Guidelines for Site-Specific Seismic Hazard Reports for Essential and Hazardous Facilities and Major and Special-Occupancy Structures in Oregon

By the Oregon Board of Geologist Examiners and the Oregon Board of Examiners for Engineering and Land Surveying.

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For over a year, the Board of Geologist Examiners has fostered the development of this document. It was drafted by members of this Board, with input from the practice community through several professional societies. Local chapters of the Association of Engineering Geologists and the Geotechnical Engineering Technical Group of the American Society of Civil Engineers, Oregon Section, were major contributors. The Boards intend to keep the guidelines current and flexible through continuous input from the practice community. Comments and suggestions for improvement of the guidelines are welcomed and encouraged and should be directed to either Board. Both agencies are located at 750 Front Street NE, Salem, OR 97310.

I. INTRODUCTION

These guidelines were prepared by the State of Oregon Boards of Geologist Examiners and Examiners for Engineering and Land Surveying to assist those who prepare reports for site-specific seismic hazard reports for essential facilities, hazardous facilities, major structures and special occupancy structures as provided in Oregon Revised Statutes 455.447(2)(a) and Oregon Administrative Rules 918-460-015. The guidelines describe the general content of these reports and are not intended to be a complete listing of all the elements of a site-specific seismic hazard report as outlined in Section 2905 of the Oregon Structural Specialty code.

These guidelines are intended to be used as a checklist for projects of varying size and complexity including hospitals, schools, and emergency-response facilities. The preparer and the reviewer of site-specific seismic hazard reports are expected to tailor the scope of work and interpretations to the size, occupancy, and critical use of the proposed structure. It is recognized that the techniques used to evaluate a site for a larger and more critical facility will be more complete and detailed than for a smaller and less critical building or other structures. The site-specific investigations vary according to the local geologic conditions that may affect the performance of the proposed or existing structure and to the proximity to faults that are expected to be seismogenic. The investigator(s) is (are) expected to be knowledgeable about the current practice of seismic geology and earthquake engineering and should be aware of the need to provide designers of buildings and other structures with information that can be readily utilized in construction or remodeling projects to reduce seismic risk.

The professional who is performing, signing, and stamping the site-specific investigation is responsible for the adequacy of investigative procedures and reporting that will adequately characterize seismic risk for the proposed use of the subject site. The report should clearly state the techniques used in the investigation, the data acquired, and the findings and recommendations, so that peer reviewers and users of the resulting reports will have a basis for judging the adequacy of the investigation.

In Oregon, the complexity of local geology, limited geologic exposure, variety of earthquake types, and the potential for multiple seismic hazards, including ground shaking, fault rupture, amplification, landsliding, liquefaction, uplift and subsidence, seiche, and tsunami generation, necessitate a choice of investigative techniques that will vary from site to site and that must be chosen based on the geologic hazards and subsurface conditions and on the intended use of the structure.

The following guidelines are intended to be applicable for projects with a wide range in size, cost, and utility. Flexibility in the use of the guidelines is expected, and professional judgment is needed in the selection of work elements for the investigation and in the thoroughness of the resulting report. The preparer and the reviewer of site-specific seismic hazard reports are expected to be familiar with the use of such reports by engineers engaged in the geotechnical and structural design of buildings, so that the reports are designed to be routinely used by designers to maximize the reduction in seismic risk, as structures are constructed or retrofitted.

State law, related administrative rules, and state and local building codes are evolving in an effort to mitigate seismic risk. The preparers, supervisors, and reviewers of site-specific seismic hazard reports are expected to be knowledgeable about relevant laws, rules, and codes.

Some cities and counties in Oregon have ordinances requiring geologic hazard reports. The content of these reports may overlap with the guidelines for the site-specific seismic hazard reports. The geologic hazard reports typically are required for areas mapped by the Oregon Department of Geology and Mineral Industries as landslide or potential landslide areas or as tsunami inundation areas. The geologic hazard reports required by local government ordinance may cover a broader range of facility uses, sizes, and occupancy levels than the site-specific seismic hazard reports that are the focus of these guidelines. The geologic hazard reports range in scope from reconnaissance level investigations to more intensive site-specific seismic hazard studies.

These guidelines are intended to be informal and not regulations. The guidelines are expected to evolve, as the relevant seismic hazards are better defined and as building codes and engineering practices change.

II. CONTENT OF SITE-SPECIFIC SEISMIC HAZARD REPORTS

The following information should be considered in preparing site-specific seismic hazard reports in Oregon.

A. Purpose and scope of the investigation, including a brief description of the proposed site use, size of the proposed building or other structure, occupancy, and current seismic zonation (UBC).

B. Regional geologic and tectonic setting, including a complete list of all seismogenic faults that could impact the site and a description of the crustal, intraplate, and subduction-zone earthquake hazards.

C. Site conditions, including elevation, subsurface conditions, landforms, site grading, vegetation, existing structures, and other features that may influence the investigation.

