The Light company Houston Lighting & Power P.O. Box 1700 Houston, Texas 77001 (713) 228-9211

October 22, 1985
ST-HL-AE-1426
File No.: G9.17

Mr. George W. Knighton, Chief
Licensing Branch No. 3
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, DC 20555

South Texas Project
Units 1 and 2
Docket Nos. STN 50-498, STN 50-499
Responses to DSER/FSAR Items Regarding
Regarding NSSS Scope of Equipment Qualification

Dear Mr. Knighton:

The attachments enclosed provide STP's response to Draft Safety Evaluation Report (DSER) or Final Safety Analysis Report (FSAR) items.

The item numbers listed below correspond to those assigned on STP's internal list of items for completion which includes open and confirmatory DSER items, STP FSAR open items and open NRC questions. This list was given to your Mr. N. Prasad Kadambi on October 8, 1985 by our Mr. M. E. Powell

The attachments include mark-ups of FSAR pages which will be incorporated in a future FSAR amendment unless otherwise noted below.

The items which are attached which are listed with a (P) below cover the NSSS Scope for the subject item and are partial responses. The last item is a complete response to the item.

Attachment	Item No.*	Subject
1	D 3.10-2(P) D 3.10-11(P) D 3.10-12(P) D 3.10-13(P) D 3.10-14(P) D 3.10-18	NSSS scope of responses to DSER items in Section 3.10

* Legend
D - DSER Open Item C - DSER Confirmatory Item
F - FSAR Open Item Q - FSAR Question Response Item

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Houston Lighting & Power Company

If you should have any questions concerning this matter, please contact Mr. Powell at (713) 993-1328.

Very truly yours,

M. R. Wisenburg
Manager, Nuclear Licensing

CAA/bl

Attachments: See above

L1/DSER/aj

cc:

Hugh L. Thompson, Jr., Director
Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Robert D. Martin
Regional Administrator, Region IV
Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 1000
Arlington, TX 76011

*N. Prasad Kadambi, Project Manager
U.S. Nuclear Regulatory Commission
7920 Norfolk Avenue
Bethesda, MD 20814

Claude E. Johnson
Senior Resident Inspector/STP
c/o U.S. Nuclear Regulatory Commission
P.O. Box 910
Bay City, TX 77414

M.D. Schwarz, Jr., Esquire
Baker & Botts
One Shell Plaza
Houston, TX 77002

J.R. Newman, Esquire
Newman & Holtzinger, P.C.
1615 L Street, N.W.
Washington, DC 20036

Director, Office of Inspection and Enforcement
U.S. Nuclear Regulatory Commission
Washington, DC 20555

E.R. Brooks/R.L. Range
Central Power & Light Company
P.O. Box 2121
Corpus Christi, TX 78403

H.L. Peterson/G. Pokorny
City of Austin
P.O. Box 1088
Austin, TX 78767

J.B. Poston/A. vonRosenberg
City Public Service Board
P.O. Box 1771
San Antonio, TX 78296

Brian E. Berwick, Esquire
Assistant Attorney General for the State of Texas
P.O. Box 12548, Capitol Station
Austin, TX 78711

Lanny A. Sinkin
3022 Porter Street, N.W. #304
Washington, DC 20008

Oreste R. Pirfo, Esquire
Hearing Attorney
Office of the Executive Legal Director
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Charles Bechhoefer, Esquire
Chairman, Atomic Safety & Licensing Board
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dr. James C. Lamb, III
313 Woodhaven Road
Chapel Hill, NC 27514

Judge Frederick J. Shon
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Mr. Ray Goldstein, Esquire
1001 Vaughn Building
807 Brazos
Austin, TX 78701

Citizens for Equitable Utilities, Inc.
c/o Ms. Peggy Buchorn
Route 1, Box 1684
Brazoria, TX 77422

*Docketing & Service Section
Office of the Secretary
U.S. Nuclear Regulatory Commission
Washington, DC 20555
(3 Copies)

Advisory Committee on Reactor Safeguards
U.S. Nuclear Regulatory Commission
1717 H Street
Washington, DC 20555

Revised 9/25/85

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5. It is stated in the specification that the vendor should demonstrate the ability of the equipment not to suffer any loss of function during and after the specified conditions. 6 Q110 27

3.9.3.2.1 Pump and Valve Operability Assurance (NSSS Scope): Mechanical equipment classified as safety-related must be capable of performing its function under postulated plant conditions. Equipment with faulted condition functional requirements includes active pumps and valves in fluid systems such as the Residual Heat Removal System (RHRS), Safety Injection System, and Containment Spray System. Active pumps and valves within Westinghouse scope are identified in Tables 3.9-1.1 and 3.9-1.2A respectively. Seismic analysis is presented in Section 3.7 and covers safety-related mechanical equipment. ISI and testing are discussed Sections 5.2.4 and 6.6. 41

Operability is assured by satisfying the requirements of the programs specified below.

