Recommended Design Ground Motion for Facilities at Paducah Gaseous Diffusion Plant

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Introduction

Selecting a level of seismic hazard for engineering design of facilities at the Paducah Gaseous Diffusion Plant is not an easy task because it not only depends on seismic hazard itself, but also on seismic risk and other related environmental, social, and economic factors. Seismic hazard is the basis for engineering design, however. There is no question that there are seismic hazards at the Paducah Gaseous Diffusion Plant because of its proximity to several known seismic zones, particularly the New Madrid Seismic Zone (NMSZ). The issues in estimating seismic hazard are (1) difficulty in characterizing the uncertainties of seismic sources, earthquake occurrence frequencies, and ground-motion attenuation relationships and (2) the methods being used.

What Do We Know About Earthquake Around PGDP?

The causes of intraplate earthquakes in the central United States are not well understood. Two hypotheses have been proposed to explain this seismicity: (1) selective reactivation of preexisting faults by local variations in pore pressure, fault friction, and/or strain localization along favorably orientated lower-crustal ductile shear zones formed during earlier deformation and (2) local stress perturbations that may produce events incompatible with the regional stress field. Figure 1 shows recorded earthquakes between 1974 and 2000 in NMSZ and surrounding area. At least three large earthquakes with magnitude about 7.5 occurred between December 1811 and February 1912 in NMSZ. As shown in Figure 1, there are some moderate to strong earthquakes occurred near Paducah.

How Strong Ground Motion Could be Expected at PGDP?

How strong of ground motion could be expected at site depends on earthquake magnitude, the distance from the earthquake source, and site geologic conditions. Generally, the larger an earthquake's magnitude, the stronger ground motion it will generates and the closer a site is to the source, the stronger the ground motion, and vice versa. Figure 2 shows the observed modified Mercalli intensity (MMI) from the February 7, 1812, earthquake. As shown in Figure 2, the Jackson Purchase Area, including Paducah, experienced an MMI VIII during the February 7, 1812, earthquake. MMI VIII is equivalent to peak ground acceleration of 0.25-0.30g (i.e., 25 to 30 percent of the acceleration of gravity).

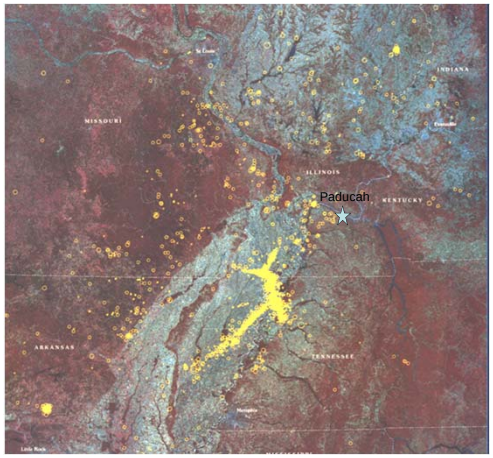

Figure 1. Recorded earthquakes between 1974 and 2000 in NMSZ and surrounding area.

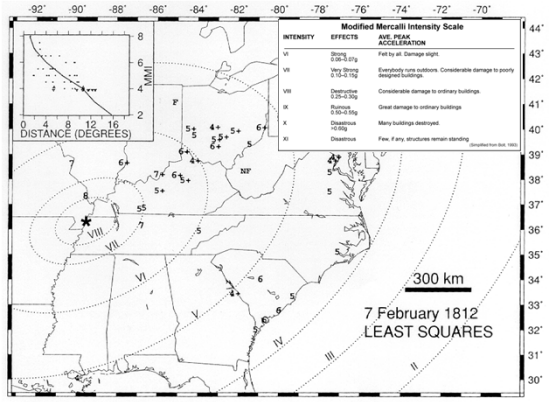

Figure 2. The observed modified Mercalli intensity (MMI) from the February 7, 1812, earthquake.

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Although earthquakes from the Wabash Valley Seismic Zone (WVSZ) and nearby may also have impact, the large earthquakes in NMSZ has the most significant impact on the facilities at PGDP. Figure 3 shows the earthquakes recommended for seismic design consideration of facilities at PGDP. Table 1 lists the recommended design ground motion.

Table 1. Recommended design ground motions on hard rock at PGDP.

Facility	Design Ground Motion	PGA (g)	0.2s PSA (g)	1.0s PSA (g)
Ordinary	Median	0.27	0.40	0.10
Critical	Median + one standard deviation	0.50	0.80	0.20

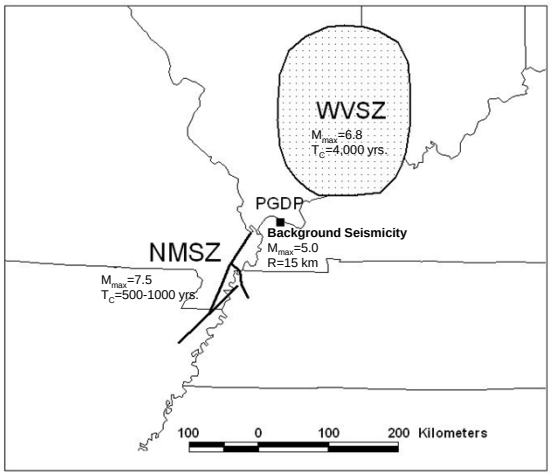

Figure 3. The earthquake sources for seismic design consideration of facilities at PGDP

Reference: Wang, Z., and Woolery, E.W., 2008, Seismic Hazard Assessment of Paducah Gaseous Diffusion Plant, Kentucky Geological Survey, Special Publication 9.