

RELATED CORRESPONDENCE

DOCKETED
LSNRG

'84 NO. 6 P2:48

August 9, 1984
(Revised November 5, 1984)

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of)	
)	
CAROLINA POWER & LIGHT COMPANY)	
and NORTH CAROLINA EASTERN)	Docket No. 50-400 OL
MUNICIPAL POWER AGENCY)	
)	
(Shearon Harris Nuclear Power)	
Plant))	

APPLICANTS' TESTIMONY OF
JAMES F. NEVILL, ALEXANDER G. FULLER,
DAVID R. TIMBERLAKE AND KUMAR V. HATE
IN RESPONSE TO EDDLEMAN CONTENTION 41
(PIPE HANGER WELDING)

1 Q.1 Please state your names.

2 A.1 James F. Nevill, Alexander G. Fuller, David R. Tim-
3 berlake and Kumar V. Hate.

4 Q.2 Mr. Nevill, by whom are you employed, and what is
5 your position?

6 A.2 (JFN): I am Principal Engineer-Civil, Harris Plant
7 Engineering Section, Harris Nuclear Project Department,
8 Carolina Power & Light Company.

9 Q.3 Please summarize your professional qualifications and
10 describe your involvement with pipe hangers at the Shearon
11 Harris Nuclear Power Plant.

12 A.3 (JFN): I received a Bachelor of Science degree in
13 Civil Engineering in 1971 from West Virginia Institute of Tech-
14 nology, and I am a registered Professional Engineer in the
15 State of North Carolina. I have been employed by CP&L in vari-
16 ous engineering assignments at the Shearon Harris site since
17 September, 1973. A complete statement of my professional qual-
18 ifications is appended as Attachment 1 to this testimony.
19 Since March, 1982, I have been responsible for two Civil
20 sub-units of the Harris Plant Engineering Section which perform
21 the following functions with respect to pipe hangers: resolu-
22 tion of identified field problems, design of new pipe supports
23 due to pipe/system changes, and stress analysis evaluations as-
24 sociated with field changes.

25 Q.4 Mr. Fuller, by whom are you employed and what is your
26 position?

1 A.4 (AGF): I am Principal Engineer-Mechanical (Hanger
2 Engineering), Harris Plant Construction Section of the Harris
3 Nuclear Project Department, Carolina Power & Light Company.

4 Q.5 Please summarize your professional qualifications and
5 describe your involvement with pipe hangers at SHNPP.

6 A.5 (AGF): I received a Bachelor of Science degree in
7 Civil Engineering in 1973 from North Carolina State University,
8 and I am a registered Professional Engineer in the State of
9 North Carolina. With the exception of thirteen months in
10 1974-75 and eight months in 1976-77, I have been engaged in en-
11 gineering assignments at the Shearon Harris site since May,
12 1973. A complete statement of my professional qualifications
13 is appended as Attachment 2 to this testimony. From January,
14 1981, through September, 1983, I was the lead in the Hanger En-
15 gineering group responsible for the technical support of pipe
16 hanger installation. I was also responsible for the revision
17 of procedures for hanger installation and the resolution of
18 nonconformances involving hanger installations. Since October,
19 1983, when the Hanger Engineering group was reorganized, I have
20 been responsible for technical support of hanger installation.

21 Q.6 Mr. Timberlake, by whom are you employed and what is
22 your position?

23 A.6 (DRT): I am Senior Engineer-Metallurgy/Welding in
24 the Harris Plant Construction Section of the Harris Nuclear
25 Project Department, Carolina Power & Light Company.

1 Q.7 Please summarize your professional qualifications and
2 describe your involvement with pipe hangers at SHNPP.

3 A.7 (DRT): I received a Bachelor of Science degree in
4 Engineering Operations from North Carolina State University in
5 1972. From 1972 to 1980, I worked for various firms as a
6 welding engineer, as a pipe welder, and in welding supply. I
7 am a certified welding inspector, a qualified welder, and a
8 member of the American Welding Society. I have been employed
9 by CP&L at the Shearon Harris site since August, 1980. A com-
10 plete statement of my professional qualifications is appended
11 as Attachment 3 to this testimony. I have been responsible for
12 the review of pipe hanger sketches from the standpoint of
13 welding requirements for field fabrication. I have been re-
14 sponsible for assigning welding procedures, filler metal and
15 mandatory inspection holdpoints on Seismic Weld Data Reports,
16 as well as supplying additional welding instructions as needed.
17 I have also been responsible for resolving field-related
18 welding problems, and have provided training to Quality
19 Control-Welding inspection personnel and craft personnel. Fi-
20 nally, I have been responsible for maintaining and, as needed,
21 revising the field welding procedure for pipe hangers.

22 Q.8 Mr. Hate, by whom are you employed and what is your
23 position?

24 A.8 (KVH): I am employed by Carolina Power & Light Com-
25 pany's Corporate Quality Assurance Department at the Shearon
26

1 Harris Nuclear Power Plant as Principal QA Engineer in the
2 QA/QC Harris Plant Section.

3 Q.9 Please summarize your professional qualifications and
4 describe your involvement with pipe hangers at SHNPP.

5 A.9 (KVH): I received a Bachelor of Science degree in
6 Metallurgical Engineering in 1970 from the Indian Institute of
7 Technology in Bombay, a Master of Science degree in Materials
8 Engineering in 1972 from Mississippi State University, and a
9 Master of Science degree in Management in 1984 from North
10 Carolina State University. I am a registered Professional En-
11 gineer, and have been employed by CP&L in various QA assign-
12 ments since July, 1974. A complete statement of my profession-
13 al qualifications is appended as Attachment 4 to this
14 testimony. The responsibilities of the QA/QC Harris Plant Sec-
15 tion with respect to pipe hangers include performance of the
16 following functions to assure that the hanger program is ade-
17 quate and complies with regulatory requirements: review of
18 construction specifications, procedures and documentation; weld
19 inspections; QA surveillances; and nonconformance identifica-
20 tion/resolution.

