UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

NRC STAFF SUPPLEMENTAL TESTIMONY OF RALPH O. MEYER RELATIVE TO FUEL FAILURE DETECTION METHODS

[Doherty Contentions 14 and 25]

Q. Please state your name and position with the Nuclear Regulatory Commission.

A. My name is Ralph O. Meyer. I am the Section Leader of the Reactor Fuels Section in the Core Performance Branch. A statement of my educational and professional qualifications was attached to my testimony on Fuel Specific Enthalpy, Gap Conductance, and Cladding Swelling (Doherty Contentions 3, 20(a) and 39).

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to respond to Mr. Doherty's Contention Nos. 14 and 25 which allege that the Allens Creek fuel failure detection methods are inadequate because they will not detect a rapid fuel failure or a flow blockage accident involving more than one fuel assembly.

Q. What fuel failure detection methods are employed at Allens Creek?

A. Two independent radiation detectors are used to sense fission product releases from failed fuel rods. One is on the main steam line just downstream from the reactor vessel, and the other is on the off-gas system for the condensor. The off-gas system radiation monitor is therefore relatively remote from the reactor core compared with the main steam line radiation monitor.

Q. What is the purpose and sensitivity of the Main Steam Line Radiation Monitor?

A. The purpose of the Main Steam Line Radiation Monitor (MSLRM) is to rapidly detect severe fuel damage and initiate steam line isolation and reactor trip. It is part of the Reactor Protection System. According to the Staff's estimate, this monitor would sense the simultaneous failure of about 150 fuel rods within about 7 seconds. This estimate assumes that each fuel rod releases 2% of its fission product inventory. Two percent is an estimate of the free activity within a fuel rod (gap activity) that would be available in the event of fuel failure after normal operations. In the event of fuel melt, the percentage of free activity would approach 100%. In this case, the monitor should be able to detect as few as 3 fuel rods simultaneously melting. Therefore, depending on the severity of fuel damage, the Main Steam Line Radiation Monitor should be able to detect the simultaneous release of fission products from about 3 to 150 fuel rods.

Q. What is the purpose and sensitivity of the Off-Gas System Radiation Monitor?

A. The purpose of the Off-Gas System Radiation Monitor (OGSRM) is to detect low-level emissions of noble gases, which would indicate the occurrence of minor fuel damage. This monitor is set to sound an alarm that would initiate operator action. According to our estimate, this monitor would sense the failure of a single rod that released 2% of its gaseous fission product inventory, but it would take 2 to 3 minutes for the activity to reach the detector from its point of origin in the core. This delay is essential to the instrument's sensitivity because it permits obscuring background activity to decay.

Q. Please describe the flow blockage accident of concern in this contention.

A. BWR fuel, such as in Allens Creek, is contained in small square bundles surrounded by a Zircaloy channel box. If the inlet to this bundle were blocked by a foreign object, the fuel rods might be inadequately cooled and become damaged. If the flow blockage were extensive and the fuel heatup were not checked, fuel melting might occur.

Q. Is a flow blockage accident likely to occur and result in severe fuel damage?

A. No. The lower (inlet) end of the BWR fuel assembly is designed to be difficult to block. There are bypass holes drilled in the sides of the inlet flow nozzle, and there is a gap where the channel box joins the nozzle so that further leakage can occur. General Electric has analyzed this postulated accident in a report NEDO-10174, which is referenced in the PSAR, and found that inlet orifice blockages of about (a) 80% are needed to produce boiling transition (incipient fuel damage), (b) 95% are needed to result in cladding melting, and (c) 98% are needed to result in fuel melting. A flow-blockage accident has not occurred in a BWR.

Q. Would the radiation monitors detect the occurrence of such fuel damage promptly?

A. For limited blockages (less than about 95%), fuel damage would occur slowly--hours or perhaps days before perforation--and fuel rod failures might occur at different times. The Off-Gas System Radiation Monitor would detect these failures within 2 or 3 minutes after their occurrence.

