www.hartcrowser.com

HARTCROWSER
Delivering smarter solutions

Anchorage Boston Chicago Denver Fairbanks Jersey City Juneau Long Beach Portland Seattle

MEMORANDUM

DATE: October 8, 1999

TO: Jim Thomson, P.E., HNTB

FROM: Michael Bailey, P.E., Allen Jones, P.E., and Doug Lindquist, Hart Crowser Inc.

RE: Sea-Tac Airport Third Runway
Probabilistic Seismic Hazard Analysis Results
J-4978-14

This memorandum presents geotechnical engineering findings from our probabilistic seismic hazard analysis (PSHA) for the Third Runway project at the Sea-Tac Airport. We present a relation between peak horizontal acceleration (PHA) and the return interval. With this seismic hazard curve, the Port of Seattle can select what level of earthquake, in terms of mean annual return interval, and find the corresponding peak horizontal acceleration to design for.

Analyses and Results

The PSHA analysis involves evaluating the seismic hazard from sources in the region that will contribute to strong ground motions at the site. Strong ground motions are motions that have the potential to produce damage to the Third Runway project and are defined as motions with a PHA greater than about 0.05 g. Sources producing these types of earthquakes include Cascadia events in and between the North American Plate and the Juan de Fuca Plate, the Seattle Fault, and shallow crustal zones throughout Western Washington. The two most significant recent events in the Puget Sound region are the 1949 Olympia earthquake (PHA = 0.28 g) and the 1965 Seatac earthquake (PHA = 0.20 g).

For this study, seismic hazard is a function of the variation in source magnitude, variation in earthquake return interval, and variation of source to site distance. Total seismic hazard for the Third Runway site is the summation of the seismic hazard from each source. The mean annual rate of return for a site is commonly referred to in terms of probabilities of exceedence. The most commonly used exceedence probabilities are listed in Table 1, with the corresponding PHAs computed for this study. Other PHAs for other return periods can be obtained by using the uniform risk curve presented on Figure 1.

1910 Fairview Avenue East
Seattle, Washington 98102-3699
Fax 206.328.5581
Tel 206.324.9530

Table 1 - Peak Horizontal Acceleration at the Sea-Tac Airport for Common Design Levels of Risk

Probability of Exceedence	Mean Annual Return Interval (see Figure 1)	Peak Horizontal Acceleration
50% in 50 years	72 years	0.16 g
10% in 50 years	475 years	0.36 g
5% in 50 years	975 years	0.47 g
2% in 50 years	2475 years	0.64 g

Discussion

Selection of the level of risk to design for is an integral part of the seismic design process. Using a design level event with a low mean annual rate of return means it has a higher probability of occurring, and is thus an event with a relatively weak ground motion. Based on input from the engineer, the project owner typically selects what is an acceptable level of seismic risk. For the case of embankment design, the lower probability events will result in larger estimated design deformations of the runway embankment. To aid in the selection of an appropriate design acceleration, we present some examples of what levels of risk we have provided in our geotechnical reports and what was used in design (bold) on other projects.

1999 Sea-Tac South Terminal Expansion (prior study)
10% probability of exceedence in 50 years (475-year event) 0.33 g
10% probability of exceedence in 100 years (950-year event) 0.46 g

1998 Martin Smith Fourth & Madison (378 tons) High-Rise Building
10% probability of exceedence in 50 years (475-year event) 0.34 g
2% probability of exceedence in 50 years (2475-year event) 0.76 g

1997 Safeco Data Center (Owner required very high earthquake resistance)
50% probability of exceedence in 50 years (72-year event) 0.15 g
10% probability of exceedence in 50 years (475-year event) 0.33 g
10% probability of exceedence in 100 years (950-year event) 0.42 g

Care should be taken when comparing peak accelerations to different projects at different sites in this region. The relative distance to seismic sources, particularly the distance to the Seattle Fault can be very different. In addition, many advances have been made in the past 5 to 10 years in understanding of the seismology of the region and the expected peak accelerations have risen in that time. The enclosed curve represents data specific to the Third Runway site.

Continuing Work

We recommend meeting with HNTB and the Port to select a seismic basis of design for the Third Runway embankment. Based on this memorandum and conversations with the Port, we propose to mutually select the level of risk to be the basis of seismic design. Once the level of risk is selected, we will use the corresponding peak horizontal acceleration to generate acceleration time histories to be the basis for the embankment and wall design. The computed accelerations and time histories will be used for dynamic slope stability and deformation analyses.

