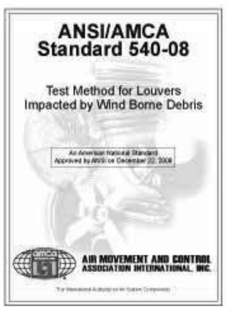
ENGINEERING REPORT

TOPIC: AMCA 540 AND AMCA 550 LOUVER RATINGS

Report No. 0413:1 **By Jim Smardo**

2012 was a year of change for codes in regards to louver testing and new ratings. The Florida Building Code FBC2010, the International Building Code IBC2012 and the International Mechanical Code IMC2012 all introduced language pertaining to two (2) new test standards AMCA 540 for Large Missile Impact and AMCA 550 for High Velocity Wind Driven Rain (WDR) performance.

AMCA 540 – IMPACT REQUIREMENTS



Impact performance of louvers is related to exposure to high wind events, like hurricanes and tornados, which damage the exterior shells of buildings. Buildings in areas prone to high wind events with flying debris are required to be impact resistant. The Air Movement and Control Association (AMCA), the trade association that governs the louver industry, introduced *AMCA Test Standard 540 – Test Method for Louvers Impacted by Windborne Debris* which uses procedures that more stringently test the unique construction of louver and louvered products and should be the basis of specification for all louvers requiring impact.

FLORIDA BUILDING CODE – TESTING REQUIREMENTS

The 540 impact standard was introduced to the Florida Building Code 2010. Section 1609.1.2 of the Florida Building Code covers the protection of openings in windborne debris regions. The subsection 1609.1.2.1 covers the impact requirements for louvers protecting intake and exhaust ventilation ducts.

FBC2010 Section 1609.1.2.1

"Louvers protecting intake and exhaust ventilation ducts not assumed to be open that are located within 30 feet (9144 mm) of grade shall meet requirements of AMCA 540 or shall be protected by an impact resistant cover complying with an approved impact-resistant standard or the large missile test of ASTM E 1996."

Prior to the introduction of AMCA 540, louver manufacturers selling in the Florida market impact tested their products to standard TAS 201 to achieve Miami-Dade product approval for the High-Velocity Hurricane Zones based in Miami-Dade and Broward counties in Florida. The TAS 201 and AMCA 540 test standards are similar. Both standards involve launching a 2x4 timber projectile into the test sample at specific locations and at specific velocities. Despite the similarities, the TAS 201 standard and the AMCA 540 standard have some key differences that make the AMCA 540 standard a better and more stringent standard for louver impact testing. Table 1 below compares the requirements of each test standard.

The first difference between the two standards is the distance of the cannon from the louver sample. In AMCA 540 the distance from the cannon to the sample is based the ASTM E1996 and ASTM E1886 testing standards. These testing standards cover impact testing of doors, windows and other impact resistant materials. It requires that the distance of travel must be one and a half times the length of the 2x4 projectile. The TAS 201 standard used for Miami-Dade County uses a greater distance. It requires the distance of travel be 9 feet plus the length of the 2x4 projectile. As can be seen in Table 1, the resulting distance for TAS 201 is larger than AMCA 540. While the initial velocity of the missile is the same in both tests, the further the missile travels the lower its velocity when it impacts the sample. As a result the AMCA 540 impact standard is more stringent than the TAS 201 standard.

Test Standard	AMCA 540	TAS 201
Missile Material	2 x 4 timber	2 x 4 timber
Missile Weight	9 lb (4.1 kg)	9 lb (4.1 kg)
Missile Velocity	50 fps (15.2 m/s)*	50 fps (15.2 m/s)
Distance from cannon to sample	1.5 x length of missile (ft) 10.5 feet in this example	9 feet + length of missile 16 feet in this example
Minimum Sample Size	Smallest section louver to be offered	N/A
Maximum Sample Size	Maximum unsupported blade span by maximum height	Maximum width offered x maximum height offered
Mullion Impact Required on Maximum Height Multi-section Assembly	Yes	Yes

* For Florida Essential Facilities, AMCA 540 includes a 80 fps test criteria referred to as Enhanced Protection.

Table 1 – AMCA 540 and TAS 201 Comparisons

The second difference between the two standards is the sample sizes to be tested. TAS 201 tests consisted of the maximum width and height at the discretion of the manufacturer. Once this sample passed the test, all widths and heights of louvers equal to or less than those tested were approved. While this logic works for items such as windows, where impact performance is likely to improve as size decreases, it does not work well for louvers. Louver construction varies greatly on small sizes versus larger sizes.

When louvers increase in size, the blade of the louver may require additional support to meet wind load requirements. These additional supports are attached to the rear of the blades and anchored into the building structure at the ends of the support. These supports generally improve the impact performance of the louver as they absorb the impact energy. Over the years, louver manufacturers have realized that the worst case test samples are those without blade supports. On these tests, the connection between the louver blade and the perimeter framing is the only connection to resist the impact energy. This is a key area for the smaller louvers to fail the impact test as the blade often disconnects from frame in this scenario. The additional blade supports that appear on the larger “maximum” TAS 201 samples provide additional attachment points. A jamb attachment failure does not create a situation where a blade could become loose.

