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)	§	
	§	

AFFIDAVIT OF DR. GERALD M. GORDON

My name is Dr. Gerald M. Gordon. I am employed by the General Electric Company as Manager, Plant Materials Engineering and Technology, Nuclear Power Systems Engineering Department. I have been so employed for two years. A statement of my experience and qualifications is set out in Attachment 1.

For the purposes of clarity, the following definitions apply to this affidavit:

a. Austenitic Stainless Steel. Austenitic Stainless Steel (nominal 18 percent chromium and 8 percent nickel compositions being the most popular) are steels that possess an austenitic (face centered cubic atomic) structure at room temperature and are non-magnetic. Austenitic stainless steels are generally either normal carbon (0.08% maximum) or low carbon (0.03% maximum). The low carbon versions are referred to as L-Grade.

b. Sensitization. The intergranular precipitation of chromium carbide and resultant depletion of chromium level in austenitic stainless steels when exposed to temperatures in the approximate range of 800° to 1500°.[1,2/] This depletion leads to decreased corrosion resistance at the grain boundaries.

c. Intergranular Stress Corrosion Cracking (IGSCC). Cracking occurring preferentially at grain boundaries resulting from a special combination of stress, material condition and environments. Sensitized austenitic stainless steel is a material condition where IGSCC has occurred in BWRs.

d. Type 316 Nuclear Grade Stainless Steel. A classification of steel alloys that has approximately 16 percent chromium, 10 percent nickel, 2 to 3 percent Molybdenum, less than 0.02 percent carbon, and some other minor alloying elements, with the remainder being iron. Type 316 Nuclear Grade does not sensitize when welded and therefore is not susceptible to IGSCC under BWR conditions.

e. Plain Carbon Steel. A classification of non-stainless steel alloy that has approximately .2 percent carbon and .5 percent manganese. This class of alloys has not exhibited stress corrosion cracking in contact with BWR coolant.

f. Heat Affected Zone. A region of base metal on either side of a weld which is heated above 800°F during

welding. In materials subject to intergranular stress corrosion this results in sensitization.

Sensitization of normal carbon content (0.05-0.08%) stainless steels occurs in those places where pipe welding has heated a narrow band of the material to an elevated temperature and the material has been allowed to cool slowly without a subsequent heat treatment. These heat-affected zones are thus "sensitized." When these sensitized areas were exposed to a particular combination of stress and dissolved oxygen in high temperature waters, these zones have in the past shown some susceptibility to stress corrosion cracking at grain boundaries. Through July 28, 1980, only 209 out of about 34,000 stainless steel pipe weld heat-affected zones within the Reactor Coolant Pressure Boundary (RCPB) have experienced IGSCC in all operating BWRs. Of these, the bulk have been in the recirculation bypass line, the core spray line, control rod drive hydraulic return line, and reactor water clean up lines. Counter measures have been identified and qualified for these lines in ACNGS. For example, the recirculation bypass line and the control rod drive hydraulic return line were eliminated from the ACNGS design and the core spray line and reactor water clean up lines were changed from normal carbon stainless steel to plain carbon steel. Plain carbon steel has not

exhibited stress corrosion under BWR conditions. The remainder of the RCPB piping is either plain carbon steel or Type 316 Nuclear Grade stainless steel.

The specific material changes in stainless steel piping for ACNGS are the result of programs suggested by a special interdisciplinary General Electric Task Force investigation conducted in 1975 to determine the cause of cracking in stainless steel piping lines. Potential improvements were identified and extensively tested. Only after being proven were they implemented into ACNGS and other plants.[3,4]

More recent changes made to the ACNGS plant to further avoid IGSCC incidents include the use of feedwater spargers and collet cylinder tube and recirculation pump housing which are made of low carbon stainless steel and Control Rod Drive Housings which are fabricated from Type 316L stainless steel.

ACNGS is designed to eliminate the occurrence of IGSCC. The most direct and certain solution to eliminate the potential for IGSCC in BWR piping, as recommended by the NRC,[5] is the use of materials resistant to stress corrosion. To that end, all of the RCPB will be composed of materials not subject to IGSCC. The NRC Staff established in Regulatory Guide 1.44 and NUREG-0313[5] the criteria for testing and

fabricating austenitic stainless steels to minimize the incidence of IGSCC. These criteria are not applicable to the very low carbon grades of austenitic stainless steels and plain carbon steel because these materials have been shown to resist IGSCC. This immunity can be produced because the most significant factor affecting the degree of sensitization is the carbon content of the alloy.[6/]

Stainless steels with a maximum of .03% carbon are essentially immune to IGSCC in a BWR environment. At great expense, Applicant has specified that all stainless steel material in the recirculation system be made of the most impervious material available--316 Nuclear Grade stainless steel. This material may not have a carbon content exceeding .02 percent which is even lower than the carbon level of 316L (.03% maximum). Hence, the entire recirculation system can be considered immune to IGSCC.

