

U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT

REGION III

Reports No. 50-546/80-44; 50-547/80-44

Docket Nos. 50-546; 50-547

Licenses No. CPPR-170; CPPR-171

Licensee: Public Service of Indiana
Post Office Box 1980
New Washington, IN 47162

Facility Name: Marble Hill Nuclear Generating Station, Units 1 and 2

Inspection At: Marble Hill Site, Jefferson County, IN

Inspection Conducted: November 18-21, 1980, January 7-9, and 15,
February 9-13, 16-20, 23-27, and March 6-7, 1981

Inspectors: *E. R. Schweibinz* 4-15-81
E. R. Schweibinz
(November 18-21, 1980, February 9-10,
18-20, 23-27, 1981)

J. J. Harrison 4/16/81
J. J. Harrison
(November 18, 1981, through February 27, 1981)

F. C. Hawkins for 4/16/81
F. C. Hawkins
(November 18-21, 1980, January 7-9,
February 18-20, and March 6-7, 1981)

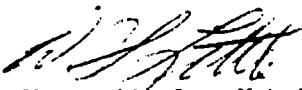
D. W. Hayes 4/16/81
D. W. Hayes
(November 19-21, 1980)

E. Gallagher for 4/16/81
E. Gallagher
(November 19-21, 1980)

R. B. Landsman 4-15-81
R. B. Landsman
(In Office Review)

K. D. Ward 4/16/81
K. D. Ward
(January 15, 1981)

8105220108


Approved By: W. S. Little, Chief
Reactor Projects Section 2C

4/16/81

Inspection Summary

Inspection during the period of November 18-21, 1980, January 7-9, and 15, February 9-13, 16-20, 23-27, and March 6-7, 1981 (Reports No. 50-546/80-44; No. 50-547/80-44)

Areas Inspected: Licensee actions on previous inspection findings; Review of Newberg-Marble Hill (N-MH) QA Manual, procedures, program implementation, and PSI audit of N-MH; Construction Verification Program (SPP-10, Checking of Category I Backfill Data); NRC concrete consultant team activities; Cadweld splice radiographs; and NRC evaluation of defective cadwelds (SPP-6 Supplement I dated January 23, 1981). This inspection involved a total of 424 inspector-hours onsite by six NRC inspectors, including 100 inspector-hours onsite during off-shifts.

Results: No items of noncompliance or deviations were identified.

DETAILS

Persons Contacted

Public Service of Indiana (PSI)

- *S. W. Shields, Senior Vice President - Nuclear Division
- *W. M. Petro, Project Director
- *L. O. Ramsett, Quality Assurance Manager
 - T. R. Burns, Project Engineering Manager
 - C. G. Beckham, Quality Engineering Manager
 - C. S. Togni, Chief Civil Engineer
- D. B. Ingmire, Construction Verification Coordinator
- *C. W. Janecke, Quality Systems Superintendent
 - D. Shuter, Quality Engineer - Civil
 - R. Latronica, Area Manager-Auxiliary Building
 - C. Anthony, Construction Engineer-Auxiliary Building
- *B. R. Morrison, Quality Engineering Superintendent-Civil
 - J. Keys, Quality Assurance Administration Assistant
 - J. Moyers, Acting Audits Supervisor
 - W. Kropp, Auditor
 - K. Tyger, Quality Engineer-Civil
- *G. T. Warner, Civil Construction Engineering Supervisor
- *N. I. Reichel, Construction Manager-Civil
 - S. Gordy, Quality Assurance Administration Supervisor

G. K. Newberg Construction Company (N-MH)

- *D. Stegemoller, Vice President-Power Construction
- *D. Maxwell, Project Quality Control Manager
 - L. M. Elliott, Deputy Project Manager
- *A. E. Archer, Project Manager
- *C. G. Barbour, Quality Assurance Manager
 - K. Morris, Document Control Supervisor
 - M. Harris, Quality Assurance Engineer
 - H. B. Gear, Staff Engineer
 - H. Wenzel, CERP Coordinator

*Denotes those attending the exit meeting on February 27, 1981.

The inspector also contacted and interviewed other licensee and contractor personnel.

Licensee Actions on Previous Inspection Findings

(Closed) Open Item (546/78-02-08; 547/78-02-08): The results of load verification tests for concrete expansion anchors were requested.

In a February 2, 1981 letter, addressing the inspection frequency of concrete expansion anchors, PSI has elected to torque test all expansion anchors for all assemblies after their installation. Because of this 100% torque testing

program, the load verification tests are not required. This is in accordance with S&L Form MH/BY/BR/CEA, Revision 10, Section 1.5.1f. This item is closed.

