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Standard Guide for Seismic Risk Assessment of Buildings[1]

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INTRODUCTION

Lenders, insurers, and equity owners in real estate are giving more intense scrutiny to earthquake risk than ever before. The 1989 Loma Prieta, California earthquake, which caused more than $6 billion in damage, accelerated the trend toward considering loss estimation in real estate transactions. The 1994 Northridge, California earthquake, with over $20 billion in damage, made seismic risk assessment an integral part of real estate financial decision-making for regions at risk of damaging earthquakes. Users of Seismic Risk Assessment reports need specific and consistent measures for assessing the possibility of future loss due to earthquake occurrences. This guide discusses specific approaches that the real estate and technical communities can consider a basis for characterizing the seismic risk assessment of buildings in an earthquake. It uses two concepts to characterize earthquake loss: probable loss (PL) and scenario loss (SL). Use of the term probable maximum loss (PML) is acceptable, provided it is specifically and adequately defined by the User.

1. Scope

1.1 This guide provides guidance on conducting seismic risk assessments for buildings. As such, this guide assists a User to assess a property's potential for losses from earthquake occurrences.

1.1.1 Hazards addressed in this guide include earthquake ground shaking, earthquake-caused site instability, including fault rupture, landslides and soil liquefaction, lateral spreading and settlement, and earthquake-caused off-site response impacting the property, including flooding from dam or dike failure, tsunamis and seiches.

1.1.2 This guide does not address the following:

1.1.2.1 Earthquake-caused fires and toxic materials releases.

1.1.2.2 Federal, state, or local laws and regulations of building construction or maintenance. Users are cautioned that current federal, state, and local laws and regulations may differ from those in effect at the time of the original construction of the building(s).

1.1.2.3 Preservation of life safety.

1.1.2.4 Prevention of building damage.

1.1.2.5 Contractual and legal obligations between prior and subsequent Users of Seismic Risk Assessment reports or between Providers who prepared the report and those who would like to use such prior reports.

1.1.2.6 Contractual and legal obligations between a Provider and a User, and other parties, if any.

1.1.3 It is the responsibility of the User of this guide to establish appropriate life safety and damage prevention practices and determine the applicability of current regulatory limitations prior to use.

1.2 The objectives of this guide are:

1.2.1 To synthesize and document guidelines for seismic risk assessment of buildings from earthquakes;

1.2.2 To encourage standardized seismic risk assessment;

1.2.3 To establish guidelines for field observations of the site and physical conditions, and the document review and research considered appropriate, practical, sufficient, and reasonable for seismic risk assessment;

1.2.4 To establish guidelines on what reasonably can be expected of and delivered by a Provider in conducting the seismic risk assessment of buildings;

1.2.5 To establish guidelines on appropriate field observations and analysis for conducting a seismic risk assessment; and

1.2.6 To establish guidelines by which a Provider can communicate to the User observations, opinions, and conclusions in a manner that is meaningful and not misleading either by content or by omission.

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2. Referenced Documents

2.1 *ASTM Standards:*[2]

E631 Terminology of Building Constructions

2.2 *Other References*—The following resource documents provide technical guidance for the seismic evaluation and retrofit of existing buildings:

ASCE 7 Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers[3]

ASCE 31 Seismic Evaluation of Existing Buildings, American Society of Civil Engineers[3]

ASCE 41 Seismic Rehabilitation of Existing Buildings, American Society of Civil Engineers[3]

3. Terminology

3.1 *Definitions:*

3.1.1 See Terminology E631.

3.1.2 For definition of terms related to building construction, ASCE 31 (**1**)[4] and ASCE 41 (**2**) provide additional resources for understanding terminology and language related to seismic performance of buildings.

3.1.3 For definition of terms and additional detailed information on concepts related to seismic events and structural design, see references at the end of this document.

3.2 *Definitions of Terms Specific to This Standard*—This section provides definitions of concepts and terms specific to this guide. The concepts and terms are an integral part of this guide and are critical to an understanding of this guide and its use.