3.9.3.2.1.1 Pump Operability Program (NSSS Scope) - All active pumps will be qualified for operability by first undergoing rigid tests prior to and after installation in the plant. The in-shop tests include: (1) hydrostatic tests of pressure-retaining parts to 150 percent of the design pressure times the ratio of material allowable stress at room temperature to the allowable stress value at the design temperature; (2) seal leakage tests; and (3) performance tests to determine total developed head, minimum and maximum head, net positive suction head (NPSH) requirements, and other pump parameters. Also monitored during these operating tests are bearing temperatures and vibration levels. Bearing temperature limits are determined by the manufacturer based on the bearing material, clearances, oil type and rotational speed. These limits are approved by Westinghouse. After pump is installed in the plant, it undergoes the cold hydrotests, hot functional tests, and the required periodic inservice inspection and operation. These tests demonstrate that the pump will function as required during all normal operating conditions for the design life of the plant. 41

In addition to these tests, the safety-related active pumps will be qualified for operability by assuring that they will start up, continue operating, and not be damaged during the faulted conditions. 41

The pump manufacturer will be required to show by analysis correlated by tests, prototype tests, or existing documented data that the pump will perform its safety function when subjected to loads imposed by the maximum seismic accelerations and the maximum faulted nozzle loads. It is required that testing or dynamic analysis be used to show that the lowest natural frequency of the pump is greater than 33 Hz. A pump with a natural frequency above 33 Hz is considered essentially rigid. This frequency is sufficiently high to avoid problems with amplification between the component and structure for all seismic areas. A static shaft deflection analysis of the rotor is performed with the conservative SSE accelerations of 2.1g in two orthogonal horizontal directions and of 2.1g in the vertical, acting simultaneously. The deflections determined from the static shaft analysis are compared to the allowable rotor clearances. The nature of seismic disturbances dictates that the maximum contact (if it occurs) will be of short duration. If rubbing or impact is predicted, it is required that it be shown by prototype tests or existing documented data that the pump will not be damaged or cease to perform its 41

INSERT A

While seismic analysis demonstrates the structural integrity of the active pump and valve assembly, operability is assured by satisfying the requirements of the Westinghouse Pump and Valve Operability Program. Through this program, operability of the active mechanical equipment is demonstrated by test or a combination of test and analysis where the analysis has been supported by testing. The tests have been performed on prototype equipment and similarity analysis is then used to justify applicability to plant specific equipment. Qualification of equipment is demonstrated for the entire assembly though portions of the assembly may be qualified separately. (e.g., active valve appurtenances such as limit switches are qualified by separate testing); however, operability of the entire assembly is demonstrated.

INSERT X

preservice and inservice testing further supplement the qualification process. These require that the pump

design function. The effect of impacting on the operation of the pump is evaluated by comparison of the impacting surfaces of the pump to similar surfaces of pumps that have been or will be tested.

In order to avoid damage during the faulted plant condition, the stresses caused by the combination of normal operating loads, SSE, and dynamic system loads are restricted to the limits indicated in Table 3.9-4B. In addition, 41
the pump casing stresses caused by the maximum faulted nozzle loads are restricted to the stresses outlined in Table 3.9-4B. The changes in operating 41
rotor clearances caused by casing distortions due to these nozzle loads are considered. The maximum seismic nozzle loads combined with the loads imposed by the seismic accelerations are also considered in an analysis of the pump supports. Furthermore, the calculated misalignment is shown to be less than that misalignment which could cause pump misoperation. The stresses in the supports are below those in Table 3.9-4B; therefore, the support distortion is 41
elastic and of short duration (equal to the duration of the seismic event).

Performing these analyses with the conservative loads stated, and with the restrictive stress limits of Table 3.9-4B as allowables, assures that critical 41
parts of the pump will not be damaged during the short duration of the faulted condition and that, therefore, the reliability of the pump for post-faulted condition operation will not be impaired by the seismic event.

If the natural frequency is found to be below 33 Hz, an analysis is performed to determine the amplified input accelerations necessary to perform the static analysis. The adjusted accelerations are determined using the same conservatisms contained in the 2.1g orthogonal horizontal and 2.1g vertical accelera- 41
tions used for "rigid" structures. The static analysis is performed using the adjusted accelerations; the stress limits stated in Table 3.9-4B must still be 41
satisfied.

