GN-75-026

Jersey Central Power & Light Company

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MEMBER OF THE General Public Utilities Corporation SYSTEM

September 30, 1975

Mr. James P. O'Reilly, Director
Office of Inspection and Enforcement, Region 1
United States Nuclear Regulatory Commission
631 Park Avenue
King of Prussia, Pa. 19406

Dear Mr. O'Reilly:

Subject: Oyster Creek Nuclear Generating Station
Docket No. 50-219
Summary Report of
Main Steam Piping Vibration Analyses

On May 7, 1974, I responded to your request of January 22, 1974 to Mr. I. R. Finfrock, Jr., for information concerning damage to piping and piping hanger systems at the Oyster Creek Nuclear Generating Station. Item I.A of Appendix I to my May 7 letter identified an investigation that was underway to determine the long-term effect of the observed vibration of the main steam lines and the 30-inch header and 9 bypass lines. This investigation has been completed and is summarized in Attachment I to this letter. Note that the report concludes that with the satisfactory operation of the piping restraints added to one of the 9, 6-inch turbine bypass lines, the steam piping evaluated should be adequate for steady-state and transient vibration conditions observed in service.

Very truly yours,

Donald A. Ross

Donald A. Ross, Manager
Generating Stations-Nuclear

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Attachment

cc: Mr. R. Boyd, Acting Director
Division of Reactor Licensing

B/747

ATTACHMENT I

SUMMARY REPORT OF MAIN STEAM PIPING VIBRATION ANALYSES

The purpose of this report is to summarize significant results and conclusions of our pipe vibration analysis work at the Oyster Creek Nuclear Generating Station. The work was initiated in response to observations by plant personnel that some piping systems appeared to have more than normal vibration. The piping systems which were studied are the main steam lines from the containment to the main steam header, the header itself, and the piping attached to the header. Other piping includes the turbine bypass lines from the bypass valve assembly to the condensers. These systems were evaluated to determine if their vibrational response is acceptable from a fatigue standpoint. Both steady-state vibrations and turbine trip transients were evaluated and, where necessary, corrective measures such as the addition of snubbers were implemented.

On the basis of analysis and test results, it was concluded that all but one of the pipes were acceptable from a fatigue standpoint. The shortest of the nine 6-inch turbine bypass lines was judged to have a potential fatigue problem and therefore was restrained by the addition of mechanical snubbers at a location where large vibration displacements were observed. This corrective action was completed in May of 1975 and appears satisfactory.

Specific tasks undertaken in the pipe vibration work are summarized below.

A. Analyses

As a first step, an analysis was performed on the systems listed below:

- 24-inch main steam piping from the containment penetration to the 30-inch main steam header.
- 18-inch main steam piping from the 30-inch header to the turbine stop valves.

- 20-inch main steam bypass line from the 30-inch header to the steam bypass valve assembly.
- Three of the nine 6-inch main steam bypass lines from the bypass valve assembly to the condensers. The lines selected were chosen to cover the range of flexibility for those systems.

These piping systems are shown in Figures 1 and 2.

The analyses performed included a static flexibility analysis of all systems under assumed displacements that were chosen to be representative of displacements due to vibration. In addition, a fatigue analysis was performed for the most highly stressed locations in the 24-inch main steam and 6-inch bypass piping. The purpose of the fatigue analysis was to determine the magnitude of the piping vibration which may be significant from a fatigue standpoint.

On the basis of the results covered in this analyses, it was concluded as a result of piping vibration that two locations could be subjected to stress levels that are significant from a fatigue standpoint. Since these results were based on estimates of pipe displacement, it was decided to obtain measurements to allow determination if a potential for reduced fatigue life was present.

