HAZUS Building Attribute Rulesets - Wind - WMUH1-3

Note: Defaults should be assigned to all WMUH1-3 Buildings as defined below; then rulesets should be applied to override those defaults as informed by available data.

SWR			*Secondary Water Resistance*
Valid Entries	yes, no	**Input Variable**	RoofShape, YearBuiltNJDEP, RoofSlope, AvgJanTemp
Default	no	**Input Variable Source**	Custom Inventory
Years Ruleset Applies	**Ruleset**	**Notes**	**Possible Extensions**
YearBuiltNJDEP > 2000	IF RoofShape = flat, SWR = yes ELSEIF RoofShape = gable or hip, assign as RV: SWR = yes (RV = 60%), SWR = no (RV = 40%)	Beyond the drainage requirements that follow, sealing to achieve SWR is voluntary action: Will require assigning a human decision on code-plus SWR. Use NC Coastal Homeowner Survey (2017) data as placeholder. Code provisions for drainage are as follows: 1503.4.1 Secondary (emergency overflow) drains or scuppers. Where roof drains are required, secondary (emergency overflow) roof drains or scuppers shall be provided where the roof perimeter construction extends above the roof in such a manner that water will be entrapped if the primary drains allow buildup for any reason. The installation and sizing of secondary emergency overflow drains, leaders and conductors shall comply with plumbing subcode, N.J.A.C. 5:23-3:15 Assumptions: All buildings of this size will likely have required roof drains Buildings with flat roofs fit under the condition that water will be entrapped if primary drains allow buildup	Assuming at present homeowner survey data can be used from NC; reach out to IBHS to determine of commercial compliance data exists. Then could refine by age, use class, etc.
1987 < YearBuiltNJDEP ≤ 2000	IF RoofShape=Flat, SWR=yes ELSEIF RoofShape=(Gable or Hip) & RoofSlope < 0.33, SWR=yes ELSEIF RoofShape=(Gable or Hip) & RoofSlope >= 0.33 & AvgJanTemp=Below, SWR=yes ELSEIF RoofShape=(Gable or Hip) & RoofSlope >= 0.33 & AvgJanTemp=Above, SWR=no ELSEIF RoofShape=(Gable or Hip) & RoofSlope >= 0.33, SWR=no	The 1996 BOCA code requires SWR for steep-slope roofs with winters at or below 25℉, according to Section 1507.4. Asphalt shingles can be installed on roof slopes 2:12 and greater. BUR is considered low-slope roofing. The 1993 BOCA code requires SWR for steep-slope roofs with winters at or below 25℉, according to Section 1507.2. Asphalt shingles can be installed on roof slopes 2:12 and greater. BUR is considered low-slope roofing. The BOCA 1987 Code specifies these requirements in 2303.1. These requirements are specifically for asphalt shingle roofs. This ruleset assumes that two layers of Type 15 felt, a strip of mineral surfaced roll roofing, and double coverage shingles all count as secondary water resistance.	
YearBuiltNJDEP ≤ 1987	Assign as RV: SWR = yes (RV = 30%) SWR = no (RV = 70%)	**This rule applied to buildings built after 1975, but was extended to those built in and before 1975 due to a lack of data** There are no specifications or requirements outlining use of SWR in the BOCA code. Thus, this ruleset refers to the homeowner data. Based on Human Subjects Data ranging from 1975 to 1987, 30% had entries that implied they had SWR, either that they bought, retrofitted, or remodeled. Therefore, 30% of houses in this time should be randomly assigned to have secondary water resistance. Data taken from Question 32 of Human Subjects Data. Responses indicating SWR: 2) Yes, bought this way 3) Yes, retrofitted/remodeled after purchase	Assuming at present homeowner survey data can be used from NC; reach out to IBHS to determine of commercial compliance data exists. Then could refine by age, use class, etc.

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	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. 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. Sources: https://www.spri.org/2019/01/singe-ply-roofing-101/, https://continuingeducation.bnpmedia.com/courses/johns-manville/understanding-single-ply-roofing-systems/ 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.	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	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. 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. Sources: https://www.spri.org/2019/01/singe-ply-roofing-101/, https://continuingeducation.bnpmedia.com/courses/johns-manville/understanding-single-ply-roofing-systems/ 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.	Any data from NJ on practices around BUR, SPM should be incorporated; trends presently inferred from when a technology entered the market

RoofQual			*Roof Quality*
Valid Entries	N/A, poor, good	**Input Variable**	YearBuiltNJDEP, RoofShape, RoofCvr
Default	good	**Input Variable Source**	Custom Inventory
Years Ruleset Applies	**Ruleset**	**Notes**	**Possible Extensions**
All Years	IF RoofShape = gable OR hip, RoofQual = N/A IF RoofShape = flat & RoofCvr = BUR & YearBuiltNJDEP < (Current Year - 30), RoofQual = poor IF RoofShape = flat & RoofCvr = BUR & YearBuiltNJDEP ≥ (Current Year - 30), RoofQual = good IF RoofShape = flat & RoofCvr = SPM & YearBuiltNJDEP < (Current Year - 35), RoofQual = poor IF RoofShape = flat & RoofCvr = SPM & Yea BuiltNJDEP ≥ (Current Year - 35), RoofQual = good	Nothing in NJ Building Code or in the Hazus manual specifies what constitutes “good” and “poor” roof conditions, so ruleset is dependant on the age of the roof and average lifespan of BUR and SPM roofs. Information taken from websites below. The average lifespan of a BUR roof is 30 years and the average lifespan of a SPM is 35 years. Therefore, BURs installed before 1989 (2019-30) are in poor condition, and SPMs installed before 1984 (2019-35) are in poor condition. Sources: https://www.thebalancesmb.com/built-up-roof-types-advantages-repairs-844654 https://www.roofedright.com/FlatRoof-SinglePly	Further information about roof cover, as well as roof replacements or renovations should be included at the building level if available

RDA-wood			*Roof Deck Attachment*
Valid Entries	A, B, C, D	**Input Variable**	YearBuiltNJDEP, DSWII, MeanRoofHt, Terrain
Default	A	**Input Variable Source**	Custom Inventory
Years Ruleset Applies	**Ruleset**	**Notes**	**Possible Extensions**
YearBuiltNJDEP > 2009	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 ⅜”-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 ⅞”-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	

2000 < YearBuiltNJDEP ≤ 2009	Assign as Random Variable (RV): RDA-wood = A (RV=50%) RDA-wood = B (RV=50%)	Table 2304.9.1, Line 31 of the 2006 NJ IBC requires 8d nails (with spacing 6”/12”) for sheathing thicknesses of ⅞”-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”. Table 2304.9.1, Line 31 of the 2000 NJ IBC requires 8d nails (with spacing 6”/12”) for sheathing thicknesses of ⅞”-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”. 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 Vn=sqrt(0.6)Vult 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. 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 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. 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. 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. 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. 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. 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.	

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	Nominal is related to ultimate by sqrt(0.6) 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. 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. 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. 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.	

YearBuiltNJDEP < 2000	R2WC = toe nail	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 . 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	

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	ELSEIF Terrain=(35 or 70) & IF DSWII > 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	
YearBuiltNJDEP ≤ 2000	IF WBD = yes, assign as Random Variable (RV): shutters = yes (RV = 46%) shutters = no (RV = 54%)	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 Note that these RV rates are comparable to those for single family residential, so extending this for all classes is acceptable	Further refine if more specific data is available