



Standard Practice for Probable Maximum Loss (PML) Evaluations for Earthquake Due-Diligence Assessments^{1, 2}

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1. Scope

1.1 This practice establishes standard-of-care for evaluation and classification of the financial risks from earthquake damage to real estate improvements for use in financial transactions. As such, this practice permits a user to satisfy, in part, their real estate transaction due-diligence requirements with respect to assessing and characterizing a property's potential losses from earthquakes. This practice is intended to address only physical damage to the property from site and building response.

1.1.1 Hazards addressed in this practice include earthquake ground shaking, earthquake-caused site instability, including faulting, subsidence, settlement landslides and soil liquefaction, earthquake-caused tsunamis and seiches, and earthquake-caused flooding from dam or dike failures.

1.1.2 Earthquake-caused fires and toxic materials releases are not hazards considered in this practice.

1.1.3 This practice does not purport to provide for the preservation of life safety, or prevention of building damage associated with its use, or both.

1.1.3.1 This practice does not address requirements of any 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 times of construction or modification of the building(s), or both.

1.1.3.2 This practice does not address the contractual and legal obligations between prior and subsequent Users of PML reports or between providers who prepared the report and those who would like to use such prior reports.

1.1.3.3 This practice does not address the contractual and legal obligations between a provider and a user, and other parties, if any.

1.1.4 It is the responsibility of the owner of the building(s) to establish appropriate life-safety and damage prevention

practices and determine the applicability of current regulatory limitations prior to use.

1.2 Considerations not included in the scope: the impacts of damage to building contents, loss of income(s), rents, or other economic benefits of use of the property, or from legal judgments, fire sprinkler water-induced damage or fire.

1.3 *The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.*

2. Referenced Documents

2.1 *ASTM Standards:*³

E 2026 Guide for the Estimation of Building Damageability in Earthquakes

2.2 *Other Standards:*⁴

UBC-97 Uniform Building Code, 1997 Edition
International Building Code 2006 Edition

2.3 *ASCE Standards:*⁵

ASCE 7 Minimum Design Loads for Buildings and Other Structures

ASCE 31 Seismic Evaluation of Existing Buildings

ASCE 41 Seismic Rehabilitation of Existing Buildings

3. Terminology

3.1 See also definitions in Guide **E 2026**.

3.2 *DBE, n*—Design Basis Earthquake, as defined in Guide **E 2026**.

3.3 *lateral load-resisting system, n*—Lateral Load Resisting System, as defined in Guide **E 2026**.

3.4 *MCE, n*—Maximum Capable Earthquake as defined in Guide **E 2026**.

3.5 *PML, n*—Term historically used to characterize building damageability in earthquakes.

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³ 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.

⁴ Available from International Organization for Standardization (ISO), 1 rue de Varembe, Case postale 56, CH-1211, Geneva 20, Switzerland, <http://www.iso.ch>.

⁵ Available from American Society of Civil Engineers (ASCE), 1801 Alexander Bell Dr., Reston, VA 20191, <http://www.asce.org>.

3.5.1 *Discussion*—Probable maximum loss, shall be defined by the user from SL or PL values using definitions of Guide E 2026. For SL-based measures include in the report the specified earthquake or ground motion for which it is to be evaluated and stipulate whether it is an expected value (SEL) or upper value (SUL). For PL-based measures, the return period for non-exceedance shall be specified, or the probability of exceedance in a given time period provided.

3.6 *probable loss (PL), n*—Probable Loss as defined in Guide E 2026.

3.6.1 *Discussion*—When there are multiple buildings in the seismic risk assessment, then the damageability values for the group of buildings is to be determined as specified in Guide E 2026.

3.7 *provider, n*—organization and individual that completes the seismic risk assessment.

3.8 *scenario loss (SL), n*—As defined in Guide E 2026.

3.8.1 *Discussion*—When multiple buildings are in the seismic risk assessment, then the SL for the group of building is to be determined as specified in Guide E 2026.

3.9 *SEL, n*—As defined in Guide E 2026.

3.9.1 *Discussion*—When there are multiple buildings in the assessment then the SEL for the group of buildings is to be determined as specified in Guide E 2026.

3.10 *SEL_{DBE}, n*—The scenario expected loss due to the occurrence of DBE site ground motions.

