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SUBJECT: Forwards response to 870709 NRC Bulletin 87-001, "Thinning of Pipe Walls in Nuclear Power Plants," descriving plant program for monitoring thackness of pipe walls in high-energy single- & two-phase carbon steel piping sys.

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JAMES D. SHIFFER
VICE PRESIDENT
NUCLEAR POWER GENERATION

September 8, 1987

PGandE Letter No.: DCL-87-217

Mr. John B. Martin, Regional Administrator
U. S. Nuclear Regulatory Commission, Region V
1450 Maria Lane, Suite 210
Walnut Creek, CA 94596-5368

Re: Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
Diablo Canyon Units 1 and 2
Response to NRC Bulletin No. 87-01, Thinning of Pipe Walls

Dear Mr. Martin:

In accordance with the requirements of NRC Bulletin No. 87-01, "Thinning of Pipe Walls in Nuclear Power Plants," dated July 9, 1987, PGandE hereby submits the enclosed report describing Diablo Canyon's program for monitoring the thickness of pipe walls in high-energy single-phase and two-phase carbon steel piping systems.

Kindly acknowledge receipt of this material on the enclosed copy of this letter and return it in the enclosed addressed envelope.

Subscribed in San Francisco, California this 8th day of September 1987.

Respectfully submitted,

Pacific Gas and Electric Company

By _____
J. D. Shiffer
Vice President
Nuclear Power Generation

Robert Ohlbach
Richard F. Locke
Attorneys for Pacific
Gas and Electric Company

By _____
Richard F. Locke

Subscribed and sworn to before me
this 8th day of September 1987

_____
Therese Toliver, Notary Public in
and for the City and County of
San Francisco, State of California

OFFICIAL SEAL
THERESE TOLIVER
NOTARY PUBLIC - CALIFORNIA
CITY AND COUNTY OF SAN FRANCISCO
My Comm. Expires Dec. 25, 1990

My commission expires December 25, 1990.

Enclosure

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ENCLOSURE

PGandE Response to NRC Bulletin No. 87-01,
Thinning of Pipe Walls in Nuclear Power Plants

As a result of the feedwater piping incident at Surry 2 in December 1986, PGandE organized a multidisciplinary task force to formulate and implement an action plan to address erosion/corrosion (E/C) of carbon steel piping at Diablo Canyon Power Plant (DCPP). Initial efforts of the task force were directed towards creating the DCPP Unit 2 baseline inspection program, which was implemented in the first refueling outage. The task force recommended the most probable locations, based on available published data, incident reports, and engineering judgment, for single-phase E/C (believed to be the cause of the Surry 2 incident) and the more familiar two-phase or wet-steam E/C. The DCPP Unit 2 inspection program preceded the development of the Nuclear Management and Resources Council (NUMARC) Guidelines and therefore does not conform precisely to the NUMARC Guidelines. DCPP Unit 1 has already been inspected to pre-Surry, two-phase E/C guidelines during the Unit 1 first refueling outage. However, the DCPP Unit 1 second refueling outage program and Unit 2 program upgrades will conform to the NUMARC Guidelines.

The following information addresses those actions specifically requested by NRC Bulletin No. 87-01 concerning programs for monitoring the wall thickness of pipes in condensate, feedwater, steam, and connected high-energy piping systems fabricated of carbon steel.

NRC REQUEST 1

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

PGandE RESPONSE 1

DCPP piping is designed and fabricated to the following codes (Reference, DCPP FSAR Update Table 3.2-2):

PGandE Class A : ANSI B31.1, 1967; ANSI B31.7, 1969 with 1970 Addenda
PGandE Class B : ANSI B31.7, 1969 with 1970 Addenda
PGandE Class C : ANSI B31.7, 1969 with 1970 Addenda
PGandE Class E : ANSI B31.1, 1967 Dead Weight and Thermal
PGandE Class @ : ANSI B31.1, 1967; ASME Section I, 1968

