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I, Charles C. Stokes, am supplying this statement to Wells Eddleman concerning the adequacy of specifications and procedures for concrete placement at the Shearon Harris Nuclear Plant, Units 1 and 2. This statement is being supplied freely on my part as a concerned structural engineer who has worked in the nuclear industry for the past twelve (12) years. I have a BCE degree from Auburn University, specializing in structural and foundation design, and am a licensed professional engineer in three (3) states. I also am a member of the National Society of Professional Engineers (NSPE). This statement is supplied out of my deep concern for the lack of adequate Quality Assurance programs and the lack of good engineering practices in the nuclear industry to ensure the public safety per 10 CFR 50.

The following project documents were reviewed:

1) Ebasco Specification for Concrete, project ident. no. CAR-SH-CH-6 rev. 11
2) Concrete Placement Inspection, TP-15 rev. 11
3) Concrete Control, no. CQC-13 rev. 5
4) Sieve Analysis of Fine and Coarse Aggregate, no. QCI-13.5 rev. 1
5) Batch Plant Inspection, no. QCI-13.2 rev. 1
6) Concrete Production and Delivery, WP-4 rev. 10
7) Concrete Field Test, no. QCI-13.3 rev. 2
8) Concrete Placement, WP-5 rev. 21
9) Concrete Compressive Strength Testing, no. QCI-13.1
10) Pour package 1CBXW219001, 6 sheets
11) Pour package 1CBXW242001, 15 sheets
12) Pour package 1CBXW256004, 47 sheets
13) Pour package 1CBXW276002, 5 sheets
14) Pour package 1CBXW290001, 35 sheets
15) Pour package 1CBXW308001, 33 sheets
16) Pour package 1CBXW336003, 22 sheets
17) Pour package 1CBXW386001, 20 sheets
18) Pour package 1CBXW425001, 10 sheets

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19) Pour package 1CBXW444001, 7 sheets
20) Pour package 1CBSL216001, 22 sheets
21) Pour package 1CBSL216002, 27 sheets
inc. 1CBSL216003 waterstop and reinf. inspection forms
inc. 1CBSL216006 waterstop and reinf. inspection forms
22) Package KBSL216002, 14 sheets, concrete repairs Pour No. 1CBSL216002

Other documents reviewed which govern the acceptability of this work:

1) 10 CFR 50, Appendix B
2) NRC REG. GUIDE 1.10, Mechanical (Cadweld) Splices in Reinf. Bars of Category I Concrete Structures
3) NRC REG. GUIDE 1.15, Testing of Reinf. Bars for Category I Concrete Structures
4) NRC REG. GUIDE 1.18, Structural Acceptance Test for Concrete Primary Reactor Containments
5) NRC REG. GUIDE 1.19, Nondestructive Examination of Primary Containment Liner Welds
6) NRC REG. GUIDE 1.28, Quality Assurance Program Requirements (Design and Construction)
7) NRC REG. GUIDE 1.35, Inservice Inspection of Ungrouted Tendons in Prestressed Concrete Containment Structures
8) NRC REG. GUIDE 1.55, Concrete Placement in Category I Structures
9) NRC REG. GUIDE 1.58, Qualification of Nuclear Power Plant Inspection, Examination, and Testing Personnel
10) NRC REG. GUIDE 1.69, Concrete Radiation Shields for Nuclear Power Plants
11) NRC REG. GUIDE 1.88, Collection, Storage, and Maintenance of Nuclear Power Plant Quality Assurance Records
12) NRC REG. GUIDE 1.90, Inservice Inspection of Prestressed Concrete Containment Structures with Grouted Tendons
13) NRC REG. GUIDE 1.94, Quality Assurance Requirements for Installation, Inspection, and Testing of Structural Concrete and Structural Steel During the Construction Phase of Nuclear Power Plants
14) NRC REG. GUIDE 1.123, Quality Assurance Requirements for Control of Procurement of Items and Services for Nuclear Power Plants
15) NRC REG. GUIDE 1.132, Site Investigations for Foundations of Nuclear Power Plants
16) NRC REG. GUIDE 1.136, Material for Concrete Containments
17) NRC REG. GUIDE 1.142, Safety-Related Concrete Structures for Nuclear Power Plants (Other Than Reactor Vessels and Containments) (For Comment)
18) NRC REG. GUIDE 1.144, Auditing of Quality Assurance Programs for Nuclear Power Plants
19) NRC REG. GUIDE 1.146, Qualification of Quality Assurance Program Audit Personnel for Nuclear Power Plants

