

Green means Go? No.

Once slapdash people said “Set the toe and let ‘em go.” Maybe those same people have now changed their slogan, changed it to “Green means Go.” But they’re just as wrong as they were before.



Alignment machines often color-code the display to indicate when adjustments fall into the specified tolerances, green usually meaning the parameter is now acceptable. This is not a mistake or a shortcut on the part of the alignment machine manufacturers: they have to calibrate their machines by the specifications given them by the carmakers. And those same carmakers are in the business of keeping their costs under control. To set a parameter within a thousandth of an inch costs a certain amount. To set it within a ten thousandth costs very much more, not just ten times as much. So most carmakers’ specifications have a certain *tolerance*, a range of adjustments anywhere within which the machine should function satisfactorily. They are betting, of course, that one tolerance will be in one direction and the next in the other. But if all the tolerances are in a given direction, we can have a machine that is, paradoxically, out of adjustment even though everything is within specifications! This is sometimes called *tolerance stackup*, and the only real preventive is probability — it’s just not that likely all the specifications will vary the same way very often.

But sometimes they do! And those times the motorist must depend not on the alignment machine’s ability to sort out the major suspension angles quickly and correctly. In those cases, only the skilled alignment mechanic, who knows what it means when the angles all tend in one direction, even if they remain within the permitted range.

Put to the Test

So let’s consider a case where a very good alignment machine, operated by a skilled person who knows exactly what he’s doing, gives us nothing but green display patterns. If everything’s in the green, are you done? Does that necessarily mean the alignment you’ve just finished is a good one, one that provides control and steering, tire life and braking as much as such adjustments can achieve?

The surprising answer is, no. The car can still be misaligned.

To test this, I schmoozled his 1999 Acura from *Import Service’s* publisher, Chris Ayers. It’s relative child’s play to put a technical hoax over on him, and he had no idea what I was up to. If I’m still technoscribbling here next month, that will show either that he’s a good sport or that he still hasn’t read this article.



Suspension untouched from the factory, the Acura ran beautifully when you released the steering wheel. As long as the road ran straight, so did the car. When you put on the brakes, it just slowed down with no pull. When you accelerated, it held a straight line. Camber and toe had to be very close to right.

I first took the car out for a road test to assess the steering and alignment qualities from the driver's seat. This is no different from a test drive to confirm a customer's reports of problems, except the customer here had no problems to complain of: We were going to create them. The car tracked perfectly at all speeds up to, perhaps even slightly beyond, the legal limits. Braking, either mild or hard, had no discernible effect on the steering feedback or direction, and the car behaved the same way in both directions.

Cautious Caster Capers

A driving test I like to use for caster involves finding an empty parking lot and turning the steering wheel all the way to full lock. Note: only professional mechanics should employ this test. The chance of vehicle damage or personal injury is too great for even a careful amateur to attempt. This is not something for do-it-yourselfers or hobbyists or car enthusiasts to try. Observing geometric phenomena while accelerating in tight circles (especially backwards) is not a natural driving skill, but a controlled experiment. If in addition something unexpected happens, you need a mechanic's reactions, not just a driver's, to cope with it.

For most cars (there are some exceptions), if you release the steering wheel and accelerate forward, the steering will wind itself to the center, straight-ahead position. It will do so, obviously, in the same manner with the steering turned left or right, and this Acura did just that. This is exactly what we expect.



For most cars, including the Acura, you can check the self-stabilizing effect of front caster by stopping in a quiet parking lot, cranking the wheel to full-lock and releasing it and then gently accelerating. The wheel should straighten 'on its own,' that is, because of the suspension geometry.



But when you repeat the same caster test in reverse, the same geometry works backwards to keep the wheel at the lock, at least as long as you mildly accelerate backwards. Both caster tests should show the same results on each side. Warning! Neither this nor the previous test is for amateurs!

Green means go?

Then I do the same test, but with the car in reverse. Since the geometric forces are exactly inverted on the front end, the steering should stay at the full lock — not jammed so hard against the lock as to make the PS belt squeal, of course, just enough to push it full left or right. Most cars will slacken the turn slightly as you ease off the throttle, as a rational person is apt to do backing up in a circle in a parking lot. The Acura behaved exactly as I expected again. Evidently, from the seat-of-the-pants tests, the alignment was correct.

