



Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings

Volume 2C - Plan Set for Masonry Chimneys

FEMA P-1100-2C / October 2019



FEMA



Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings Volume 2C – Plan Set for Masonry Chimneys

Prepared by
APPLIED TECHNOLOGY COUNCIL
201 Redwood Shores Parkway, Suite 240
Redwood City, California 94065
www.ATCouncil.org

Prepared for
CALIFORNIA EARTHQUAKE AUTHORITY
Janiele Maffei, Chief Mitigation Officer
Erin Waters, Research Program Coordinator
Sacramento, California

FEDERAL EMERGENCY MANAGEMENT AGENCY
Michael Mahoney, Project Officer
Robert D. Hanson, Subject Matter Expert
Washington, D.C.

ATC MANAGEMENT AND OVERSIGHT
Jon A. Heintz
Ayse Hortacsu

PROJECT TECHNICAL COMMITTEE
Colin Blaney (co-Project Tech. Director)
Kelly Cobeen (co-Project Tech. Director)
Thomas Anderson
Vikki Bourcier
Michael Cochran
Daniel Dolan
Andre Filiatrault
Brian McDonald
John Oстераas
Weichiang Pang

PROJECT STEERING COMMITTEE
David Bonowitz (Chair)
Ifa Kashefi
Philip Line
Thor Matteson
Bill Nagel
Steve Pryor
Frank Rollo
Williston Warren (ATC Board Contact)

WORKING GROUP
Angela Arias
Gaurav Bali
Michael Ty Billings
Brent Crawford
Steve Fedorchak
Gayle Jensen
Kari Klaboe
Dave Laverdiere
David McCormick
Javier Pascacio
Michael Stoner
Doug Thompson
Taylor Vincent
Dave Welch

October 2019



FEMA



Notice

Any opinions, findings, conclusions, or recommendations expressed in this publication do not necessarily reflect the views of the Applied Technology Council (ATC), the Department of Homeland Security (DHS), or the Federal Emergency Management Agency (FEMA). Additionally, neither ATC, DHS, FEMA, nor any of their employees, makes any warranty, expressed or implied, nor assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, product, or process included in this publication. Users of information from this publication assume all liability arising from such use.

Cover photograph – Photograph showing masonry chimney.

Purpose and Scope

This Plan Set is for retrofit of masonry chimneys and is provided as a supplement to FEMA P-1100, *Vulnerability-Based Seismic Assessment and Retrofit of One-and Two-Family Dwellings, Volume 1 – Prestandard*. The Plan Set presents prescriptive, pre-engineered plans for a suggested minimum level of retrofit design for use by a general contractor or homeowner without necessarily having to involve a registered design professional. Use of this Plan Set is limited to dwellings that are compliant with eligibility statements presented in Table 1 on Sheet S0. The extent of the scope of this Plan Set is described on Sheet S0.

The Plan Set is intended to contain all of the necessary supplemental technical information and guidance for preparation of a complete set of plans for submittal to the local building department and for use during construction; however, supplemental information may be required by some building departments. Note that building permits are always required when performing the work described in this Plan Set.

The Plan Set does not attempt to address all potential deficiencies in a home and does not eliminate the risk of potential damage in future earthquakes.

Instructions for use are provided on Sheet S0.

Limitation of Liability

Earthquake strengthening constructed in accordance with this Plan Set is intended to reduce the risk of earthquake-related damage to existing residential wood-frame dwellings with masonry chimneys. The content of this Plan Set is based on the experience and judgment of practicing engineers and limited research. All circumstances, forms, or types of construction have not necessarily been contemplated in the preparation of this Plan Set, and it is not possible to control the quality of construction or predict or test all conditions that may occur during an earthquake. No party associated with the preparation of this Plan Set makes any representation, warranty, or covenant, expressed or implied, with respect to the design, condition, quality, durability, operation, fitness for use, or suitability of earthquake strengthening based on this Plan Set.

INSTRUCTIONS FOR USE

A. Before you begin:

- This plan set is intended for use by a general contractor or homeowner without necessarily having to involve a registered design professional.
- Contact your local building department to understand the building permit application process. Ask about:
 - Fees,
 - How many copies of the plan must be submitted, and
 - Which city inspections are required
- The Building Official may also be able to assist with assessing the applicability of this plan set to a home. See Eligibility For Use, Sheet S0, Table 1.
- Complete the Eligibility For Use questionnaire on Sheet S0 to determine if this plan set is applicable. A "non-compliant" answer to any question disqualifies the home from using this plan set.

B. Prepare your plan set:

- Draw a scaled plan of the home in the space provided on Sheet S0, Detail 1. Your plan should include the following:
 - The general outline of the home. It is helpful to draw roof ridges, hips and valleys.
 - The front (street) side of the home and the back side of the home.
 - A north arrow.
 - The location of the chimney to be retrofit.
 - Chimney dimensions "A," "B," and "H," as shown in Detail 3 on Sheet S2.
 - See Sheet X1 for an example plan.

C. Gather information to complete the plan set:

- Review general notes on Sheet S1 for guidance on materials and installation for the required work.
- Use Table 2 on Sheet S0 to determine which retrofit methods are applicable to your home and chimney.
- If several retrofit methods are applicable, choose the preferred method, and identify the sheet that gives applicable detailing (choose one of Sheets S3 through S6).
- Determine whether Details 1 and 2 on Sheet S2 are required based on Note 4 on Sheet S4 or S5, or Note 3 on Sheet S6).

D. Complete your plans:

- In the space provided in Detail 1, Sheet S0, draw a plan of the dwelling with the chimney location shown. Note on the dwelling plan the sheet to be used for chimney retrofit.
- If braces per Details 1 and 2 on Sheet S2 required, note on the Sheet S0 plan the approximate location and provide a reference to the details.

E. Submit your plans to the building department:

- The submitted plan set should always include Sheets S0 and S1. If Details 1 and 2 on Sheet S2 are to be used, the submitted plan set should also include Sheet S2. Finally, also include the one sheet that is to be used for the chimney retrofit (include one only of Sheets through S6, do not submit sheets that are not being used).
- Submit a permit application and the required number of complete plan sets to the building department for review. Photographs of the chimney to be retrofitted may assist the review process.
- Before beginning work, the permit holder may be required to schedule an inspection with the building department to verify that field conditions are consistent with the information provided on the approved plans.
- Inspections by the building department during the retrofit work may be required for:
 - Foundation and rebar prior to placing concrete
 - Foundation anchor bolts
 - Anchorage to existing masonry and adaptor cone installation
 - Framing
 - Fire blocking
 - Flue and flue cap installation

1 Dwelling Plan
Scale:

SHEET LIST

- S0 Cover Sheet
- S1 General Notes
- S2 Details and Definitions
- S3 Cap Chimney at Roof or Ceiling
- S4 Replace Chimney above Shoulder, Reuse Masonry Firebox
- S5 Replace Chimney above Shoulder, Install Factory Insert
- S6 Replace Firebox and Chimney with Factory Insert and Metal Flue
- X1 Example Cover Sheet with Plan

ABBREVIATIONS

- (E) Existing
- (N) New
- min. Minimum
- max. Maximum
- NTS Not to Scale
- typ. Typical

APPLICANT INFORMATION

APPLICANT: _____
ADDRESS: _____
SIGNATURE: _____

Cover Sheet

Retrofit of Masonry Chimneys (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings
FEMA P-1100, Volume 2 - Plan Sets
Issued: SEPT 2019

PURPOSE

The purpose of this plan set is to promote public safety and welfare by reducing earthquake-induced damage to existing masonry chimneys. The provisions of this plan set address a single vulnerability - falling hazards associated with masonry chimneys. Eligible chimneys retrofit to the prescriptive designs provided in this plan set are considered to comply with the requirements of Chapter 7 of FEMA P-1100. Construction details of this plan set are intended to improve the performance of chimneys, but may not prevent their damage or collapse in earthquake shaking.

SCOPE

This plan set contains prescriptive provisions for retrofit of masonry chimneys of one- and two-family, light-frame detached dwellings of three stories or less. Considerations and methods beyond those in this plan set may be appropriate for dwellings listed in or eligible for listing in the National Register of Historic Places, or designated as historic under an appropriate state or local law.

ELIGIBILITY

Chimneys must meet all of the requirements of Table 1 on Sheet S0 to be eligible for the retrofit provisions of this plan set. Chimneys not eligible for this plan set can be retrofitted in accordance with FEMA P-1100 Prestandard, Chapter 7.

ASSESSMENT

The retrofit provisions of this plan set are intended to apply to chimneys that have been assessed using the FEMA P1100 Prestandard methodology and found to have a masonry chimney vulnerability.

Table 1: ELIGIBILITY FOR USE

To determine if a home qualifies answer the following:	Compliant	Non-Compliant
1. The dwelling is a detached <i>one- or two-family dwelling</i> or the dwelling is a unit in a <i>townhouse</i> .		
2. The dwelling is a wood light-frame dwelling that is three stories or less above grade plane.		
3. The chimney is constructed of solid brick masonry.		
4. The chimney's largest plan dimension (dimension A) is not more than 40 inches. (See Detail 3 on Sheet S2 for definition of dimension A).		
5. The chimney is either an interior chimney, or an exterior chimney engaging only one exterior wall (i.e. not at the dwelling corner).		

If you checked "Compliant" to each of the above, proceed to Table 2.
If you checked "Non-Compliant" to any of the above, the home is not eligible to apply this plan set. See Chapter 7 of the FEMA P-1100 Prestandard for engineered retrofit design methods.

Table 2: DETERMINATION OF RETROFIT SCOPE

Use this table to determine which retrofit in Sheets S3 to S6 is permitted for the home. See Detail 3 on Sheet S2 for definitions of dimensions B and H.

