UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of

HOUSTON LIGHTING & POWER COMPANY (Allens Creek Nuclear Generating Station, Unit No. 1)	)	Docket No. 50-466

AFFIDAVIT OF NOEL C. SHIRLEY

State of California
County of Santa Clara

I, Noel C. Shirley, Senior Licensing Engineer, within the Safety and Licensing Operation of the General Electric Company, of lawful age, being first duly sworn, upon my oath certify that the statements contained in the attached pages and accompanying exhibits are true and correct to the best of my knowledge and belief.

Executed at San Jose, Calfornia,
July 29 , 1980.

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Subscribed and sworn to before me this 29 day of July, 1980.

OFFICIAL SEAL
KAREN S. VOGELHUBER
NOTARY PUBLIC - CALIFORNIA
SANTA CLARA COUNTY
My Commission Expires Dec. 5, 1980

Karen S. Vogelhuber
NOTARY PUBLIC IN AND FOR SAID
COUNTY AND STATE

My commission expires 12 - 5 of 1980.

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HOUSTON LIGHTING & POWER	§	
COMPANY	§	Docket No. 50-466
	§	
(Allens Creek Nuclear	§	
Generating Station, Unit	§	
No. 1)	§	

Affidavit of Noel C. Shirley

My name is Noel Shirley. I am employed by General Electric Company as a Senior Licensing Engineer. I have served in this capacity for 6 years. A statement of my experience and qualifications is set out in Attachment 1.

This affidavit addresses McCorkle Contention No. 14, in which Intervenor states that the fuel design for ACNGS is not safe because it is subject to hydriding and densification. Intervenor contends that hydriding and densification will cause failures in the ACNGS fuel rod cladding and an increase in offgas activity.

The cause of hydriding induced fuel rod failure in GE Zircaloy clad BWR fuel has been due to internal attack of the cladding by hydrogen. Hydride attack will occur only when the hydrogen is inside the fuel rod. The source of hydrogen inside the rod has been contamination of the fuel by moisture or other hydrogenous materials during manufacture. The clad defects have occurred primarily at low fuel burnup, and appear as localized blisters that may perforate the clad.[2/]

Hydriding induced fuel rod failures were first found in the late 1960's at several operating BWRs. An extensive research program identified the cause of the failures, and provided the basis for the introduction of improvements in the manufacturing process to preclude the recurrence of the problem in newly manufactured fuel.[3/]

In order to prevent hydrogen contamination of the inside of the fuel rod, two major changes have been made in the manufacturing process. A hot vacuum outgassing system was installed in the Wilmington fuel manufacturing facility to remove moisture from the fuel and rod just prior to welding the end plug of the rod in place. The outgassing technique was refined through February, 1973, with the outgassing time and temperature being increased from that initially used. In addition, since March, 1972, a hydrogen getter in the form of Zirconium alloy chips has been installed inside the fuel rod to preferentially combine with hydrogen present in the rod. These chips are contained in an open stainless steel tube placed inside the fuel rod.[2/]

No hydride induced failures have occurred in fuel manufactured using the hydrogen getter and refined outgassing techniques. Hydriding has been effectively eliminated as a fuel failure mechanism in General Electric BWR fuel.[1,2,5/]

In 1972, densification of the UO_2 fuel was identified as a concern in fuel design. Five specific concerns were identified due to observed and/or postulated effects. They were:

1. Increased linear heat generation rate due to a decreased fuel column height with essentially constant heat generation in the pellet.

2. Decreased heat transfer capability between the fuel pellet and the clad due to the creation of a wider fuel to clad gap as the pellet shrinks.

3. Increased stored energy in the fuel caused by the increased linear heat generation rate and lowered pellet to clad thermal conductance.

4. Power spikes caused by the creation of axial gaps as the pellets shrink.

5. Cladding collapse into fuel column gaps caused by pellet axial shrinkage.[3/]

Intervenor relies primarily on Items 1 and 4 in support of the contention; however, all five items are interrelated.

The causes of in-reactor fuel densification are now well understood. This knowledge has led to quality control tests during manufacture which assure that the fuel is of such an initial density that further densification during irradiation does not adversely effect the thermal-mechanical performance of the fuel. Sample manufactured fuel pellets are removed from the production line and are resintered (baked). Tests are then made to determine the actual density of the resintered sample. These densities are compared with the theoretical maximum density. This process assures that the maximum amount of densification during the irradiation is controlled to an acceptable level.[6/] This level of densification is considered in fuel design and safety analysis to address the 5 concerns identified above.

