Universal Physics Journal

Event 4: The Physics Of A Tornado

Author: Ethan Skyler
Publication Date: July 28, 2004
Revision Date: August 12, 2004

Purpose

Much mystery surrounds the operation of a tornado. Today's scientists focus on the collection and analysis of weather data with the hope that clues to the causes of tornado formation will be revealed. Their goal is to improve tornado prediction which will give those who have the misfortune of being in a tornado's path additional minutes to seek shelter from the most intense and concentrated winds of all natural storms.

Yet an early warning can only be so effective. Some residents ignore the early warning broadcasts choosing instead to ride the storm out inside the one place they feel most protected, their home. Monuments to their life's work and often filled with their most treasured possessions, for some, to hurry out of harm's way leaving everything behind at the mercy of the approaching tornado is an unthinkable act. Yet staying inside the home they think safe can suddenly expose them to the violence of unthinkable forces as their trusted home suddenly blows off its own roof, often complete with outside walls as the tornado's high-speed winds whirl around outside.

Analysis of tornado damage points to the best hiding places within the home which are in the basement under a heavy table or workbench on the side away from the approaching tornado, or second best, on the main floor inside the smallest interior room such as a bathroom or closet. Residents have survived incredible destruction in such places. But their presence has done nothing to save their homes. Once the roof has blown away, the valued contents underneath are consumed inside this natural home-grinder, powered entirely by the pressures and accelerations of air.

I have been unable to find any logical explanation from the experts for the forces behind these pressures and accelerations. I think an understanding of the supporting role played by air's acceleration/Reaction force is the key that is being missed. The end result is that the Modern Physical explanation of the operation of a tornado, that homeowners desire, has not been forthcoming.

Accordingly, the purpose of Event 4 is to see if a Universal Physics, force-based explanation of the workings of a tornado vacuum tube is possible. If so, perhaps this investigation will reveal clues as to how buildings can be modified to better protect the lives and property of their occupants instead of just blowing their tops at the first sign of a fast-moving tornado vacuum tube passing overhead.

Event 4

Since so many similarities between them exist, I will begin this study by comparing a tornado with a giant canister vacuum of equal size. The giant vacuum canister is suspended at the same elevation as the high, rotating, supercell cloud from which is spawned a tornado. The huge vacuum hose connected to the canister extends all the way down to within a dozen feet of Earth's surface as does the tornado's tightly-whirling vacuum tube. The canister's vacuum hose and tornado's vacuum tube both travel at odd angles on the way down yet both straighten up to near vertical just above Earth's surface.

Inside the supercell cloud, a low air pressure zone exists due in part to a general low pressure in the region, in part to the rotation of the supercell and in part to the low pressure layer that naturally exists at such a high altitude above Earth's surface.

Inside the canister vacuum housing a giant fan is forcing (pushing) air out the exhaust port thereby continually maintaining a low air pressure zone inside. To keep this comparison fair, we will assume that normal Earth surface air pressure of 14.7 psi exists around the outside of the highly elevated canister housing.

Due to the high-speed whirling of air in the tornado vacuum tube, the only entry point for outside air of higher pressure is at the bottom, just above Earth's surface. In this manner, the tornado vacuum tube is like a conduit providing a direct connection between the inlet near Earth's surface and the outlet located thousands of feet up in the clouds. Air is not sucked into the inlet for that is not the nature of air molecules which, due to like charges and unlimited mobility, strive to move as far away from each other as possible. Instead, air molecules are pushed into the low pressure vacuum tube inlet by higher pressure (more closely packed) air molecules behind in an endless stream.

In a like manner, air is not sucked into the inlet of the giant vacuum hose. Instead it too is blown or pushed into the low pressure inlet by higher pressure air molecules from behind. This blown, not sucked, distinction is important for it represents an often-missed clue as to exactly how enclosed structures so easily shed their roofs.

As lower-pressure air is pushed higher and higher up the inside of the tornado vacuum tube, normal 14.7 psi higher-pressure air just outside the tube is prevented from equalizing with the low-pressure air inside by the obstruction of the high-speed whirling wall of air. Thus by the mechanism of a whirling wall of air, it is possible to maintain a low pressure core within the tornado tube.

