MIDLAND - SEISMIC INPUT

14/84
J. Kane

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

AUG 07 1980

MEMORANDUM FOR: Robert E. Jackson, Chief
Geosciences Branch, DE

THRU: Leon Reiter, Leader
Seismology Section
Geosciences Branch, DE

FROM: Jeff Kimball, Seismologist
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SUBJECT: SEISMOLOGICAL INPUT PARAMETERS IN RELATION TO GEOSCIENCES AND GEOTECHNICAL REVIEW OF MIDLAND 1 & 2

On July 2, 1980 several staff members of the Geosciences and Hydrologic and Geotechnical Engineering Branches met to discuss various methods that could be used to generate a response spectra for the Midland site. These methods included use of the Standard Review Plan (Reg. 1.60), real time histories, and Newmark-Hall (NUREG/CR-0098) using peak values for acceleration, velocity and displacement. Formerly the Michigan Basin (the region within which the site is located) was considered to be a tectonic province. Currently the staff position is that the Central Stable Region cannot be subdivided into separate tectonic provinces and that the controlling earthquake is similar to those occurring in Anna, Ohio (March 1937). Although a detailed probability study has not been attempted, the applicant has suggested (response to NRC question Q361.7) that the Michigan Basin has less seismicity compared to the entire Central Stable Region.

The Anna Chio earthquake had an estimated body wave magnitude (mbLg) of about 5.3 and an intensity of about VII-VIII. Both magnitude and intensity were used to generate different response spectra. Results from the above methods indicate that the 84th percentile response spectrum calculated from real time histories (from SSSP M=5.3 $\pm$ .5 soil sites) is similar to Reg. Guide 1.60 anchored at .13g at frequencies of interest. When using the Standard Review Plan and the intensity of the controlling earthquake (VII-VIII), the response spectra (Reg. 1.60) is anchored at .19g using the trend of the means from Trifunac and Brady (1975). The applicant originally anchored the response spectra at .12g and used a Housner spectrum over the entire frequency range. With this in mind (characterizing the earthquake in terms of magnitude and (or) intensity), I suggested that Reg. Guide 1.60 anchored at .13g or appropriate real time histories could be used as response spectra for the site.

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One topic that was discussed following the presentation was possible problems due to soil amplification at the Midland site. This problem was briefly discussed in a memo from S. L. Wastler to you on March 17, 1980. Because of the wave velocity contrasts in the natural soils beneath the plant and the man-made fill supporting and surrounding plant structures, there may be amplification of the vibratory ground motion.

Some of the factors that need to be considered in specifying ground motion at the site include the following: some buildings are founded on natural glacial till, some foundations are set on both the natural glacial till and plant fill, some are entirely on fill, other because of poor fill, are to be underpinned to till. The plant fill original design specifications were not achieved (e.g., a shear velocity of 1350 ft/sec was adopted for the plant fill, but has now been reduced to 500 ft/sec). Also the effective acceleration value suggested (o.13g) is that expected at the top of the uppermost till unit but, because of specific plant fill properties and site soil conditions, may not be the peak acceleration at the top of the fill (plant grade). A computation done by Joe Kane (Geotechnical/Engineering Section) using site soil properties at the reactor containment indicates that amplification through the ~~fill~~ foundation soils significantly occurs at a frequency of about 3-4Hz. A soil response analysis is needed to know if the soil and fill conditions would produce anomalous accelerations within the fill. Taking all the above factors into account the following ground motion specifications alternatives are possible:

Site Independent Approach

1. Require the applicant to use suggested acceleration (such as Reg. Guide 1.60 at 0.13g) as input at the foundation elevation for each structure. Disadvantage - wide range in foundation elevations would not reasonably be expected to have the same vibratory motion, hence alternative is not realistic

Site Dependent Approach

2. * Require the applicant to use the 84th percentile spectra from a set of real time histories as input at the top of the till. They then would have to calculate soil-structure interaction, including possible soil amplification for structures founded in the fill. This method could involve the use of the computer program, SHAKE, by the applicant, which, because of apparent program limitations, has sometimes calculated unreasonable acceleration levels at the ground surface when used to study soil amplification for other nuclear power projects.