NRC REQUEST 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

PGandE RESPONSE 2

The scope and extent of the Unit 2 baseline inspection program currently includes a total of 67 locations which are ultrasonically inspected: 53 for two-phase E/C and 14 for single-phase E/C. These are in addition to the turbine cross-under piping where internal visual inspections of accessible areas were performed. More specifically:

a. Piping systems have been selected for E/C inspection based on a review of reported incidents at other plants and a review of DCPP systems for their sensitivity to E/C in accordance with guidelines presented in Electric Power Research Institute (EPRI) reports on "Erosion-Corrosion in Nuclear Plant Steam Piping" (NP-3944) and "Single-Phase Erosion-Corrosion of Carbon Steel Piping," dated February 19, 1987. Plant incidents reviewed include those identified by Institute of Nuclear Power Operations (INPO) Significant Operating Event Report (SOER) 82-11 in November 1982, as well as others individually reported since that date. Based on the above, the systems reviewed were non-safety-related and were primarily large pipe steam systems, blowdown and drain systems where flashing could occur, and water systems with temperatures greater than 190°F. The Attachment lists those piping systems in which inspection points have been selected. Inspection points were selected to provide a broad overview of the E/C conditions at DCPP Unit 2.

b. Initially, wall thickness measurements will be obtained for the points described above during two successive refueling outages for each unit in order to establish: (1) a basis for the frequency of future measurements, and (2) trended erosion rates. These measurements will be made during the second and third refueling outages for Unit 1 and the first and second refueling outages for Unit 2. In addition, for single-phase systems, this data will be used in conjunction with the new EPRI CHEC computer program to help provide a basis for the extent and frequency of future inspections.

c. Digital readout ultrasonic thickness instruments with a resolution of 0.001 inch are used to obtain accurate measurement of wall thickness. Data is obtained at discrete points over the entire elbow/tee surface according to a preselected grid pattern. The grid point spacing pattern was chosen as a function of the pipe diameter and typically varies from 15 to 30 degrees meridianally and 1 to 3 inches longitudinally. Measurement points are permanently identified with high-temperature paint.

d. Actual wall loss data and projected time to minimum wall thickness from CHEC evaluations will be used to identify piping components likely to require early corrective measures to prevent encroachment on minimum wall thickness. The decision whether to repair or replace identified components will be based upon engineering evaluations of remaining life to minimum wall thickness, time remaining to the next planned outage, economics of repair vs. replacement, etc.

At present, the Unit 1 program only addresses two-phase E/C, since it preceded the Surry incident. For future upgrade of this program, refer to Response 5 below.

NRC 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 (Item 2a):

a. piping material (e.g., chromium content)

b. piping configuration (e.g., fittings less than 10 pipe diameters apart)

c. pH of water 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)

PGandE RESPONSE 3

The following factors have been considered to the extent noted in the selection of inspection points for single-phase systems:

a. Piping materials for condensate and feedwater systems are carbon steel. The higher erosion-corrosion resistance offered by alloy material was not a factor in the selection of inspection points.

b. Piping configuration has strongly influenced the selection of inspection points. Most of the fittings inspected are in configurations in which two or more changes in flow direction occur within less than 10 pipe diameters.

c. System pH was not a factor in the selection of inspection points. All fittings inspected are exposed to water with a pH of approximately 8.9.

d. EPRI has indicated a peak temperature sensitivity in single-phase E/C between 266°F to 284°F. Three points were chosen in the condensate system which closely bracket this temperature. The balance of inspected fittings are exposed to system temperatures ranging from 364°F to 432°F.

e. Fluid bulk velocities in the selected inspection points are between 11.9 and 18.1 fps.

f. Oxygen content was not a factor in the selection of inspection points. All fittings inspected are exposed to water with a dissolved oxygen content of approximately 3 ppb.

NRC 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 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 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.

PGandE RESPONSE 4

The following summarizes those cases where inspections have been performed specifically for pipe wall thinning due to E/C and/or thinning has been observed as a result of some other plant activity.

