

SAN ONOFRE UNIT 2

DOCKET 50-361 AND 50-362

CEN-176(S)-NP
REVISION 00

CPC/CEAC SYSTEM
PHASE I SOFTWARE VERIFICATION
TEST REPORT

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ABSTRACT

Phase I Design Qualification Testing is performed on the DNBR/LPD Calculator System to verify that the CPC and CEAC software modifications have been properly implemented

This report presents the Phase I Test results for the Southern California Edison Company SONGS 2 plant CPC/CEAC Revision 00 software.

The Phase I Testing was performed according to previously issued procedures (Reference 2). The test results indicate that the CPC and CEAC software modifications have been properly implemented.

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1.0 INTRODUCTION AND SUMMARY

This document summarizes the results of the Phase I Design Qualification Testing of the changes to the CPC and CEAC software for SONGS 2 Cycle 1. The programs affected by these changes, which are described in Reference 1, were required to undergo Phase I Testing in accordance with Reference 2. The changes reflect the implementation of Software Change Requests 195 through 240. These changes were made in accordance with Reference 2.

The tests reported herein were conducted on the CPC/CEAC design. A discussion of the test configuration, test methodology, and test results are presented in this document.

1.1 OBJECTIVE OF PHASE I TESTING

The objective of Phase I Design Qualification Testing is to verify the implementation of the Core Protection Calculation System (i.e., both CPC and CEAC) software.

1.2 RESULTS

Analysis of the Phase I Design Qualification Tests demonstrated that the software changes had been correctly implemented to meet the system functional requirements.

1.3 CONCLUSIONS

CPC System Phase I Testing was performed in the prescribed manner as described by Phase I Test Procedures. The comprehensive Phase I Testing was adequate to meet all of the test objectives. The success of the Phase I Testing demonstrates the adequacy of the CPC/CEAC software implementation.

1.4 PREREQUISITES

Before formal Phase I Testing was initiated, the following prerequisites were satisfied:

1. Programmer debug testing was performed on the module changes to remove all obvious errors.
2. The modules and programs that changed were integrated into complete software systems and absolute core images were generated on the CPC permanent mass storage medium (floppy disks).

2.0 APPLICATION PROGRAM TESTING

The CPC and CEAC application programs were tested in accordance with the CPC/CEAC Phase I Test Procedure. This section discusses the actual test configuration, test cases, and test execution and results.

Phase I Test runs used Disk #S88 as the A-B Reference Disk.

2.1 TEST CONFIGURATION

Phase I testing of the CPC and CEAC application programs was performed on the CEAC Single Channel Unit. For the purpose of this testing, the single channel was configured with the hardware complement listed in Table 2-1. The software configuration for the application programs Phase I Testing is shown in Figure 2-1 (CPC) and Figure 2-2 (CEAC). Memory was loaded with this configuration by the following procedure:

1. The integrated CPC or CEAC system was loaded from the SONGS Reference Disk (Disk #S88 for CPCs and CEAC #1, Disk #S89 for CEAC #2).
2. The Automated Phase I Testing Software was loaded from magnetic tape, overlaying the CPC/CEAC Executive and unused portions of memory.
3. The Interdata Hexadecimal Debug Program, CLUB, was loaded from magnetic tape, overlaying any unused portion of memory.

The Automated Phase I Testing software was then used, with CLUB, to test the programs listed in Table 2.2.

2.2 TEST CASES

2.2.1 Inputs

Phase I Test case inputs for the CPC/CEAC application programs were generated in accordance with the CPC/CEAC Phase I Test Procedure. Sufficient test cases were chosen to exercise each functional branch in the application programs. However, several branches were not exercised because assigned constant values made it impossible to branch on certain conditions. All coding that cannot be executed, because of constant assignments, was verified by inspection to assure correct implementation.

2.2.2 Expected Results

Expected results for the CPC and CEAC application programs Phase I Test cases were generated by two methods. The preferred method for generation of expected results utilized the CPC FORTRAN Simulation Code. Test case inputs were punched onto cards and entered into the Simulation Code. The FORTRAN Code calculated the expected results and punched them onto cards in a format acceptable to the automated Phase I Testing Program. In some instances, such as input/output handling, the FORTRAN Code does not simulate the CPC code. In these cases, the expected results were hand calculated by the test engineer based on the system functional requirements, the programmer's flowcharts, and the system data base document. The results were then manually punched onto cards in a format acceptable to the Automated Phase I Testing Program.