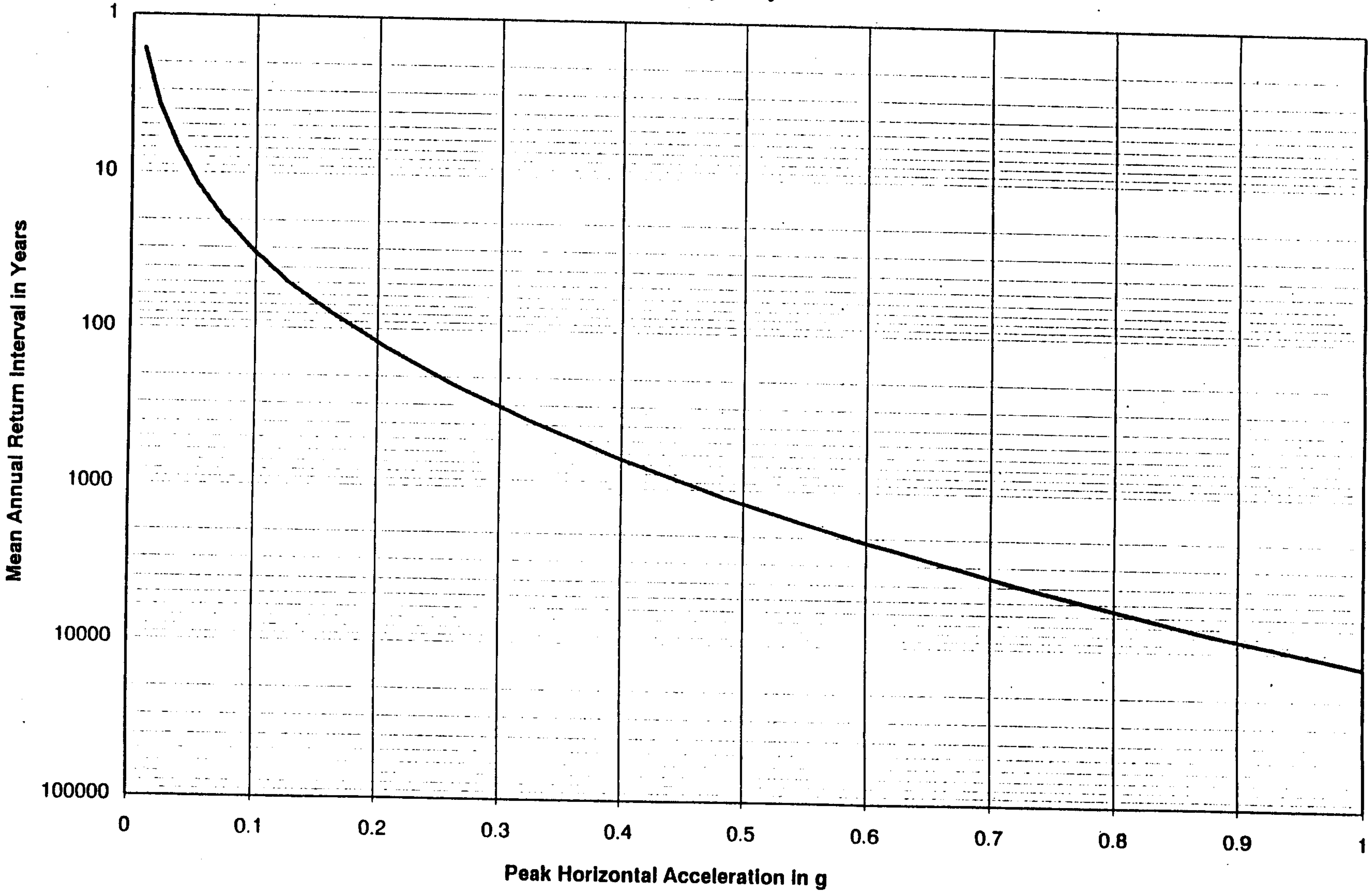
We trust this memorandum meets your current needs. Please call if you have questions or need additional information.

PSHA.doc

Attachment:

Figure 1 - Site-Specific Uniform Risk Curve for Peak Horizontal Acceleration
Third Runway Project

Site-Specific Seismic Hazard Curves for Peak Horizontal Acceleration
Third Runway Project



Hart Crowser, Inc.
J-4978-14 10/99
Figure 1