SAFETY EVALUATION REPORT
LIMERICK UNIT 2
RESPONSE TO NRC BULLETIN 88-05

1.0 Introduction

NRC Bulletin No. 88-05 and Supplements (references 1 to 3) were issued requiring holders of CP and operating licenses to submit information regarding materials purchased from Piping Supplies, Incorporated (PSI) at Folsom, New Jersey, West Jersey Manufacturing Company (WJM) at Williamstown, New Jersey and Chews Landing Metal Manufacturers (CLM), and to request that licensees: 1) take action to assure that the materials comply with ASME Code and design specification requirements or are suitable for their intended service; or 2) replace such materials. The NRC action was precipitated by the discovery that certified material test reports (CMTRs) for material supplied by PSI, CLM and WJM contained false information. A number of CMTRs were apparently used to certify that commercial-grade steel meets the requirements of ASME Code Section III, Subarticle NCA-3800.

Philadelphia Electric Company (PECo) responded to Bulletin 88-05 for Limerick Unit 2 in a report dated March 1989 (reference 4). In response to comments and questions from the staff PECo responded with a revised report (reference 5) which enabled the staff to complete its review of PECo's submittals. The response contained sections which described: the methodology used to identify, test and evaluate WJM/PSI/CLM material; the document and procurement review and testing programs; and an engineering evaluation and analysis of the nonconforming items.

Section 2 of this Safety Evaluation Report (SER) provides an overview summary of the actions taken by the licensee and the evaluation of the licensee's response by the NRC staff. Section 3 discusses the staff's evaluation of the licensee's submittal with particular emphasis on reviewing the analytical methods used to demonstrate suitability for service of the nonconforming flanges and fittings. Section 4 contains the staff's conclusions.

2.0 Overview Summary

The staff has reviewed the licensee's response to NRC Bulletin 88-05 which defines specific action and reporting requirements with respect to identifying, locating and testing nonconforming flanges and fittings supplied by PSI/WJM/CLM and evaluating their adequacy and suitability for their intended service.

The licensee's response consisted of 2 reports (references 4 and 5). The reports describe the methodology used to identify and test the non-conforming parts;contain a summary of the test results; and present the engineering evaluations and analyses.

The licensee conducted a multi-faceted program to identify and locate materials supplied by PSI/WJM/CLM. Initially, PECo conducted an in depth document review and field inspection. In addition, PECo conducted confirmatory reviews using data provided by GE. PECo determined that Limerick Unit 2 had 312 items of installed safety-related carbon steel material and 13 items of installed safety-related stainless steel material from WJM or PSI. PECo found no items supplied by CLM.

Stress analyses were performed for each of the 52 installed safety-related items which were found to have tensile strengths below 66 ksi (396 L_D converted to 137 BHN). The 52 items consist of:

- 46 carbon steel flanges (45 flanges + 1 blind flange)
- 6 stainless steel flanges (4 flanges + 2 blind flanges)

Structural evaluation of the nonconforming flanges was based on the assumption that the reduced flange capacity is linearly dependent on the yield strength of the material. Details of the evaluations are contained in Appendix C which is based on the qualification procedures in Bechtel's generic analysis report (reference 7).

On the basis of its review of the licensee's submittals, the staff finds that PECo was responsive to the action and reporting requirements of Bulletin 88-05, and that PECo has qualified all nonconforming parts as being suitable for their intended service. The staff concludes that the identification program and the results of the tests and analytical procedures used by PECo to qualify the nonconforming parts provide an adequate basis for resolving the concerns expressed in Bulletin 88-05 with respect to demonstrating adequacy for service.

3.0 Description and Evaluation of Licensee's Response

3.1 Evaluation of Licensee's Identification Efforts

In response to NRC Bulletin 88-05 and Supplements, PECo identified the safety-related materials that were purchased from West Jersey Manufacturing (WJM), Piping Supplies Incorporated (PSI) and Chews Landing Metal Manufacturing Company (CLM) for the Limerick Generating Station, (LGS) Unit 2. The search consisted of a detailed review of the following categories:

1) Review of purchasing records for bulk material purchase of PSI/WJM/CLM manufactured/supplied piping materials.

2) Review of piping subassemblies and ASME Section III in line components purchase specifications.

3) Review of skid mounted components purchase specifications.

4) Review by General Electric of the piping related purchase orders for LGS Unit 2.

5) Determine installation status (i.e., location) via review of N-5 packages for ASME Section III piping, spool installation records and other pertinent installation documentation.

