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Dr. Thomas E. Murley
Regional Administrator, Region I
U.S. Nuclear Regulatory Commission
631 Park Avenue
King of Prussia, PA 19406

SUSQUEHANNA STEAM ELECTRIC STATION
FINAL REPORT ON A DEFICIENCY INVOLVING
CLAMPS ON CRD INSERT/WITHDRAWAL LINES
ER 100508 FILE 821-10
PLA-2118 Docket No. 50-388

References: (1) PLA-2025 dated January 3, 1984 (LER 83-164)
(2) PLA-2033 dated January 12, 1984
(3) PLA-2116 dated April 19, 1984
(4) PLA-2129 dated March 9, 1984 (LER 83-164 Rev. 1)
(5) PLA-2212 dated May 21, 1984 (LER 83-164 Rev. 2)

Dear Dr. Murley:

This letter serves to provide the Commission with a final report on a deficiency involving inadequate restraint provided by clamps on the control rod drive (CRD) insert/withdrawal lines. This deficiency was reported under 10CFR50.55(e) as potentially reportable by telephone to Mr. E. C. McCabe of NRC Region I by Mr. J. Saranga of PP&L on December 9, 1983.

The attachment to this letter contains a description of the problem, its cause, the safety implications, and the corrective action.

Since the details of this report provide information relevant to the reporting requirements of 10CFR21 for Unit 2, this correspondence is considered to also discharge any formal responsibility PP&L may have for reporting in compliance thereto.

We trust the Commission will find this report to be satisfactory.

Very truly yours,

N. W. Curtis
Vice President-Engineering & Construction-Nuclear

Attachment

IE 27

Copy to:
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Attachment 1

FINAL REPORT

Subject

Deficiencies discovered on Susquehanna Units 1 and 2 involving pipe clamps on each unit's Control Rod Drive (CRD) system.

Description of Deficiency

As part of the investigation of the Control Rod Drive (CRD) system's capability to accommodate a new waterhammer load ("Fast Scram" Hydrodynamic Loads), the existing design was reviewed and laboratory tests were performed on various pipe shim configurations to determine their axial capacity. It was at this time that a disparity between the Unit 1 and Unit 2 drawings was noticed. Subsequently, deficiencies have been identified involving the inner pedestal support and supports outside containment.

For clarity, the discussion of the deficiencies involving pipe clamps on the CRD system on Susquehanna Units 1 and 2 will be separated in this letter under two different headings: Inner Pedestal Support Deficiencies and Discrepancies Outside Containment. The issues and events which led to the identification of these conditions are as follows (expanded from Reference 2):

(1) Inner Pedestal Support Deficiencies

- Nuclear Installation Services Company (NISCO) was contracted by Bechtel Power Corporation, the Susquehanna project Architect/Engineer, to install the CRD system at Susquehanna. For design support, NISCO hired Teledyne Engineering Services (TES).

- The original Unit 1 and Unit 2 design by NISCO/TES required axial restraint on the insert/withdrawal lines and this was to be provided by band-type clamps on the CRD housing.

- After installation of the Unit 1 piping and supports by NISCO inside containment, it was observed that the housing clamps did not always "mate-up", i.e., the piping was not axially restrained at this point. Subsequently, informal tests at the plant indicated that clamps that did initially mate-up also had a tendency to eventually relax so that the axial restraint was lost.

- To resolve this problem, it was decided to change the Unistrut clamps at the inner pedestal support from 2-way (guides) to 3-way type clamps (axial restraints). This was accomplished by specifying a 90 mil shim under the ears of the pipe clamp and, as required, 31 mil shims under the pipe to effect a tight fit.

  The above change was made to the Unit 1 drawings and issued to the field for installation on Unit 1. At the time this change was made, NISCO had been replaced by Bechtel as the installer. NISCO/TES were still responsible for system design. The Unit 1 installation was virtually complete when Bechtel took over. Bechtel was responsible for the major portion of the Unit 2 installation.

- For Unit 2, separate drawings were issued by NISCO/TES. While these drawings specify the 90 mil shim for the inner pedestal support clamps, no mention is made of the 31 mil shim under the pipe or any requirement for a tight fit. This omission carried over to the corresponding Bechtel "VP" drawing (Bechtel "VP" drawings are discussed later). However, although the drawing is not specific, the Bechtel QC inspection records document that a tight fit was achieved. Since no definition of tightness was provided for acceptance criteria, these records cannot be used for design adequacy determinations.

- Subsequent shim configuration testing showed that (particularly in the case of the 3/4" withdrawal lines) adequate restraint was indeterminate for non-waterhammer loads for the shimming configurations expected to exist at the inner pedestal supports.

(2) Discrepancies Outside Containment

- Subsequent to NISCO's replacement by Bechtel, a redesign effort commenced to incorporate new design loads from sources such as ATWS. Bechtel performed the system piping and pipe support modifications for the redesign effort. The Bechtel "VP" drawings were used to implement these modifications.

