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ENGINEERING SERVICE SCOPE OF WORK

FOR

PIPING SYSTEMS ANALYSIS

Surry Power Station - Unit No. 2

Virginia Electric and Power Co.

Supplier: Control Data Corporation
60 Hickory Drive
Waltham, Massachusetts 02154

Quadrex/Nuclear Services Corporation
1700 Dell Avenue
Campbell, CA 95008

APPROVED

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Stone & Webster Engineering Corporation
Boston, Massachusetts
Category I
NUCLEAR SAFETY RELATED

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1.0 GENERAL

This Engineering Services Scope of Work (ESSOW) details services supplied by Control Data Corporation (CDC) and Quadrex/Nuclear Services Corporation (NSC) for Surry Unit 2 Nuclear Power Plant Pipe Stress Analysis. CDC will supply data services with the NUPIPE II analysis program plus qualified engineers to perform the piping analysis under NSC project control. NSC will provide project management, the Quality Assurance Program, and qualified engineers to perform the analysis. The engineering team will be under the direct supervision of an NSC project engineer. Work will be performed at the CDC Waltham, MA office and the NSC office in Campbell, CA. CDC will be responsible for administrating the overall purchase order.

1.1 Definitions

- Supplier - The company(s) accepting the overall responsibility for fulfilling the requirements of this Engineering Service Scope of Work. For this ESSOW they are Control Data Corporation (CDC) and Quadrex/Nuclear Services Corporation (NSC).
- Subsupplier - Those deriving their authority to perform work under the purchase order from the supplier.
- Engineers - Stone & Webster Engineering Corporation, a Massachusetts corporation, or its duly authorized agents restricted to the performance of the particular duties entrusted to them.
- Engineers Representative - The Engineers' Project Engineer/Designee. Refer to Section 4.1.
- Purchaser - Virginia Electric Power Company, Richmond, VA
- Approval - This word, when applied by the Engineers to the Supplier's drawings or documents, mean that the drawings or documents are satisfactory from the standpoint of interfacing with all Purchaser-furnished components of the installation and/or that the Engineers have not observed any statement or feature that appears to deviate from the scope of work's requirements. Except for the interfacing with all Purchaser-furnished components, the Supplier shall retain the entire responsibility for complete conformance with all of the scope of work's requirements.
- Approved As Revised - These words, when applied by the Engineers to the Supplier's drawings or documents, mean that the Engineers believe the changes delineated thereon are necessary to be in conformance with the scope of work or with existing conditions. On the basis that the Supplier shall retain the entire responsibility for the equipment or test, the Supplier's shall either: (a) incorporate the suggested changes and resubmit to the Engineers, or (b) inform the Engineers that the suggested changes cannot be made without prejudice to the Supplier's responsibility under the scope of work and resubmit with a full explanation of the reasons therefor.

Performance - An activity to determine through investigation the adequacy of
Audit and adherence to established procedures, instructions, codes, and
other applicable contractual and licensing requirements, and the
effectiveness of implementation.

1.2 Introduction

Control Data Corporation (CDC) and Quadrex/Nuclear Services Corporation (NSC) will perform stress analysis of selected portions of Surry Unit 2 Piping Systems using the current NSC version of NUPIPE II. Cases to be analyzed will consist of portions of the systems in Section 1.3.1.

The purpose of the analyses is twofold:

- CDC/NSC shall analyze the piping system to verify that it is qualified to ANSI B 31.1, (see Section 1.4.1) (using seismic analysis methods as defined in the 1971 Seismic Design Review Report).
- CDC/NSC shall establish restraint, support, penetration, and equipment loads to facilitate verification of piping system structural and equipment interfaces.

It is essential that uniform methods and assumptions be utilized on all Surry 2 analyses and that all licensing commitments be met. Analysis criteria will therefore be supplied or approved by the Engineers.

