DAVIS-BESSE NUCLEAR STATION

UNIT No. 1

STRUCTURAL ENGINEERING BRANCH

DOCKET NO. 50-346

SAFETY EVALUATION REPORT

3.3.1 Wind Design Criteria

All Category I structures exposed to wind forces has been designed to withstand the effects of the design wind. The design wind specified has a velocity of 90 mph based on a recurrence of 100 years.

The procedures that have been 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 provide 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 have been designed to resist a tornado of 300 mph tangential wind velocity and a 60 mph translational wind velocity. The simultaneous atmospheric pressure drop was assumed to be 3 psi in 3 seconds. Furthermore, an appropriate spectrum of tornado-generated missiles was postulated.

The procedures that have beer 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. 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 has been determined by appropriate combinations of the individual effects of the tornado wind pressure, pressure drop and tornado associated missiles. Structures are arranged on the plant site and protected in such a manner that collapse of structures not designed for the tornado will not affect other safety-related strucutres.

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 will 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 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 Water Level (Flood) Design

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. The hydrostatic and hydrodynamic effects of the flood were considered in the design of all Category I structures exposed to the water head.

The procedures utilized to determine the loadings on seismic Category I strucutres induced by 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 strucutral integrity of the plant seismic Category I structures will not be impaired and, in consequences, 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 Protection

The plant Category I structures, systems and components are 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. 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 as is discussed in Section 3.8 of this report.

The procedures utilized to determine the effects and loadings on

seismic Category I structures and missile shields and barriers induced by design basis missiles selected for the plant are acceptable since these procedures provide a conservative basis for engineering design to assure that the structures or barriers are adequately resistant to and will withstand the effect of such forces.

The use of these procedures provides reasonable assurance that in the event of design basis missiles striking seismic Category I structures or other missile shields and barriers, the structural integrity of the structures, shields, and barriers will not be impaired or degraded to an extent that will result in a loss of required protection. Seismic Category I systems and components protected by these structures are, therefore, adequately protected against the effects of missiles and will perform their intended safety function, if needed. Conformance with these procedures is an acceptable basis for satisfying in part, the requirements of General Design Criteria 2 and 4.

3.7.1 Seismic Input

The seismic input design response spectra were based on the upper average record of the 1935 Helena earthquake, with consideration of Newmark's amplification factors which correspond to soft rock or firm sediment. The spectra thus obtained demonstrated an amplification tactor of 3.3 for 2% damping at 5 Hz. frequency. The damping values used in conjunction with these response spectra are much lower than those recommended in Regulatory Guide 1.61. The seismic responses to such input design response spectra and damping would therefore be more conservative than the requirements of Regulatory Guides 1.60 and 1.61.

Artificial time history motion records were developed such that their response spectra at the elevation of foundation do not fall below the design respone spectra with corresponding damping values and acceleration levels. The degree of conservatism is therefore not less than that of the design response spectra.

Conformance with requirements of Regulatory Guides 1.60 and 1.61 provides reasonable assurance that, for an earthquake of intensity 0.08g for Maximum Probable Earthquake (corresponding to OBE) and 0.15g for Maximum Possible Earthquake (corresponding to SSE), the resulting accelerations and displacements imposed on Category I structures, systems and components are adequately defined to assure a conservative basis for seismic design.

3.7.2 Seismic System Analysis

3.7.3 Seismic Subsystem Analysis

The containment building, auxiliary building, and intake structures are of fixed base since they have foundation mats either on or in sound bedrock. No soil-structures interaction analysis has been performed for these structures. For soil supported Category I structures, the soil springs approach based on elastic half space theory has been used. This approach is acceptable for shallowly embedded structures founded on deep layer of soil with uniform properties.

Seismic analyses were performed on an elastic basis. Modal analysis method for multi-degree-of-freedom systems was generally used. Governing response parameters were combined by the square root of the sum of squares except for modes with closely spaced frequencies where responses are combined by the absolute sum method.

Horizontal and vertical components of seismic motion were considered as acting simultaneously. The total seismic design values were obtained by combining the results of horizontal and vertical motions from the response spectrum method.

Floor spectra inputs used for design of structures, systems and components were generated from the time-history method. The effects on the floor response spectra of expected variations of structural properties and dampings were accounted for by widening the response spectra peaks by $\pm$ 10 %.

We conclude that the methods and procedures for seismic analysis used by the applicant provide an acceptable basis for seismic design.

3.7.4 Seismic Instrumentation Program

The type, number, location and utilization of strong motion accelerographs to record seismic events and to provide data on the frequency, amplitude and phase relationship of thed seismic response of the containment structure will correspond to the recommendations of Regulatory Guide 1.12.

Supporting instrumentation will be installed on Category I structures, systems and components in order to provide data for verification of the seismic responses determined analytically for such Category I items.

We conclude that the seismic instrumentation program proposed by the applicant is acceptable.

3.8.2 Steel Containment

The containment consisting of a free-standing steel shell, located within a separate reinforced concrete shield building is fabricated, constructed and tested as a Class B vessel in accordance with Subsection NE of the ASME Boiler and Pressure Vessel Code, Section III Nuclear Vessels (N-132), 1968 through Summer Addenda 1969. Loads include an appropriate combination of dead and live loads, thermal loads, seismic and loss-of-coolant accident induced loads including pressure and jet forces.

The analysis of the containment was based on the elastic thin shell theory. The allowable stress and strain limits are generally those delineated in the applicable sections of the ASME Code, Section III, for the various loading conditions.

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

The use of these criteria as defined by applicable codes, standards, and guides; 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 and outside the containment, the structure will withstand

the specified conditions without impariment of structural integrity or safety function. A Category I concrete shield building protects the steel 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 major code used in the design of concrete internal structures is ACI 318-63, "Building Code Requirements for Reinforced Concrete." For steel internal structures the AISC specification, "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings," has been used.

The containment concrete and steel internal structures have been designed to resist various combinations of dead and live loads, accident induced loads, including pressure and jet loads, and seismic loads. The load combinations used cover those cases likely to occur and include all loads which may act simultaneously. The design and analysis procedures that have been used for the internal structures are the same as those approved on previously licensed applications and, in general, are in accordance with procedures delineated in the ACI 318-63 Code and in the AISC Specification for concrete and steel structures, respectively.

The containment internal structures were 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 318-63 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, are in accordance with the ACI 318-63 Code and AISC Specification for concrete and steel structures, respectively.

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 are all of structural steel and concrete. The structural components consist of slabs, walls, beams and columns. The shield building is a reinforced concrete structure of right cylinder configuration with a shallow dome. It completely encloses the containment vessel, the personnel access openings, the equipment hatch and that portion of all penterations that are assocaited with primary containment. The major code used in the design of concrete Category I structures is the ACI 318-63 "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," has been used.

The concrete and steel Category I structures have been 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 318-63 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 318-63 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, have been in accordance with the ACI 318-63 Code and 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 structures, 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 2.5 and in Appendix 2C Section V1 of the SAR. Primarily, these foundations are reinforced concrete of the mat type. The major code used in the design of these concrete mat foundations is ACI 318-63. These concrete foundations have been designed to resist various combinations of dead loads; live loads; environmetanl 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 have been 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 318-63 Code. The various Category I foundations have been 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 318-63 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 318-63 Code.

The criteria used in the analysis, design, and construction of all the 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; 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.

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Section 3.5 Missile Protection

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Section 3.7 Seismic Design

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

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