- The Bechtel "VP" drawing system was established as a means of showing design changes required by NISCO/TES without the turnaround time required for TES to issue drawings to NISCO and then NISCO issuing the drawings to Bechtel. The intent of the "VP" drawing system was to increase the efficiency of the design process while maintaining quality. The "VP" drawings identified installation work which was in Bechtel's scope vs. installation work in NISCO's scope, provided a means of assigning unique Bechtel weld identification for ASME weld inspection and documentation procedures, and documented as-built conditions for purposes of stress reconciliation and ASME certification. "VP" drawings exist for all Unit 1 work done by Bechtel and for the major portion of the Unit 2 installation. As a result, parallel "VP" and NISCO/TES drawings exist for work done by Bechtel on the CRD system installation.

- NISCO "N"-stamped the portion of the CRD system installed by them. The "N"-stamp was against NISCO drawing revisions which were in existence at the time NISCO craftsmen left the site and not the latest revision in existence at the time of the "N"-stamping (ie the drawing changes resulting from the revised design criteria were not included).

- Discrepancies on supports outside containment were identified by site personnel and documented on NCRs 83-1390 and 83-1391.

Cause

(1) Inner Pedestal Support Deficiencies

The cause of the indeterminate axial restraint condition at the inner pedestal appears to be that the design intent, assumptions, and requirements of the stress analysis were not sufficien y clear on the design drawings. Therefore, a proper installation per the design drawings may not have met the design intent. In addition Unistrut specified the axial restraint that would be achieved for a configuration using no shims under the ears of the clamp. Since shims were to be added to affect a tight fit, substantiation by testing should have been utilized at the onset to support this design alteration. This testing has since been performed and is documented in TES Technical Report 5352A-2 "Design Load Testing of CRD System Pipe Clamps for Susquehanna Steam Electric Station" dated January 19, 1984. The disparity between the Unit 1 and Unit 2 NISCO/TES drawings which were issued to correct the clamp tightness problems is a design discrepancy since the Unit 2 drawings did not indicate the use of the 31 mil shim under the pipe or state the requirement to achieve a tight fit.

(2) Discrepancies Outside Containment

The pipe support discrepancies identified outside containment originated in drawing related omissions or errors. The root cause of the majority of deficiencies on each unit follows.

Unit 1:

Most of the hardware discrepancies which were identified on Unit 1 arose during the transition of installation responsibility from NISCO to Bechtel. At the time of the turnover, a comprehensive redesign effort was in progress to incorporate new design loads for annulus pressurization, ATWS, and revised GE CRD operating temperatures. To accommodate these new loads, substantial design changes were required. During the transition from NISCO to Bechtel, some of these required modifications were missed and never actually installed.

Unit 2:

The majority of the hardware discrepancies identified on Unit 2 appear to have resulted from the failure to incorporate changes made to the Unit 1 drawings in the corresponding Unit 2 drawings when changes were applicable to both units.

These deficiencies occurred even though the drawings were maintained and controlled in accordance with established jobsite procedures. The Bechtel "VP" drawing program was established with due consideration given to maintaining quality control while improving the efficiency of the design process. The method of controlling changes to these drawings was programmatically correct in that approvals were obtained and documented for specific changes, and as a final "check", the as-built Bechtel "VP"

drawings were sent to NISCO/TES for stress reconciliation. However, the complexity of the design, the intricacy of the CRD system, the number of parties involved, and the basic design criteria changes late in the construction stage all contributed to the failure of the program to prevent the identified discrepancies from occurring. This is the only instance on the Susquehanna project where this type of situation existed.

For Unit 1, the drawings considered the "as-builts of record" are the NISCO/TES drawing for the portions of work performed by NISCO and the Bechtel "VP" drawing for the portions of work performed by Bechtel. For Unit 2, the Bechtel "VP" drawing is considered the "as-built of record."

Safety Implications

(1) Inner Pedestal Support Deficiencies

The lack of adequate axial restraint at the inner pedestal support results in overstress of the insert/withdrawal lines above the code allowables, but does not result in failure of the pipe due to overstress. This overstress only occurs during a scram and is most severe when combined with seismic and annulus pressurization loads. Also, the loading is dependent upon pipe geometry, therefore, as a result of the different geometry of each CRD line, catastrophic failure of all CRD insert/withdrawal lines simultaneously is unlikely. However, if pipe failure were to occur it would only affect the ability to scram at reactor pressure less than 500 psig. This is due to the fact that the reactor can be scrammed on reactor pressure alone above 500 psig. Below 500 psig, accumulator pressure is required to scram the reactor and if an insert line is ruptured, it would not be possible to provide accumulator pressure to the control rod. An analysis has been completed that demonstrates that the operating stresses incurred to date would not result in pipe failure. An analysis was not done to determine the susceptibility to fatigue failure. Fatigue related failure could have occurred in our judgement sometime over the 40 year life of the plant if the deficiencies had gone undetected. However, the nature of fatigue related failures is such that concurrent failures would not be expected.

