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WASHINGTON NUCLEAR PROJECT NO. 3 (WNP-3)
READINESS REVIEW PROGRAM
CONSTRUCTION ASSURANCE PROGRAM
MODULE NO. C3-02 CONCRETE

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BACKGROUND AND SUMMARY

The Readiness Review Program was initiated by the Washington Public Power Supply System (WPPSS) to assure that design, construction, and operational commitments have been properly identified and implemented at the Washington Nuclear Project No. 3 (WNP-3). The program included three elements consisting of (1) Engineering Assurance Program, (2) Construction Assurance Program, and (3) Preservation Program. The WPPSS requested participation by NRC via letter dated May 22, 1985; such participation was defined July 22, 1985. The NRC concurred in the WPPSS Construction Assurance Program on February 25, 1986 and defined intentions to inspect and review the implementation of the program and its final reports.

The Construction Assurance Program was organized by discrete modules addressing specific functional areas; this included Concrete Module C3-02. The WPPSS originally scheduled March 1986 completion of the Concrete Module C3-02 experienced delays resulting in submittal to NRC on June 1, 1987. NRC staff and consultants monitored the associated reviews in-progress and reviewed the final report with resources available commensurate with the schedule delays, and consideration that the project was indefinitely deferred and WPPSS had suspended the Readiness Review Program coincident with submittal of the Module C3-02 report.

The CAP Concrete Module CAP C3-02 Final Report presents the WPPSS assessment of compliance of the completed concrete construction with Final Safety Analysis Report (FSAR) commitments and regulatory requirements for the construction phase. The inspections and reviews by the NRC were conducted to determine if the C3-02 Final Report represents an effective and accurate assessment of the requirements and provides confirmation of their proper implementation. Results of the in-process inspections and reviews were documented in 1986 - 1987 NRC inspections reports. This report documents the NRC evaluation of the WPPSS Final Report of the Concrete Module C3-02, including consideration of the results of the NRC review of in-process CAP review efforts and the record of NRC activities conducted during the actual construction work.

The NRC evaluation was performed by reviewers from NRC Region V, NRC Office of Inspection and Enforcement (IE), and Office of Nuclear Reactor Regulation (NRR). The reviewers were assisted by NRC personnel versed in statistical analysis and consultants experienced in assessing similar readiness reviews, and qualified in concrete construction technology and field practices.

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STATEMENT OF MODULE ACCEPTABILITY (CONCLUSIONS)

The NRC evaluation concluded that the WPPSS Construction Assurance Program review of Concrete was generally comprehensive and successful in identifying relevant deficiencies in work and/or documentation for the elements encompassed by the review. It provides additional assurance that the safety-related concrete and reinforcing steel were placed in accordance with FSAR commitments and regulatory requirements and will adequately perform their intended functions, conditional upon acceptable resolution of the considerations discussed below. The evaluation also concluded that WPPSS has taken appropriate actions with regard to identified deficiencies and that the concrete construction program effectiveness has been enhanced by active management participation.

The NRC evaluation concluded that the CAP Module C3-02 review results are generally supported by the record of prior NRC inspection findings and form an adequate basis for NRC acceptance of concrete work completed to date, conditional upon:

1. Acceptable completion of deferred review segments;
2. Acceptable completion of planned engineering evaluations identified in the Module C3-02 Open Items List;
3. Acceptance of FSAR change requests yet to be submitted to NRC;
4. Completion of corrective work identified in the Module C3-02 Open Items List;
5. Adequate control of future construction activities that may affect completed work;
6. Effectiveness of the preservation program for concrete structures;
7. Acceptable assessment of the impact of future Engineering Assurance Program results on adequacy of completed construction work.

Identified deficiencies and deferred items are recorded in the C3-02 Final Report Appendix 2, Open Items List. Such items include specific matters requiring correction, general items requiring further review and/or field inspections, general items requiring engineering evaluation and decision, and FSAR change requests yet to be submitted and approved by NRC. (FSAR discrepancies identified in the C3-02 report do not appear to impact the acceptability of the concrete.) Since WPPSS construction assurance review and engineering evaluation efforts have been terminated, the C3-02 Open Items List constitutes one tracking document to assure that the as yet unresolved matters will be addressed during future construction restart.

Although NRC reviewers identified some weaknesses in the CAP review, these were addressed by WPPSS either by improving the noted areas or establishing items on the Open Items List for action during future construction restart.

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PURPOSE AND SCOPE OF REVIEW

A. Purpose of Review

The purpose of this evaluation by the NRC was to determine if the results of the program review of completed concrete work, as presented in the Concrete Module C3-02 Final Report, are an effective and accurate assessment of construction requirements and implementation.

B. Scope of Review

The NRC review effort included four elements:

1. PLANNING/MOBILIZATION REVIEW:

In-office and on-site review of WPPSS plans for conducting the reviews and periodic status review meetings with WPPSS management;

2. PROBLEM HISTORY REVIEW:

In-office and on-site review and assessment of status and implications of NRC findings from inspections conducted during concrete placement activities;

3. CAP ACTIVITIES REVIEW:

Site inspections while the WPPSS review was in progress, to examine detailed review records and original construction records, interview WPPSS review personnel, and inspect completed and partially completed concrete work;

4. FINAL REPORT REVIEW:

In-office examination of the WPPSS Concrete Module C3-02 Final Report, including evaluation of each section of the report with respect to data compiled from the above in-process reviews and inspections.

The NRC reviews were performed by personnel assigned from the NRC Office of Inspection and Enforcement (IE), Office of Nuclear Reactor Regulation (NRR), and from NRC Region V. Evaluation of sampling plans and statistical approaches included assistance from the NRC Office of Research (RES). A consultant experienced in similar readiness reviews at another nuclear facility assisted in review of the WPPSS program scope and mobilization efforts. A consultant experienced in concrete technology and NRC concrete construction appraisal inspections assisted in review of construction records, disposition of identified deficiencies, inspection of completed work, and conclusions of the WPPSS Final Report.

C. NRC Methodology

The four elements of the NRC participation in the WPPSS Readiness Review Construction Assurance Program (CAP) for Concrete Module C3-02 were conducted as follows:

1. PLANNING MOBILIZATION REVIEW:

The NRC staff, with assistance of consultants, identified important attributes of concrete construction and management, which would be appropriate for a review such as the WPPSS effort, and evaluated the planned scope of the Module C3-02 effort relative to these attributes, reaching agreement as to the adequacy of the WPPSS plan. The planning evaluation included examination of qualifications of the WPPSS review team and sampling of the early implementation activities of the WPPSS plan.

2. PROBLEM HISTORY REVIEW:

The NRC staff reviewed the records of the NRC inspection program which had been conducted during concrete construction activities at WNP-3, to ascertain the scope of such in-process monitoring activities and the resolution status of findings from such inspections. This data base was utilized by the NRC staff and consultants to assist in evaluation of the scope and conclusions of the WPPSS Module C3-02 review effort.