1.3 Scope

- 1.3.1 In accordance with "Analysis Requirements" Section 2.0 and "Design Criteria" Section 3 the supplier shall perform pipe stress/support analyses, including the effects of local attachments for portions of the following systems:

Main Steam
Feedwater
Service Water
Component Cooling
Containment & Recirculation Spray
Pressurizer Spray
Residual Heat Removal
Low Head and High Head Safety Injection System
Containment Vacuum
Auxiliary Feedwater

1.3.2 Prequalification Requirements

Benchmark

The Benchmark problem provided by NSC Surry Unit 1 will be sufficient to fulfill the requirements for NSC's Unit 2 prequalification provided the same NSC version of NUPIPE II is being used for both Units 1 and 2.

- 1.3.3 All work performed by Control Data Corporation (CDC) and Quadrex/Nuclear Services Corporation (NSC) shall be in accordance with approved NSC Quality Assurance Procedures as referenced in this ESSOW.

CDC/NSC will provide the Engineers the following documentation:

1. Analysis input.
2. Benchmark problem results and conclusions.
3. Input data files (tape) for all problems run.
4. Stress Report for each analysis as described below.

1.3.4 NUPIPE Stress Analysis Results

CDC/NSC Corporations will provide a stress report for each analysis performed.

The report will include:

- o Statement of Results.
- o List of Reference Documents.
- o Pipe Section Properties.
- o Concentrated Weights.
- o System Design/Operating Values.
- o Seismic Spectra and Anchor Movements.
- o Stress Summary Sheet.
- o Tabulation of all Structural Interface Loads, for each load case analyzed. Loads on Anchors and penetrations will be provided using local pipe element coordinate system as defined by NUPIPE.
- o Isometric Sketch.
- o Maximum stress point table for evaluated code equations.
- o Tabulation of acceleration for all eccentric mass valves/operators.
- o Copy of the NUPIPE program output in microfiche, computer data check of piping input geometry, and copies of all backup calculations.
- o Pipe support analysis calculations, data, and backup information.
- o Preparation and review verifying signatures and date.

1.3.5 Structural Evaluation

For nozzles and penetrations, the Engineers will perform a comparison of calculated reactions against the loads tabulated on the original 11548-MSK drawings. The calculated reactions will be developed by CDC/NSC.

The Engineers will evaluate all equipment supports.

Integral attachments will be evaluated using appropriate hand or computer methods, as necessary. These methods shall be submitted to the Engineers for review and approval prior to use. Local stresses at monoball attachments shall be evaluated by CDC/NSC. The monoball and supporting frame will be evaluated by the Engineers.

CDC/NSC will provide a comparison of calculated support loads with the loads tabulated on the original 11548-MSK drawings. Where the calculated load is greater than the MSK listed load, the support will be analyzed by CDC/NSC for compatibility with the higher value. Reference Attachment 7.1 for required Load case combinations. Refer to the Engineer's "Procedure for Evaluation of Surry Unit 2 Dynamic Pipe Stress Analysis" (Reference 1.4.4) for methodology, guidance, and format to be used for support evaluation.

1.4 Applicable Codes Regulatory Guides, Standards, and Procedures

The following documents form a part of this ESSOW to the extent specified. Unless otherwise stated, the latest issue shall apply. In the event of conflict between the referenced documents and the ESSOW, the conflict shall be referred to the Engineers for resolution.

- 1.4.1 Power Piping Code ANSI B31.1 - 1967 including Summer 1972 Addendum
- 1.4.2 ANSI N45.2.11 Quality Assurance Requirements for the Design of Nuclear Power Plants.
- 1.4.3 10CFR50 Appendix B Quality Assurance Criteria for Nuclear Power Plants.
- 1.4.4 The Engineer's "Procedure for Evaluation of Surry Unit 2 Dynamic Pipe Stress Analysis"
- 1.4.5 Seismic Design Review (VEPCO, 1971)
- 1.4.6 NUS-20 Specification for Piping
- 1.4.7 User's Manual for "NUPIPE - SW" Computer Code
- 1.4.8 The Engineer's Engineering Department Memo EMD 79-12
- 1.4.9 ANSI N45.2.9 Requirements for Collection, Storage, and Maintenance of QA records for Nuclear Power Plants, 1974
- 1.4.10 10CFR21 Quality Assurance Requirements for Reporting Defects and Noncompliance.