3.2.1 *active earthquake fault, n*—an earthquake fault that has exhibited surface displacement within Holocene time typically about the last 11 000 years.

3.2.2 *building code, n*—a collection of laws (regulations, ordinances, or statutory requirements) applicable to buildings, adopted by governmental (legislative) authority and administered with the primary intent of protecting public health, safety, and welfare.

3.2.3 *building contents, n*—elements contained within the building that are not defined as building systems.

3.2.3.1 *Discussion*—Examples include tenant-installed equipment, storage racks, material handling systems, shelving, stored inventories, furniture, fixtures, office machines, computer equipment, filing cabinets, and personal property.

3.2.4 *building systems, n*—all physical systems that comprise a building and its services.

3.2.4.1 *Discussion*—This includes architectural, structural, mechanical, plumbing, electrical, fire life-safety, vertical transportation and security systems. More specifically architectural systems include non-structural building envelopes, roofing, ceilings, partitions, non-structural demising walls etc; structural systems include both gravity and seismic force-resisting systems and foundations; mechanical systems include heating, ventilating and air conditioning equipment, ducts, control systems etc; plumbing systems include domestic water heaters, piping, controls, plumbing fixtures, waste water system piping and natural gas or propane systems, storm water drains and pumps etc; electrical systems include switchgear, transformers, breakers, wiring, lighting fixtures, emergency power systems etc; and fire life-safety systems include fire sprinkler systems, monitoring and alarm systems etc. Not included in building systems are those contained within a building and defined as building contents.

3.2.5 *business interruption, n*—a period of interruption to normal business operations that can potentially or materially cause a loss to the owner/operator of that business.

3.2.5.1 *Discussion*—The loss may be partial or total for the period under consideration. Business interruption is expressed in days/weeks/months of downtime for the building as a whole or the equivalent operating value.

3.2.6 *correlation, n*—the tendency or likelihood of the behavior of one element to be influenced by the known behavior of another element.

3.2.7 *distribution function, n*—the probability distribution for a random variable.

3.2.7.1 *Discussion*—The random variable may include such things as loss, ground motion, or other consequence of earthquake occurrence (**3-5**).

3.2.8 *damage or repair cost, n*—cost required to restore the building to its pre-earthquake condition, allowing for salvage and demolition.

3.2.8.1 *Discussion*—The value includes hard costs of construction as well as soft costs for design, site supervision, management, etc. (See also *replacement cost*.)

3.2.9 *damage ratio, n*—ratio of the damage or repair cost divided by the replacement cost.

3.2.10 *dangerous conditions, n*—situations that pose a threat or possible injury to the occupants.

3.2.11 *design basis earthquake (DBE), n*—the site ground motion with a 10 % probability of exceedance in 50 years, equivalent to a 475-year return period for exceedance, or a 0.2105 % annual probability of occurrence.

3.2.11.1 *Discussion*—The design basis earthquake ground motions are associated with any earthquake that has the specified site ground motion value; often there are several earthquakes with different magnitudes and causative faults that yield equivalent site peak ground motions.

3.2.12 *deficiency, n*—conspicuous defect(s) in the building or significant deferred maintenance items of a building and its components or equipment.

3.2.12.1 *Discussion*—Conditions resulting from the lack of routine maintenance, miscellaneous repairs, operating maintenance, etc. are not considered a deficiency.

3.2.13 *due diligence, n*—the assessment of the condition of a property for the purposes of identifying conditions or characteristics of the property, including potentially dangerous

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Society of Civil Engineers (ASCE), 1801 Alexander Bell Dr., Reston, VA 20191, http://www.asce.org.

[4] The boldface numbers in parentheses refer to the list of references at the end of this standard.

conditions, that may be important to determining the appropriateness of the property for financial or real estate transactions.

3.2.13.1 *Discussion*—The extent of due diligence exercised on behalf of a User is usually proportional to the User's tolerance for uncertainty, the purpose of seismic risk assessment, the resources and time available to the Provider to conduct the site visit and research.