3. CAP ACTIVITIES REVIEW:

The NRC staff, with assistance of consultants, observed WPPSS review activities in progress. This included review of detailed checklists and working documents used during the WPPSS reviews, review of records examined by the WPPSS reviewers, review of a sample of additional records which were not part of the WPPSS sample selection, evaluation of WPPSS findings and records of WPPSS decisions regarding disposition of findings, inspection of completed concrete work that was inspected by the WPPSS reviewers, and inspection of a sample of completed work which was not part of the WPPSS inspection sample. NRC inspection supervisors participated in review activities and meetings with WPPSS management during this period to monitor the interpretation of commitments and assess the NRC review efforts. A statistician from the NRC Office of Research participated in a site inspection to assist in evaluation of the WPPSS sampling plan and its implementation.

4. FINAL REPORT REVIEW:

The NRC staff, with assistance of consultants, reviewed the Concrete Module C3-02 Final Report. This encompassed all segments of the report, but particularly emphasized the FSAR commitments and deviations identified in the report, and in-depth evaluation of Section 6.0 Program Results. The NRC Office of Nuclear Reactor Regulation assisted in review of the FSAR commitments and identified deviations.

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PLANNING/MOBILIZATION REVIEW RESULTS

NRC staff examined the personnel qualifications of the WPPSS technical review personnel early in the September 1986 planning/mobilization stage for Concrete Module C3-02, and in December 1986 during the review process; these were found acceptable. (NRC Inspection Reports 50-508/86-10 and 50-508/86-13).

The NRC staff also reviewed the qualifications of the members of the oversight committee, which was contracted by WPPSS to provide an independent assurance of adequacy of the Construction Assurance Program; the independence and qualifications of the committee were found acceptable. (NRC Inspection Report 50-508/87-04).

NRC staff and consultants compared the scope of the WPPSS review plan against a list of significant process control elements developed from research of NRC Inspection Procedures and concrete technology manuals. The inspectors noted some omissions in the WPPSS plan which were justifiable on the basis of the end product review approach planned (e.g. adequacy of some in process control elements could be clearly demonstrated by adequacy of concrete slump control, compressive strength test results, etc.). A few apparent omissions (e.g. effects of concrete core drilling and anchor bolt drilling, grout visual inspections for cracks, review of batch plant scale calibrations for periods of concrete activity) appeared to warrant inclusion in the plan; these omissions were resolved, in some cases by alternative reviews and/or deferral of the item until performance of future review modules.

The NRC reviewers found the WPPSS review scope to be generally comprehensive with regard to the significant elements identified by NRC staff. (NRC Inspection Report 50-508/86-13).

The NRC staff questioned the statistical methods described in the WPPSS review plan, especially the lack of focus on problem history indicators in establishing review samples. This was a subject of continued dialog between NRC and WPPSS over the course of the review activities. The WPPSS sampling approach was found acceptable with some increased emphasis on problem history reviews; however, the NRC staff concluded that statistical methodology, particularly sampling rationale, requires special consideration and judgement for application to each (future) Module of the Readiness Review Program. (NRC Inspection Reports 50-508/86-05, 86-12, 86-13, 87-01, 87-03, and 87-04).

The NRC staff questioned the absence of a comprehensive review of construction control procedures for each contractor, to identify potential problems which may not be determinable by examination of end-products of such processes. It was concluded that for the concrete work activities, the nature of the end products combined with 'focused' procedure reviews (prompted by identifiable records discrepancies) would be sufficient for Concrete Module C3-02. (NRC Inspection Reports 50-508/86-13, 87-01, 87-03, and 87-05).

The NRC staff examined several of the initial checklists which had been used and/or prepared to implement the Concrete Module C3-02 Review Plan, and interviewed WPPSS reviewers who were using the checklists. It was concluded that the checklists were prepared in accordance with the plan and were usable.

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PROBLEM HISTORY REVIEW RESULTS

A. Scope of Prior NRC Inspection Activities

Routine and emphasized NRC inspections were conducted during active construction at WNP-3 relative to concrete foundations and structures. NRC staff examined the quality assurance program and procedures of each major concrete work contractor, near the start of construction activities under each contract. This was followed by periodic inspections of work in progress for each contractor, and inspections of records of the work. The scope, criteria and sampling were conducted in accordance with established agency inspection procedures. Increased inspection resources were applied in this project commencing with assignment of a resident inspector in June 1980. Sampling of work activities increased in April 1981, following NRC regional office assessment of WPPSS management control weaknesses of multiple contractors.

Test laboratory activities were examined by NRC inspectors in early 1978, prior to commencement of first Quality Class I concrete activities. Allegations regarding the testing contractor were received prior to start of Quality Class I concrete work, and were investigated by NRC staff; contractor corrective actions taken early in these activities. Inspectors had similarly also examined the concrete batch plant activities prior to start of structural concrete work.

NRC inspectors applied significant additional effort to review licensee corrective actions for inspection findings, construction deficiency reports filed under 10 CFR 50.55.e, and response to IE Bulletins and Circulars. Findings from the NRC inspections were documented in the inspection reports, with discrepancies and questionable matters numbered for accountability. The NRC reinspection actions were documented in subsequent inspection reports and identified with corresponding identification numbers. Such NRC inspection actions, relating to concrete activities, are included in the inspection reports identified in the tables on the following page.

Also, commencing in 1980, NRC instituted a program of Systematic Assessment of Licensee Performance (SALP), which involved integrated retrospective consideration of inspection and licensee-report data. The SALP reports included assessment of concrete related activities, in addition to overall management and quality assurance performance. The first SALP report was documented in NUREG-0834 and encompassed the period August 1, 1979 through August 31, 1980 for WNP-3; it was part of a general nationwide assessment. Two WNP-3 site specific reports were issued to WPPSS via letters dated April 29, 1982 and October 27, 1982; these encompassed the period September 1, 1980 through July 31, 1982. The site specific reports included separate discussions of functional areas such as concrete and quality assurance.

The above referenced reports provided a substantial data base for evaluation of completed concrete work. This data base was reviewed and considered by NRC staff, with respect to the conclusions of Module C3-02.

TABULATION OF NRC INSPECTION PROGRAM PROFILE WNP-3 CONCRETE

A. General NRC Activity Profile

The following table displays the reference inspection report for each type inspection activity, for each year, encompassing the start of basemat concrete work October 1978, through the 1983 suspension of work:

NRC INSPECTION REPORT NUMBERS 50-508/Yr.-## (e.g. 50-508/78-01)

<u>YEAR</u>	<u>QA PROGRAM- PROCEDURES</u>	<u>WORK-OBSERVATION</u>	<u>RECORDS-REVIEW</u>
1978	01,04,06	02,07,09	07,08,09
1979	01,03,04	01,03	01,02,03,07
1980	04,07,12,15	01,06,07,09	01,07,09
1981	01,06,08	02,04,06,07,08,10,18,19	06,08
1982	02	09,13,15,23,17,18,26	09,17
1983	-	01	-

In addition to the above reports, various other reports document NRC efforts to resolve open items arising from prior inspections of concrete. Some of these follow-up inspections activities involved additional reviews of procedures and records, and inspection of work in progress:

<u>YEAR</u>	<u>REPORT NUMBER</u>
1979	01,03,04,05,06,07,10
1980	02
1981	06,08,12,15,19,21
1982	02,03,16,17
1983	02
1984	-
1985	07
1986	03,04,13