A significant portion of the louvers sold are smaller sizes where blade spans do not require additional support. The developers of the AMCA 540 standard have selected section sizes that produce the most difficult scenario for manufacturers to pass. In addition to the test sample in Figure 1, AMCA 540 requires 3 other sample sizes covering maximum height, minimum width and multi-section construction with each section being tested to the maximum width without supports. These 4 test samples required for AMCA 540 certified louvers ensure that your building is more protected from flying debris versus previous test methods

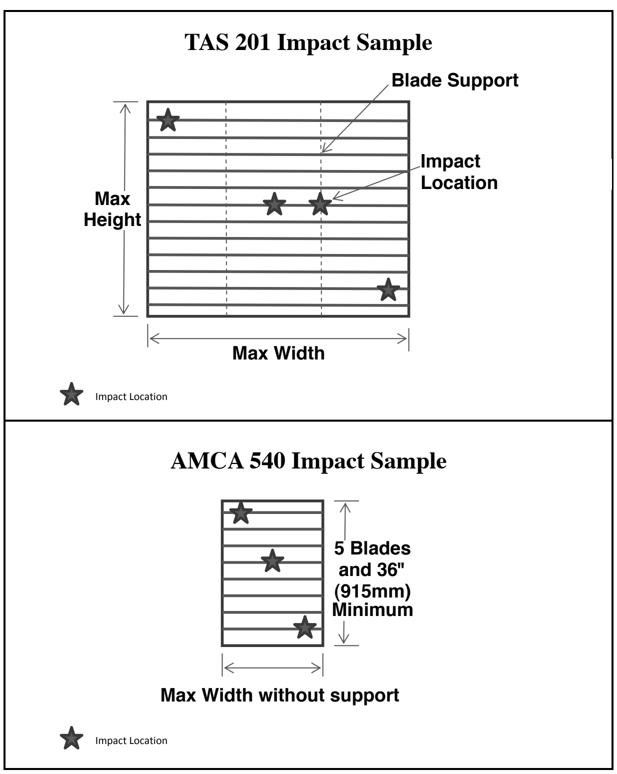


Figure 1
Impact Samples for TAS 201 and AMCA 540

FLORIDA BUILDING CODE - WIND-BORNE DEBRIS REGION

The introduction of AMCA 540 is not the only change between the 2007 and 2010 Florida Building Codes that affect louver specifications. The areas of Florida requiring impact resistance have changed. FBC2010 has new wind speed maps (see figures 2, 3 & 4) where wind velocities are higher versus 2007. This change is the result of a modification to the method used to determine wind loads in the 2010 code and therefore the areas designated as “Wind-Borne Debris Regions” have changed.

In 2007, wind-borne debris regions were areas with wind velocities greater than 120 mph and areas with wind velocities greater than 110 mph within 1 mile of the coast. In the 2010 FBC areas with wind velocities greater than 140 mph and areas with wind velocities greater than 130 mph within 1 mile of the coast are considered wind-borne debris regions. As mentioned earlier, louvers supplied in the wind-borne debris regions located lower than 30 feet from grade must be impact resistant.

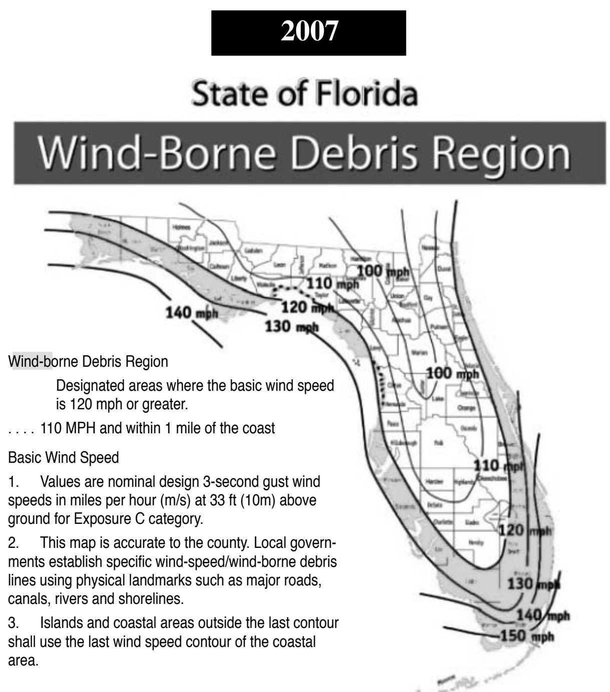


Figure 2
2007 Florida Building Code Wind-Borne Debris Regions All Structures

Additionally, FBC2010 introduces new maps for essential facilities designated in the code as Category III Health Care Facilities and Category IV structures. Category IV structures include those needed for emergency response, such as fire stations, or those that house hazardous materials that could threaten the public.