Chimney Location	Chimney Height	Unbraced Portion	Minimum Requirements for Compliance	Sheet
Exterior	Any		Demolish down to base (shoulder) of the chimney at the lowest fire box.	S4, S5, or S6
	Two or Three Stories			S4, S5, or S6
Interior	One Story	Some portion of the chimney is freestanding (not in contact with a wall on any of the four sides) for a height of more than six feet.	Demolish to floor or ceiling directly below unbraced portion.	S3 Detail 1 or S4, S5, or S6
		No portion of the chimney is freestanding (not enclosed by full-height, finished walls on at least three faces) for a height of more than six feet, and the chimney extends a height (dimension H) more than two times dimension B (2xB) above the roof.	Demolish to roof.	S3 Detail 1 or S3 Detail 2 or S4, S5, or S6



Date:

Sheet:

S0

A. CODE

- 1. All work not otherwise specified shall conform to the locally adopted building code or residential code. Contractor shall comply with all locally adopted building codes and ordinances.

B. GENERAL

- 1. The contractor shall be responsible for maintaining a safe job site and for shoring and bracing existing construction as required to safely install new work. Provide adequate bracing and support of temporary construction and temporarily unsupported and partially unsupported portions of the work. Determine or verify the location of underground utilities and utilities within the building. Use caution when working around existing utilities. Make arrangements for disconnection of utilities where required.

C. EXISTING CONDITIONS

- 1. Contractor shall confirm that existing conditions match plans and details prior to start of work. Modify choice of detail as required prior to start of work.
- 2. Contractor shall verify that existing concrete, anchor bolts, wood framing, and other materials that will become part of the work or to which retrofit construction is attached is in reasonably sound condition and free of defects that would substantially reduce the capacity of the material. Where possible, damaged or deteriorated elements shall be repaired in place or supplemented with new elements. Otherwise damaged or deteriorated members shall be replaced. Repair or replacement shall be in accordance with the adopted building or residential code.
- 3. The owner or contractor shall verify that the existing concrete within all areas to receive new anchor bolts are in reasonably good condition. Examples of poor concrete quality would include excessive spalling, large rock pockets, cracks extending completely through the footing greater than 1/8" wide, excessive efflorescence, or low strength concrete cement or mortar easily scrapable with a metal knife or trowel.

D. NOTCHING, BORING, AND CUTTING

- 1. Do not cut, bore, or notch structural members except as shown in these drawings or as specifically permitted by the building inspector. Exception: Notching and boring of framing shall be permitted as per Chapter 6 of the International Residential Code (IRC).
- 2. When drilling in concrete, do not drill through existing reinforcing steel. If reinforcing steel is hit during drilling, move a minimum of one inch and drill relocated hole. Fill original hole with non-shrink grout.

E. CONCRETE

- 1. Concrete shall have a strength of not less than 3000 psi at 28 days (design based upon 2500 psi). Concrete mixed on site shall be mixed and placed in accordance with the manufacturer's instructions using potable water.

F. REINFORCING STEEL (REBAR)

- 1. Reinforcing steel shall conform to ASTM A615 Grade 40 or 60, ASTM A706, or ASTM A996 Type R.
- 2. Reinforcing steel bend radii and other rebar detailing shall be in accordance with Concrete Reinforcing Steel Institute.
- 3. Minimum concrete cover over reinforcing steel:

a. Concrete cast against and permanently exposed to soil:	3 inches	
b. Formed concrete exposed to weather:	2 inches	
c. Concrete not exposed to weather or in contact with soil:	1-1/2 inch	
d. Reinforcing steel lap splice lengths:	No. 4	No. 5
• Horizontal bars with more than 12 inches concrete below:	32 inches	42 inches
• Other bars:	24 inches	32 inches

G. STRUCTURAL STEEL

- 1. Structural steel miscellaneous steel shall be ASTM A36, A992 or A572. Welding shall comply with AWS D1.1 requirements using prequalified welding procedures. All welding shall be conducted by welders certified for the materials and welding procedures used.
- 2. Bolts shall conform to ASTM A-307. Threaded rods shall conform to ASTM A-36.
- 3. Sheet steel for brick chimney adaptor cones shall conform to ASTM A1003, Structural Grade 33 Type H or Grade 50, Type H. Welding shall conform to AWS D1.3.

H. FASTENERS

- 1. General
 - a. All bolts, nails, and other fasteners in contact with preservative treated wood or exposed to weather shall be hot dip galvanized or stainless steel.
- 2. Nails
 - a. Unless otherwise noted, all nails specified are to be common nails.
 - b. Special care is required when installing nails in existing framing. Where required to avoid splitting of framing, predrill to 75% of nail shank diameter.
 - c. Fasteners for wood structural panel sheathing shall be full length 8d common nails (0.131" x 2-1/2"). Drive sheathing nail head flush with face of sheathing.
 - d. Do not overdrive, countersink, or otherwise damage the outermost ply when installing nails. A nail is over-driven when it breaks the surface ply. Where nails are overdriven to the point that the plywood veneer is fractured, add one new nail for every (2) overdriven nails. Space new nails between existing.
- 3. Bolts
 - a. Predrill bolt holes to not more than 1/16th inch larger than bolt or anchor bolt to be placed.
 - b. Provide cut washer between bolt head or nut and wood member where bolt or nut bears on wood.
- 4. Anchor Bolts
 - a. Predrill bolt holes to not more than 1/16th inch larger than bolt or anchor bolt to be placed.
 - b. At locations of plywood wall bracing, provide new anchor bolts between 8 and 12 inches from each end of each section of foundation sill plate, and not more than 24 inches on center.
 - c. Provide steel plate washers 0.229 x 3 x 3 inch minimum at all anchor bolts. Centerline of washer should be 1-1/2" to 2" from face of plywood sheathing.
- 5. Screws
 - a. Screws for cold-formed steel-to-steel connections shall be No.8 self-drilling tapping screws conforming to ASTM C1514.
 - b. Screws for attaching structural sheathing to cold-formed steel wall framing shall have a minimum head diameter of 0.292 inch with countersunk heads and shall be installed with a minimum edge distance of 3/8-inch.

I. WOOD STRUCTURAL PANEL SHEATHING

- 1. Plywood shall be all veneer, conforming to US voluntary Product Standard PS-1, Exposure I or Exterior Exposure, manufactured with exterior glue, and minimum 4-ply.
- 2. Oriented Strand Board (OSB) shall conform to US Voluntary Product Standard PS 2 with an exposure rating of Exposure 1 or Exterior Exposure, manufactured with exterior glue, and minimum 4-ply.
- 3. Provide 1/8-inch minimum gap at all sheathing panel ends and edges.
- 4. Maintain a minimum edge distance of 3/8" from center of nail to edges of sheathing, studs, or top and sill plates.

J. WOOD FRAMING

- 1. Framing shall be Douglas Fir-Larch, or an approved species having a greater or equal specific gravity.
- 2. Framing in contact with foundations or exposed to weather shall be preservative treated in accordance with AWWA U1 (Commodity Specification A, Use Category 4B). Field treat all cuts, bores and notches per AWWA M-4.

K. CONNECTOR DEVICES

- 1. Connectors shall be pre-engineered pre-manufactured devices, approved by the Building Official and installed in accordance with the manufacturer's instructions.
- 2. Connectors protected from weather shall be provided with a minimum of G90 zinc coating in accordance with ASTM A653. Connectors exposed to weather or in contact with preservative treated wood shall be provided with a minimum hot-dip galvanized coating or G185 coating in accordance with ASTM A653, and fasteners conforming to ASTM A153.
- 3. Connector devices shall be of the type and size specified in these drawings.
- 4. Increase nail or screw length 1/2-inch minimum when installing connectors over plywood.

L. POST-INSTALLED ANCHORS

- 1. Post-installed anchors shall be installed in accordance with the manufacturer's installation instructions.
- 2. Adhesive anchors shall be Simpson Strong-Tie SET-XP, HILTI RE 500 SD, CIA GEL 7000C, or approved equivalent.
- 3. Concrete screws shall be Simpson Strong-Tie Titen HD, KC Metals Kwik-HUS-EZ, or Powers Fasteners Wedge-Bolt, or approved equivalent.
- 4. Threaded rod into existing masonry shall be grouted in place, adhesive anchors shall not be used.

M. COLD-FORMED STEEL FRAMING

- 1. Wall studs shall be C-shaped sections with a minimum thickness of 43 mil, a minimum flange width of 1-5/8 inches and a minimum depth of 2-1/2 inches.

N. PERMITS

- 1. All work required by this plan set shall be permitted through the building department.

O. INSPECTIONS

- 1. Contractor shall coordinate with the building inspector to ensure that work is accessible for building department inspections, and shall correct noncompliant work as identified by the inspector.

P. SPECIAL INSPECTIONS

- 1. Special inspection by a third party inspector is not required for the following:
 - a. Concrete or reinforcing steel. Design is based on an ultimate concrete strength of 2500 psi or less.
 - b. Installation of cast-in-place or post-installed anchor bolts.
 - c. Nailing of wood structural panel shear walls, provided a building department inspection is performed.