B. Contractor Scope Profile

The NRC inspection scope during construction included sampling of work and records of the following WPPSS contractors engaged in Quality Class I concrete activities (The scope of each inspection varied, in terms of the particular aspects of any single concrete placement):

<u>CONTRACTOR/ACTIVITY</u>	<u>WORK OBSERVATION NRC INSPECTIONS</u>	<u>RECORDS REVIEW NRC INSPECTIONS</u>
PTL - Test Laboratory	3	5
AS&G- Batch Plant	2	4
GFA - Basemat / Other	5	3 (6-placements)
B/F - Shield Building	2	2 (6-placements)
MK - Auxiliary/Fuel Building	10	4 (7-placements)
JAJ - Reactor Building	5	2 (4-placements)

B. Evaluation of Prior NRC Inspection Findings

The NRC staff considered that the sampling plans did not reflect a consideration of past problem history to the extent which may be inferred from the approved Construction Assurance Program description. This was deemed an open item pending further NRC review of problem history files and assessment of their implications. Following such review, the NRC staff concluded that the licensee consideration of past problem history appeared sufficient, in conjunction with the overall review plan, to meet the program objectives of determining adequacy of completed work.

The NRC staff compiled and reviewed the findings from NRC inspections conducted during concrete work activities. These were categorized by contractor and type of issue raised by the inspectors. The results of this review were described in NRC Inspection Reports numbered 50-508/87-03 and 50-508/87-04. This data was compared to the various WPPSS deficiency and corrective actions records at the WNP-3 site (e.g. nonconformance reports, surveillance reports, audit findings), and the problem history reviews that were documented in the Concrete Module C3-02 Final Report.

The NRC review concluded that nearly all prior NRC findings had been addressed by the licensee and closed by NRC, with some exceptions such as upgrading work procedures. Such procedure upgrade would be anticipated during restart of construction and would be dependent on the particular contractors involved at that time.

The NRC review noted that some chronic problems had been experienced by some of the contractors involved in concrete work activities, such as persistent trends regarding concrete placement and curing practices.

The WPPSS reviewers had arrived at similar conclusions. Contractor performance questions were particularly noted regarding (1) Guy F. Atkinson, who performed work on the basemat, (2) Boecon/Fegles, who performed work on the reactor building shield wall, and (3) J. A. Jones Company, who performed work on the containment internal concrete. Although the record appeared to be inconsistent with the WPPSS review team general conclusion (e.g. that the contractors had been responsive to independent scrutiny of their programs), both the WPPSS review and the NRC review concluded that the construction management oversight had been sufficiently aggressive to identify significant deficiencies to assure that they would not remain uncorrected.

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CONSTRUCTION ASSURANCE PROGRAM (CAP) ACTIVITIES REVIEW

The NRC reviewers and consultants found that the WPPSS review activities were generally conducted in accordance with the WPPSS Module C3-02 Review Plan. Issues identified by the NRC staff were discussed with WPPSS management and corrective actions accomplished. These issues were documented in NRC Inspection Reports and considered during the NRC review of the Concrete Module C3-02 Final Report, as discussed in the next section of this report. (NRC Inspection Reports 50-508/86-02, 86-03, 86-04, 86-05, 86-11, 87-01, 87-03, 87-04, and 87-05)

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RESULTS OF NPC STAFF REVIEW OF MODULE C3-02 FINAL REPORT

The NRC staff and consultant review of the Concrete Module C3-02 Final Report included detailed consideration of each Section of the report, and concluded that the report generally is an accurate description of the actual review activities and review results and was performed in accordance with commitments to NRC.

The following NRC findings address each Section of the Final Report and are based upon NRC and consultant reviews and inspections of: in process review activities, review checklists and supporting documentation, original construction records, interviews with personnel, and inspection of completed work. Consideration was also given to the WPPSS letter to NRC (dated October 27, 1987) addressing corrosion evaluation of exposed reinforcing steel. Details of the NRC activities are documented principally in NRC inspection reports 50-508/86-10, 86-13, 87-01, 87-03, 87-04, and 87-05; other documents identified in the References section of this report describe related correspondence, meetings, and review activities.

1. Section 1.0 - Introduction

a. Discussion

This section of Module C3-02 provides brief background information regarding the WNP-3 Readiness Review Program, the purpose and scope of the Construction Assurance Program (CAP), and specifically, the review of concrete construction activities; how and by whom it was implemented; and how it was reported.

Paragraph 1.1 states that: "The scope of the Readiness Review of concrete is all Quality Class 1 concrete, reinforcing, and grouting operations, materials, inspection, and testing that were completed prior to the construction delay period which began May 23, 1983. It also includes certain masonry construction, classified QC-G, that exists in seismic areas of the plant. Whenever the term "Concrete Construction" is used in the generic sense throughout this report, it is to be understood to include related grouting and masonry work."

Although reviews were performed for equipment grouting and masonry walls, the Readiness Review team was unable to determine full compliance with the requirements. These two areas are identified in the Final Report Open Items List for further investigation by WPPSS after restart of construction.

b. Findings

This section was reviewed for background information only.

2. Section 2.0 - Summary, Conclusion and Recommendations

a. Discussion

This section of Module C3-02 provides a brief summary of statistical sampling approach, two program deferred items, and the conclusion that "On the basis of these Construction Assurance Program findings, completed concrete-related construction, except as noted, is acceptable for the eventual licensing and safe operation of the plant"

b. Findings

Although the sampling approach was considered adequate for this Concrete Module, the NRC staff concluded that statistical methodology, particularly sampling rationale, requires special consideration and judgement for application to each (future) Readiness Review Module.

Various items are identified in the Open Items List of the Final Report, including FSAR changes which must yet be submitted to NRC for review, engineering evaluations which require performance and follow-up action, review elements which have been deferred for future performance in conjunction with other Readiness Review Modules, and final resolution of existing nonconformance reports. Additionally, successful control of the preservation program for concrete, and adequate control of future work to prevent impact on work completed at this time, will be necessary to assure eventual licensing.

Section 2.1 - Executive Summary

a) Discussion

This section of Module C3-02 provides a brief summary of the areas reviewed, team qualifications and results of the review team activity.

The fourth paragraph of Section 2.1 states that "No indication of poor quality in the reinforced concrete construction was discovered by the review." This does not recognize the Open Items List included as an appendix to the Final Report. For example, two areas identified by the WPPSS review team as requiring further investigation upon restart of project (or construction) activities; i.e. structural equipment grouting and concrete masonry (CMU) wall construction.

The statement "No disclosure of poor quality construction was made,.. " appears in conflict with the findings of NRC Inspection Report 50-508/86-13; i.e. an NRC inspector found cracks in the grout for containment spray pump A; further investigation indicated that the grout manufacturer did not recommend the type of grout used for the pedestal configuration. Section 2.1 of the readiness review report implies that this was only a documentation error. This difference in NRC and review team findings has been included as an open item to be resolved prior to restart.

b) Findings

Open items identified in the Concrete Module C3-02 Final Report, and/or noted in the Summary/Statement of Module Acceptability (Conclusions) must be resolved and closed.