2.0 ANALYSIS REQUIREMENTS

2.1 Unit 1 and Unit 2 Comparison

Comparison of Unit 2 to Unit 1 field verified information will be performed by the Engineers. This may reduce the total scope.

2.2 Pipe Analysis Methods

- 2.2.1 Piping system design data is contained in the Engineers' calculation packages. The systems contain compressed fluid (water), air, or steam as indicated.
- 2.2.2 Piping material specifications are contained in the Engineer data sheets.
- 2.2.3 The piping shall be analyzed for the effects of dead weight, thermal expansion, thermal anchor displacement, earthquake inertial loads, internal stresses, and support and anchor seismic movements.
- 2.2.4 Seismic directional components shall be combined for the OBE & DBE earthquake analyses, considering:

$$S_P + S_{DL} \leq S_H$$

$$S_P + S_{DL} + S_{OBEI} + S_{OBEA} \leq 1.2 S_H$$

$$S_P + S_{DL} + S_{DBEA} + 1.5 S_{DBEI} \leq 1.8 S_H$$

$$\text{THERMAL STRESS} \leq (1.25 S_C + 0.25 S_H) f$$

where:

S_P = Longitudinal Pressure Stress

S_{DL} = Dead Load Stress

S_{OBEA} = Operational Basis Earthquake Stress Due to Anchor Movements

S_{OBEI} = Operational Basis Earthquake Stress Due to Inertia

S_{DBEA} = Design Basis Earthquake Stress Due to Anchor Movements

S_{DBEI} = Design Basis Earthquake Stress Due to Inertia

S_H = Basic Material allowable stress at maximum (hot) temperature

- S_C = Basic material allowable stress at minimum (cold) temperature
- f = Stress range reduction factor for cyclic condition, Table 102.3.2 (c), ANSI B31.1.

OBE and DBE earthquake shall be considered as 3D and anchor movement displacements shall be included.

The Engineers' version of NUPIPE has the capability of providing vertical + SRSS of horizontal inertial analysis using TLOAD = 11.0. The vendor's version may not have retained this option. If this option does not exist the deck set up for supplier's analysis should be:

FLEXAN; TLOAD = 10.0: X + Z Earthquake Response $\Rightarrow \sqrt{R_X^2 + R_Z^2}$

FLEXAN; TLOAD = 6.0: Y Earthquake Response $\Rightarrow R_Y$

MODFLEX; CCODE = 1.0:X+Y+Z,3D Earthquake $\Rightarrow \sqrt{R_Y^2 + R_X^2 + R_Z^2}$

OBE and DBE shall be considered. A sample of the Engineer's deck set up will be furnished.

- 2.2.5. The seismic inertial case and the seismic anchor movements case shall be summed by absolute values.
- 2.2.6 Seismic anchor movements shall be calculated separately for each earthquake direction. The results of each analysis are then to be combined using SRSS.
- 2.2.7 Cutoff frequency for inertial load cases shall be 100 Hz. or 100 modes whichever occurs first.

3.0 DESIGN CRITERIA:

3.1 Allowable Stresses

Allowable stresses for the systems to be reviewed are given in the Engineer's data sheets.

3.2 Restraint System Assumptions

- 3.2.1 Unless other information is provided by the Engineers, the Engineer's Engineering Department Memo EMD 79-12 shall be used to estimate restraint stiffness.
- 3.2.2 For Spring Hangers, use $K = 1.0 \text{ lb/in.}$ in dynamic analysis.
- 3.2.3 The type, location, and direction of action of all restraints will be shown on the Final Pipe Stress MKS drawings provided by the Engineers.

3.3 Branch Connections

- 3.3.1 Unless other information is provided by the Engineers, the Engineer's Engineering Department Memo EMD 79-15, shall be used to analyze branch connections. In cases where no constraints are indicated on the branch piping (as determined by Section III, paragraph 7a of the Surry #2 "Procedure for Evaluation of Dynamic Pipe Stress Analysis") the vendor shall determine that the branch piping is routed such that adequate flexibility is provided to accommodate piping motions that occur.
- 3.3.2 Unless other information is provided by the Engineers, the Engineer's Engineering Department Memo EMD 79-11, shall be used to determine stress intensification factors for branch connections which have reduced outlets and are within the scope per EMD 79-15.