20) Code Requirements for Nuclear Safety Related Concrete Structures (ACI 349-76) and Commentary on Code Requirements for Nuclear Safety Related Concrete Structures (ACI 349-76)

1) Review of Pour package 1CBXW219001 dated 12/2/78 mix no. M72 indicates three (3) problems:

These are inadequate vibration of concrete and that slump was out of specification. On sheet 1, Concrete Placement Report, at three (3) locations on this form reference is made to "Exposed Aggregate." This could be a serious problem if not monitored and corrective action made. When combined with the out-of-specification slump information on sheet 6, Concrete Test Report, indicates that the mix may have been too stiff. The form indicates that water was added, but no corrected slump is indicated. Therefore, I must assume the mix was not corrected and was too stiff.

From rough calculations, it appears that the compressive test strength values are not in compliance with Ebasco Concrete Specification Section 13.5 on page 22.

"Each 28 day strength test result shall be the average of two cylinders from the same sample. The variation between the two cylinders shall require testing of the third (spare) cylinder to determine the average strength. If the third cylinder strength "variation" is also greater than five (5) percent from the average, the Owner shall determine the reason for such a wide variation in test results and rectify it."

"The coefficient of variation for the tests on each mix as determined in accordance with ACI 214, shall not be greater than fifteen (15) percent. A greater variation will require a review of concrete batching, mixing and transporting facilities and procedures to assure a reduction in this correlation between the coefficient of variation and the average compressive strength requirements."

No action is referenced or shown to be taken on this prob-

lem.

2) Review of Pour Package 1CBXW242001 dated 9/24/80 mix no. M97 indicates two (2) problems:

These are inadequate vibration of concrete and that the concrete was slow to set up. This information is on sheet 1, Concrete Placement Report (CPR). Reference is made to "Exposed Aggregate" and that the weather was "HOT" and that "Rate of rise 2ft/hr. - Extended cure." I was not provided the Concrete Test Report sheet for this pour and would like to review it in light of the facts raised from the CRP form. There is included a document titled Concrete Defects. This form is not filled out adequately.

Under remarks, it is stated that "blister area remained until wrecked on 10-28-80. The concrete in this area will require chipping to allow steel shek (?) rods (vibrator probes) to be cut below the neat line." This does not provide a clear description of the problem and therefore, leaves much to imagination. More information required to adequately document this defect and the resolution.

3) Review of Pour Package 1CBXW256004 dated 8/11/81 mix no. M80 indicates that incorrect vibration is a problem. On sheet 1, Concrete Placement Report (CPR), reference is made to "Exposed aggregate" and that the weather was "HOT." On sheet 2, Placement Checklist, the first time that corrective action has been noted. "Workers warned about vibration techniques; both under- and over-

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vibration. A most difficult placement." Note, the comment "a most difficult placement."

On the Concrete Test Report (CTR) form, it is shown that the slump had a large variance. Section 4.2.2 of the ACI 349 code states "when laboratory trial batches are made the air content shall be within +/-0.5 percent and the slump within +/-.75 inch of maximum permitted by the specification." The difference shown on the CTR form is 2.5 inches. This indicates a material control problem may exist. Also, under weather on the CTR form, it is shown to be "overcast." These comments indicate that voids are likely below reinforcing steel as well as between forms and reinforcing steel.

4) Review of Pour Package 1CBXW276002 dated 5/2/80 mix no. M72 indicates that adequate vibration is a problem. From sheet 1, Concrete Placement Report, it is stated that aggregate is exposed and that the "slump= 4" max.----no tolerance." On sheet 5, Concrete Test Report, in reviewing the slump, it appears that the mix was out-of-specification. A minor problem is that the weather has not been indicated on the CTR form. This should be filled out. The comments about exposed aggregate and the low slump indicate voids are likely around reinforcing and the interior of the pour.

5) Review of Pour Package 1CBXW290001 dated 7/23/82 mix no. M72 indicates that vibration problems have not been resolved and that

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the concrete strength is not to specification.