In the giant vacuum hose a low pressure core is maintained due solely to the structural strength of the wire coil embedded within the wall of the hose. If this wire coil were to suddenly go missing, the vinyl vacuum hose would immediately collapse as the 14.7 psi air pressure outside would equalize with the lower air pressure inside.

The real challenge here is to understand exactly what forces are present across a cross-section of a tornado tube that are successful in providing for the maintenance of a low pressure zone inside. Instrumented tests of this low pressure zone indicate it might be about 1.5 psi lower than normal 14.7 psi sea level air pressure or around 13.2 psi at the center.

Looking down upon a whirling tornado tube from above, it is clear that centripetal acceleration is occurring to the air that forms the tube as this air's direction of travel is continually changing. An inward-directed centripetal external (contact) force is required to be present for this change in direction to occur. This acceleration/Action force can only come from a portion of the 14.7 psi high normal air pressure from the non-rotating air present around the outside of the tornado tube. At the interface between the whirling wall and the non-whirling air outside the wall, equal and opposite 14.7 psi pressures must exist due to the mutual nature of opposing forces. Meanwhile at the center of the tornado tube, the air pressure is a low 13.2 psi. So how is it that the outward push of 13.2 psi at the core becomes an outward push of 14.7 psi at the outer-most surface of the whirling wall of air? What is the cause of the additional outward-directed force that must be present to increase the 13.2 psi core pressure up to become the equal of the 14.7 psi pressure of normal high-pressure non-whirling air bearing inward against the tornado's whirling wall of air?

A better question is "What force is present that reduces the inward-directed 14.7 psi outside air pressure down to equal just 13.2 psi at the whirling tube's core? The answer to this question requires an understanding of the mechanism whereby an action force or portion of an action force is terminated after it acts as the cause of some accelerational event. As the inward-directed 14.7 psi air pressure of the non-whirling air bears against the tornado's whirling wall of air, a 1.5 psi portion of this 14.7 psi air pressure is the centripetal acceleration/Action force responsible for causing inward-directed or centripetal acceleration for this whirling air. The accelerating air reactively bears outward with a 1.5 psi outward-directed acceleration/Reaction force against which the 1.5 psi acceleration/Action portion of the outside air pressure terminates. Here one must not expect the inward 1.5 psi a/A force to first cause the whirling wall's acceleration and then, undiminished, to go on inward to act as the cause of some other event. No, once it has acted as the cause of the whirling air's inward-directed acceleration, the 1.5 psi a/A force responsible is finished, terminated, done, and thereby ceases to exist for its existence is canceled out against the whirling air's outward-directed 1.5 psi acceleration/Reaction force. Thus one should not expect the force that is causing the action of acceleration to be capable of continuing on to act as the cause of anything more than that one action.

Once the inward-directed 1.5 psi a/A portion of the inward-directed 14.7 psi pressure of non-whirling air has acted as the cause of the whirling wall's centripetal acceleration, it ceases to exist. The inward-directed 13.2 psi pressure that remains is equal to the outward-directed 13.2 psi pressure that exists within the low pressure core of the tornado's tube. This balance of pressures at the core means that as long as the whirling wall of air whirls, higher outside air pressure will be effectively reduced so as to be incapable of crushing out of existence the low pressure zone at the tornado's core.

Let us see if the application of Newton's math to a whirling air event will lock in reality by providing support for this description. Since air pressure is listed using pounds per square inch

(psi) I propose taking one square inch of the outside surface of a tornado's whirling wall, determining the mass of the air's matter located behind that single square inch of surface area in the horizontal direction of the whirling tube's axis, and then calculating the centripetal acceleration/Action force necessary to accelerate that rectangular, horizontal "bar" of air about the axis. The question in need of an answer here is what magnitude of an external contact force needs to be applied inward against the outer square inch of the air "bar" in order to cause the whirling air bar to continue to experience the centripetal acceleration of traveling a high-speed circular path about the tornado's axis.