APPLICANT: _____

PROPERTY ADDRESS: _____

General Notes

Retrofit of Masonry Chimneys (Plan Set)
 Vulnerability-Based Seismic Assessment and Retrofit of
 One- and Two-Family Dwellings
 FEMA P-1100, Volume 2 - Plan Sets
 Issued: SEPT 2019

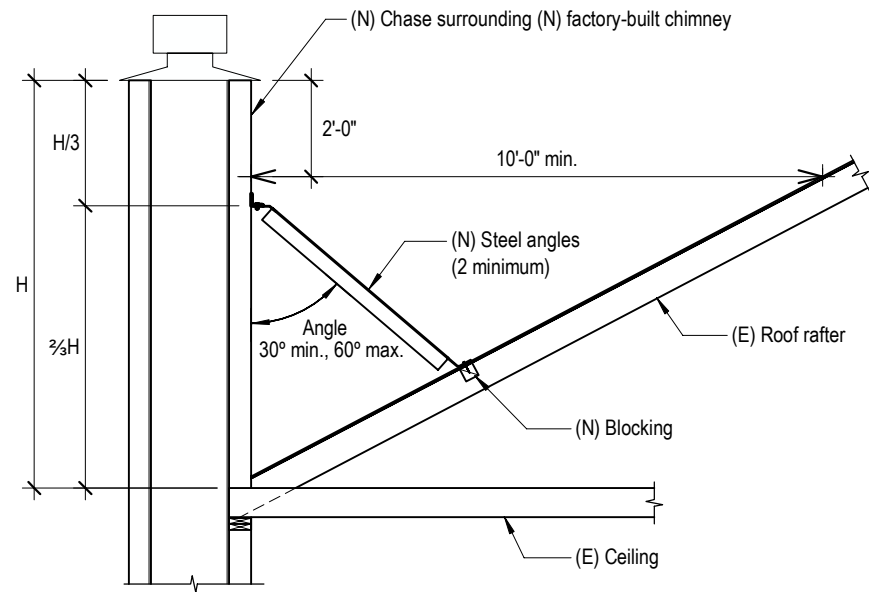


FEMA

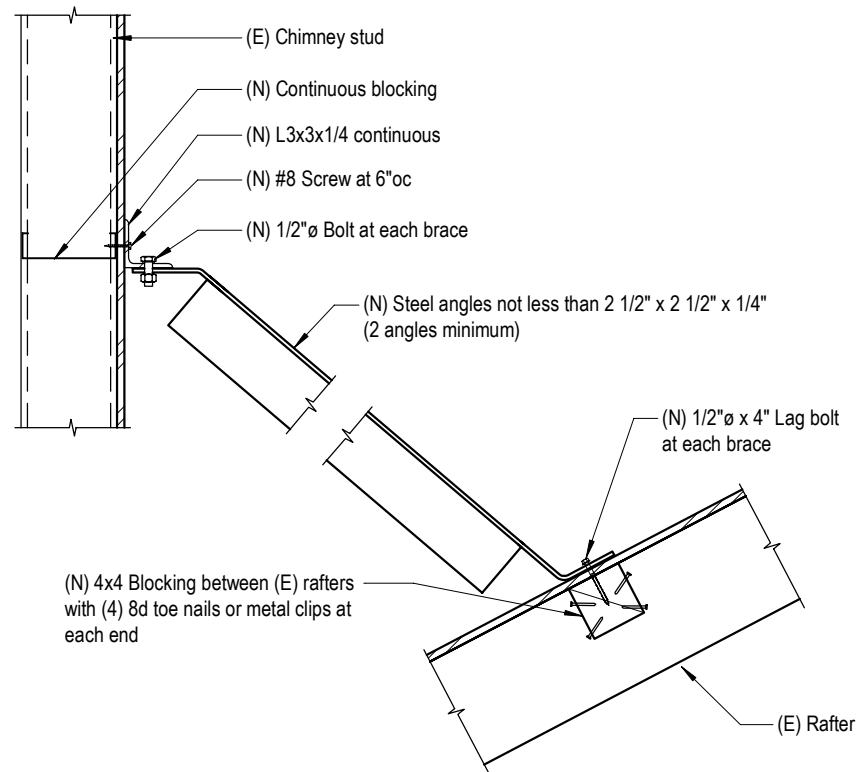
Date: _____

Sheet: _____

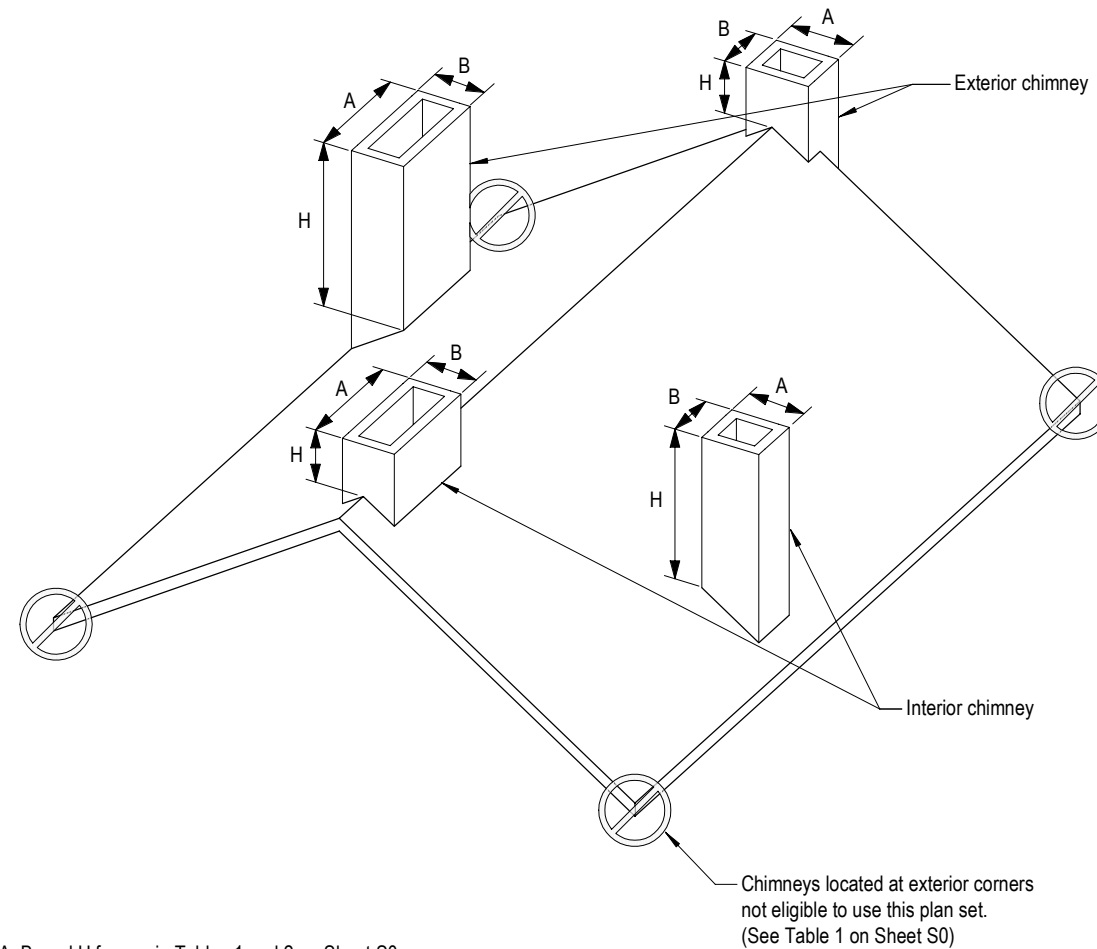
S1



1 BRACE FOR NEW CHASE



2 BRACE CONNECTION FOR NEW CHASE



Notes:

1. Dimensions A, B, and H for use in Tables 1 and 2 on Sheet S0.
2. The dimension B is the small horizontal dimension of the chimney as measured above the roof. The dimension H is the height of chimney that extends vertically above the highest point of the adjacent roof. This figure shows how those measurements are defined for various chimney configurations.

3 CHIMNEY DIMENSIONS

APPLICANT: _____
PROPERTY ADDRESS: _____

Details and Definitions

Retrofit of Masonry Chimneys (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of
One- and Two-Family Dwellings
FEMA P-1100, Volume 2 - Plan Sets
Issued: SEPT 2019