In conclusion, the materials used for ACNGS piping supplied by General Electric comply fully with 10 CFR 50, Appendix A, Criterion 31, and reduce the potential incidence of intergranular stress corrosion cracking to virtually nil. The NRC has reviewed the substitution of materials described above and accepts this alternative as a resolution for the generic problem.[5/]

References

1. G. E. Linnert, "Welding Metallurgy," American Welding Society, 1949.

2. American Society for Metals, Metals Handbook, Volume 1. "Properties and Selection of Metals," Eighth Edition, 1961.

3. "The Application of Low Carbon Type 316 Stainless Steel for BWR Recirculation Piping Systems," J. F. Copeland and E. D. Sayre. Paper to be presented at Symposium "Material-Environment Interactions in Structural and Pressure Containment Service," organized by the Metal Properties Council, Inc., in cooperation with the Materials Division of ASME, to be held during the 1980 ASME Winter Annual Meeting, Chicago, Illinois, November 16-21, 1980.

4. "Mitigation of Stress Corrosion Cracking in Boiling Water Reactors" by R. E. Hanneman and R. L. Cowan II. Paper presented at the American Power Conference, Chicago, Illinois, April 1980, to be published in proceedings.

5. "Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping," NUREG-0313, Rev. 1 (October, 1979).

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

ATTACHMENT 1

GERALD M. GORDON

PRESENT POSITION

Manager, Plant Materials Engineering and Technology, Nuclear Power Systems Engineering Department, General Electric Company.

EDUCATION

B. S. - Metallurgical Engineering, Wayne State University, 1956
Ph.D. - Metallurgical Engineering, The Ohio State University, 1959

TECHNICAL ASSIGNMENTS

Prior to joining General Electric, Dr. Gordon was a Senior Metallurgist at Stanford Research Institute, Menlo Park, California, from 1959-63. He served as a Project Leader on a number of government and commercially sponsored programs in the areas of high temperature oxidation and mechanical performance of refractory metal alloys.

Dr. Gordon joined the General Electric Company Nuclear Energy Division in 1964 as a Senior Metallurgist in the Reactor Materials Development Group at Vallecitos. He became Manager of the Metallurgy Development Component in 1969. This group had materials research and development responsibility for physical metallurgy, fracture toughness and radiation damage of reactor materials and aqueous corrosion and stress cracking of nuclear reactor pressure boundary and internals materials. In 1973, Dr. Gordon became Manager of the Zircaloy Performance Group with responsibility for development and evaluation of nuclear fuel cladding and channel materials. He also served as Manager, Plant Component Behavior Analysis and was responsible for implementation of laboratory developments in design of reactor plants. He assumed the position as Manager, Plant Materials Engineering in 1976, and his current position as Manager, Plant Materials Engineering and Technology in 1978, and is currently responsible for evaluating and specifying BWR plant materials as well as materials surveillance and identification and solution of potential or actual stress corrosion cracking problems.

Dr. Gordon is a Registered Professional Engineer in California and a Fellow of the American Society of Metals. He has authored numerous publications and patents and has been an invited lecturer or Session Chairman at several International Conferences on Corrosion & Stress Corrosion Cracking. He is past Chairman of the National Association of Corrosion Engineers Committee T-11A on Corrosion in High Purity Power Plant Water.

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	)	
(Allens Creek Nuclear Generating Station, Unit No. 1)	)	
	)	

AFFIDAVIT OF LOUIS A GUNTHER

State of New Jersey
County of Bergen

I, Louis A Gunther, Welding and Materials Engineer, Allens Creek Project for Ebasco Services Incorporated, of lawful age, being first duly sworn, upon my oath certify that I have reviewed and am thoroughly familiar with the statements contained in the attached affidavit addressing intervenor TexPirg's Contention 10 regarding IGSCC and that all statements contained therein are true and correct to the best of my knowledge and belief.

Louis A Gunther

Subscribed and sworn to before me this 22nd day of January, 1980.

CAROL A. OPITENOK
NOTARY PUBLIC OF NEW JERSEY
MY COMMISSION EXPIRES SEPT. 18, 1983

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(Allens Creek Nuclear Generating Station, Unit No. 1)	)	
	)	

AFFIDAVIT OF WALTER F MALEC

State of New Jersey
County of Bergen

I, Walter F Malec, Supervising Mechanical Nuclear Engineer, Allens Creek Project, for Ebasco Services Incorporated, of lawful age being first duly sworn, upon my oath certify that I have reviewed and am thoroughly familiar with the statements contained in the attached affidavit addressing intervenor TexPirg's Contention 10 regarding IGSCC and that all statements contained therein are true and correct to the best of my knowledge and belief.