3.11 *SEL_{MCE}, n*—The scenario expected loss due to the occurrence of MCE site ground motions.

3.12 *significant damage, n*—Damage costs that exceeds five percent of the replacement cost of construction for the building caused by site failure from soil liquefaction, landsliding, or other earthquake-induced site response other than shaking. Damage cost for this purpose includes the cost of the site topography away from the building.

3.12.1 *Discussion*—Conditions resulting from lack of routine maintenance, miscellaneous repairs, operating maintenance, and so forth are not considered a deficiency. The damage is not significant if it does not affect the structural elements of the building because the movement is not substantial or the foundation is resistant to settlement-induced damage. Damage limited to underground utilities or slabs on grade is not significant.

3.13 *SUL, n*—As defined in Guide E 2026.

3.13.1 *Discussion*—When there are multiple buildings in the assessment then the SUL for the group of buildings is to be determined as specified in Guide E 2026.

3.14 *SUL_{DBE}, n*—The scenario upper loss due to the occurrence of DBE site ground motions.

3.15 *SUL_{MCE}, n*—The scenario upper loss due to the occurrence of MCE site ground motions.

3.16 *third party, n*—A technically qualified individual and organization that has not been engaged in the design or modifications of the building(s), and is not part of the due-diligence team that provided the earthquake loss assessment.

4. Summary of Practice

4.1 The objectives of this practice are as follows:

4.1.1 To synthesize and document good commercial practice for the determination and rating of seismic risk for buildings.

4.1.2 To facilitate standardization of earthquake risk evaluation terminology for financial transactions.

4.1.3 To establish an industry standard for the requirements to evaluate the financial risk for real estate.

5. Significance and Use

5.1 This practice is intended for use as a voluntary standard by parties who wish to undertake the seismic risk assessment of properties. The goal is for users to objectively and reliably compare the financial risks of earthquake damage to buildings, or groups of buildings, on a consistent basis.

5.2 This practice is designed to provide requirements for the evaluation of earthquake damage risk so that technical reports prepared for the evaluation and rating of seismic risk of a building(s) will be adequate for use by other entities. Potential users including, but are not be limited to, those making equity investments, lending, and financial transactions, including securitized mortgage lending by mortgage originators, loan servicers, underwriters, rating agencies, and purchasers of bonds secured by the real estate.

5.3 The use of this practice may permit a user to satisfy, in part, their requirements for due diligence in assessing a property's potential for losses associated with earthquakes for real estate transactions.

6. Due-Diligence Investigation

6.1 The site stability, building stability and building damageability of the property shall be assessed.

6.2 The user shall specify the condition of the property to be evaluated. The seismic performance can be evaluated for the property in its current condition, or as changed by proposed modification of the seismic response of the soils supporting the building or a proposed seismically retrofitted condition of the building(s) or its sections, or both.

6.2.1 The proposed seismic modifications of the site must be sufficiently described to allow evaluation of the modifications by an independent qualified party.

6.2.2 The proposed seismic modifications of the building systems must be sufficiently described to allow evaluation of the modifications by a qualified third party.

6.3 The Guide E 2026 level of investigation shall be specified by the user. The same level of investigation should be performed for each type of the seismic risk assessment. Appendix X1 gives guidance on the setting of the level of investigation.

6.4 The qualifications of the provider shall be specified as required for the level of investigation specified in 6.3 by Guide E 2026. The qualifications level must be equal to or higher than the corresponding level specified in 6.3. Appendix X1 gives further guidance on the setting of minimum qualifications.

6.5 *PML Report*—The findings shall be reported in conformance to the requirements of Guide E 2026 for the level of investigation specified by the user in 6.3 and by a provider qualified in accordance with the requirements of 6.4, with the following sections:

6.5.1 A summary that contains the conclusions of the seismic risk assessment:

6.5.1.1 Location of the building(s) and characterization of the site and site soils, and gravity and lateral load-resisting systems.

6.5.1.2 Stability determination of each building site under consideration when subjected to the seismic loadings for the building site location and building characteristics and for the level of investigation specified as set forth in Section 9 of Guide E 2026. Site stability determination need only be qualitative in nature for an SS0 investigation. For SS1 investigations the site stability is a qualitative assessment that includes the implications on damage to the building structural elements. For SS2 and SS3 investigations the site should be considered unstable if significant damage is caused to the building by the site instability.