3.2.14 *expected value, n—of a random variable*, the average or mean of the distribution function.

3.2.14.1 *Discussion*—The expected value is determined as the sum (or integral) of all the values that can occur multiplied by the probability of their occurrence. (Compare: *median value*.)

3.2.15 *fault zone, n*—area within a prescribed distance from any of the surface traces of a fault.

3.2.15.1 *Discussion*—The distance depends on the magnitude of earthquakes that could occur on the fault—typically 500 ft (152 m) from major faults, which are those capable of earthquakes with magnitudes of 6.5 or greater, and 250 ft (761 m) away from other well-defined faults. Within California, the fault zones are determined by the California Geological Survey under the Earthquake Special Studies Zones Act for active and potentially active earthquake faults that have been identified by the state or other governmental bodies.

3.2.16 *Independent Reviewer, n*—technically qualified individual or organization that has not been engaged in the design or modifications of the building(s), and is not in any way affiliated with the Provider.

3.2.16.1 *Discussion*—The concept may also be represented by the phrases "independent technical reviewer," or "independent peer reviewer".

3.2.17 *interdependency, n*—a condition wherein the function of the building is dependent on another building, on utilities, or on other critical elements in the supply chain.

3.2.17.1 *Discussion*—Other critical elements include transportation and may include a customer, vendor (for example, supplier of materials), contractor (supplier of services), staff (for example, supplier of staff), information (for example, data processing for accounting or distribution), etc.

3.2.18 *landslide, n—(1)* ground motion, the rapid downslope movement of soil or rock material, or both, often lubricated by ground water, over a basal shear zone; and *(2)* geological, stationary material deposited in the past by the rapid downslope movement of soil or rock material, or both.

3.2.19 *lateral load-resisting system, n*—the elements of the building system that resist the seismic forces applied to the building. This includes vertical, horizontal, and torsional response of elements and systems.

3.2.20 *magnitude of earthquake, n*—any of a variety of measures that indicates the "size" of an earthquake.

3.2.20.1 *Discussion*—At least 20 different magnitude scales are in use within the technical community. The most commonly used lay term is the Richter magnitude, which is determined by taking the common logarithm (base 10) of the largest ground motion recorded during the arrival of a "P" wave, or seismic surface wave, and applying a standard correction for the distance to the epicenter of the earthquake. The measure most widely used in the technical community is the moment magnitude, a measure of the total strain energy released in the event. Magnitudes calculated using different scales can vary widely for the same earthquake.

3.2.21 *maximum capable earthquake (MCE), n*—earthquake that can occur within the region that produces the largest average ground motion at the site of interest.

3.2.21.1 *Discussion*—This is NOT the same as the ASCE 7 definition of MCE, which is a ground motion with a 2475-year return period or 150 % of the median ground motion in a design basis earthquake, which ever is the lesser. The concept of MCE for purposes of the guide does not include a return period value.

3.2.22 *median value, n*—value that divides the distribution function into equal parts, such that the value of the random variable has an equal probability of being above or below the reference value. (Compare *expected value*.)

3.2.23 *Modified Mercalli Intensity (MMI), n*—qualitative description of the local effects of the earthquake at a site.

3.2.23.1 *Discussion*—Normally, it is given as a roman numeral, from I to XII, to emphasize its qualitative, not quantitative, nature. A single earthquake can have many different MMI intensities assigned over the region in which the earthquake is felt. MMI does not specify a specific ground motions, but a range of peak horizontal ground motion are assigned to a given MMI value. Use of MMI to characterize ground motions for use in the seismic risk assessment of buildings should be done with caution because the damage level predicted is associated with a very wide range of earthquake ground motions, not a specific earthquake ground motion.

3.2.24 *non-structural components, n*—components of a building system that are not part of the vertical or lateral-load resisting structural systems nor are defined as building contents.

3.2.25 *observations, n*—the relevant information or measurements, or combination thereof, documented during the site visit survey.

