



## Standard Practice for Probable Maximum Loss (PML) Evaluations for Earthquake Due-Diligence Assessments<sup>1,2</sup>

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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, mortgage transactions and capital investment evaluation.~~ 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 seismic risk assessment~~ 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:*<sup>3</sup>

[E2026 Guide for Seismic Risk Assessment of Buildings](#)

#### 2.2 *Other Standards:*<sup>4</sup>

~~UBC-97~~ [Uniform Building Code, 1997 Edition](#)

~~International Building Code~~ [IBC 2006 Edition International Building Code, current edition](#)

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.25 on Whole Buildings and Facilities.

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<sup>3</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>4</sup> Available from International Organization for Standardization (ISO), 1 rue de Varembé, Case postale 56, CH-1211, Geneva 20, Switzerland, <http://www.iso.ch>. Code Council (ICC), 500 New Jersey Ave., NW, 6th Floor, Washington, DC 20001, <http://www.iccsafe.org>.

2.3 *ASCE Standards:*<sup>5</sup>

[ASCE 7 Minimum Design Loads for Buildings and Other Structures](#), current edition

~~ASCE 31 Seismic Evaluation of Existing Buildings~~

[ASCE 41 Seismic Rehabilitation-Evaluation and Retrofit of Existing Buildings](#), current edition

### 3. Terminology

3.1 See also definitions in Guide [E2026](#).

3.2 ~~475-year site ground motions, *n*—seismic induced ground motions at a site with approximately: a return period of 475 years, a 10 % probability of exceedance in 50 years, and an annual frequency of 0.21 %. Also referred to as the DBE.~~

3.3 ~~DBE, field assessor, *n*—Design Basis Earthquake, field assessor, as defined in Guide [E2026](#).~~

3.4 ~~lateral load-resisting system, independent reviewer, *n*—Lateral Load Resisting System, independent reviewer, as defined in Guide [E2026](#).~~

3.5 ~~MCE, lateral load-resisting system, *n*—Maximum Capable Earthquake, lateral load-resisting system, as defined in Guide [E2026](#).~~

3.6 ~~PML, MCE, *n*—Term historically used to characterize building damageability in earthquakes, Maximum Capable Earthquake, as defined in Guide [E2026](#).~~

<sup>5</sup> 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 [E2026](#). 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.~~

3.7 ~~probable loss (PL), *n*—Probable Loss, probable loss, as defined in Guide [E2026](#).~~

#### 3.7.1 ~~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 [E2026](#).~~

3.8 ~~provider, probable maximum loss (PML), *n*—organization and individual that completes the seismic, probable maximum loss, as defined in Guide [E2026](#).~~

3.9 ~~scenario loss (SL), provider, *n*—As provider, as defined in Guide [E2026](#).~~

#### 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 [E2026](#).~~

3.10 ~~SEL, scenario expected loss (SEL), *n*—As scenario expected loss, as defined in Guide [E2026](#).~~

#### 3.10.1 ~~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 [E2026](#), Section 5.3.~~

3.10 ~~SEL<sub>DBE</sub>, *n*—The scenario expected loss due to the occurrence of DBE site ground motions.~~

3.11 ~~SEL<sub>MCE</sub>, *n*—The scenario expected loss due to the occurrence of MCE site ground motions.~~

3.11 ~~significant damage, scenario loss (SL), *n*—Damage costs that exceeds five percent scenario loss, as defined in Guide [E2026](#) 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.~~

#### 3.11.1 ~~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.~~ When multiple buildings are in the seismic risk assessment, then the SL for the group of buildings is to be determined as specified in Guide E2026, Section 5.3.

3.12 ~~SUL~~, *scenario upper loss (SUL), n*—~~As scenario upper loss, as defined in Guide E2026.~~

3.12.1 *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 E2026, Section 5.3.

3.13 ~~SUL<sub>SEL475,DBE</sub>~~, *n*—~~The scenario upper expected loss due to the occurrence of DBE-10 %/50-year site ground motions.~~

3.14 ~~SUL<sub>SEL<sub>MCE</sub></sub>~~, *n*—~~The scenario upper expected loss due to the occurrence of MCE site ground motions.~~

3.15 ~~third party, senior assessor, n~~—~~A technically qualified individual and organization that has not been engaged in the senior assessor, as defined in Guide E2026 design or modifications of the building(s), and is not part of the due-diligence team that provided the earthquake loss assessment.~~

3.16 *significant damage, n*—significant damage, as defined in Guide E2026

3.17 *SUL<sub>475</sub>*, *n*—the scenario upper loss due to the occurrence of 10 %/50-year site ground motions.

3.18 *SUL<sub>MCE</sub>*, *n*—the scenario upper loss due to the occurrence of MCE site ground motions.

#### 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 any combination of these conditions.

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:Independent Reviewer.

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:an Independent Reviewer.

6.3 The Guide E2026 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 Provider shall be specified as required for the level of investigation specified in 6.3 by 6.3 of Guide E2026. The qualifications level must be equal to or higher than the corresponding level specified in 6.3-6.2 Appendix X1 gives further guidance on the setting of minimum qualifications and 6.3.

6.4.1 For an assessment of Level 1 or higher, the qualifications of Senior Assessor and the Field Assessor of the property and its buildings shall be those of Guide E2026 Sections 6.2.3.2 and 6.2.3.3.

6.4.2 Notwithstanding the asserted level of investigation of a report, if the Senior Assessor or the Field Assessor, or both, do not demonstrate the qualifications of Guide E2026 Section 6.2.3.2 and 6.2.3.3, then the report shall be designated a Level 0 report.

6.5 ~~PML~~ *Seismic Risk Assessment Report*—The findings shall be reported in conformance to the requirements of Guide E2026 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~~ building(s), 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 E2026~~. 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 E2026.

6.5.1.4 ~~The PML value~~ building damageability values for the building or group of buildings as a whole, ~~if there are multiple buildings in the seismic risk assessment and for the level~~ whole for the level of investigation specified as set forth in Section 10 of Guide E2026 of investigation specified.

(1) ~~For commercial mortgage backed securities the PML is defined as~~ PML shall be user-defined. At a minimum, the SEL<sub>DBE</sub> and SUL<sub>DBE</sub> shall be reported.

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

NOTE 1—CMBS industry is currently defining PML as SEL<sub>DBE</sub>. It is advisable that SEL and SUL values also be reported for MCE events in areas of low and moderate seismicity areas where MCE poses significantly higher risk than the DBE.

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 ~~6.2.26.2~~ that apply.

6.5.1.7 Appropriate reliance language for the report and ~~signature, and for signature~~. 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 E2026 and Practice E2557 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]. The project [meets/does not meet] the building stability and [meets/does not meet] the site stability requirements.

6.5.1.10 Each report should include a completed Appendix X2.

6.5.1.11 Each report should include a completed Appendix X3.

6.5.2 A body of the report that provides:

6.5.2.1 All detailed reporting information required by Guide E2026, Section ~~46.13~~, 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.~~

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

(2) 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~~ appropriate including detailed resumes of the Senior Assessor and the Field Assessor that demonstrate their qualifications to perform this work as stated in this Practice.