There are several steps to take before we will arrive at an approximate answer, so please bear with me in this effort. The first step is to determine the volume of air that exists horizontally inward from that outer-most whirling square inch. I will use a tornado vacuum tube radius of 120 feet, with the whirling air portion being 80 feet thick. Initially our rectangular air "bar" may be drawn as being 1" high its entire length but tapering in width from 1" at the outer surface to 0" at the central axis. But since the whirling air wall portion is 80 feet thick I will figure our horizontal air "bar" is 1" high but only 1/3" wide at its inner surface which ends 40 feet short of the axis.

The volume of this air bar may be arrived at by averaging the inner and outer surface area of the ends of the air bar and then multiplying this average surface area times the 80 foot (960 inch) length. Once the air bar's volume in cubic inches is determined, dividing it by 1,728 will give us its volume of 0.37,037,04 cubic feet. Then by multiplying the cubic feet so obtained, by 0.07,491,27 lb.m per cubic feet, we will arrive at the mass rating of this high-speed sideways-rotating tapered air bar as containing 0.02,777,778 lb.m of air matter.

The following formula applies:
volume (cu in) = ((s1 * s2) + (s3 * s4)) / 2 * length
= ((1 in * 1 in) + (1 in * 0.33,333,3 in)) / 2 * 960 in
= 640 cubic inches

volume (cu. ft) = 640 cu. in. / 1,728 cu. in. per cu. ft.
= 0.37,037,04 cubic feet
mass rating = cu. ft. * 0.07,491,27 lb.m per cu. ft
= 0.02,777,778 lb.m.

Almost all of this small amount of mass resides inward of the outer square inch. So I think we have to find the approximate center of mass in order to determine the sideways whirling air bar's average distance from its axis of orbit. Because of its taper, the 80 ft. long air bar's center of mass turns out not to be at its 40 ft. center but instead is located very near the 30 ft. mark measuring inward from the outer end. If we accept that all of its mass resides here, in Newton's tradition, then the radius of orbit will equal the 120 ft. vacuum tube radius minus 30 ft. leaving a net radius of 90 ft. If I assign the tangential velocity of this whirling air bar at 260 mph, we are ready to calculate the inward-directed external acceleration/Action force present.

With a tangential speed of 260 mph (a tornado has been recorded with a tangential airspeed of over 300 mph), a radius of 90 ft and a mass rating of 0.02,777,778 lb.m, the following calculations should give us the final answer.

speed = mph * feet per mile / 3,600 sec. per hour
= 260 mph * 5,280 ft. / 3,600 sec.
= 381.33,33 ft./sec.

centripetal a/A force = (mass * speed^2)/radius/gravity
= (0.02,777,778 lb.m * 381.33,33 ft/sec^2)/90 ft / 32.17 ft/sec^2
= 1.39,5 lb.f

While I was hoping for a 1.5 lb.f, you have to admit that these results are very close. There are many variables here that will affect the results. For example, if the tornado's whirling wall thickness is greater than 80 ft or the tangential speed is greater than 260 mph or the radius of rotation is less than 90 ft then the results will predict a higher a/A force. Overall, I just wanted to show you that these calculations, along with the Universal Physics concepts upon which they are based, reside well inside Reality Ballpark. With every square inch of the whirling wall's outer surface receiving the calculated 1.4 pounds of inward-directed force, the cause of the whirling wall's inward-directed centripetal acceleration is now explained.

To make recalculation easier as variables change, I put together the following Microsoft QuickBasic (R) program. Start the QuickBasic Editor and enter the program below exactly as written. Be sure your printer is hooked up and turned on or you may get a "Device Fault Error" when running. Press shift/PrtSc to print the output. Or, better yet, add LPRINT statements after the PRINT statements such as 160 LPRINT "Whirling mass = ";m; " lb.m"

```
10 PRINT "Tornado Centripetal acceleration/Action Force Calculator"
20 REM Written by Ethan Skyler 8/12/2004
30 g = 32.17  ' acceleration of Earth gravitation in ft/sec
40 INPUT "Enter rotational speed in mph"; mph
50 INPUT " Enter radius in feet"; rd
60 INPUT " Enter cubic inches of air"; vol
70 s = mph * 5280 / 3600 'Convert miles per hour to feet per second
80 m = (vol / 1728) * .0749 'Cubic inches to cubic feet to mass in lb.m
90 f = (m * s ^ 2) / rd / g 'Calculate centripetal a/A force in lb.f
100 PRINT
110 PRINT "Whirling mass = "; m; " lb.m "
120 PRINT "Whirling airspeed = "; s; " ft/sec"
130 PRINT "Centripetal a/A force = "; f; " lb.f"
140 INPUT "Press enter to recalculate or ctrl/break to end "; x
150 PRINT
200 GOTO 10
```

