Building Division
777 B Street
Hayward, CA 94541

Bulletin C9A7-1

Hayward Municipal Code Chapter 9 Article 7

Contents:

Part A. Administrative Provisions

A.1 Applicability

A.1.1. Purpose of this Bulletin. The purpose of this Bulletin is to establish requirements and Building Official interpretations regarding compliance with criteria for voluntary seismic evaluation provided in Hayward Municipal Code (HMC) Section 9-7.400 and criteria for voluntary seismic retrofit provided in HMC Section 9-7.500.

> ***Commentary:*** *This Bulletin is intended primarily as a technical document for use by design professionals, construction professionals, and building department staff. Additional material intended for building owners and tenants is available at the program website:* *https://www.hayward-ca.gov/your-government/programs/mandatory-soft-story-seismic-screening-ordinance*
> *HMC Chapter 9 Article 7, created by Ordinance 19-14 with an effective date of August 1, 2019, requires screening of certain multi-unit residential buildings. It does not require seismic evaluation or retrofit, but criteria for voluntary evaluation or retrofit are provided as a basis for confirming a screening status.*
> *This Bulletin does not replace either the Ordinance or HMC Chapter 9 Article 7. It is a supplement to the requirements in the Ordinance and the HMC, produced by the Building Division in accordance with HMC Section 9-7.100.70, which authorizes the Building Official to develop and require compliance with technical bulletins.*

A.1.2. Use of this Bulletin. This Bulletin addresses the engineering requirements of HMC Chapter 9, Article 7, as follows:

- Voluntary seismic evaluation intended to comply with HMC Section 9-7.400 shall comply with Part B, Part C, or Part D of this Bulletin, except that Part B shall be allowed only for evaluation of retrofits designed after January 1, 2000.
- Voluntary seismic retrofit intended to comply with HMC Section 9-7.500 shall comply with Part B, Part C, or Part D of this Bulletin.

A.1.3. Other regulations. Unless otherwise specified, work considered by this Bulletin is subject to all City of Hayward regulations and procedures applicable to building alteration projects.

> ***Commentary:*** *The main purpose of this Bulletin is to reference, modify, and interpret CEBC Chapter A4, ASCE 41, and FEMA P-807, as shown in Parts B through D. All work done to comply with HMC Chapter 9 Article 7 should otherwise comply with normal regulations and*

procedures, including those related to design review, permitting, fees, and inspections.

A.2 Voluntary seismic evaluation documentation

A.2.1. Report procedure. A seismic evaluation report intended to comply with HMC Section 9-7.400 shall be submitted as an attachment to a completed Seismic Screening Form.

> ***Commentary:*** *Seismic Screening Form Part 3, Questions 4-5, provide a space in which to indicate that an evaluation report is being submitted. Otherwise, follow the instructions on the Seismic Screening Form.*

A.2.2. Report format. The seismic evaluation report shall be formatted as follows:

1. PDF format.

2. Pages shall be 8.5x11 inches.

3. A table of contents shall list the main sections of the report. Supporting materials shall be attached and identified in the table of contents as appendices, showing the date and page count of each appendix.

   Commentary: *Supporting materials are likely to include copies or excerpts of building plans, condition assessment reports, soil reports, material testing reports, etc. See Bulletin Section A.2.3, item 5.*

4. Each page of the report and of each appendix shall be dated and numbered. Revised reports shall have a separate date, which shall be shown on each page.

5. Each page of the report and of each appendix shall identify the subject building either by address or parcel number. Where the property or parcel has multiple buildings, the building identifier shall include a building number or other unique building designation.

A.2.3. Report content. The seismic evaluation report shall include:

1. A statement that the report and its supporting documents are intended to comply with HMC Section 9-7.400 for voluntary seismic evaluation.

2. A statement and description of the evaluation engineering criteria, with reference to HMC Section 9-7.400.20, as interpreted by this Bulletin.

3. A summary statement plainly confirming that the existing structure satisfies the engineering criteria, together with the signature of the design professional responsible for the evaluation.

   Commentary: *For a report in pdf format, the city will accept a scanned or electronic signature.*

4. A listing of existing conditions assumed for purposes of condition assessment or structural

evaluation, each of which shall be subject to verification at the discretion of the Building Official.

5. All building investigation, soils, geotechnical, condition assessment, or other supporting reports, as well as a summary of such reports indicating how the findings or conclusions are reflected in the structural calculations.

6. Identification of structural properties and capacities assumed for all existing materials and elements, including any capacity reductions for damage, deterioration, or defect.

7. If requested by the Building Official, verification calculations for any engineering software used.

8. Other information as required by the Building Official.

A.3 Voluntary seismic retrofit documentation

A.3.1. Permit Application. A permit for voluntary seismic retrofit is required. On the permit application, under Project Information, the Description of the work shall include the following: “Voluntary seismic retrofit in compliance with HMC Section 9-7.500.” Any work not directly related to the voluntary seismic retrofit but intended to be executed at the same time shall be done under a separate permit, unless otherwise allowed by the Building Official.

> ***Commentary:*** *Work in addition to the retrofit scope covered by HMC Section 9-7.500 may be performed simultaneously but must be done under a separate permit, especially if the owner intends to apply to the county assessor with a “Claim for Seismic Safety Construction Exclusion from Assessment.” This exclusion, described in California Revenue and Taxation Code Section 74.5(c), allows property owners to apply for a waiver from reassessment related to seismic retrofit. More information is available here: https://www.acgov.org/forms/assessor/Claim_Seismic_Safety.pdf*

A.3.2. Plans. Plans shall comply with all applicable format and procedural requirements for voluntary structural alteration projects. Submitted plans shall include all information and details needed to properly construct all of the intended work. Any work not directly related to the voluntary seismic retrofit shall be clearly identified and distinguished from the seismic retrofit work. In addition, submitted plans shall include:

1. As part of the Project Title, the words “HMC Section 9-7.500 voluntary seismic retrofit.”

2. In the General Notes or other project information, the following: “Voluntary seismic retrofit designed to comply with HMC Section 9-7.500.”

3. Existing conditions requiring verification during construction, clearly identified, and coordinated with the structural calculations.

4. Information required by the reference code or standard used, as modified in Part B, C, or D of this Bulletin.

A.3.3. Structural calculations. Submitted calculations shall include all information needed to support and validate the submitted plans and to demonstrate compliance with this Bulletin. The calculations shall include:

1. A statement that the calculations are intended to comply with HMC Section 9-7.500 for voluntary seismic retrofit.

2. A statement and description of the retrofit engineering criteria, with reference to HMC Section 9-7.500.30, as interpreted by this Bulletin.

3. A listing of existing conditions assumed for purposes of condition assessment or structural design, each of which shall also be identified on the plans as requiring verification during construction.

4. All building investigation, soils, geotechnical, condition assessment, or other supporting reports, as well as a summary of such reports indicating how the findings or conclusions are reflected in the structural calculations.

5. Identification of structural properties and capacities assumed for all existing materials and elements, including any capacity reductions for damage, deterioration, or defect.

6. Identification of structural properties and capacities assumed for all new materials and elements, including product literature for proprietary devices or systems.

7. If requested by the Building Official, verification calculations for any engineering software used.

8. Other information as required by the Building Official.

A.4 Retrofit construction quality assurance

A.4.1 Structural observation. Structural observation, in accordance with Section 1704.6 of the *California Building Code*, is required, regardless of seismic design category, height, or other conditions. Structural observation shall include visual observation of work for conformance to the approved construction documents and confirmation of existing conditions assumed during design.

A.4.2 Contractor responsibility. Contractor responsibility shall be in accordance with Section 1704.4 of the *California Building Code*.

A.4.3 Testing and inspection. Structural testing and inspection for new construction materials, submittals, reports, and certificates of compliance, shall be in accordance with Sections 1704 and 1705 of the *California Building Code*. Work done to comply with HMC Section 9-7.500 shall not be eligible for Exceptions 1, 2, or 3 to *California Building Code* Section 1704.2 or for the Exception to *California Building Code* Section 1705.12.2.

Bulletin C9A7-1

Hayward Municipal Code Chapter 9 Article 7

Part B. Engineering Criteria for Target Story Evaluation or Retrofit Using CEBC Chapter A4

B.1 Reference code. Appendix Chapter A4 of the current edition of the *California Existing Building Code* (Chapter A4), as modified and interpreted by Section B.2 of this Bulletin, shall be permitted as the criteria for voluntary seismic evaluation to comply with HMC Section 9-7.400 or for voluntary seismic retrofit to comply with HMC Section 9-7.500. Any code references within Chapter A4 shall be construed to refer to the corresponding provisions of the *California Building Code* (CBC), the *California Existing Building Code* (CEBC), and their reference standards, as adopted and amended by the City of Hayward.

> ***Commentary:*** *HMC Section 9-7.500 allows three different documents to be used as retrofit design criteria. Therefore, Part B allows but does not require Chapter A4. HMC Section 9-7.400 also allows Chapter A4 as criteria for evaluation, but only for the evaluation of prior retrofits designed after January 1, 2000; this is because Chapter A4 does not accommodate existing non-conforming materials characteristic of older buildings.*
>
> *The current CEBC is the 2016 edition. When the 2019 CEBC becomes effective, it will be applicable instead. The 2019 Chapter A4 will be based on the 2018* International Existing Building Code *(IEBC) and is essentially identical to the 2015 IEBC (and 2016 CEBC) versions. Both editions as published by ICC are available in read-only mode at* https://codes.iccsafe.org/public/collections/I-Codes*. Until the 2019 CEBC becomes effective, the 2018 IEBC Chapter A4 may be used instead of the 2016 CEBC Chapter A4, with Building Official approval.*
>
> *HMC Section 9-7.500.30 also allows the* California Historical Building Code *as retrofit criteria for eligible historic buildings. Demonstration of eligibility and modifications to Chapter A4 based on the CHBC should be proposed and will be approved on a case-by-case basis.*
>
> *The commentary below also refers in places to FEMA P-807 (May 2012), titled* Seismic Evaluation and Retrofit of Multi-Unit Wood-Frame Buildings With Weak First Stories*, available at:* https://www.fema.gov/media-library-data/20130726-1916-25045-2624/femap_807.pdf

B.2 Modification and interpretation of CEBC Chapter A4

The following modifications and interpretations refer to Chapter A4 section numbers.

