CHAPTER 4
STRUCTURAL PROVISIONS

SECTION 401
GENERAL

401.1 General. The structural design of log structures shall comply with the general requirements of this chapter.

401.2 Structural provisions. The provisions of this Chapter provide minimum load, resistance and prescriptive requirements for structures within the scope of this document. The information does not represent a complete engineering analysis. All log structures shall meet the requirements of Section 401 and further comply with the prescriptive provisions of Section 402 or the engineered provisions of Section 403, or a combination thereof.

401.3 General provisions. General provisions for the design of log structures shall be in accordance with provisions of this section and Chapter 3.

401.4 Continuous load path. A continuous load path shall be provided to transfer all lateral and vertical loads from the roof, wall, and floor systems to the foundation.

401.5 Interpolation. Interpolation of tabulated values in this chapter shall be permitted unless otherwise noted in the applicable table footnotes.

SECTION 402
PRESCRIPTIVE PROVISIONS

402.1 Prescriptive provisions. Log structures not requiring engineering design in accordance with Section 403 shall be permitted to use prescriptive provisions as approved by the building official.

SECTION 403
ENGINEERED PROVISIONS

403.1 Applicability. If the building geometry, or loads related to the log structure, exceed any of the following limitations, then the building shall be designed using the provisions of Sections 403 through 407. If portions of building geometry, or loads related to those portions, exceed any of the following limitations, then the affected portions shall be designed using the provisions of Sections 403 through 407. The limitations are:

1. **Loads:**
   a. Greater than 40-psf (1916 N/m^2) live load on floors.
   b. Greater than 70-psf (3353 N/m^2) ground snow load.
   c. Greater than 90 mph (39.6 m/s) wind speed (3 second gust).
   d. Greater than Wind Exposure Category B.
   e. Greater than Seismic Design Category B.

   Exception: Detached one- and two-family dwellings located in Seismic Design Category C.

2. **Building dimensions**
   a. Greater than three stories or a mean roof height of 33 feet, (100.6 m) measured from average grade to average roof elevation.
   b. The building aspect ratio (L/W) less than 1:4 or greater than 4:1.
   c. The building dimension, length (L) or width (W), greater than 80 feet (243.8 m).
   d. Floor to floor story height greater than 10 feet (3.0 m) .

3. **Log floor systems**
   a. Single spans of log floor framing members greater than 26 feet (79.2 m).
   b. Spacing of logs used as floor framing members greater than 48 inches (1219 mm) on center.
   c. Cantilever lengths of logs used as cantilevered floor framing members supporting load bearing walls or shear walls greater than the depth, d, of the log joists.
   d. Log floor joist cantilevers supporting nonload-bearing walls which are not shear walls greater than one-quarter of the span, L/4.
   e. Setbacks of load bearing walls or shear walls on log floor joist systems greater than the depth, *d*, of the log joists. Log floor joists shall be located directly over structural elements when used in setback conditions supporting load bearing walls.
   f. Vertical log floor offsets greater than the log floor depth, (including log floor framing members and floor sheathing).
   g. Log floor diaphragm aspect ratios greater than limits from Table 403.1.
   h. Log floor diaphragm openings greater than 12 feet (36.6 m) or 50 percent of the building, whichever is less.

4. **Log walls**
   a. Load bearing and nonload-bearing log walls greater than 20 feet (61 m) in unsupported height.
   b. Offsets in a log shear wall line within a story greater than 4 feet (1219 m).
   c. Upper story log shear wall segments offset from lower story log shear wall segments by more than the depth, *d*, of the log floor framing members.
   d. Log shear wall segment aspect ratios greater than 1:1.

e. Log shear wall lines oriented to resist loads in two orthogonal directions.

5. Log roof systems

a. Single spans (horizontal projection) of log roof framing members greater than 26 feet (79.2 m).

b. Roof framing member spacing greater than 48 inches on center.

c. Log rafter overhang lengths greater than one-third of the rafter span or 4 feet (1219 mm), whichever is less. Rake overhangs greater than one-half of the purlin length or 4 feet (1219 mm), whichever is less.

d. Roof slope greater than 12:12. For purposes of determining uplift, gravity loads, and lateral bracing requirements, the attic shall be considered an additional story when the roof slope is 7:12 or greater.

e. Roof diaphragm aspect ratios greater than values from Table 403.1.