Now that we have verification of the presence of a 1.4 psi inward-directed centripetal acceleration/Action force causing centripetal acceleration for our sideways rotating air bar while terminating against the air bar's outward-directed centrifugal acceleration/Reaction force, let us take a moment to consider how these equal and opposite external verses internal action/reaction

pair of forces interface. Do you remember reading about what happens whenever an external force is opposed or finds support against an internal force in Article IV The Nature of Force"? The internal forces being generated within the individual components of the object's matter always stack up or increase through the object in the direction of the external (contact) force. In this case, the external (contact) force is present as the external force the non-rotating high-pressure air is impressing inward against the outer surface of the tornado's whirling vacuum tube. Each square inch of this outer surface is bearing with a 14.7 psi force load in the inward direction. This 14.7 psi force is supported at the same outer surface by the combination of the 13.3 psi external action force bearing outward from the core plus the cumulative 1.4 psi total of the acceleration/Reaction forces stacking up in the outward direction from the accelerating components of the whirling 80' air bar. Just 13.3 psi of the external action force makes it through the entire length of the horizontal air "bar" to bear with that pressure against the tornado's core. The 1.4 psi a/A force portion terminates by stacking down a little bit at a time against each of the air bar's acceleration components of matter. .

Here I should like to point out again that since a Modern Physics education includes no training as to the existence of the accelerating air's acceleration/Reaction force of support and termination, no logical Modern Physics-based explanation of the forces present across a tornado vacuum tube is possible. The correct tools necessary to provide support for a complete explanation of this event only exist here within the teachings of Universal Physics.

Now that we understand how the mechanism of the tornado's whirling wall of air allows for the maintenance of a low pressure zone at its core, it is time to discuss the effect that causes the air to whirl about an axis in the first place. In the United States of America, most tornados are reported to whirl in a counter-clockwise direction when viewed from above. This is the same direction of rotation that most if not all USA hurricanes revolve. It is the result of an effect known as the Coriolis Effect where air that approaches the storm with a definite forward velocity is slow to experience change to the sideways velocity it has inherited from its existence at a previous location above Earth's rotating surface.

Understand that air near Earth's equator inherits a rotational speed about Earth's core of around 1040 miles per hour (mph). If this air starts out traveling due north, a westward force is required to slow the air's eastward 1040 mph inherited velocity in order for the air to be able to maintain this due north course. Often, such a westward force is missing or slow to occur so the air follows a course to the right of the rightward rotating due north line due to its inherited 1040 mph eastward velocity which is now too fast for the slower velocities inherited by air currents at latitudes north of Earth's equator. The same Coriolis Effect holds true for southward-moving air from the Artic only here the air's sideways velocity is zero at the pole. If this Artic air follows a due south course, an eastward force is required to be present to speed up the air's eastward velocity in order for the due south course to be maintained. With such an eastward force missing or slow to occur, the air current ends up following a course to the right of of the leftward-rotating due south line.

Even eastward-moving air from the Pacific is Coriolis Effected. Initially it inherits a direction that points east and beyond out into space. Also the gravitational weight of eastward-moving air

is less due to the increased centripetal acceleration caused by the increased speed of its rotation about Earth's axis. As Earth rotates, a downward force is require to curve the eastward and upward moving air away from its space-bound direction. This downward force is caused by Earth gravitation that is directed somewhat southward toward Earth's center of matter, and most specifically not at right angle to Earth's axis. The end result is that the eastward-moving air current inherits a direction that is gravitationally pulled southward or again to the right. Also to be considered is the fact that any air flow will follow the path of least resistance. Since an eastward-moving air current will be gaining on air that is traveling eastward more slowly at Earth's rotational speed for that latitude, and further since air at a more southerly latitude is on average traveling eastward at a greater speed, any eastward-moving air current will be forced to take the less resistant path by being deflected south or to the right.