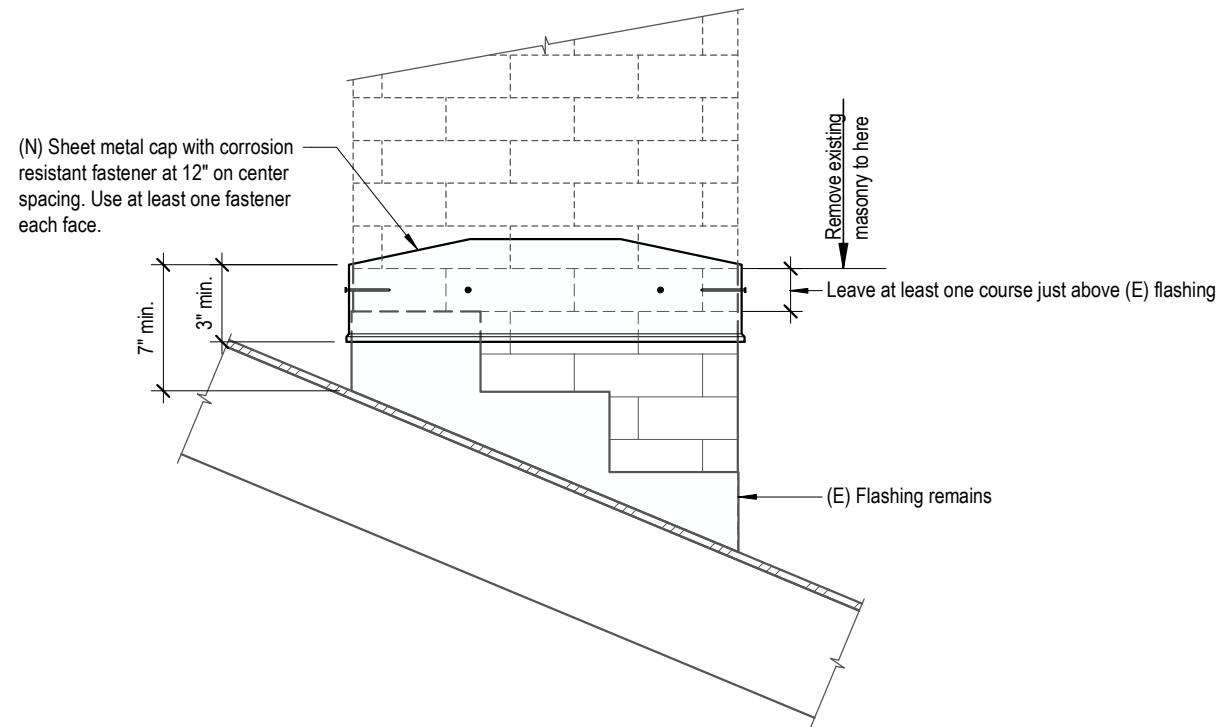
Date: _____

Sheet: _____

S2

SCOPE FOR CAP AT ROOF OPTION

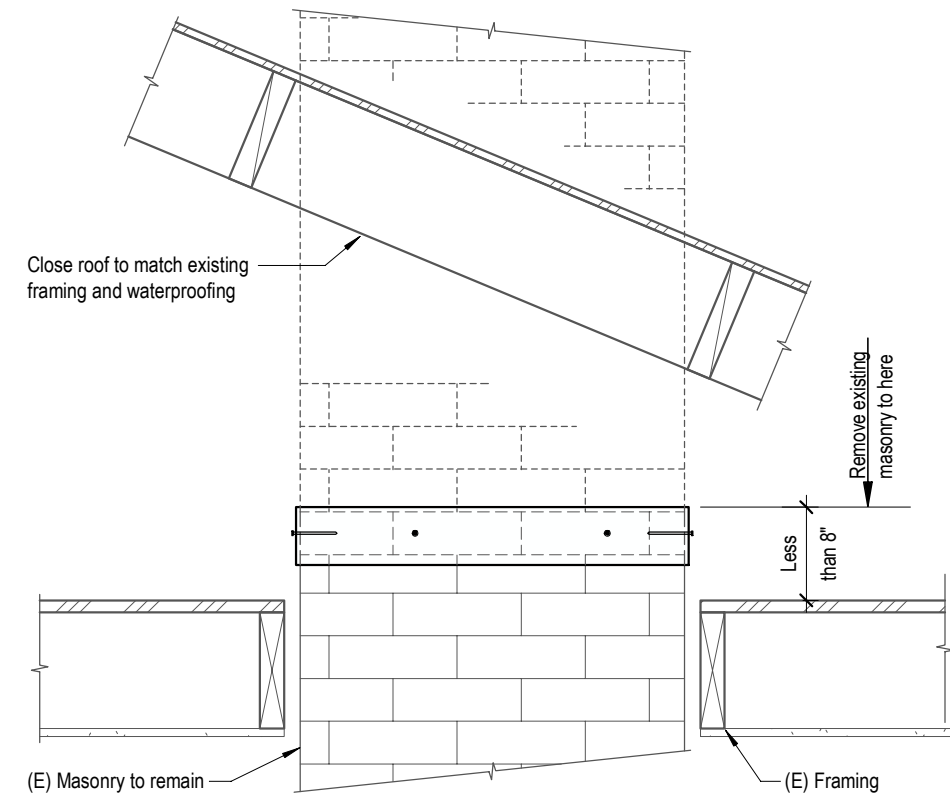
1. Remove masonry above top of the course just above the highest existing roof flashing, but not less than seven inches above roof surface, leaving the upper course undisturbed. A sheet metal cap of galvanized steel or stainless steel shall be provided for weather protection. The cap shall extend not less than three inches down each side of the chimney, overlapping the existing flashing by minimum two inches where it occurs. The cap shall be secured to the chimney with corrosion-resistant fasteners. Deteriorated mortar on masonry below the level of the cap shall be repaired or replaced.
2. Completely and permanently close off the interior of the firebox from the dwelling interior with an infill of gypsum wallboard, wood structural panel sheathing, masonry, or other material, permanently affixed and installed in conformance with provisions of the locally adopted building or residential code.
3. The capped chimney shall not be used to convey products of combustion. Any flues previously discharging products of combustion through the chimney shall be re-routed in accordance with all applicable building or residential code provisions.



1 REMOVE MASONRY CHIMNEY TO ROOF

SCOPE FOR CAP AT FLOOR OR CEILING OPTION

1. Remove masonry to a distance of not more than eight inches above the top of ceiling or attic floor framing. Cap the chimney with sheet metal. Close the roof opening and weatherproof using framing and roofing materials to match the existing construction. Deteriorated mortar on masonry below the level of the cap shall be repaired or replaced.
2. Completely and permanently close off the interior of the firebox from the dwelling interior with an infill of gypsum wallboard, wood structural panel sheathing, masonry, or other material, permanently affixed and installed in conformance with provisions of the locally adopted building or residential code.
3. The capped chimney shall not be used to convey products of combustion. Any flues previously discharging products of combustion through the chimney shall be re-routed in accordance with all applicable building or residential code provisions.

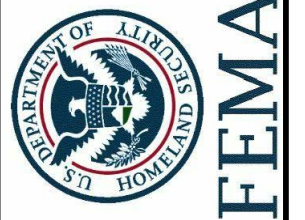


2 REMOVE MASONRY CHIMNEY TO FLOOR OR CEILING

APPLICANT: _____
PROPERTY ADDRESS: _____

Cap Chimney at Roof or Ceiling

Retrofit of Masonry Chimneys (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of
One- and Two-Family Dwellings
FEMA P-1100, Volume 2 - Plan Sets
Issued: SEPT 2019



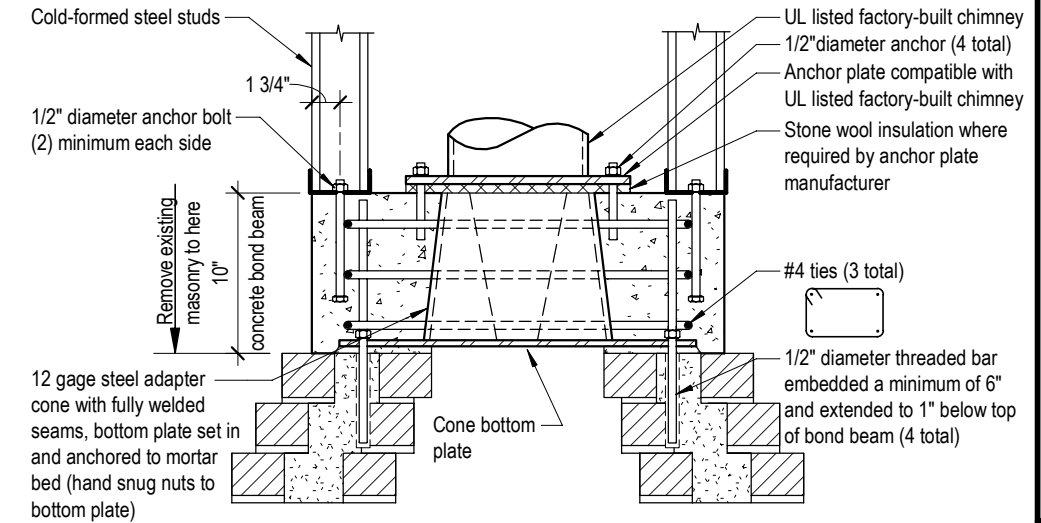
Date: _____
Sheet: _____

S3

All construction shall be in accordance with the factory-built chimney manufacturer's installation instructions and the following requirements. All clearances required by the manufacturer and listing shall be maintained. The reconstruction shall incorporate a UL 103 listed, factory-built chimney with a masonry fireplace adapter tested per UL 103A and listed for use with the specific factory-built chimney.