> ***Commentary:*** *The modifications and interpretations below are consistent with those also adopted by San Francisco, Berkeley, and Oakland for their mandatory retrofit programs. Most were developed by the Structural Engineers Association of Northern California (SEAONC) Existing Buildings Committee, and most have been tentatively adopted by ICC for the 2021 IEBC (with confirmation expected in October 2019).*

A401.2 Scope. *Omit this section.*

> ***Commentary:*** *In the context of HMC Section 9-7.500, the applicability of Chapter A4 is established by the Ordinance and by the definition of Subject Buildings in HMC Section 9-7.100.30.*

A402 Definitions. *Add, omit, or revise as follows:*

GROUND FLOOR. *Omit this definition.*

> ***Commentary:*** *This term is omitted because it is unnecessary and could be confused with the new term Target Story. In Chapter A4, the term is used in only two places: the exception to A403.2, which is omitted (see below), and A404.1, where the plain English meaning is sufficient.*

STORY STRENGTH. *Omit this definition.*

> ***Commentary:*** *This definition is omitted because it is unnecessary and to avoid conflict with "expected story strength" as used in Section A403.3.1. It is used only once in Chapter A4, in the definition of "weak wall line," but that definition is itself unnecessary because of the new definition of Target Story.*

TARGET STORY. Either (1) a basement story or underfloor area that extends above grade at any point or (2) any story above grade, where the wall configuration of such basement, underfloor area, or story is substantially more vulnerable to earthquake damage than the wall configuration of the story above, except that a story is not a target story if it is the topmost story or if the difference in vulnerability is primarily due to the story above being a penthouse or an attic with a pitched roof.

> ***Commentary:*** *This definition, given in HMC Section 9-7.300.10, is added as a preferred way to refer to the structural deficiency of interest in Chapter A4 and the subject of the seismic evaluation or retrofit.*
>
> - *The definition simplifies and clarifies the Chapter A4 terminology. Chapter A4 and this Bulletin call for consideration of whole stories, but Chapter A4 only defines its critical deficiencies in terms of wall lines and does not clearly recognize complexities posed by sloped sites (e.g. the target story might not be the ground story, and a building might have more than one target story). That said, any story that contains a soft wall line, a weak wall line, or an open-front wall line as defined in Chapter A4 would normally be considered a target story.*
> - *By including underfloor areas, the definition avoids confusion about crawl spaces and the building code definition of "story," especially on sloped sites.*
> - *The definition facilitates coordination with similar programs in Berkeley, San Francisco, and Oakland.*
> - *Because the definition is not quantitative, it usefully relies on the judgment of engineers or other qualified design professionals. This is consistent with the screening requirements of the Ordinance. If a building has no apparent target story, it may be exempted by screening, without the need for a quantitative seismic evaluation.*

WOOD FRAME TARGET STORY. A target story in which a significant portion of lateral or torsional story strength or story stiffness is provided by wood frame walls.

> ***Commentary:*** *Together with the definition of target story, this definition, also given in HMC Section 9-7.300.10, identifies the deficiency of interest in Chapter A4 and the subject of the seismic evaluation or retrofit. As with the definition of target story, the definition of wood frame target story relies intentionally on the judgment of design professionals.*

A403.1 General. *Omit the exception and revise the first sentence as follows:* All modifications required by the provisions in this chapter shall be designed in accordance with the *California Building Code* provisions for new construction, except as modified or otherwise allowed by this chapter and by Bulletin C9A7-1.

> ***Commentary:*** *The exception is omitted because the additional phrase "or otherwise allowed" makes it moot.*

A403.2 Scope of analysis. *References to "soft, weak, or open-front wall line" shall be taken to mean "wood frame target story." Omit the exception.*

> ***Commentary:*** *By substituting the definition of wood frame target story, this modification clarifies the scope of work. (It also makes the two sentences about podium structures and hillside conditions largely moot.) The exception is omitted because it improperly focuses on individual wall lines; any reduced retrofit scope should be justified by full-story calculations. Also, many cases that would be covered by the exception are also covered by the prescriptive solution of Section A404.*

A403.3 Design base shear and design parameters. *Correct Δ_0 to Ω_0 in multiple places. Add Exceptions 4 and 5 and subsections A403.3.1 and A403.3.2:*

> ***Commentary:*** *Where applicable, the allowance for a capped base shear coefficient in ASCE 7 Section 12.8.1.3 may be applied so that the value of $0.75S_{DS}$, including the 75 percent factor allowed by Chapter A4 Section A403.3, need not be taken greater than 1.00.*

Exception 4: For retrofit systems involving different seismic force-resisting systems in the same direction within the same story, resisting elements are permitted to be designed using the least value of R for the different structural systems found in each independent line of resistance if the following conditions are met: (1) The building is assigned to Risk Category I or II (2) The building height is no more than four stories above grade plane, and (3) the seismic force-resisting systems of the retrofitted building comprise only wood structural panel shear walls, steel moment-resisting frames, steel cantilever columns, and steel braced frames. Values for C_d and Ω_0 shall be consistent with the R value used.

Exception 5: With reference to ASCE 7 Table 12.2-1, ordinary, intermediate, and special steel systems and all light-frame systems shall be permitted without limitation where those systems are used only for retrofit of target stories.

Commentary: *More than one of the exceptions to Section 403.3 can apply in a single building. Added Exception 4 implements the SEAONC recommendation to allow retrofit schemes that involve different structural systems on different lines. Without this exception, a retrofit using an intermediate or ordinary steel frame along one line and wood structural panels elsewhere would be forced to over-design the wood elements. Exception 5 recognizes that height limits applicable when certain structural systems are used for a whole building should not apply when the same system is used only within a single story. In this regard, Exception 5 is like Exceptions 1 through 3, in that it decouples the design of the new retrofit system from non-conforming conditions in the existing structure.*

A403.3.1 Expected story strength. Despite any other requirement of Section A403.3 or A403.4, the total expected strength of retrofit elements added to any target story need not exceed 1.7 times the expected strength of the story immediately above in a two-story building, or 1.3 times the expected strength of the story immediately above in a three-story or taller building, as long as the retrofit elements are located symmetrically about the center of mass of the story above or so as to minimize torsion in the target story. Calculation of expected story strength and identification of irregularities in Section A403.3 shall be based on the expected strength of all wall lines, even if sheathed with nonconforming materials. The strength of a wall line above the target story may be reduced to account for inadequate load path or overturning resistance.

Commentary: *This added provision is based on a SEAONC recommendation to cap the required strength, consistent with FEMA P-807. The expected strength of the story above may be calculated using the FEMA P-807 criteria. If the strength is reduced to account for an inadequate load path, as allowed, the load path should be documented by field observation and condition assessment; otherwise, the strength calculation should assume an adequate load path to avoid underestimating the upper story strength.*

A403.3.2. Seismicity parameters, Site Class, and geologic hazards. Any building located in an area labeled “NEHRP E” on the latest USGS map of “Soil Type and Shaking Hazard in the San Francisco Bay Area” shall be assigned to Site Class E unless site-specific investigation in accordance with ASCE 7 Chapter 20 indicates otherwise. For any site designated as Site Class E, the value of F_a shall be taken as 1.2. Site-specific procedures are not required for compliance with HMC Chapter 9 Article 7. Compliance with HMC Chapter 9 Article 7 does not require mitigation of existing geologic site hazards such as liquefiable soil, fault rupture, or landslide.

Commentary: *Other than this provision regarding Site Class E, Site Class shall be determined following the normal procedures for new construction, including the use of Site Class D as a default. The USGS map of Bay Area site classes is at https://earthquake.usgs.gov/hazards/urban/sfbay/soiltype/map/.*

Seismic hazard parameters as needed may be obtained from the SEAOC/OSHPD Seismic Design Maps, using “2015 IBC” as the Reference, at https://seismicmaps.org/ or from the ATC Hazards by Location tool at https://hazards.atcouncil.org/.

Neither the SEAOC/OSHPD nor the ATC application, however, implements the additional requirement to take F_a as 1.2 in Site Class E; design professionals will need to make that adjustment separately. This requirement implements a SEAONC recommendation related to observed performance and recorded ground motions in the Loma Prieta earthquake. The 1.2 value is based on an allowance in ASCE 7 Section 11.4.8, Exception 1 (and is different from the 1.3 value used in other Bay Ares cities).

The site-specific ground motion procedures normally required by ASCE 7 Section 11.4.8 are waived for these retrofit projects. Many buildings eligible for CEBC Chapter A4 would be exempt from site response analysis in any case by the exception to ASCE 7 Section 20.3.1. Similarly, voluntary seismic retrofit to comply with HMC Section 9-7.500 is deemed exempt from requirements of the Alquist-Priolo Earthquake Fault Zoning Act because the cost of the work is not expected to exceed 50 percent of the value of the structure (California Public Resources Code Section 2621.7).

A403.7 Collector elements. *Revise this section to read, "Collector elements shall be provided to transfer the seismic forces between the elements within the scope of Section A403.2."*

Commentary: *This provision is revised to eliminate potential confusion over the words "other portions of the building," which could be misread to mean even parts of the building outside the scope identified in Section A403.2.*

A403.8 Horizontal diaphragms. *Replace the entire section as follows:*

A403.8. Floor diaphragms. Floor diaphragms within the scope of Section A403.2 shall be shown to have adequate strength at the following locations:

1. For straight lumber sheathed diaphragms without integral hardwood flooring: Throughout the diaphragm. The Building Official is authorized to waive the requirement where it is shown that the condition occurs in areas small enough not to affect overall building performance.
2. For all other diaphragms: At locations where forces are transferred between the diaphragm and each new or strengthened vertical element of the seismic force-resisting system. Collector elements shall be provided where needed to distribute the transferred force over a greater length of diaphragm.

Exception: Where the existing vertical elements of the seismic force-resisting system are shown to comply with this chapter, diaphragms need not be evaluated.