TABLE 403.1
MAXIMUM DIAPHRAGM ASPECT RATIOS (HORIZONTAL OR SLOPED DIAPHRAGMS)

Diaphragm	Maximum
Sheathing Type	L/W Ratio
Wood structural panel, unblocked	3:1
Wood structural panel, blocked	4:1
Single-layer straight lumber sheathing	2:1
Single-layer diagonal lumber sheathing	3:1
Double-layer diagonal lumber sheathing	4:1

403.2 Design methodology. Log structures shall be designed using allowable stress design or load and resistance factor design as follows:

403.2.1 Allowable stress design. Allowable stress design of wood structural components shall be in accordance with AFPA NDS.

Exception: Log structures intended for one- and two-family dwellings shall be permitted to be designed in accordance with the applicable provisions of AF&PA's WFCM.

403.2.2 Load and resistance factor design. Load and resistance factor design of wood structural components shall be in accordance with AFPA NDS.

403.3 Design values. Design values shall be in accordance with Section 302.2.3.

403.4 Design capacities. When design capacities are required, the design values shall be multiplied by the section properties from Section 302.2.3.4 as follows:

Apparent Rigidity	$= E'I$
Moment	$M_r = F'_b S$
Shear	$V_r = F'_v Ib/Q$
Bearing	$B_r = F'_{c\perp} A$
Tension	$T = F'_t A$
Compression	$P = F'_c A$

403.5 Combined loads. Combined bending and axial load conditions shall be designed in accordance with the AF&PA NDS.

SECTION 404
CONNECTIONS

404.1 Lateral connections. Connections between roof, ceiling, wall, and floor assemblies shall be designed to transfer lateral forces acting perpendicular to the wall surface.

Connections to transfer lateral loads from the foundation wall into the floor diaphragm assembly shall be in accordance with the foundation design.

404.2 Shear connections. Connections between roof, ceiling, wall, and floor assemblies shall be designed to transfer shear forces due to wind and seismic loads, acting parallel to the wall surface.

404.2.1 Roof, ceiling, or floor assembly to wall assembly. Connections shall be designed to transfer shear loads from the roof, ceiling, or floor diaphragm assembly to the shear wall segments.

404.2.2 Wall assembly to wall assembly. Connections shall be designed to transfer shear loads from a shear wall segment above to a shear wall segment below.

404.2.3 Floor assembly to foundation. Connections shall be designed to transfer shear loads from the floor assembly to the foundation.

404.2.4 Wall assembly to foundation. Connections shall be designed to transfer shear loads from the wall assembly to the foundation.

404.3 Uplift connections. Connections shall be designed to resist uplift forces.

404.4 Overturning resistance. Resistance to overturning shall be provided. Hold downs to provide overturning restraint to shear wall segments at each level shall be provided at the ends of shear walls and as required to develop the shear capacity of the wall segments in accordance with Section 406.1. A continuous load path from the hold down to the foundation shall be maintained. Where a hold down resists the overturning load from the story or stories above, the hold down shall be sized for the required hold down tension capacity at its level plus the required hold down tension capacity of the story or stories above. Hold downs used to resist both uplift and overturning shall be designed to resist the sum of the forces determined in accordance with Section 404.3 and this section.

404.5 Sheathing and cladding attachment. Attachment of sheathing and cladding shall be designed to transfer specified loads into framing members.

404.5.1 Roof sheathing. Roof sheathing shall be designed and attached to roof structural members to resist the calculated withdrawal loads (suction) and provide the roof diaphragm shear capacity required in Section 407.14.

404.5.2 Floor sheathing. Floor sheathing shall be designed and attached to provide the floor diaphragm shear capacity required in Section 405.10.

404.6 Special connections. Consideration shall be given to special connections as addressed in this section.

404.6.1 Ridge connections. Connections at the roof ridge shall be designed to resist the calculated loads.

404.6.2 Log jack rafters. Connection of the log jack rafter to the log wall shall be designed in accordance with Section 404.3. Connection of the log jack rafter to log hip beam or log valley beam shall be designed to resist the calculated loads.

