Florida Power
CORPORATION

September 3, 1987
3F0987-01

Dr. J. Nelson Grace
Regional Administrator, Region II
U.S. Nuclear Regulatory Commission
101 Marietta Street N.W., Suite 2900
Atlanta, GA 30323

Subject: Crystal River Unit 3
Docket No. 50-302
Operating License No. DPR-72
NRC Bulletin 87-01
Thinning of Pipe Walls in Nuclear Power Plants

Dear Sir:

The subject bulletin requested Florida Power Corporation (FPC) provide information about our programs for monitoring the wall thickness of pipes in condensate, feedwater, steam, and connected safety and nonsafety high energy pipings systems fabricated of carbon steel.

In preparing our response FPC has considered high energy piping to be piping which has design conditions of 275 psig and 200°F or greater.

1. Identify the codes or standards to which the piping was designed and fabricated.

Response

All carbon steel piping of concern was designed and fabricated in accordance with USAS B31.1 - 1967 edition. Some modifications were performed to later editions of this same code.

2. Describe the scope and extent of your programs for ensuring that pipe wall thicknesses are not reduced below the minimum allowable thickness. Include in the description the criteria that you have established for:

a. selecting points at which to make thickness measurements
b. determining how frequently to make thickness measurements
c. selecting the methods used to make thickness measurements
d. making replacement/repair decisions

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Response

Before 1987, only two-phase flow conditions were subjected to an inspection program. Prior to the Surry event industry experience indicated only concerns in two-phase flow piping. This two-phase flow program was limited to high pressure extraction steam lines where twelve (12) inspection points were selected to provide indication of wall-thinning. This effort was established in 1983 as a result of an Oconee pipe rupture. Inspections were performed in the fall of 1983 and the spring of 1985 with straight beam ultrasonics. The results of those inspections confirmed the original belief that an inspection frequency equivalent to a fuel cycle was adequate.

One fitting was replaced subsequent to the first inspection (1983) because the wall thickness was below manufacturer's minimum wall. No evaluation was performed. Two fittings were identified in 1985 to have wall thickness below manufacturer's tolerances, but were not replaced until 1986 because they were well above code (B31.1) minimum wall allowances.

FPC had intended to continue the use of ultrasonics to make thickness determinations, to base replacement decisions on B31.1 allowables, and to inspect at each refueling outage. The inspection points selected considered velocities greater than 150 ft/sec and moisture content greater than 5%. These criteria were consistent with industry practice at the time.

3. For liquid-phase systems, state specifically whether the following factors have been considered in establishing your criteria for selecting points at which to monitor piping thickness (Item 2a):

a. piping material (e.g., chromium content)
b. piping configuration (e.g., fittings less than 10 pipe diameters apart)
c. pH conditions in the system (e.g., pH less than 10)
d. system temperature (e.g., between 190 and 500°F)
e. fluid bulk velocity (e.g., greater than 10 ft/s)
f. oxygen content in the system (e.g., oxygen content less than 50 ppb)

Response

There is not an established program currently in effect for liquid phase systems at CR-3. However, in January 1987, twenty-two (22) feedwater system fittings were selected for wall thickness inspections as a result of the Surry incident.

These inspection were performed because, like Surry, CR-3 piping is mild carbon steel (no chromium content). The points were selected primarily on geometrical configuration where severe direction changes occur and around pump suctions and discharges where cavitation and higher local velocities potentially exist. The points inspected have operating temperatures of 300°F and higher. Oxygen content and pH of water in the system were not considered in establishing our criteria. In early 1987 industry understanding of the Surry event was that geometry of the system was the primary factor in causing the event. Future plans are discussed in the response to Question No. 5.

4. Chronologically list and summarize the results of all inspections that have been performed, which were specifically conducted for the purpose of identifying pipe wall thinning, whether or not pipe wall thinning was discovered, and any other inspections where pipe wall thinning was discovered even though that was not the purpose of that inspection.

   a. Briefly describe the inspection program and indicate whether it was specifically intended to measure wall thickness or whether wall thickness measurements were an incidental determination.

   b. Describe what piping was examined and how (e.g., describe the inspection instrument(s), test method, reference thickness, locations examined, means for locating measurement point(s) in subsequent inspection(s).

   c. Report thickness measurement results and note those that were identified as unacceptable and why.

   d. Describe actions already taken or planned for piping that has been found to have a nonconforming wall thickness. If you have performed a failure analysis, include the results of that analysis. Indicate whether the actions involve repair or replacement, including any change of materials.

Response

FPC performed inspections on three different piping systems within the steam and power conversion system. These inspections are described below:

- Moisture Separator Reheater (MSR) shell drains (4 ea.) piping to condenser and H.P. Reheater dump (4 ea.) piping to condenser

  Inspected - Summer 1981
  Replaced (all) - Fall 1981

  Inspected - Fall 1984
  Replaced (all) with Stainless Steel - Spring 1985

These lines contain high energy water that dump to the vacuum conditions in the condenser causing a flashing condition in the short segments of piping around the control valve. Many pinhole leaks developed, but were not considered dangerous due to the low pressure at the specific location in the line. Temporary repairs were performed until replacements could be made. Ultrasonic inspections were performed to determine the limits of the wear in the piping system. These sections were ultimately replaced with stainless steel material and are no longer a concern.

o High Pressure Extraction Steam (12 locations)

Inspected - Fall 1983
Replaced (one) - Fall 1983 (below manufacturer's minimum wall)

Inspected - Spring 1985
Replaced (two) - Winter 1986

	Fitting #1	Fitting #2
Actual minimum thickness determined	0.300	0.300
Manufacturer's min. wall	0.328	0.328
Manufacturer's nom. wall	0.375	0.375
B31.1 min. wall (calculated)	0.148	0.226

These fittings were inspected by straight beam ultrasonics for the purpose of determining where wall thinning may be occurring, as found at other operating plants. Four inch grid patterns were used, with 1" grids established in areas determined to be suspect by the larger grid at the 1983 inspection. One inch grids were used during the 1985 inspection. Based on nominal wall (actual original wall thickness unknown), wear rates of these two fittings are about 10 mils per calendar year. No fittings were found to be below code allowable wall after eight (8) years of commercial operation. Nine (9) of the twelve (12) fittings were still within manufacturer's tolerances for new fittings.