Commentary: *This replacement implements an interpretation considered appropriate for the limited objective of Chapter A4. Straight lumber sheathed diaphragms without integral hardwood flooring are weaker and more flexible than other diaphragm systems. Though there are no known collapses due to this condition, expected poor performance could compromise the building's ability to meet even the limited objective of Chapter A4. Integral hardwood flooring – but not newer "floating" wood flooring – provides significant added strength and stiffness. Even in buildings with original hardwood flooring, some remodeled, carpeted, or tiled areas might have had the original wood flooring removed. Areas of the diaphragm that form a roof for the target story (such as the portion of a garage that extends beyond the wall line above, or at a lightwell or building setback) are also unlikely to have hardwood flooring to supplement the straight* *sheathing. These areas should be identified as part of the condition assessment and evaluated. Small isolated areas without hardwood flooring are not expected to affect overall building performance, so the provision grants a waiver for these cases. As a rule of thumb, an area up to 150 square feet per unit might represent such an acceptable condition.*

For other less vulnerable diaphragm types, the provision requires a local check for each new or strengthened SFRS element but does not require an overall analysis of the full diaphragm. The unit shear demand at each vertical element is calculated as the force in the element divided by the total length of the element and its collectors. The shear demand is then compared to the unit shear capacity of the diaphragm. Where demand is greater than capacity, either the diaphragm must be strengthened or the collector lengthened. An existing diaphragm can be strengthened by adding a wood structural panel soffit to the bottom of the floor joists in the critical area. Diaphragm capacity need not be checked at existing vertical elements that are not strengthened because (except for straight lumber sheathed diaphragms) it is assumed that the unit capacities of the existing vertical elements and the diaphragm are comparable.

The exception waives the diaphragm evaluation where the main elements of the seismic force-resisting system are found to be adequate. That is, if the only potential seismic deficiency is in the diaphragm, the building is still deemed to pass the evaluation. The exception applies only where a prior, recent (post-2000) retrofit is being evaluated, since those are the only cases for which HMC Section 9-7.400 allows the use of Chapter A4 for evaluation.

A403.9 Wood-framed shear walls. *Add the following sentence at the end of the provision:* Where new sheathing is applied to existing studs to create new wood-framed shear walls, the new wall elements shall be considered bearing wall systems for purposes of determining seismic design parameters.

Commentary: *Since existing studs are presumed to carry existing gravity loads, the walls they frame must be considered bearing walls, as opposed to "building frame" systems. This affects the selection of seismic design coefficients R, C_d, and* Ω_0.

A403.9.1 Gypsum or cement plaster products. *Replace the entire provision as follows:* Gypsum or cement plaster products shall not be used to provide the strength required by Section A403.3 or the stiffness required by Section A403.4.

Commentary*: Since Chapter A4 is based on code provisions for new construction, code provisions and standards that allow like materials do not apply, and non-conforming materials are not allowed to be counted toward the minimum required strength. They must be considered, however, if the cap in Section 403.3.1 is applied, which is why the provision is modified.*

Add Section A403.10 and subsections A403.10.1 and A403.10.2:

A403.10 Steel retrofit systems. Steel retrofit systems shall have strength and stiffness sufficient to resist the seismic loads and shall conform to the requirements of this section.

A403.10.1 Special moment frames. Steel special moment frames shall comply with all applicable provisions of AISC 341, including but not limited to connection design and lateral bracing of beams. It is permitted to employ approved commercially available proprietary frame systems to achieve the special moment frame classification.

Exception: The "strong-column/weak-beam" provision of AISC 341 is waived, provided that the columns carry no gravity load.

A403.10.2 Intermediate or ordinary moment frames. Steel intermediate or ordinary moment frames shall comply with all applicable provisions of AISC 341.

> ***Commentary:*** *See Section A403.3 Exception 5 as added by this Bulletin for a waiver on height limits otherwise applicable to these systems.*

A403.10.3 Cantilevered column systems. Steel special or ordinary cantilevered column systems shall comply with all applicable provisions of AISC 341.

A403.10.4 Inverted moment frame systems. Cantilevered column systems shall be permitted to be designed as inverted special, intermediate, or ordinary moment frames, with corresponding moment frame seismic design coefficients, where the system satisfies the following conditions:

1. The columns carry no gravity load.
2. The columns are configured in pairs (or larger groups) connected by a continuous reinforced concrete foundation or grade beam.
3. The foundation or grade beam is designed to resist the expected plastic moment at the base of each column, computed as R_yF_yZ in accordance with AISC 341.
4. The flexibility of the foundation or grade beam, considering cracked section properties of the reinforced concrete, is included in computing the deformation of the steel frame system.
5. The columns are considered as twice their actual height when checking lateral torsional buckling.

> ***Commentary:*** *This provision implements a SEAONC recommendation developed to accommodate a modification of traditional cantilevered column systems. Cantilevered column systems for new construction are normally assigned seismic design coefficients that severely limit their use. When used for retrofit of wood frame structures, however, the columns are less vulnerable to buckling failure because they carry no gravity load. SEAONC has therefore recommended that these cantilever column systems, configured as upside-down moment frame bents (with concrete cross beams), should be allowed to be designed as moment frame systems.*

A404.1 Limitation. *In the first sentence, omit the words "and only where deemed appropriate by the code official."*

> ***Commentary:*** *These prescriptive measures are deemed appropriate for compliance with HMC Section 9-7.500.*

A405.3 Existing materials. *No modification, but see commentary.*

> ***Commentary:*** *While an overall condition assessment is often beneficial, this provision is applicable primarily to the existing structural elements that will be relied on to provide the required strength and stiffness. If the cap allowed in Section 403.3.1 is used, this will include all*

existing elements contributing to the expected story strength in each target story and the story above, as well as diaphragms and foundations. If the cap is not used, the condition assessment may be limited to just the structural scope identified in Section A403.2. ASCE 41-17 provisions and commentary for condition assessment may be useful as a guide to the work. The investigation should be based on a combination of non-destructive testing or inspection, destructive testing or inspection, and reference to record documents. Where record documents are used to reduce the scope of testing or other on-site work, appropriate field verification is normally required. The Building Official is authorized to require additional investigation as needed to fulfill the purpose of the condition assessment. Findings of the condition assessment should be included with the structural calculations per Section A.3.3 of this Bulletin.

With the approval of the Building Official, field verification of assumed conditions may be performed during construction; in these cases adjustments to previously approved structural calculations and plans might be needed, which is why Section A.3.2 of this Bulletin calls for field verification items to be shown on the plans.

A405.3.6 Existing masonry partitions. *Add this subsection:* Masonry partitions or fire separation walls within a target story shall be investigated to determine their capacity to resist story shears and deformations, whether intended as seismic force-resisting elements or not. The investigation shall consider their material strength and condition, grouting and reinforcing, connections and continuity to stories above and foundation below, and related detailing and load path as they relate to likely performance in in-plane shear, out-of-plane shear, overturning moment, and uplift. Based on the investigation, the design professional shall document and substantiate a design approach and acceptability criteria.

Commentary: *Some buildings are known to have concrete masonry fire separation partitions that might act as* de facto *seismic force-resisting elements, even if not designed to carry lateral forces and not detailed for ductile response. Since the construction of these partitions is not well documented, it is the responsibility of the design professional to understand their likely performance and to account for it in the retrofit design. In some cases, the walls might be usable as SFRS elements (as is, or as strengthened). In other cases, it might be preferable to isolate them from the seismic response by breaking the lateral load path, as long as necessary fire safety and support for gravity loads is maintained.*

A405.3.7 Existing unreinforced brick footings. *Add this subsection:* The capacity of an existing brick footing to resist shear or pullout of an existing or new anchor shall be established by testing or by reference to approved tests of similar conditions.

Commentary: *Older buildings might have unreinforced brick footings. In general, these are unlikely to be adequate for new or strengthened shear walls, but the added provision allows a method to substantiate their capacity.*

A406.1 General. *Omit this subsection.*

Commentary: *Section A.3.2 of this Bulletin replaces Chapter A4 Section A406.1.*

A406.2 Existing construction. *Add the following sentence to this subsection:* If the cap allowed by Section A403.3.1 is used to limit the scope of retrofit, the foregoing information shall be shown for each target story and at least one story above the uppermost target story. If the cap allowed by Section A403.3.1 is not used, the foregoing information need only be shown for each target story and for the floor immediately above the uppermost target story.

A407.1 Structural observation, testing and inspection. *Omit this subsection.*

> ***Commentary:*** *Section A.4 of this Bulletin replaces Chapter A4 Section A407.1.*

Part C. Engineering Criteria for Target Story Evaluation or Retrofit Using ASCE 41

C.1 Reference standard. ASCE 41, the 2017 version of *Seismic Evaluation and Retrofit of Existing Buildings*, as modified and interpreted by Section C.4 of this Bulletin, shall be permitted as the criteria for voluntary seismic evaluation to comply with HMC Section 9-7.400 or for voluntary seismic retrofit to comply with HMC Section 9-7.500.

> ***Commentary:*** *HMC Sections 9-7.400 and 9-7.500 allow three different documents to be used as engineering criteria. Therefore, Part C allows but does not require ASCE 41.*

C.2 Definitions (ASCE 41 Section 1.2.1)

TARGET STORY. Either (1) a basement story or underfloor area that extends above grade at any point or (2) any story above grade, where the wall configuration of such basement, underfloor area, or story is substantially more vulnerable to earthquake damage than the wall configuration of the story above, except that a story is not a target story if it is the topmost story or if the difference in vulnerability is primarily due to the story above being a penthouse or an attic with a pitched roof.

> ***Commentary:*** *This definition, given in HMC Section 9-7.300.10, is added as a preferred way to refer to the structural deficiency of interest and the subject of the seismic evaluation or retrofit.*
> - *By including underfloor areas, the definition avoids confusion about crawl spaces and the building code definition of "story," especially on sloped sites.*
> - *The definition facilitates coordination with similar programs in Berkeley, San Francisco, and Oakland.*
> - *Because the definition is not quantitative, it usefully relies on the judgment of engineers or other qualified design professionals. This is consistent with the screening requirements of the Ordinance. If a building has no apparent target story, it may be exempted by screening, without the need for a quantitative seismic evaluation.*

WOOD FRAME TARGET STORY. A target story in which a significant portion of lateral or torsional story strength or story stiffness is provided by wood frame walls.

