

SAFETY EVALUATION REPORT
DAVIS-BESSE UNITS 2 AND 3
GEOLOGY
DOCKET NO. 50-500/501

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2.5.2 SEISMOLOGY

In this review of vibratory ground motion the key areas of discussion are earthquakes in the same tectonic province and the possible correlation of seismicity with tectonic structure. We conclude that using a reasonable level of conservatism, the safe shutdown earthquake should be a Modified Mercalli intensity of VII-VIII at the site. The corresponding acceleration for seismic design of structures is 0.2g. The vibratory ground motion at the Davis Besse Unit 1 site is described by Regulatory Guide 1.60 response spectra anchored at .2g and input at the free field finished grade. The rationale for this conclusion is given below.

Tectonic Province

The site lies within the Central Stable Region Tectonic Province described by Eardley (Reference 1). We have accepted this and other large tectonic provinces defined and accepted in the literature (King, Reference 2) as guidance in assessing the appropriate seismic design in the eastern United States. Beneath the surface sediments the Central Stable Region province is characterized by a series of arches, basins and domes formed during the Paleozoic Era. King (Reference 2) describes this area as "platform deposits on Precambrian foldbelts." The site is situated on the east flank of the Cincinnati-Findlay Arch structure which extends from central Tennessee to southern Ontario. In west central Ohio the Kankakee Arch splays off to the northwest not far from the town of Anna.

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2.5.2.1 Maximum Earthquake

Vibratory motion at the site can be estimated using three different bases discussed in Appendix A to 10 CFR Part 100. These include seismicity of tectonic provinces and structures within 200 miles of the site, and large earthquakes at greater distances that might also affect the site.

1. Tectonic Province: Earthquakes of intensity VII within the U. S. portion of the Central Stable Region have occurred in Oklahoma, Kansas, Nebraska, Michigan, Illinois, Indiana and Ohio. Earthquakes of greater intensity within this province have occurred at Anna, Ohio (VII-VIII), Keweenaw Peninsula, Michigan (VIII) and Attica, New York (VIII). Of the latter three events we consider only the Attica earthquake to have a demonstrated association with local structure (Reference 3). There have been suggestions that the Michigan earthquake was associated with the Mid-Continent Geophysical Anomaly (Reference 4). Recent investigations by Frantti (Reference 5 and personal communication) have correlated this and several other events characterized by high local intensity and small felt area with areas of intense mining activity. In the 1906 event the high intensity was related to an actual mine collapse over a tunnel. In a 1905 event in Calumet no surface or subsurface failure was found even though intensity VIII was reached at several points. These events appear to be a case of earthquakes induced by mining activity.

The applicant has found a spatial relationship between the Anna, Ohio earthquake (and related smaller events) and a bifurcation in the Cincinnati Arch. He believes that this event may be related to a local structure anomaly or weakness. This, however, has not yet been accepted by the staff. Thus, we consider a Modified Mercalli intensity VII-VIII to be a reasonably conservative value for the site safe shutdown earthquake, based on the seismicity of the Central Stable Region tectonic province and the seismicity and geological structure of the site vicinity.

2. Tectonic Structure: A series of earthquakes in the vicinity of Anna, Ohio includes 31 felt events during the past 100 years, four of intensity VII and one of intensity VII-VIII. These earthquakes occurred in a small cluster at the junction of the Cincinnati Arch with its northeast branch the Findlay Arch. Although this is seismically the most active point on the structure it is not the only place along the arch where earthquakes have occurred. Smaller events (intensity VI or less) have occurred along the Cincinnati-Findlay Arch in Tennessee, southern Ohio and in the Toledo area. A study done for the Fort Calhoun site (Docket No. 50-548) lists 75 events which have occurred along the Cincinnati-Findlay structure. Another study conducted for the Marble Hill site (Docket Nos. 50-546/547) presented evidence of faulting associated with the cluster of seismicity near Anna, Ohio. However, pending the outcome of ongoing seismic monitoring and additional geophysical studies in the area, we regard the postulated association between the Anna, Ohio earthquake activity

and the identified faults as being inconclusive. In the initial report (Reference 6) of a seismograph station recently installed in the Anna area, the only prominent local or near local event to occur was a magnitude 3 earthquake astride the Findlay Arch in westernmost Lake Erie. This event was felt in parts of eastern Michigan and southern Ontario. It is presently not possible to determine whether these earthquakes are indeed related to the Findlay Arch or are part of a random or undetermined pattern of seismicity.

The applicant has considered and partially rejected and partially accepted the possibility that the Anna, Ohio earthquakes may be related to the Findlay Arch. In his discussion of the site safe shutdown earthquake he has assumed that: (1) an earthquake larger (VIII-IX) than that indicated by historical seismicity could occur only at Anna and (2) an earthquake equivalent in size to the largest historical earthquake VII-VIII could occur on the Findlay Arch at the site.

We consider the correlation of earthquake activity with the Cincinnati-Findlay Arch or with localized faulting to be unresolved, thus the seismic design should be based on regional considerations.

3. Large Distant Earthquakes: The largest earthquake to occur in the mid-continent region of the United States was the Intensity XI-XII New Madrid earthquake of 1812. This earthquake has been associated with the central Mississippi Valley seismic zone. It is the staff

position that present knowledge would allow the earthquake zone in which such an earthquake could occur to extend as far as Vincennes, Indiana in the Wabash Valley. Assuming an Intensity XI-XII earthquake entered at Vincennes and utilizing Gupta and Nuttli's intensity distance relationship (Reference 7) results in Intensity VIII at the site (epicentral distance of 300 miles).

2.5.2.2 Safe Shutdown Earthquake

The above analysis leads to a maximum local Intensity VII-VIII at the site from nearby sources. Utilizing the Trifunac and Brady intensity acceleration curve (Reference 8) yields a peak acceleration of 0.2g.

Nuttli's analysis of intensity and ground motion at distances greater than 100 miles for central U.S. earthquakes (Reference 9), indicates lower peak accelerations and relatively stronger motions at long periods (around one second). Previous reviews of the Callaway site (Docket No. 50-483-86) showed that even at the closer epicentral distances of 155 miles, the Regulatory Guide 1.60 response spectrum scaled to 0.2g would adequately envelope the response spectra expected for a New Madrid type earthquake. Therefore, we have concluded as a result of our review that for the safe shutdown earthquake the appropriate ground acceleration for seismic design of structures at the Davis-Besse Nuclear Unit 1 is 0.2g. The applicant using a maximum intensity of VII-VIII and the Gutenberg-Richter intensity acceleration relationship, arrived at an acceleration for seismic design of 0.15g.

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2.5.2.3 Operating Basis Earthquake

Appendix A to 10 CFR Part 100 defines the OBE as that earthquake which could reasonably be expected to affect the plant site during the operating life of the plant. Probabilistic techniques taking into account historical seismicity, and regional geology would appear to be the best method for arriving at quantitative estimates of the OBE. Short or inaccurate earthquake histories and an insufficient understanding of seismogenic geological structure can place constraints on the use of such techniques. One recent study (Reference 10) has estimated the maximum horizontal acceleration in rock at different locations in the United States that have a 10 percent probability of being exceeded in 50 years. The peak value in a region consisting of most of Ohio and southeast Michigan is 0.07g. This would correspond to intensity VI utilizing the Trifunac and Brady intensity acceleration curve. Intensity VI is not an unreasonable estimate considering that the maximum intensity felt at the site, as determined from historical records, was V. The applicant has proposed a maximum horizontal acceleration of 0.08g for the OBE. We consider this a sufficiently conservative value for the OBE reference acceleration.

References

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