

HAZUS Building Attribute Rulesets - Wind - MLRM2

Note: Defaults should be assigned to all MLRM2 Buildings as defined below; then rulesets should be applied to override those defaults as informed by available data.

RoofCvr		Roof Cover	
Valid Entries	N/A, BUR, SPM	Input Variable	YearBuiltNJDEP, RoofShape
Default	N/A	Input Variable Source	Custom Inventory
Years Ruleset Applies	Ruleset	Notes	Possible Extensions
YearBuiltNJDEP >= 1975	IF RoofShape = (Gable OR Hip), RoofCvr = N/A IF RoofShape = Flat, RoofCvr = SPM	<p>NJ Building Code Section 1507 (in particular 1507.10 and 1507.12) address Built Up Roofs and Single Ply Membranes. However, the NJ Building Code only addresses installation and material standards of different roof covers, but not in what circumstance each must be used.</p> <p>SPMs started being used in the 1960s, but different types continued to be developed through the 1980s. Today, single ply membrane roofing is the most popular flat roof option. BURs have been used for over 100 years, and although they are still used today, they are used less than SPMs. Since there is no available ruleset to be taken from the NJ Building Code, the ruleset is based off this information.</p> <p>Sources: https://www.spri.org/2019/01/singe-ply-roofing-101/, https://continuingeducation.bnppmedia.com/courses/johns-manville/understanding-single-ply-roofing-systems/</p> <p>Assumptions of the Ruleset: All flat roofs built before 1975 are BURs. SPMs were developed in the 1960s, and considering that there is a time lag to start consistently using new methods, SPMs rose in importance through the 1970s, becoming more popular. This ruleset assumes that all roofs built after 1975 are SPMs.</p>	Any data from NJ on practices around BUR, SPM should be incorporated; trends presently inferred from when a technology entered the market
YearBuiltNJDEP < 1975	IF RoofShape = (Gable OR Hip), RoofCvr = N/A IF RoofShape = Flat, RoofCvr = BUR	<p>NJ Building Code Section 1507 (in particular 1507.10 and 1507.12) address Built Up Roofs and Single Ply Membranes. However, the NJ Building Code only addresses installation and material standards of different roof covers, but not in what circumstance each must be used.</p> <p>SPMs started being used in the 1960s, but different types continued to be developed through the 1980s. Today, single ply membrane roofing is the most popular flat roof option. BURs have been used for over 100 years, and although they are still used today, they are used less than SPMs. Since there is no available ruleset to be taken from the NJ Building Code, the ruleset is based off this information.</p> <p>Sources: https://www.spri.org/2019/01/singe-ply-roofing-101/, https://continuingeducation.bnppmedia.com/courses/johns-manville/understanding-single-ply-roofing-systems/</p> <p>Assumptions of the Ruleset: All flat roofs built before 1975 are BURs. SPMs were developed in the 1960s, and considering that there is a time lag to start consistently using new methods, SPMs rose in importance through the 1970s, becoming more popular. This ruleset assumes that all roofs built after 1975 are SPMs.</p>	Any data from NJ on practices around BUR, SPM should be incorporated; trends presently inferred from when a technology entered the market
shutters			
Valid Entries	yes, no	Input Variable	YearBuiltNJDEP, WBD
Default	no	Input Variable Source	Custom Inventory
Years Ruleset Applies	Ruleset	Notes	Possible Extensions
YearBuiltNJDEP > 2000	IF WBD = yes, shutters = yes IF WBD = no, shutters = no	<p>1609.1.2 in 2015 IBC: Protection of Openings. In wind-borne debris regions, glazing in buildings shall be impact resistant or protected with an impact-resistant covering meeting the requirements of an approved impact-resistant covering meeting the requirements of an approved impact-resistant standard.</p> <p>Exceptions: Wood structural panels with a minimum thickness of 7/16 of an inch and a maximum panel span of 8 feet shall be permitted for opening protection in buildings with a mean roof height of 33 feet or less that are classified as a Group R-3 or R-4 occupancy.</p> <p>1609.1.2 Protection of Openings in the 2006 NJ IBC. In wind-borne debris regions, glazing in buildings shall be impact resistant or protected with an impact-resistant covering meeting the requirements of an approved impact-resistant covering meeting the requirements of an approved impact-resistant standard.</p> <p>Exceptions: Wood structural panels with a minimum thickness of 7/16 of an inch and a maximum panel span of 8 feet shall be permitted for opening protection in buildings with a mean roof height of 33 feet or less that are classified as a Group R-3 or R-4 occupancy.</p> <p>1609.1.4 Protection of Openings in the 2000 NJ IBC. In wind-borne debris regions, glazing in the lower 60 feet in buildings is required to be impact-resistant or meet standards of the Large and Small Missile Test.</p> <p>Exceptions: Wood structural panels with a minimum thickness of 7/16 of an inch and a maximum panel span of 8 feet shall be permitted for opening protection in one or two story buildings.</p>	