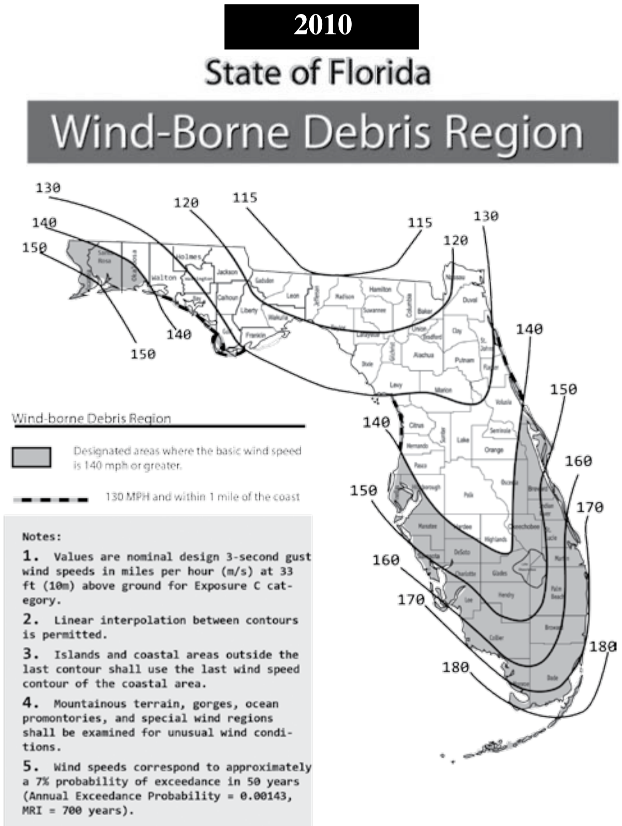


Figure 3
2010 Florida Building Code (Figure 1609A)
Wind-Borne Debris Regions
Category II and Category III – Non-Health Care

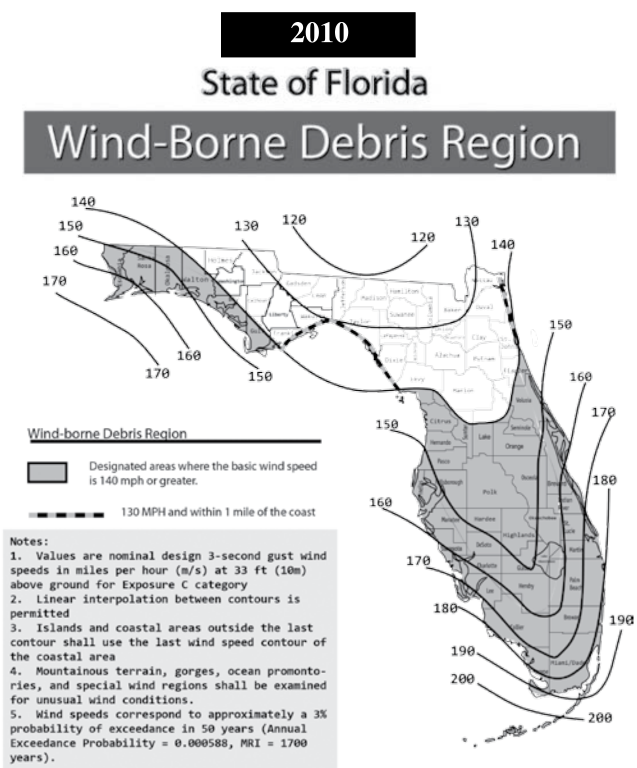


Figure 4
2010 Florida Building Code (Figure 1609B)
Wind-Borne Debris Regions, Category III Health Care Facilities and Category IV Emergency Response

FLORIDA BUILDING CODE – PRODUCT APPROVAL

Once a product has been tested, the manufacturer applies for product approval through the Florida Department of Business and Professional Regulation. The product approval requirements are outlined in the Florida Administrative Code under chapter 61G20-3. To obtain a product approval, the applicant must provide test reports from an approved testing laboratory and must have proof that the products are manufactured under a quality assurance program audited by an approved quality assurance agency. Approved quality assurance agencies are third-party and are certified as ISO 17020 compliant. Examples of such agencies are Underwriters Laboratories (UL), Intertek (ETL), the Miami Dade Building Code Compliance Office or the International Code Council International Evaluation Service (IES). Once approved the manufacturer is provided a Florida Approval number. A record of Florida approved products can be located at www.floridabuilding.org.

