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R. C. DeYoung, Assistant Director
for Light Water Reactors
Division of Project Management

WPPSS NUCLEAR PROJECT NO. 3 (WPPSS UNITS 3 & 5)
PRELIMINARY SAFETY ANALYSIS REPORT, SAFETY EVALUATION REPORT

Plant Name: WPPSS Nuclear Project No. 3
Licensing Stage: PSAR-SER
Project Numbers: STN 50-508/509
Responsible Branch and Project Manager: LWR 1-3, A. Bournia
Requested Completion Date: January 5, 1976
Applicant's Response Date Necessary for Completion of Next Action
Planned on Project: As Scheduled
Description of Response: N/A
Review Status: Complete

The PSAR submitted by the applicant has been reviewed and evaluated by the Structural Engineering Branch, Division of Systems Safety. Our sections of the safety evaluation are enclosed. This evaluation is based on information provided through Amendment No. 27 dated December 11, 1975.

R. R. Maccary, Assistant Director
for Engineering
Division of Systems Safety

Enclosure:
Structural Evaluation
Report

cc w/o encl:
R. Boyd, PM
W. McDonald, MIPC

cc w/encl:
R. Heineman, SS
F. Schroeder, SS
B. Vassallo, PM
M. Kehnemuyi, SS
A. Bournia, PM
I. Sihweil, SS
K. Kapur, SS
C. Tan, SS

8605290702 760106
PDR ADOCK 05000508
E PDR

OFFICE	TR:SEB x27807	TR:SEB	TR:SEB	TR:AD:E
SURNAME	CTan da	KKapur	ISihweil	RRmaccary
DATE	1/6/76	1/6/76	1/6/76	1/6/76

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WPPSS NUCLEAR PORJECT NO 1
STRUCTURAL ENGINEERING BRANCH
DOCKET NOS. STN 50-508 AND STN 50-509
SAFETY EVALUATION REPORT

3.3.1 Wind Design Criteria

All Category I structures exposed to wind forces will be designed to withstand the effects of the design wind. The design wind specified has a velocity of 105 mph based on a recurrence interval of 100 years.

The procedures that are used to transform the wind velocity into pressure loadings on structures and the associated vertical distribution of wind pressures and gust factors are in accordance with ASCE paper No. 3269.

The procedures utilized to determine the loadings on seismic Category I structures induced by the design wind specified for the plant are acceptable since these procedures provide a conservative basis for engineering design to assure that the structures will withstand such environmental forces.

The use of these procedures provides reasonable assurance that in the event of design basis winds, the structural integrity of the plant seismic Category I structures will not be impaired and, in consequence, seismic Category I systems and components located within these structures are adequately protected and will perform their intended safety functions if needed. Conformance with these procedures is an acceptable basis for satisfying, in part, the requirements of General Design Criterion 2.

3.3.2 Tornado Design Criteria

All Category I structures exposed to tornado forces and needed for the safe shutdown of the plant will be designed to resist a tornado of 240 mph tangential wind velocity and a 60 mph translational wind velocity. The simultaneous atmospheric pressure drop was assumed to be 2.25 psi at a rate of 1.2 psi/sec. Furthermore, an appropriate spectrum of tornado-generated missiles was postulated.

The procedures that are used to transform the tornado wind velocity into pressure loadings are similar to those used for the design wind loadings as discussed in Section 3.3.1 of this report using a gust factor of 1.0. The tornado missile effects were determined using procedures to be discussed in Section 3.5 of this report. The total effect of the design tornado on Category I structures is determined by appropriate combinations of the individual effects of the tornado wind pressure, pressure drop and tornado-associated missiles. Structures on the plant site are arranged and constructed in such a manner that collapse of structures not designed for the tornado will not affect other safety-related structures.

The procedures utilized to determine the loadings on structures induced by the design basis tornado specified for the plant are acceptable since these procedures provide a conservative basis for engineering design to assure that the structures withstand such environmental forces.

The use of these procedures provides reasonable assurance that in the event of a design basis tornado, the structural integrity of the plant structures that have to be designed for tornadoes will not be impaired and, in consequence, safety-related systems and components located within these structures will be adequately protected and may be expected to perform necessary safety functions as required. Conformance with these procedures is an acceptable basis for satisfying, in part, the requirements of General Design Criterion 2.

3.4.2 Water Level (Flood Design Procedures)

The design flood level resulting from the most unfavorable condition or combination of conditions that produce the maximum water level at the site is discussed in Section 2.4, Hydrology. Since the maximum attainable water level is below the finished grade elevation, no flood loads were considered in the design of Category I structures. A seismic Category I drainage system will be provided to permanently lower the groundwater elevation.