21 Q.10 What is the purpose of this testimony?

22 A.10 (AGF): The purpose of this testimony is to respond
23 to Eddleman Contention 41, which states:

24 Applicants' QA/QC program fails to assure
25 that safety-related equipment is properly
26 inspected (e.g. the "OK" tagging of defec-
tive pipe hanger welds at SHNPP).

1 In its Memorandum and Order of September 22, 1982, the Atomic
2 Safety and Licensing Board clarified the scope of this conten-
3 tion by holding that it does not cover the entire Quality As-
4 surance (QA)/Quality Control (QC) program, but rather is limit-
5 ed to the assertion "that there exist defective hanger welds
6 that have been improperly inspected and approved."

7 Q.11 How is your testimony organized?

8 A.11 (AGF): First we provide background information on
9 pipe hangers, including an overview of the processes for design
10 and fabrication, installation and inspections. Second, we de-
11 scribe the relevant deficiencies discovered in 1980 and in
12 1982, and the resultant reinspection programs and other correc-
13 tive actions undertaken. Third, we assess the safety signifi-
14 cance of these occurrences. Fourth, we describe the enhance-
15 ments to the hanger program, implemented in December 1983, and
16 demonstrate the effectiveness of that program in ensuring that
17 the quality of the final hanger product is established. Fi-
18 nally, we assess the implications of the hanger program experi-
19 ence for the quality assurance program.

20 Q.12 Mr. Nevill, what is a pipe hanger?

21 A.12 (JEN): A pipe hanger is a component or structural
22 assembly designed and installed to support or restrain a sec-
23 tion of pipe subjected to a combination of loads, and which
24 protects the pipe from stresses that could impair the pipe's
25 ability to perform its function. For purposes of the QA
26

1 program and this testimony, safety-related pipe hangers may be
2 equated with the term seismic pipe hangers.

3 Q.13 Please summarize the design process for the seismic
4 pipe hangers.

5 A.13 (JEN): The design of seismic pipe supports starts
6 with the piping designer and pipe stress analysts. For SHNPP,
7 the architect/engineer, Ebasco, is the organization responsible
8 for piping design and analysis. The piping group develops pipe
9 lay-outs to satisfy system function requirements and provides
10 design parameters for stress analyses. The piping arrangement
11 is then stress analyzed for operating loads, thermal loads,
12 seismic loads and other appropriate loadings to determine loca-
13 tion, function, and magnitude of support loads. This data is
14 utilized by the support designer to develop pipe support de-
15 signs.

16 The supports are designed to counteract the combined loads
17 and to prevent the pipe from being overstressed. For SHNPP,
18 Bergen-Paterson was the primary design and fabrication organi-
19 zation for the pipe supports.

20 Q.14 Are inspections performed at the vendor's facility?

21 A.14 (KVH): Yes. Welds received both in-process and
22 final inspection by Bergen-Paterson inspectors, and hangers
23 were presented to Ebasco inspectors for final approval prior to
24 shipment. Inspections were conducted visually by trained in-
25 spectors using the Bergen-Paterson design drawing to identify
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1 size and type of weld and hanger geometry. Prior to the iden-
2 tification in 1982 of deficiencies in vendor-supplied welds,
3 inspection was done on a sampling basis.

4 Q.15 How are the pipe hangers installed?

5 A.15 (AGF): Early in the hanger erection effort, CP&L
6 studied the hanger erection problems being reported in the in-
7 dustry and visited several other sites to gain a better under-
8 standing of current hanger erection and inspection problems.
9 It was concluded that many of the problems being encountered at
10 other sites during the completion phase could be avoided if in-
11 spection started as early as possible. A complete hanger in-
12 spection cannot be accomplished, however, until both the pipe
13 and hanger are installed in final location. This sometimes
14 does not occur until late in the overall construction schedule.
15 Site management nevertheless concluded that delaying any hanger
16 inspection until the final phase of construction would deny the
17 project an early indication of problems. It was also concluded
18 that the absence of any early preliminary inspection contrib-
19 uted to the problems being reported at other sites.

20 Based on these considerations, the initial hanger erection
21 program was set up to include an initial (Phase I) inspection
22 and a final (Phase II) inspection. Phase I inspections were
23 set up to include an intermediate check of location and an in-
24 spection of any field welding performed up to the point of in-
25 spection. Phase II inspections were to verify the total hanger
26

1 installation after both pipe and hanger had been adjusted to
2 final location and work was completed. In fact, to a great ex-
3 tent the deficiencies being discussed here were found as a re-
4 sult of the early start on inspection activities during Phase I
5 inspections. Consequently, the early inspections accomplished
6 the goal of providing site management with early warning of
7 potential hanger problems.

8 The following groups are involved in the installation of
9 seismic hangers:

- 10 - Document Control issues and controls design docu-
11 ments.
- 12 - Harris Plant Engineering Section generates and ap-
13 proves design changes required.
- 14 - Hanger Engineering (Harris Plant Construction Sec-
15 tion) provides technical support to the craft.
- 16 - Welding Engineering (Harris Plant Construction Sec-
17 tion) provides technical support to the craft and
18 hanger engineering.
- 19 - Construction Inspection (CI) inspects hangers for de-
20 sign compliance, including geometry, location, and
21 bill of materials.
- 22 - QC performs receipt inspections and inspects hanger
23 welds.