3.4 Pressure & Temperature

To ensure consistency for the CDC/NSC analyses; Design Pressure shall be used for primary stress check, maximum Operating Temperature shall be used for the expansion stress check. Pressure and Temperature Data is provided in the Engineer's calculation packages.

3.5 Concentrated Weights

A list of concentrated weights to be considered in the analyses will be supplied by the Engineer's as will the center of gravity of weights which do not coincide with the pipe axis.

3.6 Seismic Spectra

SSI-ARS values will be supplied by the Engineers.

3.7 Building Seismic Movements

A set of horizontal/vertical, OBE/DBE building seismic displacements will be supplied by the Engineers.

To incorporate the effects of Relative Building Motion, the Engineer's will provide the movements to be used in the analyses of piping running between different buildings and the method of their combination with the building seismic displacements.

3.8 Thermal Anchor Movements

Thermal Anchor Movements will be considered.

For all containment penetration anchors, the effects of a containment uniform operating temperature of 105°F should be considered in each analysis.

4.0 DOCUMENTATION, FINAL REVIEW AND APPROVAL

4.1 Documentation

The Engineers will provide to CDC/NSC the format for documentation required by CDC/NSC to perform the work detailed in Section 1.2, "Scope of Work".

All substantive decisions and documentation interchange shall be documented and distributed as defined below (Correspondence).

All official documents transferred between CDC/NSC and the Engineer's must be accompanied by a cover letter which identifies the documents involved. Each letter of correspondence shall have a unique identification number. Correspondence from CDC/NSC to the Engineers shall be prefaced by the letters CS (eg., CS-001, CS-002, ...). Correspondence from the Engineers to CDC/NSC will be prefaced by the letters SC (eg., SC-001, SC-002,...). Logs shall be maintained to control the correspondence identification designations assigned and documents received. These logs shall be submitted upon completion of the effort.

At the conclusion of the analysis program, the supplier shall submit to the Engineers a list of the applicable files. Upon review of this list, the Engineers will identify those files that require transfer to the Engineers. Disposition of these files will be discussed and agreed upon by the Engineers and the Purchaser in accordance with ANSI N45.2.9.

In order to expedite dissemination of final stress results from CDC/NSC or required design documents to CDC/NSC, special courier service, such as Federal Express, Purolator or equivalent, shall be used. The Engineers will hand deliver design documents to the CDC/NSC representative at the Engineers' Boston office. CDC/NSC will provide transportation. (Note: Telecopy of signed and dated results or documents may be used for analyses pending the receipt of original hard copy.)

<u>Engineer's Representatives:</u>	<u>Telephone No.</u>	<u>Telecopy No.</u>
B.F. Crowe (Project Engr.)	(617) 973-6620	(617) 973-2305
S.R. Stoll (Project Coord.)	(617) 973-6620	(617) 973-2305

Addresses

Stone & Webster Engineering Corporation
 Attention: Mr. B.F. Crowe 245/14
 P.O. Box 2325
 Boston, MA 02107

Control Data Corporation
 Attention: J.M. McAndrew
 60 Hickory Drive
 Waltham, MA 02154

Quadrex/Nuclear Services Corporation
 Attention: W. S. Benedict
 1700 Dell Avenue
 Campbell, CA 95008

Virginia Electric and Power Company
 Attention: Mr. W.C. Spencer
 P.O. Box 26666
 Richmond, VA 23261

Correspondence

	<u>Original</u>	<u>Copies</u>
From CDC/NSC to the Engineers (S&W)		
Technical	Engineers (S&W)	2 Engineers (S&W) (Vepco)
From the Engineers (S&W) to CDC/NSC		
Technical	CDC/NSC	2 (CDC/NSC) (Vepco)

4.2 Data Compatability

CDC/NSC will perform a review of the NUPIPE-SW user's manual and a CDC/NSC typical analysis to verify that input files for analyses performed at CDC/NSC on NUPIPE II can be rerun by the Engineers on the IBM version of NUPIPE-SW. CDC/NSC will provide the Engineers with input data files (tape) for all problems analyzed.

