ATTACHMENT 1

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
DUKE POWER COMPANY	)	Docket Nos. 50-369
	)	50-370
(William B. McGuire Nuclear Station, Units 1 and 2)	)	

AFFIDAVIT OF NORMAN LAUBEN

I, Norman Lauben, being duly sworn, depose and state:

Q: By whom are you employed, and describe the work you perform?

A: I am employed by the Reactor Systems Branch, Division of Systems Integration, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission. A copy of my professional qualifications is attached to this affidavit.

Q: Have you read "Applicant's Motion for Summary Disposition Regarding Application for License Authorizing Fuel Loading, Initial Criticality, Zero Power Physics Testing and Low-Power Testing for McGuire Unit 1; Request for Expedited Consideration," filed September 30, 1980, and the documents attached thereto, including the affidavits of William H. Rasin and K. S. Canady?

A: Yes.

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Q: Would you describe the scope of the subject matter addressed in your affidavit.

A: I have been asked to evaluate the potential for hydrogen generation in connection with short-term low-power testing (up to 5% rated power) of the McGuire Nuclear Station, Units 1 and 2.

Q: Can significant amounts of hydrogen be generated in a light water reactor under any circumstances?

A: Yes. Hydrogen is generated almost entirely due to the high temperature reaction of zirconium in the cladding with steam resulting from boiling reactor coolant. Significant amounts of hydrogen can be generated in a light water reactor, but only if there is a failure to cool the core.

However, NRC requires that all facilities licensed to operate are provided with reliable and redundant emergency core cooling systems (ECCS). NRC regulations (10 CFR §50.46) require applicants to analyze a spectrum of pipe breaks and locations with various assumed equipment failures. These analyses are performed with NRC-specified conservative assumptions and must demonstrate coolability of the core and minimum generation of hydrogen. Specifically, ECCS evaluations must demonstrate that ECCS performance will result in a coolable geometry and less than 1% core-wide metal-water reaction even with the reactor at 102% power and worst-case linear heat rates. The McGuire facility ECCS is required to conform to these requirements. Thus, for all power levels the requirements of NRC regulations provide adequate protection against severe core damage.

Nevertheless, for purposes of this affidavit, I have considered the potential for hydrogen generation at low power, which can only occur if one assumes (1) a LOCA coupled with failure of the ECCS, or (2) certain transients coupled with a total loss of feedwater.

Q: With a reactor operating at a maximum of 5% of full power, would these events lead to the generation of significant amounts of hydrogen?

A: No. I have looked at these events and have concluded, as discussed herein, that at 5% power it is extremely unlikely that such events would lead to the generation of significant amounts of hydrogen. By "significant" I mean 5% metal-water reaction.

Q: Please provide the basis for your conclusions.

A: At 5% power the number of events that can result in failure to adequately cool the core is greatly reduced. All transients initiated by turbine trip are eliminated since the turbine is not on line. Total loss of feedwater caused by any other transient becomes negligible with respect to potential hydrogen generation. In such a case, core heat is transferred through the steam generators from the primary to secondary systems. At 5% power I calculate that it would take about 2½ days to boil the steam generators dry, conservatively assuming no feedwater makeup. During that period of time, diagnosis, corrective action or alternate heat removal methods could easily be accomplished. Moreover, by that time fission product heat will have decayed sufficiently so that passive steam heat losses (radiant heat transfer) would be enough to keep the reactor cool, even if no corrective action were taken. If one assumes that the highly unlikely scenario of total loss of feedwater is followed by a failure of the reactor system to scram (i.e., the worst ATWS event), complete boil-off of the water in the steam generators would occur in 1 hour. During this period of time there are a number of things the operator could do to bring the reactor to safe shutdown, including initiation of the boron injection system and diagnosis and correction of the failure to scram. These would terminate the event before boil-off of significant reactor vessel inventory and thus, well before the onset of severe core damage. Moreover, at low power, significant overpressurization of the primary system does not occur because of the low integrated reactor power.

The only class of accidents that results in the loss of heat removal capability is that class covering loss-of-coolant accidents with assumed failure of ECCS.