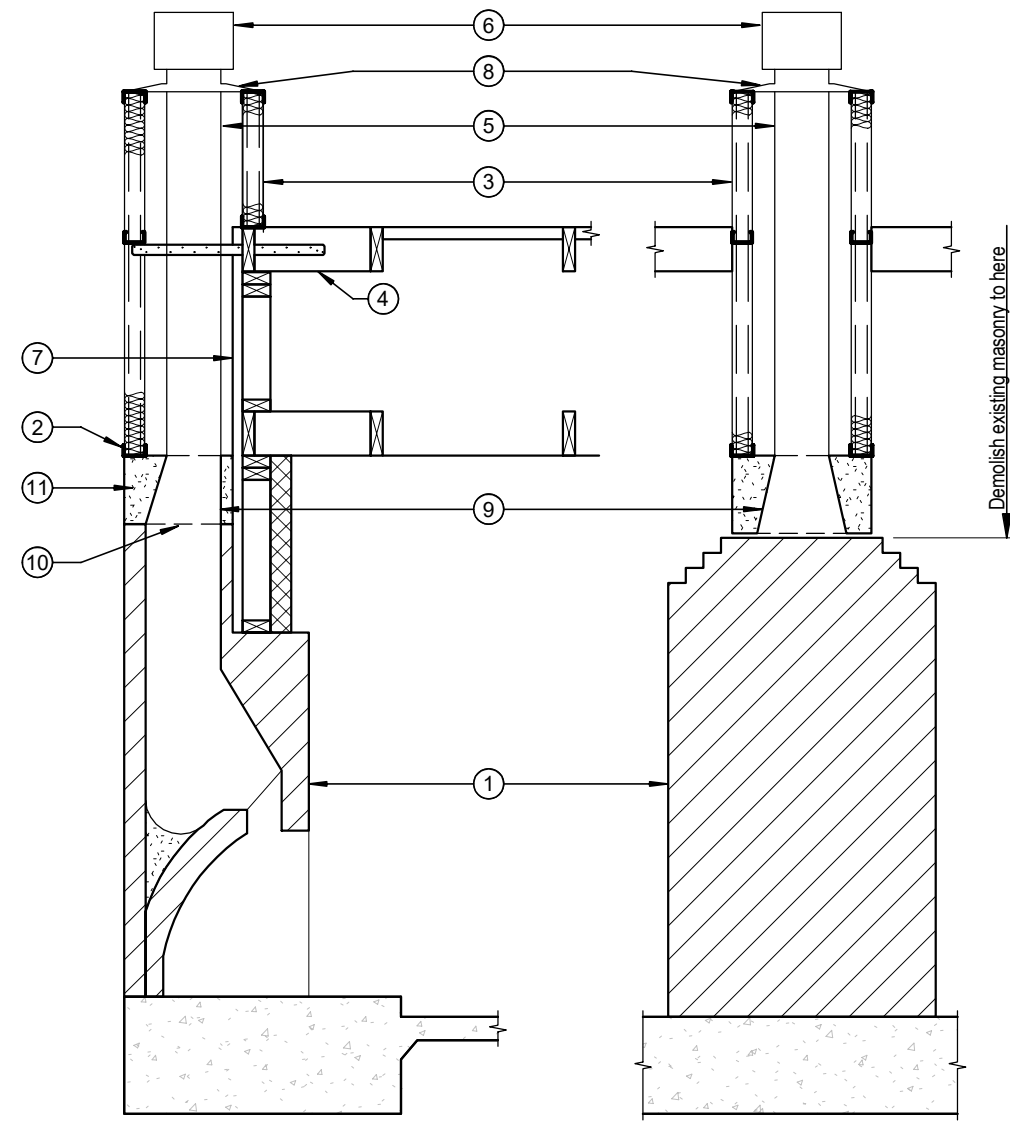
1. **Masonry firebox.** The existing masonry firebox shall remain up to the base of the flue as shown in Detail 2 on Sheet S4.
2. **Track or sill plate.** Cold-formed steel track sections matching the thickness of the studs shall be provided at the bottom of cold-formed steel chimney chase walls. Wood sill or sole plates having a width not less than the supported studs shall be provided at the bottom of wood chimney chase walls. Wood sill or sole plates shall be protected against decay by the use of naturally durable wood or wood that is preservative-treated. Fasteners in contact with wood sill or sole plates shall be of hot-dipped, zinc-coated galvanized steel or of stainless steel. Tracks and sill or sole plates shall be anchored to the concrete beam per Detail 1 on Sheet S4.
3. **Chimney chase stud walls.** Chimney chases shall be constructed of full height stud walls spaced at no more than 12 inches on center. Stud sizes shall be selected based on story clear height. Wood studs shall not be less than nominal two-inch by three-inch. Cold-formed steel studs shall be not less than 43 mil thickness (18 gage) by 2-1/2 inches deep. The top of the chimney chase shall extend not less than 3 feet above the edge of the roof and not less than 2 feet above the maximum roof elevation, or maximum elevation of other construction located within a 10-foot horizontal dimension in any direction from the chimney (Detail 1 on Sheet S2). Where the exterior walls adjacent to the chase are less than 5 feet from the lot line, they shall be constructed with full 2x4 wood or 54 mil (16 gage) 3 7/8-inch steel studs with exterior sheathing that includes 7/8-inch thick conventional stucco or minimum 1/2-inch thick Type X gypsum sheathing. Check with building department for any additional fire protection requirements in the currently adopted building or residential code. The chimney chase shall be capped, with roofing and flashing to be weatherproof and to match existing construction.
4. **Chimney chase connection to dwelling.** The chimney chase studs shall be fastened to the existing residence exterior wall with minimum No. 8 wood screws at 12 inches on center. The chimney chase framing shall be strapped to the existing floor, ceiling and roof framing with not less than two steel straps 1-1/4 inches minimum in width and 33 mil (20 gage) minimum in thickness, with each strap located on an opposing face of the chase. Each strap shall be fastened to steel blocking between steel studs of the chimney chase with minimum four No. 8 sheet metal screws, or to wood blocking between wood studs of the chimney chase with not less than four 8d common nails. Each strap shall be fastened to existing steel floor, roof or ceiling framing with minimum four No. 8 sheet steel screws, or to existing wood floor, ceiling or roof framing with minimum four 8d common nails. Where chimney chase stud walls extend more than four feet above the highest roof elevation immediately adjacent to the chimney, bracing shall be provided in accordance with this section or in a manner acceptable to the building department. The bracing shall be connected to the chimney chase in the upper third of the chase clear height above the roof (H/3 as shown in Detail 1 on Sheet S2). Bracing steel angles shall be galvanized or otherwise corrosion resistant and not less than 2-1/2x2-1/2x1/4-inch installed per Detail 2 on Sheet S2. Not less than two bracing shall be provided at not less than two locations. The bracing slope shall be not less than 30 degrees and not more than 60 degrees from vertical.
5. **Factory-built chimney.** Factory-built chimneys shall be sized such that round chimney flues shall have a minimum net cross-sectional area of not less than 1/12 of the fireplace opening. Square chimney flues shall have a minimum net cross-sectional area of 1/10 of the fireplace opening. Rectangular chimney flues with an aspect ratio less than 2 to 1 shall have a minimum net cross-sectional area of 1/10 of the fireplace opening. Rectangular chimney flues with an aspect ratio of 2 to 1 or more shall have a minimum net cross-sectional area of 1/8 of the fireplace opening. Factory-built chimneys shall be listed and labeled and shall be installed and terminated in accordance with the manufacturer's instructions. Decorative shrouds shall not be installed at the termination of factory-built chimneys except where the shrouds are listed and labeled for use with the specific factory-built chimney system and installed in accordance with the manufacturer's instructions. No part of the chimney shall be at an angle of more than 30 degrees (0.52 rad) from vertical at any point in the assembly and the chimney assembly shall not include more than four elbows.
6. **Flue cap.** Factory-built cap installed in accordance with manufacturer's instructions and complying with the metal chimney UL listing.

7. **Fireblocking.** Spaces between chimneys and floors and ceilings through which chimneys pass shall be fireblocked with noncombustible material securely fastened in place. The fireblocking of spaces between chimneys and wood joists, beams or headers shall be self-supporting or be placed on strips of metal or metal lath laid across the spaces between combustible material and the chimney. Draft stops consisting of drywall, plywood or OSB shall be provided to separate the chase from wood framing of the dwelling.
8. **Chimney cap.** A framed chimney cap shall be constructed at the top of the chimney chase.
9. **Adapter cone.** A 12 gage (97 mil) minimum thickness galvanized sheet steel adapter cone shall be provided. The cone shall have minimum 12 gage (97 mil) thickness sheet steel top and bottom plates, and shall provide a smooth-surfaced transition between the flue opening at the top of the firebox and the flue. The bottom plate geometry shall match the opening geometry at the top of the smoke chamber, and the anchor plate geometry shall be coordinated with the flue. The adapter cone shall be set in cementitious grout, and all cone seams shall be continuously welded.
10. **Cone bottom plate.** The adapter cone bottom plate shall be anchored to the firebox masonry with not less than four 1/2-inch diameter galvanized threaded rod anchors. The threaded rods shall extend upward to 1 inch below the top of the concrete beam, shall be embedded 6 inches into masonry at the firebox, and shall be set in cementitious grout.
11. **Bond beam.** A reinforced concrete beam shall be constructed around the adapter cone, using the cone as the inside form. A minimum 1-1/2 inch cover shall be maintained between the reinforcing steel and the outside face of concrete.



1 TRANSITION TO FACTORY-BUILT CHIMNEY

- 1 Masonry Firebox
- 2 Track or Sill Plate
- 3 Chimney Chase Stud Walls
- 4 Chimney Chase Connection to Dwelling
- 5 Factory-Built Chimney
- 6 Flue Cap
- 7 Fireblocking
- 8 Chimney Cap
- 9 Adapter Cone
- 10 Adapter Cone Bottom Plate
- 11 Bond Beam



2 CHIMNEY CONSTRUCTION AND NOTATION

APPLICANT: _____
PROPERTY ADDRESS: _____

Replace Chimney above Shoulder, Reuse Masonry Firebox

Retrofit of Masonry Chimneys (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings
FEMA P-1100, Volume 2 - Plan Sets
Issued: SEPT 2019



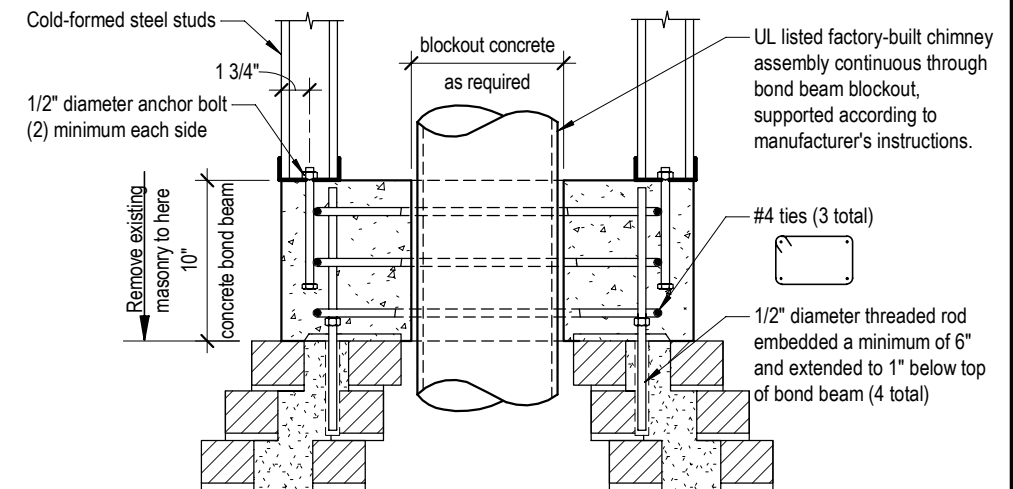
Date: _____
Sheet: _____

S4

Reconstruction shall be in accordance with the insert manufacturer's installation instructions and the requirements of this section. All clearances required by the manufacturer and listing shall be maintained. The reconstruction shall incorporate a factory-built, UL 127 listed insert and chimney.