(Closed) Noncompliance (546/79-04-04; 547/79-04-04): Inadequate PSI document control measures for specifications.

The complete PSI document control system, including control of specifications, was reviewed and found acceptable during IE Inspection Report No. 50-546/80-38. This item is closed.

(Closed) Noncompliance (546/79-11-02; 547/79-11-02): Failure of established measures to assure that conditions adverse to quality were promptly identified and corrected.

The corrective action for this item was found to be acceptable in IE Inspection Report No. 50-546/80-24, Details Section, Paragraph 3. This item remained open pending the successful ASME implementation survey for "N" certification. The NRC Resident Inspector participated as an observer on this survey, reference IE Inspection Report No. 50-546/80-43, Details Section, Paragraph 6. PSI received its "N" Certificate from ASME via a letter dated January 13, 1981, thereby completing ASME accreditation. This item is closed.

(Closed) Open Item (546/80-36-01; 547/80-36-01): SPP-13, Attachment 6.18 specifies that the maximum chloride ion in the mixing water shall not exceed 500ppm.

The 500ppm requirement specified in SPP-13 is based on the requirements of S&L specification Y-2722. Y-2722, Section 408.1 states that, "The content of chloride ions in the mixing water shall not exceed 500ppm." Because the guidance lended by ACI 318-71 and ASME Section III, Division 2 difers from Y-2722 and because both ACI and ASME are recognized by industry, a review of mixing water physical test results was conducted. Of eight tests conducted on mixing water/ice, the maximum chloride ion content noted was 18ppm. This is well below the maximum chloride ion content of 400-500ppm suggested by ACI 318-71 and the maximum of 250ppm allowed by ASME. This item is closed.

(Closed) Open Item (546/80-36-02; 547/80-36-02): Concrete mix designs were not conducted using material proportions which yield the maximum air content and slump permitted by the specification as required by ACI 318-71, Section 4.2.2.

Also addressing concrete mix design qualifications; ACI 318-71, Section 4.2.2.1 states that when concrete production facility records exist and these records are based on at least thirty consecutive strength tests representing similar materials and conditions to those expected, the strength used as the basis for selecting proportions shall exceed the required specified compressive strength by at least those values specified in Section 4.2.2.1. CAR No. PC-0193 addresses the S&L review to verify that the compressive strengths for the Marble Hill concrete mixes are well above the values required in Section 4.2.2.1 for the established standard deviations. This item is closed.

(Closed) Open Item (546/80-36-03; 547/80-36-03): The proposed resolution of CAR No. PC-0469, relative to inadequate concrete placement curing records, was determined unacceptable.

CAR No. PC-0469 has been revised to satisfactorily address the resolution of concrete placements for which the records indicated improper curing. The proposed resolution includes provisions for the use of a rebound hammer in accordance with N-MH QCP 10.10. The hammer will be calibrated as specified by N-MH QCP 12.01. This item is closed.

(Closed) Open Item (546/80-36-04; 547/80-36-04): Documentation from the two reinforcing steel suppliers, concerning the maximum size heat each is capable of producing, was not available during the inspection. (Reference CAR No. PC-0716)

The Region III inspector reviewed letters from both reinforcing steel suppliers. Each supplier stated that they were incapable of producing reinforcing steel heats in excess of 50 tons due to the limitations of their production equipment. This item is closed.

(Closed) Open Items (546/80-36-05; 547/80-36-05): Documentation from the air-entrainment admixture supplier, as specified in CAR No. PC-0719, was not available during the inspection.

The documentation requested to provide resolution of CAR No. PC-0719 was reviewed. The data supplied by the air-entrainment admixture supplier satisfactorily addressed the identified documentation deficiencies. This item is closed.

(Closed) Open Item (546/80-39-02; 547/80-39-02): PSI to conduct an audit of the off-site testing Laboratory (UST-Hoboken).

The results of PSI audit No. 16-USTEST-08, conducted in response to this item, was reviewed by the Region III inspector. The audit, performed on December 2-3, 1980, adequately addressed the NRC concerns. This item is closed.