The Edge of the Green

Then I took the car to Euro-Car in Norton, Ohio. Euro-Car is a three-generation shop doing work of a quality few new car dealerships can even aspire to match. The Demrovsky family, who own and work at Euro-Car, have been very generous with their time and their shop's resources, not only for us at *Import Service*, but for you who read our magazine, too. Many photos you've seen in our pages have been shot at the Demrovsky's shop, and many stories formulated or questions clarified there. If we credited them with every favor they've done us, you'd suspect the fix was in.

Besides their time on the job and generosity, as you can see from the photos, they also have the best equipment obtainable. Their equipment, not much to my surprise, confirmed that all the Acura's alignment numbers fell into the green specification boxes. But I wanted to push the case, so Euro-Car's Duane Hovey working with Brian Demrovsky, set each rear wheel to the maximum allowable left toe — toe-out on the left; toe-in on the right, but all within 'green' specs. Then they did just the opposite on the front wheels, setting maximum allowable toe-in on the left and maximum toe-out on the right.



We knew from our road test they'd done the alignment right at the factory, and we weren't going to throw it exactly out of specifications. We were going to push it to the very edge of the specs, though, and to just the right edge in each case.



The displays were all in the green, both before and after our tinkering. So someone who just thought 'green means go' would have been satisfied with the alignment. Someone who'd just taken the car out for a road test, however, could notice the degradation of the steering control. All's green does not mean go! You have to understand the numbers.

Green means go?

Right: The Acura adjusts toe and camber simultaneously on the rear with an eccentric cam and locking nut. We kept the numbers within specs, but we pushed them to opposite limits on opposite sides.

While there are aftermarket eccentric bushings you can use to change the Acura's front and rear camber and the front caster, that seemed a bit much of a time-favor to ask.

Back on the road later and the next day, the results were subtle but undeniable. The caster tests were unchanged, but then, so was the caster. But you could no longer comfortably let go of the steering wheel at 70 mph. The car didn't whip off the road like something horribly out of adjustment, but you didn't care to release the wheel, either. Braking, of course, had no perceptible effect because we'd done nothing to the brakes.

Stack 'Em Up, and Park the Car...

Now suppose we'd pushed *all* the specifications to their 'green' limits. Suppose we coupled the toe adjustments we made with as much left-pushing camber as we could dial into the rear end and as much right-pushing as we could into the front. Suppose we maximized caster on the right and minimized it on the left. Suppose our right tires had the minimum inflation pressure and the lefts had the maximum.

You get the picture. The car would gradually become almost undriveable even though all the alignment numbers stayed in the green. It is true that the chances of all the variables stacking up in just the right way to maximize pull are low, but it's also true that there are about 200 million cars on the road, and some of them have exactly that kind of tolerance stackup. Many more have milder cases, such as this one we artificially induced in our publisher's Acura.



Front toe on the Acura adjusts just outboard of the rack bellows. For the fronts, we also pushed each side to the limits, but to the opposite limits we'd used for the rear. For our purposes, all the displays had to stay in the green, however!

Green means go?



Now, after our exploration of the limits of the alignment tolerances, it was no longer comfortable to release the steering wheel at cruising speed. You wouldn't crash, at least right away, but now you had to steer the car all the time. Both safety and comfort had declined, even though we were still within specifications.

The moral of the story? You not only need a good alignment machine to do a good alignment. You need a good alignment mechanic, one who understands the suspension and steering angles, one who understands what will happen if this or that angle approaches the limits. A shopowner who owns a fine alignment machine can be proud of his equipment. A shopowner who employs a fine alignment mechanic can boast even more: he can be proud of the work his shop puts out.

This article is a kind of thank-you note to Al Mytyk, who used to teach alignment and suspension at Federal Mogul's Ann Arbor Michigan technical training center, which has been moved to St. Louis. The basic idea of this article was his; my own contributions are limited to words and photos — and any mistakes I've introduced! Thanks, Al, for all the things I learned from you! ■

—By Joe Woods