Further action is pending FPC's evaluation of this system (refer to the response to Question No.5).

o Main Feedwater Pump Recirculation Lines to the Deaerator (2 ea.)

Inspected - January 1986
Replaced with Stainless Steel - March 1986

	Nozzle 1	Nozzle 2
Actual minimum thickness determined	0.061	0.146
Manufacturer's min. wall	0.378	0.378
Manufacturer's nom. wall	0.432	0.432
B31.1 min. wall (calculated)	0.222	0.222

These vessel nozzles are downstream of flow orifices in the Main Feedwater Pump recirculation lines back to the Deaerator. These lines protect the pumps in low flow conditions, normally start-ups and shutdowns. During normal operation, they are isolated. Flashing conditions exist downstream of the orifice when the lines are in service. Visual inspections by FPC substantiated an anticipated E/C problem. A subsequent straight beam ultrasonic inspection on a 1" grid pattern confirmed extensive wall thinning.

These carbon steel nozzles were replaced with stainless steel material and are no longer a concern.

o Feedwater Piping (22 locations)

Inspected - January 1987
Replaced - none (no indications below manufacturer's min. wall)

An inspection was performed to determine if wall thinning in the single phase flow feedwater system existed, similar to Surry's problem. Straight beam ultrasonics was utilized as the measurement technique. Locations were selected based on their geometrical conditions. Converging flow tees, potential cavitation areas (pump suctions), and series of directional changes were the basis for selection.

No indication of a thinning problem was discovered. Future action will be based upon FPC's further evaluation of the system. (Refer to the response to Question No. 5).

5. Describe any plans either for revising the present or for developing new or additional programs for monitoring pipe wall thickness.

Response

Following the Surry event, FPC established a task force comprised of a Material Specialist, Design Engineer, Maintenance Specialist, Chemist, Licensed Operator, and other technical specialists. The task force is responsible for development of a program to monitor and evaluate erosion and corrosion at CR-3. As a first step, FPC has contracted with Technicon Enterprises, Inc. (TEI), who is a recognized leader in the erosion/corrosion technology, to establish a list of inspection points for both single and two phase flow systems at CR-3. FPC will utilize TEI's experience and mathematical models to determine locations based on relative susceptibility to erosion/corrosion. FPC is requiring TEI to account for temperature, pressure, fluid velocity, moisture content, geometry, and chemistry (pH and Oxygen) in their selection of inspection points. The inspections will take place during the Fall 1987 outage.

The inspection points selected for evaluation will be ultrasonically examined to determine the actual wall thickness. This measured wall thickness, the initial wall thickness, and the hours of operation for the inspection point will be used to determine a wear rate. The initial wall thickness will be conservatively assumed to be 1.10 times the nominal wall thickness. This 10% increase in wall thickness above nominal wall thickness recognizes that piping manufacturer's typically produce pipe and fittings with greater than nominal wall thicknesses.

The assumed wear rate determined above will be used to establish the time for future inspections of the identified inspection point. We plan to perform future inspections at the time when it is expected that 50% of the remaining corrosion allowance will have been consumed for each specific inspection point. Replacements will be based on ANSI B31.1 formulas. FPC anticipates two categories of wall thinning: general and local. Permissible minimum wall will be code allowable plus 10% for generalized wear and code allowable for localized wear ($\leq$ 25% of the circumference), prior to replacement. FPC considers this approach to be conservative, with adequate structural section remaining in the pressure boundary in both categories.

Sincerely,

E C Simpson

E. C. Simpson, Director
Nuclear Operations Site Support

ECS/JWT/mm

xc: Document Control Desk (original + copy)

Mr. T. F. Stetka
Senior Resident Inspector

STATE OF FLORIDA

COUNTY OF CITRUS

E. C. Simpson states that he is the Director, Nuclear Operations Site Support for Florida Power Corporation; that he is authorized on the part of said company to sign and file with the Nuclear Regulatory Commission the information attached hereto; and that all such statements made and matters set forth therein are true and correct to the best of his knowledge, information, and belief.

E C Simpson

E. C. Simpson
Director, Nuclear Operations Site Support

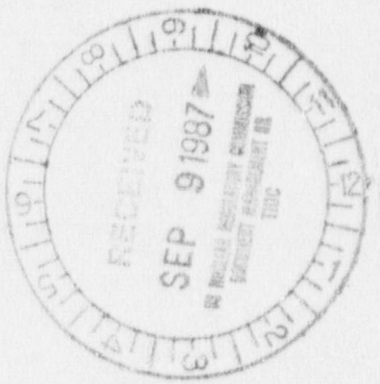
Subscribed and sworn to before me, a Notary Public in and for the State and County above named, this 3rd day of September, 1987.

Joan Lisa Snyder

Notary Public

Notary Public, State of Florida at Large,
My Commission Expires: _____

NOTARY PUBLIC, STATE OF FLORIDA.
MY COMMISSION EXPIRES: JUNE 21, 1991.
BONDED THRU NOTARY PUBLIC UNDERWRITERS.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