> ***Commentary:*** *Together with the definition of target story, this definition, also given in HMC Section 9-7.300.10, identifies the deficiency of interest and the subject of the seismic evaluation or retrofit. As with the definition of target story, the definition of wood frame target story relies intentionally on the judgment of design professionals.*

C.3 Scope of evaluation or retrofit (ASCE 41 Section 1.1)

C.3.1 Elements to be considered. Evaluation or retrofit to comply with HMC Chapter 9 Article 7 need only consider the lateral load path elements from the wood diaphragm immediately above any wood frame target story to the foundation soil interface. Stories above the uppermost wood frame target story shall be considered in the analysis but need not be modified. The lateral-load-path analysis for added structural elements shall include evaluation of the allowable soil-bearing and lateral pressures in accordance with the building code.

> ***Commentary:*** *Normally, ASCE 41 is applied to an entire building or structure. HMC Sections 9-7.400.20 and 9-7.500.30, however, make clear that the intent is to apply the engineering criteria only to the building's wood frame target stories. The wording is consistent with the similar scope of CEBC Chapter A4, Section A403.2.*

C.3.2 Required Retrofit Strength. Despite any other requirement of ASCE 41, the total expected strength of retrofit elements added to any target story need not exceed 1.7 times the expected strength of the story immediately above in a two-story building, or 1.3 times the expected strength of the story immediately above in a three-story or taller building, as long as the retrofit elements are located symmetrically about the center of mass of the story above or so as to minimize torsion in the target story. Calculation of expected story strength and identification of irregularities shall be based on the expected strength of all wall lines, even if sheathed with nonconforming materials. The strength of a wall line above the target story may be reduced to account for inadequate load path or overturning resistance.

> ***Commentary:*** *This provision is consistent with this Bulletin's addition of Section A403.3.1 to CEBC Chapter A4 (see Part B). The provision is based on a SEAONC recommendation to cap the required strength, consistent with FEMA P-807. Strictly speaking, the allowance should not be needed if the ASCE 41 rules for selecting analysis procedures and for modeling secondary components are carefully followed. In concept, the strength cap could be applied to all elements (new and existing) in the target story, but it is applied only to retrofit elements to ensure that some ductility, reliability, and torsion control is provided.*
>
> *The expected strength of the story above may be calculated using the FEMA P-807 criteria. If the strength is reduced to account for an inadequate load path, as allowed, the load path should be documented by field observation and condition assessment; otherwise, the strength calculation should assume an adequate load path to avoid underestimating the upper story strength.*

C.4 Modification and interpretation of ASCE 41

C.4.1 Performance Objective (ASCE 41 Sections 1.4.1 and 1.5.2). For either evaluation or retrofit, the performance objective shall be Structural Life Safety in the BSE-1E seismic hazard.

> ***Commentary:*** *This objective is given in HMC Sections 9-7.400.20 and 9-7.500.30. It need only be applied to the building elements identified in Bulletin Section C.3.1. As such, the seismic retrofit contemplated by HMC Section 9-7.500 is, in ASCE 41 terms, a partial retrofit in accordance with ASCE 41 Section 2.2.5.*

C.4.2 Seismic hazard, seismicity parameters and Site Class (ASCE 41 Section 2.4). Any building located in an area labeled "NEHRP E" on the latest USGS map of "Soil Type and Shaking Hazard in the San Francisco Bay Area" shall be assigned to Site Class E unless site-specific investigation in accordance with ASCE 7 Chapter 20 indicates otherwise. For any site designated as Site Class E, the value of F_a shall be taken as 1.2. Site-specific procedures are not required for compliance with HMC Chapter 9 Article 7.

Commentary: *Other than this provision regarding Site Class E, Site Class shall be determined following the normal procedures for new construction, including the use of Site Class D as a default. The USGS map of Bay Area site classes is at https://earthquake.usgs.gov/hazards/urban/sfbay/soiltype/map/.*

Seismic hazard parameters as needed may be obtained from the SEAOC/OSHPD Seismic Design Maps, using "2015 IBC" as the Reference, at https://seismicmaps.org/ or from the ATC Hazards by Location tool at https://hazards.atcouncil.org/.

Neither the SEAOC/OSHPD nor the ATC application, however, implements the additional requirement to take F_a as 1.2 in Site Class E; design professionals will need to make that adjustment separately. This requirement implements a SEAONC recommendation related to observed performance and recorded ground motions in the Loma Prieta earthquake. The 1.2 value is based on an allowance in ASCE 7 Section 11.4.8, Exception 1 (and is different from the 1.3 value used in other Bay Ares cities).

The site-specific ground motion procedures normally required by ASCE 7 Section 11.4.8 are waived for these retrofit projects. Many buildings eligible for CEBC Chapter A4 would be exempt from site response analysis in any case by the exception to ASCE 7 Section 20.3.1. Similarly, voluntary seismic retrofit to comply with HMC Section 9-7.500 is deemed exempt from requirements of the Alquist-Priolo Earthquake Fault Zoning Act because the cost of the work is not expected to exceed 50 percent of the value of the structure (California Public Resources Code Section 2621.7).

C.4.3 Benchmark Buildings (ASCE 41 Section 3.3). In ASCE 41 Table 3-2, the benchmark code of 1976 UBC for Building Types W1 and W2 does not apply.

Commentary: *HMC Chapter 9 Article 7 applies to buildings constructed before 1978 or designed with the 1976 or earlier edition of the* Uniform Building Code. *Most buildings subject to HMC Chapter 9 Article 7 will be type W1a and will therefore not be eligible for benchmarking with ASCE 41 Table 3-2, but this restriction is made for buildings that might be classified as type W1 or W2.*

C.4.4 Performance Level and Seismic Hazard Level (ASCE 41 Sections 4.1.1 and 4.1.2). These sections do not apply.

Commentary: *These ASCE 41 sections are moot, since the performance objective is given in Bulletin Section C.4.1. Since the given objective is consistent with the ASCE 41 "BPOE" objective, the Tier 1 and Tier 2 procedures are appropriate for buildings evaluated or retrofitted for compliance with HMC Chapter 9 Article 7.*

C.4.5 Selection and use of checklists (ASCE 41 Section 4.3). For evaluation of Structural Life Safety, the Tier 1 screening checklists for Collapse Prevention shall be used, except that checklist statements using Quick Check procedures shall be based on values provided for Life Safety performance.

Commentary: *In ASCE 41-17, checklists are provided for the Immediate Occupancy and*

Collapse Prevention structural performance levels, but not explicitly for Life Safety. This provision clarifies how to use the checklists for the HMC Chapter 9 Article 7 objective. It is consistent with footnote d to ASCE 41 Table 2-2.

C.4.6 Structural compliance (ASCE 41 Section 4.3 and Table 17-2). Compliance with HMC Chapter 9 Article 7 using ASCE 41 requires full compliance with all applicable ASCE 41 provisions, unless specifically noted in this Bulletin. A finding of "Compliant" for the Weak Story and/or Soft Story Tier 1 checklist items shall not by itself indicate compliance with HMC Chapter 9 Article 7.

C.4.7 Geologic site hazards (ASCE 41 Section 4.3 and Table 17-2). ASCE 41 Tier 1 checklist items for Liquefaction, Slope Failure, and Surface Fault Rupture do not apply.

Commentary: *Compliance with HMC Chapter 9 Article 7 does not require mitigation of existing geologic site hazards.*

C.4.8 Modeling Primary and Secondary Components (ASCE 41 Section 7.2.3.3) Only primary components are to be modeled in linear analyses. In particular, for purposes of establishing the distribution of story forces, discontinuous upper story walls and partitions should not be modeled unless their stiffness is reduced to account for lack of overturning resistance or load path to elements below.

Commentary: *This provision is consistent with this Bulletin's addition of Section A403.3.1 to CEBC Chapter A4 (see Part C). See also the commentary to Bulletin Section C.3.2.*

C.4.9 Modeling Overturning (ASCE 41 Section 7.2.8). Where dead loads alone are used to resist overturning, existing walls without hold-downs should be considered force-controlled for purposes of checking overturning. Existing walls without hold-downs may be considered deformation-controlled for purposes of checking shear strength, as long as the demands and capacities assigned to them account for the lack of hold-downs. Alternatively, where in accordance with ASCE 41 provisions for designating secondary elements, existing walls without hold-downs may be designated as secondary and removed from the linear model for purposes of distributing design forces to retrofit elements.

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Part D. Engineering Criteria for Target Story Evaluation or Retrofit Using FEMA P-807

D.1 Reference document. FEMA P-807, *Seismic Evaluation and Retrofit of Multi-Unit Wood-Frame Buildings With Weak First Stories* (May, 2012), as modified and interpreted by Part D of this Bulletin, shall be permitted as the criteria for voluntary seismic evaluation to comply with HMC Section 9-7.400 or for voluntary seismic retrofit to comply with HMC Section 9-7.500.

> ***Commentary:*** *FEMA P-807, unlike the other documents cited by HMC Chapter 9 Article 7, is not a code or standard; it is instead written in a guideline or narrative style. Enforceable provisions in "code language" are therefore provided here, adapted from FEMA P-807 Appendix B. In general, use of FEMA P-807 for compliance with HMC Chapter 9 Article 7 means compliance with the code language provisions in Part D of this Bulletin; FEMA P-807 itself constitutes a commentary or background reference for these provisions.*
>
> *Because FEMA P-807 is customizable and performance-based, its use in general requires the selection of a hazard level, a performance level, and acceptable probabilities of exceedance (see Section D.2 of this Bulletin). As explained in FEMA P-807 Appendix B, these parameters can be selected with various rationales. With this Bulletin, Hayward has opted to use the same parameters previously selected by the City of Berkeley, which made its selections essentially to match the outcomes of using IEBC Appendix Chapter A4, given Berkeley's building stock and seismicity. Because Hayward's seismicity is similar to Berkeley's, these parameters are deemed appropriate for Hayward. However, conditions in Hayward generally, and at any particular Hayward site, may differ, and Hayward has not studied whether the use of FEMA P-807, as an alternative to CEBC Appendix Chapter A4 (see Part B of this Bulletin) or ASCE 41 (Part C of this Bulletin), will lead to different results. Rather, the use of FEMA P-807 is being allowed to provide the most flexibility for Hayward building owners seeking to comply with HMC Chapter 9 Article 7.*

D.2 Compliance

D.2.1. Performance Objective

D.2.1.1. Hazard level. The spectral demand shall be $0.5S_{MS}$, calculated in accordance with ASCE 7 except that for sites in Site Class E, the value of F_a shall be taken as 1.2.