Florida Department of Business & Professional Regulation

MIAMI-DADE COUNTY APPROVED

FLORIDA BUILDING CODE - HIGH VELOCITY HURRICANE ZONES

The Florida Building Code contains special testing provisions for the High Velocity Hurricane Zones (HVHZ). The HVHZ consists of Miami-Dade and Broward counties in the state of Florida (see Figure 5 below). The HVHZ has additional testing requirements for components and cladding consisting of impact testing, pressure testing and cycle testing per test standards TAS 201, TAS 202 and TAS 203. To provide products in the HVHZ manufacturers are required to obtain product approval through the Miami-Dade County Building Code Compliance Office. This approval is commonly referred to as a Notice of Acceptance (NOA) and approved products are issued a Notice of Acceptance number. A record of Miami-Dade approved products can be located at http://www.miamidade.gov/building/pc-search_app.asp.

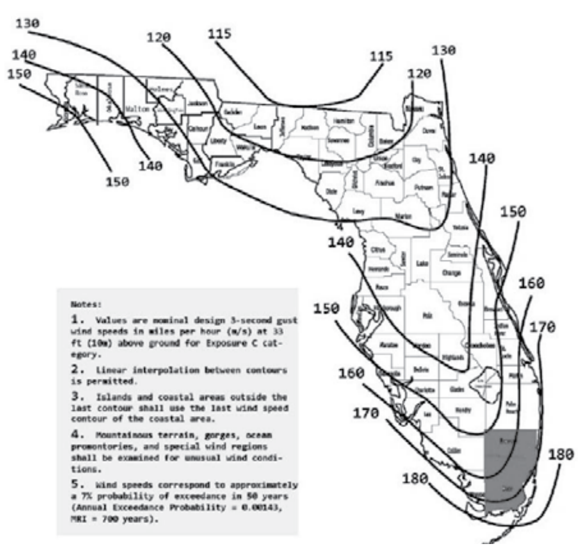


Figure 5
2010 Florida Building Code
High Velocity Hurricane Zone

INTERNATIONAL BUILDING CODE 2012 – TESTING REQUIREMENTS

Outside of the State of Florida, the International Building Code (IBC) is used in a majority of other USA regions to design buildings. IBC 2012 requires that louvers in wind-borne debris regions meet the impact requirements of AMCA 540.

IBC2012 Section 1609.1.2.1

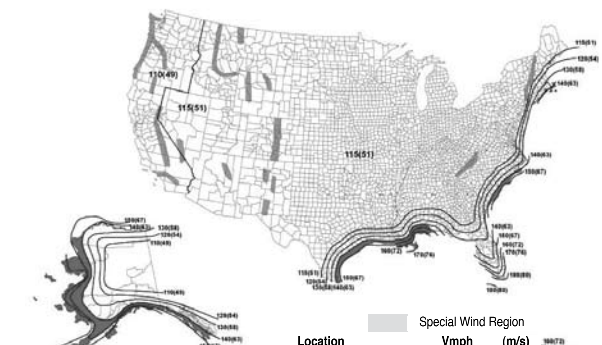
"Louvers protecting intake and exhaust ventilation ducts not assumed to be open that are located within 30 feet (9144 mm) of grade shall meet the requirements of AMCA 540."

Previous versions the IBC (2006 and 2009) required impact resistant louvers, but the standard specified was ASTM E1996.

While all states have building codes based on the International Building Code, they may not have adopted the 2012 IBC. Adoption rates of new IBC codes vary from state to state. A chart showing the state by state adoption of the IBC is available at www.iccsafe.org/gr/documents/stateadoptions.pdf. This chart indicates which version of the code these states are currently using. As the various states and jurisdictions begin to adopt IBC2012, the A/E community should ensure that louvers supplied into the wind-borne debris region have been tested to AMCA 540.

INTERNATIONAL BUILDING CODE 2012 – WIND-BORNE DEBRIS REGION

Like FBC2010, IBC2012 uses the new, higher wind velocity maps. The wind-borne debris criteria encompasses areas with wind velocities greater than 140 mph and areas with wind velocity greater than 130 mph within 1 mile of the coast. Louvers supplied in the wind-borne debris regions located lower than 30 feet from grade must be impact resistant. Figure 6 shows the wind-borne debris region for category II and category III, non-healthcare buildings. Figure 7 shows the wind-borne debris region for category III healthcare facilities and category IV buildings.



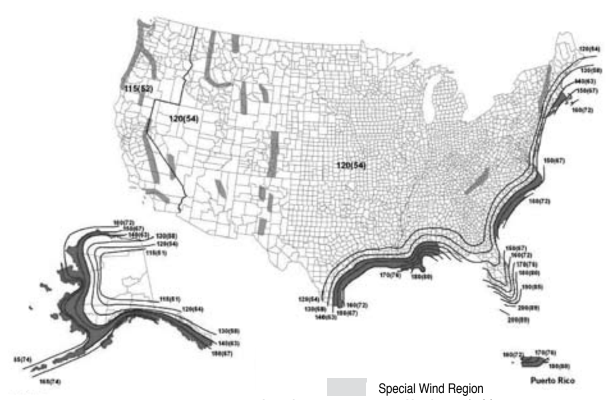
Special Wind Region

Location	Vmph	(m/s)
Guam	195	(87)
Virgin Islands	165	(74)
American Samoa	160	(72)
Hawaii - Special Wind Region Statewide	130	(58)

Notes:

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 years).