The review of the first two categories indicated that 4076 items were purchased for LGS Units 1 and 2 during the time frame established by the Bulletin. Upon discovery of the suspect components, those components determined to be in the warehouse were immediately segregated and placed on hold. Further investigation revealed that 312 carbon steel items and 13 stainless steel items were received and installed in safety-related systems at LGS Unit 2. The 312 carbon steel and 13 stainless steel items were composed of 51 heats and 4 heats respectively.

On the basis of its review of PECo's report, the staff finds that PECo conducted a thorough and comprehensive search to identify and locate nonconforming flanges and fittings supplied by PSI/WJM/CLM in response to the requirements of Bulletin 88-05, original issue and supplements 1 and 2. The staff also finds that PECo was responsive to the action and reporting requirements of Bulletin 88-05, supplements 1 and 2, and that there is a very high probability that all nonconforming flanges and fittings have been identified.

The staff concludes that PECo's identification efforts provide an adequate basis to resolve the nonconforming material identification concerns described in Bulletin 88-05 and are acceptable.

3.2 Evaluation of Licensee's Test Program

Bulletin 88-05 required PECo to provide assurance that PSI/WJM/CLM supplied materials meet the code and specification requirements. PECo responded by developing and conducting a test program to:

1) Develop specific in-situ testing guidelines in accordance with NUMARC developed guidelines.

2) Conduct hardness testing on the safety-related, installed components.

3) Conduct chemical testing on representative material samples of heat numbers of components installed in LGS Unit 2.

4) For comparison purposes, conduct testing in-house (through PECo Metallurgy Lab) and through an independent testing lab (LTI) on 37 flanges common to the NUMARC program.

NUMARC developed an industry-wide generic testing program and established guidelines for testing of carbon steel and stainless steel components. The guidelines established by NUMARC and accepted by the NRC include the use of:

- The Equotip Portable Hardness Tester to screen non-conforming carbon steel material installed in the plant.

- Magnetic test for confirming austenitic stainless steel.

- The Texas Nuclear Alloy Analyzer (TNAA) to determine the correct metallic alloy composition of stainless steel materials.

The NUMARC Program included comprehensive laboratory testing of PSI/WJM items contributed by the utilities; and in-situ testing of installed items. LGS Unit 2 contributed 47 stock flanges for the NUMARC laboratory testing. For comparison purposes, PECo Metallurgy Lab (PML) and an independent testing laboratory (LTI) conducted hardness, tensile and chemical tests on 37 flanges common to the NUMARC Laboratory Test Program. PECo tested the safety related carbon steel flanges installed at LGS Unit 2 with the Equotip Portable Hardness Tester.

The results of the testing performed on the carbon and stainless steel flanges showed:

1) The NUMARC laboratory tests on carbon steel material supplied by LGS, Unit 2 exceeded the lower bound values of 63 ksi ultimate tensile strength and the LD 350 Equotip hardness established by the NUMARC test program.

2) A comparison between the 37 common flanges included in the NUMARC laboratory test program and the PML/LTI comparison tests shows good correlation. No Equotip hardness values less than L_D 350 and no ultimate tensile strengths less than 63 ksi were shown in the PML/LTI comparison tests. The chemistry of carbon steel material met the requirement of SA-105, except for 3 flanges (2 heats), slightly low in manganese. However, these met the manganese requirement of the pre-1974 specification which is acceptable. One blind flange did not meet SA-105 chemistry requirements and is being replaced.

3) The thirteen stainless steel items installed at LGS Unit 2 were identified as austenitic stainless steel using the Texas Nuclear Alloy Analyzer (TNAA).

4) The laboratory testing of all stainless steel material received from LGS Unit 2 met the mechanical and chemical properties of SA-182 for the appropriate grade.

5) Equotip hardness testing was performed on all of the 325 installed safety-related flanges of which 312 are carbon steel and 13 are stainless steel. Fifty-two (52) items were found to have tensile strengths below 66 ksi (396 L_D converted to 137 BHN). The 52 items consist of:

- 46 carbon steel flanges (45 flanges + 1 blind flange)

- 6 stainless steel flanges (4 flanges + 2 blind flanges)

The purpose of the various test programs was to confirm that the installed materials met Code and to identify any items that may need to be replaced. The methods selected for in-situ testing were intended to screen out nonconforming materials and verify that the specified materials were furnished.

For ferritic steels, such as SA-105, the principal attribute is strength, which can be evaluated by hardness testing. Thus, by demonstrating an appropriate tensile strength through hardness testing, an item satisfactorily tested and inspected after welded installation would be considered acceptable.

For stainless steels, such as SA-182, the principal attributes are sufficient corrosion resistance and weldability as indicated by the proper alloy content. The determination of alloy content using the Texas Nuclear Alloy Analyzer (TNAA) is appropriate for testing in-situ stainless steel items.