From sheet 1, Concrete Placement Report, comments are made that the weather was "HOT" and that "Exposed Aggregate" existed. On the Placement Checklist, a note exist that "one concrete worker warned several times about vibration techniques." On the Concrete Test Report, the 28 day test are below the required strength and on sheet titled Compressive Strength Evaluation for Mix #72 for Lab # 9323 the strength is shown as 4105 psi which is more that 500 psi below the required 5000 psi required strength. This is in contradiction to paragraph 1 at the bottom of this form, which states "the 28 day tests are not 500 psi or more below the required strength."

From page 21 of the Ebasco Specification for Concrete, "the strength level of the concrete shall be satisfactory if: a - No individual strength test results falls more that 500 psi below the required class strength at 28 days." On the Field Change Request/Permanent waiver form, PW-C-3769, it is stated that "the actual average 28 day cylinder strength (laboratory moist cured) for this placement was 4865 psi. See attached Concrete Test Report." This appears to be in error since on the Compressive Strength Evaluation form for pour 1CBXW290001 under lab #9323 the strength is shown as 4105 psi.

The 4105 psi value is not within Ebasco Concrete Specification Section 13.5. See review of 1) above for quote. In reviewing this concrete specification, I did not find reference to any procedure for evaluating this problem beyond Section 13.5.

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However, documentation is included in the package for what seems to be core test breaks. ACI 349 code section 4.3.5 provides guidance as to the steps taken to justify accepting this pour, but the results of the test indicate that the pour should not be accepted. The documentation indicates that three (3) samples were tested on 8/8/83 and two (2) on 8/23/83. Only 1 out of 5 met the specification requirement of 5000 psi, four (4) failed. This pour is not acceptable.

6) Review of Pour Package 1CBXW308001 dated 8/25/83 mix no. M80 indicates two (2) problems: Inadequate vibration and strength.

On the Concrete Test Report, the test strength values are shown at 28 days as 4930 psi and 4810 psi not 5000 psi required but upon evaluation per Ebasco Concrete Specification Section 13.5, the strength is found to be acceptable. Voids are still possible due to inadequate vibration.

7) Review of Pour Package 1CBXW336003 dated 9/21/83 mix no. M80 indicates vibration problems still not corrected. Mix problem from 6) above is still in question as one of the 28 day test was 4880 psi. The strength of this pour was found to be acceptable.

8) Review of Pour Package 1CBXW386001 dated 3/12/82 mix no. M81 had several documentation problems concerning the mix code and the strength required. I am concerned that the strength required for this pour is only 4000 psi when all other "CBXW" pours were 5000 psi required. Is the 4000 psi value correct? If not additional review is necessary. Other wise, why did it change?

9) Review of Pour Package 1CBXW396002 dated 4/5 or 6/82 mix no.

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M81 indicates vibration problems. The strength required is 4000 psi.

10) Review of Pour Package 1CBXW425001 dated 10/5/82 mix no. M81 has vibration problem. The strength required is 4000 psi.

11) Review of Pour Package 1CBXW4444001 dated 12/21/82 mix no. M97 indicates vibration problems on the Concrete Placement Report but on the Placement Checklist, it is stated "a smooth and satisfactory placement (if somewhat over-supervised). Form vibrators and head box arrangements worked well and produced good results." This was the only note in all packages that the vibrators worked well. This pour also had a problem with the air content being out-of-specification. This does not appear to be a serious problem as this is the only pour reviewed with a low value for air content.

12) Review of Pour Package 1CBSL216001 dated 7/14/78 mix no. M56 has three (3) problems: Inadequate vibration, damaged waterstop, and out-of-specification slump.

This package includes documentation on pours 1CBSL216004, and 1CBSL216005. On pour 1CBSL216001 Field Inspection Report for Waterstop and Waterproofing (FIRWW), it is indicated that the waterstop was damaged and required repair. Acceptance for a clearance less than 1/2 inch between asbestos board and cadweld was given but it was decided that "future clearance to be 1/2 inch min." On pour 1CBSL216004 FIRWWs, the same problems are evident. Waterstop damaged when cadwelds installed and the same reference to the 1/2 inch clearance-asbestos board to cadweld.

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On pour 1CBSL216005 FIRWWs, both waterstop damage and asbestos board to cadweld are shown.

On the Concrete Test Reports, it is shown that 29 out of 64 samples (1/2 approximately) are out-of-specification. The low values indicate the mix was dry. This could when combined with inadequate vibration cause voids. Why this was not corrected before so many truck loads were placed, needs to be answered and corrected.

13) Review of Pour Package 1CBSL216002 dated 8/17/78 mix no. M56 has the same problems as 12) above but with one difference. A large void is documented as repaired on Quality Control Field Report No. C-160. Extensive honey combing was found at one location and repaired.