Functional or Program Areas Inspected

A. Newberg - Marble Hill (N-MH)

A programmatic review of Newberg-Marble Hill's Quality Assurance Program to ascertain if the program was adequate to support receiving inspection and construction activities was conducted as follows:

1. N-MH Quality Assurance Manual

The N-MH QA manual was reviewed to establish its consistency with licensee commitments to the NRC and to the PSI Quality Assurance Manual (PQAM). The N-MH QA manual, as reviewed, was found to be acceptable. This review was as follows:

<u>Section Number</u>	<u>Title</u>	<u>Revision Number</u>
	Statement of Policy and Authority	2
	Table of Contents	7
1	Organization	7
2	Quality Assurance Program	7
3	Design Control	3
4	Procurement Document Control	3
5	Instructions, Procedures	8
6	Document Control	7
7	Control of Purchased Material, Items and Services	6
8	Identification and Control of Material, Parts and Components	4
9	Control of Special Processes	4
10	Inspection	5
11	Test Control-Design, Procurement and Construction Phase	3
12	Control of Measuring and Test Equipment	5
13	Handling, Storage and Housekeeping	3
14	Inspection, Test and Operating Status	2
15	Nonconforming Materials and Items	4
16	Corrective Action	6
17	Quality Assurance Records	2
18	Audits	3

No items of noncompliance or deviations were identified.

2. Procedures

The following N-MH Quality Assurance, quality control and work procedures, and Whalen-Chilstrom work procedures were reviewed by NRC inspectors for conformance to regulatory, licensee, code and standard requirements and were found to be acceptable.

a. N-MH Quality Assurance Procedures

<u>Procedure Number</u>	<u>Procedure Title</u>	<u>Revision</u>
2.01	Training of Personnel	5
2.02	Quality Trending	2
2.03	Stop-Work Order Control	3
2.04	QA Manual Preparation and Control	1 ICN-107
4.01	QA Procurement Document Control	2
5.01	Preparation and Control of Project Procedures	3
7.01	Vendor/Subcontractor	2
9.01	Qualification and Certification of NDE Personnel	2

<u>Procedure Number</u>	<u>Procedure Title</u>	<u>Revision</u>
10.01	QC Personnel Qualifications and Certification	2
14.01	QA/QC Monthly Status Report	1
16.01	Corrective Action	2
16.02	Reporting Significant Deficiencies	3
17.01	Quality Assurance Records	4
17.02	Master QA Records File Index	0
18.01	QA Auditor Personnel Qualification and Certification	2
18.02	N-MH Quality Assurance Audits	4
18.04	Management Audits	2

b. N-MH Quality Control Procedures

<u>Procedures</u>	<u>Procedure Title</u>	<u>Revision</u>
2.01	Stop-Work Authority	1
7.01	Receiving Inspection of Materials and Equipment	2
7.02	Receiving and Storage Inspection of Concrete Materials	2
7.03	Surveillance	1 ICN-110
7.04	Reinforcing Steel Status Reporting	1
9.01	AWS Welding Inspection	2
9.02	Stud Welding Inspection	3 ICN-108
9.03	Megger Testing and Inspection	0 ICN-111
9.04	Liquid Penetrant Examination	0 ICN-113
10.02	Concrete Preplacement Inspection	2
10.03	Concrete Placement Inspection	1
10.04	Concrete Curing Inspection	1
10.05	Concrete Production Inspection	2
10.06	Post Placement and Patching Inspection	2
10.08	Structural Steel Election Inspection	0
10.10	Swiss Hammer	1
12.01	Control of Measuring and Test Equipment	2
13.01	Storage, Maintenance and Handling Inspection	2
14.01	Retain Taggin	0 ICN-112
15.01	Nonconformance Reports	2

c. N-MH Work Procedures

<u>Procedure</u>	<u>Procedure Title</u>	<u>Revision</u>
WPN 1	Blasting	9
WPN 4	Backfill	9
WPN 5	AWS Welding	6 ICN-5-6-1
WPN 5-01	General Welding Standard- Structural	0 ICN-5-01-1
WPN 5-02	General Welding Standard Defect Repair (DR)	0 ICN-5-02-1
WPN 5-03	General Welding Specification Welder Qualifications	0 ICN-5-03-1
WPN 6	Receiving, Storage and Control of Materials and Equipment	5 ICN-6-5-1
WPN 7	Receipt, Storage and Handling of Concrete Materials	9
WPN 9	Concrete Placement	14
WPN 11	Concrete Production	12
WPN 13	Installation of Embedded Items	10
WPN 20	Stud Welding	6 ICN-20-6-1
WPN 21	Hoisting	4
WPN 25	Concrete Patching	4
WPN 25-01	Unit 1 Containment Trumplate Repair Per NRC No. 325	0
WPN 25-02	SPF-5 Concrete Patch and Repair Area Evaluation	1
WPN 26	Election of Structural Steel	1
WPN 34	Production Preplacement Evaluation	4
WPN 39	Concrete Sealing	5
WPN 41	Concrete Curing	1
WPN 42	Design Document Control	4
WPN 44	Procurement	1 ICN-44-1-1
WPN 48	Work Procedure Preparation and Control	0 ICN 49-0-3
WPN 49	Design Control	1
WPN 5-04	Welding Material Control	0

d. Whalen-Chilstrom Work Procedures

WCWP-1	Cadwelding	Revision 5
WCWP-2	Reinforcing Steel Erection	Revision 4
WCWP-3	Post-Tensioning	Revision 5
WCWP-5	Field Fabrication	Revision 4

No items of noncompliance or deviations were identified.