YearBuiltNJDEP ≤ 2000	IF WBD = yes, Assign as Random Variable (RV): shutters = yes (RV = 46%) shutters = no (RV = 54%)	Shutters were not required by code until the 2000 IBC. Before 2000, the percentage of commercial buildings that have shutters is assumed to be 46%. This value is based on a study on preparedness of small businesses for hurricane disasters, which says that in Sarasota County, 46% of business owners had taken action to wind-proof or flood-proof their facilities. In addition to that, 46% of business owners reported boarding up their businesses before Hurricane Katrina. In addition, compliance rates based on the Homeowners Survey data hover between 43 and 50 percent. Source: https://www.sciencedirect.com/science/article/pii/S2212420916303855	Further refine if more specific data is available
Mreinf			<i>Masonry Reinforcing</i>
Valid Entries	yes, no	Input Variable	YearBuiltNJDEP
Default	yes	Input Variable Source	Custom Inventory
Years Ruleset Applies	Ruleset	Notes	Possible Extensions
YearBuiltNJDEP ≤ Current Year	Mreinf = yes	Based on the NJ 2015 IBC and information found at https://www.fema.gov/media-library-data/20130726-1728-25045-2959/femap774.pdf , current construction of unreinforced masonry buildings are allowed in very rare circumstances. Therefore, we assume it is reinforced. Reinforced concrete started being widely used in the 1950s, and has become a requirement in building codes. Thus, this ruleset should be assumed for all years following 1960. https://www.fireengineering.com/2011/09/12/249232/havel-reinforced-masonry/#gref	
WindDebris			<i>wind Debris sources</i>
Valid Entries	Res/Comm, Varies by Direction, Residential, None	Input Variable	YearBuiltNJDEP, OccupancyClass
Default	Res/Comm	Input Variable Source	
Years Ruleset Applies	Ruleset	Notes	Possible Extensions
YearBuiltNJDEP ≤ Current Year	If OccupancyClass = RES1, RES2, RES3A, RES3B, RES3C, RES3D, WindDebris=Residential If OccupancyClass = RES3E, RES3F, RES4, RES5, RES6, COM1, COM2, COM3, COM4, COM5, COM6, COM7, COM8, COM9, COM10, IND1, IND2, IND3, IND4, IND5, IND6, REL1, GOV1, GOV2, EDU1, EDU2, WindDebris=Res/Comm If OccupancyClass = AGR1, WindDebris=None	If a building is a given class, according to zoning, neighboring buildings are likely of this class. Thus this assignment is made based on OccupancyClass. We cannot assign "varies by direction" because we don't have specific information.	More accurate assignments can be achieved by parsing zoning for each municipality.
Option 1: Wooden Truss Roof: Apply the following rules in blue if RoofSystem = Wood			
RDA-Wood			<i>Roof Deck Attachment</i>
Valid Entries	A, B, C, D	Input Variable	YearBuiltNJDEP, DSWII, Terrain
Default	B	Input Variable Source	Custom Inventory
Years Ruleset Applies	Ruleset	Notes	Possible Extensions
YearBuiltNJDEP > 2000	ELSEIF Terrain=(35 or 70) & IF TerrainDSWII > 168, RDA-wood = D ELSEIF Terrain=(35 or 70) & IF DSWII <= 168: RDA-wood = B ELSEIF Terrain=(3 or 15) & DSWII > 142, RDA-wood = D ELSEIF Terrain=(3 or 15) & DSWII <= 142: RDA-wood = B	Requires 8d nails (with spacing 6"/12") for sheathing thicknesses between ¾"-1", see Table 2304.10, Line 31. Fastener selection is contingent on thickness of sheathing in building codes. Wind Speed Considerations taken from Table 2304.6.1, Maximum Nominal Design Wind Speed, Vasd. Permitted For Wood Structural Panel Wall Sheathing Used to Resist Wind Pressures. Typical wall stud spacing is 16 inches, according to table 2304.6.3(4). NJ code defines this with respect to exposures B and C only. These are mapped to HAZUS categories based on roughness length in the ruleset herein. [THE BASE RULE WAS THEN EXTENDED TO THE EXPOSURES CLOSEST SUBURBAN (LT. TREES) AND LIGHT SUBURBAN (OPEN) EVEN THOUGH THESE ARE NOT CONSIDERED BY THE CODE.] Requires 8d nails (with spacing 6"/12") for sheathing thicknesses of ¾"-1", see Table 2304.9.1, Line 31. Fastener selection is contingent on thickness of sheathing in building codes. Basic wind speed is the former term for nominal design wind speed, so ruleset can remain the same regardless of changed terminology. For Typical wall stud spacing is 16 inches, according to table 2304.6.1. NJ code defines this with respect to exposures B and C only. These are mapped to HAZUS categories based on roughness length in the ruleset herein. [THE BASE RULE WAS THEN EXTENDED TO THE EXPOSURES CLOSEST SUBURBAN (LT. TREES) AND LIGHT SUBURBAN (OPEN) EVEN THOUGH THESE ARE NOT CONSIDERED BY THE CODE.] This is converted to Vult by Vasd=sqrt(0.6) Vult	