September 1986 - Unit 1 First Refueling Outage

- A Unit 1 baseline inspection of 29 fittings in selected two-phase systems (primarily high-pressure [HP] turbine extraction, exhaust and high-pressure feedwater heater drains) was conducted by ultrasonic method during the first refueling outage. The program was developed in 1983 as a result of INPO SOER 82-11. It was less extensive than the current Unit 2 program. Although some fittings had thickness measurements less than nominal, none were unacceptable and none were repaired. All measurements were above minimum wall thickness. An internal visual examination of extraction steam elbows at the inlet connections to the No. 2 feedwater heaters (made accessible due to the replacement of those heaters) revealed visible signs of E/C. Random ultrasonic thickness measurements were obtained in the affected areas of these elbows, and no significant wall loss was noted.

  The HP turbine cross-under piping was also internally inspected visually, where accessible, and visible signs of E/C were observed. Ultrasonic thickness measurements were obtained in the thinnest appearing areas, and all were acceptable.

- During plant surveillance of Unit 1 prior to the its first refueling outage, the following piping and components were found to be severely eroded due to the effects of impingement:

  a. Blowdown piping at the inlet connections to the Unit 1 steam generator blowdown tank (downstream of the throttling valves), as well as portions of the tank internal wear plates adjacent to the inlet connections. No thickness measurements were obtained. A check of Unit 2 revealed similar conditions. During the Unit 1 first refueling outage, the affected piping in both units was replaced with chrome-moly piping, and the affected areas of the tank wear plates in both units were replaced with chrome-moly.

  b. Blowdown piping at the inlet connections to the Unit 1 steam generator blowdown flash tank (downstream of the control valves), as well as the interior tank wall opposite the inlet connections due to a problem with the impingement screen. No thickness measurements were obtained. During the Unit 1 first refueling outage, the affected piping was replaced with chrome-moly piping, the impingement screen was replaced, and the tank wall was repaired.

April 1987 - Unit 2 First Refueling Outage

- During the first refueling outage, Unit 2 baseline inspection was conducted in accordance with the program described in PGandE Response 2. Severe thinning was observed in two branch connections off the HP turbine exhaust piping which supply steam to the No. 2 feedwater heaters. The branch connections, which are stub-in type, showed localized wall thicknesses as low as 69% of nominal in one branch and 70% of nominal in the other. Although these thicknesses did not infringe on the calculated minimum wall thickness, the branches were weld repaired during the outage to ensure acceptability through the second fuel cycle.

  The same section of Unit 1 piping was inspected in response to the Unit 2 findings. The Unit 1 piping showed localized wall thicknesses as low as 65% of nominal in one branch and 68% of nominal in the other. At the observed rate of wear, the wall thicknesses will not infringe on the calculated minimum wall thickness before the next Unit 1 refueling outage. As an additional measure, DCPP will measure the wall thickness during forced outages prior to the refueling outage.

  Results of the Unit 2 baseline inspection program for the remainder of the inspection points are still preliminary. The preliminary results indicate that some fittings in both two-phase and single-phase systems have thickness measurements less than nominal but greater than minimum wall thickness. Until another set of measurements is made, it will not be possible to determine whether this variation is due to E/C or manufacturing tolerances.

- During the performance of valve maintenance in the Unit 2 condensate booster pump recirculation lines, piping immediately downstream of the restriction orifices as well as the orifices themselves were found to be severely eroded. Thickness measurements were not obtained. The affected areas were replaced during the Unit 2 first refueling outage.

- During a Unit 2 plant surveillance, a main steam and two HP turbine exhaust condensate drain orifice blocks and their inlet reducers were found to be severely eroded. Thickness measurements were not obtained. The orifice blocks and inlet reducers were replaced with stainless steel during the Unit 2 first refueling outage.

- During a Unit 2 plant surveillance, prior to the first refueling outage, a section of the Unit 2 HP turbine extraction line which contains branch connections for the moisture separator reheater (MSR) excess heating steam lines was found to contain a wall perforation opposite one branch connection and severe thinning opposite an adjacent branch connection. The other four similar areas in Unit 2 were inspected and found acceptable. The pipe section was temporarily repaired, then later replaced with a chrome-moly section during the Unit 2 first refueling outage. The same section of Unit 1 piping was inspected at the time of the initial discovery on Unit 2 and was found acceptable.