2.2 Section 2.2 - Summary of Results

a) Discussion

This section briefly describes the six types of assessments that were performed by the Readiness Review Team:

- o Checklist review of quality records
- o Field inspection (walkdowns)
- o In-place strength Testing of hardened concrete
- o CAP Assessment of special issues
- o Evaluation of contractor performance
- o FSAR commitments

b) Findings

The NRC reviewers found that such assessments had been performed.

2.3 Section 2.3 - Conclusions

a) Discussion

This section concludes that based on "The results of the CAP review, the concrete-related construction performed to date at WNP-3 is of high quality and meets appropriate standards for safety-related construction, with the exception of grout placements and concrete block wall construction, which need further investigation."

b) Findings

In general the conclusions were found to be acceptable, pending completion of deferred items and resolution of other items on the Open Item List of the Concrete Module C3-02 Final Report.

2.4 Section 2.4 - Recommendationsa) Discussion

The readiness review team recommends that this report provide the basis for acceptance of the WNP-3 Concrete with no outstanding quality issues to be addressed after the restart of construction except grout placements and masonry wall construction. This section also briefly outlines a program to evaluate grout placements and masonry walls.

b) Findings

The NRC reviewers considered that the recommendations of this section should acknowledge the known additional constraints on acceptability.

In addition to evaluation of grout placement and masonry walls: open items previously mentioned must be resolved; future evaluation of the effectiveness of the concrete preservation program; impact of future results of the incomplete Engineering Assurance Program review of structural design acceptability.

3.0 Section 3.0 - Review Program Description

a) Discussion

This section of Module C3-02 provided a brief description of the review program for completed safety-related concrete construction at WNP-3. Applicable contractors were identified, program content was described, and related project reviews were noted. Lists and brief descriptions of applicable Construction Assurance Program (CAP) procedures and instructions were provided. Also, a review plan and a list of checklists used in the concrete review were included.

Module C3-02 did not include review of drilled-in expansion anchors and embedments, although Section 6 of the report describes a review of the procedures and controls for such work. Open Item List item "Future-006" indicates review of these items in future CAP modules.

b) Findings

The NRC reviewers found that this section appears to accurately describe the C3-02 program.

4.0 Section 4.0 - Program Management

a) Discussion

This section of Module C3-02 described the organization, internal controls, management involvement, NRC involvement, and oversight committee.

b) Findings

The NRC reviewers found that this section appears to accurately describe the program management.

5.0 Section 5.0 - Methodology

a) Discussion

This section addresses the rationale applied to sampling and the techniques used to select items for inspection for this module. It also describes the approach and extent of the problem history review conducted by the review team.

The introduction to this section indicates that it covers the philosophy applied by reviews and inspections in the Readiness Review Program and the methods used to perform them. The following NRC comments pertain to this philosophy:

1) Sampling Rationale

The sampling methodology described in Module C3-02 is geared to "binomial populations." As such, its use in the CAP should be limited to situations which meet the necessary conditions for application of binomial probability distribution theory, such as:

- ° homogeneity of items within a population
- ° random selection of items from a population
- ° ability to classify - with certainty - each item as acceptable or unacceptable.

The statistical sampling plans may conclude with 95% confidence that less than 5% of the sample population contains defects. The application of this approach should consider whether existence of up to 5% of that particular defect would be acceptable for the specific situations involved.

2) Review and Inspection Philosophy

The attributes reviewed to provide added assurance that a given construction area such as "concrete" is in conformance to regulatory requirements must be selected using "good engineering judgement." A sufficient set of these attributes may not always be effectively drawn from a random sample of contractor-generated documents. The attributes could have also included those that have already been identified as "problem areas" from previous licensee, NRC, and INPO audits and inspections and could have included experiences of both WPPSS and other utilities with plants similar to WNP-3. The NRC reviewers found that the WPPSS problem history review and incorporation into the Module C3-02 review effort were sufficient, but could have been improved.

b) Findings

The NRC reviewers found that this section appears to accurately describe the sampling plans and problem review efforts. In general, the NRC reviewers found the methodology used for concrete Module C3-02 acceptable.

However, the methodology to be used by WPPSS for future modules will be evaluated by NRC on a case by case basis.

6.0 Section 6.0 - Program Results

a. Discussion of Results of Licensee CAP Reviews of Concrete

This section of Module C3-02 presents the results of licensee CAP reviews of concrete, and required extensive review by the NRC reviewers and inspectors. The NRC review included examination of results of CAP reviews of concrete and the results of independent

NRC inspections of a selected sample of critical elements and attributes of concrete (Reference NRC Inspection Reports 50-508/86-13, /87-03, and /87-04). Comments regarding NRC review of this section of Module C3-02 relative to numbered paragraphs, and results of the independent NRC inspections are as follows:

(1) Paragraph 6.1 General Findings

This paragraph provided a brief summary of the WNP-3 review program activity for concrete. The readiness review team concluded that with the exception of equipment grouting and masonry wall construction there was no indication of poor quality of concrete or concrete related construction.

The NRC reviewers discovered an additional weakness in the program; the alkali reactivity testing did not demonstrate that there would not be an alkali reaction between the cement and the aggregate. (See IR 50-508/87-04). However, review of records indicated that low alkali cement was generally used throughout the project.

This paragraph also stated that "Water/cement ratio was controlled by a computerized batching process ensuring conformance within limits. One NRC reviewer challenged the simplicity of this conclusion, noting that compensation for moisture in aggregate and water addition to trucks at the job-site are also necessary. However, NRC inspectors verified from site records that moisture compensation and job-site water addition to mixing trucks was controlled and documented. This was acceptable.

(2) Paragraph 6.2 Construction Work Reviewed

The NRC reviewers confirmed that the readiness review team reviewed the completed portions of the following structures:

- Internal structures of the containment Building
- Shield Building
- Reactor Auxiliary Building
- Dry Cooling Tower Structure
- Diesel oil Storage Tank Structure
- Condensate and Refueling Tank Enclosure
- Reactor Auxiliary Building (RAB) Ground Water Drainage System

The review included a sample of completed concrete construction, reinforcing steel installation, embed plate location and grout installations.

(3) Paragraph 6.3 Checklist Findings

This section of the report provides a summary of results for each of the 31 checklists developed by the licensee. NRC

reviewers examined each of these and much of the supporting data for each checklist. The NRC review confirmed the review team conclusions, with some specific minor exceptions noted below:

6.3.1 Concrete Compressive Strength Tests Checklist #01

The data for the 60 sets of placement test reports were reviewed by the readiness review team. All were found to be in accordance with compressive strength requirements. The FSAR discrepancy identified in Item 16 of Table 6.5-1 of the final report should be added to the open item list.

6.3.2 Concrete Delivery Checklist #02

Data for the temperature and delivery time limitations of 60 concrete placements were reviewed by the readiness review team. All were found to be within specification limits. Temperature of a small batch of grout used to lubricate the pumpline was found to be 20°F high; this was not a significant discrepancy.

6.3.3 Concrete Durability and Strength Tests Checklist #03

Nineteen test reports were reviewed by the readiness review team and all were found to be acceptable. The review included all test for freeze/thaw durability, modules of elasticity and poisson's ratio.