2.3 TEST EXECUTION AND RESULTS

When test case inputs had been selected and expected results had been generated, the test engineer prepared the test deck to be read by the Automated Phase I Testing Program. The test case inputs overlayed the portions of memory where data is accessed by the software module under test. After each set of inputs overlayed appropriate memory locations, the software module under test was executed and the actual CPC results were compared to the expected results by the Automated Phase I Testing Program. Whenever the actual value differed from the expected value by more than 0.1 percent, an analysis of the error was performed by the test engineer to assure that the deviation was not caused by a coding error.

Documentation generated by the Automated Phase I Testing Program consisted of listings which contain input and output differences. For several of the modules tested, it was not obvious which branches in the code were taken when observing the outputs. When tracing through a portion of code, the location of each instruction was printed when that instruction was executed, which enabled the test engineer to verify that each functional branch was taken. A Phase I Test Log was used to maintain a daily account of testing activities.

Phase I Testing was performed on the CPC application programs on July 24 and July 25, 1981. While the application program test results were being analyzed, Phase I Testing of the Executive System was performed between July 25 and July 30, 1981.

Tests in the Penalty Factor program were run on July 25, 1981. No problems were found. Tests on the Display program for both CEAC1 and CEAC2 were also run on July 25, 1981. No problems were found.

It was concluded that there were no coding errors in the CPC and CEAC application programs.