B. Tests

In order to measure pipe displacements, mechanical scratch gages were installed at the 30-inch header, the 18-inch main steam line where it connects to the turbine stop valve assembly, the turbine bypass valve assembly, and on the stiffest of the 6-inch turbine bypass lines to the condenser. These locations had been identified by the preliminary analyses as the points where piping displacements are important in defining the maximum stress levels and fatigue usage due to the observed vibration. A mechanical scratch gage consists of a painted aluminum plate attached to the pipe and a hard metal scribe on a flexible arm which contacts the plate surface. The arm is attached to the building foundation. Relative movement of the piping and foundation results in a trace in the painted plate surface and provides a measurement of pipe displacement envelopes. The plates were oriented to measure displacements in the horizontal plane; displacements in the vertical direction were observed to be minimal. The locations of the four scratch gage installations are indicated in Figures 1 and 2 as Gages A, B, C, and D.

The first set of gages was installed in June of 1974, and as of October 1974, five sets of gages were obtained (a set of gages consists of the plates from the four scratch gage installations). Data obtained included steady-state vibration envelopes, and traces from a reactor scram at low power and a turbine trip from full power (665 Mwe).

The significant results obtained from the experimental data and from additional stress and fatigue analyses based on the measurements are summarized below:

° <u>24-Inch Main Steam Lines from Containment to 30-Inch Header</u>

Steady-state vibration amplitudes were small and the resulting stresses are not expected to reduce the pipes' fatigue life. An analysis based on measured transient displacement indicated that the calculated fatigue usage factor for a 40-year service life is small (approximately 0.10) and is considered acceptable.

° <u>18-Inch Main Steam Lines from 30-Inch Header to Turbine Stop Valves</u>

The 18-inch steam lines move at the turbine stop valve as well as the 30-inch header. It was conservatively assumed that measured motions at the ends are in opposite directions and are therefore additive. Re-analysis of the 18-inch lines indicated that even on this basis, the calculated fatigue usage factor for a 40-year service life, considering both transient and steady-state vibration, is low (approximatley 0.04) and is considered acceptable.

° 6-Inch Bypass Line -- Shortest Run from Bypass Valves to Condenser

Transient displacement data for this line were incomplete due to damage to the scratch gage on this pipe during the turbine trip. Steady-state measurements show that both the pipe and the bypass valve assembly move and it was conservatively assumed that motions at these points are additive. Re-analysis of this 6-inch bypass line based on only the steady-state vibration resulted in stress levels which would be significant from a long-term (high cycle) fatigue standpoint. Specifically, the calculated stress level for the measured steady-state displacement is slightly greater than the endurance limit (allowable stress at $>10^6$ cycles) for the material. Thus, on this basis, a fatigue usage factor which exceeds the design allowable of 1.0 can be calculated.

It should be noted that the above calculations are based on the design fatigue curves of Section III of the ASME Boiler and Pressure Vessel Code, and as a result include a significant amount of margin. For example, the design fatigue curves of Section III include a factor of safety of at least 2 on stress, or 20 on cycles. Thus, the actual failure of the 6-inch bypass line due to steady-state vibration is not likely. Nevertheless, in view of the calculated results, actions were taken to define the potential problem, to confirm that significant fatigue damage has not occurred, and to reduce the stresses in the 6-inch bypass piping. These actions are described below.