24 Installation involves the following basic phases: (1) re-
25 ceipt and processing of design documents; (2) receipt and
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1 inspection of material; (3) issuance of hanger design documents
2 and material for construction; (4) installation and inspection
3 of the hanger; and, (5) final documentation review.

4 Q.16 What is involved in the receipt and processing of
5 design documents?

6 A.16 (AGF): Hanger design drawings are received by Docu-
7 ment Control and are issued to Hanger Engineering for inclusion
8 in the hanger work package.

9 Q.17 Mr. Hate, what presently occurs during the receipt
10 and inspection of material?

11 A.17 (KVH): The hanger material for a particular design
12 is received and inspected by QC for compliance to the purchase
13 order (i.e., identification, dimensions, damage and shop
14 welds).

15 Q.18 What presently takes place in connection with the
16 issuance of the hanger work package and material for construc-
17 tion?

18 A.18 (AGF): First, an initial review group of Hanger En-
19 gineering personnel reviews the hanger drawing and develops a
20 work package consisting of:

21 (1) A Seismic Weld Data Report (SWDR) for weld joint in-
22 spection records.

23 (2) A traveler for tracking the status of installation
24 and inspection.

1 (3) Work directives for detailing special instructions if
2 required.

3 (4) The hanger design drawing.

4 (5) Field modifications as required.

5 (6) A Material Verification Sheet.

6 Second, the hanger package is then "weldmapped" by num-
7 bering the welded joint(s) on the hanger. The field joint num-
8 bers are listed on the SWDR for tracking weld acceptance. This
9 procedure was instituted in December 1983, per Work Procedure
10 139. Prior to implementation of WP-139, field welds were
11 tracked by various methods.

12 Third, the package is reviewed by Welding Engineering to
13 determine the particular welding procedure specification neces-
14 sary in accordance with project site requirements, mandatory
15 holdpoints for fitup and preheat prior to welding, and to iden-
16 tify unclear, missing, or erroneous welding instructions on the
17 drawing. Any additional instructions are placed on the SWDR.

18 Fourth, QC Welding then reviews the new SWDR for com-
19 pleteness and accuracy. Documentation for previous welding is
20 also reviewed and, if accepted, is transcribed forward to the
21 new SWDR. Welds not yet accepted on the SWDR will be
22 reinspected along with any additional new welding.

23 Finally, the package is routed to a construction crew
24 foreman who requisitions the material from the warehouse/fab
25 shop for installation.

1 Q.19 What presently is involved in the installation and
2 inspection of a hanger?

3 A.19 (AGF, DRT, KVH): The following steps are involved in
4 the installation and inspection process:

- 5 (1) The hanger members are fit-up, tack welded in place,
6 and examined by Hanger Engineering personnel prior to
7 weldout. Field Mods (modifications) are generated by
8 Hanger Engineering personnel to resolve interferences
9 or other installation problems.
- 10 (2) QC welding inspections are performed to insure fit-up
11 compliance and preheat verifications as required by
12 the SWDR.
- 13 (3) The hanger is welded out by qualified welders.
- 14 (4) Final shimming and adjustments are made to the hang-
15 er.
- 16 (5) Welding Engineering personnel examine hanger welds.
- 17 (6) Hanger Engineering personnel examine the hanger for
18 compliance to the design intent. Field Mods may be
19 generated to report the field condition to HPES
20 (Harris Plant Engineering Section).
- 21 (7) CI (Construction Inspection) inspects hanger geome-
22 try, location, and other parameters for design com-
23 pliance.
- 24 (8) QC Welding inspects hanger field welds and records
25 the weld joint acceptance on the SWDR.

1 Q.20 What is the final documentation review?

2 A.20 (AGF): Final documentation review includes verifi-
3 cation of the following: documentation has been properly com-
4 pleted and signed-off; pertinent documentation has been includ-
5 ed in the hanger package; and modifications have been correctly
6 incorporated into the final drawing.

7 Q.21 Mr. Hate, please describe in more detail the in-
8 spection process applicable to pipe hangers, including Vendor
9 QA and the site inspections performed by the CI and QC organi-
10 zations.

11 A.21 (KVH): CP&L has contracted with Ebasco for vendor
12 surveillance pertaining to shop fabrication of hangers supplied
13 by Bergen-Paterson. Ebasco Vendor QA performs surveillances,
14 inspections, and audits of the vendor's facility and work ac-
15 tivities. The actions include review of such documents as ma-
16 terial test reports, inspection records and non-destructive
17 test reports and coating records, and performance of shop in-
18 spections on work accomplished. Inspections now include, but
19 are not limited to, inspection of welds on non-standard parts
20 prior to painting. Nonconformances identified during the shop
21 inspections are documented and resolved. Vendor-caused
22 nonconformances identified by CP&L after receipt of the hanger
23 on site are investigated by Ebasco Vendor QA and reviewed with
24 Bergen-Paterson management to prevent recurrence.