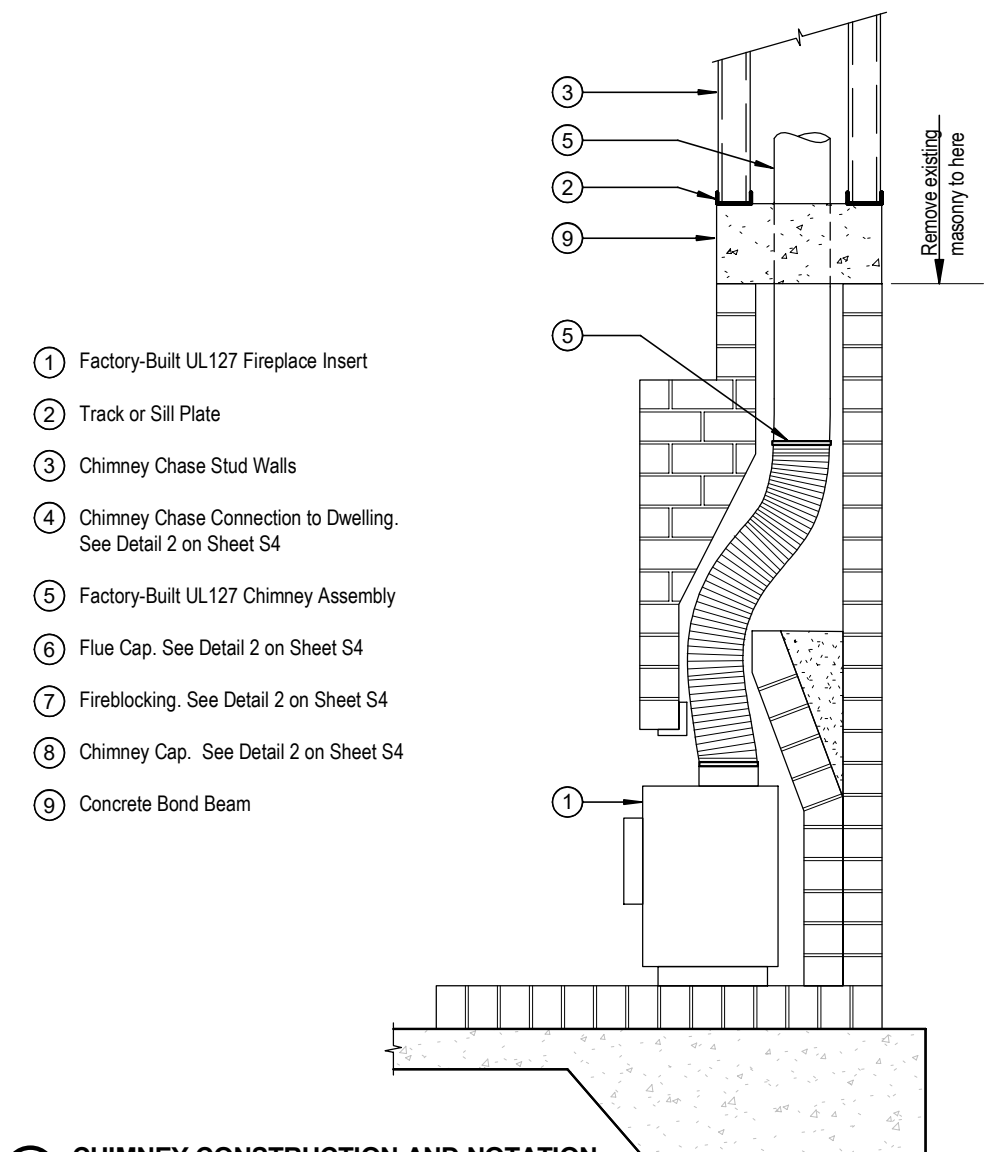
- Masonry firebox. The existing masonry firebox shall remain up to the base of the flue as shown in Detail 2 on Sheet S5.
- Track or sill plate. Cold-formed steel track sections matching the thickness of the studs shall be provided at the bottom of cold-formed steel chimney chase walls. Wood sill or sole plates having a width not less than the supported studs shall be provided at the bottom of wood chimney chase walls. Wood sill or sole plates shall be protected against decay by the use of naturally durable wood or wood that is preservative-treated. Fasteners in contact with wood sill or sole plates shall be of hot-dipped, zinc-coated galvanized steel or of stainless steel. Tracks and sill or sole plates shall be anchored to the concrete beam per Detail 1 on Sheet S5.
- Chimney chase stud walls. Chimney chases shall be constructed of full height stud walls spaced at no more than 12 inches on center. Stud sizes shall be selected based on story clear height. Wood studs shall not be less than nominal two-inch by three-inch. Cold-formed steel studs shall be not less than 43 mil thickness (18 gage) by 2-1/2 inches deep. The top of the chimney chase shall extend not less than 3 feet above the edge of the roof and not less than 2 feet above the maximum roof elevation, or maximum elevation of other construction located within a 10-foot horizontal dimension in any direction from the chimney (Detail 1 Sheet S2). Where the exterior walls adjacent to the chase are less than 5 feet from the lot line, they shall be constructed with full 2x4 wood or 54 mil (16 gage) 3/8-inch steel studs with exterior sheathing that includes 7/8-inch thick conventional stucco or minimum 1/2-inch thick Type X gypsum sheathing. Check with building department for any additional fire protection requirements in the currently adopted building or residential code. The chimney chase shall be capped, with roofing and flashing to be weatherproof and to match existing construction.
- Chimney chase connection to dwelling. The chimney chase studs shall be fastened to the existing residence exterior wall with minimum No. 8 wood screws at 12 inches on center. The chimney chase framing shall be strapped to the existing floor, ceiling and roof framing with not less than two steel straps 1-1/4 inches minimum in width and 33 mil (20 gage) minimum in thickness, with each strap located on an opposing face of the chase. Each strap shall be fastened to steel blocking between steel studs of the chimney chase with minimum four No. 8 sheet metal screws, or to wood blocking between wood studs of the chimney chase with not less than four 8d common nails. Each strap shall be fastened to existing steel floor, roof or ceiling framing with minimum four No. 8 sheet steel screws, or to existing wood floor, ceiling or roof framing with minimum four 8d common nails. Where chimney chase stud walls extend more than four feet above the highest roof elevation immediately adjacent to the chimney, bracing shall be provided in accordance with this section or in a manner acceptable to the building department. The bracing shall be connected to the chimney chase in the upper third of the chase clear height above the roof (H/3 as shown in Detail 1 on Sheet S2). Not less than two bracing steel angles shall be galvanized or otherwise corrosion resistant and not less than 2-1/2x2-1/2x1/4-inch installed per Detail 2 on Sheet S2. Bracing shall be provided at not less than two locations. The bracing slope shall be not less than 30 degrees and not more than 60 degrees from vertical.
- Factory-built chimney. Factory-built chimneys shall be sized such that round chimney flues shall have a minimum net cross-sectional area of not less than 1/12 of the fireplace opening. Square chimney flues shall have a minimum net cross-sectional area of 1/10 of the fireplace opening. Rectangular chimney flues with an aspect ratio less than 2 to 1 shall have a minimum net cross-sectional area of 1/10 of the fireplace opening. Rectangular chimney flues with an aspect ratio of 2 to 1 or more shall have a minimum net cross-sectional area of 1/8 of the fireplace opening. Factory-built chimneys shall be listed and labeled and shall be installed and terminated in accordance with the manufacturer's instructions. Decorative shrouds shall not be installed at the termination of factory-built chimneys except where the shrouds are listed and labeled for use with the specific factory-built chimney system and installed in accordance with the manufacturer's instructions. No part of the chimney shall be at an angle of more than 30 degrees (0.52 rad) from vertical at any point in the assembly and the chimney assembly shall not include more than four elbows.
- Flue cap. Factory-built cap installed in accordance with manufacturer's instructions and complying with the metal chimney UL listing.

- Fireblocking. Spaces between chimneys and floors and ceilings through which chimneys pass shall be fireblocked with noncombustible material securely fastened in place. The fireblocking of spaces between chimneys and wood joists, beams or headers shall be self-supporting or be placed on strips of metal or metal lath laid across the spaces between combustible material and the chimney. Draft stops consisting of drywall, plywood or OSB shall be provided to separate the chase from wood framing of the dwelling.
- Chimney cap. A framed chimney cap shall be constructed at the top of the chimney chase.
- Bond beam. A reinforced concrete beam shall be constructed at transition from masonry to light-framed chimney chase as shown in Detail 2 on Sheet S5. A minimum 1-1/2 inch cover shall be maintained between the reinforcing steel and the outside face of concrete. The bond beam shall be blocked-out to allow minimum 1/2 inch free space between the concrete and the factory-built chimney assembly. Any material used to form block-out must be completely removed after concrete cure.



Note: Material used to form and blockout concrete bond beam to allow passage of factory-built chimney assembly must be completely removed after concrete has cured.

1 MASONRY TO CHIMNEY CHASE TRANSITION



2 CHIMNEY CONSTRUCTION AND NOTATION

APPLICANT: _____
PROPERTY ADDRESS: _____

Replace Chimney above Shoulder, Install Factory Insert

Retrofit of Masonry Chimneys (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of
One- and Two-Family Dwellings
FEMA P-1100, Volume 2 - Plan Sets
Issued: SEPT 2019