3. Program Implementation

The following program elements were reviewed to verify sufficient controls for program implementation. These controls were found to be acceptable:

a. QA Program

Quality Assurance Manual control was verified thru review of the control log, transmittal records, verifying actual manuals in use by control number and correct revisions. These controls were adequate.

The Training Program was reviewed. Specifically, content, adequacy and attendance of training (general and specific) and indoctrination programs were confirmed. The training sessions were conducted for craft, QA/QC and other project personnel who are involved with activities affecting quality. Training was noted to have greatly improved and management backing of the programs was evident.

Quality Trending is being performed and reported monthly, this system will not be fully in-place until work resumes and data can be compiled on safety-related activities.

b. Design Control

Implementation was verified through review of the use of Request for Information (RFI) system by N-MH. Controls for the RFI system are through the (1) N-MH tracking system and (2) the required response and follow-up to PSI Field Change Requests (FCR). Affected work will not proceed until an approved FCR is received. These controls appear to be adequate.

c. Procurement Document Control

Two purchase orders were reviewed under the revised N-MH system. These were verified to be correctly processed through the requisition and placement stages. One purchase order was for services and one was for material. All review and approval requirements were met and the vendors were on the approved vendors list.

d. Instructions, Procedures and Drawings

The review of adequacy for procedures is documented in the preceding section of this report.

N-MH is generating lift drawings and construction joint drawings. These drawings are receiving review and approval as required and appear to contain sufficient data to control quality.

Instructions are being prepared for equipment storage and maintenance. These instructions contained sufficient data from the licensee and manufacturers. These were reviewed and appeared to be adequate.

e. Document Control

Controls for procedures were reviewed as follows and found to be acceptable:

Quality Assurance Procedures Manuals, 35 issued, verified controls for five (5).

Quality Control Procedures Manuals, 36 issued, verified controls for five (5).

Work Procedures Manual, 32 issued, verified controls for five (5).

The above controls were verified through review of issue lists, transmittal records and actual manual review at point of utilization. Controls were adequate.

Control of drawings and changes were verified by review of master index, master copies, issued documents at control points and transmittal records. This review was as follows:

S & L Drawings

Reviewed 29, revisions were correct.

Vendor/Supplier Drawings

Reviewed 15, revisions were correct.

Newberg Lift Drawings

Reviewed 12, revisions were correct.

Newberg Construction Drawings

Reviewed 5, revisions were correct.

Engineering Change Notices

Reviewed 7 against drawings or specifications as applicable, all were correct.

Field Change Requests

Reviewed 8 against drawings or specifications as applicable, all were correct.

Request for Information

Reviewed 2 against drawing and specifications, controls were adequate.

Specifications

Y-2722 and Y-2944, issue and revision controls were adequate.

f. Control of Purchased Material, Equipment and Services

The controls for this criterion were verified as follows:

The approved vendors list was reviewed for accuracy against vendors and suppliers who were actually qualified by audit. One vendor supplying a service, although evaluated and approved, was not on the list. This was corrected during the inspection. This area was satisfactory.

Receiving inspection controls were reviewed for adequacy. This was accomplished by a walk-thru of the system to demonstrate that controls were capable from the time of receipt through receiving inspection. The qualifications and training of personnel performing these tasks were also reviewed. This area was found to be satisfactory.

Control of subcontractors was verified through review of surveillance reports. Audits of these subcontractors were also reviewed.

g. Identification and Control of Materials, Parts, and Components

The controls in this area were verified by review of material marking and associated records. This review also included verification that a system existed to maintain such traceability from issuance through fabrication, erection and installation. These controls were acceptable.

h. Control of Special Processes

Control of special processes included review of welding and nondestructive testing as follows:

Welding - Welder qualifications were reviewed for eight (8) of thirty (30) qualified welders. This included the system for verifying that qualifications are maintained. A new system for identifying weld joint requirements (parameters), QC hold points, nondestructive testing requirements, and initiating a weld traveler was recently developed. Although these controls were in their infant stages, the fundamental system was sound. The control of filler metals was also reviewed. Future plans in this area should also improve these controls. The review proved special process controls to be adequate.

Nondestructive Testing

Currently, there are no N-MH personnel qualified to perform any nondestructive examination other than visual. N-MH is currently

seeking qualified personnel to fill Level II and III positions. Procedures for the training of personnel to perform nondestructive examinations were adequate.

i. Inspection

The hold points and surveillance activities prescribed in various procedures demonstrated adequate control to assure procedural compliance. Personnel assigned the responsibility for performing these activities are independent of those performing the activity. Inspection personnel in this area have authority to stop further processing should a condition adverse to quality occur.