By this logic, westward-moving air from the Atlantic will also be affected. It's inherited direction, west and beyond out into space, soon becomes directed underground due to Earth's rotation. Also the gravitational weight of the westward-moving air is greater due to the decreased centripetal acceleration caused by the air's decreased speed of rotation about Earth's axis. Here an upward force from Earth's surface is required to curve the westward and downward moving air in the upward direction. This upward force from Earth's surface is an external (contact) force. The resulting friction ultimately with Earth's surface will slow the speed of the westward and downward-directed air current causing it to be forced to take the less resistant path into the slower oncoming air which is the air located at a more northerly latitude. Here the westward-moving air current ends up being forced to the north which is again to the right relative to its initial direction of travel.

The bottom line is that when a tornado vacuum tube touches down to Earth's surface, air currents arriving from all directions push their way into the low pressure zone at the tube's opening. During arrival, each such air current ends up veering to the right as it enters the tube. All of these off-center-to-the-right pushes force an overall high-speed turbine-type rotation of the whirling wall of air in the counter-clockwise direction when viewed from above. This Coriolis Effect is not always strong enough to overpower other environmental or topographical factors that also affect the direction of airflow. Occasionally a tornado is reported where its direction of rotation is clockwise when viewed from above. So it appears that exceptions to the counter-clockwise rule for northern-hemisphere tornados possibly exist.

When each of the approaching air currents enters the tornado vacuum tube at its ground-level inlet, they are suddenly forced to change direction from horizontal to one that is more vertical. A high pressure zone is so created as air arriving from all directions pushes in under the rim of the whirling vacuum tube only to be forced upward. This upward change in direction represents a centripetal acceleration that can only be caused by the high pressure of a centripetal acceleration/Action force. In effect, air currents arriving from opposite directions butt "heads" with each other resulting in a central high pressure zone that causes each and every incoming air current to veer (accelerate due to a change in direction) on up the inside surface of the whirling tube of air. This high pressure zone at the center at ground level is important to recognize for it has a significant role, that we will soon discuss, in assisting a house to blow off its own roof.

Now that we understand the rotation and operation of a tornado's vacuum tube, let us turn our attention to a test home that lies directly in the path of an approaching tornado. Prior to the vacuum tube's arrival, the air pressure inside the home is the same value as the air pressure outside the home. In other words, every square inch of roof area is receiving a 14.7 lb. downward force of air pressure from above supported by a 14.7 lb. upward force of air pressure present inside the home's attic. The pressure differential between these mutually opposing action forces is zero. No threat to the home's roof exists at this time.

While the supercell cloud high above may be traveling along above Earth more slowly, the lower end of the tornado is closing fast at 60 miles per hour (mph) which converts to 88 feet per second. The diameter of the tornado tube near ground level is about 240 feet. The test home is a single story structure 80 feet in length. If the tornado tube's wall thickness is around 80 feet then as the tornado approaches in line with the roof's 80 foot length then upon its arrival, during second #1 we will see the tornado deliver a high velocity wind from the tornado's whirling wall of air against one side of the home. Let us say this is the east side of the home. The speed of this wind could be from 150 mph up to as high as 300 mph. For one second, as the whirling wall of air collides with the test home's east side (wall and roof), a high pressure zone that is different from the central high pressure zone discusses above is so caused. This zone, also at ground level causes the ultra high-speed winds in the whirling wall of the tornado vacuum tube to quickly change their direction from horizontal to more vertical. Due to the sudden ultra high pressure against the test home's east side, the soffit air vents located traditionally under the home's roof overhang on that side allow pressurized air access to the home's attic. While air pressure inside the attic is on the increase, vents on the west side may allow for some depressurization. Meanwhile up on the sloping roof, air pressure is high on the east side and low on the west side figuring a north/south ridge. If there are any vents to the attic on the north side then incoming air streams from that direction may cause additional pressurization of the attic or at least reduce the attic's ability to vent off high-pressure air streaming in through the east vents.