5.0 QUALITY ASSURANCE

5.1 Quality Assurance Program

To assure the accuracy and quality of all work done, the supplier shall perform the required work of this ESSOW in accordance with the NSC Quality Assurance Program and said program will be in compliance with applicable portions of 10CFR50, Appendix B and with the design control provisions of ANSI N45.2.11.

The Quality Assurance Program will consist of the following for documentation and assurance of traceability:

- a. Supplier's Quality Assurance Manual that shall be submitted for review and approval by the Engineers prior to start of work.
- b. A record of the supplier's professional staff doing work required by this ESSOW shall be maintained and updated.
- c. A file of qualifications (education and experience records) of persons engaged in this work shall be maintained by the supplier.

5.2 Quality Assurance Manual

The NSC Quality Assurance Manual shall document, as a minimum, the design control measures for this work.

Written policies, procedures, and instructions shall exist which are subject to provisions of ANSI N45.2.11-1974 and provide conformance to the following:

1. Design input requirements to be identified to ensure that the design activity was carried out in a correct manner.
2. Design analysis to be provided in sufficient detail for properly planned requirements of specifications, calculations, drawings (sketches), procedures, and other design documents.

3. Internal and external interface control to be provided between organizations performing work affecting quality of design and to be identified in writing regarding criteria and technical direction including responsibilities, lines of communications, and design information transmittal.

These interface control procedures between CDC and NSC, CDC/NSC and the Surry CDC/NSC representative, and CDC/NSC and the Engineers shall be submitted to the Engineers preferably upon start of the analysis but no later than two weeks after work commencement.

4. Detailed design verification to be exercised by acceptable verification methods such as design reviews, use of alternate calculations, and/or qualification testing.
5. Document control to be provided to ensure that documents, including changes, are reviewed for adequacy and approved for release by authorized personnel, and are properly distributed.
6. Design change control to be exercised to ensure the impact of a change is carefully considered, required actions documented, and information concerning the changes is transmitted to all affected persons and/or organizations. Documented design changes are to be reviewed and approved by the same groups or organizations which reviewed and approved the original design documents.
7. Corrective action to be exercised where needed for reporting deficiencies and errors to appropriate level of supervision and management, and for follow-up actions to ensure timely resolution and/or completion.
8. Design records to be legible, identifiable, and retrievable.
9. A comprehensive system of planned and documented in-house audits to be carried out to assess compliance with all aspects of the QA Program for design.
10. A system to be established for the selection and review for suitability of application of materials, processes, parts, and equipment that are essential to the safety-related functions of the structures, systems, and components.

5.3 Performance Audits

Authorized representatives of the Engineers shall be allowed access to a supplier's offices at all reasonable times for the purpose of auditing established procedures. Such audits will include but not be limited to examination of documentary evidence of activities affecting quality and will be carried out on a planned basis during the course of the work to verify compliance with all aspects of the program and to determine the effectiveness thereof.

5.4 Access by Others

The Purchaser's representative/regulatory body representatives shall have the same access to facilities and documents as the Engineers' representative.

5.5 Nonconformance

The supplier shall identify all nonconformance to the requirements of this Scope of Work. Nonconformance shall be documented, including suggested corrective action, and referred to the Engineers for resolution before continuing any work which may cause further nonconformances.

5.6 Deviations

Deviations from the requirements of this scope of work without prior approval from the Engineers are not allowed. The supplier shall request approval of such deviations from the Engineers.

All analyses are to be in accordance with established procedures and shall be reviewed and approved by the Engineers.

5.7 Availability of ESSOW

The supplier shall specifically ensure that a copy of this Scope of Work with all addenda thereto, or appropriate work instructions which included the specific requirements, are readily available where work covered by this Scope of Work is in progress.