Figure 6
2012 IBC Wind-borne Debris Regions for Category II and Category III Non-Healthcare



Special Wind Region

Location	Vmph	(m/s)
Guam	210	(94)
Virgin Islands	175	(78)
American Samoa	170	(76)
Hawaii - Special Wind Region Statewide	145	(65)

Notes:

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 3% probability of exceedance in 50 years (Annual Exceedance Probability = 0.000588, MRI = 1700 years).

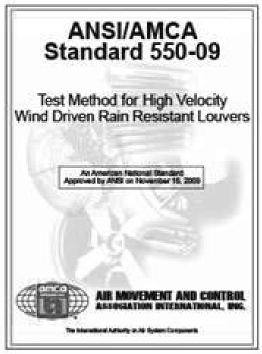
Figure 7
2012 IBC Wind-borne Debris Regions for Category III Healthcare and Category IV

INTERNATIONAL BUILDING CODE – PRODUCT APPROVAL

The International Building Code does not directly require impact resistant louvers to be approved by an independent agency. The requirements regarding approval are left to the local authority having jurisdiction (AHJ) and the design professionals responsible for a particular project. If the local AHJ and/or design professional require product approval by a third party, they typically will accept the Florida Approval, Miami-Dade Notice of Acceptance or approval by a listing agency such as Underwriters Laboratory (UL) or Intertek (ETL). In addition to these agencies, the Air Movement and Control Association (AMCA) lists approved louvers per the AMCA 540 standard. An A/E specifying louvers should consult with the local AHJ to determine what is required.

Louvers supplied in wind-borne debris regions throughout the U.S. must be impact resistant. The areas requiring impact performance have changed in the 2010 FBC and 2012 IBC and code officials have been increasing their enforcement of these provisions. The 2010 FBC and the 2012 IBC have also introduced language that requires that these louvers be tested to the AMCA 540 impact test standard. The AMCA 540 test standard was developed by engineers in the louver industry as an improvement to the previously used test procedures outline in ASTM E1996 and TAS 201. The AMCA 540 test standard tests the worst case construction of louvers, previously neglected in other test standards. In addition to the typical performance criteria of free area, pressure drop, water performance and aesthetics, architects and engineers specifying louver should select louvers suitable for impact.

AMCA 550 – WEATHER RESISTANT – “EME” TYPE LOUVERS



Louvers protect air intake and exhaust openings in buildings and equipment from the infiltration of rain. Water that passes the outer shell of the building can damage interior building finishes and can result in mold growth (see Figure 8). Louvers come with seemingly infinite varieties of components to help collect rain water and funnel it to the outside of the building shell. The Air Movement and Control Association (AMCA) offers certified ratings programs that use various AMCA test standards to determine the ability of louvers to eliminate water from the incoming air stream. In 2009 a new AMCA test standard for water was introduced to established water performance in hurricane and other extreme weather events. This new standard is AMCA 550. AMCA 550 has been adopted by the International Mechanical Code and Florida Mechanical Code as the performance standard for louvers in hurricane prone areas. To ensure building protection and code compliance, architects and engineers need to be familiar with this new standard and when it is required.

MULTIPLE LOUVER WATER TESTS – OVERVIEW

Prior to Hurricane Andrew in the early 1990’s, manufacturers certified their louvers to ANSI/AMCA 500L for still-air water penetration. This test evaluates when water will be pulled into a louver by system intake velocities. It has some shortcomings, however. It does not evaluate the effects of wind on how much water will enter the building through the louver. After Hurricane Andrew, AMCA 500L revised this test standard to establish procedures for a **Wind Driven Rain (WDR)** tests modeled after the European HEVAC test standards. WDR louvers are subjected to system intake velocities in combination with wind velocities of 29 and 50 mph with rain fall rates of 3 in/hr and 8 in/hr respectively. Water is injected into the air stream and driven toward the louver. Simultaneously, the intake fan draws air through the louver. Readings are taken at several intake velocities and an elimination percentage is established based on how much of the applied water passes through the louver. While both of these tests have their place in certain locations and building types for specifying louvers, neither test is set up to determine how a louver will perform when faced by the wind and water produced by hurricanes and other extreme weather.

Figure 8
Interior Dry Wall Damage Due to Water Infiltration

To provide building protection during these events, louvers must be capable of removing enormous amounts of water from the system air stream. If a louver with high water performance is not used, a damper must be located behind the louver and it must be closed during the event. If a damper is not provided, large amounts of water will penetrate the building resulting in water damage to the interior contents as stated before. To provide engineers with information regarding the performance of louvers and louver/damper combinations during hurricane events, AMCA has developed and introduced AMCA 550.