The procedures utilized to protect Category I structures from the design flood or highest groundwater level specified for the plant are acceptable since these procedures provide a conservative basis for engineering design to assure that the structures will withstand such environmental forces.

The use of these procedures provides reasonable assurance that in the event of floods or high groundwater, the structural integrity of the plant seismic Category I structures will not be impaired and, in consequence, seismic Category I systems and components located within these structures will be adequately protected and may be expected to perform necessary safety functions, as required. Conformance with these design procedures is an acceptable basis for satisfying, in part, the requirements of General Design Criterion 2.

3.5 Missile Barrier Design

The plant Category I structures, systems and components will be shielded from, or designed for, various postulated missiles. Missiles considered in the design of structures include tornado generated missiles and various containment internal missiles, such as those associated with a loss-of-coolant accident.

Adequate information has been provided indicating the structures, shields and barriers that are designed to resist the effect of missiles. The missiles applicable to each of these structures, shields and barriers are also adequately identified and their characteristics defined.

The analysis of structures, shields and barriers to determine the effects of missile impact is accomplished in two steps. In the first step, the potential damage that could be done by the missile in the immediate vicinity of impact is investigated. This is accomplished by estimating the depth of penetration of the missile into the impacted structure through the use of Modified Petry Formula for concrete and the Stanford Formula for steel. Furthermore, secondary missiles are prevented by fixing the target thickness well above that determined for penetration. In the second step of the analysis, the overall structural response of the target when impacted by a missile is determined using established methods of impactive analysis. The equivalent loads of missile impact, whether the missile is environmentally generated or accidentally generated within the plant, are combined with other applicable loads.

The design procedures used to determine the effects and loading on seismic Category I structures by design basis missiles selected for the plant provide a conservative basis for engineering design to assure adequate protection from the effects of missile impacts.

The use of this information provides reasonable assurance that, in the event of design basis missiles striking seismic Category I structures, the structural integrity of structures will not be impaired or degraded to an extent that will result in a loss of required protection. Seismic Category I systems and components located within these structures are, therefore, expected to be adequately protected against the effects of missiles. Conformance with these missile protection design procedures is an acceptable basis for satisfying the requirements of General Design Criterion 4.

3.7.1 <u>Seismic Input</u>

The input seismic design response spectra (OBE and SSE) applied in the design of Seismic Category I structures, systems, and components comply with the recommendations of Regulatory Guide 1.60, "Design Response Spectra for Nuclear Power Plants".

The specific percentage of critical damping values used in the seismic analysis of Category I structures, systems and components are in conformance with Regulatory Guide 1.61, "Damping Values for Seismic Analysis of Nuclear Power Plants".

The synthetic time history used for seismic design of Category I plant structures, systems, and components is adjusted in amplitude and frequency content to obtain response spectra that envelop the design response spectra specified for the site.

Conformance with Regulatory Guides 1.60 and 1.61 requirements provides reasonable assurance that for an earthquake whose intensity is 0.05g for OBE, and 0.10g for SSE, the seismic input to Category I structures, systems and components is adequately defined to assure a conservative basis for the design of such structures, systems and components to withstand the consequent seismic loadings.

3.7.2 Seismic System Analysis

3.7.3 Seismic Subsystem Analysis

The scope of review of the Seismic System and Subsystem Analysis for the plant included the seismic analysis methods for all Category I structures, systems and components. It included review of procedures for modeling, seismic soil-structure interaction, development of floor response spectra, inclusion of torsional effects, and evaluation of Category I structure overturning. The review has included design criteria and procedures for evaluation of interaction of non-Category I structures and piping with Category I structures and piping and effects of parameter variations on floor response spectra.

The system and subsystem analyses are performed by the applicant on an elastic basis. Modal response spectrum multidegree of freedom and time history methods form the basis for the analysis of all major Category I structures, systems and components. When the modal response spectrum method is used, governing response parameters are combined by the square root of the sum of the squares rule. However, the absolute sum of the modal responses are used for modes with closely spaced frequencies.

The square root of the sum of the squares of the maximum codirectional responses is used in accounting for three components of the earthquake motion for both the time history and response spectrum methods. Floor spectra inputs to be used for design and test verifications of structures, systems, and components are generated from the time history method taking into account variation of parameters by peak widening. A vertical seismic system dynamic analysis will be employed for all structures, systems, and components where analyses show significant structural amplification in the vertical direction. Torsional effects and stability against overturning are considered.

The finite element approach is used to evaluate soil-structure interaction effects upon seismic responses. For the finite element analysis, appropriate nonlinear stress-strain and damping relationships for the soil are considered in the analysis.

