3C Computer Programs Used in the Design and Analysis of Seismic Category I Structures

The information in this appendix of the reference ABWR DCD, including all subsections, is incorporated by reference with the following departure and supplements.

STD DEP Admin

3C.1 Introduction

The list in this subsection is supplemented to include the following site-specific structures.

(4) Ultimate Heat Sink

(5) Reactor Service Water Piping Tunnel

3C.5 ANSYS

3C.5.1 Description

ANSYS is a large, finite element program for a broad range of analyses types. The structural analysis capabilities include material and geometric nonlinear analysis, static analysis, and a variety of dynamic analyses.

The element for a concrete cracking analysis allows a full-nonlinear analysis of reinforced concrete with cracking and crushing of concrete.

3C.5.2 Validation

ANSYS, Inc. of Canonsburg, Pennsylvania developed ANSYS. The program validation documentation is available at ANSYS, Inc.

3C.5.3 Extent of Application

This program is used for the containment dynamic analysis of containment loads, for the containment ultimate capacity analyses and for containment seismic margin analysis.

3C.8 A System for Analysis of Soil-Structure Interaction - SASSI2000

3C.8.1 Description

SASSI2000 is used to solve a wide range of dynamic soil-structure interaction (SSI) problems, including layered soil conditions and embedment conditions, in two or three dimensions. SASSI was originally developed at the University of California, Berkeley in 1982 under the technical direction of John Lysmer. The program is based on the finite-element method formulated in the frequency domain using a substructuring technique.

3C.8.2 Validation

SASSI2000 was obtained from ISATIS, LLC, University of California, Berkley and validated by Simpson Gumpertz and Heger (SGH). The program validation documentation is available at SGH. The program validation was also accepted by Sargent & Lundy (S&L) under S&L's QA Program.

3C.8.3 Extent of Application

SASSI2000 is used to obtain seismic design loads and in-structure floor response spectra for the Seismic Category I buildings accounting for the effects of SSI.

3C.9 Free-Field Site Response Analysis (SHAKE and P-SHAKE)

3C.9.1 Description

SHAKE is used to perform the free-field site response analysis to generate the design-earthquake-induced strain-compatible free-field soil properties and site response motions required in the seismic SSI analysis. SHAKE is a computer program developed at the University of California, Berkeley, by B. Schnabel, John Lysmer and H. B. Seed in 1972.

P-SHAKE is a Bechtel proprietary modified version of SHAKE. P-SHAKE generates the same design earthquake-induced strain-compatible soil properties and site response motions as SHAKE does, and the input files of the two programs for the most part are compatible. However, P-SHAKE is built on a different program logic that allows the site response analysis to be performed with acceleration response spectrum as input instead of acceleration time histories used by SHAKE.

3C.9.2 Validation

SHAKE was developed by UC Berkeley. The program validation documents are located at UC Berkeley.

P-SHAKE was developed by Bechtel. The program validation documents are located in Bechtel's Computation Service Library.

3C.9.3 Extent of Application

SHAKE is used to generate free-field site response motions for use in seismic analysis of Category I structures, e.g., Reactor Building, Control Building and Ultimate Heat Sink.

P-SHAKE is used to provide site-specific earthquake-induced design ground motions and the associated strain-compatible soil properties for Category I structures, e.g., Reactor Building, Control Building, and Ultimate Heat Sink.

3C.10 GT STRUDL

3C.10.1 Description

GT STRUDL (Structural Design Language) is a subsystem of GTICES (The Georgia Tech Integrated Civil Engineering System). It solves structural engineering problems in frame analysis, finite element analysis, static and dynamic analysis, as well as steel and concrete design.

3C.10.2 Validation

GT STRUDL is developed by Georgia Tech Research Corporation (GTRC). The program validation documents are located at GTRC.

3C.10.3 Extent of Application

GT STRUDL is a general purpose program used to perform structural analysis for structures.

3C.13 DYNAS

3C.13.1 Description

DYNAS is used for seismic analysis of structures, including generation of floor response spectra.

3C.13.2 Validation

DYNAS was developed and validated by Sargent & Lundy. The program validation documentation is available at Sargent & Lundy.

3C.13.3 Extent of Application

This program is used to calculate concrete shear wall stiffnesses and determine forces in shear wall design for shear wall structures.

3C.14 SAFE

3C.14.1 Description

SAFE is used for the analysis and design of concrete slabs and basemats. It integrates modeling analysis and design of slabs and foundations.

3C.14.2 Validation

SAFE was developed by Computers and Structures, Inc., Berkeley. It was purchased and validated by Sargent & Lundy. The program validation documentation is available at Sargent & Lundy.

3C.14.3 Extent of Application

SAFE is used to determine required reinforcing for concrete slabs and foundations.

3C.15 RSG

3C.15.1 Description

RSG is used to generate artificial synthetic time histories for seismic analysis. It also generates response spectrum from an input acceleration time history. It can envelope spectra, combine spectra, and generate a spectrum consistent time history.

3C.15.2 Validation

RSG was developed and validated by Sargent & Lundy. The program validation documentation is available at Sargent & Lundy.

3C.15.3 Extent of Application

RSG is used to generate response spectra for various percentages of critical damping from a given acceleration time history.

3C.16 TEMCO

3C.16.1 Description

TEMCO analyzes reinforced concrete beam and plate sections subjected to non-thermal and thermal loads. The program can also perform design for reinforced concrete sections subjected to axial bending or shear forces.

3C.16.2 Validation

TEMCO was developed and validated by Sargent & Lundy. The program validation documentation is available at Sargent & Lundy.

3C.16.3 Extent of Application

TEMCO is used to analyze reinforced concrete sections subjected to non-thermal and thermal loads.

3C.17 APLAN

3C.17.1 Description

APLAN is used to analyze rectangular attachment plates mounted on concrete walls or slabs by means of expansion anchors, headed welding studs or wire embedments.

3C.17.2 Validation

APLAN was developed and validated by Sargent & Lundy. The program validation documentation is available at Sargent & Lundy.

3C.17.3 Extent of Application

APLAN is used to analyze rectangular attachment plates mounted on concrete walls by means of expansion anchors, headed welding studs or wire embedments.

3C.18 SAP2000

3C.18.1 Description

SAP2000 is a finite element program for analysis and design of structures. It performs both static and dynamic analysis.

3C.18.2 Validation

SAP2000 was developed by Computers and Structures, Inc., Berkeley. It was purchased and validated by Sargent & Lundy. The program validation documentation is available at Sargent & Lundy.

3C.18.3 Extent of Application

SAP2000 is used to perform general structural analysis for buildings.

3C.19 PCACOLUMN

3C.19.1 Description

PCACOLUMN is a software program for the design and investigation of reinforced concrete column sections. The column section can be rectangular, round or irregular, with any reinforcement layout or pattern. Slenderness effects can also be considered.

3C.19.2 Validation

PCACOLUMN was developed by Portland Cement Association. It was purchased and validated by Sargent & Lundy. The program validation documentation is available at Sargent & Lundy.

3C.19.3 Extent of Application

PCACOLUMN is used for analysis and design of concrete columns.