404.6.3 Log hip and log valley beams. Log hip and log valley beams do not require special uplift connections when log jack rafters are attached in accordance with Section 403.6.6.2.

404.6.4 Uplift loads on exterior log wall assemblies. Log walls that support log rake overhang outlookers or lookout blocks shall be designed to resist the uplift loads. Log walls that do not support the roof assembly need only resist the uplift load.

404.6.5 Log wall openings. Connections to transfer lateral, shear, and uplift loads around log wall openings shall be in accordance with the loads specified in Sections 406.1, 406.4, and 406.5. A continuous load path shall be maintained around the opening.

404.6.6 Thrust connection. Connections to transfer thrust loads in the lower third of the attic space shall be designed to resist the calculated thrust loads.

404.6.7 Log rake overhang outlookers. Connections of log rake overhang outlookers to the gable end wall shall be designed to resist the calculated uplift loads.

SECTION 405
FLOOR SYSTEMS

405.1 Log framing members. Single span, continuous span, and cantilevered log framing members shall be designed to resist the calculated loads.

405.2 Framing spans. Design of log framing members shall consider both strength and serviceability limits. For serviceability, the computed log floor joist deflection under live load shall not exceed the deflection limits in the applicable code. For simple, continuous and cantilevered bending members, the span shall be taken as the distance from face to face of supports, plus ½ the required bearing length at each end.

405.3 Framing member spacing. Logs used as floor framing members shall be spaced according to the design requirements.

405.4 Bearing. Framing members shall bear directly on beams, girders, ledgers, or load bearing walls or be supported by hangers or framing anchors. Framing members shall be designed to resist the calculated bearing loads. Minimum bearing area shall be based on consideration of both the framing member and supporting member.

405.5 Single or continuous log floor joists supporting load bearing walls. Load bearing log walls parallel to log joists shall be supported directly by beams, girders, or other load bearing walls. Log joists supporting load bearing log walls that are perpendicular to the joists shall be designed to carry the additional gravity load.

405.6 Single or continuous log floor joists supporting non-load bearing walls. Where nonload-bearing log walls are parallel or perpendicular to log floor joists, the joist(s) and sheathing supporting the nonload-bearing wall shall be designed to carry the additional weight of the wall.

405.7 Cantilevered log floor joists supporting walls. Overhang lengths of cantilevered log floor joists supporting a wall at the end of the cantilever shall be designed for the cantilevered condition with the additional floor load of the cantilevered area and the gravity load of the wall specified.

405.8 Floor openings. Framing around floor openings shall be designed to transfer loads to adjacent framing members that are designed to support the additional concentrated loads. Fasteners, connections, and stiffeners shall be designed for the loading conditions. Where the edge of the opening is less than 2 feet (610 mm) from an exterior wall, the exterior wall adjacent to the opening shall be designed to resist gravity, lateral, and uplift loads at that location.

405.9 Sheathing and decking spans. Floors shall be fully sheathed with materials capable of resisting and transferring the applied gravity loads to the floor framing members.

405.10 Diaphragm capacity. Floor sheathing and fasteners shall be capable of resisting the total calculated shear loads for wind or seismic motion perpendicular to the ridge and parallel to the ridge. Diaphragm chords shall be continuous for the full length of the diaphragm. Diaphragm chords and chord splices shall be capable of resisting the chord forces, calculated by the following equation:

$$T = vL/4$$

where:

T = Chord force, lbs.

v = Required unit shear capacity of the floor diaphragm, plf

L = Floor diaphragm dimension perpendicular to the lateral load, ft.

405.11 Floor diaphragm bracing. Framing and connections shall be designed, to transfer the lateral wind loads from the exterior wall to the floor diaphragm assembly in accordance with the calculated loads.

SECTION 406
LOG WALLS

406.1 Load resistance. Log walls shall be designed to resist wind and seismic loads, gravity loads and uplift loads in accordance with applicable load standards. The maximum shear

wall aspect ratio shall be 1:1 for walls used in the design as shear walls to resist wind and seismic loads.