6.0 SUPPLEMENTAL PROVISIONS

6.1 Communications

All correspondence from the supplier shall consist of an original plus appropriate copies as indicated in Section 4.1 and shall contain the following subject headings:

Stone & Webster Engineering Corporation
Attention: Mr. B.F. Crowe
245 Summer Street
Boston, Massachusetts 02108

Refer to Sections 4.1. and 6.8

6.2 Progress Reports

The supplier shall provide a weekly progress summary report indicating problems submitted to the Engineers for approval, problems currently undergoing analysis and problems on "hold" (engineering hold). (Circumstances may occur that include stopping work via engineering "holds" on problems and this ESSOW, or other reasons due to the exercise of the Engineers' control over the supplier, and the stopping of engineering work due to engineering management action.)

Status will be provided on a daily basis to the Engineers' representative.

Reporting format will be determined by the Engineers.

6.3 Responsibility

The supplier shall be completely responsible that his piping analysis is entirely suitable for the purpose outlined herein or reasonably inferred therefrom. Therefore, if any requirements of this ESSOW is deemed by the supplier to be incorrect, unsuitable, contradictory, or such that conformance therewith would diminish or adversely affect in any way the supplier's responsibility, the supplier shall specifically delineate his objections and the reasons therefor in his proposal, so that they may be resolved before the order is placed. In all other respects the supplier by accepting the order shall be deemed to have agreed that conformance with the ESSOW's requirements will not prejudice in any way the Purchaser's rights under warranty. The Engineers' review and approval do not relieve the supplier from the above-mentioned responsibility.

6.4 Furnished by the Engineers

The Engineers will furnish the following:

Procedure for Analysis of the Dynamic Pipe Stress Pipe Drawings

MKS Piping Isometric Drawings

Load Case Combinations

Reference Drawings

Insulation Requirements

Valve and Special Information as Required

System Operational Data

Pipe Support Detail Data

Seismic Analysis Criteria

All other pertinent information required to support the CDC/NSC analysis detailed in this ESSOW.

6.5 Furnished by the Supplier

- a. The supplier shall provide all the manpower, equipment, apparatus, services, and facilities required to perform the work herein described except for those items provided by the Purchaser.
- b. Daily Progress Report
- c. Weekly Progress Summary Report
- d. Documentation required by Sections 1.3, 4.0, 5.0.

6.6 Coordination of Work

A CDC/NSC representative will be located at the Engineers' Boston office with another at the Surry jobsite in Surry, Virginia as required by the Engineers during performance of the work herein described.

The Engineer's representative shall consult with CDC/NSC to coordinate, monitor, and advise in all activities associated with this ESSOW.

No change to this ESSOW shall be binding on either party until an addendum has been issued.

6.7 Compliance with 10CFR21

The engineering service provided under this contract is a basic component of a Nuclear Regulatory Commission (NRC) licensed facility. Accordingly, the supplier is subject to the provisions of Part 21, Chapter 1 of Title 10 of the Code of Federal Regulations. Refer to the body of the contract for further information.

6.8 Interface

The primary engineering contacts for the supplier's interface with the Engineers will be with Messrs B.F. Crowe and S.R. Stoll. Reference Section 4.1.

6.9 Schedule

A schedule showing the key dates pertaining to this ESSOW will be prepared by the Engineers. This will show the milestone dates that must be met in accordance with the project requirements. This schedule, or a revision of it as agreed upon by the supplier and the Engineers shall be binding upon the supplier.

6.10 Subsuppliers

Should the supplier propose to purchase from another supplier any of the services specified herein, the supplier shall, upon request, identify the subsupplier for those specific services itemized by the Engineers. These subsuppliers shall be subject to approval by the Engineers and the Purchaser.

The supplier shall impose on each of its subsuppliers the complete requirements of this ESSOW. The supplier shall be directly responsible that the subsuppliers are completely aware of all these requirements and abide by them. The subsupplier shall be subjected to all stipulations listed in this ESSOW including review and audit by the Engineers.

7.0 ATTACHMENTS

7.1 Load Case Combination Sample