TABLE 2-1
HARDWARE CONFIGURATION FOR PHASE I

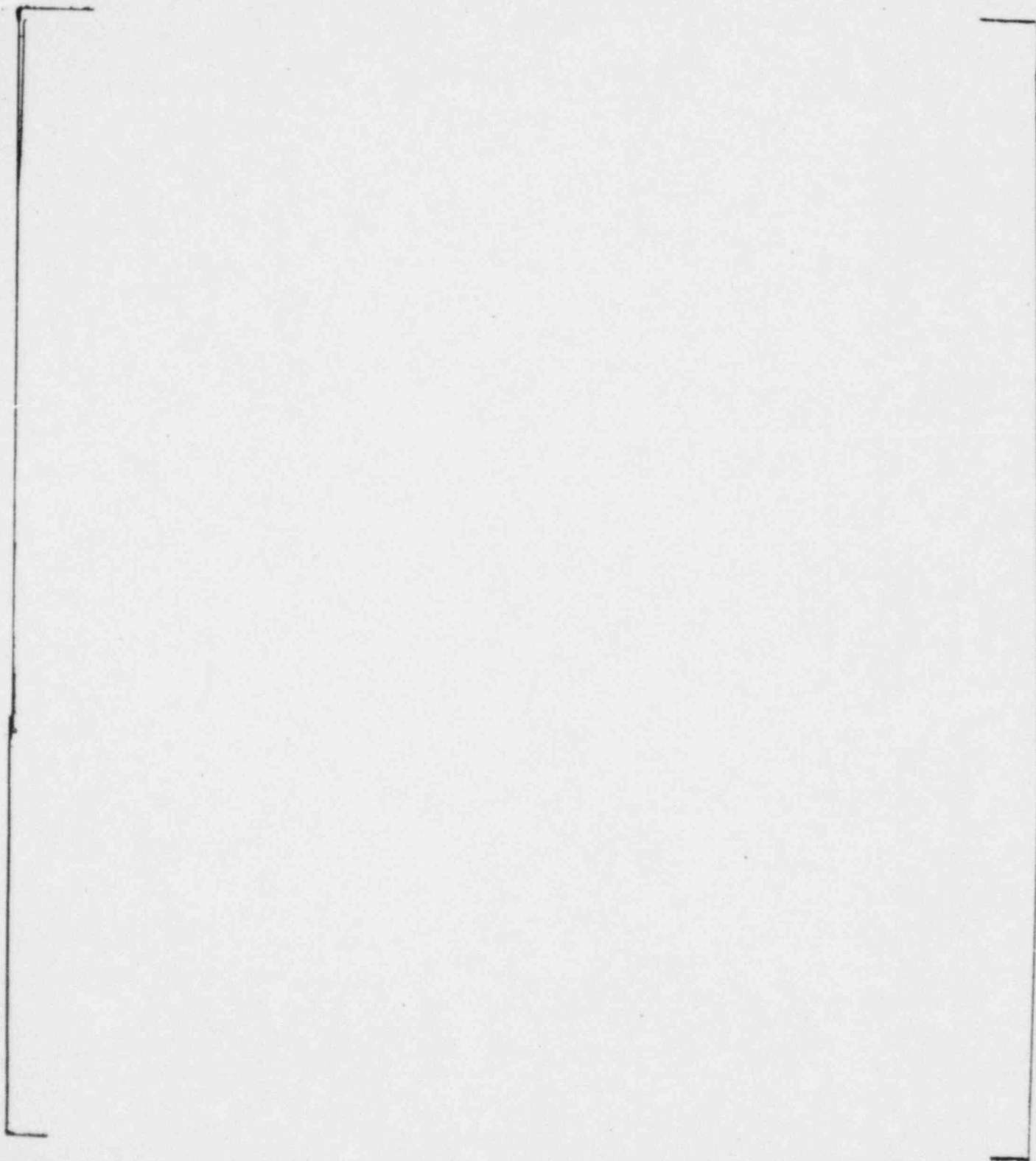
APPLICATION PROGRAM TESTING

TABLE 2-2

APPLICATION PROGRAMS TESTED WITH THE
AUTOMATED PHASE I TESTING PROGRAM

FIGURE 2-1
MEMORY MAP FOR PHASE I CFC APPLICATION PROGRAM TESTING

FIGURE 2-2
MEMORY MAP FOR PHASE I CEAC APPLICATION PROGRAM TESTING



3.0 EXECUTIVE TESTING

The CPC/CEAC Executive software was tested in accordance with the CPC/CEAC Executive Phase I Test Procedure. This section discusses the actual test configuration, test cases, and test execution and results.

3.1 TEST CONFIGURATION

Phase I testing of the CPC/CEAC Executive was performed on the CPC Single Channel System. For the purpose of this testing, the single channel was configured with the hardware complement listed in Table 3-1. This hardware configuration is functionally identical to the as-built CPC/CEAC design.

The software configuration for the Executive Phase I Testing is shown in Figure 3-1. Memory was loaded with this configuration by the following procedure:

1. An integrated CPC/CEAC system was loaded from SONGS 2 Reference Disk #S88 (the entire image was loaded although only the Executive system is tested).
2. The Interdata Hexadecimal Debug Program, CLUB, was loaded from magnetic tape overlaying an unused area in memory.

The prescribed test cases were then set up and executed using the CLUB program to test the Executive software.

3.2 TEST CASES

The CPC/CEAC Executive Phase I Test Cases are described in the Executive Phase I Test Procedure. Sufficient test cases were chosen to exercise each functional branch in the Executive.