Conservative limits have also been placed on the Linear Heat Generation Rate (LHGR) allowed in the reactor fuel. These limits assure that the actual LHGR will remain within design limits if maximum theoretically possible densification occurs. ACNGS will comply with any limits that are in force when it begins operation through restrictions that are part of the plant Technical Specifications. The Technical Specifications are issued by the NRC as part of the operating license for the plant.

With regard to densification induced axial gap formation several techniques were used to quantify the size, if any, of axial gaps in BWR fuel rods. In-reactor neutron flux scans were used at operating power plants to measure the actual peaks in neutron flux that would occur if axial gaps existed. Gamma scans of irradiated fuel rods were made at reactor sites. In a gamma scan a steam of gamma rays is directed at the fuel rod. If an axial gap exists, a spike in the gamma radiation will be detected in the opposite side of the fuel rod. In addition, post-irradiation neutron radiography and gamma scans were performed at General Electric laboratories. The results of all these tests showed that axial gap formation either does not occur, or that only very small gaps are formed of a size insufficient to compromise fuel integrity. It should be noted that no fuel cladding failures or collapses attributable to densification have ever occurred in BWR fuel.[1/]

If, in spite of all indications that hydriding and densification will not be fuel rod failure mechanisms for ACNGS, clad perforations do occur, no genuine safety concern exists. Extensive experience in the operation of reactor coolant and/or the offgas system can be controlled by regulating the power level of the reactor.[3/] If necessary, the reactor can be shut down and the failed fuel replaced. This ensures that radioactivity released from the plant is always well within regulatory requirements as delineated in the ACNGS Technical Specifications.

In summary, Intervenor has offered only an unsupported contention that hydriding and densification problems make the ACNGS fuel unsafe. Explicit consideration of fuel densification is used in fuel design and safety analyses and the effects of fuel densification are reflected in the plant Technical Specifications. Further, new production techniques and extensive testing have shown that these two concerns are not potential fuel failure mechanisms for ACNGS.

References

1. Elkins, R. B., "Experience with BWR Fuel Through September, 1974," NEDO-20922, June, 1975.

2. Ditmore, D. C. and Williamson, H. E., "Experience with BWR Fuel Through September, 1971," NEDO-10505, May, 1972.

3. "General Electric Boiling Water Reactor Generic Reload Application for 8 x 8 Fuel," NEDO-20360, April, 1974.

4. ACNGS PSAR, Section 4.2.1.3.4.6 and 4.2.1.3.4.9.

5. Elkins, R. B., "Experience with BWR Fuel Through December, 1976," NEDO-21660, July, 1977.

6. Meyer, R. O., "The Analysis of Fuel Densification," NUREG-0085, July, 1976.

ATTACHMENT I

PROFESSIONAL QUALIFICATIONS OF NOEL C. SHIRLEY

POSITION: Senior Licensing Engineer

EDUCATION:

B.S. - Business Science, 1960, San Francisco State

B.S. - Engineering, 1961, San Francisco State

M.S. - Management Science, 1967, San Francisco State

ADDITIONAL BACKGROUND:

Professional Engineer, California (License NU 1388)

Guest Lecturer, Civil Defense Preparedness Agency, Staff College, Battle Creek, Michigan, 1973-1976

EXPERIENCE:

From 1965 through 1967 I was a Design Engineer responsible for the design and fabrication of the containments of prototypical fuel assemblies, scheduled for experimental modification in the GETR, MTR, TREAT and EBR-II. As such I used the physical and nuclear properties of the fuel assembly in designing the containment for the assembly.

From February, 1971 through September, 1974 I was the Specialist-Licensing and Transportation for the Midwest Fuel Recovery Plant (MFRP). In this capacity I was responsible for both the generation and maintenance of the AEC issued license to receive and store spent reactor fuel at the MFRP. I also was responsible for the transportation of all spent fuel shipped to the MFRP.

From October, 1974 through September, 1979 I was a Senior Licensing Engineer in Gf's in Bethesda office. In this capacity I interacted directly with both the NRC and the Advisory Committee on Reactor Safeguard on fuel related issues affecting G.E.

From October, 1979 to present I have been a Senior Licensing Engineer in the Safety and Licensing Operations BWR Systems Licensing Subsection. In this capacity I am responsible for all Generic Licensing Issues affecting BWR fuel.