1 After completion of final inspection in the vendor's shop,
2 Ebasco issues a Quality Release (QR) indicating the hanger is
3 acceptable and is ready for shipment to the field. Originally
4 when hangers were received at the site they were accepted based
5 on this QR. The hangers were also checked for identification,
6 documentation, damage, and obvious welding discrepancies prior
7 to release for installation. The quality attributes to be
8 checked during receipt inspection were increased once QC in-
9 spections started noting discrepancies with previously accepted
10 shop welds. Statistical sampling of vendor welds was initiated
11 in May 1982. Due to the high reject rate experienced from this
12 statistical sampling, 100 percent receipt inspection of vendor
13 welds was initiated during June 1982. This high reject rate
14 was due in part to the fact that vendor QA and site QC in-
15 spectors were using somewhat different weld acceptance
16 criteria. The majority of welds rejected on site were for
17 minor weld defects. Increased vendor QA inspection and stan-
18 dardization of weld acceptance criteria have resolved this
19 problem. The inspection of shop weld quality attributes has
20 been retrofit to include hangers received on site prior to
21 June, 1982.

22 Inspection of pipe hangers in the field is performed by
23 Construction Inspection (CI) and QC. The CI inspections
24 address hanger attributes other than welding.

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1 Inspection of welding performed on site is done by the QC
2 Welding group. These inspections are performed to assure:
3 compliance with the hanger drawings with respect to weld type,
4 size and length; acceptability of materials; and weld quality.
5 These inspections are performed by inspectors who are qualified
6 and certified in accordance with procedure CQA-1, and are per-
7 formed in accordance with procedure CQC-18 (procedure on weld
8 control) and NDEP605 (visual weld inspection procedure), and
9 documented on a SWDR. Acceptance and rejection of the welds
10 are noted on the SWDRs. Rejected welds must be dispositioned
11 (reworked or waived) and accepted by a QC inspector prior to
12 final acceptance of the hanger. The SWDR is included in the
13 hanger package and becomes a QA record. SWDRs are reviewed by
14 the QC welding specialist for completeness and accuracy. The
15 QC welding specialist periodically trends the weld reject rate
16 to determine if an adverse trend is developing and whether man-
17 agement attention is required. Since the implementation in
18 December 1983 of the enhanced hanger program, no adverse trends
19 have been identified; rather, as discussed later, positive re-
20 sults have been noted.

21 Q.22 Were there early indications of pipe hanger problems
22 at SHNPP?

23 A.22 (AGF): Yes. On September 3, 1980, the resident NRC
24 inspector identified several hangers with unclear and incorrect
25 weld symbols on Bergen-Paterson Seismic Class I pipe hanger
26

1 drawings. Additionally, the NRC inspector identified cases in
2 which the field applied weld was different from the drawing
3 requirements and had not been identified by QC. This discovery
4 was cited as an infraction in an inspection report dated
5 November 3, 1980. Consequently, a site investigation by CP&L
6 into selected hanger drawings and installed hangers was con-
7 ducted. The results indicated that several weaknesses existed
8 in the program for installing and inspecting seismic hangers,
9 in that a substantial number of seismic hanger drawings
10 contained erroneous, missing, or unclear welding instructions,
11 and many installed hangers were not welded to meet the design
12 requirements or quality acceptance criteria. Due to the exten-
13 sive scope of the problems identified, it was deemed necessary
14 to reinspect seismic hangers on which field welding had been
15 performed. A final report on the deficiencies and subsequent
16 reinspection program was submitted to the Staff on May 1, 1981
17 (and revised on June 11, 1981); and the NRC closed out this
18 item on September 14, 1981.

19 Q.23 What did the reinspection program consist of which
20 was initiated as a result of discovering these problems?

21 A.23 (AGF): Approximately 1800 hanger design drawings
22 which had been issued to the field were reviewed for missing,
23 unclear, and erroneous weld symbols. These hanger drawings
24 were issued to QC for reinspection. Of the 1800, approximately
25 1100 hangers were found to have some completed welds and these
26

1 were reinspected by the QC inspectors. None of the hangers had
2 yet been completed and finally accepted by QC. (The hangers
3 had been basically assembled and some welding completed, but
4 final adjustments and/or welding work remained to be done.)
5 Discrepant welds were either reworked by craft personnel or ac-
6 cepted by the design organization on the basis of an appropri-
7 ate engineering analysis.

8 Q.24 What corrective actions were undertaken with respect
9 to review of hanger drawings?

10 A.24 (AGF, DRT): Hanger Engineering and Welding Engi-
11 neering began reviewing pipe hanger design drawings for miss-
12 ing, unclear, and incorrect weld symbols prior to issuance to
13 the field. Welding Engineering personnel performed the primary
14 review for weld symbol problems. Drawings with problems were
15 reported to Ebasco/Bergen-Paterson for correction via pipe
16 hanger problem memos written by Hanger Engineering. Revised
17 design drawings were received and reviewed to ensure that welds
18 were properly dispositioned.

19 Ebasco discussed the design drawing problems with
20 Bergen-Paterson, which identified the problem to its design
21 personnel. Bergen-Paterson agreed to revise their review pro-
22 cedures to insure that design drawings show proper weld sym-
23 bols. Drawings being issued from Bergen-Paterson's three de-
24 sign offices were routed through a single office to provide
25 more consistent review by Bergen-Paterson engineering
26 personnel.

1 Q.25 Were any corrective actions undertaken in connection
2 with the welders?

3 A.25 (DRT): Yes. Weld symbol identification training
4 classes were conducted by welding and hanger engineers. The
5 classes consisted of training on AWS standard weld symbol no-
6 menclature in accordance with AWS A2.4-79 as related to
7 Bergen-Paterson pipe hangers. Craft personnel attending these
8 training classes included superintendents, general foremen,
9 foremen and welders of pipe and pipe hangers. In addition to
10 instructions on weld symbol identification, emphasis was given
11 to the importance of welding the pipe hanger exactly as the de-
12 sign drawing requires. In those instances where this is not
13 possible, due to physical limitations or drawing errors, craft
14 personnel were directed to return the hanger drawing to Hanger
15 Engineering.

