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SUBJECT: Forwards response to NRC Bulletin 87-001, "Thinning of Pipe Walls in Nuclear Power Plants." Scope & extent of program includes all moderate & high energy carbon steel piping sys, both nuclear safety-related & nonsafety-related.

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U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D. C. 20555

Gentlemen:

Re: St. Lucie Units 1 and 2
Docket Nos. 50-335 and 50-389
NRC Bulletin NO. 87-01
Thinning of Pipe Walls in Nuclear Power Plants

By the subject Bulletin, the NRC staff requested information concerning programs for monitoring the wall thickness of pipes in condensate, feedwater, steam, and connected high-energy piping systems.

Attached is the response to this Bulletin for St. Lucie Units 1 and 2.

The attached information is provided pursuant to Section 182a of the Atomic Energy Act of 1954, as amended. If further information is required on this topic, please contact us.

Very truly yours,

C. O. Woody
Group Vice President
Nuclear Energy

COW/EJW/gp

Attachments

cc: Dr. J. Nelson Grace, Regional Administrator, Region II, USNRC
Senior Resident Inspector, USNRC, St. Lucie Plant

IE11

STATE OF FLORIDA)
) ss.
COUNTY OF PALM BEACH)

C. O. Woody being first duly sworn, deposes and says:

That he is a Group Vice President of Florida Power & Light Company, the Licensee herein;

That he has executed the foregoing document; that the statements made in this document are true and correct to the best of his knowledge, information, and belief, and that he is authorized to execute the document on behalf of said Licensee.

C. O. Woody
C. O. Woody

Subscribed and sworn to before me this
10 day of September, 1987.

Bernice M. Dahmes
NOTARY PUBLIC, in and for the County
of Palm Beach, State of Florida

My Commission expires: NOTARY PUBLIC STATE OF FLORIDA
MY COMMISSION EXP SEPT 18,1989
BONDED THRU GENERAL INS. UND.

NRC BULLETIN 87-01 - THINNING OF PIPE WALLS IN NUCLEAR POWER PLANTS

Information Request 1:

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

Response 1

St. Lucie Unit 1

Non-nuclear safety related piping: ANSI B31.1.

Nuclear safety related piping: ANSI B31.7.

St. Lucie Unit 2

Non-nuclear safety related piping: ANSI B31.1.

Nuclear safety related piping: ASME Section III.

Information Request 2

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

A. Selecting points at which to make thickness measurements.
B. Determine how frequently to make measurements.
C. Selecting methods used to make thickness measurements.
D. Making repair/replacement decisions.

Response 2

St. Lucie Unit 1 & 2

In general, the scope and extent of the St. Lucie program includes all moderate and high energy (i.e., above 200°F) carbon steel piping systems, both nuclear safety related and non-nuclear safety related. Inspection locations are established in accordance with accepted industry methods such as those provided by EPRI for single and two phase systems. Within specific piping systems, locations for inspections are selected based upon such factors as fluid velocity, piping geometry, moisture content (for steam) and chemistry. Areas which are subjected to flow disturbances such as elbows, branch connections, piping and fittings downstream of control valves or flow orifices are preferred locations for inspections.

Response 2 (cont'd)

Frequency of inspection is based upon the rate of erosion/corrosion. Each operating cycle, inspection data is reviewed to determine which locations, based upon measured maximum erosion/corrosion rates, may be approaching code minimum wall thickness values. Locations which may violate code minimum wall thickness within the next operating cycle require corrective action.

The method of examination is selected based upon the ability to accurately provide a profile of wall thickness readings over the entire area of the piping or fitting expected to experience significant erosion/corrosion. In general, ultrasonic devices have been used for this purpose.

Decisions to take corrective action for piping and fittings which have suffered erosion/corrosion damage are based upon the ability of the piping or fitting to satisfy code minimum wall thickness requirements during the subsequent operating cycle. If the lowest wall thickness reading in a piping section subtracted from the erosion/corrosion expected during the subsequent operating cycles is less than the minimum value required by the applicable code, the piping section must be repaired or replaced.

Information Request 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:

A. Piping material
B. Piping configuration
C. pH of water in the system
D. System temperature
E. Fluid bulk velocity
F. Oxygen content

Response 3

St. Lucie Units 1 & 2

The initial single-phase inspection programs for St. Lucie Units 1 & 2 were developed soon after the Surry pipe rupture incident. The major factors used to select inspection locations were similar to those accepted for two-phase flow systems and included material composition, temperature, flow path geometry, fluid velocity, fluid pH and oxygen content. Inspection planning tools such as EPRI's "CHEC" Computer Program for single-phase erosion/corrosion were not available during initial St. Lucie single-phase systems such as feedwater, heater drain, condensate and blowdown. Within these systems, geometry was considered the most important selection factor. Closely spaced fittings, branch connections, elbows and piping/fittings downstream of control valves were given highest priority for inspections.