The qualifications and training records for inspection personnel were verified for 26 QA/QC employees. Of the test and qualification records reviewed, deficiencies were noted for eight (8) personnel. These deficiencies were corrected during the inspection.

j. Test Control

Test controls pertaining to hydrostatic testing, blast monitoring, in process concrete testing, reinforcing steel testing, cadweld testing, and bolt torque testing were reviewed. Vendor proof tests were also reviewed for accuracy. The programs reviewed which control these activities are adequate.

k. Control of Measuring and Test Equipment

Calibration records for concrete truck sight gauges, concrete pocket thermometers, clamp-on ammeter testers, and the main batch plant water meter were reviewed. The recall system and calibration stickers were verified. Vendors supplying calibration services were on the Approved Vendors List, with the exception of the source calibrating the clamp-on ammeter. N-MH is switching to a new source with a pre-award audit scheduled for April, 1981. This item is open and will be verified by the NRC in a future inspection. (546/80-44-01; 547/80-44-01)

l. Handling, Storage, and Shipping

The controls in this area were verified by reviewing N-MH storage and maintenance instructions (34 issued) and preventative maintenance instructions (20 issued) for compliance to owner and manufacturer instructions. Inspection records and surveillance reports for these activities were also verified. These instructions and inspection records were for owner furnished and N-MH procured material/items. Controls currently being implemented are adequate.

m. Inspection, Test, and Operating Status

The control of inspection test and operating status is implemented by N-MH through the use of tags, tape, and flagging of materials and items. This review consisted of observing the implementation of the system, and examining tag logs. The use of travelers was previously noted in the "Control of Special Processes" section of this report. These controls appear to be adequate.

n. Nonconforming Materials, Parts, or Components

The controls in this area was verified by reviewing the nonconformance report log and the nonconformance report file. This included both open and closed reports. Reports requiring owner approval and those issued by subcontractors were also reviewed. The segregation of nonconforming material/items was verified by observing tagging, flagging, or taping. Quarterly trend analysis reports were reviewed with no significant results noted. These controls appear to be adequate.

o. Corrective Action

These controls were verified by reviewing the corrective action report log, corrective action reports (both open and closed), reporting of 10 CFR 21 reportable items and quarterly trending reports. Current trending reports reflected no conditions adverse to quality. These controls appear to be adequate.

p. Quality Assurance Records

The review of this area includes the QA Records Index, QA Files, storage, and file maintenance. N-MH has committed to construct a record storage vault, within 120 days, to meet the requirements of ANSI N45.2.9 and Regulatory Guide 1.88. This action will be verified in a future inspection. Other controls were adequate.

q. Audits

Internal and external audits were reviewed. The audits contained some deficiencies with regard to the use of current checklists. These deficiencies were corrected during the inspection.

A Management audit was conducted January 6-9, 1981, by Energy, Inc. This report reflected an excellent audit with sufficient depth and thoroughness to identify potential significant problems in the N-MH QA program. The audit included concerns/suggestions to help improve the N-MH QA program. Some deficiencies with this audit were (1) Energy, Inc., was not on the Approved Vendors List and (2) Correspondence forwarding the audit from the President to

the Vice President-Power Construction and from the Vice President-Power Construction to the Project QA Manager was not formalized. N-MH took positive action and corrected these items during the inspection. The response to the management audit was reviewed and found to be acceptable.

No items of noncompliance or deviations were identified in this area.

4. PSI Audit of Newberg-Marble Hill

The Inspectors reviewed the audit of N-MH performed during the period of February 3-10, 1981, as documented in PSI report number 81-Newberg-01. The N-MH response to this audit was also reviewed for corrective action and follow-up by PSI. The audit and responses were acceptable.

No items of noncompliance or deviations were identified in this area.

Conclusion:

Based on this inspection it was concluded that the Newberg-Marble Hill Quality Assurance Program as written and demonstrated can:

1. Support Receiving Inspection Activities,
2. Can further Support Construction Activities.
- B. Construction Verification Program (SPP-10): Section 9.0 Final Report

As committed to in the Description of Licensee Activities addressing Order Confirming Suspension of Construction, PSI submitted to Region III on September 12, 1980, Section 9.0 of the Construction and Material Verification Program. Section 9.0, "Checking of Category I Backfill Data" (SPP-10), is one of the twelve sections which make up the final report of the PSI Construction and Material Verification Program. The scope of the SPP-10 program was to verify the adequacy of the earthwork quality control documentation and the compliance of the backfill with design requirements.