Debris from the destruction of trees and nearby structures can impact the walls and roof of our test home puncturing vent holes to the attic.

During second #2, the tornado vacuum tube can move on so that its low-pressure core is located directly over the 80 foot long test home. Now the pressure bearing down on the test home's roof is suddenly lowered by as much as 1.5 lb. to 13.2 lb. per square inch. At the same time, the entire home is now residing at the center of the tornado's central high-pressure zone located at ground level where incoming horizontal air currents "butt" heads against the home's sidewalls and roof as these 100 mph air currents are forced to change their direction from horizontal to one that is more vertical.

Now, all of the home's air vents located under the roof overhangs are pressurized by these incoming air currents. Thus the pressure inside the attic can increase beyond its normal 14.7 psi. to perhaps 15 psi. or more. The only vent holes available to reduce this increase in attic pressure will be vents installed along the ridge or holes in the roof caused by impact damage. In our test home, ridge vents do not exist but a few impact holes have occurred. But this event is happening

too quickly for these limited vent holes to reduce by much the pressure built up inside the attic. The attic is pressurized like an inflated balloon.

It is predicted by some scientists that if a pressure differential of 1.5 psi exists between air pressure inside an attic bearing up and air pressure outside bearing down, 3 seconds of venting time is all that is needed for these air pressures to equalize. But at our test home, 3 seconds is an eternity. In addition, these scientists assume that the vents to the attic are experiencing less than normal 14.7 psi at their outlets. They are overlooking an increase, not a decrease, in outside air pressure precisely at the soffit vent region due to the upward acceleration of incoming air currents arriving from all directions at ground level. In truth, these soffit vents are effectively plugged by higher-than-normal air pressure on the outside. Worse than that, it is likely that some of the soffit vents are pressurizing the attic to a higher-than-normal 14.7 psi pressure inside.

Here, during second #2, the home's roof may exist with 15 psi or more bearing up inside the attic and only 13.2 psi bearing down. But let us predict a smaller pressure differential to keep this example as conservative as possible. Let us predict the attic is able to vent some of this excess pressure so that nothing more than normal 14.7 psi air pressure exists inside. Meanwhile let us predict that the outside pressure bearing down on the roof is 13.2 psi as has already been instrumentally measured. Some scientists seem to think that a pressure differential of "only" 1.5 psi is too small to be the cause of a home blowing off its roof. So let's have a look at the overall force such a conservative pressure differential is capable of producing.

Our test home has an attic area of 2500 square feet which when multiplied times 144 inches per square foot equals 360,000 square inches. Understand that due to the pressure differential, each of these 360,000 square inches is being pushed up with a 1.5 lb. force greater than it is being pushed down from above. When totaled, this seemingly insignificant 1.5 lb. pressure differential for each square inch combines to equal a sudden total upward 540,000 lb. force. Now do you see why it is that a home is capable of blowing off its own roof? Imagine for a moment that a crane able to lift 270 tons is attached by cables to the roof of your home. Do you think the scientists are correct in predicting that your home's roof will have no problem remaining in place as this immense upward force is applied? Or do you think that the crane, which is easily capable of lifting an empty Boeing 747 Jumbo Jet straight up off the runway, would have no trouble detaching the test home's entire roof and walls for that matter?!

Pressure differential logically represents the answer as to why so many homes blow off their own roofs as the low pressure zone of a tornado passes quickly overhead. Of this conclusion there can be no doubt. A survey of the damage paths of a severe tornado provides support that is obvious. With a large tornado, rows of houses with their roofs missing are often left in its wake. A smaller diameter tornado can momentarily center over and thereby cause the required pressure differential for a single home to push off its own roof while causing only impact damage to neighboring homes. If the right conditions exist, no conventional home can resist such a powerful force contained inside. Mobile homes are especially vulnerable to a pressure differential explosion. Possessing no attic, no traditional ventilation exists in a mobile home. With its doors and windows shut, a sudden drop in air pressure overhead can allow the now higher inside pressure to split the roof's thin metal skin wide open its entire length, often with tragic results.