This package includes documentation on pours 1CBSL216003 and 1CBSL216006. On all the FIRWWs for all pours, there is an extensive problem with damage to waterstop by cadwelding and other assorted reasons. There is also documented clearance problems.

On the Concrete Test Reports, we find the same problem as in 12) above with the slump being out-of-specification. In 49 out of 97 (1/2 approx.) samples, the slump is below the minimum allowed.

On Quality Control Field Report No. C-160 which references pour 1CBSL216002, a large void is shown in a front view to be 81" by 21" maximum. A note states "the extent of the void from (north to south) cannot be determined until chipping operations are completed."

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Based on the last two pours reviewed, all documentation for pours poured before 1CBSL216001 on 7/14/78 and after 1CBSL216002 on 8/16/78 mix no. M56, as well as all pours poured between these two, should be reviewed to see if the slump was out-of-specification, then all installed areas with out-of-specification slump values should have non-destructive test made to find more voids. All voids should be repaired.

In summary, many problems were not timely corrected. The damage to waterstop should have been stopped. Every time the waterstop was damaged and repaired, a possible leak of radiation became more probable. This problem developed for the following two reasons: the personnel did not realize the safety significance of this item in providing a leak proof barrier, and management did not take corrective action for an extensive time period.

The possibility of extensive voids because the slump was out-of-specification is also a serious safety concern for the same reasons as the waterstop. Voids offer one other serious concern, and that is structural integrity may be reduced below safe levels. This is extremely important in the case of the base slabs. Attached equipment may fail when the concrete fails. These may be: columns, walls, pipe supports, piping, pumps, motors, diesel generators etc. I should state that many small voids are likely in the wall pours which I reviewed. These for the most part will be around the reinforcing, embeded plates, embeded pipe, and penetrations. These also effect the structural

integrity. Additional review is required.

I have read the above -11- page document and it is accurate, complete and true to the best of my knowledge.

Charles C. Stokes, P.E.
Charles C. Stokes,PE.

Subscribed and sworn to before me this -12th- day of June, 1984.

Lisa R. Wenter
Notary Public in and for the County of San Luis Obispo, State of California

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the matter of CAROLINA POWER & LIGHT CO. Et al.) Docket 50-400
Shearon Harris Nuclear Power Plant, Unit 1) O.L.

CERTIFICATEOF SERVICE

I hereby certify that copies of separate responses to summary disposition on ~~132(c)(20, Joint 7, and~~ Eddleman 65; Motion to Compel Discovery of Staff on Joint I, ~~and New Contentions 65-A and B,~~

HAVE been served this 14 day of June 1984, by deposit in the US Mail, first-class postage prepaid, upon all parties whose names are listed below, except those whose names are marked with an asterisk, for whom service was accomplished by hand

---

* Judges James Kelley, Glenn Bright and James Carpenter (1 copy each)
Atomic Safety and Licensing Board
US Nuclear Regulatory Commission
Washington DC 20555

* George F. Trowbridge (attorney for Applicants)
Shaw, Pittman, Potts & Trowbridge
1800 M St. NW
Washington, DC 20036

Ruthanne G. Miller
ASLB Panel
USNRC Washington DC 20555

* Office of the Executive Legal Director
Attn Dockets 50-400/401 O.L.
USNRC
Washington DC 20555

(E Spence W. Perry
FEMA Room 840
(FCM only) 500 C St SW
Washington DC 20740

Docketing and Service Section (3x)
Attn Dockets 50-400/401 O.L.
Office of the Secretary
USNRC
Washington DC 20555

* Dan Read
CHANGE/FLP
5707 Waycross
Raleigh, NC 27606

Dr. Linda W. Little
Governor's Waste Mgt. Bd.
513 Albemarle Bldg.
325 N. Salisbury St.
Raleigh, NC 27611

* John Runkle
CCNC
307 Granville Rd
Chapel Hill Nc 27514

Bradley W. Jones
USNRC Region II
101 Marietta St.
Atlanta GA 30303

* Travis Payne
Edelstein & Payne
Box 12607
Raleigh NC 27605

Robert Gruber
Exec. Director
Public Staff
Box 991
Raleigh NC 27602

* Richard Wilson, M.D.
729 Hunter St.
Apex NC 27502

Certified by W. W. Eddleman