AMCA 550 WATER PENETRATION

AMCA 550 evaluates louvers for water penetration at wind speeds of 35 mph, 70 mph, 90 mph and 110 mph. These wind speeds more accurately reflect those experienced in these hurricane and high wind/rain events. The rain fall rate used during the test is 8.8 in/hr.

The procedure for the test is based on *Testing Application Standard (TAS) No. 100(A) Test Procedure for Wind and Wind Driven Rain Resistance and/or Increase Windspeed Resistance of Soffit Ventilation Strip and Continuous or Intermittent Ventilation System Installed at the Ridge Area* TAS 100A original intent was for “establishing the resistance to wind driven rain of a continuous or intermittent ridge area ventilation system...”

The Miami-Dade Building Code Compliance Office (BCCO), which establishes building standards for Miami-Dade county in the state of Florida, states, “louvers installed in a location where the room behind the louver is not designed to drain water penetrating into the room, or the room will house non-water resistant equipment, components, or supplies, the following test (TAS100A) shall be performed.” To accommodate this requirement the BCCO issued a modified TAS100A procedure for louvers under checklist #0240.

The procedures for AMCA 550 and TAS100A are virtually identical. The main difference is in the pass/fail criteria. The TAS100A test requires no water infiltration at the 35 and 70 mph wind speeds while the AMCA 550 allows trace amounts that must be less than 1%. The BCCO has reviewed the new AMCA 550 standard and found it acceptable as an alternative test procedure to TAS100A.

During the AMCA 550 test, the louver sample to be tested is mounted in a block wall. A chamber is mounted behind the louver to collect water that passes through the louver. The collection chamber is open at the top to allow the passage of air. During the test, water is injected into the air stream at a rate of 8.8 in/hr at the specified wind speeds. Figures 9 and 10 provide a diagram and photo of the test. The total volume of water applied over the test interval is measured and recorded. Unlike 500L WDR test, intake air is drawn through the louver. The test duration is 15 minutes at each required velocity followed by a 5 minute period with no spray and no wind. At the conclusion of the 20 minute period the water passing through the louver is measured. If the amount of water collected behind the louver is in excess of 1% of the total volume of water applied to the louver for the test period, the louver fails the test. Table 2 summarizes the test intervals.

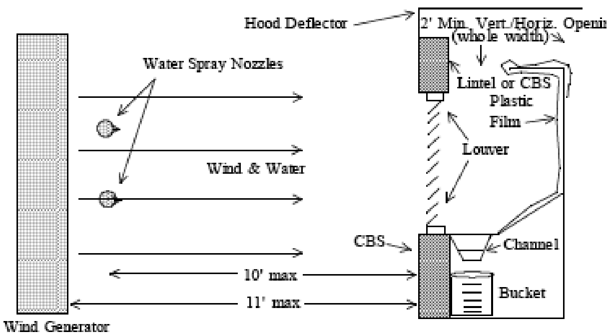


Figure 9
AMCA 550 Test Diagram

Figure 10
AMCA 550 Test Photograph

Interval #	Wind Speed mph (m/s)	Time (min)	Water Spray	Test result
1	35 (15.65)	15	ON	
2	0	5	OFF	<1% of the water applied in interval 1
3	70 (31.3)	15	ON	
4	0	5	OFF	<1% of the water applied in interval 3
5	90 (40.2)	15	ON	
6	0	5	OFF	<1% of the water applied in interval 5
7	110 (49.2)	5	ON	
8	0	5	OFF	<1% of the water applied in interval 6

Table 2 - AMCA 550 Test Intervals

CODE REQUIREMENTS FOR AMCA 550

Both the IMC2012 (International Mechanical Code) and FBC2010 codes now require that louvers must pass AMCA 550 for intake openings in hurricane prone regions.

IMC2012 Section 401.5 states:

"Louvers that protect air intake openings in structures located in hurricane prone regions, as defined in the International Building Code, shall comply with AMCA 550."

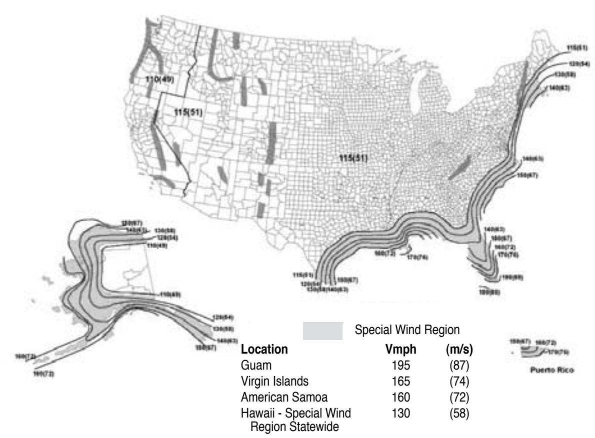
Similarly, **2010 Florida Mechanical Code section 401.5** states:

"Louvers that protect air intake openings in structures located in hurricane-prone regions, as defined in the Florida Building Code, Building, shall comply with AMCA 550."