What, if anything, can be done to improve the safety of a homeowner unfortunate enough to be trapped inside at the moment a whirling tornado vacuum tube swishes overhead? For certain any home that retains its roof is safer than one that rockets its roof straight up into oblivion. So let us start here in looking for a solution. I think speedy ventilation of air trapped inside the attic is the answer. The best place to vent normal or high pressure air from inside an attic is to provide vents straight up to the low pressure zone of the tornado core located above.

Currently in the United States of America, the Uniform Building Code calls for 1 square foot (144 square inches) of ventilation under the eaves (soffit area) for every 150 square feet of horizontal attic area. In our 2500 square foot home, this amounts to soffit vents totaling 17 square feet in surface area. This is equal to a single opening measuring a bit more than 4 feet square. Note that these requirements are for roofs with nothing but soffit vents installed around the roof's perimeter. These vents are in the high pressure zone under the roof's overhang when the tornado vacuum tube sweeps overhead. Their location enhances the roof's removal by allowing pressurization of the attic while blocking the vital depressurization required to keep the home's roof in place.

As an approved alternative, the Uniform Building Code now allows a 50 percent reduction in total attic ventilation if half of the ventilation area is located along the ridge or through the top surface of the roof. In other words, it is allowable to have 1 square foot of ventilation area for every 300 square feet of attic area if half of that ventilation area is provided for along the ridge. What do you think this alternative will do for helping a home to retain its roof?

I see this 1 in 300 square foot alternative as a positive step in the right direction for fewer under-the-eaves soffit vents will be present to assist in dangerous attic pressurization while truly effective depressurization vents will now exist through the roof's top surface. Less air is getting in while more air has a guaranteed way out. What could be better? I think tripling the ridge vent area would be better. For our 2500 square foot home, the ridge vent area would change from 0.5 square feet per 300 square feet of attic area to instead be 1.5 square feet for each 300 square feet of horizontal attic area. Even this suggestion should be increased if there is a higher-than-normal volume of air contained by the roof. Not being an engineer, I recommend if you are interested in learning your structure's requirements, consult an engineering firm with air handling experience. It is my intent here to get you started in thinking about the Physics Of A Tornado and what modifications to your home's design will increase its chances of survival.

Speaking of modifications, what if your home has been built to the older Uniform Building Code specifications where ridge vents are not mentioned? I think you should consider reducing the size of the under-the-eaves soffit vents to 0.5 square feet for every 300 square feet of attic area while adding 1.5 square feet or more of ridge ventilation for every 300 square feet of attic area. This way your attic can more quickly equalize its pressure inside with the tornado's low pressure core overhead. I would not count gable ventilation area as part of the ridge ventilation area for gable overhangs can trap outside high pressure air against the gable wall.

Many structures exist that have no attic space. Mobile homes, churches and warehouse shopping centers come to mind. With 270 tons of force easily effecting the removal of the roof from our 2500 square foot test home, imagine the huge "explosive" pressures that can suddenly rip open and remove the roofs of larger structures. Oversized roof-top vents with coarse screening and light spring-loaded doors are suggested to provide quick ventilation of a portion of the huge volumes of high pressure air contained within.

These general suggestions are recommendations only. Please consult an air handling engineering firm for professional advice. They can provide you with the specific answers suitable for your home, outbuilding, or business building. Have them begin by reading through Event 4 so you are certain they understand the Physics Of A Tornado before working on the solution for your structure.

In time, I think the authors of the Uniform Building Code will address the problem of pressure differential responsible for homes blowing away their roof structures as a tornado's vacuum tube passes overhead. Hopefully they too will study Event 4 so they can begin with a realistic understanding of the problem.

It is clear that pressure differential is the problem. The sooner this problem and its solution are addressed, the sooner lives can be saved and property losses reduced.

Ethan Skyler

Suggested Tornado Links

1. SirLinksAlot.net (http://www.sirlinksalot.net/tornado.html) Great link site for tornado news!
2. BBC h2g2 (http://www.bbc.co.uk/dna/h2g2/A517169)

"As it turns out, a house with no vents and airtight closed doors is in more danger of losing its roof than a well-vented building. This is because the air pressure inside is higher than that outside. Therefore, it is more likely for the roof to be pushed off than blown off."