3.2.26 *obvious, adj*—readily accessible and can be seen easily by the independent reviewer without the aid of any instrument or device and understood by the Provider as a result of a walk-through survey.

3.2.27 *occupant, n—of a building*, a group or organization, or a part thereof, or an individual or individuals, that is or will be occupying space in a particular facility.

3.2.27.1 *Discussion*—Persons who are authorized to be present only temporarily, or in special circumstances such as those permitted to pass through during an emergency, are visitors.

3.2.28 *original construction documents, n*—documents used in the initial construction phase and any subsequent modification(s) of building(s) for which the seismic risk assessment is prepared.

3.2.28.1 *Discussion*—Generally as-built plans are the preferred form of construction documents.

3.2.29 *other earthquake hazards, n*—other earthquake hazards include, but are not limited to, soil liquefaction; ground deformation including subsidence, rupture, differential settlement, landsliding, slumping, etc; and, hazards from off-site response to the earthquake including flooding from dam or dike failure, tsunami, or seiche.

3.2.30 *Owner, n*—the entity or individual holding the deed to the building, or their designated representative. An agent or contractor may be considered an owner in some circumstances.

3.2.31 *P-delta effect, n*—the secondary effect of column axial loads and lateral deflections on the shears and moments in various components of a building.

3.2.32 *peak ground acceleration, (PGA), n*—the maximum acceleration at a site caused by an earthquake ground motion. PGA may be an actual recording or an estimate. PGA is most often given as the maximum of the horizontal components and is usually expressed as a fraction of gravitational acceleration, g, 33.2 ft/s^2 (9.8 m/s^2). Often the terms effective peak acceleration (EPA) and/or effective maximum acceleration (EMA) are used in seismic analysis; these are often expressed as a fraction of the peak value to represent a more meaningful measure of an earthquake ground motion.

3.2.33 *potentially active earthquake fault, n*—an earthquake fault that shows evidence of surface displacement during the Quaternary period (approximately the last two million years).

3.2.34 *probabilistic ground motion, n*—earthquake ground motions for the building site that are determined from an evaluation of the seismic exposure for the site for a given time period and are represented by a probability distribution function. Where appropriate, the ground motion assessment process should reflect conditional probabilities of the temporal dependence of earthquakes on specific seismic features, where they are known.

3.2.35 *probable loss (PL), n*—earthquake loss to the building systems that has a specified probability of being exceeded in a given time period, or an earthquake loss that has a specified return period for exceedance.

3.2.35.1 *Discussion*—This value is meant to reflect in a statistically consistent computational manner all of the uncertainties that can impact damage, including when and where earthquakes occur and with what magnitude, attenuations of ground motion to the site, local site effects and performance of the building systems in this ground motion. The PL is expressed in terms of the damage ratio and is generally limited to earthquake loss associated with the earthquake ground-shaking hazard, but may include losses from other earthquake hazards as prescribed by a User. Dollar values can be determined by multiplying the damage ratio by the replacement cost estimate for the building. Where seismic analysis of discounted present value is to be performed then annual PL, mean and standard deviation are appropriate damageability measures for use in such application.

3.2.36 *probable maximum loss (PML), n*—term historically used to characterize building damageability in earthquakes.

3.2.36.1 *Discussion*—PML has had a number of very different explicit and implicit definitions. The concepts of probable loss (PL) and scenario loss (SL) are used in this guide to characterize the earthquake losses of buildings or groups of buildings. When a Provider uses the term PML, it should be defined in terms of SL or PL as defined herein.

3.2.37 *Provider, n*—person or organization that conducts the site visit and prepares a report on the seismic risk of a building or group of buildings.

3.2.38 *replacement cost, n*—cost required to construct an entirely new building of the same size, envelope, configuration and character as the referenced building, assuming a virgin site.

3.2.38.1 *Discussion*—Replacement cost includes costs for construction, including building materials and labor; design; site supervision; management; etc.

3.2.39 *retrofit scheme, n*—preliminary suggestion(s) of modifications or additions to the building intended to correct, mitigate, or repair a physical deficiency that will improve the seismic performance of the building so that it is acceptable to the User.