16 Q.26 Were any other corrective actions initiated?

17 A.26 (KVH): Yes. QC personnel attended the weld symbol
18 identification classes Mr. Timberlake just discussed, and addi-
19 tional classes given within their organization. These classes
20 emphasized the necessity for inspections to be conducted
21 strictly in accordance with drawing details and also instructed
22 QC personnel to report incorrect design drawings to Hanger En-
23 gineering.

24 Q.27 Was there a subsequent reinspection?
25
26

1 A.27 (AGF): Yes, in 1982. Surveillances performed by
2 Harger Engineering identified hangers with documentation errors
3 and weld defects. The Receipt Inspection Program, revised to
4 encompass examination of vendor welds, discovered deficient
5 shop welds made by Bergen-Paterson. Finally, it was determined
6 that inspectors and craftsmen were using an improper technique
7 in the measurement of skewed tee welds.

8 The widespread scope of these deficiencies made it neces-
9 sary to reinspect seismic pipe hangers welded or partially
10 welded out prior to June 26, 1982. The reinspection program
11 addressed both shop and field welds, and the results for each
12 hanger were documented on that hanger's individual SWDR and
13 dispositioned on that document.

14 Q.28 What did the 1982 reinspection reveal?

15 A.28 (AGF): The reinspection found: (1) missing and un-
16 dersized shop and field welds; (2) minor shop and field weld
17 defects; and (3) inaccurate and incomplete QC weld documenta-
18 tion.

19 Q.29 Why did these deficiencies occur in view of the cor-
20 rective actions initiated after the discovery of deficiencies
21 in 1980?

22 A.29 (AGF, DRT, KVH): Undersized skewed tee welds were
23 not discovered until the first quarter of 1982, and therefore
24 were not the subject of the efforts in 1980. Further, there
25 had been no training of craft personnel, and improper training
26

1 of inspectors, on the technique for measuring the fillet weld
2 size on skewed tee joints.

3 Similarly, vendor-supplied welds were not part of the 1980
4 reinspection. While isolated cases of minor weld defects had
5 been identified previously and documented on deficiency and
6 disposition reports which were forwarded to Ebasco for
7 strengthening of the vendor QA programs, the isolated nature of
8 the defects indicated that the vendor QA program had been per-
9 forming satisfactorily.

10 Neither did the 1980 reinspection address the documenta-
11 tion problems identified in 1982 caused by minimal review of
12 weld records or the absence of a procedure for standardizing
13 the requirements for completing documentation records. Fi-
14 nally, the 1980 reinspection relied on the qualifications of QC
15 inspectors and their acceptance of welds as the final word,
16 without routine checks or surveillances on their work.

17 Q.30 What corrective actions and/or preventive measures
18 were undertaken as a result of the 1982 reinspection effort?

19 A.30 (AGF, DRT, KVH): Shop and field welds on installed
20 hangers were reinspected and deficiencies were either reworked
21 by the craft or evaluated and accepted by the design organiza-
22 tion, except for the few hangers currently on design hold.
23 Deficiencies were recorded on the SWDR and acceptance eventual-
24 ly recorded on that document by the QC inspection organization.
25 In addition, vendor welds were examined prior to releasing
26

1 material to the field for installation. Deficiencies noted
2 were also either reworked or accepted by engineering evalua-
3 tion. This program is still in progress.

4 In addition, the following measures were implemented:

5 (1) Weld acceptance criteria were revised to provide con-
6 sistent inspection criteria to be used by site and vendor QA
7 inspectors.

8 (2) Ebasco assigned four vendor QA representatives to the
9 Bergen-Paterson facility and began performing both in process
10 and 100 percent final visual weld inspections. These in-
11 spections consist of a visual inspection of shop welds prior to
12 coating of the hangers. After the hangers are coated, they un-
13 dergo a dimensional and coating inspection. (Prior to the cor-
14 rective action, Ebasco had one vendor QA representative as-
15 signed to the Bergen-Paterson facility who performed random
16 dimensional, coating and welding inspections when the hangers
17 were ready for shipment.)

18 (3) An inspection/documentation procedure specifically
19 for pipe hanger welding was developed.

20 (4) Routine audits of each QC inspector's field work were
21 implemented by QC supervisors.

22 (5) Weld documentation was reviewed to insure it was cor-
23 rect and complete.

24 (6) Additional training on weld acceptance criteria
25 (including skewed tee welds) was initiated.

26

1 Q.31 Mr. Nevill, the witnesses have been describing vari-
2 ous deficiencies discovered in connection with the welding of
3 seismic pipe hangers. Are there design considerations which
4 might provide some perspective on the significance of the
5 deficiencies?

6 A.31 (JEN): Yes. There are various input criteria used
7 in support design that induce conservatism in support func-
8 tions. I will briefly describe these conservative aspects,
9 which are considered inherent to the design process but are not
10 routinely utilized in engineering evaluations of a defective
11 condition.

12 (1) Material Properties. Actual mill test reported val-
13 ues of material stresses are typically higher than the
14 specified nominal stress properties used in design.

15 (2) Design Allowables. Design codes and regulatory agen-
16 cies dictate allowable stresses and loading combinations. Mar-
17 gin exists between the stress limits used in design when
18 comparing allowable, yield, and ultimate stresses. Design
19 loading aspects are combined in a manner to assure the gov-
20 erning design input provides worst-case analysis.