We conclude that the seismic system and subsystem analysis procedures and criteria proposed by the applicant provide an acceptable basis for the seismic design.

3.7.4 Seismic Instrumentation Program

The installation of the specified seismic instrumentation in the reactor containment structure and at other Category I structures, systems, and components constitutes an acceptable program to record data on seismic ground motion as well as data on the frequency and amplitude relationship of the seismic response of major structures and systems. A prompt readout of pertinent data at the control room can be expected to yield sufficient information to guide the operator on a timely basis for the purpose of evaluating the seismic response in the event of an earthquake. Data obtained from such installed seismic instrumentation will be sufficient to determine that the seismic analysis assumptions and the analytical model used for the design of the plant are adequate and that allowable stresses are not exceeded under conditions where continuity of operation is intended. Provision of such seismic instrumentation complies with Regulatory Guide 1.12.

3.8.2 Steel Containment

The reactor coolant system will be housed within a free-standing steel cylindrical shell topped with a hemispherical dome. The bottom is continuous through an inverted dome embedded in concrete.
The steel containment will be enclosed by a reinforced concrete shield building.

The steel containment including all its penetrations will be designed, analyzed, fabricated, constructed, inspected and tested in accordance with the rules of Subsection NE of the ASME Boiler and Pressure Vessel Code Section III, Division 1.

The containment will be designed for all the various load combinations that are considered credible, including appropriate combinations of accident loads and seismic loads.

The materials that will be used in the construction of the containment will meet the requirements of Article NE-2000 of Subsection NE of the ASME Section III Code.

After the completion of construction and prior to operation the containment will be subjected to a structural proof test.

Conclusions

It is concluded that the criteria that will be used in the analysis, design and construction of the steel containment structure to account for the loadings and conditions that are anticipated to be experienced by the structure during its service lifetime are in conformance with established criteria, and with codes, standards, and specification acceptable to the Regulatory staff.

The use of these criteria as defined by applicable codes, standards, and specifications; the loads and loading combinations; the design and analysis procedures; the structural acceptance criteria; the materials, quality control and special construction techniques; and the testing and inservice surveillance requirements, provide reasonable assurance that, in the event of earthquakes and various postulated accidents occurring within and outside the containment, the containment structure will withstand the specified conditions without impairment of its structural integrity or safety function. A Category I concrete shield building will protect the containment from the effects of wind and tornadoes and various postulated accidents occurring outside the shield building. Conformance with these criteria constitutes an acceptable basis for satisfying in part the requirements of General Design Criteria #2, #4, #16, and #50.

3.8.3 Concrete and Structural Steel Internal Structures

The containment interior structures consist of a shield wall around the reactor, secondary shield walls and other interior walls, compartments and floors. The interior structures will be designed in accordance with the ACI-318 Code for concrete and the AISC specifications for structural steel.

The applicant has considered those loads which may act on the structure during its lifetime, such as dead and live loads, accident-induced loads, including pressure and jet loads, and seismic loads. The load combinations used cover all postulated events and include all loads which may act simultaneously. In the design of concrete interior structures, the strength design method is used.

The criteria used in the design, analysis, and construction of the containment internal structures to account for anticipated loadings and postulated conditions that may be imposed upon the structures during their service lifetime are in conformance with established criteria, and with codes, standards, and specifications acceptable to the Regulatory staff.

The use of these criteria as defined by applicable codes, standards, and specifications; the loads and loading combinations; the design and analysis procedures; the structural acceptance criteria; the materials, quality control programs, and special construction techniques; and the testing and in-service surveillance requirements provide reasonable assurance that, in the event of earthquakes and various postulated accidents occurring within the containment, the interior structures will withstand the specified design conditions without impairment of structural integrity or the performance of required safety functions. Conformance with these criteria constitutes an acceptable basis for satisfying in part the requirements of General Design Criteria 2 and 4.

3.8.4 Other Category I Structures

Category I structures other than containment and its interior structures will be built from structural steel and concrete members. The structural components consist of slabs, walls, beams and columns. The major code used in the design of concrete Category I structures is the ACI 318-71, "Building Code Requirements for Reinforced Concrete." For steel Category I structures, the AISC, "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings," is used.

The concrete and steel Category I structures are designed to resist various combinations of dead loads; live loads; environmental loads including winds, tornadoes, 1/2 SSE and SSE; and loads generated by postulated ruptures of high energy pipes such as reaction and jet impingement forces, compartment pressures, and impact effects of whipping pipes.

The design and analysis procedures that are used for these Category I structures are the same as those approved on previously licensed applications and, in general, are in accordance with procedures delineated in the ACI 318-71 Code and in the AISC Specification for concrete and steel structures, respectively.