Specific results of previous inspections relating to SPP-10 are documented in IE Reports No. 80-06 and No. 80-16. Report No. 80-16 documents the review of the implementing SPP-10 procedure.

The Region III inspector reviewed the documented corrective action requests and nonconformance reports as they pertain to the SPP-10 final report. The corrective action specified by each is to be implemented following the resumption of safety-related work activities.

1. Corrective Action Requests (CAR)

PSI generated four (4) CAR's as a result of the SPP-10 program. The CAR's address deficiencies in field testing documentation, placement inspection, and test location identification.

The Region III inspector reviewed the following CARs to determine whether each identified discrepancy was appropriately denoted, whether appropriate corrective action was specified, and whether the responsible personnel had reviewed and signed the CARs.

- a. CAR PC-0708, dated July 22, 1980
- b. CAR PC-0709, dated July 22, 1980
- c. CAR PC-0710, dated July 22, 1980
- d. CAR PC-0711, dated July 22, 1980

2. Nonconformance Reports (NCR)

PSI generated three (3) NCRs as a result of the SPP-10 program. The NCR's document the results of in-place density tests and backfill material gradations which failed to meet specification requirements.

The Region III inspector reviewed the following NCRs to determine whether each identified nonconformance was appropriately denoted, whether appropriate disposition was obtained, and whether the responsible personnel had reviewed and signed the NCR.

- a. NCR PC-0205, dated July 2, 1980
- b. NCR PC-0447, dated July 22, 1980
- c. NCR PC-0847N, dated August 4, 1980

No items of noncompliance or deviations were identified in this area.

Conclusion

Based on the review of Section 9.0 of the Construction and Material Verification Program Final Report, NCR's, CAR's, and discussions with licensee personnel, the Region III inspector has concluded that the licensee's Category I backfill verification activities are satisfactorily responsive to the commitments made to the NRC, and is acceptable pending review by NRC Region III management.

C. Concrete Consultant Team Activities

A meeting was held on March 2, 1981 in the NRC Region III office to discuss the status of the consultant's activities in regard to the Marble Hill concrete imperfection issue. Those in attendance included

A. L. Parme (consultant), R. C. Hamm (consultant), NRC regional staff members, and NRC headquarters staff members.

The consultant team reported that the majority of their concerns had been satisfactorily addressed, but that one item still remained which required resolution. Specifically, R. C. Hamm expressed that additional assurance was justified, concerning the accuracy and reliability of the non-destructive (microseismic) concrete testing technique used at Marble Hill. To provide this additional assurance, PSI was requested to either drill or core specified areas within the plant structures. The specific areas are detailed in the consultant's March 5, 1981 letter to the Region III NRC office.

In response to the request for additional investigative work, PSI committed to perform the required drilling and/or coring. The work was completed on March 6, 1981. An inspection was then conducted to confirm that the drilling and coring results were consistent with the information in Sargent & Lundy Report SL 3753, Revision 1. The inspection was conducted by both an NRC and S&L representative. The results of the inspections were satisfactory and are documented on Attachment 6.2 to Special Process Procedure No. SPP-26. A copy of the inspection results were forwarded to the consultants for their review on March 9, 1981.

No items of noncompliance or deviations were identified in this area.

D. Cadwell Splice Radiographs

A Region III inspector reviewed the radiographs of the following cadweld splices in accordance with the Test Program to Address Cadwell Splices Failing Visual Examination, Per SPP-6, PC 0602 Attachment 1, paragraphs 2.1 and 2.2. The subject cadwelds were radiographed by Cherne Contracting Corporation (CCC) in accordance with, Radiographic Technique for Cadwell Splices, Attachment 6.6.2.

TV-506	TV-213	TV-1017	BV-665
TV-654	TV-235	TV-1029	BV-670
TV-845	TV-339	TV-1052	BV-755
TV-777	TV-341	TV-1121	BV-757
TV-1131	TV-343	TV-1134	BV-759
TV-1133	TV-358	BV-62	BV-768
TV-41	TV-360	BV-63	BV-816
TV-51	TV-366	BV-133	BV-820
TV-55	TV-370	BV-236	BV-823
TV-73	TV-440	BV-350	BV-827
TV-75	TV-450	BV-356	BV-828
TV-77	TV-454	BV-377	BV-837
TV-79	TV-712	BV-485	BV-911
TV-82	TV-729	BV-488	BV-920
TV-85	TV-912	BV-539	BV-1122
TV-171	TV-959	BV-605	

E. Construction Verification Program (SPP-6 Section 6.0, Supplement I, dated January 23, 1981)

The review and acceptance of the licensee's Supplement I to SPP-6 (Mechanical Cadweld Splices) dated January 23, 1981 is documented in an April 8, 1981 memo from Sniezek to Fiorelli on the subject of "Evaluation of defective cadwelds at Marble Hill Units 1 and 2." A copy of this memo and it's 3 page enclosure is attached to this report as Enclosure 2.