Walter F Malec

Subscribed and sworn to before me this 24th day of March, 1980.

CAROL A. OPITENOK
NOTARY PUBLIC OF NEW JERSEY
MY COMMISSION EXPIRES SEPT. 18, 1983

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

AFFIDAVIT ADDRESSING TEXPIRG'S CONTENTION NO. 10
RELATING TO INTERGRANULAR STRESS CORROSION CRACKING

My name is Louis A. Gunther. My business address is Two World Trade Center, New York, N. Y. I am the Welding and Materials Engineer for the Allens Creek Project employed by Ebasco Services Incorporated. The statement of my background and qualifications is attached as Exhibit I to this testimony.

My name is Walter F. Malec. My business address is 160 Chubb Avenue, Lyndhurst, N. J. I am the Supervising Mechanical Nuclear Engineer for the Allens Creek Project employed by Ebasco Services Incorporated. The statement of my background and qualifications is attached as Exhibit II to this testimony.

This affidavit responds to the Intervenor's concerns about intergranular stress corrosion cracking of austenitic stainless steels supplied by Ebasco Services Incorporated. The phenomenon of IGSCC is described in the affidavit of Dr. Gerald M. Gordon of General Electric.

The piping within the reactor coolant pressure boundary (RCPB) of the standby liquid control system, instrumentation of the nuclear boiler system, and instrumentation of the recirculation system will be fabricated from 304L stainless steels. This classification of steel alloy has 18-20 percent chromium and 8-12 percent nickel, a maximum of 0.03 percent carbon,[1/] some other minor alloying elements and the remainder is iron. The resistance of low carbon steels, such as 304L, to IGSCC is also described in the affidavit of Dr. Gerald M. Gordon.

Despite great confidence in the prophylaxis provided by proper materials selection and processing, ACNGS will also be provided with a positive leak detection system. This system, which is described in PSAR Section 5.2.7, will detect any uncontrolled or unanticipated leakage from the RCPB. Since all IGSCC failures produce easily detectable leakage well before the presence of rapidly propagating cracks, this detection system provides the final conservative assurance that the safety of ACNGS will not be threatened.

1/ Some stainless steel A312 piping with a 0.035 percent carbon content, will be used in the ECCS for piping in direct contact with the Suppression Pool. This is a corrosion prevention measure. This piping is open-ended and not subject to the same stress levels as in the pressurized piping in which IGSCC has been observed.

EXHIBIT I

RESUME - LOUIS A GUNTHER

Senior Engineer - Materials Applications

SUMMARY OF EXPERIENCE (Since 1968)

Total Experience - More than 12 years engineering experience in metallurgical and welding engineering in the areas of welding design and material selection, pressure vessel fabrication and advanced welding process development for utility, naval nuclear, deep sea submergence and aerospace projects.

Professional Affiliations - Professional Engineer in the State of New York.

Patents - Method of Welding a Tube to a Tube Sheet, Patent No. 3,824,663.

Honors and Awards - Tau Beta Pi
Noah A Kahn Memorial Award - ASTM

Professional Society Memberships - American Society for Metals
American Welding Society
Welding Research Council

Education - BS Metallurgical Engineering (magna cum laude)

Polytechnic Institute of Brooklyn - 1968

MS Metallurgy - New York University 1970

MBA Management Systems - New York University 1975

Specialized Training - Completed the following courses:

(a) TT-4 Practical Nuclear Power Plant Technology Course/sponsored by Ebasco-1977.

(b) B&W Basic Steam Generating Technology Course/sponsored by Ebasco-1976.

(c) GE-BWR Course/sponsored by Ebasco-1975.

(d) Titanium and Its Alloys/sponsored by the American Society for Metals-1968.

LOUIS A GUNTHER

REPRESENTATIVE EBASCO PROJECT EXPERIENCE

(As Senior Engineer)

Nuclear

Louisiana Power & Light Company	Waterford Unit 3
Houston Lighting & Power Company	Allens Creek Unit 1

Fossil

New York State Electric & Gas Company	Homer City Unit 3
Pennsylvania Electric Company	
Iowa Public Service Company	Neal Unit 4
Public Service Company of Colorado	Pawnee Unit 1
Houston Lighting & Power Company	Limestone Units 1 and 2

EBASCO EXPERIENCE (Since 1974)

Senior Engineer - (6 years), New York Office

Responsible for all matters concerning New York Office welding fabrication and materials selection during design and construction phases on assigned projects and for providing technical support for project site support engineers. Assigned to special projects for development of automatic fixed position pipe welding procedures.