The various Category I structures are designed and proportioned to remain within limits established by the Regulatory staff under the various load combinations. These limits are, in general, based on the ACI 318-71 Code and on the AISC Specification for concrete and steel structures, respectively, modified as appropriate for load combinations that are considered extreme.

The materials of construction, their fabrication, construction and installation, will be in accordance with the ACI 318-71 Code and with the AISC Specification for concrete and steel structures, respectively.

The criteria used in the analysis, design and construction of all the plant Category I structures to account for anticipated loadings and postulated conditions that may be imposed upon each structure during its service lifetime, are in conformance with established criteria, codes, standards, and specifications acceptable to the Regulatory staff.

The use of these criteria as defined by applicable codes, standards and specifications; the loads and loading combinations; the design and analysis procedures; the structural acceptance criteria; the materials, quality control; and special construction techniques; and the testing and in-service surveillance requirements provide reasonable assurance that, in the event of winds, tornadoes, earthquakes and various postulated accidents occurring within the structure, the structures will withstand the specified design conditions without impairment of structural integrity or the performance of required safety functions. Conformance with these criteria, codes, specifications, and standards constitutes an acceptable basis for satisfying, in part, the requirements of General Design Criteria 2 and 4.

3.8.5 Foundations

Foundations of Category I structures are described in Section 3.8.5 of the PSAR. Primarily, these foundations are reinforced concrete of the mat type. The major code used in the design of these concrete mat foundations is ACI 318-71. These concrete foundations will be designed to resist various combinations of dead loads; live loads; environmental loads including winds, tornadoes, 1/2 SSE and SSE; and loads generated by postulated ruptures of high energy pipes.

The design and analysis procedures that will be used for these Category I foundations are the same as those approved on previously licensed applications and, in general, are in accordance with procedures delineated in the ACI 318-71 Code. The various Category I foundations will be designed and proportioned to remain within limits established by the Regulatory staff under the various load combinations. These limits are, in general, based on the ACI 318-71 Code modified as appropriate for load combinations that are considered extreme. The materials of construction, their fabrication, construction and installation, will be in accordance with the ACI 318-71 Code.

The criteria used in the analysis, design and construction of plant Category I foundations to account for anticipated loadings and postulated conditions that may be imposed upon each foundation during its service lifetime are in conformance with established criteria, codes, standards, and specifications acceptable to the Regulatory staff.

The use of these criteria as defined by applicable codes, standards and specifications; the loads and loading combinations; the design and analysis procedures; the structural acceptance criteria; and the materials, quality control and special construction techniques; and the testing and in-service surveillance requirements provide reasonable assurance that, in the event of winds, tornadoes, earthquakes, and various postulated events, Category I foundations will withstand the specified design conditions without impairment of structural integrity and stability or the performance of required safety functions. Conformance with these criteria, codes, specifications, and standards constitutes an acceptable basis for satisfying in part the requirements of General Design Criteria 2 and 4.

Bibliography

Section 3.3 Wind and Tornado Loadings

3.1-1 "Wind Forces on Structures", Final Report of the Task Committee on Wind Forces of the Committee on Load and Stresses of the Structural Division, Transactions of the American Society of Civil Engineers, 345 East 47th Street, New York, N. Y., 10017, Paper No. 3269, Vol. 126, Part II, 1961, p. 1124-1198.

Section 3.5 Missile Protection

3.5-1 Gwaltney, R. C., Missile Generation and Protection in Ligt Water-Cooled Power Reactor Plants, ORNL-NSIC-22, September, 1968.

3.5-2 Williamson, R. A., and Alvy, R. R., "Impact Effect of Fragments Striking Structural Elements", Holmes and Narver, Revised Edition, 1973.

Section 3.7 Seismic Design

3.7-1 USAEC Regulatory Guide 1.60 "Design Response Spectra for Nuclear Power Plants."

USAEC Regulatory Guide 1.61 "Damping Values for Seismic Analysis of Nuclear Power Plants."

3.7-4 USAEC Regulatory Guide 1.12 "Instrumentation for Earthquakes."

Section 3.8 Design of Category I Structures

3.8-1 American Institute of Steel Construction, "Specification for Design, Fabrication & Erection of Structural Steel for Buildings, 101 Park Avenue, New York, N. Y. 10017, Sixth Edition, 1969.

Bibliography - Cont'd

3.8-2 American Concrete Institute, "Building Code Requirements for Reinforced Concrete (ACI 318-1971), P. O. Box 4754, Redford Station, Detroit, Michigan 48219

3.8-4 American Society of Mechanical Engineers, "ASME Boiler and Pressure Vessel Code," Section III, and Addenda United Engineering Center, 345 East 47th Street, New York, N. Y. 10017.