6.5.1.3 Stability determination of each building under consideration in the seismic loadings for the building site location and building characteristics and for the level of investigation specified, as set forth in Section 8 of Guide E 2026.

6.5.1.4 The PML value for the building or group of buildings as a whole, if there are multiple buildings in the seismic risk assessment and for the level of investigation specified.

(1) For commercial mortgage backed securities the PML is defined as the SEL_{DBE} .

(2) For other applications the PML shall be user-defined.

6.5.1.5 A specification of the level of investigation for each assessment and a review of the methods used and the personnel engaged.

6.5.1.6 Results for each of the conditions described in 6.2.2 that apply

6.5.1.7 Appropriate reliance language for the report and signature, and for Level 1 or higher investigations, the professional seal of the provider.

6.5.1.8 All deletions and deviations from this practice (if any) shall be listed individually and in detail.

6.5.1.9 The report conclusion shall include the following statement: "We have performed a probable maximum loss (PML) evaluation for earthquake due diligence assessment in conformance with the scope and limitations of Guide E 2026 and E 2557 for a Level XX (specify) assessment of [insert address or legal description], the property. Any exceptions to, or deletions from, this practice are described in Section [] of this report. This probable maximum loss (PML) evaluation for earthquake due diligence assessment has determined the PML to be []%". PML is defined as [fill in the definition used].

6.5.2 A body of the report that provides:

6.5.2.1 All detailed reporting information required by Guide E 2026, Section 16, including the basis and background for the work performed in support of the conclusions presented in the report.

6.5.2.2 PML values for each building, and, if appropriate, for the group of buildings.

(1) For CMBS applications, in addition to the PML, SEL, and SUL values for the DBE and MCE ground motions and PL values for 190- and 475-year return periods shall be reported .

(2) For other applications the PML and other damageability values as specified by the user shall be reported.

(3) Report of any other information required by the user, which may include business interruption, and contents damageability.

(4) The organization that commissioned the report and the professional liability limitations of the report provider shall be disclosed in the report.

6.5.3 Attachments and appendices to the report as appropriate.

APPENDIX

(Nonmandatory Information)

X1. LEVEL OF INVESTIGATION

X1.1 The selection of the level of the investigation performed should be guided by the level of uncertainty in the result that is acceptable to the user. Two guidance tables are provided: 1) based upon the level of uncertainty in the results and 2) based upon the building replacement cost.

X1.1.1 If the degree of uncertainty is the guiding consideration in selecting the level of investigation, then Table 1 is offered as a guide to selection of the levels of investigation to match the acceptable level of uncertainty. The zone references are from the map of seismic zones as it appears in UBC-97,

TABLE 1 Seismic Zone of the Property and the Acceptable Level of Uncertainty of the User

Acceptable Uncertainty Level	Zones 0, 1	Zones 2A, 2B	Seismic Zone/UBC-97	
			Zone 3	Zone 4
Low	none	BS0, SS0, BD0	BS1, SS1, BD1	BS2, SS2, BD2
Moderate	none	none	BS0, SS0, BD0	BS1, SS1, BD1
High	none	none	none	BS0, SS0, BD0

which is reproduced in Fig. 1. The acceptance uncertainty levels are not defined, but are given to reflect the progression of investigation levels with changes in acceptable uncertainty.

X1.1.2 If the cost of replacement of the building is the guiding consideration in selecting the level of investigation, then Table 2 is offered as a guide to selection of the levels of investigation to match the acceptable level of uncertainty.

X1.1.2.1 The rationale for changing requirements for different property values is as follows. It is expected that the uncertainty in seismic loss for a given property will decrease significantly with increasing level of investigation. Since most loans will be part of a limited group of financial commitments, the larger an individual loan, the greater is its participation as a fraction of the total risk of the group. A method to reduce the level of uncertainty is to require a higher level ASTM assessment for the greater value property. When the pool gets larger, say for a security, then the impact is the same. Therefore, it was assumed in preparing the table threshold values that some parity was needed to keep the uncertainties of the same order for groups of lower property values compared to one larger property.