Q: Have you, for the purpose of the staff evaluation of the applicant's motion for summary disposition performed calculations relating to potential for hydrogen generation resulting from a LOCA during low-power operation assuming failure of ECCS systems?

A: Yes. I performed several LOCA analyses with severely degraded ECCS's which demonstrate the large amount of time that would be available at

5% power for diagnosis and corrective action to prevent the generation of significant amounts of hydrogen. For these analyses, it was conservatively assumed that none of the pumped E systems was functioning. A bounding calculation was performed for a large-break LOCA. In such a case, with no pumped ECCS, after refill by the accumulators which is completed about 1 minute after the break, the water in the reactor vessel would begin to heat up and boil away. Boil-off would drop the water level to the top of the core between 1 hour and 1½ hours. [This figure corresponds to the 3900 seconds mentioned in Mr. Rasin's affidavit, page 7.] However, the core does not immediately start to heat up rapidly until a substantially greater amount of water has boiled off (below the top of the active core). Using the TOODEE2 computer code, I have prepared the attached graph plotting average pin hot spot temperature against time after break. As seen from the graph, fuel clad temperature does not begin to rise rapidly to temperature at which metal water reaction (temperatures of around 1800°F or higher) would occur until some 10 to 11 hours. This is a minimum available time even for this highly unlikely event--large break LOCA coupled with ECCS failure. For the more credible small breaks (but still assuming the failure of pumped ECCS), I have had Sandia Laboratories, our consultant, run a calculation for me using the RELAP4 code to estimate the time at which boil-off begins. For a small 4-inch cold-leg break LOCA, boil-off would not begin for about 1 hour and uncovery would be delayed until about 3 hours. Significant hydrogen generation (that is, rapid increase in fuel clad temperature) would not begin until about 15 hours.

I have also obtained information from the NRC staff Project Manager for the Sequoyah nuclear power plant concerning the actual maximum power level and test duration for the low-power test program. Sequoyah is a comparable facility and the test program is similar to that planned for McGuire. This information indicates that actual test power was about 4% full power or less and lasted only some 8 days. For similar conditions at McGuire, uncovery would not occur until about 4 or 5 hours. More than 20 hours would elapse before significant hydrogen generation would occur.

Q: Based upon this assessment, what is the likelihood of significant hydrogen generation at low power?

A. As I have indicated above, with the NRC's requirements for reliable ECCS performance, the potential for severe core damage and associated significant hydrogen generation is very small even at full power. The time available at low power for the operator to take corrective action ranges from 10 to 11 hours in the event of a large break LOCA coupled with failure of the ECCS, to 2 1/2 days in the event of a transient followed by total loss of feedwater. Moreover, the number of events at low power that could result in core damage and subsequent generation of hydrogen is significantly reduced. Consequently, the potential for generation of significant amounts of hydrogen at low power is insignificant.

I hereby certify that the above statements are true and correct to the best of my knowledge and belief.

G. Norman Lauben
Norman Lauben

Subscribed and sworn to before me
this 7 th day of November 1980

Marilyn Jollenten
Notary Public

My Commission expires: July 1, 1982

Statement of Professional Qualifications

Norman Lauben

My name is George Norman Lauben. I am employed as a Nuclear Engineer in the Reactor Systems Branch, Division of Systems Integration, U.S. Nuclear Regulatory Commission. I have worked in the field of nuclear reactor safety for 19 years, and in nuclear activities for 23 years. I have worked for the Commission and its predecessor, the Atomic Energy Commission, since 1968. During this time I have worked directly on reactor safety matters, including Emergency Core Cooling System (ECCS) performance review and Loss-of-Coolant Accident (LOCA) analysis.

I was a member of the 1971 AEC ECCS task force and the AEC Staff Panel for the ECCS Rulemaking Hearing. I am the author of the TOODEE2 computer program used by the NRC and the nuclear industry for transient fuel pin thermal analysis during a LOCA. I was a member of the technical team that accompanied Mr. Harold Denton to the Three Mile Island Reactor on March 30, 1979.

I have a B.S. and M.S. in Chemical Engineering from Case Institute of Technology (now Case Western Reserve University).

AVERAGE PIN CLADDING TEMPERATURES AT 9.25 FT. AND 11.25 FT. VS. TIME