3.2.39.1 *Discussion*—The term "rehabilitation" is used in lieu of "retrofit" in ASCE 41.

3.2.40 *return period, n—of a random variable*, is the inverse of the annual probability that the value is equaled or exceeded.

3.2.40.1 *Discussion*—Return period is not the time period between occurrences of the value, but is the long-term average of the random times between occurrences. Often, return period is incorrectly interpreted to mean that if the value was realized in 1994, and the return period is 100 years, then the next occurrence will be in 2094. For example, earthquake occurrences usually are considered as Poisson-distributed random variables, that is, variables where the probability is near constant from year to year, and the probability of an occurrence this year is independent of what happened last year. For a Poisson random variable, the probability that the value will be equaled or exceeded in its return period term is 63 %.

3.2.41 *scenario expected loss (SEL), n*—expected value of the scenario loss for the specified ground motion of the earthquake scenario selected.

3.2.42 *scenario loss (SL), n*—earthquake damage loss expectation to building systems and site improvements and where User-prescribed, building contents and/or related business interruption loss, associated with specified earthquake events on specific fault(s) affecting the building.

3.2.42.1 *Discussion*—SL values are expressed in terms of the damage ratio or damage cost/repair cost in present day dollars. The SL is generally limited to earthquake loss associated with the earthquake ground-shaking hazard, but may include losses from other earthquake hazards, as prescribed by a User.

3.2.43 *scenario upper loss (SUL), n*—scenario loss that has a 10% percent probability of exceedance due to the specified ground motion of the scenario considered.

3.2.44 *seiche, n*—water wave caused in an enclosed, or partially enclosed, body of water in response to the passage of seismic waves.

3.2.45 *site visit, n*—visual reconnaissance of the site and physical property by the Provider to gather information on the physical property for the purposes of preparing seismic risk assessment.

3.2.45.1 *Discussion*—The Provider is not expected to use or provide scaffolding, ladders, magnifying lenses, etc. in undertaking the visual reconnaissance of the building systems and components during the site visit. This definition implies that such a visit is preliminary, not in-depth, and typically done without the aid of exploratory probing, removal of materials, or testing. It is literally the Provider's visual survey of the building(s) and site improvements.

3.2.46 *soil liquefaction, n*—the transformation of loose, saturated, sandy soil materials into a fluid-like state.

3.2.46.1 *Discussion*—Damage from soil liquefaction results primarily from horizontal and vertical displacements of the ground. This movement of the land surface can damage buildings and buried utility lines such as gas mains, water lines and sewers, particularly at their connection to the building. Extreme tilting or settlement of the building can occur if soil liquefaction occurs underneath the building foundations.

3.2.47 *statistically consistent manner, n*—following the mathematical rules and concepts of probability and statistics.

3.2.48 *structural component, n*—component that is a part of a building's lateral and/or vertical load-resisting system.

3.2.49 *tsunami, n*—long water waves that are generated impulsively by tectonic displacements of the sea floor associated with earthquakes.

3.2.49.1 *Discussion*—Tsunamis also may be caused by eruption of a submarine volcano, submerged landslides, rock falls into the ocean, and underwater nuclear explosions.

NOTE 1—Tectonic displacements with a substantial vertical (dip-slip) component are more likely to cause tsunamis than are strike-slip displacements. Wave heights associated with tsunamis in deep water generally are small; however, as the wave fronts approach coastlines where there is shallow water, the wave heights increase and will run up onto the land. Tsunami run-up can cause loss of life and substantial property damage.

3.2.50 *uncertainty, n*—degree of random behavior represented by an applicable probability distribution and associated parameters.

3.2.51 *uncertainty tolerance level, n*—amount of uncertainty in financial exposure that a User is willing to accept resulting from the cost to remedy earthquake damage not identified by an seismic risk assessment.

3.2.51.1 *Discussion*—This can be influenced by such factors as initial acquisition cost or equity contribution, mortgage underwriting considerations, specific terms of the equity position, projected term of the hold, etc.

