

PUBLIC SERVICE ELECTRIC AND GAS COMPANY  
 NUCLEAR DEPARTMENT

PHYSICAL TESTING OF U-BOLT ANCHOR ASSEMBLY

SALEM NUCLEAR GENERATING STATION  
 UNIT NO'S. 1 AND 2  
 LOWER ALLOWAYS CREEK TOWNSHIP  
 SALEM COUNTY, NEW JERSEY

SPECIFICATION NO. ND-SA-84-01

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## 1.0 INTRODUCTION

1.1 On January 26, 1984, NRC informed PSE&G (reference letter 2.5.1) that they would be performing an engineering review of information provided in response to IE Bulletins 79-02 and 79-14. When this review was completed on February 3, 1984, one of the concerns of the NRC team was the ability of the double U-bolt to adequately restrain torsional and axial loads.

1.2 PSE&G had analytically demonstrated that this would be achieved with sufficient pretension on the U-bolts. Additionally, PSE&G stated that limited on site testing was performed to compare with the analytical data utilized in engineering calculations. However, as a result of discussions between PSE&G and NRC the following tests will be performed in accordance with the commitments made in reference letter 2.5.2.

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1.2.1 Perform a test to confirm load-bearing capacity of typical "U" bolt configurations utilized as anchors in Salem Generating Station and to establish appropriate stiffness parameters.

1.2.2 The stiffness parameters determined by testing shall be utilized in sample stress calculations to demonstrate adequate consistency with current program modeling.

1.2.3 The testing shall be performed in accordance with approved QA/QC surveillance practices.

1.2.4 The program procedure will be submitted to the NRC prior to implementation. A program report together with an engineering evaluation will be submitted to the NRC upon completion of the program.

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2.0 SCOPE

The U-bolt anchor assembly testing for determining axial and torsional characteristics, shall be performed on three (3) different pipe sizes. These shall be 2", 4" and 8" diameter pipe sizes since they generally represent most U-bolt anchors employed at Salem Generating Station.

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Within each pipe size, PSE&G has utilized different configurations of U-bolt anchor assemblies. Typical configurations are U-bolts with a flat plate and a structural steel channel or angle section, U-bolts with V notch flat plate and PSE&G standard U-1 type U-bolt assembly.

Testing shall be performed on each of the above sizes for three (3) different U-bolt anchor assemblies as tabulated below. Carbon steel U-bolts shall be tested.

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PIPE SIZE DIAMETER	2-U BOLTS ASSEMBLY	TYPE U-1 ASSEMBLY	2U-BOLTS WITH V NOTCH ASSEMBLY
2"	X	X	X
4"	X	X	X
8"	X	X	

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X - denotes perform testing

2.1 Description of Work

The main objectives of this testing shall be as follows:

2.1.1 Verify the capability of properly installed standard U-bolt configurations as discussed in 2.0 to provide axial and torsional restraint to the piping which they support.

2.1.2 Determine the small order deflections which may occur at U-bolt anchors under anticipated thrust, torsion and lateral loads.

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2.1.3 Evaluate the effects of the measured deflections on results of the piping analysis and the consequent ability of the piping to meet the applicable stress code requirements. | Rev. 1

2.2 Responsibilities of Contractor

2.2.1 Upon award of the contract, the responsibilities of the Contractor shall include but are not necessarily limited to the following:

- a. Generation of the Test Report on schedule and in conformance with the requirements of this specification and its attachments. | Rev. 1
- b. Submission of a testing manual with test procedures and apparatus utilized.

2.2.2 A Certification that the Test Report is in conformance to the requirements of the specification and its attachments.

2.2.3 The explanation and any resulting modifications of the engineering report, if questioned by the NRC. | Rev. 1

2.2.4 Implementation of a quality assurance program in accordance with PSE&G Specification Q-01 Rev. 1 "Quality Requirements for Suppliers". It shall be subject to Company's approval.

2.3 Responsibilities of Company | Rev. 1

The responsibilities of the Company include the following:

2.3.1 Generation of other documentation required by the Contractor to perform said work.

2.3.2 Approvals of the Contractor's testing manual, QA manual, and the engineering calculation report. | Rev. 1

## 2.4 Acceptance Requirements

Company acceptance of the test report will be contingent upon satisfying the following requirements:

- 2.4.1 Approval of the Contractor's engineering procedures for performing this testing by the Company. | Rev. 1
- 2.4.2 Approval of the Contractor's Quality Assurance Manual by the Company.
- 2.4.3 Review of the Engineering Analysis Report by the Company to determine its conformance with this specification. | Rev. 1

## 2.5 References

- 2.5.1 Letter NRC to PSE&G (Richard T. Ferri, Director - Division of Resource Management and Administration to Richard A. Uderitz, Vice President - Nuclear) dated January 26, 1984.
- 2.5.2 Letter PSE&G to NRC (E. A. Liden, Manager - Nuclear Licensing & Regulation to Thomas T. Martin, Director - Division of Engineering and Technical Programs) dated February 10, 1984.

## 2.6 Quality Assurance

The Quality Assurance program shall conform to all governing QA requirements. Any sub-contractor shall have a QA program approved by the Contractor and will become part of the contractor's QA program.

- 2.6.1 The Quality Assurance program shall be audited and approved by PSE&G Q/A auditors as implementing all requirements of 10 CFR 50, 10 CFR 21, ANSI N45.2, and ASME PVC Art NCA-4000.
- 2.6.2 Testing shall be conducted in accordance with documented test procedures.