(2) Discrepancies Outside Containment

The various discrepancies outside containment may also have resulted in a fatigue related failure due to thermal stress. These failures, if they occurred, would not have been expected to occur simultaneously and would have resulted in a small pipe leak. This pipe leak would have been accommodated within our present capabilities of mitigating the consequences of a NUREG 0803 type of event.

Corrective Action

(1) Inner Pedestal Support Deficiencies

The lack of sufficient axial restraint capacity of the inner pedestal support has been compensated for by a modification to the outer pedestal

support. This was accomplished under DCP 83-863 for Unit 1 and DCP 83-869 for Unit 2.

(2) Discrepancies Outside Containment

The following portions of the CRD system were included in a detailed review/comparison of design drawings (scope of review for each unit follows):

(a) All insert/withdrawal lines outside of containment.

(b) The insert/withdrawal lines inside the containment but outside the RPV pedestal (the pedestal penetration supports were not reviewed since they had recently been reworked).

(c) The SDV piping/supports.

Unit 1:

The NISCO/TES drawings for portions of the CRD system on Unit 1 were compared with the Bechtel "VP" series drawings and/or with the actual installation in order to verify that all Field Change Requests (FCRs) and design changes issued subsequent to NISCO's last revision of their drawings was reflected on either the as-built Bechtel "VP" drawings or in the actual installation (on Unit 1 in cases where there were no corresponding Bechtel "VP" drawings).

On Unit 1 the review initially resulted in a set of markups of the related TES and VP drawings, showing the differences between the as-built N-5 revision and the latest version of the TES drawings, as well as any differences between the latest TES drawings and the VP drawings. For the purpose of early categorization, the differences were classified as either "potential hardware discrepancies" or "software-related only". All "potential hardware discrepancies" resulting from these reviews were initially referred to TES via telecon. All Unit 1 drawing discrepancies were subsequently transmitted to NISCO/TES for complete review. All discrepancies which TES indicated as adverse to their stress analysis resulted in a visual inspection of as-built status and where a hardware problem was evident, an NCR was issued to document the discrepancy. A list of the discrepancies identified is included under Attachment 2.

Unit 2:

As indicated previously, Bechtel was responsible for the major part of the Unit 2 installation. The Unit 2 drawing review consisted of a comparison of the Bechtel as-built "VP" drawings to the last issue of the NISCO/TES drawings. All differences between the two sets of drawings were indicated on mark-ups of the "VP" drawings which were then transmitted to NISCO/TES. NISCO/TES compared the NISCO/TES drawings with the NISCO/TES stress report and evaluated the differences noted by Bechtel on their "VP" drawing mark-ups. NISCO/TES identified errors involving two NISCO/TES drawings (180-1031-2 and 180-1035-2) which resulted in two NCRs on Unit 2. These

discrepancies are listed in Attachment 2. NISCO/TES concluded after their review of the marked-up "VP" drawings that the differences shown do not impact the TES stress report.

Conclusions

The systems have been evaluated to determine what possible effects the lack of adequate restraint may have had on the system. The results of this evaluation are as follows:

(1) The operating stresses experienced by Unit 1 were sufficiently below the yield point so that no significant overstressing of the pipe occurred. There was a potential for significant overstress at support 1S53 (see Unit 1 item 9. in Attachment 2); however, an inspection of this support did not reveal any significant overstress condition.

(2) Worst case loading (scram combined with seismic, annulus pressurization and thermal loads) may have resulted in pipe stresses above the code allowables, but would not instantaneously result in a pipe failure. However, fatigue failure could be expected sometime over the 40 year life of the plant.

All discrepancies have been reconciled with the TES stress report. In some cases this involved hardware modifications as indicated in Attachment 2. The drawing discrepancies will be corrected via the drawing revision process by the end of 1984. Since a guide was installed at Unit 1 support 1S53 instead of a three-way restraint, there was a potential for a sizeable overstress in the vent line from SDV Vent and Drain Valve Waterhammer (a new load which has just been evaluated, see Reference (3)). As noted above no significant overstress was found on inspection of this support. This support has been reworked to the required configuration (see Unit 1 item 9 in Attachment 2). There were no supports identified on Unit 2 that had a potential for a significant overstress condition.

Since fatigue failure could be expected sometime over the 40 year life of the plant if the deficiencies had gone unidentified, the safety of operations could have been adversely affected even though fatigue failure would not result in concurrent pipe breaks. Consequently, PP&L feels this deficiency is reportable under 10CFR50.55(e).