C Actions Taken for 6-Inch Turbine Bypass Line

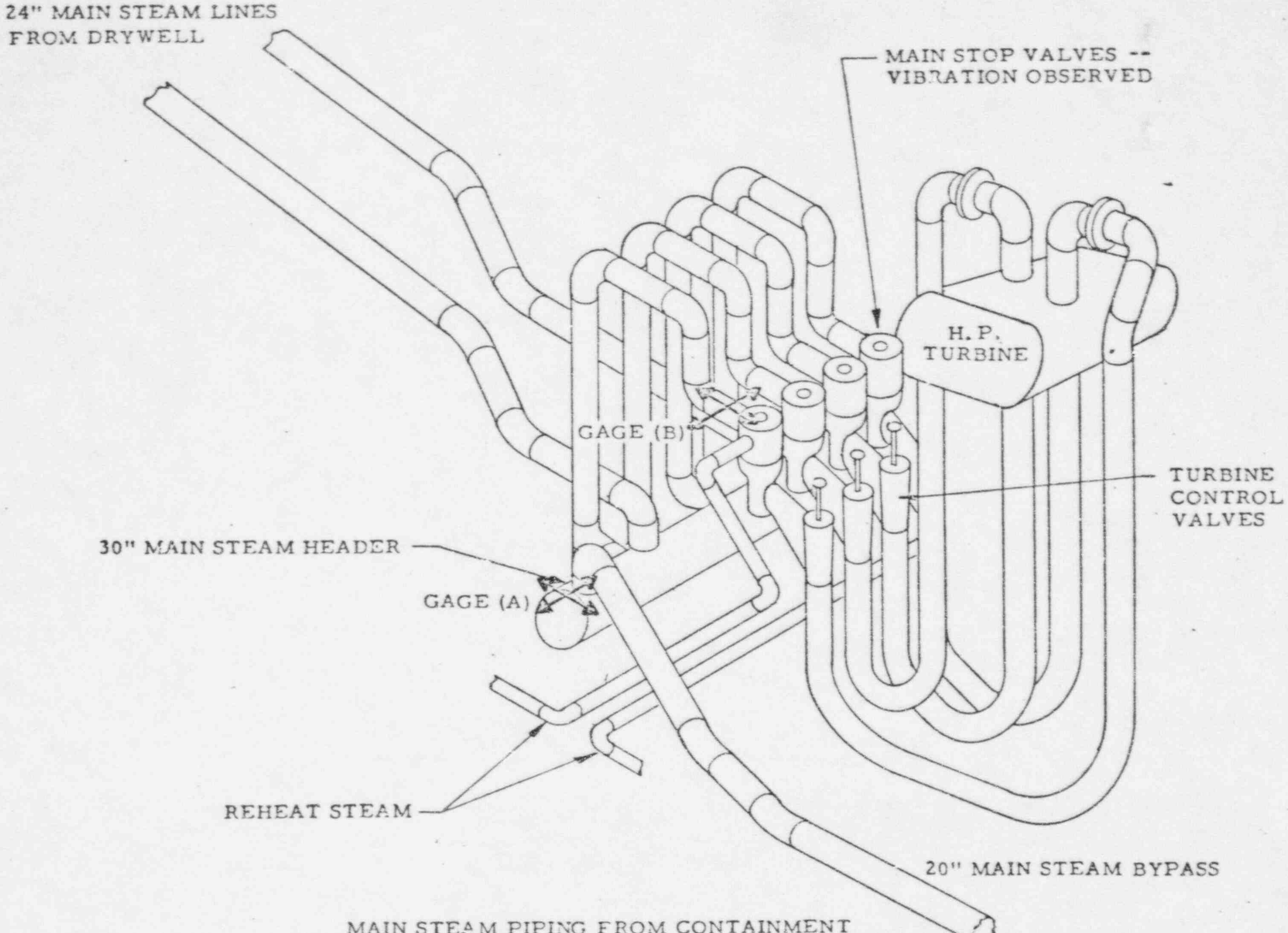
The actions taken to eliminate any potential problems associated with steady-state and transient vibration of the shortest of the 6-inch turbine bypass piping are described below.

1. Magnetic particle examinations of the more highly stressed portions of the bypass line were performed in May 1975, to confirm that significant fatigue damage has not occurred. The results of these examinations revealed no indications of fatigue cracks or other surface defects.