- 2.6.3 Qualified personnel shall be used to perform the test. The Contractor shall submit documentation for test personnel competency and certification. The Contractor shall meet the intent of ANSI 45.2.6.
- 2.6.4 The calibration of all test instrumentation shall be documented.
- 2.6.5 PSE&G Quality Assurance personnel shall witness complete or portions of this testing to assure that testing is in conformance with the requirements of this specification.

### 3.0 DEFINITIONS

This Section sets forth those definitions that shall apply in this Specification and in any contract, or purchase order.

- 3.1 "Contract" shall mean either a written contract or a purchase order constituting acceptance of Contractor's bid of proposal, with specifications and warranties included. All drawings, charts, prints, and photographs attached to Company's and Contractor's specifications shall be part of the contract.
- 3.2 A "purchase order" is a document issued by the Purchaser authorizing a Contractor to supply material, or services of the nature or type described in the purchase order or in specifications, drawings and other data referred to in that order.
- 3.3 "Contractor" shall mean the corporation, partnership, firm or individual engaged to perform work or furnish equipment or both. Forms of the pronoun "He" may be used for "Contractor".
- 3.4 "Company" or "Purchaser", shall mean Public Service Electric and Gas Company and any representative designated by it to perform duties in connection with the contract.
- 3.5 "Work" shall mean labor, material or services or any or all of these.



#### 4.0 TEST REQUIREMENTS AND PROCEDURE

4.1 Two (2) test activities shall be performed to accomplish the following test objectives:

##### 4.1.1 Test Activity 1

This test activity shall determine the magnitude of axial and torsional pipe support that U-bolts provide. These capabilities depend strongly, but by no means entirely, on the friction that can be developed between the pipe and the clamp. Test Activity 1 is expected to demonstrate that the so-called frictional capacity is significantly augmented by effects due to small surface deflections of Hertzian character, and that these minute deflections tend to increase the effective resistance of the clamp to applied pipe loads.

4.1.2 Test Activity 1 shall be designed to measure the combined capacity of friction and surface deformation to anchor pipes against axial thrust and torsion. Test forces shall be applied up to and including twice the design capacity of pipe anchors.

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4.1.3 Test Activity 1 shall require two types of load capacity tests (one axial, one torsional) per U-bolt configuration. Testing shall be conducted on assemblies as supplied by Company typical of U-bolt installations at the plant.

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##### 4.2 Test Activity 2

4.2.1 Test Activity 2 shall measure deflection of U-bolt in three of the six possible deflection modes (i.e. three perpendicular linear deflections and three corresponding rotations). These are axial deflection, torsional rotation and deflection under lateral thrust.

- 4.2.2 Test Activity 2 shall be supplemented by an analytical phase in which U-bolt supports are modelled for finite element analysis.

Each of the three types of supports described in Section 2.0 shall be modelled for one of the specified sizes. The size selected for modelling shall be as specified by PSE&G.

The objective of this work shall be to provide a method to predict support deflections analytically which has been verified by tests. Verification will be accomplished by comparing analytically predicted and experimentally measured deflections.

- 4.2.3 Test Activity 2 shall also assess the effect that such deflection has upon the analytical documentation of the structural integrity of the piping.

#### 4.3 Testing Method

- 4.3.1 The Contractor shall design the testing device and submit the design for acceptance by PSE&G. The design should include methods for measuring loads and deflections and the expected accuracy of the measuring devices and the measured variables through rods and links for applying thrust and torsion forces.

#### 5.0 HARDWARE REQUIREMENTS FOR PERFORMING TESTING

- 5.1 PSE&G shall provide Contractor with various U-bolt anchor assemblies as discussed in section 2.0 of this specification. They shall be delivered to the Contractors shop.
- 5.2 The contractor shall furnish the components required to do this testing. Hydraulic power supply, bed plate actuator, load cell and recorder shall be the responsibility of the Contractor. The holding fixtures shall be custom made to accomodate PSE&G representative anchor assemblies.

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## 6.0 DOCUMENTATION CRITERIA

### 6.1 Documentation supplied by Company

One (1) copy of the following documents shall be supplied by the Company. Additional copies and/or information will be furnished upon written request and subject to approval by the Company:

- a) Hanger detail drawings
- b) Stress Isometric drawings
- c) Hanger arrangement drawings
- d) Specification Q-01 "Quality Requirements for Supplies"
- e) General terms and conditions and Consulting Service dated February 1, 1984

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### 6.2 Documentation supplied by Contractor

The documents to be supplied by the Contractor as part of the test report shall include the following:

In addition to supplying the test report, conforming to this Specification and its attachments, the Contractor shall also include the following:

- 6.2.1 Two certified copies of engineering analysis report for each work performed as specified in this specification. The copies of report shall also include individual sub-reports summarizing the effects of this testing on U-bolt anchor assemblies.
- 6.2.2 The engineering evaluation report shall include analytical calculations derived from finite element modelling as discussed in 4.2.2, and comparison between analytical and experimental results.

7.0 GENERAL TERMS AND CONDITIONS FOR CONSULTING SERVICES

The Contractor shall comply with PSE&G "General Terms and Conditions for Consulting Services". They shall be part of any contract or purchase order and Contractor shall submit, in writing, agreeing to those terms and conditions upon award of the contract.

- 7.1 Contract - When required by Company, Contractor shall, at no expense to Company, assemble four (4) suitable binders, copies of the contract and deliver them to Company for approval and signature. After signing by Company, two (2) copies shall be returned to Contractor for execution, and Contractor shall return one (1) executed copy to Company. Company will supply copies of specifications for this purpose in such quantity as may be requested by Contractor.