YearBuiltNJDEP ≤ 2000	Assign as Random Variable (RV): RDA-wood = A (RV=50%) RDA-wood = B (RV=50%)	<p>Table 2304.9.1, Line 31 of the 2006 NJ IBC requires 8d nails (with spacing 6"/12") for sheathing thicknesses of ¾"-1". Fastener selection is contingent on thickness of sheathing in building codes. Table 2308.10.1 outlines the required rating of approved uplift connectors, but does not specify requirements that require a change of connector at a certain wind speed. Thus, all RDAs are assumed to be 8d @ 6"/12".</p> <p>Table 2304.9.1, Line 31 of the 2000 NJ IBC requires 8d nails (with spacing 6"/12") for sheathing thicknesses of ¾"-1". Fastener selection is contingent on thickness of sheathing in building codes. Table 2308.10.1 outlines the required rating of approved uplift connectors, but does not specify requirements that require a change of connector at a certain wind speed. Thus, all RDAs are assumed to be 8d @ 6"/12".</p> <p>The BOCA 1996 Building Code Requires 8d nails (with spacing 6"/12") for roof sheathing thickness up to 1". See Table 2305.2, Section 4. Attachment requirements are given based on sheathing thickness, basic wind speed, and the mean roof height of the building. This is converted to Vult by $V_n = \sqrt{(0.6)V_{ult}}$</p> <p>The BOCA 1993 Building Code Requires 8d nails (with spacing 6"/12") for sheathing thicknesses of 19/32 inches or greater, and 6d nails (with spacing 6"/12") for sheathing thicknesses of ½ inches or less. See Table 2305.2, Section 4. Typical rafter spacings would require 0.625" thickness sheathing; thinner sheathing would be possible, though recommended at 7/16 in hurricane zones based on FORTIFIED standards. With no way to determine actual sheathing thickness, assign as a random variable.</p> <p>This is defined for buildings later than 1975; for 1975 or earlier, there is no guidance so this rule is extended back for all time</p> <p>The BOCA 1987 Building Codes require these nail spacings based on sheathing thickness. This information was taken from Appendix C of the 1987 BOCA Building Code.</p> <p>The BOCA 1984 Building Codes require these nail spacings based on sheathing thickness. This information was taken from Appendix C of the 1984 BOCA Building Code.</p> <p>The BOCA 1981 Building Codes require these nail spacings based on sheathing thickness. This information was taken from Appendix E of the 1981 BOCA Building Code.</p> <p>The BOCA 1978 Building Codes require these nail spacings based on sheathing thickness. This information was taken from Appendix M of the 1978 BOCA Building Code.</p> <p>The BOCA 1975 Building Codes require these nail spacings based on sheathing thickness. This information was taken from Appendix M of the 1975 BOCA Building Code.</p> <p>Typical rafter spacings would require 0.625" thickness sheathing; thinner sheathing would be possible, though recommended at 7/16 in hurricane zones based on FORTIFIED standards. With no way to determine actual sheathing thickness, assign as a random variable.</p>	
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R2WC			Roof to Wall Connection
Valid Entries	strap, toe-nail	Input Variable	YearBuiltNJDEP, DSWII
Default	toe-nail	Input Variable Source	Custom Inventory
Years Ruleset Applies	Ruleset	Notes	Possible Extensions
YearBuiltNJDEP > 2000	IF DSWII ≤ 142, R2WC = toe nail IF DSWII > 142 mph, R2WC = strap	<p>Nominal is related to ultimate by $\sqrt{(0.6)}$</p> <p>Present to 2006:</p> <p>1507.2.8.1 High Wind Attachment. Underlayment applied in areas subject to high winds (Vasd greater than 110 mph as determined in accordance with Section 1609.3.1) shall be applied with corrosion-resistant fasteners in accordance with the manufacturer's instructions. Fasteners are to be applied along the overlap not more than 36 inches on center. Underlayment installed where Vasd, in accordance with section 1609.3.1 equals or exceeds 120 mph shall be attached in a grid pattern of 12 inches between side laps with a 6-inch spacing at the side laps.</p> <p>1507.2.8.1 High Wind Attachment. Underlayment applied in areas subject to high winds (Vasd greater than 110 mph as determined in accordance with Section 1609.3.1) shall be applied with corrosion-resistant fasteners in accordance with the manufacturer's instructions. Fasteners are to be applied along the overlap not more than 36 inches on center. Underlayment installed where Vasd, in accordance with section 1609.3.1 equals or exceeds 120 mph shall be attached in a grid pattern of 12 inches between side laps with a 6-inch spacing at the side laps.</p> <p>1507.2.8.1 High Wind Attachment. Underlayment applied in areas subject to high winds (Vasd greater than 110 mph as determined in accordance with Section 1609.3.1) shall be applied with corrosion-resistant fasteners in accordance with the manufacturer's instructions. Fasteners are to be applied along the overlap not more than 36 inches on center. Underlayment installed where Vasd, in accordance with section 1609.3.1 equals or exceeds 120 mph shall be attached in a grid pattern of 12 inches between side laps with a 6-inch spacing at the side laps.</p> <p>2000-2006:</p> <p>1507.2.8.1 High Wind Attachment. Underlayment applied in areas subject to high winds (greater than 110 mph) shall be applied with corrosion-resistant fasteners in accordance with the manufacturer's instructions. Fasteners are to be applied along the overlap not more than 36 inches on center. According to Figure 1609, this is basic wind speed.</p>	

