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 ~~standard~~ supplements.

STD DEP Admin

3C.1 Introduction

The following building was inadvertently omitted from the list of Category I structures in this subsection of the reference ABWR DCD.

(4) ~~(4)~~Radwaste Building Substructure

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

(5) ~~(5)~~Ultimate Heat Sink

(6) ~~(6)~~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.6 Section Design Program-2D (SSDP-2D)

3C.6.1 Description

Section design of Reactor Building Concrete Structures, such as the Reinforced Concrete Containment Vessel (RCCV), shear walls, and slabs is performed using SSDP-2D.

SSDP-2D computes stresses in a thick concrete element under thermal and/or nonthermal (real) loads, considering effects of concrete cracking. The element represents a section of a concrete shell or slab, and may include two layers of orthogonal reinforcing. It does not include the effect of the orthogonal liner.

SSDP-2D calculates the stresses considering two-dimensional equilibrium conditions of section forces with the existence of thermal loads and concrete cracking. It is assumed in the code that concrete has an anisotropic property and that cracked concrete does not carry tensile forces. Concrete is assumed to have no tensile strength.

3C.6.2 Validation

SSDP-2D is written and maintained by Shimizu Corporation of Tokyo, Japan. Program validation documentation is available at Shimizu Corporation.

3C.6.3 Extent of Application

This program is used for evaluating the Reactor Building (RB) including the RCCV and Control Building (CB).

3C.7 NASTRAN

3C.7.1 Description

NASTRAN is a GE in-house version of the MSC/NASTRAN program which is developed by the MacNeal Scwendler Corporation. NASTRAN is a general purpose computer program for finite element analysis; its capabilities include: static response to concentrated and distributed loads, to thermal expansion and to enforced displacements; dynamic response to transient loads, to steady-state sinusoidal loads, and to random excitation; and determination of Eigen values for use in vibration analysis.

3C.7.2 Validation

MSC-Software Corporation of Santa Ana, California developed NASTRAN. The program validation documentation is available at MSC-Software Corporation.

3C.7.3 Extent of Application

This program is used for the static and Eigen value analysis of the concrete containment, RB, and CB. This program is also used for the static and dynamic analysis of the Drywell Head and containment internal structures.

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

3C.8.1 Description

SASSI 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. It was 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

SASSI was obtained from the University of California, Berkeley. Program validation documentation is available at UC Berkeley.

3C.8.3 Extent of Application

SASSI 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)

3C.9.1 Description

This program 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.

3C.9.2 Validation

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

3C.9.3 Extent of Application

This program is used to provide site response motions input to the SASSI analysis for 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

This is a general purpose program and is extensively used on various buildings, such as UHS, Turbine Building, Water Treatment Building, etc.

3C.11 DATAN

3C.11.1 Description

The program DATAN (Probabilistic Data Analysis) processes and generates data which are randomly varied with time using Fast Fourier Transform (FFT) algorithm.

3C.11.2 Validation

DATAN was developed by Bechtel. The program validation documents are located in the Data Processing Library at the Bechtel San Francisco office.

3C.11.3 Extent of Application

DATAN is used to process input and response time histories for the seismic SSI analyses.

3C.12 BISMQKE

3C.12.1 Description

This computer program is used to generate spectra compatible time history functions. For given acceleration response spectra of (input) seismic motion, BISMQKE can generate a time history function that will closely match the given spectra.

3C.12.2 Validation

BISMQKE is developed by Bechtel. The program validation documents are located in the Data Processing Library at the Bechtel San Francisco office.

3C.12.3 Extent of Application

BISMQKE is used to generate acceleration time history functions that will closely match a given acceleration response spectra.