> ***Commentary:*** *The provision for Site Class E is consistent with the provision in Bulletin Part B (adding Section A403.3.2 to the CEBC) and in Bulletin Part C (Section C.4.2). See the commentary there for additional explanation.*

D.2.1.2. Performance level. Acceptable performance shall be based on drifts corresponding to the Onset of Strength Loss in the seismic force-resisting elements.

> ***Commentary:*** *Onset of Strength Loss criteria are already embedded in the criteria given in this Part.*

D.2.1.3. Maximum drift limit probability of exceedance. The maximum drift limit *POE* for validation of the retrofit design shall be 20 percent.

Exception: The maximum drift limit *POE* for assessment or for retrofit design shall be 40 percent, as long as the additional requirements of Bulletin Section D.8.3 are met.

D.2.2. Required scope of work

Compliance with the provisions of HMC Chapter 9 article 7 using FEMA P-807 requires:

1. Correction of all aspects of eligibility non-compliance per Bulletin Section D.4, and
2. Correction of all building survey non-compliance per Bulletin Section D.5, and either

3a. Demonstration of an acceptable existing condition per Bulletin Section D.7, or

3b. Design and execution of a retrofit in accordance with Bulletin Section D.8 and other applicable codes and regulations.

Where the provisions of Bulletin Section D.8 cannot be satisfied, the building shall be considered ineligible for compliance with HMC Chapter 9 Article 7 using FEMA P-807.

D.3 Definitions

> ***Commentary:*** *In some instances, the notation and terminology here differ slightly from those in FEMA P-807 Chapters 1-7.*

D.3.1. Terminology

Terms used in Bulletin Part D shall have the meanings provided here. Terms not defined here shall have the meanings provided in the building code.

CENTER OF STRENGTH. At each story, the location in plan that represents the weighted average location of the load in all wall lines, at the drift associated with the story strength.

DRIFT. For a given story, the calculated or postulated lateral deflection within that story divided by the story height, normally expressed as a percentage.

FIRST STORY. The story of interest with respect to assessment or retrofit, spanning vertically between the first floor and the second floor. Depending on the building and its relationship to grade, the story designated as the First Story can be an underfloor area or cripple story, a basement, the first story above grade, or another story above grade. The First Story can be partial in plan. For a building with multiple stories of interest, the First Story can vary as each story of interest is analyzed.

LOAD-DRIFT CURVE. For a wall assembly, wall line, or story, the relationship characterizing the variation of shear resistance versus drift, for the full range of relevant drifts. For a wall assembly, the load value is given in units of force per unit length. For wall lines and stories, the load value is given in units of force.

LOAD-ROTATION CURVE. For a story, the relationship characterizing the variation of torsional resistance versus story rotation, for the full range of relevant rotations, given in units of torque as a function of rotation angle.

PROBABILITY OF EXCEEDANCE (*POE*). The desired or calculated probability that the structure will respond beyond the drift limits representing the desired performance level, in at least one direction, when subjected to a specified hazard level. Within HMC Chapter 9 Article 7 and this

Bulletin, *POE* means the probability of exceeding the drift limits associated with Onset of Strength Loss.

Commentary: *As used in this Bulletin, POE is identical to what FEMA P-807 Chapters 1 through 7 typically call "drift limit POE."*

QUALIFYING WALL LINE. For purposes of checking eligibility of floor or roof diaphragms, a wall line that contributes substantially to the peak story strength and has an adequate load path connecting it to the diaphragms it affects.

Commentary: *See FEMA P-807 Section 2.6.4 for discussion of rules for "qualifying" wall lines. The definition is subject to the judgment of the design professional and the Building Official.*

SPECTRAL CAPACITY. For a given POE, the highest level of spectral acceleration a structure can sustain without responding beyond the drift limits representing the desired performance level, given as a multiple of the acceleration of gravity, and calculated separately in each principal direction.

SPECTRAL DEMAND. See Bulletin Section D.2.1.1. The spectral demand is given as a multiple of the acceleration of gravity.

STORY. See the building code definition and this Bulletin's definition of First Story.

STORY STRENGTH. The maximum load value from the story load-drift curve, calculated separately in each principal direction.

STORY STRENGTH, BASE-NORMALIZED. The story strength divided by the total seismic weight of the building.

STORY STRENGTH, STORY-NORMALIZED. The story strength divided by the sum of the tributary floor weights of all the floors above the story in question.

STORY TORSIONAL STRENGTH. The maximum torsional resistance value from the story load-rotation curve.

STRENGTH DEGRADATION RATIO. In each direction, a value between 0.0 and 1.0 calculated as the first story strength divided by the load corresponding to a drift of 3 percent from the first story load-drift curve.

TORSION COEFFICIENT. A value that need not be taken greater than 1.4, calculated as the first story torsional demand divided by the first story torsional strength.

TORSIONAL ECCENTRICITY. The absolute value of the plan distance, in x and y components, between the second story center of strength and the first story center of strength.

TRIBUTARY FLOOR WEIGHT. The total seismically active weight tributary to a single floor level comprising dead load and applicable live load, snow weight, and other loads as required by the building code.

UPPER STORY. Any story above the first story.

WALL ASSEMBLY. A unique combination of sheathing materials over wood-stud framing.

WALL LINE. A collection of full-height and partial-height wall segments or frames within a single story that satisfies the rules in Bulletin Section D.6.1.2.

Commentary: *A wood-frame wall line is generally assumed to contribute strength only in the direction parallel to its length. A wall line expected to contribute strength in a direction other than parallel to its length, such as a cantilever column or fixed-based moment frame, must be* *modeled appropriately.*

WALL SEGMENT. A portion of wood-frame wall made from a single wall assembly. For purposes of this definition, any sheathed run of wood-stud framing that could contribute to a story's lateral strength or stiffness shall be considered a potential wall segment, whether or not the framing and sheathing were intentionally designed, detailed, sized, or located to contribute that strength or stiffness.

D.3.2. Notation

A_U The base-normalized upper-story strength, calculated separately for each direction.
A_W The weak-story ratio, calculated separately for each direction.
C_D The strength degradation ratio, calculated separately for each direction.
C_T The torsion coefficient.
C_U The minimum of the story-normalized story strengths of any of the upper stories, calculated separately for each direction.

Commentary: *Where the story strength is roughly constant for all upper stories, C_U will generally be the story-normalized strength of the second story.*

COS_i The plan location, in *x* and *y* coordinates, of the center of strength of story *i*.
e_x, e_y The *x* and *y* components, respectively, of the torsional eccentricity.
f_w The load-drift curve for wall line *w*.
F_i The load-drift curve for story *i*, calculated separately for each direction.
h_w The floor-to-ceiling height of wall line *w*.
H_1 The floor-to-ceiling height of the tallest first story wall line, determined separately in each direction.
i A subscript index indicating floor or story. Story *i* is between floor *i* and floor *i+1*.
L_w The length of wall line *w*, taken as the longest possible length of wall that satisfies the rules in Bulletin Section D.6.1.2, including the length of any openings within it.
L_x The overall building dimension in the *x* direction.
L_y The overall building dimension in the *y* direction.
POE Probability of Exceedance
Q_{open} The adjustment factor for openings in a wall line.
Q_{ot} The adjustment factor for overturning of a wall line.
Q_s The story height factor for the first story, calculated separately for each principal direction.
S_c The spectral capacity, calculated separately for each direction.
S_d The spectral demand.
t_i The load-rotation curve for story *i*.
T_i The story torsional strength of story *i*.
V_{1r} The story strength of the retrofitted first story, calculated separately for each direction.
V_i The story strength of story *i*, calculated separately for each direction.
V_U The story strength of the upper story that determines the value of C_U.

Commentary: *Where the story strength is roughly constant for all upper stories, V_U will generally be the second story strength.*

w	A subscript index indicating a single wall line.
W	The total seismic weight of the building, equal to the sum of all the tributary floor weights.
W_i	The tributary floor weight of floor i.
WSP	Wood structural panel
x	A subscript index indicating one of two principal directions.
$\alpha_{POE,0}$	The *POE* adjustment factor for a C_D value of 0.0.
$\alpha_{POE,1}$	The *POE* adjustment factor for a C_D value of 1.0.
δ_φ	Drifts at which load-drift curves are characterized. See Table D.6.1.1.
Δ_t	In each direction, the drift at which the story strength of story i occurs.
τ_1	The first story torsional demand.

D.4 Eligibility

D.4.1. General

Buildings that do not comply with the requirements of Bulletin Section D.4 shall be considered ineligible for compliance using FEMA P-807.

Exception: Buildings in which all aspects of non-compliance will be eliminated through alteration or retrofit are eligible for compliance using FEMA P-807.

D.4.2. Massing

1. The building has no more than four stories above grade plane at any point around its perimeter.

2. The building's wood-framed stories are not supported by an above-grade podium structure.

> ***Commentary:*** *Item 1 relies on the building code's definition of story above grade plane. Item 2 is referring to a concrete podium structure generally extending at least one story above grade and topped by a concrete diaphragm that provides a base for wood framing above. Item 2 is not intended to rule out concrete foundation elements or stem walls that extend above grade.*

D.4.3. Upper stories

1. The upper-story seismic force-resisting systems are bearing wall or building frame systems of wood-frame walls with shear panels.

2. The upper-story floor-to-floor heights are between 8 feet and 12 feet and are constant within each story.

3. In each upper story, in each principal direction, the distance from the center of strength to the center of mass of the floor below it is no more than 25 percent of the corresponding building dimension.

> ***Commentary:*** *The intent of this approximate rule is to ensure that no upper story is prone to significant torsion, and that inertial forces from upper stories should transfer to the first story near the geometric center of the second floor. See FEMA P-807 Section 2.6.2.*

4. No upper story or floor above an upper story has a weight irregularity as defined by ASCE 7 Table 12.3-2, Type 2.

5. No upper story has a vertical geometric irregularity as defined by ASCE 7 Table 12.3-2, Type 3.

D.4.4. First story, basement and foundation

1. The first story height may vary, but the maximum first story height, from top of foundation to top of second floor framing is between 8 feet and 15 feet.

2. The first story seismic force-resisting systems are bearing wall or building frame systems of wood-frame walls with shear panels or combine such systems with steel moment-resisting frame systems, steel cantilever column systems, or steel buckling-restrained braced frame systems.