PRIOR EXPERIENCE (6 Years)

Curtiss Wright Corporation
Wood-Ridge, New Jersey
Senior Engineer (3 years)

Assigned to the Welding Technology Department, Nuclear Division. Responsible for development, implementation and surveillance of specialized welding procedures employed in the manufacture of Naval Nuclear Components to NAVSHIPS-250-1500-1 requirements. These procedures included specialized seal welding, automatic tube-to-tube sheet welding, and automatic orbital pipe welding processes. Additional responsibilities included metallurgical studies for development projects and production support, manpower and schedule estimating for new welding projects, capital equipment selection, and vendor auditing.

RESUME - LOUIS A GUNTHER

PRIOR EXPERIENCE (6 Years) (Continued)

Curtiss Wright Corporation
Wood Ridge, New Jersey
Engineer (2 years)

Assigned to the Process Metallurgy Department, Aerospace Division. Responsible for development projects concerned with repair welding and heat treatment of turbine blades, plasma arc welding, inertia welding, and production welding of D6AC steel assemblies for the Grumman F14 Program.

U S Naval Applied Science Laboratory
New York, New York
Physical Metallurgist (1 year)

Assigned to the Titanium Development Program, responsible for carrying out welding development studies and welder training programs on heavy section titanium alloys in support of U S Navy deep submergence vehicle programs.

Ebasco Services Incorporated
Materials Laboratory Technician (Summer Employment)

Responsible for specimen preparation, metallographic work on failure analyses, and brazing and machining operations performed during laboratory studies for the power industry.

EBASCO SERVICES
INCORPORATED

EXHIBIT II

WALTER F MALEC
Supervising Engineer
4 Years With EBASCO

Born	Philadelphia, Pennsylvania
Education	Polytechnic Institute of Technology, degree of Engineer in Nuclear Engineering - 1978 Massachusetts Institute of Technology, MS in Nuclear Engineering - 1970 U.S. Coast Guard Academy, BS - 1968
Member	American Nuclear Society
Licensed	Registered Professional Engineer in the State of New York (No. 56673)

Experience:

1980	Ebasco Services Incorporated, Lyndhurst (NJ) Office; Supervising Engineer, Mechanical-Nuclear Engineering Department: Houston Lighting & Power Co - Allens Creek NGS - Unit No. 1 - 1200 MW(e) BWR Technical and administrative responsibility for mechanical, fire protection, plumbing, HVAC, stress analysis, hangers and supports, and inservice inspection activities. Includes schedules, budgets, and client relations.
1978-1980	Ebasco Services Incorporated, Lyndhurst (NJ) Office; Principal Engineer, Mechanical-Nuclear Engineering Department Houston Lighting & Power Co - Allens Creek NGS - Unit No. 1 - 1200 MW(e) BWR, Lead NSSS Engineer Responsible for preparation and maintenance of ECCS and BOP flow diagrams, piping layouts, system design descriptions, inservice inspection provisions, Nuclear Island building general arrangements, PSAR and FSAR preparation, equipment sizing and specification, NSSS vendor interface for correspondence, drawing review, and contract administration.
1976-1978	Ebasco Services Incorporated, New York Office; Senior Engineer, Mechanical-Nuclear Engineering Department including: Houston Lighting & Power Co - Allens Creek NGS - Unit No. 1 - 1200 MW(e) BWR, Lead NSSS Engineer Louisiana Power & Light Co - Waterford SES Unit No. 3 - 1165 MW(e) PWR. Lead NSSS Engineer (Same responsibilities as listed for 1978-1980 above.)

1976-1978 (Cont'd) Responsible for preparation and maintenance of ECCS and BOP flow diagrams, piping layouts, system design descriptions, inservice inspection provisions, Nuclear Island building general arrangements, PSAR and FSAR preparation, equipment sizing and specification, NSSS vendor interface for correspondence, drawing review, and contract administration.

* * * * *

1974-1976 United States Coast Guard, Marine Inspection Office, New York; Lieutenant - Supervisory Boiler Inspector. Responsibility for supervision, assignment and training of Marine Inspectors in largest Marine Inspection Office in country. Inspection of hull and machinery material condition of U.S. flag and foreign merchant vessels, and pressure vessels under construction. Application of various laws and regulations of the United States, ASME Code, ANSI, TEMA, NEC and NFPA Standards. Review of engineering plans and alterations, reports from field and resident inspectors.

1973-1974 United States Coast Guard, USCGC Spencer (WHEC-36), Lieutenant - Chief Engineer. Responsibility for operation, maintenance and repair of hull and engineering plant of 6200 slip twinscrew steamship. Direct supervision of 40 officers and men. Duties included preparation of repair specifications and maintenance of vessel records. Received Coast Guard Achievement Medal for superior performance of duty.

1970-1973 United States Coast Guard, Marine Inspection Office, New York, Lt and Ltjg - Marine Inspector. Inspection of hull and machinery of U.S. and foreign flag merchant vessels.

1968-1969 United States Coast Guard, USCGC Mellon (WHEC-717), Ensign, Assistant Engineer Officer.