mile Island, a.k.a. the Kemeny Commission, dated December, 1979. The commission's report concluded that all of the reactor's 69 control rods fell into place, "as they were designed to do." Control rods are defined as the 69 neutron-absorbing rods that provide reactivity control within the reactor core. The reactor components are listed as 177 fuel rod assemblies, 52 tubes containing instruments, and 69 tubes containing control rods.

Document B, recently obtained through a Freedom of Information Act [FOIA] request, was prepared in 1983 for the Department of Energy. It states that the TMI-2 reactor components include only 61 control rods. The other 8 rods, the document states, are "Axial Power Shaping Rods" [APSRs] which provide no safety or criticality control function. It further states that the 8 APSRs did not fall during the scram sequence at 8 seconds into the accident.

The Coalition believes that this major official discrepancy between two equally sanctioned interpretations should be addressed, and is forwarding this package to interested parties in response to that need. It should be noted that this Coalition's independent investigation of the accident at TMI-2 (dated September, 1981)

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Instruction 1: Read document A. Please note the several references to the subject of the number of control rods contained in the TMI-2 reactor. Also note the conclusion (and material used to support the conclusion) that all 69 control rods functioned properly to fall into the core during the scram sequence.

Instruction 2: Read document B. Please note the first paragraph of the Abstract, which states the TMI-2 reactor contained **61 control rods and 8 axial power shaping rods.** In this document it is clearly stated that only 61 control rods fell during the scram sequence.

ATTACHED DOCUMENTS:

Report on the Accident at Three Mile Island, prepared by the Coalition for Independent Investigation for the chairman of the Joint Congressional Subcommittee on Energy and the Environment in September of 1981. Title page, excerpts from the report concerning control rods.

An Assessment of the TMI-2 Axial Power Shaping Rod Dynamic Test Results, prepared by EG&G Idaho, Inc. for the U.S. Department of Energy, TMI Operations Office in April of 1983. Cover page, title page, abstract, summary, reference.

This documentation package was compiled for general release by the Coalition for Independent Investigation in September, 1985.

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Report on the Accident At Three Mile Island

A

3.4.1 THE CONTROL RODS
September, 1981

Prepared by the Coalition for Independent Investigation for General Release

[Excerpted from draft II of the CII Report on the Accident at TMI]

3.4.1 THE CONTROL RODS

In the following quoted passages taken from the 'Prologue' of the *Report of the President's Commission on the Accident at Three Mile Island,* the design components of the TMI-2 reactor core are listed and defined.

In paragraph 1, the emphasized sentence clearly states that TMI-2's reactor core contained **69 control rods**.

[From 'Prologue', page 83]:
"TMI-2's reactor contained 36,816 fuel rods – 208 in each of its 177 fuel assemblies. A fuel assembly contains not only fuel rods, but space for cooling water to flow between the rods and tubes that may contain control rods or instruments to measure such things as the temperature inside the core. ***TMI-2's reactor had 52 tubes with instruments and 69 with control rods."***

Paragraph 2 gives a definition of what is termed a 'scram' sequence. Note that the definition is qualified by the word "all." All the control rods must fall to stop the fission reaction. The paragraph also indicates another use of the control rods: regulation of the fission reaction. A distinction between control rods which are used for regulation and those used for starting or stopping the chain reaction is not made, because no such distinction exists.
"Control rods contain materials that are called 'poisons' by the nuclear industry because they are strong absorbers of neutrons and shut off chain reactions. The absorbing materials in TMI-2's control rods are 80 percent silver, 15 percent indium, and 5 percent cadmium. ***When the control rods are all inserted into the core, fission is effectively blocked,*** *as atomic nuclei absorb neutrons so that they cannot split other nuclei.* ***A chain reaction is initiated by withdrawing the control rods. By varying the number of and length to which the control rods are withdrawn, operators can control how much power a plant produces.*** *The control rods are held up by magnetic clamps.* ***In an emergency, the magnetic field is broken and the control rods, responding to gravity, drop immediately into the core to halt fission. This is called a 'scram'."*** 76

The Kemeny Commission, in fact, conclud-ed specifically that **all** the control rods did fall to stop the fission reaction at 8 seconds into the accident, as evidenced by the following quotes:

[From 'Prologue', page 90]
"Pressure continued to rise, however, and 8 seconds after the first pump tripped, TMI-2's reactor – as it was designed to do – scrammed: ***its control rods automatically dropped down into the reactor core to halt its nuclear fission.***

Less than a second later, the heat generated by fission was essentially zero." 71

Mark Stephens, a member of the Public Information Task Force of the Kemeny Commission, explained the Commission's official findings concerning the TMI-2 scram sequence for the general public in his book, *Three Mile Island,* published by Random House in 1980:

[page 10]:
"***Within nine seconds, 69 boron and silver control rods fell into place*** *among the 36,816 zirconium fuel rods with their millions of pellets of uranium dioxide fuel. The rods absorbed neutrons to stop the chain reaction.* ***The falling into place of these rods, called a 'scram', worked as it should. The reaction stopped.*** *"* 78

In the following quote from pages 12 and 13 of the same book, Mr. Stephens explains the procedures used by the TMI-2 operators to verify the scram sequence. Note the emphasized quotation Mr. Stephens took directly from operator Craig Faust's testimony to the Kemeny Commission, where he (operator Faust) states that he verified **all rods had fallen**:

"At first the operators thought the problem was just a turbine trip… and they began the emergency procedures specified for that occurrence. But then the shift supervisor Zewe came out of his office as another light appeared on the alarm board. 'you just lost the reactor', he said to Faust.