X1.1.2.2 It should be noted that the costs of doing higher-level investigations are higher and they do not go up linearly, so there is an administrative cost of the decisions made based on this table.

X1.2 The seismic zone references in Tables 1 and 2 are from the map of seismic zones as it appears in the UBC-97 which is reproduced in Fig. 1. While there are more recent seismic risk maps, these generally require specific information on the seismic response characteristics of the site and structure that are seldom available before the seismic risk assessment has begun. Therefore, for ease and consistency of use, the 1997 map is used.

X1.3 Level 0 investigations are considered to provide the highest uncertainty of results of any investigation. Some moderation of this uncertainty can be achieved by requiring the person(s) performing the assessment to be a licensed professional with qualifications for an Guide E 2026 Level 1 investigation, rather than the minimal requirements for a Level 0 investigation.

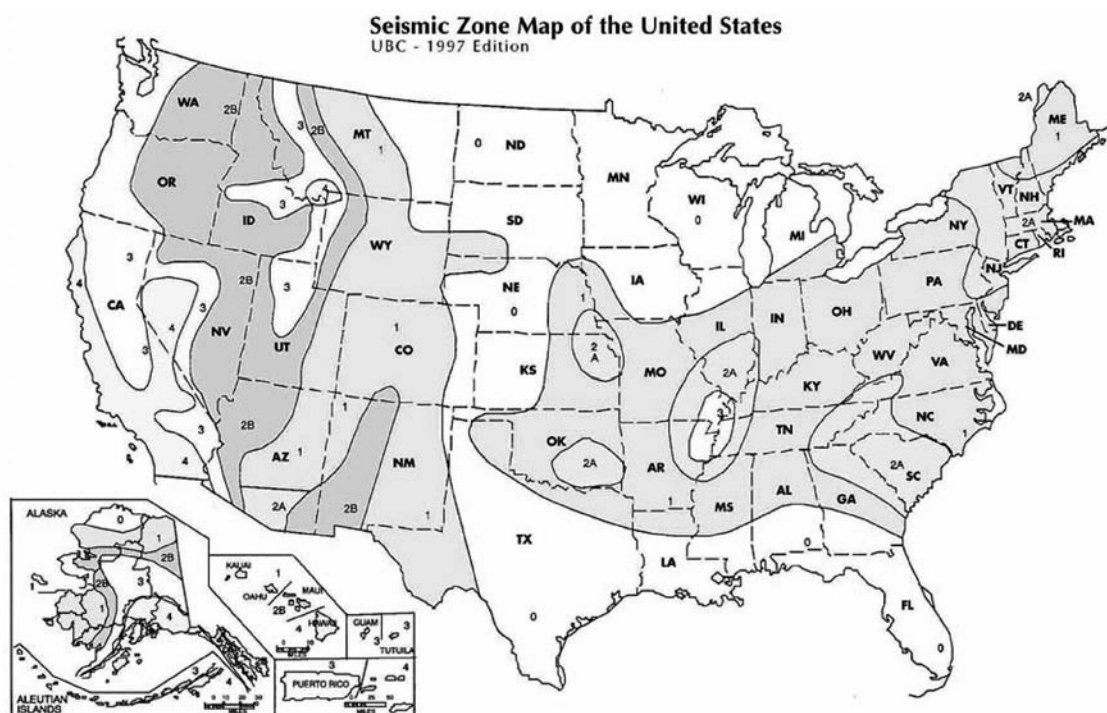


FIG. 1 Seismic Zone Map of the United States
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TABLE 2 Seismic Zone of the Property and the Building Replacement Cost

X, Building Replacement Cost	Seismic Zone/UBC-97			
	0, 1	2A, 2B	3	4
\$0M<X=\$5M	none	none	BS0, SS0, BD0	BS0, SS0, BD0
\$5M<X=\$15M	none	none	BS0, SS0, BD0	BS1, SS1, BD1
\$15M<X=\$50M	none	none	BS1, SS1, BD1	BS1, SS1, BD1
\$50M<X=\$100M	none	BS0, SS0, BD0	BS1, SS1, BD1	BS2, SS2, BD2
\$100M<X	none	BS1, SS1, BD1	BS2, SS2, BD2	BS2, SS2, BD2

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