Large yet incomplete blockages (between about 95 and 98%), would result in severe fuel damage. The cladding would oxidize and the fuel might fragment. If the fuel pellets do not heat up and melt, the fission product release would be about the same as from simple perforations in 62 fuel rods (there are 62 fuel rods in an assembly). This release would give a very pronounced indication on the Off-Gas System Radiation Monitor, but the Main Steam Line Radiation Monitor set point would probably not be exceeded. It would be difficult to distinguish this event with severe local damage from a more widespread event with minor damage unless the situation degraded further.

If fuel pellet heatup occurred from either complete blockage (greater than 98%) or from degradation of the previous situation, large increases in fission product release would accompany the heatup. Even if only 10% of the fuel pellet inventory were released, this would be equivalent to the gap activity of about 300 fuel rods and should result in prompt detection by the Main Steam Line Radiation Monitor followed automatically by main steam line isolation and scram.

Q. Then what is the inadequacy referred to in NUREG-0401 that is referred to as the basis for this contention?

A. The limitation discussed in NUREG-0401 was simply the inability of these monitors to detect early stages of damage in the severe blockage case.

Q. Are the radiation monitors in pressurized water reactors (PWRs) better than those in Allens Creek?

A. No. The sensitive Letdown Line Radiat on Monitor in a PWR has the same 2- to 3-minute delay as the Off-Gas System Radiation Monitor in the BWR and is sensitive for the same reason--the N-16 background activity has decayed.

Q. Would detection of fuel damage resulting from blockage in 2 or more fuel assemblies be more difficult than for the single assembly case that you have previously discussed?

A. No. It would be easier because the activity to be detected would be 2 or more times greater.

Q. Does a higher core power density or a high total thermal power output increase the probability of inlet flow blockage or make detection of damaged fuel more difficult?

A. Since the probability of blockage depends on the presence of foreign objects and their ability to block individual bundles (and hence on the bundle inlet design), there does not appear to be any connection between power density or total power and the probability of a blockage.

A larger total power would result in a larger amount of N-16 background activity, however, which could have a small degrading effect on the sensitivity of the Main Steam Line Radiation Monitor. This same effect would in principle apply to the Off-Gas System Radiation

Monitor. However, the half-life of N-16 is only 7.4 seconds, so any lost sensitivity could be recovered by increasing the 2- to 3-minute delay time by several seconds. Average power density does not appear to be related to failure detection.

Q. Is the fuel failure detection capability for Allens Creek adequate?

A. Yes. Considering (a) the low probability of occurrence of inlet flow blockage, (b) the ability to detect low-level damage within 2 or 3 minutes, and (c) the ability to detect significant fuel melting within a few seconds and to automatically activate the Reactor Protection System on such a signal, the Allens Creek fuel failure detection capability is adequate.

Ralph O. Meyer
Professional Qualifications

In 1960 I received a B.S. in physics from the University of Kentucky and was made a member of Phi Beta Kappa. In 1966 I received a Ph.D. from the University of North Carolina (Chapel Hill) with a thesis subject in the field of solid state physics.

Following graduation, diffusion studies related to the thesis topic were continued while I was a Research Associate in physics at the University of Arizona. In 1968 I was employed as an Assistant Metallurgist in the reactor development program of the Materials Science Division at Argonne National Laboratory, Illinois. At Argonne diffusion techniques were applied to study the properties of nuclear reactor fuels. This research included studies of gaseous fission product migration, segregation of fissile fuel material, and restructuring of oxide fuel elements. More than 20 technical journal papers and topical reports were published on this fundamental and applied research.

In 1973, I joined USNRC as a Reactor Engineer in the Reactor Fuels Section of the Core Performance Branch. In addition to other duties related to the performance of nuclear fuel, I was the principal reviewer of fuel densification analyses. Since 1976, I have been the Section Leader of the Reactor Fuels Section and have a continuing responsibility for the review of fuel densification, fission gas release and overall fuel performance.