Insert B →

To complete the seismic qualification procedures, the pump motor is qualified for operation during the maximum seismic event. Any auxiliary equipment identified as vital to the operation of the pump or the pump motor and which is not proven adequate for operation by the pump or motor qualifications will 41
also be separately qualified by meeting the requirements of IEEE 344-1975, with the additional requirements and justifications outlined in Section 3.9.3.2.1.3.

The program described above gives the required assurance that the safety-related pump/motor assemblies will not be damaged and will continue operating under SSE loadings and, therefore, will perform their intended functions. These requirements take into account the complex characteristics of the pump and are sufficient to demonstrate and assure the seismic operability of the active pumps.

Since the pump is not damaged during the faulted condition, the functional ability of active pumps after the faulted condition is assured since only normal operating loads and steady-state nozzle loads exist. Since it is demonstrated that the pumps would not be damaged during the faulted condition, the post-faulted condition operating loads will be identical to the normal plant operating loads. This is assured by requiring that the imposed nozzle loads (steady-state loads) for normal conditions and post-faulted conditions are limited by the magnitudes of the normal condition nozzle loads. The

Insert B

To verify analytical techniques and provide data for correlation to analytical results, full assembly operability testing was performed on a Charging/Safety Injection Pump. The assembly consisted of an 11 stage centrifugal pump, a speed increaser gear and a 600 HP induction motor mounted on a common baseplate typical of normal plant installation. Of all Westinghouse supplied NSSS active pump assemblies, this one was chosen as being most representative of the various design features of active pumps. The assembly was mounted on a shaker table such that triaxial seismic input could be simulated. A flow loop connected to the pump permitted full pump operation while special fixtures were fabricated to apply nozzle loads to the suction and discharge nozzles. Instrumentation including accelerometers, strain gauges, strain bolts, proximity probes and thermocouples were used to monitor the complete assembly during testing.

In general, the testing consisted of a preseismic resonance search, a preseismic pump head-flow characterization, five OBE's, four SSE's, pump head-flow characterization between seismic runs, a post-test resonance search and a post-test pump head-flow characterization. The pump was started prior to and during seismic testing without difficulty. As a result of the testing, no pump damage was visually observed or measured and the hydraulic characteristics remained within specific tolerances. It was concluded that the test pump assembly remained operational during and after a design basis seismic event.

The specific pump attributes (e.g., weight, RPM, gear ratio, full load current) of both the test unit and the pumps employed at the South Texas Project are compared in a Pump and Valve Operability report which includes a summary report for the testing performed on the charging pump assembly.

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post-faulted condition ability of the pumps to function under these applied loads is proven during the normal operating plant conditions for active pumps.

3.9.3.2.1.2 Valve Operability Program (NSSS Scope) - Safety-related active valves must perform their mechanical motions in times of an accident. Assurance is supplied that these valves will operate during a seismic event. Tests and analyses will be conducted to qualify active valves. 41

The safety-related valves will be subjected to a series of stringent tests prior to service and during plant life. Prior to installation, the following tests are performed: shell hydrostatic test to ASME Section III requirements, backseat and main seat leakage tests, disc hydrostatic test, and operational tests to verify that the valves will open and close within the specified time limits when subjected to the design differential pressure. For qualification of motor operators for environmental conditions, refer to Section 3.11. Cold hydro tests, hot functional qualifications tests, periodic inservice inspections, and periodic inservice operations are performed in situ to verify and assure the functional ability of the valve. These tests guarantee reliability of the valve for the design life of the plant. 41

The valves are designed in accordance with ASME B&PV Code Section III. On active valves, an analysis of the extended structure is performed for static equivalent seismic SSE loads applied at the center of gravity of the extended structure. The maximum stress limits allowed in these analyses show structural integrity. The maximum stress limits used for active Class 2 and 3 valves are shown in Table 3.9-6. Class 1 valves will be designed/analyzed according to the rules of the ASME Code, Section III, NB-3500. 41

In addition to these tests and analyses, representative valves of each design type will undergo tests for verification of operability during a simulated plant faulted condition event by demonstrating operational capabilities within the specified limits. The testing procedures are described below. 41

The valve is mounted in a manner that conservatively represents typical valve installations. The valve includes the operator and appurtenances normally attached to the valve in service. The faulted condition nozzle loads are considered in the test in either of two ways: (1) loads equivalent to the faulted condition nozzle loads are simultaneously applied to the valve through its mounting during the test described below; or (2) by analysis, the nozzle loads are shown to not affect the operability of the valve. Operability of the valve during a faulted condition is demonstrated by satisfying the following criteria: 41

1. All active valves are designed to have a first natural frequency greater than 33 Hz.

2. The actuator and yoke of the valve system is statically deflected by an amount equal to the deflection caused by the faulted condition accelerations applied at the center of gravity of the operator alone in the direction of the weakest axis of the yoke. The design pressure of the valve will be simultaneously applied to the valve during the static deflection tests.