21 (3) Minimum Weld Size. The design codes require the ap-
22 plication of minimum weld sizes. Compared to actual loading
23 conditions, minimum weld size may be larger than the size re-
24 quired to resist the design stresses.

1 (4) Response Spectra Curves. The engineering application
2 of response spectra curves provides margin due to the need to
3 address complexities in the time history seismic modeling tech-
4 nique. Curves are broadened, enveloped, and amplified for
5 qualification and design of plant systems and structures, which
6 increase the range of frequencies using peak values as well as
7 increasing accelerations throughout the entire frequency range.
8 This results in analyses using conservatively higher seismic
9 inputs than will actually occur.

10 (5) Support Stiffness. Structural designs are based on
11 stress levels and deflection criteria. Since the pipe analysis
12 dictates deflection limitations, the support design deflection
13 criteria rather than stress levels typically govern the member
14 size and support configuration. Weld sizing is developed from
15 the stress levels, and therefore margin is induced.

16 Where weld problems are accepted by engineering evalua-
17 tion, various applications of design techniques are available
18 to determine functional acceptance. Examples are: comparison
19 of actual weld stresses to allowables; additional pipe analysis
20 to reduce the loading on a particular hanger; or computer mod-
21 eling in place of hand calculations.

22 Q.32 What is the significance, then, of the typical pipe
23 hanger welding deficiencies in light of these design conserva-
24 tisms?

1 A.32 (JEN): The types of weld defects reported primarily
2 involved relatively minor instances of undersize, undercut,
3 lack of fusion and porosity. Consideration of conservative as-
4 pects of the design criteria indicates the significance of the
5 typical deficiency to be minor and to have no adverse impact on
6 structural integrity.

7 Q.33 For the 1980 and 1982 reinspections, did you fre-
8 quently rely on engineering evaluations to disposition pipe
9 hanger welding nonconformances?

10 A.33 (AGE): No. The majority of the deficiencies iden-
11 tified in these reinspections were not evaluated to determine
12 if they were acceptable as is, but were repaired due to the
13 economics associated with the engineering evaluation.

14 Q.34 Have further changes been made to the pipe hanger
15 program since 1982?

16 A.34 (AGE, DRT, KVH): Yes. An enhanced hanger installa-
17 tion/inspection program was put into place in December 1983 in
18 order to provide more positive control of construction, in-
19 spection and documentation activities. The enhanced program
20 was initiated by QA and Construction management to achieve
21 these goals. The key elements of the enhanced program are as
22 follows:

23 (1) A work package group has been created to review hang-
24 er work packages prior to issuance to the field. During the
25 review the hanger sketch is weld mapped for inspection
26

1 documentation and the drawing is checked for constructability.
2 Weld mapping has provided a high level of confidence that welds
3 are inspected and accepted. (This is being retrofitted to pre-
4 viously installed hangers as well as applied to the installa-
5 tion of new hangers.) This review also insures that necessary
6 documentation and instructions for installation and inspection
7 are present in the package prior to issuance to the field.
8 Hangers are also surveyed in the field to identify attachment
9 points.

10 (2) The seismic hanger work procedure has been revised
11 and its requirements simplified. Generic engineering documents
12 are for the most part no longer used as solutions to common
13 problems. Instead, field modifications are written for each
14 hanger detailing necessary changes due to these problems. This
15 has greatly reduced the potential for misinterpretation and
16 subsequent misapplication of construction requirements.

17 (3) A field hanger engineering support unit has been
18 developed whose purpose is to support the craft during hanger
19 installation. These Hanger Engineering personnel remain in the
20 field throughout the hanger's construction and identify and re-
21 solve installation problems. These efforts produce additional
22 confidence that the design organization's intent is being met
23 during construction. Field Hanger Engineering personnel also
24 examine the hanger for design compliance and have Welding Engi-
25 neering personnel examine hanger welds (both shop and field)

26

1 prior to submitting the hanger package to CI and QC for final
2 inspection. Hanger Field Mods are generated by Hanger Engi-
3 neering personnel to resolve problems encountered. These exam-
4 inations by the Hanger and Welding Engineering personnel will
5 generate higher quality levels in the work being presented for
6 final inspection and thereby render this process more effec-
7 tive.

8 (4) In addition to CI and QC review, a Hanger Engineering
9 final review group has been formed to review seismic hanger
10 packages prior to final turnover to the permanent QA records
11 vault. Hanger package documentation is verified as being com-
12 plete and accurate.

13 Q.35 Is there any evidence that the enhanced program is
14 effective?

15 A.35 (KVH): Yes. For example, in the second quarter of
16 1984, approximately 93 percent of the quality attributes
17 presented by the craft to CI for inspection were found to be
18 acceptable. Also, approximately 93 percent of the work
19 presented by the craft to QC for weld inspection was found to
20 be acceptable. In addition, an independent check of inspector
21 performance for the period February to April, 1984, by QA sur-
22 veillance revealed a 99.82 percent acceptance rate for
23 CI-inspected attributes and a 99.37 percent acceptance rate for
24 QC Welding inspected attributes.

1 Q.36 What are the implications of the pipe hanger welding
2 experience, if any, for the effectiveness of the QA/QC programs
3 for construction of SHNPP?