Date: _____

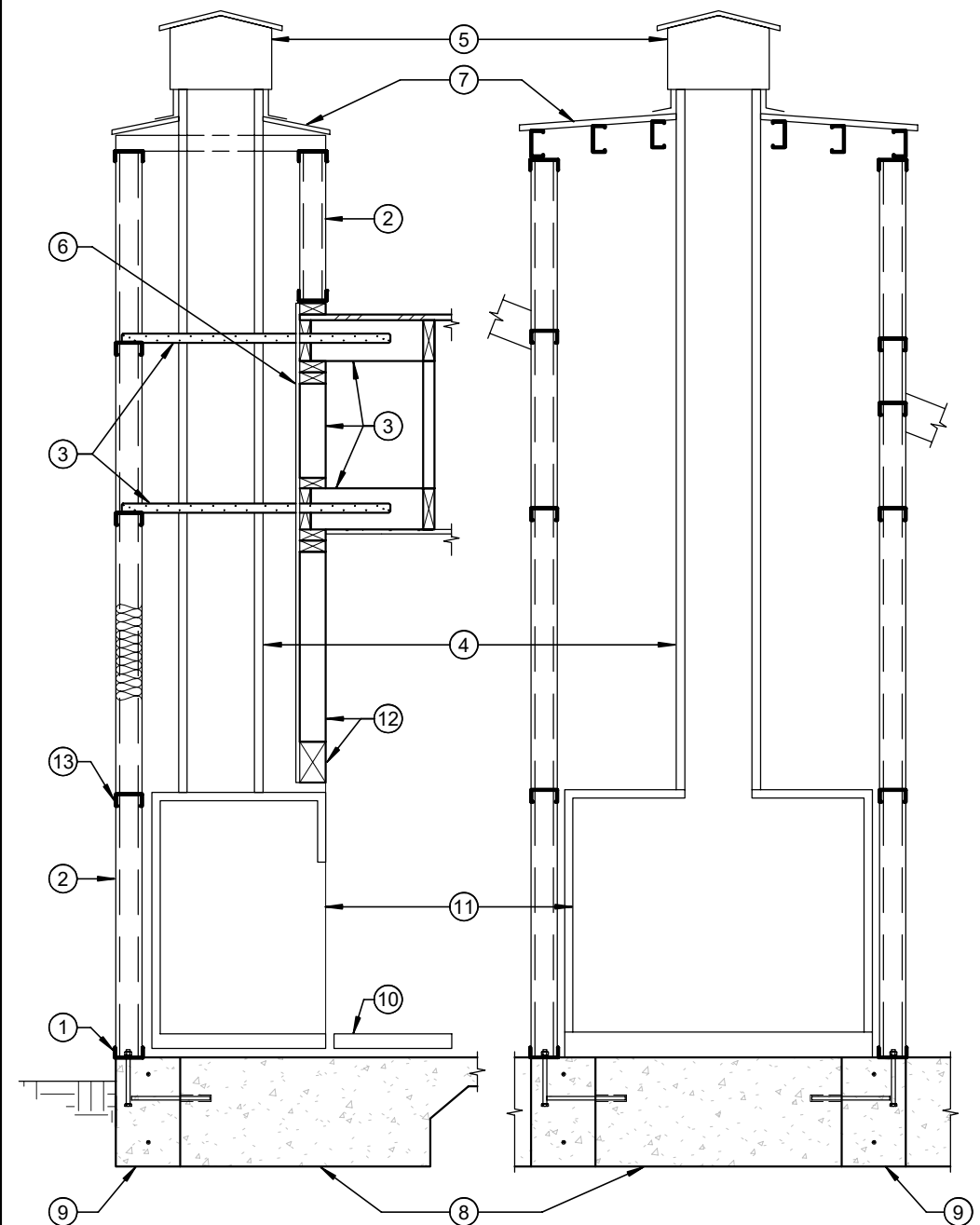
Sheet: _____

S5

All construction shall be in accordance with the factory-built chimney manufacturer's installation instructions and the following requirements:

1. Track or sill plate. Cold-formed steel track sections matching the thickness of the studs shall be provided at the bottom of cold-formed steel chimney chase walls. Wood sill or sole plates having a width not less than the supported studs shall be provided at the bottom of wood chimney chase walls. Wood sill or sole plates shall be protected against decay by the use of naturally durable wood or wood that is preservative-treated by the supplier. Fasteners in contact with wood sill or sole plates shall be of hot-dipped, zinc-coated galvanized steel or of stainless steel. Tracks and sill or sole plates shall be anchored to the concrete beam per Detail 1 on Sheet S5.
2. Chimney chase stud walls. Chimney chases shall be constructed of full height stud walls spaced at no more than 12 inches on center. Stud sizes shall be selected based on story clear height. Wood studs shall not be less than nominal 3-inch by 2-inch. Cold-formed steel studs shall be not less than 43 mil thickness (18 gage) by 2-1/2 inches deep. The top of the chimney chase shall extend not less than three feet above the edge of the roof and not less than 2 feet above the maximum roof elevation, or maximum elevation of other construction located within a 10-foot horizontal dimension in any direction from the chimney. Where the exterior walls adjacent to the chase are less than 5 feet from the lot line, they shall be constructed with full 2x4 wood or 54 mil (16 gage) 3-5/8 inch steel studs with exterior sheathing that includes 7/8-inch thick conventional stucco or minimum 1/2-inch thick Type "X" gypsum sheathing. Check with building department for any additional fire code requirements. The chimney chase shall be capped, with roofing and flashing to be weatherproof and to match existing construction.
3. Chimney chase connection to dwelling. The chimney chase studs shall be fastened to the existing residence exterior wall with minimum No. 8 wood screws at 12 inches on center. The chimney chase framing shall be strapped to the existing floor, ceiling, and roof framing with not less than two steel straps 1-11/4 inches minimum in width and 33 mil (20 gage) minimum in thickness, on two opposing faces of the chase. Each strap shall be fastened to steel blocking between steel studs of the chimney chase with minimum four No. 8 sheet metal screws, or to wood blocking between wood studs of the chimney chase with not less than four 8d common nails. Where chimney chase stud walls extend more than four feet above the highest roof elevation immediately adjacent to the chimney, bracing shall be provided in accordance with this section. The bracing shall be connected to the chimney chase in the upper third of the chase clear height above the roof (H/3 as shown in Detail 1 on Sheet S2). Not less than two bracing steel angles shall be galvanized or otherwise corrosion resistant and not less than 2-1/2x2-1/2x1-4-inch installed per Detail 2 on Sheet S2. Bracing shall be provided at not less than two locations. The bracing slope shall be not less than 30 degrees and not more than 60 degrees from vertical.
4. Factory-Built Chimney. Factory-built chimneys shall be per UL 103 (and UL 959 for medium-heat appliances), sized such that round chimney flues shall have a minimum net cross-sectional area of not less than 1/12 of the fireplace opening. Square chimney flues shall have a minimum net cross-sectional area of 1/10 of the fireplace opening. Rectangular chimney flues with an aspect ratio less than 2 to 1 shall have a minimum net cross-sectional area of 1/8 of the fireplace opening. Factory-built chimneys shall be listed and labeled and shall be installed and terminated in accordance with the manufacturer's instructions. Decorative shrouds shall not be installed at the termination of factory-built chimneys except where the shrouds are listed and labeled for use with the specific factory-built chimney system and installed in accordance with the manufacturer's instructions. No part of the chimney shall be at an angle of more than 30 degrees (0.52 rad) from vertical at any point in the assembly and the chimney assembly shall not include more than four elbows.
5. Flue Cap. Factory-built cap installed in accordance with manufacturer's instructions and complying with the metal chimney UL listing.
6. Fireblocking. Spaces between chimneys and floor and ceilings through which chimneys pass shall be fireblocked with noncombustible material securely fastened in place. The fireblocking of spaces between chimneys and wood joists, beams, or headers shall be self-supporting or be placed on strips of metal or metal lath laid across the spaces between combustible material and the chimney.

7. Chimney Cap. A framed chimney cap shall be constructed at the top of the chimney chase.
8. Existing Foundation. An existing concrete foundation in good condition shall be permitted to be retained and incorporated. Where the existing foundation is deemed to be in poor condition or constructed of material other than concrete, it shall be removed and replaced in accordance with the fireplace manufacturer and this section. At minimum, the new footings shall be constructed of concrete not less than 12 inches (305 mm) thick and shall extend not less than 6 inches (152 mm) beyond the face of the fireplace or foundation wall on all sides. Foundations shall be founded on natural, undisturbed earth or engineered fill below frost depth. In areas not subjected to freezing, footings shall be not less than 12 inches (305 mm) below finish grade. Provide 1/2" threaded rod anchor bolt with epoxy anchors embedded not less than 4 inches into existing concrete, minimum three per side. Provide 1/2" anchor bolts with 7 inches minimum embedment into new concrete, minimum three per side.
9. Extension of Existing Foundation. Where required to meet dimensional requirements specified by the fireplace manufacturer or the requirements in #1 above, the existing concrete footing shall be extended as shown in detail. The depth of the new foundation shall match the depth of the existing foundation, but the bottom of the foundation shall not be less than 12 inches below grade. The foundation extension shall be reinforced with one #4 bar top and bottom and epoxy dowels into the existing foundation spaced no more than 12 inches on center, embed 4 inches minimum into existing concrete with epoxy anchors. Provide 1/2" threaded rod anchor bolt with epoxy anchors embedded not less than 4 inches into existing concrete, minimum three per side. Provide 1/2" anchor bolts with 7 inches minimum embedment into new concrete, minimum three per side.
10. Non-combustible Hearth Extension. Where required to meet manufacturer's requirements or fireplace listing, a hearth extension listed and labeled per UL 1618 shall be provided.
11. Factory-built Fireplace. Factory-built fireplaces shall be listed and labeled and shall be installed per the conditions of the listing.
12. Existing Framing. Existing roof, wall, and ceiling framing shall remain. Where existing wall framing requires modification to accommodate a new fireplace opening, it shall be verified to be in good condition and in accordance with conventional construction provisions. New framing shall match existing construction.
13. Stud Blocking. Continuous blocking shall be installed at 4-foot maximum vertical spacing. Blocking size shall match studs.



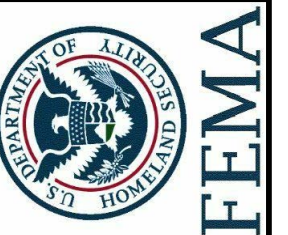
- | | |
|--|------------------------------------|
| ① Track or Sill Plate | ⑧ Existing Foundation |
| ② Chimney Chase Stud Walls | ⑨ Extension of Existing Foundation |
| ③ Chimney Chase Connection to Dwelling | ⑩ Non-combustible Hearth Extension |
| ④ Factory-built Chimney | ⑪ Factory-built Fireplace |
| ⑤ Flue Cap | ⑫ Existing Framing |
| ⑥ Fireblocking | ⑬ Stud Blocking |
| ⑦ Chimney Cap | |

1 NEW FIREBOX AND CHIMNEY

APPLICANT: _____
PROPERTY ADDRESS: _____

Replace Firebox and Chimney with Factory Insert and Metal Flue

Retrofit of Masonry Chimneys (Plan Set)
Vulnerability-Based Seismic Assessment and Retrofit of
One- and Two-Family Dwellings
FEMA P-1100, Volume 2 - Plan Sets
Issued: SEPT 2019



Date: _____

Sheet: _____

S6

INSTRUCTIONS FOR USE

A. Before you begin:

- This plan set is intended for use by a general contractor or homeowner without necessarily having to involve a registered design professional.
- Contact your local building department to understand the building permit application process. Ask about:
 - Fees,
 - How many copies of the plan must be submitted, and
 - Which city inspections are required
- The Building Official may also be able to assist with assessing the applicability of this plan set to a home. See Eligibility For Use, Sheet S0, Table 1.
- Complete the Eligibility For Use questionnaire on Sheet S0 to determine if this plan set is applicable. A "non-compliant" answer to any question disqualifies the home from using this plan set.