Insert C

Westinghouse, working in conjunction with the valve manufacture, evaluates the various valve attributes (e.g., material composition, weight, wall thickness, size) and selects valves that are the most susceptible to seismic induced loads for testing. This permits extrapolation of demonstrated operational performance to other valves within the design family. The pump and valve operability report prepared for this project identifies the tested valves (including valve sizes) and each plant specific valve for which a given tested valve is employed for qualification purposes. A comparative analysis is performed with conclusions drawn on acceptability.

INSERT Y

After the valve is installed in the plant preservice and inservice testing further supplement the qualification process.

INSERT Z

performed under full operational conditions.

and cycle times are recorded

This data is

3. The valve is cycled while in the deflected position, ~~The time required to open or close the valve in the deflected position will be~~ compared to similar data taken in the undeflected condition to evaluate the significance of any change.

4. Motor operators, and other appurtenances necessary for operation are
qualified by IEEE 344-1975 with additional requirements and justifica- 41
tions as supplied in Section 3.9.3.2.1.3.

The accelerations which are used for the static valve qualification shall be
equivalent, as justified by analysis, to 4.0g acting in two orthogonal hori-
zontal directions and 4.0g vertical simultaneously. The piping designer must 41
~~maintain the operator~~ limit accelerations to these levels.

If the lowest natural frequency of the valve is less than 33 Hz, a dynamic analysis
will be performed to determine the equivalent acceleration to be applied
during the static test. The analysis will ~~provide~~ account for the amplification of the
input acceleration, by considering the natural frequency of the valve and the
frequency content of the applicable plant floor response spectra. The
adjusted accelerations will be determined using the same conservatisms con-
tained in the 4.0g horizontal and 4.0g orthogonal vertical accelerations used 41
for "rigid" valves. The adjusted acceleration will then be used in the static
analysis, and valve operability will be assured by the methods outlined. ~~in steps 2 through 4, above, using the modified acceleration input.~~

~~The program outlined above applies to valves with extended structures. The
testing will be conducted on a representative number of valves. Valves from
each of the primary safety-related design types will be tested. Valve sizes 41
covering the range of sizes in service are qualified by the tests, and the
results are used to qualify all valves within the intermediate range of sizes.
Stress and deformation will be used to support the interpolation.~~ 41

Valves that are safety-related but can be classified as not having an extended structure, such as check valves and safety valves, are considered separately.

Check valves are characteristically simple in design, and their operation will
not be affected by seismic accelerations or the maximum applied nozzle loads.
The check valve design is compact, and there are no extended structures or
masses whose motion could cause distortions that could restrict operation of
the valve. The nozzle loads due to maximum seismic excitation will not affect
the functional ability of the valve since the valve disc is typically designed
to be isolated from the body wall. The clearance supplied by the design
around the disc will prevent the disc from becoming bound or restricted due to
any body distortions caused by nozzle loads. Therefore, the design of these
valves is such that once the structural integrity of the valve is assured
using standard design or analyses methods, the ability of the valve to operate 41
is assured by the design features. The valve will also undergo the following:
(1) stress analysis of critical parts which may affect operability, including
the faulted condition loads (2) in-shop hydrostatic test, (3) in-shop seat 41
leakage test, and (4) periodic in situ valve exercising and inspection to
assure functional ability of the valve.

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Pressurizer safety valves will be qualified by the following procedures (these valves are also subjected to tests and analysis similar to check valves): (1) stress and deformation analyses of critical items that might affect operability for faulted condition loads, (2) in-shop hydrostatic and seat leakage tests, and (3) periodic in situ valve inspection. In addition, a static load equivalent to that applied by the faulted condition is applied at the top of the bonnet, and the pressure is increased until the valve mechanism actuates. Successful actuation within the design requirements of the valve assures its overpressurization safety capabilities during a seismic event. 41

Using these methods, all safety-related valves in the systems will be qualified for operability during a faulted event. The methods outlined above conservatively simulate the seismic event and assure that the active valves will perform their safety-related function ~~when necessary~~. 41