Exit Meeting

The inspectors met with the staff representatives (denoted under Persons Contacted) at the conclusion of the inspection on February 27, 1981. The inspectors summarized the scope and findings of the inspection. The licensee acknowledged the findings as stated.



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

APR 8 1981

Docket No. 50-546
-547

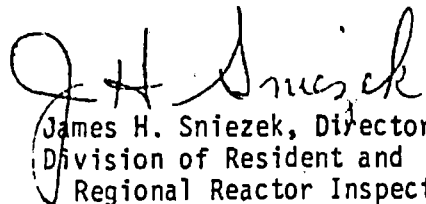
MEMORANDUM FOR: G. Fiorelli, Chief, Projects Branch No. 2, Division of Resident and Project Inspection, Region III

FROM: James H. Sniezek, Director, Division of Resident and Regional Reactor Inspection, IE

SUBJECT: EVALUATION OF DEFECTIVE CADWELDS AT MARBLE HILL UNITS 1 AND 2

As part of the "Construction Verification" program at Marble Hill Units 1 and 2, Public Service of Indiana, Inc. (PSI) has performed inspections of accessible cadweld splices. The results of the inspections showed that there were numerous cadwelds with visual deficiencies which exceeded the acceptance criteria of the Marble Hill project and the manufacturer's specifications. There have been several discussions with IE (Region III and IE:HQ) and PSI on this issue and a meeting was held on January 8, 1981 in Bethesda, Maryland. As a result of this meeting, PSI has submitted Supplement 1 to Section 6.0 of "The Construction and Material Verification Program Final Report."

We have reviewed the results of PSI's investigation and evaluation of the cadwelds at Marble Hill and agree with PSI that the affected structures will perform acceptably under postulated loads, including the affects of potentially defective cadwelds. The results of the cadweld evaluations and the bases for our recommendation for acceptance of the existing structures with replacement or repair of accessible defective cadwelds are provided in Enclosure 1.


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Enclosure: As stated

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EVALUATION OF CADWELDS
AT MARBLE HILL UNITS 1 AND 2

Public Service of Indiana, Inc. (PSI) has reinspected all accessible cadwelds, a total of 2431, of which 1927 met visual acceptance criteria and 504 (21%) were found to not meet the visual acceptance criteria. The accessible cadwelds are in Unit 2 structures. In order to evaluate the overall character of the inaccessible cadwelds in Units 1 and 2 a random selection of 59 cadwelds from the accessible population were chosen. Of these 59 cadwelds, 48 were found acceptable, 8 had gage mark deficiencies (5 passed radiography testing, 3 failed radiography), and 3 had other visual criteria deficiencies. The 3 cadwelds that failed radiography and the 3 which had visual deficiencies were tensile tested with acceptable results.

The gage mark deficiencies were further evaluated by selection of 58 additional cadwelds based on biased sampling. Since gage marks are not required to be permanent markings, these cadwelds were subjected to radiographic examination to determine if the bar ends were actually centered in the cadweld sleeve. The method of radiography and the interpretation of the results were reviewed and accepted by the Region III Office. Of the 58 cadwelds selected, 55 cadwelds passed the radiographic examination, while 3 did not pass. Tensile testing of these 3 cadwelds demonstrated that the applicable Regulatory Guide and project specification for strength were met. There was no apparent relationship between the gage marks and the actual distances off center. Of the total of 6 cadwelds not passing the radiographic testing, 3 were marginally out of alignment (bar ends less than 3/4 of an inch from the center of the tap hole) and 2 were unique cases in which the rebar had to be bent to avoid post-tensioning sheaths. In addition, all 6 of these cadwelds were No. 18 vertical Type T splices and it was observed that the No. 18 vertical Type T splices did not suffer from the additional deficiency of excessive voids. Therefore, the centering deficiency is most likely not compounded by excessive voids. Additionally, from discussions with the cadweld supplier (ERICO), the rebar suppliers at Marble Hill are considered to have provided rebar with adequate deformation patterns.

Based on the review and testing of the additional cadwelds, the acceptable tensile test results, the low incidence of true gage mark rejects (verified by radiography), the conclusion that certain of the identified rejects are a unique situation, the fact that Cadwelds were typically staggered, the evaluation that true gage mark rejects do not have void deficiencies, and the acceptability of the rebar deformation patterns, it is our opinion that the gage mark deficiencies can be accepted without significantly affecting the design margin of the structure.