below natural loose sands & plant fill

* This approach does not require anchoring to a specific g level (is very close to 0.2g @ 33Hz) because it has been developed from actual records of soil sites in Mag. 5.5 earthquake range which is appropriate for Midland

Site Dependent Approach

3. Require the applicant to gather real time data for M=5.3 ± .5, R ≤ 25 km at rock sites. Use this rock outcrop data as input to the SHAKE program at a rock outcrop of the modeled soil column, then calculate the propagation of the motion thru the glacial till and engineering fill. Acceleration histories at the various foundation levels could then be calculated taking into account the depth and dynamic properties of the till and fill below the various foundations. Again the program limitations of SHAKE must be looked at because of the great depth to the rock at this site.

(Method suggested in NUREG)

SITE DEPENDENT APPROACH

4. Require the applicant to gather real time data for M=5.3 ± .5, R< 25 km at specific soil sites assuming that this data set already represents soil and fill amplifications conditions at this particular plant. Assume the acceleration history occurs at the top of the fill and use the SHAKE program to deconvolve and calculate accelerations and seismic motion at the various foundation levels. Again the SHAKE computational limitations apply.

These alternatives were discussed on July 22, 1980 by R. E. Jackson, L. Reiter, J. Kimball, T. Cardone, L. Heller and J. Kane of the Geosciences Branch and Geotechnical Engineering Branch. L. Heller initiated discussion by saying he thought method number 2 would be the most appropriate because of the complex foundations to be utilized for this plant and because the spectra to be developed represents the motion of naturally occurring soils. Others present agreed with this and the discussion centered on a statement of staff position. This position would take into account the fact that the applicants limiting earthquake differs from that currently accepted by the staff and that soil amplification problems should be addressed.

The major elements of the position would take the following form.

1. The controlling earthquake is assigned a body wave magnitude of 5.3. It should be noted here that this magnitude is also suggested by Nuttli (1978) as the maximum when using Residual events (those left over after Anna, Wabash etc. are removed) for the Central United States.

2. The applicant should use a collection of real time histories for M=5.3 ± .5, R<25 km and soil sites. This collection could come from TERA Corporation (Seismic Hazard Analysis: submitted to Lawrence Livermore Laboratory 1979) but it would be suggested that the applicant update this data set.

3. The 84th percentile (mean plus one standard deviation) response spectra should be used as input at the top of the uppermost cohesive till unit. Above the till is a thin but variable sand layer and plant fill. The applicant could then calculate the motion that would occur at the various structural foundations as a part of the soil-structure interaction analysis which should adequately address soil amplification.

4. The NRC staff is aware of the limitations of SHAKE and SSI computational programs and recognize that unreasonable response acceleration values are a possible outcome of the applicants analysis using a broad-band spectra at the top of the till. These results however, are needed for use in a qualitative sense to address the question of soil amplification and the seismic response of the plant fill.

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Once the branch position has been forwarded, GSB, HGEB, and SEB should meet to discuss the current position in relation to what the applicant has designed for.