Information Request 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 meausrements 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 inspections).

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.

St. Lucie Unit 1

During the 1983 refueling outage, the turbine cross under piping was inspected for wall thickness loss. The results are contained in Attachment D.

As a result of the Surry incident and general concerns regarding erosion/corrosion in two-phase systems, a comprehensive inspection program was developed. The program was specifically intended to collect data on the wall thickness profiles of several high energy pipe/fittings to detect erosion/corrosion degradation. For two-phase systems such as extraction steam, an EPRI methodology (EPRI NP-3944) for predicting erosion/corrosion rates was utilized. For single-phase systems, such factors as flow geometry, temperature, fluid chemistry as previously discussed were utilized in selecting inspection points. The program was designed to first inspect the most likely points for erosion/corrosion and to collect "baseline" data on other locations, with program expansion required if wall thinning in any location was more severe than anticipated.

Ultrasonic examination was used to determine wall thickness. "Zone maps", as shown in the attachments, were used to specify the extent of examination required at each selected inspection point. The ultrasonic probes were moved along each circumferential line of the zone map, the data was fed to a strip chart recorder. The ultrasonic instrumentation was of the pulse echo-type with cathode ray tube display. Carbon steel incremental step blocks were utilized to provide reference thickness to calibrate the instrumentation.

Response 4 (cont'd)

A total of 52 locations were selected based on anticipated erosion/corrosion rates; of these, 42 locations were in the extraction steam systems, and 10 locations were in single-phase systems. For each of these locations, a "screening criteria" was provided to indicate when engineering evaluation of the thinning was required. The screening criteria was conservatively defined as the minimum wall thickness for the piping plus the maximum possible erosion/corrosion which could occur during the subsequent cycle of operation. A copy of the inspection program document is provided as Attachment A.

The 1987 refueling outage inspections revealed that significant erosion/corrosion degradation was limited to the extraction steam piping and the moisture separator reheater shell side drains. In the case of the extraction steam systems, several fitting and piping segments required replacement. All measurements in single-phase piping systems revealed that the piping is all still within manufactureres tolerances for wall thickness (i.e., nominal wall thickness plus or minus 12½%). Based on single-phase piping inspection results, erosion/corrosion rates appear to be very low, and encroachment on minimum wall thickness values is not expected for several operating cycles. Attachment B is a summary report which provides the results of all Unit 1 wall thickness inspections and describes corrective actions which were required.

St. Lucie Unit 2

St. Lucie Unit 2 has been operating for less than half the time that St. Lucie Unit 1 has operated. Since the plants are virtually identical in terms of configuration and erosion/corrosion parameters, pipe wall thinning location-for-location is expected to be generally 50% or less of the Unit 1 values. A program has been developed for Unit 2 which is modeled after the Unit 1 program. Inspection points have been selected based upon Unit 1 inspection results. The first Unit 2 wall thickness measurements to detect erosion/corrosion will be conducted during the 1987 refueling outage in October and November. Attachment C is a copy of the Unit 2 inspection program document.

Information Request 5

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

Response 5

St. Lucie Units 1 & 2

Florida Power & Light Company is satisfied with the program as a whole and in particular the inspection method. The "ultrasonic zone mapping" technique proved adequate in providing the information necessary to make sound decisions on corrective actions. The methods for determining "screening values" are logical and ensure that code requirements for minimum wall thickness are satisfied.

St. Lucie Units 1 & 1 (cont'd)

With respect to selection criteria, the EPRI methodology for two-phase erosion/corrosion proved to be an excellent tool for determining, on a relative basis, where to concentrate inspection resources.

Future program inprovement is expected in the single-phase inspection location selection technique. Future programs (beginning with the 1988 Unit 1 inspection) will have single-phase locations selected with assistance from EPRI's "CHEC" computer program. This program will provide a prioritized selection of inspection points based on consideration of piping material, flow rates, configuration, water chemistry, etc.. In addition, we will continue to monitor the inspection results from the nuclear industry, particularly in the single-phase flow areas. Modifications to the inspection program will be made to reflect new findings elsewhere as considered appropriate.