~~The above testing program for valves is conservative~~. Alternate valve operability testing, such as dynamic vibration testing will be allowed if it is shown to adequately assure the faulted condition functional ability of the valve system. 41

3.9.3.2.1.3 Pump Motor and Valve Operator Qualification (NSSS Scope) - Motors for active pumps and motor operators for active valves and all vital electrical appurtenances thereto, will be seismically qualified in accordance with IEEE 344-1975. If the testing option is chosen, sine-beat testing will be justified. This justification may be provided by satisfying one or more of the following requirements to demonstrate that multi-frequency response is negligible or that the sine-beat input is of sufficient magnitude to conservatively account for this effect. 41

1. The equipment response is basically due to one mode.

2. The sine-beat response spectra envelops the floor response spectra in the region of significant response.

3. The floor response spectra consists of one dominant mode and has a peak at this frequency.

If the degree of coupling in the equipment is small, then single-axis testing is justified. Multi-axis testing will be required if there is considerable cross-coupling; however, if the degree of coupling can be determined, then single-axis testing can be used with the input sufficiently increased to include the effect of coupling on the response of the equipment.

Seismic qualification by analysis alone, or by a combination of analysis and testing, may be used when justified. The analysis program can be justified by demonstrating: (1) that equipment being qualified is amenable to analysis, and (2) that the analysis be correlated with tests or be performed using standard analysis techniques.

3.9.3.2.2 Pump Operability (BOP Scope): The operability of ASME active pumps under plant conditions, when their safety function is relied upon to safely shut down the plant or to mitigate the consequences of an accident, has been demonstrated by seismic analysis or tests to the extent of availability and capability of test equipment by any of the following programs: 41

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3.10N SEISMIC QUALIFICATION OF SEISMIC CATEGORY I INSTRUMENTATION AND ELECTRICAL EQUIPMENT

and

This section presents information to demonstrate that instrumentation and electrical equipment classified as seismic Category I is capable of performing designated safety-related functions in the event of an earthquake. The information presented includes identification of the Category I instrumentation and electrical equipment that is within the scope of the Westinghouse Nuclear Steam Supply System (NSSS), the qualification criteria employed. Included for each item of equipment; the designated safety-related functional requirements, definition of the applicable seismic environment and documentation of the qualification process employed to demonstrate the required seismic capability.

Insert →
1

3.10N.1 Seismic Qualification Criteria

3.10N.1.1 Qualification Standards. The Commission's recommendations concerning the methods to be employed for seismic qualification of electrical equipment are contained in Regulatory Guide (RG) 1.100, which endorses IEEE 344-1975. Westinghouse meets this standard, as modified by RG 1.100, by either type test, analysis, or an appropriate combination of these methods. Westinghouse meets this commitment employing the methodology described in Reference 3.10N-1.

According to RG 1.89, equipment for plants in the stage of construction permit application and having the issue date of the Safety Evaluation Report after July 1, 1974 take into account aging and environmental effects prior to seismic qualification, as specified in the Institute of Electrical and Electronics Engineers (IEEE) Standard 323-1974. Westinghouse has committed to meet IEEE 323-1974. Required seismic tests conform to the procedures specified in IEEE 344-1975 which account for multiaxis and multifrequency effects of seismic excitation and fatigue effects caused by a number of OBE events. This commitment will be satisfied by implementation of the final staff approved version of Reference 1. 41

Reference 2 presents the Westinghouse testing procedure used to qualify equipment by type testing. Seismic qualification testing of equipment to IEEE 344-1971 is documented in References 3.10N-3 through 3.10N-8. Reference 3.10N-9 presents the theory, practice, and justification for use of single axis sine beats test inputs used in seismic qualification. In addition, it is noted that Westinghouse has conducted a seismic qualification "Demonstration Test Program" Reference 3.10N-10 to confirm equipment operability during a seismic event.

For the seismic qualification of Westinghouse electrical equipment outside of the containment, the above-noted demonstration test program, in conjunction with the justification for the use of single axis sine beat tests (presented in Reference 3.10N-13) and the original tests (documents in Reference 3.10N-3 through 3.10N-8, 3.10N-13) meets the requirements of IEEE Standard 344-1975.

Thus, since the "Demonstration Test Program" was successfully completed, the equipment's operability has been demonstrated to the requirements of IEEE Standard 344-1975.

Insert 1

The environmental qualification of the equipment including qualified life is discussed in Section 3.11N. The operability of active pumps and valves is discussed in Section 3.9.3.2.1.