UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING APPEAL BOARD

In the Matter of	)	
DUKE POWER COMPANY, ET AL.	)	Docket Nos. 50-413
	)	50-414
(Catawba Nuclear Station,	)	
Units 1 and 2)		

AFFIDAVIT OF CARL J. CZAJKOWSKI AND JOHN R. WEEKS

Our names are Carl J. Czajkowski and John R. Weeks. We are both employed by Brookhaven National Laboratory, Upton, New York 11973. Our respective titles are Research Engineer and Division Head in the Materials Technology Division of the Department of Nuclear Energy at Brookhaven National Laboratory. Statements of our professional qualifications are attached to this affidavit.

This affidavit is in response to the Affidavit of David A. Schlissel filed in the captioned case, which addresses the finding of the Atomic Safety and Licensing Board in the Catawba Nuclear Station operating license proceeding that intergranular stress corrosion cracking (IGSCC) is not expected to occur as a result of "sensitization" of certain "critical" welds in the Catawba plant's primary cooling system.

Annealed stainless steels owe their excellent resistance to corrosion to the presence of chromium in the steel which imparts an extremely protective oxide on the steel surface. When stainless steels are heated to certain temperatures (typically 538°C to 816°C), the chromium and the carbon in the steel react to form particles of chromium carbide, which nucleate in the grain boundaries of the steel structure and leave, adjacent to them, a narrow zone with lower chromium concentration. In certain environments, this situation can lead to grain boundary (intergranular) corrosion or stress corrosion. This type of structure is described as sensitized, meaning it is susceptible under certain conditions to intergranular attack. IGSCC is the formation of cracks that propagate through the grain boundaries of an alloy such as sensitized stainless steel, when it is stressed in tension while exposed to a corrosive environment.

IGSCC of austenitic stainless steels occurs through the simultaneous interaction of three variables: 1) a residual or applied tensile stress, 2) a susceptible microstructure (in the case of austenitic stainless steel this is termed "sensitized"), and 3) a corrosive environment. If any one of these variables can be eliminated or significantly altered, IGSCC will not occur.

For purposes of this affidavit, it will be assumed that the material adjacent to the welds in question has a relatively high residual stress and a "sensitized" microstructure, since both high residual stresses and a sensitized microstructure can be produced by the welding process. These two conditions should not be considered unique to Catawba, however. During normal construction/repair activities at a nuclear site, a significant number of welds may become sensitized (to one degree or another) with relatively high residual stresses present. The licensing hearings were concerned with sensitization allegedly caused by violation of interpass temperature on welds on the primary cooling system piping.

The main reason that so small a number of welds fail by IGSCC is the absence of a corrosive environment. In boiling water reactors (BWR's), the species responsible for the most instances of IGSCC has been oxygen. The role of oxygen and its interaction with impurities has been discussed in some detail by the NRC Pipe Crack Review Group (NUREG-1061)[1]. In the presence of oxygen, the concentration of other impurities can accelerate the onset and rate of IGSCC.

In pressurized water reactors (PWRs) like Catawba, however, impurities are much less likely to enter the primary coolant, since it is not directly connected to the condenser which, with the condensate demineralizers, form the primary source of impurities that have entered BWRs. Further, oxygen is controlled in PWRs by the use of hydrogen. The Pipe Crack Study Group reports NUREG-0531[2] and NUREG-0691[3] have stated that no occurrence of IGSCC has occurred in PWR primary coolant piping to date, and that no occurrences of IGSCC are anticipated in the future. The reason for the Pipe Crack Study Group's confidence is the rigidly controlled oxygen concentrations mandated in PWR operation. The technical specifications for Catawba, as for all

Westinghouse PWRs, have a maximum allowable oxygen content of $\leq$0.1 ppm during operation above 121°C (TS3.4.7). This value is a maximum, with normal operating oxygen levels being maintained in the 5 ppb range (FSAR Table 5.2.3.4). To our knowledge no IGSCC of sensitized stainless steels will occur in pure water at any temperature between 0°-300°C if the oxygen content is below 0.08 ppm, or a factor of 16 times greater than the normal operating conditions of a PWR. This evaluation of the potential for cracking in PWR primary systems has been substantiated by the latest Pipe Crack Study Group (Ref. 1, pages 1-3 to 1-4). This review states "PWR primary piping systems whether ferritic or austenitic have been essentially immune to any cracking mechanisms." Probabilitistic studies done by Lawrence Livermore National Laboratory (LLNL) reviewed by this Pipe Crack Study Group gave rise to the following statement in this report. "The LLNL studies and extensive studies in the Federal Republic of Germany (1.4) both led to the conclusions that catastrophic failure of PWR primary piping is an incredible event." On the basis of their reviews, this task group finally concluded that "...there are no bases for an extensive review and analysis of PWR pipe cracking."

With regard to instances of cracking of austenitic stainless steel welds in secondary or non-safety systems at PWR's, all instances have involved a contaminant species and stagnant lines, and each of the instances gave an adequate warning of "leak before break" so there was no danger to the safety and health of the public.

Considering the literature and operating experience available on IGSCC in PWRs, it is our conclusion that the propensity for cracking of the stainless steel welds at the Catawba plant in the primary system is virtually non-existent under normal operating conditions and that any potential cracking of austenitic stainless steel welds in the secondary or other systems is very slight and if it does occur it would be with adequate "leak before break" warning.

As a result of the foregoing consideration, we also conclude that an independent inspection of the primary system welds questioned during the Catawba licensing proceeding is not warranted.