6.3.4 Concrete Slump and Air Tests Checklist #04

Sixty placement test reports were reviewed for slump and air content. All tests results were within specified limits and test frequencies. Three observations noted by the review team were minor discrepancies and would have an insignificant effect on concrete quality.

6.3.5 Concrete Testing - Contractor Personnel Qualification Checklist #05

The readiness review team reviewed the qualifications of all ninety-one Pittsburgh Test Laboratories (PTL) lab and field personnel; they documented 37 observations and performed further investigation. The NRC reviewers found the WPPSS resolution of all 37 observations acceptable.

6.3.6 Testing Contractor Equipment Calibration Checklist #06

The PTL site testing laboratory equipment calibration records were reviewed to assure that equipment calibrations were performed in accordance with the specifications and site procedures. Several observations were noted; NRC reviewers found WPPSS resolutions of all observations acceptable.

6.3.7 Concrete Preplacement Inspection Checklist #07

Sixty concrete preplacement inspection records were reviewed by the readiness review team. One observation was noted by the team; it was resolved satisfactorily.

6.3.8 Post-Placement Concrete Inspection and Concrete Repairs Checklist #08

The records for 60 post-placement inspection were reviewed to assure that the post-placement activities and concrete repairs were properly documented. One observation was noted by the review team; it was resolved satisfactorily.

6.3.9 Concrete Curing Inspection Checklist #09

The curing records of 60 concrete placements were reviewed to ensure proper documentation of this activity. The review revealed a lack of any clear standards for curing documentation. Four observations were noted. Three were resolved satisfactorily and the fourth was referred to the Engineering Assurance Program for future resolution.

6.3.10 Cement In Process (User) Tests Checklist #10

The readiness review team reviewed 60 user reports by Associated Sand and Gravel Company (AS&G) responsible for stockpiling, batching and delivery of concrete and aggregates. The team found the test reports to be in accordance with specified chemical properties. These test reports were also reviewed by the WPPSS independent concrete materials consultant who also did not find any problems with the user tests. The Module C3-02 report states that "Cement conforming to low alkali requirements as stipulated in ASTM C-150 was provided for QC-1 Concrete Construction."

The inspectors reviewed the Certified Mill Test Reports (CMTR) identified by the WPPSS review team, which encompassed a test period from mid-1977 to early 1982. This review was to ascertain that only cement conforming to low-alkali specifications (less than 0.6% NAO) was provided for QC-I concrete. The inspectors found that specifications were revised in 1980 to allow cement with a higher alkali content (0.75% NAO); the change was based on testing incorporating unsubstantiated assumptions regarding the alkali content of the test specimens. However, the CMTR's showed that cement supplied to the project after the specification change, in general, had an alkaline content of less than 0.6%. (A few cases were identified where the alkaline content was slightly above 0.6%; however, the WPPSS review team sampling-based conclusions appeared generally accurate.) See Item #6.3.11, below.

6.3.11 Concrete Alkali Reactivity and Abrasion Resistance of Aggregate Checklist #11

The readiness review team reviewed all ten Six-Month Test Reports for concrete aggregate alkali reactivity and abrasion resistance. These tests were found to be in accordance with the specification and specified testing frequency. The readiness review team noted that "numerous petrographic examinations reports (ASTM C-295) for both Weyerhaeuser and Steilacoom aggregates indicated a potential reactivity problem of alkali content of cement is in excess of 0.6% ... (however) low alkali cement was used (less than 0.6% NAO)".

The NRC reviewers also reviewed all 10 Test Reports. As stated in the previous checklist item, the NRC reviewers discovered that the specification had been revised to allow higher (0.75%) alkali content without proper testing and/or documentation. The WPPSS readiness review project team were unable to determine the alkaline content of the cement used in the ASTM C-227 (Mortar Bar Test) that formed the basis for the June 1980 specification revision. This item was identified in NRC inspection report 50-508/87-04 as item 87-04-02 for additional NRC review during future construction restart.

6.3.12 Concrete Placing Contractor Personnel Qualifications Checklist #12

The readiness review team reviewed the qualifications of 69 inspectors. Eleven observations were noted by the review team; these were satisfactorily resolved.

6.3.13 Concrete Placing Contractor Equipment Calibrations Checklist #13

The readiness review team reviewed 53 calibration records; eight observations and four deficiencies were noted; these were satisfactorily resolved.

6.3.14 Rebar in Process Tests Checklist #14

Sixty in-process test reports were reviewed by the readiness review team. The sample revealed that 5 tests were below yield strength; additional samples from this heat were retested and found acceptable.

6.3.15 Cadweld In-Process Testing Checklist #15

Sixty Cadweld In-Process tensile test reports were reviewed by the readiness review team; all were found acceptable.

6.3.16 Grout Strength Tests; Equipment Foundations Checklist #16

The readiness review team reviewed sixty grout strength tests; all were found to be acceptable. One minor observation was satisfactorily resolved.

6.3.17 Contractors QC Grout Inspections Checklist #17

The readiness review team reviewed sixty grout placement inspections; three observations were noted. The team was unable to satisfactorily resolve these observations and recommended that this item be reevaluated when the project is reactivated; this was included on the Open Item List.

6.3.18 Grout Placing Contractors' Personnel Qualifications Checklist #18

The Readiness review team reviewed qualifications of forty-five concrete inspectors; all were in accordance with the applicable procedures.

6.3.19 Concrete Batch Plant Certifications Checklist #19

Seven batch plant certification records were reviewed and found to be in accordance with NRMCA requirements.

6.3.20 Cement Storage Inspections Checklist #20

The readiness review team reviewed sixty cement storage inspections records. The review included acceptance records of weather tightness of bins, lack of contamination by other material and lumps. No observations were noted.

6.3.21 Concrete Placement Walkdowns Checklist #21

The readiness review team visually inspected sixty concrete placements for surface defects. No unacceptable observations were noted.

6.3.22 Concrete Block (CMU) Testing Checklist #22

The block walls were constructed to quality class QC-G requirements; quality records for QC-G construction differ significantly from those of QC-I construction in type, number, completeness. The readiness review team reviewed test records which were available. One deficiency was noted. The review team identified this area as inconclusive and subject for future review. This matter was included in the Open Item List of the C3-02 Final Report.

6.3.23 Walkdown of Rebar Dowels Checklist #23

The readiness review team reviewed/examined ten rebar placements for size, configuration, spacing and cover. Cadweld splices, if present, were also visually examined. One observations was made on a set of dowels (one each face) which were missing.

The NRC inspectors reviewed five accessible rebar placements; three areas were the same areas inspected by the Readiness Review team; the other two were selected by the NRC inspectors. Bar size, grade of steel and spacing were inspected. In one concrete blockout location selected by the inspectors, WPPSS was unable to locate documentation (Field Change Request) authorizing the observed cut rebar dowels. This observation is discussed in detail in NRC inspection report 50-508/87-04 as open item 87-04-01. The item was subsequently appropriately included in the Open Items List of the C3-02 Final Report (item C3-02-048) for further review and resolution during project restart.