> ***Commentary:*** *FEMA P-807 is not suitable for assessing or designing concentrically braced frames, concrete shear walls, or reinforced masonry shear walls. See FEMA P-807 Section 6.5. If these systems exist or are proposed as retrofit elements, compliance must be demonstrated using one of the other methods allowed by HMC Chapter 9 Article 7.*

3. The first story includes no full-height concrete or masonry walls.

4. The first story walls and frames have continuous concrete footings or concrete slab-on-grade foundations. If some or all of the first floor is raised over a crawl space, the crawl space has concrete stem walls to the underside of the first floor framing.

> ***Commentary:*** *Concrete stem walls are considered to provide a base similar to a concrete foundation. Wood-framed cripple walls may be considered to meet this eligibility condition at the discretion of the Building Official.*

5. First story walls and frames may be partial height over a concrete or reinforced masonry retaining wall or foundation stem wall, but any partial-height wall or frame is at least four feet tall from top of stem wall to underside of second floor framing.

6. If the building has a basement, the basement walls and the floor diaphragm just above them are capable of transferring seismic forces between the foundation and the first story, and the basement story is laterally stronger than the first story above it.

D.4.5. Floor and roof diaphragms
Floor and roof diaphragms shall satisfy the eligibility requirements of this subsection.

Exception: Diaphragms shown to have no deficiencies or irregularities that would prevent development of the strength of any seismic force-resisting wall or frame or would otherwise control the overall seismic response of the structure need not satisfy the eligibility requirements in this subsection.

> ***Commentary:*** *The intent of these approximate rules for diaphragms is to ensure that the structure does not develop a premature mechanism or failure mode. See FEMA P-807 Section 2.6.4 for additional explanation and guidance.*

1. No portion of the second floor diaphragm between qualifying wall lines has an aspect ratio greater than 2:1.

2. The second floor diaphragm does not cantilever more than 25 feet from a qualifying wall line.

3. If the second floor diaphragm cantilevers more than 10 feet from a qualifying wall line, diaphragm chords are adequate to develop the lesser of the strength of the diaphragm or the diaphragm forces associated with the peak strength of the qualifying wall line.

4. No floor or roof diaphragm has a reentrant corner irregularity in which either projecting leg of the diaphragm beyond the reentrant corner is longer than 15 percent of the corresponding plan dimension of the building, unless each leg of the diaphragm satisfies the aspect ratio and cantilever rules of this subsection.

> ***Commentary:*** *This provision differs from the irregularity defined in ASCE 411-03 or as Type 2 in ASCE 7-10 Table 12.3-1 in order to limit diaphragm demands. See FEMA P-807 Section 2.6.4.*

5. No floor or roof diaphragm has a vertical offset unless load path components are present and adequate to develop the diaphragm strength across the offset.

6. No floor or roof diaphragm has cutouts or openings within it such that, along any line across the diaphragm, the sum of the opening widths along that line is more than 25 percent of the overall diaphragm dimension along that line.

D.5 Building Survey

D.5.1. General

Structural components shall be investigated in accordance with Bulletin Section D.5 as needed to confirm eligibility per Bulletin Section D.4 and to support structure characterization per Bulletin Section D.6, assessment per Bulletin Section D.7, and retrofit design per Bulletin Section D.8.

D.5.2. Wall framing and sheathing

The investigation shall determine the length and location in plan of all wall segments and wall lines in all stories as needed to calculate load-drift curves.

The investigation shall determine the size and location of openings in each wall line as needed to calculate adjustment factors for openings and adjustment factors for overturning.

The investigation shall determine all unique frames or wall assemblies in the first story and representative wall assemblies in the upper stories. Where sheathing includes wood structural panels or where sheathing load-drift data is a function of nailing, the investigation shall also determine the nail size and edge nail spacing. Panel edge nailing shall be investigated over at least five nail spaces and as needed to confirm a reliable spacing assumption.

> ***Commentary:*** *Unless building-specific conditions indicate a need for more extensive investigation, the minimum recommended investigation should include one location of each distinct wall assembly in the first story and in any upper story, but not less than one perimeter and one interior wall line in the first story and in any upper story. If prior investigation reports based on destructive investigation are available, they may be relied on. If original drawings are available, they may be relied on to reduce the scope of investigation, but some investigation is still necessary to confirm the reliability of the drawings.*

D.5.3. Floor and roof framing and diaphragm

The investigation shall determine the construction of floor and roof framing and diaphragm sheathing, including the direction of framing and the mechanism of gravity load transfer, as needed for calculation of adjustment factors for overturning. The second floor shall be investigated. Subject to approval of the Building Official, the roof and upper floors need not be investigated in detail where there is evidence that their relevant attributes are similar to those of the second floor.

D.5.4. Load path components

The investigation shall determine the nature of the load path components and connections for transfer of forces between diaphragms and walls or frames as needed to confirm that the wall line will participate in resisting drift.

> ***Commentary:*** *For non-WSP sheathing, the intent is to confirm that fastening reasonably conforms to conventional construction requirements. For existing WSP shear walls with nail spacing closer than six inches, it should be confirmed at representative locations that shear wall top and bottom connection capacity is appropriate to the sheathing capacity.*

The investigation shall determine the presence or absence of hold-down hardware at the base of all first story walls, as well as the adequacy of installation of representative types at representative locations.

The investigation shall confirm that anchors are provided at the base of the first story walls.

Table D.5.4 shows where the load path may be assumed adequate or is subject to investigation or confirmation. Table D.5.4 applies only to walls whose strength is counted in the analysis. For any condition subject to investigation, the load path may be assumed lacking, and the corresponding wall strength may be ignored, but only if assumed so consistently throughout the building.

> ***Commentary:*** *The load path may be assumed lacking, but not selectively so as to "correct" torsion or other irregularities. This provision is similar to ASCE 41 limits on the designation of secondary components.*

Exception: Wherever the strength of two stories is being compared, an adequate load path must be assumed for all walls and partitions in the upper story.

> ***Commentary:*** *The exception prevents underestimating the upper story strength. The exception also applies to calculations of weak story or soft story ratios in ASCE 41 or IEBC A4 and to application of the 1.3 or 1.7 caps on retrofit strength for ASCE 41 and IEBC A4 retrofits. (For IEBC A4, see Bulletin Section B.2, adding Section A403.3.1. For ASCE 41, see Bulletin Section C.3.2.)*

The adequacy of an investigated load path may be confirmed by the judgment of the design professional, without calculations, but is subject to approval by the Building Official. Judgment should be based on the presence of a positive connection with multiple or redundant attachments distributed over the length of the wall line. For partitions perpendicular to floor framing above, blocking between floor joists nailed to the partition top plate (through a lath nailer, if present) should be deemed adequate for partitions with non-WSP sheathing.

Table D.5.4.
Investigation Requirements for Load Path between Partitions and Floor Framing Above

Condition	First / Target Story	Second / Upper Stories
Perimeter walls with non-WSP sheathing	May be assumed adequate	May be assumed adequate
Demising walls/partitions between units or between units and common areas	May be assumed adequate	May be assumed adequate
Any wall or partition with WSP sheathing where the top of the panel is nailed directly to a header beam, floor girder, or rim joist	May be assumed adequate	May be assumed adequate
Any wall or partition with WSP sheathing where the top of the panel is nailed only to a single or double top plate.	Confirm or provide load path	Confirm or provide load path
Room partitions within units, perpendicular to floor framing above	Investigate	May be assumed adequate
Room partitions within units, parallel to floor framing above	Investigate	Investigate

D.5.5. Foundation elements

The investigation shall determine the nature of the existing foundation elements and supporting soils as needed for calculation of adjustment factors for overturning.

D.6 Structure Characterization

D.6.1. Story strength

D.6.1.1. Wall assemblies. For each wall assembly present, a load-drift curve shall be computed by summing contributions from Table D.6.1.1 at each drift level for each layer of sheathing. With approval of the Building Official, test results specific to the wall assembly or its components may be used in place of Table D.6.1.1.

> ***Commentary:*** *See FEMA P-807 Section 4.4 and Appendix F regarding the development of Table D.6.1.1 and the use of alternate test data.*

The values in Table D.6.1.1 are subject to the following additional requirements:

1. Horizontal wood sheathing or wood siding shall be at least 1/2" thick and fastened to existing studs with at least two nails per board per stud. Otherwise, the expected strength shall be taken as 0.

2. Where siding panel edges are lapped, each panel shall be nailed separately. Otherwise, the expected strength shall be taken as 0.

Table D.6.1.1. Expected Strength for Load-Drift Curves [plf]

Sheathing Material	**Drift, δ_j [%]**								
	0.5	**0.7**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**4.0**	**5.0**
Stucco	333	320	262	0	--	--	--	--	--
Horizontal wood sheathing or wood siding	85	96	110	132	145	157	171	0	--
Diagonal wood sheathing	429	540	686	913	0	--	--	--	--
Plaster on wood lath	440	538	414	391	0	--	--	--	--
Plywood panel siding (T1-11), 6d@6	354	420	496	549	565	505	449	0	--
Gypsum wallboard	202	213	204	185	172	151	145	107	0
Plaster on gypsum lath	402	347	304	0	--	--	--	--	--
WSP, 8d@6	521	621	732	812	836	745	686	0	--
WSP, 8d@4	513	684	826	943	1,018	1,080	1,112	798	0
WSP, 8d@3	1,072	1,195	1,318	1,482	1,612	1,664	1,686	1,638	0
WSP, 8d@2	1,393	1,553	1,713	1,926	2,096	2,163	2,192	2,130	0
WSP, 10d@6	548	767	946	1,023	1,038	1,055	1,065	843	0
WSP, 10d@4	707	990	1,275	1,420	1,466	1,496	1,496	1,185	0
WSP, 10d@3	940	1,316	1,696	1,889	1,949	1,990	1,990	1,576	0
WSP, 10d@2	1,120	1,568	1,999	2,248	2,405	2,512	2,512	2,231	0

D.6.1.1.1. Wall assemblies without WSP sheathing. The assembly load drift curve is the sum of the load drift curves for each of the sheathing layers.

D.6.1.1.2. Wall assemblies with WSP sheathing. The assembly load drift curve is whichever of the following two load-drift curves has the larger peak strength:

1. The assembly load-drift curve using 50 percent of the strength of the wood structural panel layers and 100 percent of the strength of the other sheathing materials.