Attachment 2

DISCREPANCIES IDENTIFIED OUTSIDE CONTAINMENT

The following discrepancies were discovered outside containment:

Unit 1

1. CRD Insert/Withdrawal line support 1N41 was shown by the design drawing to support 4 withdrawal lines. However, the as-built condition of this hanger was found to support only 2 withdrawal lines. Two new three-way restraints were installed and shims were removed from a clamp on withdrawal line 58-35W at support 1N41 to make this clamp a three-way restraint. (documented under NCR 83-1390 & PMR 84-3027)

2. CRD Insert/Withdrawal line support 1S17 as built condition did not conform to design drawing. Subsequently, it was discovered that the design drawing and the as-built condition were both incorrect. At support 1S17, clamps on withdrawal lines 18-31W, 14-31W, and 06-31W were changed from guides to three-way restraints. Also on 1S17, clamps were changed from three-way restraints to guides on lines 14-31I and 10-31I. (documented under NCR 83-1391 & PMR 84-3028)

3. CRD Insert/Withdrawal line support 1N14 was shown by the design drawing to support three withdrawal lines as 3-way restraints. However, the as-built condition of this support shows all lines (insert & withdrawal) as 3-way restraints. Shims were added to clamp configurations on withdrawal lines 58-31W and 58-35W to change the clamps from three-way restraints to guides at support 1N14. (NCR 84-234 & PMR 84-3045)

4. Support 1N07 was shown supporting one withdrawal line by the use of a Z clip but shown on another drawing with a standard half moon clip. The as-built condition uses the standard half moon clip (NCR 84-235 - dispositioned use as is, drawing will be changed, DCN 84-928 on M164-149).

5. Support 1S14 was shown on design drawing as supporting all 1" insert lines with 3-way restraints and all 3/4" withdrawal lines with guides. However, the as built condition has 3-way restraints on all lines. The 5 withdrawal lines were changed to guides by adding shims (NCR 84-246 and WA-S-43393).

6. Support 1S69 as built condition did not conform to design drawing. The existing Type B support was replaced with the required Type E support (NCR 84-253 and WA-S-43394).

7. Support 1S46 was found to be a guide restraint but the design drawing calls for a three-way restraint. Support 1S54A was found to be a three-way restraint but the design drawing calls for a guide restraint. 1S46 was reworked to a three-way restraint by removing shims and 1S54A was reworked to a guide restraint by adding shims (NCR 84-333 and WA-S-43397).

8. Deficiencies on supports 1S12 and 1N12. 1S12 contained two supports that were loose. 1N12 contained a support that was missing the upper bolt and spacers. The supports were reworked to the required configuration (NCR 84-451 and WA-S-43614).

9. SDV Vent Line support 1S53 is shown on the Bechtel "VP" drawing and installed with a guide clamp configuration. The CRD TES Stress Report requires this support to provide a three-way restraint. The support was reworked to a three-way restraint (NCR 84-459 and CWO C44118).

10. Guide clamps were installed on support 1N08 & 1N11 instead of the "Z" clips required by the CRD stress report. The supports were reworked (NCR 84-460 and CWO C44117).

11. Two "Z" clips and one guide clamp were installed on support 1S11. The CRD stress report calls for the "Z" clips to be guides and the guide to be a "Z" clip. Two guides were installed on support 1S12 instead of the "Z" clips required by the CRD stress report (NCR 84-461 and CWO C44116).

Unit 2

1. Support 2S17 as built condition did not conform to design drawing. The number and location of Z-clips was incorrect. However, neither the drawing nor the as built condition met the design requirements. Clamps on lines W31-14 and W31-18 were reworked to three-way restraints and clamps on lines I31-06, I31-14, and I31-18 were reworked to guide restraints to meet stress report requirements (NCR 84-223 and PMR 84-3058).

2. Various discrepancies involving Z-clip and Z-clamp configurations identified during a comparison of the Unit 2 NISCO/TES drawings with the Unit 2 TES stress report. Supports 2S08, 2S09, 2S10, 2S11, 2S12, 2S13, 2S14, 2S17, 2S18, 2S19, 2S20, 2S21, 2S22, 2N08, 2N09, 2N10, 2N11, 2N12, 2N13, 2N14, 2N17, 2N18, 2N19, 2N20, 2N21, 2N22, and 2N41 were reworked to meet the stress report requirements (NCR 84-485 and PMR 84-3058).

3. Guide clamp installed on support 2S08 instead of the Z-clamp shown on the design drawings and assumed in the stress report. A Z-clamp was installed and the guide clamp removed (NCR 84-676 and WA-V-43193).

Summary

All NCRs are closed. The deficiency documented by NCR 84-676 was originally identified by the NRC Resident Inspector. All other deficiencies were identified during the drawing review/comparison discussed in Attachment 1.