NRC inspectors also identified apparent discrepancies in rebar spacing and associated specifications for the shield building (NRC inspection report 50-508/86-13). This issue was subsequently acceptably resolved as documented in March 31, 1987 and June 15, 1987 correspondence to NRC and as summarized in NRC inspection reports 50-508/87-03 and /04.

6.3.24 Walkdown of Groundwater Drainage System Checklist #24

The RAB ground water drainage system was inspected for accessibility, flow restrictions, and physical configuration. Some silting had taken place and a WPPSS nonconformance report (NCR 15225) issued to control future action on this condition. This NCR recommends that the system be cleaned and restored to its original condition.

6.3.25 In-Place Strength Testing Hardened Concrete Checklist #25

Sixty placements were reviewed by the readiness review team's consultant Donald E. Graham; the NRC reviewers found the conclusions to be generally acceptable.

Visual Inspection

The completed concrete structures appear to be sound and of excellent quality. Minor cracking was observed.

Material

The cement, water, aggregates and admixtures met project requirements.

Rebound Tests

The results of the rebound hammer tests indicate that the strengths appear to be appropriate for the age and condition of the structures and the compressive strengths appear to be uniform throughout the structures tested.

Overall Assessment

Mr. Graham concluded that the quality was high, that the strength surpassed design requirement and that the cracking was less than other plants of this type.

6.3.26 Concrete Block (CMU) Construction in Seismic Areas Checklist #26

The readiness review team reviewed the records of 43 fill placements for proper material certificates and certificates of compliance of completed construction. Concrete block walls were classified as QC-G and some of the walls are in seismic category 1 areas and therefore should be constructed

in accordance with quality requirements of 10 CFR 50 Appendix B. This is commonly referred to as a 2 over 1 requirement. In August 1982, the NRC issued a Notice of Deviation 82-16-03. This stated that some block walls were not constructed in accordance with these requirements.

This issue remains open pending resolution of these items.

6.3.27 QA Audit Checklist #27

The readiness review team reviewed 78 QA Audits. Six observations were noted. All were satisfactorily resolved. The NRC reviewers also included the various audit reports in an integrated review of WNP-3 concrete problem history.

6.3.28 Rebar and Embed Preventive Maintenance Checklist #28

The readiness review team reviewed 12 quarterly reports. No observations were noted.

The NRC reviewers recommended that the preventive maintenance program monitor the corrosion of the exposed rebar at the face of the concrete since this is an area where corrosion is likely to occur. In an October 28, 1987, letter to the NRC, WPPSS stated that inspection of these areas at time of construction restart would be made to assess corrosion. This is an open item to be addressed by WPPSS and NRC at restart.

6.3.29 Anchor Bolts and Embedded Plates Checklist #29

The review of anchor bolts and embedded plates were deferred to a future module; these reviews were included in the Open Items List of the C3-02 Final Report. This was found to be acceptable by the NRC reviewers.

6.3.30 Concrete Batch Plant Scale Calibrations Checklist #30

The readiness review team reviewed 38 calibration records including all scales of the main and standby plant. Two observations were noted and were satisfactorily resolved.

6.3.31 Concrete Sand Graduation Checklist #31

The readiness review team reviewed 49 test reports. All test reports were in order and no observations were noted.

b) Finding

The results of the following checklist were found to be acceptable:

CAP-D-C-02-02 to 10
 CAP-D-C-02-12 to 16
 CAP-D-C-02-18 to 21
 CAP-D-C-02-25
 CAP-D-C-02-27
 CAP-D-C-02-30 to 31

The following checklists have either open items to be resolved prior to the restart of construction, or have been deferred for future modules. The issues are included in the Open Items List of the module C3-02 Final Report to assure future resolution:

CAP-D-C-02-01	Concrete Compressive Strength Tests
CAP-D-C-02-11	Cement Alkali Test Basis
CAP-D-C-02-17	Equipment Grout Evaluation
CAP-D-C-02-23	Cut Rebar Dowel Evaluation
CAP-D-C-02-24	Groundwater Drainage System Cleanout
CAP-D-C-02-22 & 26	Concrete Masonry Units
CAP-D-C-02-28	Rebar Corrosion Inspection
CAP-D-C-02-29	Anchor Bolts & Embeds

7.0 Section 7.0 - Oversight Committee

This section describes the involvement, conclusions, and recommendations of the oversight committee. It includes a copy of the committee final report.

The NRC reviewers examined qualifications of the committee, interviewed the committee and reviewed its final report. The committee appeared to have functioned as described in the program plan, and WPPSS appeared to have duly considered the committee recommendations, especially regarding attention to clarifying sampling and statistical approaches.

8.0 Appendix 1 - Review Plan and Inspection Checklists

This section includes the review plan used by the review team and the checklists used by the reviewers, in addition to the concrete consultant report.

The NRC reviewers had examined these documents during and/or prior to the performance by the review team, and conclude that those in the final report are an accurate representation of the documents utilized during the review efforts. The NRC reviewers found these documents to be of sufficient scope to accomplish the review objectives.

9.0 Appendix 2 - Open Items List

This list summarizes the items identified by the readiness review team and the status of their resolution at the time of issuance of the Module C3-02 final report. Items identified by NRC staff during the site inspection following issuance of the final report were added to the general project plant tracking system to assure future consideration. Since such items represent 'work-to-complete', they are not categorized as completed work and fall outside of the review module. Resolution of such items will be addressed in conjunction with the licensee's overall scope of work to be completed. To the extent that such items may impact the completed work addressed by the Module C3-02 Final Report, such items must be completed in an acceptable manner and constitute isolated exceptions to the overall acceptability conclusions of the final report, (e.g., NRC Inspection Report 50-508/87-04).

The NRC reviewers evaluated the technical resolution of those Open Items List items identified as closed, and the appropriateness of deferred items. The NRC reviewers found the Open Items List to be an accurate reflection of significant issues and their status at the time of issuance of the final report.