2. The assembly load-drift curve using 100 percent of the strength of the wood structural panel layers and 50 percent of the strength of the other sheathing materials.

D.6.1.2. Wall line assignment. Each segment of sheathed wall framing within a story shall be assigned to a wall line. Wall lines shall satisfy the following rules:

1. Full-height wall segments separated by window or door openings but connected by sheathed segments and continuous framing above or below the opening shall be assigned to the same wall line, unless other rules require them to be treated separately.

2. Wall segments assigned to the same wall line shall not be offset out-of-plane from adjacent segments by more than four feet.

3. At bay windows, the wall segments within the common plane shall be assigned to the same wall line if they satisfy the other rules, but the wall segments within the cantilevered portions of the bay shall not be counted toward the wall-line strength.

4. Wall segments of different heights, including wall segments along a stepped foundation, shall be assigned to separate wall lines.

5. A wall segment of varying height due to a sloped foundation shall be assigned to a separate wall line, and its height shall be taken as the average height of the segment.

6. Wall segments of different wall assemblies shall be assigned to separate wall lines.

7. Where hold-downs exist at each end of a wall segment, that segment may be considered a separate wall line.

8. Wall segments less than one foot long shall be treated as openings.

9. Wall segments between openings with height-to-length ratios greater than 8:1 shall be treated as openings.

10. Steel elements (moment frames, cantilever columns, etc.) shall be assigned to separate wall lines.

11. Wall segments or frames considered to have significant damage, deterioration, or construction defects may be counted toward a wall line's strength but shall have their load-drift strength values reduced.

D.6.1.3. Wall line load-drift curve. For each wall line, a load-drift curve shall be computed by multiplying the applicable wall assembly load-drift curve by the wall line's length and by applicable adjustment factors per Bulletin Equation D.6.1.3-1.

$f_w = (v_w)(L_w)(Q_{open})(Q_{ot})$ (Equation D.6.1.3-1)

where:

f_w is the load-drift curve of wall line w, expressed as a function of drift.

v_w is the load-drift curve of the wall assembly associated with wall line w, as derived per Bulletin Section D.6.1.1 and adjusted for height variation per Bulletin Section D.6.1.3.1.

D.6.1.3.1. Adjustment for height variation. Where first story wall lines in a given direction are of different heights, the load-drift curve of the wall assembly of each wood-frame wall line shall be adjusted to account for increased drift demands in all but the tallest first story wall line. This may be done by shifting the assembly load-drift curve from the standard set of drifts given in Table D.6.1.1 to an adjusted set of drifts for each wall line, given by Equation D.6.1.3.1-1.

$\delta_{jh} = (\delta_j)(h_w/H_1)^{0.7}$ (Equation D.6.1.3.1-1)

D.6.1.3.2 Adjustment for openings. Each wall line load-drift curve shall account for the effects of openings within it. This may be done by applying the adjustment factor for openings, given by Equation D.6.1.3.2-1 and Equation D.6.1.3.2-2.

$Q_{open} = 0.92a - 0.72a^2 + 0.80a^3$ (Equation D.6.1.3.2-1)

$$a = \frac{1}{\left(1 + \frac{\sum A_o}{h_w \sum L_f}\right)}$$ (Equation D.6.1.3.2-2)

where:

$\sum A_o$ = sum of the areas of the openings within the wall line

$\sum L_f$ = sum of the lengths of the full-height wall segments within the wall line.

D.6.1.3.3. Adjustment for overturning. Each wall line load-drift curve shall account for the effects of overturning demand and resistance. This may be done by applying the adjustment factor for overturning, given by Equation D.6.1.3.3-1 or, for existing upper-story wall lines only, by Table D.6.1.3.3.

$$Q_{ot} = 0.4\left(1+1.5\frac{M_r}{M_{ot}}\right) \leq 1.0$$ (Equation D.6.1.3.3-1)

where M_{ot} is the overturning demand on the wall line and M_r is the resisting moment due to all available dead loads tributary to the wall line plus the effects of any tie-down hardware.

Commentary: *See FEMA P-807 Section 4.5.3.2 for guidance on calculating Q_{ot}.*

Table D.6.1.3.3.
Default Adjustment Factor for Overturning, Q_{ot}, for Existing Upper Story Wall Lines

Number of stories above	Perpendicular to Framing	Parallel to Framing	Unknown or mixed
Two or more	0.95	0.85	0.85
One	0.85	0.80	0.80
None (Top story)	0.75	0.75	0.75

D.6.1.4. Story load-drift curves. For each story, in each direction, a load-drift curve shall be computed by adding the load-drift curves of all the walls in that story and aligned in that direction.

Commentary: *Where all the wall line load-drift curves are mapped to the same set of drifts, the summation is straightforward. Where some first story wall lines have load-drift curves mapped to a height-adjusted set of drifts, load values at the standard drift values should be determined by linear interpolation. Once interpolated values are calculated, the various load-drift curves can again be added in a straightforward way based on the standard drift values. See FEMA P-807 Section 4.6 for additional discussion.*

D.6.2. First story torsion

D.6.2.1. Center of strength. The center of strength for the first and second stories shall be determined based on the wall line loads at the drift at which the story strength in the corresponding story and direction occurs.

Commentary: *FEMA P-807 Section 4.6.4 illustrates the calculation of the center of strength.*

D.6.2.2. First story torsional demand. The first story torsional demand represents the effect of the first story strength acting at the torsional eccentricity, given by Equation D.6.2.2-1.

$\tau_1 = e_x V_{1y} + e_y V_{1x}$ (Equation D.6.2.2-1)

Building Division
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D.6.2.3. First story load-rotation curve. For the first story, a load-rotation curve shall be derived, relating torsion about the story center of strength to the resulting rotation of the story, assuming a rigid second floor diaphragm and accounting for the load-drift behavior of each first story wall line. The load-rotation curve shall consider rotation angles up to at least the rotation associated with 5 percent in-plane drift in at least one first story wall line.

> ***Commentary:*** *FEMA P-807 Section 4.6.6 illustrates one method for calculating of the load-rotation curve, dividing the rotation range of interest into ten even increments.*

D.6.3. Characteristic coefficients

D.6.3.1. Base-normalized upper-story strength. The base-normalized upper-story strength shall be calculated for each principal direction per Equation D.6.3.1-1.

$$A_U = \frac{V_U}{W}$$ (Equation D.6.3.1-1)

D.6.3.2. Weak-story ratio. The weak-story ratio shall be calculated for each principal direction per Equation D.6.3.2-1.

$$A_W = \frac{V_1}{V_U}$$ (Equation D.6.3.2-1)

D.6.3.3. Strength degradation ratio. The strength degradation ratio, C_D, shall be calculated for each principal direction based on the first story load-drift curves.

> ***Commentary:*** *FEMA P-807 Section 4.7.4 illustrates the calculation of the strength degradation ratio.*

D.6.3.4. Torsion coefficient. The torsion coefficient, given by Equation D.6.3.4- 1, need not be taken greater than 1.4.

$$C_T = \frac{\tau_1}{T_1}$$ (Equation D.6.3.4-1)

D.6.3.5. Story height factor. The story height factor shall be calculated for each principal direction per Equation D.6.3.5-1, where H_1 is given in inches.

$Q_s = 0.55 + 0.0047\ H_1$ (Equation D.6.3.5-1)

D.7 Assessment

D.7.1. Assessment relative to the performance objective
Subject to the additional requirements of Bulletin Section D.2.2, any eligible structure shall be deemed to comply with the requirements of this Bulletin if its spectral capacity in each principal direction exceeds the spectral demand.

D.7.1.1. Spectral capacity. Spectral capacity in each direction shall be calculated from Equations D.7.1.1-1 through D.7.1.1-5, using drift limit *POE* adjustment factors given in Table D.7.1.1 for the drift limit *POE* specified in Bulletin Section D.2.1.3. Drift limit *POE* adjustment factors for intermediate values of drift limit *POE* shall be calculated by linear interpolation.

> ***Commentary:*** *HMC Chapter 9 Article 7 does not require the calculation of a POE. However, given a spectral demand, the POE of a structure can be calculated. See FEMA P-807 Section 5.4.2 or Appendix B model provision 6.2.*

$$S_c = C_D^3 S_{c1} + \left(1 - C_D^3\right) S_{c0}$$ (Equation D.7.1.1-1)

$$S_{c1} = \alpha_{POE,1} S_{\mu 1}$$ (Equation D.7.1.1-2)

$$S_{c0} = \alpha_{POE,0} S_{\mu 0}$$ (Equation D.7.1.1-3)

$$S_{\mu 1} = \left(0.525 + 2.24 A_W\right)\left(1 - 0.5 C_T\right) Q_s A_U^{0.48}$$ (Equation D.7.1.1-4)

$$S_{\mu 0} = \left(0.122 + 1.59 A_W\right)\left(1 - 0.5 C_T\right) Q_s A_U^{0.60}$$ (Equation D.7.1.1-5)

Table D.7.1.1. Drift limit probability of exceedance adjustment factors.

POE	$\alpha_{POE,1}$	$\alpha_{POE,0}$
2%	0.36	0.29
5%	0.44	0.37
10%	0.53	0.46
20%	0.66	0.60
30%	0.77	0.73
50%	1.00	1.00
60%	1.14	1.16
70%	1.30	1.37
80%	1.52	1.66

D.8 Retrofit

D.8.1. Retrofitted first story strength

The first story strength of the retrofitted structure shall account for all existing unaltered elements, existing altered elements, new elements provided to increase story strength, and new elements provided to correct aspects of eligibility or building survey non-compliance.

Exception: Out-of-plane or weak axis strength of existing or retrofit elements need not be considered where the sum of those strengths is deemed insignificant to the total story strength.

> ***Commentary:*** *The Exception is intended to allow wood frame walls and pin-based frames to be ignored in their weak directions, and to allow the Building Official to accept the design professional's judgment or to require modeling of fixed-based frames and cantilever columns in their weak directions.*

D.8.2. Retrofit compliance

The retrofit design shall demonstrate that both of the following conditions are true:

1. The retrofitted structure's spectral capacity in each principal direction exceeds the spectral demand.

2. The first story strength of the retrofitted structure in each principal direction satisfies Equation D.8.2-1 or Equation D.8.2-2.