406.2 Corners and intersecting log walls. Log walls shall be connected by mechanical fastening or interlocking joinery at corners, and intersecting walls and beams to resist and transfer lateral loads to the roof or floor diaphragm. Wall logs shall be continuous within a single course between openings, or have designed fastening at splices between logs to resist lateral loading.

406.3 Log bottom plate to foundation. Log bottom plates shall be connected to transfer lateral loads to the floor diaphragm. Sill logs shall be connected to transfer lateral loads to the foundation.

406.4 Header logs. Header logs shall be provided over all log wall openings to resist lateral and gravity loads. Header logs shall be continuous over and beyond the wall opening to provide connection to the wall assembly and bearing area such that the load imposed by the header will be distributed over the supporting logs.

406.5 Window sill log. Window sill logs shall be designed to resist lateral loads. Window sill logs shall extend beyond the edge of the window opening to provide connection to the wall assembly.

406.6 Interior nonload-bearing log partitions. Interior nonload-bearing log partitions shall be designed to support their self-weight. Foundations or other supporting elements shall also be designed for the dead weight of the log partition.

SECTION 407
ROOF SYSTEMS

407.1 Framing spans. Log framing members shall be evaluated for both strength and serviceability limits. For serviceability, the computed log rafter deflection under live load shall not exceed the deflection limitations listed in the applicable code. For simple, continuous and cantilevered bending members, the span shall be taken as the distance from face to face of supports, plus $^1/_2$ the required bearing length at each end.

407.2 Framing spacing. Logs used as framing members shall be spaced according to the design requirements.

407.3 Slope. Roof slope shall be used to calculate vertical and lateral loads on the structure.

407.4 Log jack rafters. Log jack rafters shall be in accordance with Section 404.6.2.

407.5 Log rafter overhangs. Log rafter overhang lengths shall be designed to resist calculated loads.

407.6 Rake overhangs. Log rake overhang outlookers shall use continuous purlins connected in accordance with Section 404.6.7.

407.7 Bearing. Framing members shall bear directly on beams, girders, ledgers, posts or load-bearing walls or be supported by hangers or framing anchors. Framing members and supports shall be designed to resist the calculated bearing loads. Minimum bearing area shall be based on consideration of both the framing member and supporting member.

407.8 Ridge beams. Log rafters shall be supported on bearing walls, headers, purlins and/or ridge beams. When ridge beams support log rafters, beams shall be in accordance with the calculated capacity requirements. Log rafters shall bear directly on the ridge beam or be supported by hangers or framing anchors. Ceiling joists or rafter ties shall not be required to resist horizontal thrust where a ridge beam is provided.

407.9 Hip and valley log beams. Hip and valley log beams shall be designed to resist the calculated loads.

407.10 Log ceiling joists. Log ceiling joists shall be designed to resist the calculated loads, including bending and tension.

407.11 Open ceilings. Where ceiling joists and roof ties are omitted and log rafters are used to create an open (cathedral) ceiling, log rafter ends shall be supported on bearing walls, headers, purlins or ridge beams. Log rafters shall be attached to the support at each end in accordance with Section 404.6.6.

407.12 Roof openings. Framing around roof openings shall be designed to transfer loads to adjacent framing members that are designed to support the additional concentrated loads. Fasteners and connections, shall be designed for the loading conditions.

407.13 Sheathing and decking spans. Roofs shall be sheathed sheathing materials capable of resisting and transferring the applied gravity loads and wind loads to the roof framing members.

407.14 Diaphragm capacity. Roof sheathing and fasteners shall be capable of resisting the total shear loads calculated for wind or seismic motion perpendicular or parallel to the ridge. Diaphragm chords shall be continuous for the full length of the diaphragm. Diaphragm chords and chord splices shall be capable of resisting the chord forces, calculated by the following equation:

$$T = vL/4$$

where:

T = Chord force, lbs.

v = Required unit shear capacity of the roof diaphragm, plf

L = Roof diaphragm dimension perpendicular to the lateral load, ft.

407.15 Roof diaphragm bracing. Framing and connections shall be designed, to transfer the lateral wind loads from the exterior wall to the roof diaphragm assembly in accordance with the calculated loads.