4 A.36 (KVH): The fact that improvements have been made
5 over a period of time does not undermine my view that our QA/QC
6 programs have been effective in discovering and reporting
7 deficiencies. Weaknesses were looked for and identified early
8 in the hanger program, and the QA/QC programs were
9 strengthened. As with any program of procedures, the human el-
10 ement exists and mistakes will be made. One measure of program
11 effectiveness, however, is the ability to identify weaknesses
12 and correct them; and another is the prompt implementation of
13 corrective actions necessary to preclude recurrence of identi-
14 fied deficiencies. The corrective steps taken in the resolu-
15 tion of these problems represent a systematic and prudent ap-
16 proach to assure a safe and quality product. As demonstrated
17 by the audit results I discussed above, the improvements in the
18 hanger program, vendor surveillance activities, receipt in-
19 spection and installation inspections, along with increased
20 field surveillances have resulted in a program which assures
21 that desired results are and have been achieved.

JAMES F. NEVILL

Principal Engineer - Civil

Date of Birth: January 12, 1947

I. EDUCATION

- A. B.S. Degree in Civil Engineering from West Virginia Institute of Technology, 1971

II. EXPERIENCE

- A. June 1967 to September 1973

1. Newport News Shipbuilding & Dry Dock Company

- a. June 1967 to January 1968 - Junior Engineer - Drafting experience with compartment and access plans. Returned to school.
- b. May 1968 to August 1968 - Junior Designer - Drafting experience in structural and welding detail. Returned to school.
- c. January 1969 to August 1969 - Junior Designer - Drafting experience associated with structural design. Returned to school.
- d. May 1970 to August 1970 - Designer - Aiding engineers in design. Returned to school.
- e. January 1972 to September 1973 - Engineer - Supervision of construction for fabrication of two nuclear submarines.

- B. September 10, 1973 to Present

1. Carolina Power & Light Company

- a. September 10, 1973 - Employed as a Junior Engineer in the Nuclear Construction Section of the Power Plant Construction Department. Located at the Harris Site, New Hill, NC.
- b. June 8, 1974 - Promoted to Civil Engineer, Nuclear Construction Section, Power Plant Construction Department. Located at the Harris Site, New Hill, NC.
- c. September 27, 1975 - Reclassified as Engineer II, Nuclear Construction Section, Power Plant Construction Department. Located at the Harris Site, New Hill, NC.
- d. August 14, 1976 - Promoted to Engineer III in the Nuclear Construction Section of the Power Plant Construction Department. Located at the Harris Site, New Hill, NC.

- e. November 5, 1977 - Promoted to Senior Engineer in the Nuclear Construction Section of the Power Plant Construction Department. Located at the Harris Site, New Hill, NC.
- f. June 16, 1979 - Promoted to Project Engineer - Civil in the Harris Site Management Section of the Power Plant Construction Department. Located at the Harris Site, New Hill, NC.
- g. June 28, 1980 - Promoted to Principal Engineer - Civil in the Harris Site Management Section of the Power Plant Construction Department. Located at the Harris Site, New Hill, NC.
- h. July 5, 1980 - Transferred to Nuclear Power Plant Engineering Department, Harris Plant Engineering Section, as Principal Engineer-Civil. Located at the Harris Site, New Hill, NC.

III. PROFESSIONAL SOCIETIES

- A. Engineer-In-Training with State Board of Registration for Professional Engineers of West Virginia.
- B. Professional Engineer Registered in North Carolina, February 9, 1979.

Alexander G. Fuller
Principal Engineer - Mechanical

- I. Date of Birth - October 14, 1951
- II. Education
 - A. BS Degree in Civil Engineering from N. C. State University, 1973.
- III. Experience
 - A. Summer, 1970
 1. Carolina Builders
 - a. Salesman.
 - B. Summers, 1971 and 1972
 1. N. C. State Highway Commission
 - a. Engineering Assistant.
 - C* May 29, 1973, to Present
 1. Carolina Power & Light Company
 - a. May 29, 1973 - Employed as Junior Engineer in the Construction Section of the Power Plant Engineering & Construction Department. Located at the Harris site, New Hill, N. C.
 - b. September 1, 1973 - Transferred from Power Plant Engineering & Construction Department to Power Plant Construction Department, Nuclear Construction Section. Located at the Harris site, New Hill, N. C.
 - c. August 17, 1974 - Transferred from the Nuclear Construction Section to the Fossil Construction Section. Assigned to Cape Fear Plant working out of General Office.
 - d. January 18, 1975 - Promoted to Civil Engineer in the Fossil Construction Section of the Power Plant Construction Department. Assigned to Cape Fear Plant working out of General Office.
 - e. September 27, 1975 - Transferred from Fossil Construction Section to Nuclear Construction Section. Located at the Harris site, New Hill, N. C.
 - f. September 27, 1975 - Reclassified as Engineer II in the Nuclear Construction Section of the Power Plant Construction Department. Located at the Harris site, New Hill, N. C.

- g. August 16, 1976 - Transferred from Harris site to Cape Fear Plant as Engineer in the Nuclear Construction Section of the Power Plant Construction Department. Assigned to supervise contractor accomplishment of drainage modifications at the Cape Fear Plant.
- h. April 2, 1977 - Transferred from Cape Fear Plant to Harris site as Engineer in the Nuclear Construction Section of the Power Plant Construction Department. Resumed duties as civil engineer in the Resident Engineer subunit.
- i. March 25, 1978 - Promoted to Senior Engineer in the Nuclear Construction Section of the Power Plant Construction Department. Located at the Harris site, New Hill, N. C.
- j. July 1, 1978 - Transferred to the Miscellaneous Projects Unit in the Nuclear Construction Section of the Power Plant Construction Department. Assigned to supervise contractor accomplishment of the main dam. Located at the Harris site, New Hill, N. C.
- k. November 15, 1980 - Promoted to Project Engineer - Civil in the Miscellaneous Projects Unit, Nuclear Construction Section, Power Plant Construction Department. Located at the Harris site, New Hill, N. C.
- l. January 31, 1981 - Transferred to the Mechanical Engineering Subunit in the Harris Site Management Section of the Nuclear Plant Construction Department. Located at the Harris site, New Hill, N. C.
- m. June 27, 1981 - Reclassified as Project Engineer-Mechanical in the Harris Site Management Section of the Nuclear Plant Construction Department. Located at the Harris site, New Hill, N. C.
- n. October 30, 1982 - Promoted to Principal Engineer-Mechanical in the Harris Site Management Section of the Nuclear Plant Construction Department. Located at the Harris site, New Hill, N. C.
- o. September 3, 1983 - Reorganization - Group, Department, and Section renamed to Nuclear Generation Group, Harris Nuclear Project Department, Harris Plant Construction Section. Located at the Harris Plant, New Hill, N. C.