In addition, the **2010 Florida Mechanical Code section 501.2.2** states:

"Louvers that protect exhaust openings in structures located in hurricane-prone regions, as defined in the Florida Building Code, Building, shall comply with AMCA 550."

Different than HVHZ, both IBC2012 and FBC2010 define the hurricane-prone regions as, "The U.S. Atlantic Ocean and Gulf of Mexico coasts where the basic wind speed for Risk Category II buildings is greater than 115 mph (40m/s) and Hawaii, Puerto Rico, Guam, Virgin Islands and American Samoa." The maps provided below in Figures 11 and 12 highlight the areas outlined above. Note that <u>all of the state of Florida</u> is considered hurricane-prone.



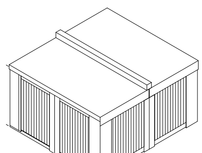
Notes:

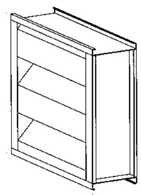
1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 years).

Figure 11
2012 International Building Code
Hurricane-Prone Region

CODE REQUIREMENTS FOR AMCA 550 (Cont.)

To provide the code required protection for intake openings, louvers located in the code defined hurricane-prone regions must now pass the AMCA 550 Test Method for High Velocity Wind Driven Rain Resistant Louvers. This test subjects louvers to simulated wind levels and rainfall amounts that reflect those that occur during hurricane events. Louvers tested to the AMCA 500L water penetration and wind driven rain tests are not subjected to these wind and rain levels and therefore do not provide adequate opening protection. Architects and engineers should review their project locations and code requirements to ensure that their project specifications required louvers that have been tested to AMCA Standard 550.





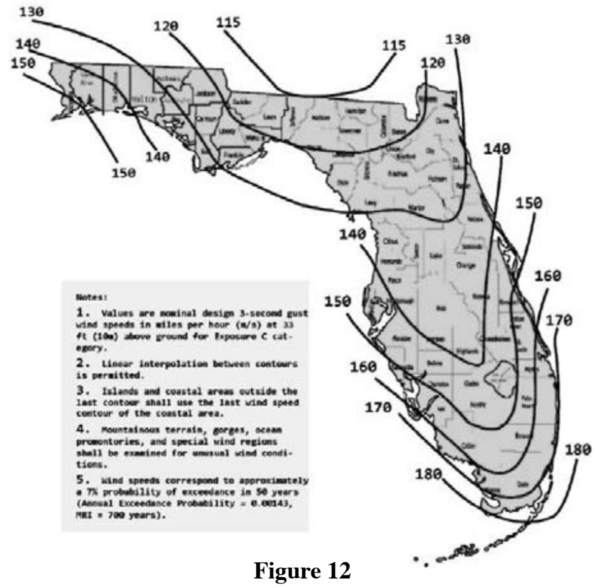


Figure 12
2010 Florida Building Code Hurricane-Prone Region

Ruskin Florida Approved Louvers

AMCA 540 and AMCA 550 Certified

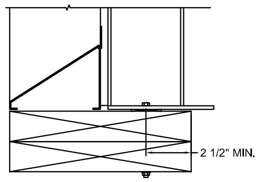
AMCA 540 - Large Missile Impact		
EME6325D*	Vertical WDR	FL 14156-R1
EME6625D*	Vertical WDR	FL 3286-R3
EME520MD*	Horizontal WDR	FL 9846-R2
ELF375DXD*	Horizontal Still-Air	FL 10234-R2
ELF6375DXD*	Horizontal Still-Air	FL 12226-R1
PHB637HDXD*	Horizontal Penthouse Still-Air	FL 10235-R3
PHB6625D*	Vertical Penthouse WDR	FL 11721-R1
PHB6375DXD*	Horizontal Penthouse Still-Air	FL 12736-R1
ELC6375DXD*	Horizontal Combination	FL 12232-R1
EME420MD*	Horizontal WDR	FL 16090.1
EME545D	Horizontal WDR	2010 FBC # Pending
EME1050 (HZ1050)	Horizontal WDR	2010 FBC # Pending
HZ950	Horizontal WDR	AMCA 540 Certification in Process
HZ850	Horizontal WDR	AMCA 540 Certification in Process
EME6625	Vertical WDR	2010 FBC # Pending
ELF6375DFL	Horizontal Still-Air	2010 FBC # Pending
ACL645D*	Horizontal Acoustical Still-Air	2010 FBC # Pending
ACL1245D*	Horizontal Acoustical Still-Air	2010 FBC # Pending
ACL1245AFD*	Horizontal Acoustical Still-Air	2010 FBC # Pending