3.3 TEST EXECUTION AND RESULTS

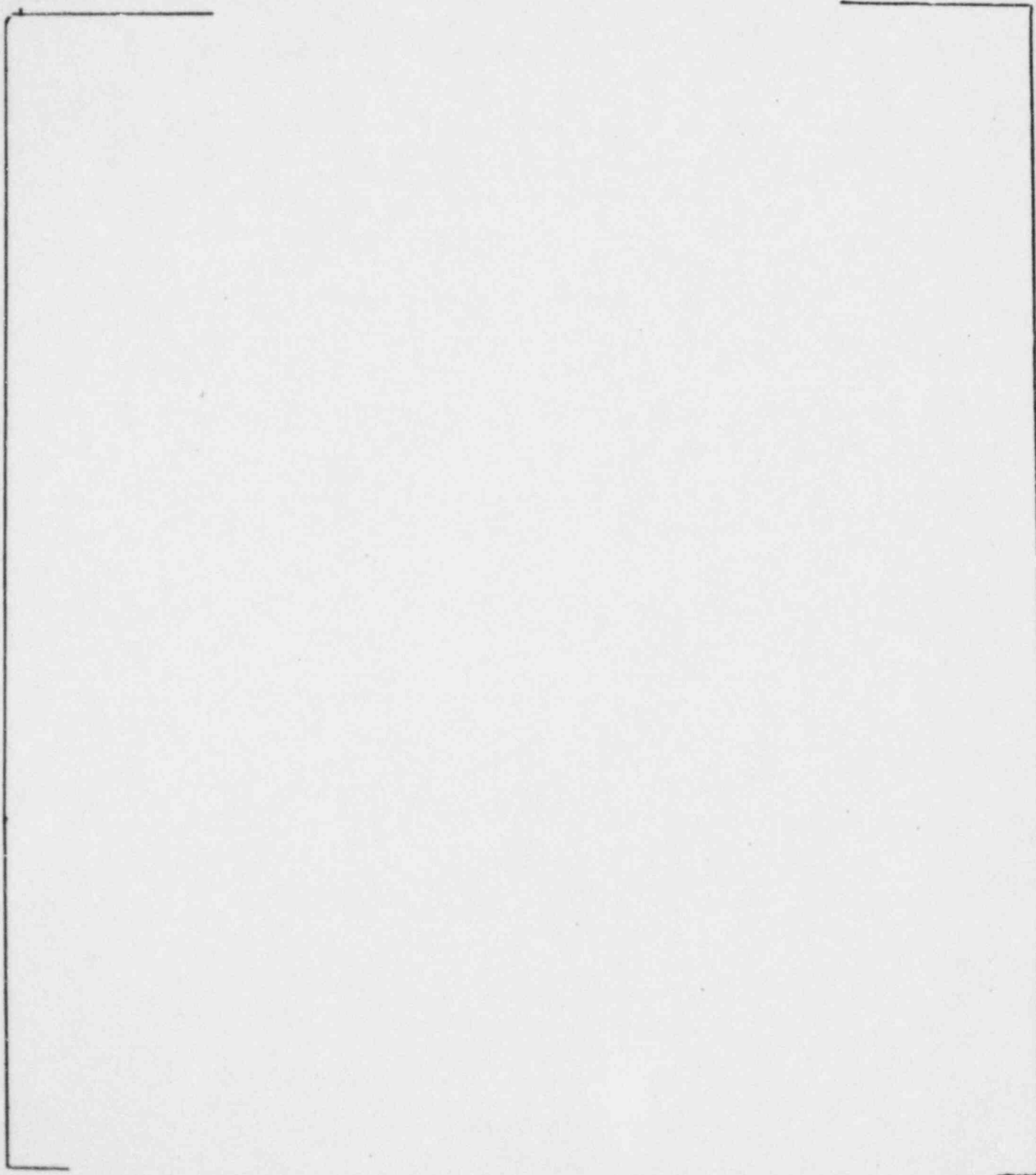
For testing of the CPC/CEAC Executive, the debug program, CLUB, was used to insert test case inputs into memory; to insert breakpoints to trace and intercept code executions; and to examine results. Documentation produced as a result of Executive Phase I Testing consists of the CLUB teletype printouts, initialed and dated by the test engineer.

The CPC/CEAC Executive was tested on July 25 through July 30, 1981. No errors were detected.

TABLE 3-1
HARDWARE CONFIGURATION FOR PHASE I
EXECUTIVE PROGRAM TESTING

FIGURE 3-1

MEMORY MAP FOR CPC/CEAC EXECUTIVE PHASE I TESTING



4.0

PHASE I TEST RESULTS SUMMARY

Phase I testing of the CPC and CEAC software for SONGS 2 Cycle 1 was performed in accordance with Reference 2. Test results conclude that all software modifications outlined in Reference 1 were correctly implemented.

5.0

REFERENCES

1. CPC/CEAC Software Modifications for San Onofre Unit 2, CEN-135(S)P, Revision 00, August 1980.
2. CPC Protection Algorithm Software Change Procedure CEN-39(A)-P, Revision 02, December 21, 1978.