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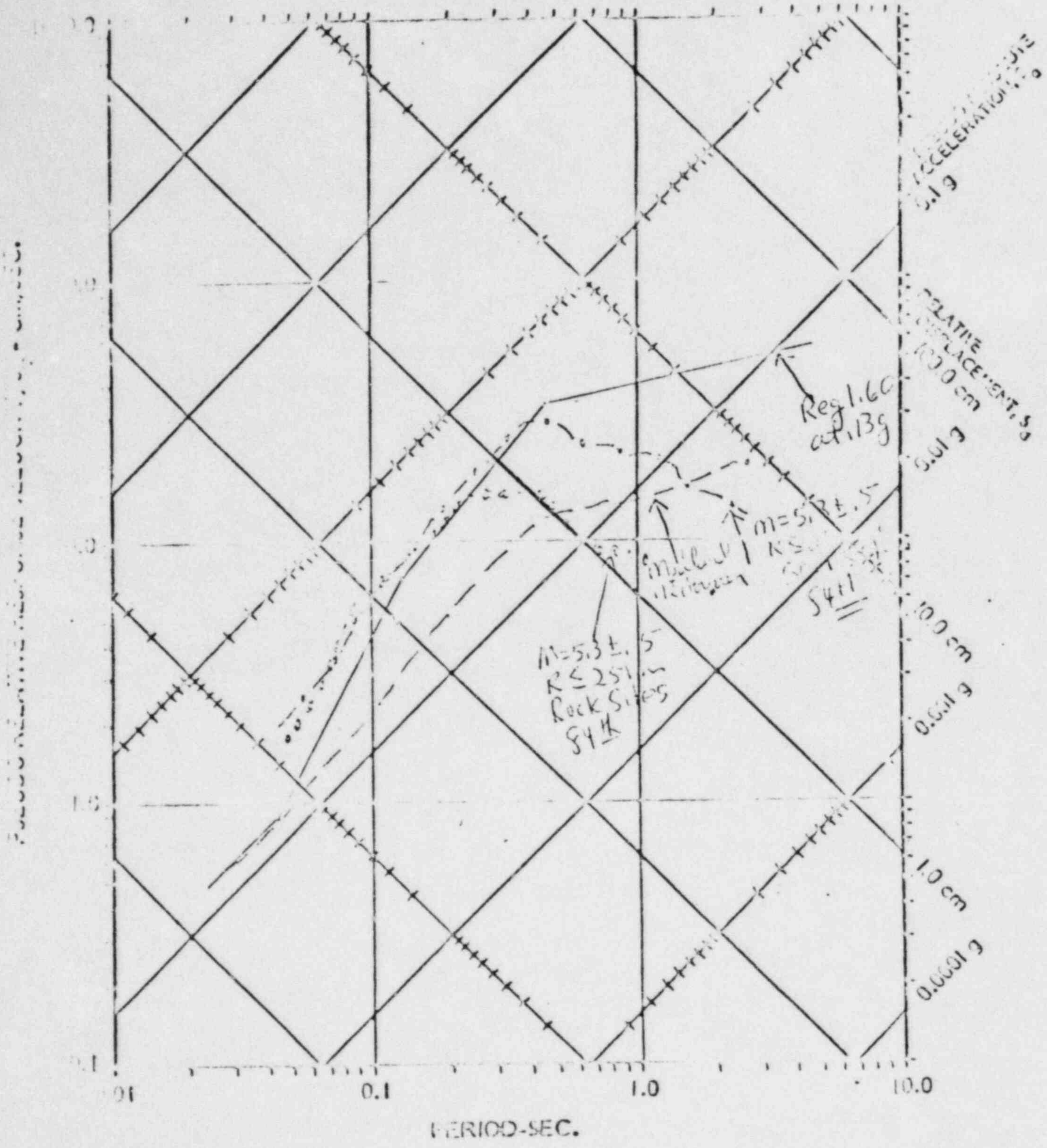

ACCELERATION, g
0.1 g
RELATIVE DISPLACEMENT, Sd
100.0 cm
0.01 g
10.0 cm
0.001 g
1.0 cm
0.0001 g
Reg 1.60
at .13g
M=5.3 ± .5
R ≤ 25 km
Rock Sites
84 th
.01
0.1
1.0
10.0
PERIOD-SEC.

7/22/80

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Seismic Design BEFORE current reanalysis (As of 11/78)

A3.7-1 - Modified the TAFT time history to produce a response record which enveloped the "modified Housner" response spectra

- Appear to have put design response spectra input at foundation level & used lumped mass model (Fig. 3.7-9 & Table 3.7-3 for OBE, Containment Bldg.)

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* No analysis conducted that addresses soil amplification
Reason - The method (Trifunac & Brady or Neumann) used to determine peak acceleration from an SSE event depends upon a relationship between PEAK ACCELERATION and INTENSITY which is based on a broad spectrum of soil conditions and therefore the adopted PEAK ACCELERATION VALUE is considered to be conservative without further need to consider amplification