B. Prepare your plan set:

- Draw a scaled plan of the home in the space provided on Sheet S0, Detail 1. Your plan should include the following:
 - The general outline of the home. It is helpful to draw roof ridges, hips and valleys.
 - The front (street) side of the home and the back side of the home.
 - A north arrow.
 - The location of the chimney to be retrofit.
 - Chimney dimensions "A," "B," and "H," as shown in Detail 3 on Sheet S2.
 - See Sheet X1 for an example plan.

C. Gather information to complete the plan set:

- Review general notes on Sheet S1 for guidance on materials and installation for the required work.
- Use Table 2 on Sheet S0 to determine which retrofit methods are applicable to your home and chimney.
- If several retrofit methods are applicable, choose the preferred method, and identify the sheet that gives applicable detailing (choose one of Sheets S3 through S6).
- Determine whether Details 1 and 2 on Sheet S2 are required based on Note 4 on Sheet S4 or S5, or Note 3 on Sheet S6).

D. Complete your plans:

- In the space provided in Detail 1, Sheet S0, draw a plan of the dwelling with the chimney location shown. Note on the dwelling plan the sheet to be used for chimney retrofit.
- If braces per Details 1 and 2 on Sheet S2 required, note on the Sheet S0 plan the approximate location and provide a reference to the details.

E. Submit your plans to the building department:

- The submitted plan set should always include Sheets S0 and S1. If Details 1 and 2 on Sheet S2 are to be used, the submitted plan set should also include Sheet S2. Finally, also include the one sheet that is to be used for the chimney retrofit (include one only of Sheets S3 through S6, do not submit sheets that are not being used).
- Submit a permit application and the required number of complete plan sets to the building department for review. Photographs of the chimney to be retrofitted may assist the review process.
- Before beginning work, the permit holder may be required to schedule an inspection with the building department to verify that field conditions are consistent with the information provided on the approved plans.
- Inspections by the building department during the retrofit work may be required for:
 - Foundation and rebar prior to placing concrete
 - Foundation anchor bolts
 - Anchorage to existing masonry and adaptor cone installation
 - Framing
 - Fire blocking
 - Flue and flue cap installation

PURPOSE

The purpose of this plan set is to promote public safety and welfare by reducing earthquake-induced damage to existing masonry chimneys. The provisions of this plan set address a single vulnerability - falling hazards associated with masonry chimneys. Eligible chimneys retrofit to the prescriptive designs provided in this plan set are considered to comply with the requirements of Chapter 7 of FEMA P-1100. Construction details of this plan set are intended to improve the performance of chimneys, but may not prevent their damage or collapse in earthquake shaking.

SCOPE

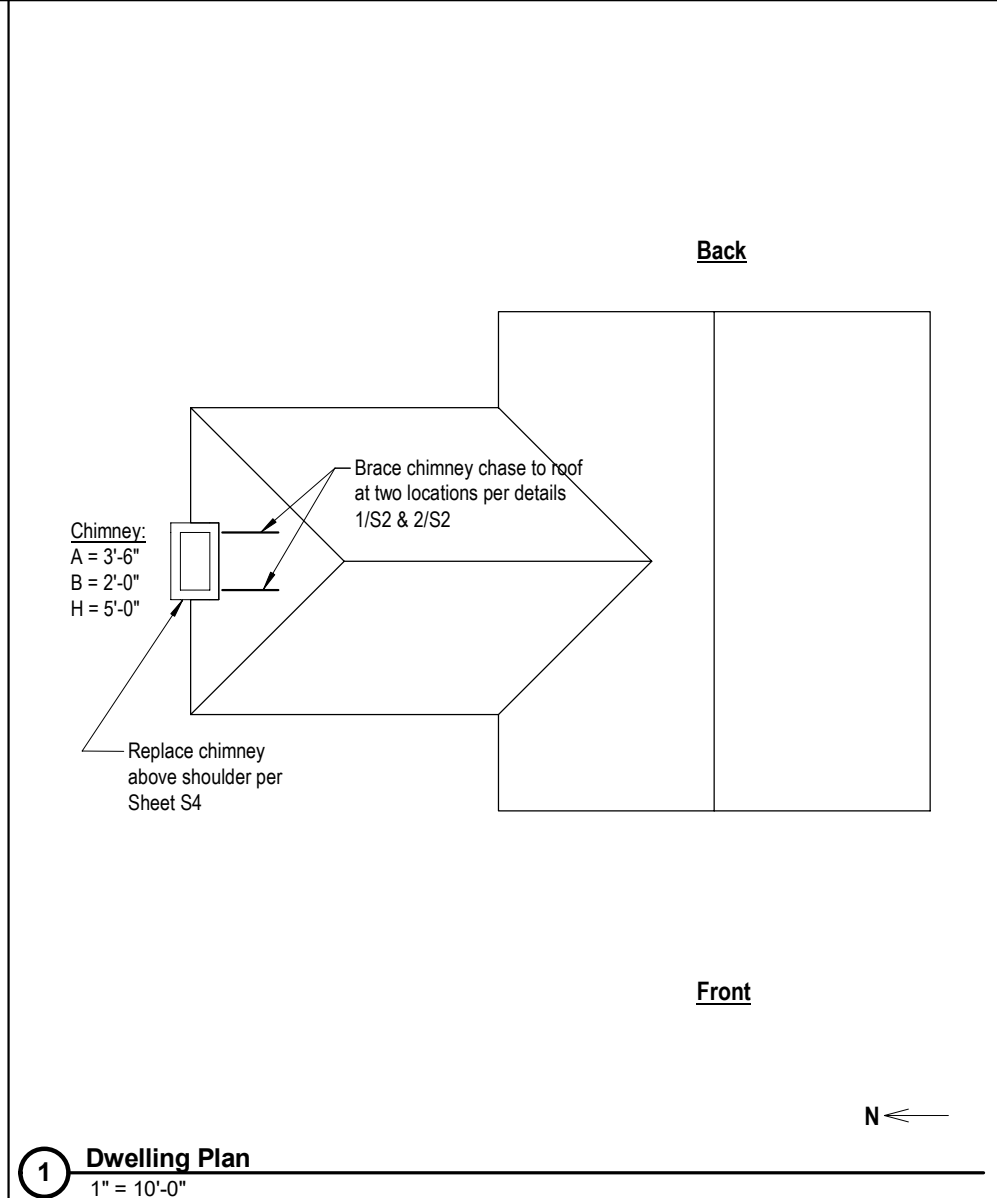
This plan set contains prescriptive provisions for retrofit of masonry chimneys of one- and two-family, light-frame detached dwellings of three stories or less. Considerations and methods beyond those in this plan set may be appropriate for dwellings listed in or eligible for listing in the National Register of Historic Places, or designated as historic under an appropriate state or local law.

ELIGIBILITY

Chimneys must meet all of the requirements of Table 1 on Sheet S0 to be eligible for the retrofit provisions of this plan set. Chimneys not eligible for this plan set can be retrofitted in accordance with FEMA P-1100 Prestandard, Chapter 7.

ASSESSMENT

The retrofit provisions of this plan set are intended to apply to chimneys that have been assessed using the FEMA P1100 Prestandard methodology and found to have a masonry chimney vulnerability.



SHEET INDEX

- S0 Cover Sheet
- S1 General Notes
- S2 Details and Definitions
- S3 Cap Chimney at Roof or Ceiling
- S4 Replace Chimney above Shoulder, Reuse Masonry Firebox
- ~~S5 Replace Chimney above Shoulder, Install Factory Insert~~
- ~~S6 Replace Firebox and Chimney with Factory Insert and Metal Flue~~
- X1 Example Cover Sheet with Plan

ABBREVIATIONS

- (E) Existing
- (N) New
- min. Minimum
- max. Maximum
- NTS Not to Scale
- typ. Typical

This sheet is for instruction and reference only. Do not submit to the building department.

Example Cover Sheet with Plan

Retrofit of Masonry Chimneys (Plan Set)

Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings
FEMA P-1100, Volume 2 - Plan Sets
Issued: SEPT 2019

Table 1: ELIGIBILITY FOR USE

To determine if a home qualifies answer the following:	Compliant	Non-Compliant
1. The dwelling is a detached <i>one- or two-family dwelling</i> or the dwelling is a unit in a <i>townhouse</i> .	✓	
2. The dwelling is a wood light-frame dwelling that is three stories or less above grade plane.	✓	
3. The chimney is constructed of solid brick masonry.	✓	
4. The chimney's largest plan dimension (dimension A) is not more than 40 inches. (See Detail 3 on Sheet S2 for definition of dimension A).	✓	
5. The chimney is either an interior chimney, or an exterior chimney engaging only one exterior wall (i.e. not at the dwelling corner).	✓	

If you checked "Compliant" to each of the above, proceed to Table 2.
If you checked "Non-Compliant" to any of the above, the home is not eligible to apply this plan set. See Chapter 7 of the FEMA P-1100 Prestandard for engineered retrofit design methods.

Table 2: DETERMINATION OF RETROFIT SCOPE

Use this table to determine which retrofit in Sheets S3 to S6 is permitted for the home. See Detail 3 on Sheet S2 for definitions of dimensions B and H.

Chimney Location	Chimney Height	Unbraced Portion	Minimum Requirements for Compliance	Sheet
Exterior	Any		Demolish down to base (shoulder) of the chimney at the lowest fire box.	S4, S5, or S6
	Two or Three Stories			S4, S5, or S6
Interior	One Story	Some portion of the chimney is freestanding (not in contact with a wall on any of the four sides) for a height of more than six feet.	Demolish to floor or ceiling directly below unbraced portion.	S3 Detail 1 or S4, S5, or S6
		No portion of the chimney is freestanding (not enclosed by full-height, finished walls on at least three faces) for a height of more than six feet, and the chimney extends a height (dimension H) more than two times dimension B (2xB) above the roof.	Demolish to roof.	S3 Detail 1 or S3 Detail 2 or S4, S5, or S6



Date:

Sheet:

X1



FEMA

FEMA P-1100-2C