3.2.52 *User, n*—individual or institution that retains the Provider to prepare a seismic risk assessment.

3.2.53 *weak story, n*—story in a building that is expected to deform significantly more than any story above it under a given lateral loading. Such weak stories can occur at any level in a building, except the top story.

4. Significance and Use

4.1 *Uses*—This guide is intended for use on a voluntary basis by parties such as lenders, loan servicers, insurers and equity investors in real estate (Users) who wish to estimate possible earthquake losses to buildings. This guide outlines procedures for conducting a seismic risk assessment for a specific User considering the User's requirements for due diligence. The specific purpose of this guide is to provide Users with seismic risk assessment during the anticipated term for holding either the mortgage or the deed. A seismic risk assessment prepared in accordance with this guide should reference or state that the guidance in this document was used as a basis for the report and should also identify any deviations from the guidelines. This guide is intended to reflect a commercially prudent and reasonable investigation for performance of seismic risk assessments.

4.1.1 *Users*—This guide is designed to assist the User in developing information about the earthquake-related damage potential of a building, or groups of buildings. Potential Users include, but are not be limited to, building owners, building tenants, lenders, loan servicers, insurers, occupants, and potential investors/owners and mortgagors.

4.1.1.1 Use of this guide may permit a User to satisfy, in part, their requirements for due diligence in assessing a building's potential for losses associated with earthquakes for real estate transactions.

4.1.2 *Types of Investigations*—This guide provides suggested approaches for the performance of five different types of seismic risk assessments. Each is intended to serve different financial and management needs of the User. Several of these types of assessment specifically depend on characterization of the earthquake ground motion as given in Section 7.

4.1.2.1 *Building Stability (BS)*—Assessment of whether the building will maintain vertical load-carrying capacity in whole or in part during considered earthquake ground motions (see Section 8).

4.1.2.2 *Site Stability (SS)*—Assessment of the likelihood that the site will remain stable in earthquakes and is not subject to failure through faulting, soil liquefaction, landslide, or other site response that can threaten the building's stability or cause damage (see Section 9).

4.1.2.3 *Building Damageability (BD)*—Assessment of the damageability of the building(s) during earthquake ground motions and the degree of damage expected over time. The assessment includes performing and completing the building damageability assessment as either a probable loss (PL) or a scenario loss (SL) assessment, or both (see Section 10).

4.1.2.4 *Contents Damageability (CD)*—Assessment of the damageability of the building(s) contents to earthquake ground motions. This guide suggest that the contents damageability assessment be performed using the SL assessment approach (see Section 11).

4.1.2.5 *Business Interruption (BI)*—Assessment of the implications for continued use or partial use of the building for its intended purpose due to earthquake damage, whether to the building systems, or contents, or both. This guide suggests that the business interruption assessment be performed using the SL assessment approach (see Section 12).

4.1.3 *Application and Temporal Relevance of Report*—A User should only rely on the study for the seismic risk assessment report for the specific purpose that such estimate was commissioned and only for that time when the report was completed and for the building in the condition it was at the time of assessment as documented in the report.

4.1.4 *Availability of Information*—This guide recognizes that a Provider's opinions and observations may be affected or contingent on information (or the lack thereof) that is readily available to the Provider during the conduct of an investigation. For instance, a Provider's observations may be affected by the number of people using the building or the availability of property management to provide information, such as the original construction documents.

4.1.5 *Site-Specific*—Seismic risk assessments are site-specific in that they relate to estimation of earthquake loss to building(s) located at a specific site.

4.2 *Principles*—The following principles are an integral part of this guide and should be referred to in resolving any ambiguity or exercising such discretion as is accorded the User or the Provider in estimating loss to buildings from earthquakes. The principles should also be used in judging whether a User or Provider has conducted an appropriate assessment and estimation of earthquake loss to a building.