YearBuiltNJDEP ≤ 2000	R2WC = toe nail	<p>There is no mention of straps or enhanced tie-downs of any kind in the BOCA codes, and there is no description of these adoptions in IBHS reports or the New Jersey Construction Code Communicator .</p> <p>Although there is no explicit information, it seems that hurricane straps really only came into effect in Florida after Hurricane Andrew (1992), and likely it took several years for these changes to happen. Because Florida is the leader in adopting hurricane protection measures into codes and because there is no mention of shutters or straps in the BOCA codes, it is assumed that New Jersey did not adopt these standards until the 2000 IBC. https://www.insurancejournal.com/news/southeast/2007/05/18/79827.htm https://forum.nachi.org/t/hurricane-straps/4617 http://www.floridaretrofits.com/service/hurricaneStrapsClips</p>	
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Option 2: Steel Joist: Apply the following rules in green if RoofSystem = OWSJ

RDage			Roof Deck Age
Valid Entries	new/avg, old	Input Variable	YearBuiltNJDEP
Default	new/avg	Input Variable Source	
Years Ruleset Applies	Ruleset	Notes	Possible Extensions
YearBuiltNJDEP >= (Current Year - 50)	RDage = new/avg	Average lifespan of a steel joist roof is roughly 50 years according to the source below. Therefore, if constructed 50 years before the current year, the roof deck should be considered old. https://www.metalroofing.systems/metal-roofing-pros-cons/	
YearBuiltNJDEP < (Current Year - 50)	RDage = old	Average lifespan of a steel joist roof is roughly 50 years according to the source below. Therefore, if constructed 50 years before the current year, the roof deck should be considered old. https://www.metalroofing.systems/metal-roofing-pros-cons/	Any information on roof replacements on individual homes should be used to specify further