From those reject cadwelds without gage mark deficiencies 21 additional cadwelds were selected for tensile testing on a worst case bases. The tensile testing results showed that these cadwelds failed at 84,445 to 109,764 psi and the lowest 15 had an average ultimate strength greater than 90,000 psi; therefore, the strength requirements were met. In addition, the 351 Category I sister and production splice test results show all those splices passed the minimum and average strength criteria. Due to previous findings of the Region III office, all type B and T cadwelds of Unit No. 1 were reinspected between August 1978 and February 1979 for excessive voids and porosity. The corrective

actions taken by the licensee were reviewed and accepted by the Regional office. Since excessive void and porosity rejects accounted for 90% of the non-gage mark rejects identified in Unit 2, the reinspection program on Unit 1 would have eliminated the potential for a large majority of similar types of rejects in Unit 1.

Even though tensile strength requirements for the cadwelds were met, there was still the question of the potential effect splices with a reduced stress-strain relationship may have on structural integrity or functionality of the structures. The ability of the structures to perform their intended function was demonstrated in stress and crack analyses performed by PSI. The containment internal structures and containment shell were analyzed assuming that the identified deficient cadwelds (non-gage mark deficiencies) were nonexistent. The calculated steel stresses were below the ACI 318-71 allowable of 54 ksi (0.9 Fy) and crack analyses of the containment internals and shell structures demonstrate the location and degree of cracking is insignificant. Evaluations by PSI of these structures for the effects of splices with a reduced stress-strain relationship on deflection of the structures indicate that (1) for the containment internal structures, for which shielding requirements not strength governs design, deflections are insignificantly affected and (2) for the containment shell, deflections are also insignificantly affected. The basemats were also evaluated by PSI to be structurally unaffected by potentially degraded cadwelds due to staggering the cadwelds and the short term nature of localized effects, if any.

These results are also confirmed in limited tests of beams performed by the University of Illinois. The tests showed that at service loads and at the ultimate load the "soft" splices have no effect on deflection. At yield loads, deflections are increased 15 to 20% for "soft" splices. Also, ultimate moment capacities are not affected. Considering the parameters of porosity, void area, Poisson's effect on the sleeve, and the degree of structural "softening", we agree with PSI that the University of Illinois test conditions were more severe than the actual condition of structures at Marble Hill.

In the letter dated January 23, 1981, PSI has committed to keep in effect the original Marble Hill specification for cadwelds. Therefore, visually rejectable cadwelds produced in the future will be removed and replaced. In addition, those existing cadwelds which were identified with non-gage mark deficiencies will be removed and replaced or repaired. An increase of 10% in the allowable void criteria was permitted due to the lack of precision in the void area determination, the acceptable tensile test results on the worst case voids, and the acceptability of the stress and crack analyses of structures.

Based on the results of the sampling program, the additional testing of worst case cadwelds, the acceptable results of production and sister splice testing, previous reinspection of Unit 1 cadwelds, consideration of the typical staggering of splices, results of previous testing at the University of Illinois, and the evaluation of stress, cracking, and deflection due to potentially defective cadwelds, we have the following findings:

1. Through reinspection of the accessible cadwelds, PSI was not able to demonstrate with 95% reliability and a 95% confidence factor that cadwelds at Marble Hill meet the original visual acceptance criteria. However, not meeting the visual acceptance criteria does not necessarily imply structural inadequacy under the design loads. Analyses, evaluations, and additional testing were performed to demonstrate that structures would still perform to design requirements (see 2 and 3 below).
2. The structural adequacy of the cadwelds and associated structures has been demonstrated by: --the-sample-testing program; the testing (radiography and tensile) of cadwelds; the acceptable results of production and sister splice testing; previous reinspection of Unit 1 cadwelds; evaluation of previous test results performed at the University of Illinois; and the evaluation of the effects due to potentially defective cadwelds on stress, cracking, and deflection.
3. The testing performed by PSI did, however, demonstrate that a 95% reliability with a 95% confidence factor that cadwelds at Marble Hill will meet the visual, radiograph, or tensile test acceptance criteria. In addition, the effect on structures of potentially "soft" splices on stresses, cracking, and deflections were shown to be insignificant by analyses and evaluation.
4. Since the adequacy of existing cadwelds and structures has been sufficiently demonstrated, additional testing is not necessary.
5. This investigation of the Marble Hill cadwelds should not be viewed as a precedent for accepting non-conforming cadwelds. It should remain the policy of the NRC to reject those cadwelds not meeting the visual acceptance criteria. The evaluation of the accessible cadwelds was done to demonstrate the adequacy of those cadwelds already embedded in concrete.