The staff reviewed the test program and results contained in PECo's report and concludes that the testing was well planned and that the results provide assurance that all suspect safety-related items have been identified.

3.3 Evaluation of Licensee's Structural Analyses of Nonconforming Parts

The reference 6 report contains the stress analysis and evaluation of the 46 carbon steel installed safety-related flanges which were found to have tensile strengths below 66 ksi (396 L_D converted to 137 BHN). The methodology is based on the generic analysis methods contained in the reference report which was prepared for NUMARC/EPRI by Bechtel.

The flanges were evaluated for both design pressure and moment loading capacity. The design pressure capacity of the flanges was evaluated using tables B1 and C1 of reference 7; if these requirements are not satisfied,

the flanges are qualified using the analytical procedures in either NC-3325 or Appendix XI, Section III, of the ASME B&PV Code. PECo qualified the flanges for moment loading using table C4 of reference 7 for the large bore flanges (above 2") and table C6 of reference 7 for the small bore flanges (2" and below). In case the requirements for the large bore flanges are not satisfied using table C4 of reference 7, the flanges are qualified using the normal, upset, emergency and faulted allowable bending moments given in table C5 of reference 7.

Table 1.0 of PECo's stress analysis report (reference 6) contains the evaluation of the flanges for design pressure using tables B1 and C1 of the Bechtel generic report (reference 7). Nine (9) flanges were found to have a ratio of design pressure to allowable pressure greater than 1.0. Additional evaluation of these 9 flanges using the analytical procedures in NC-3325 or Appendix XI is shown in table 1.0A; the flanges were found to be acceptable.

Moment evaluation of the flanges are shown in table 2.0 of reference 6. The results show that 3 welding neck, large bore flanges have ratios greater than 1.0. For these 3 flanges, the actual moments are compared with the allowable moments in table C5 of reference 7. The results are presented in table 2.0A and were found to be acceptable.

In summary, the 46 installed safety-related carbon steel flanges which were found to have tensile strengths below 66 ksi from Equotip hardness tests have been qualified as acceptable for service as follows:

Design Pressure

Acceptable per Bechtel Generic Report	37
Acceptable per NC-325	1
Acceptable per Appendix XI	8
Total	46

Moment Loading

Acceptable per Bechtel Generic Report	43
Acceptable per Table C5 of Bechtel Report	3
Total	46

The 6 installed safety-related stainless steel flanges which are included in the scope of PECo's reference 6 analysis were found to be acceptable based on compliance with the criteria in NUMARC's Generic Testing Program Response (reference 8).

4.0 Conclusions

On the basis of its review of the licensee submittals, the staff finds that PECo conducted adequate material property tests and structural analyses of the nonconforming flanges and fittings using acceptable and conservative analytical methods and evaluation criteria. The staff also finds that PECo was responsive to the action and reporting requirements of Bulletin 88-05, Supplements 1 and 2, and has qualified all nonconforming parts as being suitable for the intended service.

The staff concludes that the analytical procedures used by PECo to qualify the nonconforming parts and the results of the analyses provide an adequate basis for resolving the concerns with respect to demonstrating adequacy for service. The staff does not consider the nonconforming parts to be ASME Code material. However, the staff finds the use of this material is an acceptable alternative in accordance with 10 CFR 50.55a(a)(3)(ii) because full compliance with all specified requirements would result in hardship or unusual difficulties without a compensating increase in the level of quality or safety.

5.0 References

1. USNRC Bulletin No. 88-05 dated May 6, 1988, "Nonconforming Materials Supplied by Piping Supplies, Inc. at Folsom, New Jersey and West Jersey Manufacturing Company at Williamstown, New Jersey."

2. USNRC Bulletin No. 88-05, Supplement 1 dated June 15, 1988.

3. USNRC Bulletin No. 88-05, Supplement 2 dated August 3, 1980.

4. Letter from Philadelphia Electric Company (PECo), March 31,1989, "Response to NRC Bulletin 88-05 for Limerick Generating Station (LGS), Unit 2."

5. Revised Edition of PECo report cited in reference 4, dated June 2, 1989.

6. PECo Calculation 18240-SS05, "Stress Analysis for Installed Flanges with Hardness Less than 396 L_D," dated 1/4/89, 22 pages, Appendix C of PECo report cited in references 4 and 5.

7. Report on Generic Analysis and Evaluation of Suspect Material Identified in NRC Bulletin 88-05, prepared for NUMARC/EPRI by Bechtel Power Corporation, July 21, 1988.

8. NUMARC Generic Testing Program Response to NRC Bulletin 88-05, Final Report, October, 1988. Section 5.: Stainless Steel and Low Alloy Steel.