Metal-RDA			Metal Roof Deck Attachment
Valid Entries	standard, superior	Input Variable	YearBuiltNJDEP, DSWII
Default	standard	Input Variable Source	Custom Inventory
Years Ruleset Applies	Ruleset	Notes	Possible Extensions
YearBuiltNJDEP > 2000	IF DSWII ≤ 142 mph, Metal-RDA = standard IF DSWII > 142 mph, Metal-RDA = superior	<p>Present to 2006: 1507.2.8.1 High Wind Attachment. Underlayment applied in areas subject to high winds (Vasd greater than 110 mph as determined in accordance with Section 1609.3.1) shall be applied with corrosion-resistant fasteners in accordance with the manufacturer's instructions. Fasteners are to be applied along the overlap not more than 36 inches on center. Underlayment installed where Vasd, in accordance with section 1609.3.1 equals or exceeds 120 mph shall be attached in a grid pattern of 12 inches between side laps with a 6-inch spacing at the side laps.</p> <p>1507.2.8.1 High Wind Attachment. Underlayment applied in areas subject to high winds (Vasd greater than 110 mph as determined in accordance with Section 1609.3.1) shall be applied with corrosion-resistant fasteners in accordance with the manufacturer's instructions. Fasteners are to be applied along the overlap not more than 36 inches on center. Underlayment installed where Vasd, in accordance with section 1609.3.1 equals or exceeds 120 mph shall be attached in a grid pattern of 12 inches between side laps with a 6-inch spacing at the side laps.</p> <p>1507.2.8.1 High Wind Attachment. Underlayment applied in areas subject to high winds (Vasd greater than 110 mph as determined in accordance with Section 1609.3.1) shall be applied with corrosion-resistant fasteners in accordance with the manufacturer's instructions. Fasteners are to be applied along the overlap not more than 36 inches on center. Underlayment installed where Vasd, in accordance with section 1609.3.1 equals or exceeds 120 mph shall be attached in a grid pattern of 12 inches between side laps with a 6-inch spacing at the side laps.</p> <p>2000-2006: 1507.2.8.1 High Wind Attachment. Underlayment applied in areas subject to high winds (greater than 110 mph) shall be applied with corrosion-resistant fasteners in accordance with the manufacturer's instructions. Fasteners are to be applied along the overlap not more than 36 inches on center. According to Figure 1609, this is basic wind speed.</p> <p>convert Vasd to Vult using Vasd=sqrt(0.6)Vult --- 110 -> 142</p>	
YearBuiltNJDEP ≤ 2000	Metal-RDA = standard	<p>There is no mention of straps or enhanced tie-downs of any kind in the BOCA codes, and there is no description of these adoptions in IBHS reports or the New Jersey Construction Code Communicator.</p> <p>Although there is no explicit information, it seems that hurricane straps really only came into effect in Florida after Hurricane Andrew (1992), and likely it took several years for these changes to happen. Because Florida is the leader in adopting hurricane protection measures into codes and because there is no mention of shutters or straps in the BOCA codes, it is assumed that New Jersey did not adopt these standards until the 2000 IBC. https://www.insurancejournal.com/news/southeast/2007/05/18/79827.htm https://forum.nachi.org/t/hurricane-straps/4617 http://www.floridaretrofits.com/service/hurricaneStrapsClips</p> <p>Thus, all connections before 2000 are assumed to be standard.</p>	

UnitClass			
Valid Entries	single, multi	Input Variable	YearBuiltNJDEP, NoUnits
Default	multi	Input Variable Source	Custom Inventory
Years Ruleset Applies	Ruleset	Notes	Possible Extensions
YearBuiltNJDEP ≤ Current Year	IF NoUnits = 1, UnitClass = Single IF NoUnits = 1, UnitClass = Multi	Field (24) of the MOD IV data specifies the number of commercial units on a property. This ruleset assumes that the MOD IV data designates a multi-unit low-rise strip mall as having multiple commercial units.	
JoistSpace			
Valid Entries	N/A, 4, 6	Input Variable	YearBuiltNJDEP, UnitClass
Default	4	Input Variable Source	Custom Inventory
Years Ruleset Applies	Ruleset	Notes	Possible Extensions
YearBuiltNJDEP ≤ Current Year	IF UnitClass = single, Joist Spacing = N/A IF UnitClass = multi, Joist Spacing = 4	<p>The Steel Joist Institute guidance on Open Web Steel Joists indicates that joist spacing is a function of load: 5.7 Joist Spacing: Joints shall be spaced so that the loading on each joist does not exceed the design load for the particular joist designation as shown in the applicable load tables. Load is assumed to be dependent on snow loads, with a high load considered to be 20 psf. Most of New Jersey falls in this category, so for multi-unit buildings, the joist spacing is assumed to be 4 feet.</p> <p>Sources: https://www.newmill.com/pdfs/SJISpecifications.pdf http://design.medeek.com/resources/snow/groundsnowloads.html</p> <p>Options are N/A for single units and 4 or 6 for multi units</p>	