References

- January 31, 1985, Letter, D. W. Mazur (WPPSS) to J. B. Martin (NRC)
Proposes Readiness Review Program with NRC participation.
- March 20, 1985, Letter, D. W. Mazur (WPPSS) to J. B. Martin (NRC)
Discusses schedule of overall readiness program.
- April 26, 1985, Letter, A. D. Kohler (WPPSS) to J. B. Martin (NRC)
Transmit copy of Preservation of Assets, Preservation Program.
- April 29, 1985, Letter, William J. Dircks (NRC) to Edwin Sheets (NWPPC)
Discusses status and future licensing issues for WNP-3 and WNP-1.
- May 22, 1985, Letter, D. W. Mazur (WPPSS) to W. J. Dircks (NRC)
Discusses Readiness Review Program, including Preservation Program.
- May 24, 1985, Letter, A. D. Kohler (WPPSS) to J. B. Martin (NRC)
Submit Preservation of Assets Program for NRC approval.
- June 3, 1985, Letter, G. C. Sorensen (WPPSS) to J. B. Martin (NRC)
Describes Design Review (Engineering Assurance Program).
- June 7, 1985, Letter, D. F. Kirsch (NRC) to D. W. Mazur (WPPSS)
May 22, 1985 - Meeting Report for Readiness Review Program.
(NRC Inspection Reports 50-460/85-01 and 50-508/85-01)
- June 28, 1985, Letter, G. C. Sorensen (WPPSS) to J. B. Martin (NRC)
Provides requested program control document for Preservation Program.
- July 12, 1985, Letter, William J. Dircks (NRC) to D. W. Mazur (WPPSS)
Advises that NRC will participate in Readiness Review Program.
- July 16, 1985, Letter, F. D. Hahn (EFSEC) to J. B. Martin (NRC)
Recommends NRC consideration of WPPSS Readiness Review Program Proposal.
- July 22, 1985, Letter, D. F. Kirsch (NRC) to D. W. Mazur (WPPSS)
July 22, 1985 - Meeting Report for Readiness Review Program.
(NRC Inspection Report 50-508/85-04)
- August 2, 1985, Letter, D. F. Kirsch (NRC) to A. D. Kohler (WPPSS)
Comments on Preservation Program and Engineering Assurance Program.
- August 16, 1985, Letter, G. C. Sorensen (WPPSS) to J. B. Martin (NRC)
WPPSS reply to comments on Preservation and Engineering Assurance Program.
- August 20, 1985, Letter, G. C. Sorensen (WPPSS) to J. B. Martin (NRC)
Provides identification and resumes of Oversight Committee.
- September 18, 1985, Letter, D. F. Kirsch (NRC) to D. W. Mazur (WPPSS)
Accepts commitments and program description of Preservation Program.
(NRC Inspection Report 50-508/85-05)

- September 25, 1985, Letter, G. C. Sorensen (WPPSS) to J. B. Martin (NRC)
Describes Construction Assurance Program part of Readiness Review.
- October 25, 1985, Letter, J. B. Martin (NRC) to D. W. Mazur (WPPSS)
Accepts commitments and plan for Engineering Assurance Program.
- October 28, 1985, Letter, Curtis Eschels (EFSEC) to J. B. Martin (NRC)
Supports NRC participation in Readiness Review Program.
- November 6, 1985, Letter, D. F. Kirsch (NRC) to A. D. Kohler (WPPSS)
October 29, 1985 - Meeting Report for Construction Assurance Program.
(NRC Inspection Report 50-508/85-08)
- November 11, 1985, Letter, G. C. Sorensen (WPPSS) to J. B. Martin (NRC)
Describes Engineering Assurance activities, including Civil/Structural.
- November 15, 1985, Letter, G. C. Sorensen (WPPSS) to J. B. Martin (NRC)
Provides first Readiness Review Schedule - Engineering Assurance.
- November 20, 1985, Letter, D. F. Kirsch (NRC) to A. D. Kohler (WPPSS)
NRC comments on Construction Assurance Program.
- December 5, 1985, Letter, D. F. Kirsch (NRC) to D. W. Mazur (WPPSS)
Site inspection of initial Construction Assurance activities.
(NRC Inspection Report 50-508/85-10)
- December 30, 1985, Letter, D. F. Kirsch (NRC) to D. W. Mazur (WPPSS)
December 18, 1985 - Meeting Report for Construction Assurance Program.
(NRC Inspection Report 50-508/85-11)
- January 9, 1986, Letter, G. C. Sorensen (WPPSS) to J. B. Martin (NRC)
WPPSS reply to comments on Construction Assurance Program.
- January 20, 1986, Letter, G. C. Sorensen (WPPSS) to J. B. Martin (NRC)
Provides revised Readiness Review Program description.
- January 29, 1986, Letter, D. W. Mazur (WPPSS) to V. Stello (NRC)
Requests confirmation of continued NRC participation in Readiness Review.
- February 25, 1986, Letter, J. B. Martin (NRC) to D. W. Mazur (WPPSS)
Accepts commitments and plan for Construction Assurance Program.
(NRC Inspection Report 50-508/86-01)
- March 4, 1986, Letter, D. F. Kirsch (NRC) to D. W. Mazur (WPPSS)
NRC inspector review of open issues and Construction Assurance Program.
(NRC Inspection Report 50-508/86-02)
- March 31, 1986, Letter, D. F. Kirsch (NRC) to D. W. Mazur (WPPSS)
NRC inspector review of open issues relating to concrete work.
(NRC Inspection Report 50-508/86-03)

- April 14, 1986, Letter, A. E. Chaffee, (NRC) to D. W. Mazur (WPPSS)
NRC inspector review of Construction Assurance reviewers qualifications.
(NRC Inspection Report 50-508/86-04)
- April 22, 1986, Letter, G. C. Sorensen (WPPSS) to J. B. Martin (NRC)
Provides Readiness Review schedules; first Construction Assurance Schedule
- May 13, 1986, Letter, A. E. Chaffee (NRC) to D. W. Mazur (WPPSS)
NRC inspector review of Construction Assurance sampling approach.
(NRC Inspection Report 50-508/86-05)
- August 7, 1986, Letter, G. C. Sorensen (WPPSS) to J. B. Martin (NRC)
Provides Readiness Review schedules.
- October 2, 1986, Letter, A. E. Chaffee (NRC) to D. W. Mazur (WPPSS)
NRC inspector review of Construction Assurance reviewers qualifications.
(NRC Inspection Report 50-508/86-10)
- October 15, 1986, Letter, G. C. Sorensen (WPPSS) to J. B. Martin (NRC)
Provides Management Plan for Extended Construction Delay.
- November 26, 1986, Letter, A. E. Chaffee (NRC) to D. W. Mazur (WPPSS)
NRC inspector review of Construction Assurance reviewers qualifications.
(NRC Inspection Report 50-508/86-11)
- February 6, 1987, Letter, R. J. Pate (NRC) to D. W. Mazur (WPPSS)
January 7, 1987 - Meeting Report regarding Concrete Module C3-02.
(NRC Inspection Report 50-508/87-01)
- February 24, 1987, Letter, R. J. Pate (NRC) to D. W. Mazur (WPPSS)
NRC inspection of Preservation Program activities.
(NRC Inspection Report 50-508/87-02)
- February 26, 1987, Letter, R. J. Pate (NRC) to D. W. Mazur (WPPSS)
NRC inspection of Concrete Module C3-02 activities.
(NRC Inspection Report 50-508/86-13)
- June 1, 1987, Letter, D. W. Mazur (WPPSS) to J. B. Martin (NRC)
Provides Concrete Module C3-02 Final Report.
- June 2, 1987, Letter, R. J. Pate (NRC) to D. W. Mazur (WPPSS)
NRC inspection of Concrete Module C3-02 activities.
(NRC Inspection Report 50-508/87-03)
- June 23, 1987, Letter, R. J. Pate (NRC) to D. W. Mazur (WPPSS)
May 29, 1987 - Meeting Report regarding Concrete Module C3-02.
(NRC Inspection Report 50-508/87-05)
- August 26, 1987, Letter, R. J. Pate (NRC) to D. W. Mazur (WPPSS)
NRC inspection of Concrete Module C3-02 activities.
(NRC Inspection Report 50-508/87-04)

October 28, 1987, Letter, G. C. Sorensen (WPPSS) to J. B. Martin (NRC)
Provides information requested by NRC during October 14, 1987 telecon.