That initiated a different emergency procedure. 'We moved from turbine trip to reactor trip', Faust said later. 'The verifications there are different. ***So I verified that all the rods had dropped into the core.*** *The individual rod positions are straight ahead on the panel, and so I verified that and the neutron power indication coming down.'"*

In the very next paragraph, Mr. Stephens further qualifies 'all' as meaning **69 control rods.**

"In a graphic display, the rod status showed lines of red lights to symbolize ***the 69 control rods****. As the reactor shut down, these lines of lights began to turn on, following, from top to bottom, the descent of the control rods into the reactor core."* 79

REFERENCES:

1. R.C. Thompson, M.B. Thompson, D.J. Bloombaum, *The Coalition for Independent Investigation – The Accident at Three Mile Island*. September, 1981.

2. J.G. Kemeny, *Report of the President's Commission on the Accident at Three Mile Island*. October, 1979.

3. M. Stephens, *Three Mile Island*. Random House, 1980.

B

GEND

General Public Utilities • Electric Power Research Institute • U.S. Nuclear Regulatory Commission • U.S. Department of Energy

AN ASSESSMENT OF THE TMI-2 AXIAL POWER SHAPING ROD DYNAMIC TEST RESULTS

GEND-INF-038

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ABSTRACT

The Three Mile Island Unit-2 (TMI-2) nuclear power reactor contains **61 control rod assemblies and 8 axial power shaping rod assemblies** (APSRs). The APSRs are positioned symmetrically, forming a ring approximately mid-radius around the core. **The APSRs do not perform a safety or control function**, but are used only to flatten the axial power distribution within the core.

All control rod APSR drive leadscrews must be uncoupled and removed prior to vessel head removal. **Leadscrew removal is facilitated by having the rod assemblies inserted to a down hard-stop position**. Following the TMI-2 accident, **the eight axial power shaping rods were in a partially withdrawn position** (~25% of their full travel). Therefore, a test was performed to attempt to insert the APSRs **to the fully inserted, or at least a hard-stop position.** In addition, accelerometers were mounted on the drive mechanisms of all the APSRs in an attempt to obtain acoustical signals that would provide some information about the physical condition of the APSRs and of the damaged TMI-2 reactor core. The acoustical data obtained were analyzed independently by the Babcock and Wilcox Company (B&W) and by Science Applications, Incorporated (SAI). In addition to the APSR Insertion Test results, information obtained from postaccident in-core instrumentation evaluation and "Quick Look" closed-circuit television camera pictures of the damaged core was used to interpret the physical condition of the TMI-2 core. This report describes the TMI-2 APSR Insertion Test performance and results, and presents an evaluation of correlations between APSR insertion information and other available information on the condition of the TMI-2 reactor.

SUMMARY

When the TMI-2 accident occurred, the eight APSRs were all at approximately the 37-in. (25%) withdrawn position. **Since they perform no safety or criticality control function, these rods were not inserted during reactor shutdown and remained in the withdrawn position throughout the duration of the accident.** Uncoupling the APSR leadscrews from the APSR assemblies is essential to head removal prior to defueling the reactor, and uncoupling is facilitated by having the APSRs in the fully inserted, or at least a downward hard-stop position.

An APSR Insertion Test was performed in an attempt to move each APSR leadscrew to its fully inserted position. In addition to positioning the leadscrews for easy uncoupling and removal, the insertion test also provided an opportunity to obtain information on the physical condition of the leadscrew drive motors, the APSR rods themselves, the upper plenum guide tubes, and possibly the core itself. Accelerometers were attached to the top of the drive mechanism of each of the eight APSRs to provide acoustical data related to drive motor functions, leadscrew movement, and possibly resistance to APSR movement in the fuel assembly and upper plenum areas, due to distortion or blockage of guide tubes. Specific objectives of the TMI-2 APSR Insertion Tests were (a) to insert the APSRs as fully as possible to facilitate later uncoupling of the leadscrews, and (b) to obtain electrical and acoustical signatures, insertion distance data, and as much insight as possible into the extent and location of damage to the core and upper plenum.

The acoustical signals obtained from the TMI-2 APSR Insertion Test were evaluated by comparison to acoustic signals obtained from APSR movement in the identical, but

undamaged TMI-1 reactor, and from APSR mockup tests performed at the Diamond Power Specialty Company. The acoustic signals were analyzed independently by the B&W and by SAI. Results from these independent analyses are included and the analyses are provided in their entirety as Appendixes B and C of this report.

REFERENCE

1. J.A. Gannon, *Development of In Situ Test Procedures for TMI-2 Axial Power Shaping Rod Drive Mechanism,* GEND-INF-028, December, 1982.