4.2.1 *Uncertainty Not Eliminated*—No estimate can wholly eliminate uncertainty regarding damage resulting from actual earthquakes. The successive levels of assessment described in this guide are intended to reduce, but not eliminate, uncertainty regarding the estimation of damage. This guide acknowledges the reasonable limits of time and cost related to a selected level of assessment.

4.2.2 *Not Exhaustive*—There is a point at which the cost to gather information outweighs the usefulness of the information and, in fact, may be detrimental to the orderly completion of transactions. This guide identifies and suggests that a balance be sought between the competing goals of limiting the costs and time demands versus limiting the uncertainty regarding unknown conditions by acquiring as much information as possible.

4.2.3 *Level of Investigation*—Not every property warrants the same level of seismic risk assessment. Consistent with good commercial or customary practice, choosing the appropriate assessment level is guided by the type of buildings subject to assessment, the resources and time available, the expertise and risk tolerance of the User, and the information developed during the course of the investigation.

4.3 *Subsequent Use of Seismic Risk Assessments*—This guide recognizes that assessments of buildings prepared for specified levels of investigation and performed on the basis of the approaches discussed herein may include information that subsequent Users will want to use to avoid undertaking duplicative investigations. Consequently, this guide describes procedures to assist subsequent Users in determining how appropriate it would be to use these results. Usage of prior reports is based on the following principles that should be adhered to in addition to the specific procedures set forth in this guide.

4.3.1 *Comparability*—An estimate of loss to buildings from earthquakes is not to deemed as inappropriate merely because it did not identify all potentially vulnerable areas in connection with a building or a group of buildings. Seismic risk assessments must be evaluated based on the reasonableness of judgments made at the time and under the circumstances in which they were made. The result of any subsequent seismic risk assessments performed to similar parameters should not be considered as valid standards to judge the appropriateness of any prior seismic risk assessment based on hindsight, new information, use of developing technology or analytical techniques, or other factors.

4.3.2 *Use of Prior Information*—Users and Providers may use information in prior reports that meet or exceed the requirements of this guide for specified levels of investigation and then only provided that the specific procedures set forth in the guide were met, including the qualification of the Provider.

4.3.3 *Prior Assessment Meets or Exceeds*—A prior seismic risk assessment report prepared for specified levels of investigation may be used in its entirety, without regard to specific procedures set forth in this guide, if in the reasonable judgment of the Provider, the prior report was prepared for specified levels of investigation meeting or exceeding the requirements of this guide and the conditions of the building(s), current data on the earthquake performance of the building types is assessed, and the seismic hazards affecting the site are not likely to have changed materially since the prior report was prepared. In making this judgment, the Provider should consider the types of building construction assessed in the report, any new information related to the behavior of building constructions of that specific type in recent earthquakes, as well as current understanding of the site conditions.

4.3.4 *Current Investigation*—Prior seismic risk assessments should not be used without current investigation of conditions likely to affect the current seismic risk assessment. Likely conditions include the current level of knowledge on and experience with building constructions of particular types, as well as, current understanding of the site conditions that differ from those in existence when the prior report was prepared.

4.3.5 *Actual Knowledge Exception*—If the User or Provider has actual knowledge that the information being used from a prior seismic risk assessment report is not accurate or is suspected of being inaccurate, then such information from a prior report should not be used.

4.4 When a new seismic risk assessment is performed for the same User that is consistent with this guide and has a higher level of investigation than a prior investigation, then the new investigation should supersede the former one.

5. Assessment Methodology and Approach

5.1 *Minimum Requirements:*

5.1.1 Seismic risk assessments may be performed for an individual building or a group of buildings.

5.1.2 At the minimum, an earthquake loss estimation should include an assessment of building stability (BS, Section 8) and site stability (SS, Section 9). It may also include a building damageability (BD, Section 10), contents damageability (C, Section 11), and/or business interruption (B, Section 12) assessment, or any combination of these.

5.1.3 An earthquake ground motion assessment (Section 7) should be conducted in conjunction with probable loss (PL) evaluations for building damageability and may have applications in some scenario loss (SL) studies, as well as building stability or site stability assessments. They may also be useful