IV. Professional Societies:

- A. Professional Engineer Registered in North Carolina - July 7, 1978

David R. Timberlake
Senior Engineer

I. Date of Birth - June 26, 1950

II. Education

A. BS Degree in Engineering Operations from N. C. State University, 1972

III. Experience

A. June, 1972 to September, 1974

1. Newport News Shipbuilding

A. Welding Engineer

B. February, 1975 to November, 1977

1. National Welders, Charlotte, N. C.

a. District Manager - managed retail welding supply distributorship

C. December, 1977 to May, 1978

1. Victor Equipment Company, Denton, Texas

a. Contractor Specialist

D. May, 1978 to March, 1979

1. Brown & Root, Glen Rose, Texas

a. Pipe Welder

E. April, 1979 to February, 1980

1. Brown & Root, Roxboro, N. C.

a. Welding Engineer

F. March 3, 1980, to Present

1. Carolina Power & Light Company

a. March 3, 1980 - Employed as a Construction Specialist in the Brunswick Site Management Section of the Power Plant Construction Department. Located at the Brunswick site, Southport, N. C.

- b. August 1, 1980 - Transferred to the Harris Site Management Section of the Power Plant Construction Department. Located at the Harris Site, New Hill, N. C.
- c. November 15, 1980 - Reclassified to Engineer in the Harris Site Management Section of the Power Plant Construction Department. Located at the Harris site, New Hill, N. C.
- d. January 31, 1981 - Reorganization - Department renamed to Nuclear Plant Construction.
- e. March 5, 1983 - Promoted to Senior Engineer in the Harris Site Management Section of the Nuclear Plant Construction Department. Located at the Harris Site, New Hill, N. C.
- f. September 3, 1983 - Reorganization - Department renamed to Harris Nuclear Project - Section renamed to Harris Plant Construction.

IV. Professional Societies

- A. American Welding Society

V. Certification

- A. Certified Welding Inspector (AWS) - Certificate #82055171

Kumar V. Hate'
Principal QA Engineer

I. Date of Birth

January 30, 1947

II. Education and Training

- A. BS Degree in Metallurgical Engineering, Indian Institute of Technology, Bombay, India, 1970
- B. MS Degree in Materials Engineering, Mississippi State University, State College, Mississippi, 1972
- C. MS Degree in Management, NC State University, Raleigh, North Carolina, 1984
- D. Completed course in "Quality Assurance", Ohio State University, Columbus, Ohio, 1974

III. Experience

A. AMBAC Industries, Columbus, Mississippi

- 1. October 1971 - September 1972
 - a. Engineering Laboratory Technician
- 2. September 1972 - July 1974
 - a. Materials Engineer

B. Carolina Power & Light Company

- 1. July 1974 employed as a QA Engineer in the QA Section of the Power Plant Engineering Department. Located in the General Office, Raleigh, North Carolina.
 - a. September 1975 reclassified as a QA Engineer II in the QA Section of the Power Plant Engineering Department. Located in the General Office, Raleigh, North Carolina.
 - b. June 1976 promoted as a QA Engineer III in the QA Section of the Power Plant Engineering Department. Located in the General Office, Raleigh, North Carolina.
 - c. November 1976 transferred and reclassified as a QA Engineer in the Engineering & Construction QA Section of the Technical Services Department. Located in the General Office, Raleigh, North Carolina.
 - d. July 1977 promoted as a Senior QA Engineer in the Engineering & Construction QA Section of the Technical Services Department. Located in the General Office, Raleigh, North Carolina.

- e. June 1979 promoted as a Project QA Engineer in the Engineering & Construction QA Section of the Technical Services Department. Located in the General Office, Raleigh, North Carolina.
- f. March 1981 transferred as a Project QA Engineer in the Engineering & Construction QA/QC Section of the Corporate Quality Assurance Department. Located in the General Office, Raleigh, North Carolina.
- g. February 1982 promoted and transferred as a Principal QA/QC Engineer in the Engineering & Construction QA/QC Section of the Corporate Quality Assurance Department. Located at the Harris site, New Hill, North Carolina.
- h. February 1983 - SECTION TITLE CHANGE - Principal QA/QC Engineer in the QA Engineering Unit of the QA/QC Harris Plant Section of the Corporate Quality Assurance Department. Located at the Harris site, New Hill, North Carolina.
- i. March 1983 reclassified as a Principal QA Engineer in the QA Engineering Unit of the QA/QC Harris Plant Section of the Corporate Quality Assurance Department. Located at the Harris site, New Hill, North Carolina.

IV. Professional Societies

- A. Licensed Professional Engineer, Commonwealth of Virginia, April 1975