D. Description of the investigation

   1. Regional seismic history and tectonic setting

      a. Significant historic earthquakes and tsunamis in the region and locations and magnitudes of seismic events in the vicinity of the site. Crustal earthquakes, intraplate, and interface subduction zone events should be included.

      b. Evidence of prehistoric earthquakes and tsunamis that may have affected the site.

      c. Map showing the location of seismic features relative to the proposed project and an estimate of the amount of disturbance relative to bedrock and surficial materials.

      d. Selection for appropriate strong-motion attenuation relationships for the site.

   e. Published probabilistic estimate of earthquake occurrence.

   f. Geodetic and strain measurement, microseismicity monitoring, or other monitoring.

2. Interpretation of aerial photography and other available remotely sensed images relative to the geology and earthquake history of the site, including vegetation patterns, soil contrasts, and lineaments of possible fault origin.

3. Site investigation

   a. Detailed field mapping of soils, geologic units and structures, and topographic features indicative of faulting, such as sag ponds, spring alignments, disrupted drainage systems, offset topographic and geologic features, faceted spurs, vegetation patterns, and deformation of buildings or other structures.

   b. Review of local groundwater conditions including water depth and elevation.

   c. Trenching and other excavating to permit the detailed and direct observation and logging of continuously exposed geologic units, including soils and features that are relevant to seismic hazards. Trenching should cross known or suspected active faults in order to determine the location, timing, and recurrence rate of past movements, the area disturbed, the physical condition of fault zone materials, and the geometry of faulting.

   d. Exploratory drilling and/or test pits designed to permit the collection of data needed to evaluate the depth, thickness, and types of earth materials and groundwater conditions that may identify past seismicity or could contribute to damage potential at the site. Drill holes and/or pits should be located and spaced sufficiently to allow valid interpretations of the resulting data. Subsurface testing could include Standard Penetration Tests (SPT), Cone Penetrometer Tests (CPT), undisturbed tube samples, and collection of bulk samples for laboratory testing.

   e. Surface and subsurface geophysical surveys as appropriate to determine the dynamic properties of the subsurface materials, including shear-wave velocity, shear modulus, and damping.

4. Subsurface investigation

   a. Laboratory testing of samples for moisture content, grain size, density, dynamic properties, and other pertinent parameters.

   b. Radiometric analysis of geologic units, study of fossils, mineralogy, soil-profile development, paleomagnetism, or other age-determinating techniques to characterize the age of geologic units.

   c. Estimates of expected magnitude, acceleration, and duration of strong motion for the design earthquakes for crustal and intraplate and interface subduction-zone sources and for other defined earthquakes if required by statute or regulation of the proposed project. The rationale for earthquake-source selection for the relevant types of events should be provided. The design basis earthquakes and ground acceleration maps available from the State of Oregon should be consulted and described.

d. Determination of appropriate UBC site-specific soil-profile coefficients.

e. Analytic dynamic soil response analyses to evaluate potential amplification or attenuation of subsurface soil deposits to the underlying bedrock motions.

f. Evaluation of the liquefaction potential of the subsurface deposits at the site and, if applicable, estimation of liquefaction-induced settlement and liquefaction-induced lateral spreading.

g. Evaluation of other seismic hazards, including earthquake-induced landslides, generation of tsunamis or seiches, regional subsidence, and fault displacement.

E. Conclusions and recommendation

1. Summarize the results of the seismic study, including the review of regional seismicity, site investigations, selection of the design earthquakes, and office analysis, including the evaluation of ground response, liquefaction, landsliding, and tsunamis on the proposed structure and use of the site. The report should be stamped and signed by a certified engineering geologist or by a registered professional engineer experienced in seismic hazard design or by both, when the work of each can be clearly identified.

2. Recommendations for site development to mitigate seismic hazards. The recommendations could include: ground modification to reduce amplification of ground shaking or liquefaction-induced settlement and lateral spreading potential, remedial treatment options for slope stability, and foundation alternatives to minimize seismic impact to structure.

F. References and appendices

1. Literature and records reviewed.

2. Aerial photographs or other images used, including the type, scale, source, date, and index numbers.

3. Maps, photographs, plates, and compiled data utilized in the investigation.

4. Description of geophysical equipment and techniques used in the investigation.

5. Personal communications or other data sources.

G. Illustrations

1. Location map to identify the site locality, significant faults, geographic features, seismic epicenters, and other pertinent data.

2. Site development map at a scale appropriate to show the site boundaries, existing and proposed structures, graded and filled areas, streets, and proposed and completed exploratory trenches, geophysical traverses, drill holes, pits, and other relevant data.

3. Geologic map and sections showing the distribution of soils, geologic units, topographic features, faults and other geologic structures, landslides, lineaments, and springs.

4. Logs of exploratory trenches, borings, and pits to show the details of observed features and conditions. Groundwater data should be included.

III. ACKNOWLEDGMENTS

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