$V_{1r} \leq 1.7V_U$, for 2-story buildings. (Equation D.8.2-1)

$V_{1r} \leq 1.1V_U(0.11A_U + 1.22)$, for 3-story and taller buildings. (Equation D.8.2-2)

> ***Commentary:*** *The intent of Equations D.8.2-1 and D.8.2-2 is to ensure that over-strengthening the first story is not miscounted as beneficial. Given the maximum POE, if the required first story strength cannot be achieved without exceeding this limit, it indicates that the proposed retrofit would push failure to the second story and would not achieve its intended effect. Where the exception to Bulletin Section D.2.1.3 is applied, the higher POE value will give the same spectral capacity for less first story strength, effectively allowing a lighter retrofit that might satisfy the equation. FEMA P-807 Section 6.2.1 provides formulas for estimating the strength of the retrofitted first story needed to reach the required spectral capacity, but use of the estimating formulas is not required.*

D.8.3 Additional requirements where the Exception to Bulletin Section D.2.1.3 is applied
The retrofit design shall demonstrate that all of the following additional conditions are true:

1. The first story strength of the retrofitted structure in each principal direction satisfies Equation D.8.3-1.

2. The retrofit design satisfies the requirements of Bulletin Section D.8.3.1.

$V_{1r} \geq 0.9V_U(0.11A_U + 1.22)$ (Equation D.8.3-1)

D.8.3.1 Minimized torsional eccentricity. Retrofit elements shall be located along perimeter wall lines so as to minimize the torsional eccentricity of the retrofitted structure, or so as to satisfy Equations D.8.3.1-1 and D.8.3.1-2. This requirement may be waived with the approval of the Building Official to accommodate other building or planning code requirements or to avoid disproportionate construction costs.

$e_x \leq 0.10L_x$ (Equation D.8.3.1-1)

$e_y \leq 0.10L_y$ (Equation D.8.3.1-2)

> ***Commentary:*** *Where the Exception to Bulletin Section D.2.1.3 is needed, but the additional requirements of Section D.8.3 cannot be satisfied, it indicates that there is no retrofit solution that both strengthens the target story sufficiently and protects the upper story from damage. In*

these cases, the Building Official may allow an owner to over-strengthen using ASCE 41 or IEBC A4, but better performance is likely to be achieved by voluntarily strengthening one or more upper stories as well as the critical target story.

D.8.4 Design criteria for retrofit elements

Retrofit elements shall conform to the general requirements in this section and to the applicable requirements in the following subsections.

> ***Commentary:*** *See Bulletin Section D.4.4 for discussion of retrofit systems for which FEMA P-807 is suitable.*

1. Where retrofit elements are sized based on unit strengths from codes or standards, the expected strength, without strength reductions or resistance factors, may be used.

> ***Commentary:*** *The allowance of expected strength, which is typically greater than nominal strength is appropriate because FEMA P-807 requires retrofit elements to be ductile (or, in ASCE 41 terms, deformation-controlled).*

2. The load-drift curve of each retrofit element type shall be based on expected material properties, including overstrength. The full expected capacity, without strength reduction or resistance factors, shall be used to calculate load-drift curves and peak strengths.

3. Each retrofit element shall be such that a load-drift curve based on similar elements alone would have a strength degradation ratio, C_D, greater than or equal to 0.8.

4. The load-drift curve of each retrofit element type shall be defined up to five percent interstory drift or as needed to fully characterize the retrofit design per Bulletin Section D.6.

5. Materials and systems for all retrofit elements shall be generally consistent with provisions of the building code for new construction of the same occupancy and risk category. Building code provisions that allow like materials for alterations do not apply to retrofits intended to comply with HMC Chapter 9 Article 7. However, the Building Official may waive restrictions on certain systems based on building height, irregularity, seismic design category, or other conditions not related to the critical deficiencies of the story being assessed or retrofitted.

> ***Commentary:*** *FEMA P-807 presumes that retrofit elements will be reliably ductile (as indicated by the requirement for a minimum C_D value in item 3 above). Systems detailed as special should generally be deemed to comply with this requirement, but systems detailed as intermediate or ordinary may also be shown to be adequate. The final sentence of this provision allows intermediate and ordinary steel frames to be used in seismic design category D and E; this is consistent with the allowance made in Bulletin Section B.2, adding Exception 5 to CEBC Section A403.3.*

6. Design criteria for load path components and connections shall be appropriate to the performance objective and shall be based on the building code for new construction, appropriate provisions of other criteria allowed by HMC Chapter 9 Article 7, or principles of capacity design.

D.8.4.1. Wood structural panel shear walls. Load-drift curves for wood structural panel retrofit elements shall be calculated in accordance with Bulletin Section D.6. Existing shear walls modified by replacing sheathing materials or by adding supplemental wood structural panels shall be considered retrofit elements.

D.8.4.2. Steel special moment frames. Steel retrofit elements that conform to the requirements of AISC 341 for Special Moment Frames, including but not limited to connection design and lateral bracing of beams, shall be deemed to comply with the provision requiring a C_D value greater than or equal to 0.8. The load-drift curve may be characterized per FEMA P-807 Figure 6-7 as follows: $V_y = ZF_{ye}$ with post-yield strengthening up to $1.2V_y$ at d_{max}, with $d_{max} = d_y + 4\%$. It is permitted to employ approved commercially available proprietary frame systems to achieve the special moment frame classification.

Exception: The “strong-column/weak-beam” provision of AISC 341 is waived, provided that the columns carry no gravity load.

D.8.4.3. Steel intermediate moment-resisting frames. For steel retrofit elements that conform to the requirements of AISC 341 for Intermediate Moment Frames, the load-drift curve may be characterized per FEMA P-807 Figure 6-7 as follows: $V_y = ZF_{ye}$ with no post-yield strengthening, and $d_{max} = d_y + 2\%$.

D.8.4.4. Steel ordinary moment-resisting frames. For steel retrofit elements that conform to the requirements of AISC 341 for Ordinary Moment Frames, the load-drift curve may be characterized per FEMA P-807 Figure 6-7 as follows: V_y per AISC 360 Chapter F, using F_{ye} instead of F_y, $d_{max} = 2\%$.

D.8.4.5. Steel special cantilever columns. For steel retrofit elements that conform to the requirements of AISC 341 for Special Cantilevered Column systems, the load-drift curve may be characterized per FEMA P-807 Figure 6-7 as follows: $V_y = ZF_{ye}$ with no post-yield strengthening, and $d_{max} = d_y + 2\%$.

D.8.4.6. Steel ordinary cantilever columns. FEMA P-807 shall not be used to demonstrate compliance of steel ordinary cantilever columns as retrofit elements.

D.8.4.7. Inverted moment frame systems. Cantilevered column systems shall be permitted to be designed as inverted special, intermediate, or ordinary moment frames, with corresponding moment frame seismic design coefficients, where the system satisfies the following conditions:

1. The columns carry no gravity load.
2. The columns are configured in pairs (or larger groups) connected by a continuous reinforced concrete foundation or grade beam.
3. The foundation or grade beam is designed to resist the expected plastic moment at the base of each column, computed as R_yF_yZ in accordance with AISC 341.
4. The flexibility of the foundation or grade beam, considering cracked section properties of the reinforced concrete, is included in computing the deformation of the steel frame system.
5. The columns are considered as twice their actual height when checking lateral torsional buckling.

> ***Commentary:*** *This provision is consistent with Bulletin Section B.2, adding Section A403.10.4 to CEBC Chapter A4.*

D.8.4.8. Steel buckling-restrained braced frames. Steel retrofit elements that conform to the requirements of AISC 341 for buckling-restrained braced frames shall be deemed to comply with the provision requiring a C_D value greater than or equal to 0.8.

> ***Commentary:*** *FEMA P-807 Section 6.5.5 offers further guidance on characterizing and designing these elements.*

D.8.4.9. Damping systems. FEMA P-807 may be used to demonstrate compliance of hysteretic damping systems that rely on the yielding of steel components by modeling the retrofit elements as bi-linear systems similar to other structural steel systems. The Building Official is authorized to require third party peer review at the expense of the permit applicant. FEMA P-807 shall not be used to demonstrate compliance of other damping systems, including viscous- or friction-damped systems.

> ***Commentary:*** *Viscous- and friction-damped systems cannot be designed with FEMA P-807 because the FEMA P-807 surrogate models did not include these mechanisms.*

D.8.5 Design criteria for load path elements and components

The retrofit design shall confirm or provide a load path from the second floor diaphragm through the first story seismic force-resisting elements and their foundations, to the supporting soils. The ultimate strength of load path components shall be reduced with strength reduction factors as needed to ensure that the load-path elements are able to develop the strength and the intended mechanism of first story wall and frame elements. Specific design criteria may be derived from principles of capacity design, from other criteria allowed by HMC Chapter 9 Article 7, or from building code provisions for new construction involving the overstrength factor, Ω_0.

D.8.5.1. Foundations and overturning. New foundation elements shall be provided as needed to resist bearing, sliding, and overturning forces associated with the retrofit elements acting at their strength. Connections and load path components related to wall or frame overturning shall not assume any acting dead load except for the self-weight of the retrofit element unless the retrofit element incorporates existing gravity load-carrying framing or unless the design and construction explicitly transfer existing dead load to the retrofit element. The weight of foundation elements may be considered if adequately connected.

D.8.5.2. Second floor diaphragm. The second floor diaphragm shall be strengthened as needed to ensure that expected forces can be transferred between the diaphragm and the first-story elements.

D.8.5.3. Fixed-base frame columns. Moment-resisting frame systems and cantilever column systems whose capacity assumes other than a pin-based condition shall be provided with connection details demonstrated to develop the assumed fixity and the assumed column strength. In general, an anchor-bolted base plate without substantial embedment within a foundation element is not considered to provide a fixed-base condition.

D.9 Design quality assurance

D.9.1. Structural calculations
In addition to the requirements of Bulletin Section A.3.3, structural calculations and documentation of assessments and retrofit designs using FEMA P-807 shall include, at minimum:

1. Plans and/or elevations for each floor level identifying each wall line and showing the wall assembly, length, location, and openings.

2. A schedule of wall assemblies and load drift curves for existing, altered, and new elements.

3. A list or schedule of wall lines with overturning and opening adjustments.

4. Derivation of characteristic coefficients.

5. Spectral capacity calculations.

6. Site-specific spectral demand calculations.