(1) NUREG-1061, Vol. 1, August 1984, "Report of the U. S. Nuclear Regulatory Commission Piping Review Committee, Investigation and Evaluation of Stress Corrosion Cracking in Piping of Boiling Water Reactor Plants."

(2) NUREG-0531, 1979, Investigation and Evaluation of Stress Corrosion Cracking in Piping of Light Water Reactor Plants.

(3) NUREG-0691, 1980, Investigation and Evaluation of Cracking Incidents in Piping in Pressurized Water Reactors.

The above statements are true and accurate to the best of our knowledge.

John R. Weeks

Carl J. Czajkowski

Sworn before me this

day of ____________

DONNA M. GALLAGHER
NOTARY PUBLIC, State of New York
No. 4777833, Suffolk County
Term Expires March 30, 19__

____

Notary Public

PROFESSIONAL QUALIFICATIONS

OF

CARL J. CZAJKOWSKI

I am currently a Research Engineer at Brookhaven National Laboratory (BNL) where I have been employed since 1980. I am in the Materials Technology Division of the Department of Nuclear Energy. My current duties are providing technical assistance (both field and laboratory) to the United States Nuclear Regulatory Commission (USNRC) in the areas of metallurgy and failure analysis related to nuclear power plants. Failure analysis performed in my current position have included the following material systems: austenitic stainless steels, ferritic and martensitic low alloy steels, inconel, aluminum and martensitic stainless steel.

Prior to my employment at BNL, I was employed for five years by the Long Island Lighting Company (LILCO). My job title from September 1977 to February 1980 was Chief Welding Supervisor at the Shoreham Nuclear Power Station. My duties in this position included ordering and maintenance of equipment/gases/electrodes to support a 400 welder workforce at the site. Additional responsibilities included conducting training sessions for supervisory and manual personnel on industry codes, standards and welding inspection in addition to administering the weld test booth for qualification testing. Subsequent to my promotion to Chief Welding Supervisor, I was employed by LILCO as a Quality Assurance Engineer (both home office and Shoreham site). This position was held by me from February 1975 to September 1977. The duties of this position encompassed preparation and review of LILCO's QA manual and procedures, reviewing A/E and NSSS quality programs, evaluating and surveying vendor activities and performing field audits and surveillance of mechanical contractors' (Shoreham site) welding and nondestructive testing practices.

I also held the job title Quality Assurance Engineer while employed by Ebasco Services Inc. from September 1973 to February 1975. This position's duties included review of procurement specifications and drawings for inclusion of quality requirements, preparation of quality plans for surveillance of safety related component fabrication in vendors' shops, conducting interdepartmental audits of engineering and design disciplines in addition to QA evaluation of vendors including review of documented Quality programs and source evaluation.

Prior to my employ at Ebasco Services, I held the job title QC Materials Engineer for United Nuclear Corporation from April 1972 to August 1973. This position's responsibilities included review of material purchase orders for compliance with contract requirements monitoring of the test-overcheck program for ferrous and non-ferrous material, establishing materials receiving inspection instructions and audit participation as needed.

My academic qualifications include a B.S. in Metallurgical Engineering from the University of Missouri at Rolla in 1971, and an M.S. in Metallurgical Engineering from the Polytechnic Institute of New York in 1982. I am a member of the American Society for Metals and American Welding Society. I am the author or co-author of approximately fifteen publications in the area of failure analysis on reactor components.

PROFESSIONAL QUALIFICATIONS

OF

JOHN R. WEEKS

I am currently a Senior Metallurgist at Brookhaven National Laboratory, (BNL), where I have been employed since 1953. My present title is Head, Materials Technology Division in the Department of Nuclear Energy. My current responsibilities include managing experimental investigations on the mechanisms of stress corrosion cracking and pitting corrosion of stainless steels and Inconel, and providing technical assistance to the U.S. Nuclear Regulatory Commission (NRC) in the areas of materials performance and corrosion and coolant chemistry in light water reactors. I have been a participating consultant on the four NRC Pipe Crack Study Groups, investigating the causes of stress corrosion cracking in both BWRs and PWRs. My responsibility on all four review groups was to review the environmental factors causing the stress corrosion cracking.

Since joining Brookhaven, I have performed and supervised research on materials behavior in both liquid metal and water cooled reactors. From 1970 to 1972, I headed Brookhaven's program on liquid sodium technology. I have been materials advisor to the Reactor Divisions at BNL since 1959. I was keynote lecturer in 1966 at the International Atomic Energy Agency Symposium on Alkali Metal Coolants, and served in 1967-1969 as a U.S. delegate at the U.S.-U.K. information exchanges on corrosion of reactor materials. I was a consultant to Aeroject General on the SNAP-8 project. I also am a member and former Chairman of the BNL Reactor and Critical Experiments Safety Committee.

I was an adjunct associate professor of materials science at SUNY - Stony Brook in 1962-1963, and am currently an adjunct professor of Metallurgy and Nuclear Engineering at the Polytechnic Institute of New York. From 1972 to 1974 I was on assignment to the U. S. Atomic Energy Commission as a senior metallurgist in the Materials Engineering Branch, Directorate of Licensing.

My academic qualifications include a Met. E. degree from the Colorado School of Mines in 1949, a M.S. in 1950, and a Ph.D. in 1953 in Metallurgy from the University of Utah. I am a member of the American Society for Metals, for which I have been Chairman of the Long Island Chapter, the Metallurgical Society of AIME, for which I have served as Chairman of the Nuclear Metallurgy Committtee, The National Association of corrosion Engineers, and the American Nuclear Society. I am the author or co-author of approximately eighty publications in my areas of research.