March 11, 1988, Letter, R. J. Pate (NRC) to D. W. Mazur (WPPSS)
NRC inspection of Preservation Program activities.

U. S. Nuclear Regulatory Commission
Region V

REINFORCED CONCRETE CRITICAL ELEMENT OUTLINE

EG&G Idaho, Inc.
(12/8/86)

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U. S. NUCLEAR REGULATORY COMMISSION
REINFORCED CONCRETE CRITICAL ELEMENT OUTLINE
(EG&G Draft CGB 12/8/86)

A. Concrete and Grout

1. Material

a. Aggregates

(1) Material selection

- (a) Petrographic analysis
- (b) Aggregate reaction
- (c) Abrasion resistance
- (d) Contamination limits
- (e) Soundness
- (f) Softness

(2) Crushing operation

- (a) Specification
- (b) Material uniformity
- (c) Gradation Control
- (d) Contamination control

(3) Receiving inspection

- (a) Specification
- (b) Test reports

(4) Stockpile management

- (a) Gradation uniformity control
- (b) Contamination control
- (c) Moisture monitoring

b. Cement

(1) Receiving inspection

- (a) Specification requirements
- (b) Mill test reports
- (c) Receiving inspection records
- (d) Independent test reports

(2) Material handling

- (a) Type identification and control
- (b) Storage Security
- (c) Contamination control
- (d) Equipment operability

c. Admixtures and Flyash

(1) Receiving inspection

- (a) Specification requirements
- (b) Vendor test reports
- (c) Vendor data and instructions
- (d) Receiving inspection records
- (e) Independent test reports

(2) Material handling

- (a) Type identification and control
- (b) Storage security
- (c) Contamination Control

d. Water

(1) Material

- (a) Specification
- (b) Test reports

(2) Material handling

- (a) Contamination control
- (b) Temperature control

2. Mix Design

a. Constituent variables

- (1) Standard deviation record and f'c
- (2) Aggregate gradation groups
- (3) Aggregate proportion(s)
- (4) Sand proportion
- (5) Cement proportion
- (6) Admixture proportion
- (7) Water proportion

b. Physical properties

- (1) Workability (slump)
- (2) Compressive strength
- (3) Freeze/thaw resistance
- (4) Air content
- (5) Elastic modulus
- (6) Rupture modulus
- (7) Mix temperature limits
- (8) Unit weight
- (9) Yield

c. Uniformity control

- (1) Tests required
- (2) Test frequency

3. Batching

a. Mix operations

- (1) Standard deviation record
- (2) Mix design utilization
- (3) Workability verification
- (4) Mix time limits
- (5) Temperature control
- (6) Water control
- (7) Scale and meter calibration
- (8) Equipment operability
- (9) Hot weather operations
- (10) Cold weather operations

4. Delivery

a. Delivery operations

- (1) Drum volume limit
- (2) Transit time limits
- (3) Slump test
- (4) Cylinder samples
- (5) Air volume test
- (6) Batch ticket review
- (7) Equipment operability

5. Placement

a. Procedure requirements

- (1) Pour slip procedure completed
- (2) Reinforcing
- (3) Embedded items
- (4) Cleanliness
- (5) Bonding provisions
- (6) Form work
- (7) Tools and equipment
- (8) Temperature and weather

b. Placement operations

- (1) Maximum depth limits observed
- (2) Maximum drop limits observed
- (3) Vibration performed
- (4) Delays avoided or documented
- (5) Visual inspection recorded

6. Curing and Form Removal

a. Curing

- (1) Minimum times observed
- (2) Moisture and temperature controlled
- (3) Curing compound approved
- (4) Curing compound properly applied
- (5) Cold weather temperature history

b. Form stripping

- (1) Visual inspection recorded
- (2) Repair needs documented

7. Testing Program

a. Cylinder samples

- (1) Cylinder frequency required
- (2) Made to procedure requirements
- (3) Tagged and recorded
- (4) Properly cured
- (5) Properly prepared (capped)
- (6) Equipment calibrated
- (7) Breaking procedure followed
- (8) Data recorded
- (9) Data analyzed

b. Core samples

- (1) Location determined
- (2) Bored properly
- (3) Properly prepared
- (4) Equipment calibrated
- (5) Breaking procedure followed
- (6) Data recorded
- (7) Data analyzed

c. Aggregate samples

- (1) Gradation test
- (2) Abrasion test
- (3) Aggregate reaction test
- (4) Contamination tests
- (5) Sulphate soundness
- (6) Other tests as appropriate

d. Miscellaneous samples

- (1) Cadweld splices
- (2) Grout shrinkage test

B. Formwork

1. Design

- (a) Special engineering
- (b) Approved standards
- (c) Approved materials
- (d) Approved hardware

2. Installation

- (a) Erection
- (b) Surface preparation
- (c) Inspection

3. Removal

- (a) Dismantling
- (b) Cleaning
- (c) Repair
- (d) Salvaged component inspection
- (e) Storage

C. Reinforcing

1. Material Receipt and Storage

- (a) Specifications
- (b) Mill test reports
- (c) Receiving inspection records
- (d) Storage cleanliness

2. Fabrication

- (a) Procedures followed
- (b) Minimum radius observed
- (c) Physical dimensions verified
- (d) Properly tagged or marked

3. Material Handling

- (a) Documentation obtained
- (b) Tagging verified
- (c) Storage segregation observed
- (d) Storage cleanliness maintained
- (e) Issue records maintained

4. Installation

- (a) Assembly inspected
- (b) Typing inspected
- (c) Splice lengths verified
- (d) Welding inspected
- (e) Cadwelds inspected
- (f) Support/spacing inspected
- (g) Cleanliness inspected

D. Concrete Specialties

1. Identification

- (a) Embed plates
- (b) Electrical strut anchorage
- (c) Penetrations
- (d) Electrical conduit
- (e) Piping
- (f) Prestress/post tension assemblies

2. Material Handling

- (a) Specifications
- (b) Receiving inspection records
- (c) Vendor data and instructions
- (d) Tagging
- (e) Storage segregation
- (f) Storage cleanliness maintained
- (g) Issue records maintained

3. Installation

- (a) Assembly inspected
- (b) Location verification map
- (c) Cleanliness inspected
- (d) Vendor and/or design requirements verified
- (e) Applicable procedures followed

4. Post placement installations

- (a) Procedures
 - (1) drilling
 - (2) reinforcement cutting
 - (3) installation
 - (4) testing
 - (5) drawing change

E. Training and Certification

1. Needs Identified

- (a) Test laboratory techniques
- (b) Receiving inspectors
- (c) Construction inspectors
- (d) Batch plant operators

2. Training Programs

- (a) Formally conducted
- (b) Written lesson plans

3. Certification

- (a) Formal test
- (b) Formal records
- (c) Identification cards
- (d) Duration times specified

4. Specific Areas

- (a) Reinforcing steel
- (b) Cadweld
- (c) Concrete placement
- (d) Batch plant operation
- (e) Concrete fresh testing
- (f) Surveying
- (g) Test laboratory operations
- (h) Test equipment calibration
- (i) Core drilling