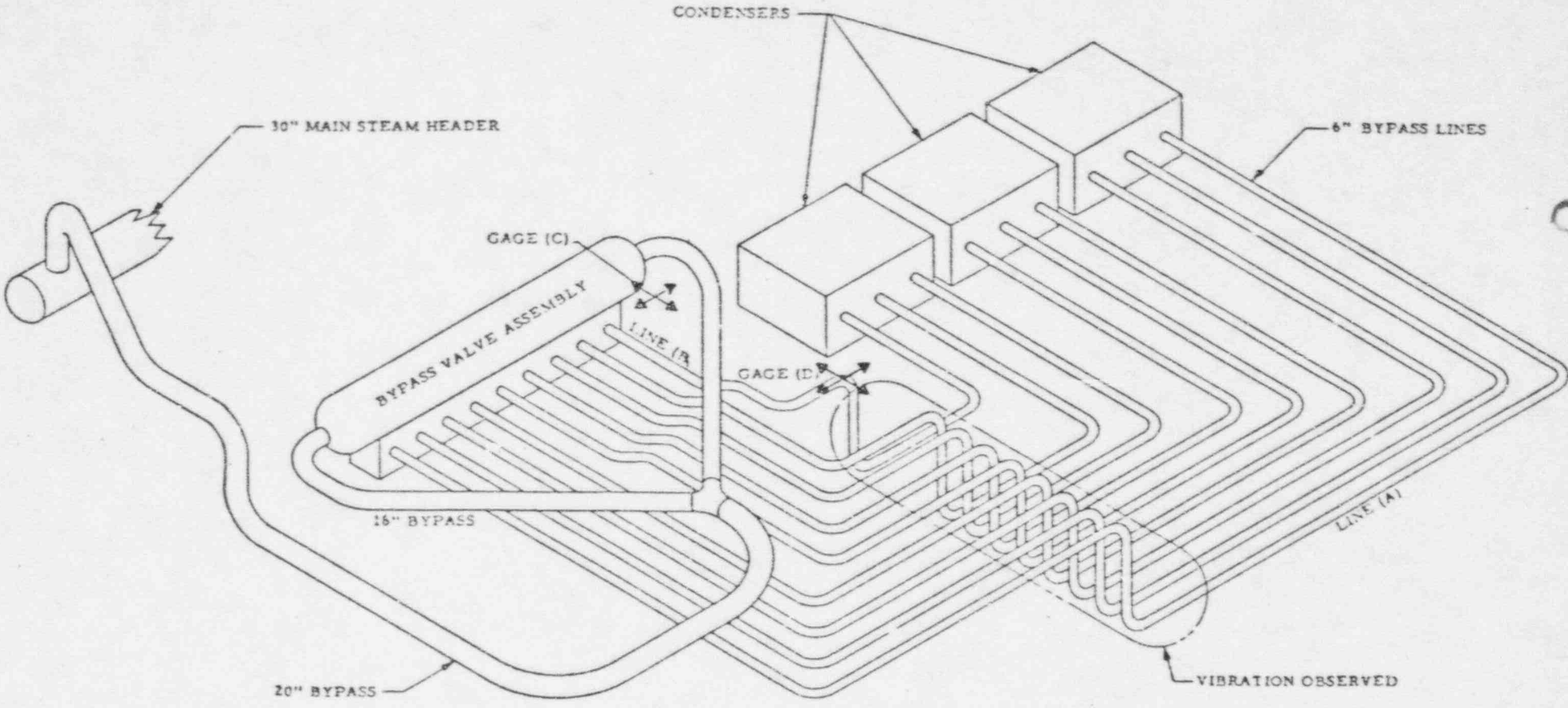
2. An evaluation of the feasibility of adding pipe restraints to the 6-inch bypass line was performed and snubber support design requirements were determined. The results of this work concluded that the addition of two 10,000 pound capacity snubbers to the shortest of the 6-inch bypass lines at the location where steady-state vibrations were measured would reduce the stresses in the piping to levels that are below the material's endurance limit so that fatigue due to pipe vibration should not be a problem.
3. Two 10,000 lb. mechanical snubbers and support structures were procured and installed during the Spring 1975 refueling outage. This installation was checked during plant startup and was found to be satisfactory.
4. The displacements of the modified 6-inch bypass line were rechecked visually and with the aid of scratch plates after the return of the plant to normal operation. The results of these observations indicated that the added snubber restraints limit piping displacements during both steady-state and transient operation to acceptable values without imposing any significant restraint on piping thermal expansion and contraction during heatup and cooldown of the system.

D. Conclusions

Based on the results of the analyses and tests summarized above, and the satisfactory operation of the piping restraints added to the 6-inch bypass line, it is concluded that the steam piping evaluated in this study should now be adequate for the steady-state and transient vibration conditions observed in service.



MAIN STEAM PIPING FROM CONTAINMENT
TO
HIGH PRESSURE TURBINE



BYPASS PIPING FROM MAIN STEAM HEADER TO CONDENSERS

FIGURE 2