- As a result of the previous Unit 1 discovery, the blowdown piping at the inlet connections to the Unit 2 steam generator blowdown flash tank (downstream of the control valves) was inspected, found eroded, and replaced with chrome-moly piping during the Unit 2 first refueling outage. No thickness measurements were obtained. No problems were found with the tank wall.

NRC REQUEST 5

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

PGandE RESPONSE 5

Immediate plans are to revise and update the Unit 1 inspection program referred to in Response 2 to incorporate knowledge gained from the Unit 2 inspection, the results of the EPRI CHEC program, and recent industry experience. This program will be implemented during the second refueling outage, currently scheduled for March 1988.

Long-range plans include the continued review of industry data, refinement of the DCPP programs for both units (possibly to include more emphasis on single-phase systems, particularly in light of Information Notice 87-36 of August 4, 1987), and studies of remedial actions to mitigate the effects of E/C in those DCPP systems where E/C is determined to be significant.

After a second set of measurements is available and actual wear rates are defined, subsequent inspection intervals will be incorporated into the erosion-corrosion programs.

ATTACHMENT

RECOMMENDED EROSION/CORROSION INSPECTION POINTS - UNIT 2

Piping System Description	Line No.	No. of Points
A. Steam Systems		
1. HP Turbine Exhaust Steam to MSR and FWHTR-2	604 - 43-1/2	See Note 1
	609 - 43-1/2	
	821 - 43-1/2	
	822 - 43-1/2	
	605 - 62	
	610 - 62	
	606 - 37-1/2	
	607 - 37-1/2	
	608 - 37-1/2	
	611 - 37-1/2	
	612 - 37-1/2	
	613 - 37-1/2	
	431 - 24	4
	823 - 18	3
	824 - 18	3
	1199 - 16	1
	1200 - 16	1
	1201 - 16	1
2. Auxiliary Steam	1877 - 16	1
	1604 - 10	1
	2447 - 16	1
3. LP Turbine Extraction Steam to FWHTR-4	1205 - 26	1
	1206 - 26	1
	1207 - 26	1
4. HP Turbine Extraction Steam to MSR Stg 1 and FWHTR-1	801 - 12	1
	1196 - 14	1
	803 - 18	2
	433 - 24	3
	804 - 12	1
	617 - 8	1
5. LP Turbine Extraction Steam to FWHTR-5	1211 - 30	1
6. LP Turbine Extraction Steam to FWHTR-6	1221 - 26	1
7. Main Steam to Feedpump Turbine and Gland Steam Supply	633 - 4	1
	810 - 4	1

B. Drain, Dump, and Blowdown Systems

Piping System Description	Line No.	No. of Points
1. MSR Shell Dumps and Drains	847 - 6 4025 - 8	1 1
2. FWHTR-1 Drains	1226 - 8 1227 - 8 1228 - 8	1 1 1
3. FWHTR-2 Drains	1229 - 8 1230 - 8 1231 - 8	1 1 1
4. FWHTR-3 Dumps	1387 - 6	1
5. HTR-2 Drain Tank Dump	3675 - 18	1
6. Steam Generator Blowdown	3874 - 2 1040 - 2-1/2	2 2
7. FWHTR-3 Drains	1234 - 6	1
8. FWHTR-1 Dumps	1375 - 8	1
9. MSR LP Drain Tank Dumps and Drains	4193 - 6 4189 - 6	1 1
10. FWHTR-4 Drains	1235 - 8	1
11. MSR HP Drain Tank Dumps and Drains	3973 - 8 4047 - 8	1 1

C. Water Systems

1. Feedpump Suction	501 - 30 503 - 24 504 - 24	2 2 2
2. Feedpump Discharge	543 - 30	2
3. Steam Generator Lead	2478 - 24 556 - 16	1 1
4. Htr 2 Drain Pump Discharge	1179 - 18	1
5. Condensate from FWHTR-3 to FWHTR-2	1109 - 24	2
6. Condensate from FWHTR-4 to FWHTR-3	482 - 16	1

Notes:

1. The Westinghouse portion of the HP turbine exhaust piping (cross-under piping) shall be inspected in accordance with O&MM 034 of 4-27-83. Inspection points will be determined visually via a walkdown performed by NECS Engineering with UT mapping performed as required.