AMCA 550 - High Velocity WDR - No Damper		
EME6325D*	Vertical WDR	FL 14156-R1
EME6625	Vertical WDR	2010 FBC # Pending
EME1050 (HZ1050)	Horizontal WDR	2010 FBC # Pending
HZ950	Horizontal WDR	2010 FBC # Pending
HZ850	Horizontal WDR	2010 FBC # Pending
ELC6375DXD*	Horizontal Combination	FL 12232-R1

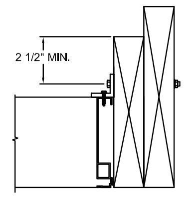
AMCA 550 - High Velocity WDR - Includes Ruskin CD550 Low-Leak Control Damper
All of Ruskin's AMCA 540 certified louvers are also AMCA 550 certified with Ruskin's CD550.

***These models have current Miami-Dade NOA # approved for use in HVHZ's described on page 3.**

STANDARD INSTALLATION FOR VARIOUS WALL TYPES

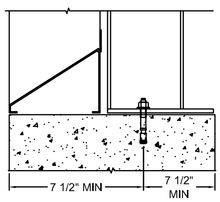


1 - SILL DETAIL- WOOD SUBSTRATE (HEAD SIM)
N.T.S.
NOTE EDGE DIST REQUIREMENTS

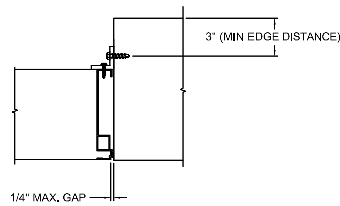


2 - JAMB DETAIL - WOOD SUBSTRATE
N.T.S.
NOTE EDGE DIST REQUIREMENTS

STANDARD WOOD INSTALLATION

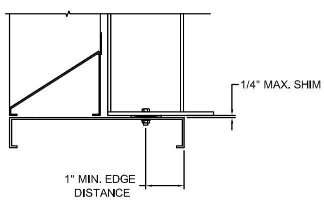


3 - SILL DETAIL - CONCRETE SLAB (HEAD SIM)
N.T.S.
3000 PSI MIN CONCRETE
NOTE EDGE DIST REQUIREMENTS

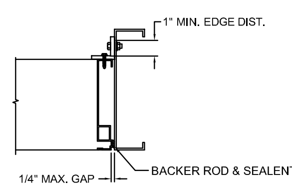


4 - JAMB DET - CONCRETE
N.T.S.
3000 MIN COMPRESSIVE STRENGTH
NOTE EDGE DISTANCE REQUIREMENTS

STANDARD CONCRETE INSTALLATION

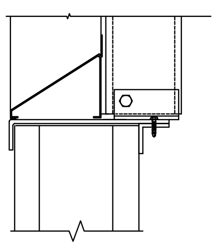


5 - SILL DETAIL - METAL SUBSTRATE (HEAD SIM)
N.T.S.
NOTE EDGE DIST REQUIREMENTS

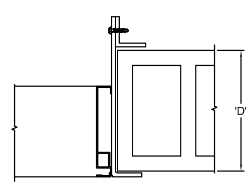


6 - JAMB DET - METAL SUBSTRATE
N.T.S.
NOTE EDGE DIST REQUIREMENTS

STANDARD STEEL INSTALLATION

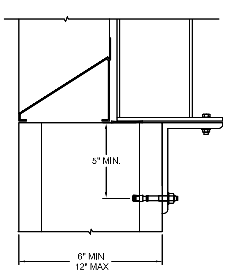


7 - SUPPORT ATTACHMENT - UNIVERSAL SLEEVE (HEAD SIM)
N.T.S.

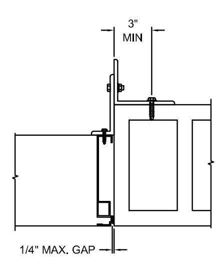


8 - JAMB DET - UNIVERSAL SLEEVE
N.T.S.

STANDARD UNIVERSAL SLEEVE INSTALLATION



9 - SILL DETAIL 6",8",10",12" - CMU BLOCK (HEAD SIM)
N.T.S.
MIN PRISM STR OF 1500 PSI AT INSTALLATION
TYPE I, N, LIGHT, MED, NORMAL WEIGHT ASTM C90
GROUT MUST COMPLY WITH FBC SECT 2103.12
TYPE N, S, OR M MORTAR PER FBC SECT 2103.8



10 - JAMB DET - CMU
N.T.S.
MIN PRISM STR OF 1500 PSI AT INSTALLATION
TYPE I, GRADE N, LIGHT, MED, NORMAL WEIGHT ASTM C90
GROUT MUST COMPLY WITH FBC SECT 2103.12
TYPE N, S, OR M MORTAR PER FBC SECT 2103.8

STANDARD CMU WALL INSTALLATION