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# DIRT SPORTS

JANUARY/FEBRUARY 2009

## ONE FOR THE AGES

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# UNCOMMON COURAGE

STORY BY PETER BROCK >> PHOTOS BY GAYLE AND PETER BROCK


*DIRT SPORTS'* ULTIMATE INSIDER, PETER BROCK, TAKES ON AN EXCLUSIVE JOURNEY BEHIND VOLKSWAGEN'S RADICAL NEW DIESEL-POWERED "BAJA TOUAREG." THIS IS WHAT HAPPENS WHEN AUTOMOTIVE FACTORIES THINK OUTSIDE THAT STALE OLD BOX.

Contrary to popular opinion, consistent motor sports champions, whether they represent drivers, team owners or designers, are some of the most conservative individuals on the planet. Risk has a high probability of failure. The specter of destroying budgets and squandering irreplaceable time encourages conservative thinking. Bravery in race car design begins with vision; that rare combination of practical experience and the uncommon ability to see beyond immediate success which ultimately establishes legendary status. The dizzying costs of utilizing untried design concepts and construction of a totally new racing car can create some serious quiet in any corporate boardroom. The pressure to reject the unproven and support something exactly like the current standard is tremendous.

But stepping into this unstable environment is Volkswagen (whose iconic rear-mounted, air-cooled, flat-four engine completely upset the motoring world in the late 1930s with just such a reach) now attempting to repeat history with their new clean-burning diesel Trophy-Truck. Indeed, the wonder of VW's new Baja Touareg project is that it exists at all. The whole combination of foreign vision, untried components, different fuel, diverse engineering cultures, unique methodology, language challenges, and the sudden consolidation of a small but dedicated group of unique individuals, most entirely unknown to each other prior to the factory's ambitious decision to proceed with the goal of winning one of the most difficult races in the world, is almost without precedent. Only the remarkable Ted Mangels-designed, PPI factory Toyota Trophy-Trucks driven by Ivan Stewart even come close.

## MILLER THE VISIONARY

The impetus for the whole Baja Touareg Trophy-Truck project began with American entrepreneur Mark Miller, a veteran desert racer gifted with that rare combination of business acumen and enough practical, world-wide competition experience to allow him to envision a remarkable, but seemingly improbable, objective. It was a quest that would require his team at Arciero-Miller Racing (AMR) to exceed the time-honored performance levels established by SCORE's tightly knit community of Trophy-Truck racers who had, over a period of some 14 years, refined their equipment and skills to an almost invulnerable level.

The program's first hurdle was the simple fact that turbo-diesels were excluded from SCORE's Trophy-Truck class. This was not intentional, but a by-product of the sanctioning body's concept for its marquee class coming from earlier era when diesel power wasn't considered a viable option for any race truck. Of primary concern was the long-held restriction in SCORE's rule book against engines running with any sort of forced induction (read turbo or super chargers). Clearly it would take some skillful negotiations to convince Sal Fish, SCORE's benevolent dictator and CEO, and his tech guru, Bill Savage, that something as unusual as a turbo-diesel powered SUV could somehow compete with the world's fastest desert racers.

**"Only the remarkable Ted Mangels-designed, PPI factory Toyota Trophy-Trucks driven by Ivan Stewart even come close."**

Under its skin, VW's luxurious but powerful production V10 turbo-diesel Touareg SUV is unlike any other similar appearing vehicle on the market; the obvious result of very advanced, but also unorthodox, thinking. When Miller and racer/business partner, Ryan Arciero, ran a couple of production VW Touaregs at the Pikes Peak International Hillclimb in 2006, they realized its engine and drive train components, in a lighter racing chassis, might make a good Baja racer. Miller was not surprised, as he had been a factory driver for the Red Bull Volkwagen team at the famed African rally of the same name and was amazed at the performance of the car's tiny 2.5 liter, 5-cylinder turbo diesel. Competing in these diverse events afforded Miller considerable face time with Volkswagen of America's Motorsport Manager, Clark Campbell, and VW's overall Director of Motorsports in Germany, Kris Nissen. Miller learned of VW's performance marketing plans for the United States, which included an eight-race spec-series for VW's fast little Jetta TDI sedans as well as ideas for promoting the Touareg.

In addition to persuading Nissen and Campbell that AMR could handle the entire spec-series for the Jetta, Miller and Arciero also convinced Campbell that VW's storied 40-year history and reputation in Baja, with its air-cooled "Beetle" engine, might be just the marketing bridge to reinforce the Touareg name into the American market with a whole new performance image. As a practical test, VW agreed to bring two of their "Dakar Touaregs" to Baja for the 2007 Baja 500. Since there was no existing class for the Dakar VWs, SCORE's Sal Fish created a special category to allow them to run. In spite of their comparatively small engines and minimal, FIA-specified ground clearance, Mark Miller and Giniel de Villiers managed to run the entire 420-mile race without re-fueling, placing 11th and 16th against a huge field of Trophy-Trucks and Class 1 unlimited buggies powered by mammoth American V8s. The race was a revelation to VW management. Conversations back in Germany resulted in the decision to explore the possibility of building a "Baja Touareg" Trophy Truck for the 2008 SCORE Baja 1000.

In the meantime, Campbell embarked upon a comprehensive promotional program with SCORE, presenting various ideas for expanding VW's participation in the series. Obviously, inclusion of the then-unbuilt VW Trophy-Truck was primary in these discussions, but Campbell also proposed corporate support and recognition of all that VW had done for the off-road sport since the race's inception in 1967. VW's arrangement for a three-year racing program with AMR required some stability in the rules so these negotiations were extremely important.

**DAYLIGHT AT LAST.** After months of fabrication VW's Baja Touareg chassis emerges from AMR's secret development compound in California's high desert just weeks before its race debut at the Baja 1000

**AIRBORNE!** Ryan Arciero takes to the air in Ensenada's famous wash at the start of the 2008 Baja 1000. Note the long travel of the rear suspension.

**GREAT MINDS CONFER.** Mark Miller and AMR designer Trevor Harris discuss the VW's performance potential just prior to the Touareg's debut in the Tecate SCORE Baja 1000.

**THE SOUND OF SILENCE.** The Baja Touareg's 550 Bhp V12 turbo-diesel is eerily silent, even at 100 MPH!

Contingency money for any winning VW-powered racer in the SCORE race was also included, as well as making VW Touaregs the official support vehicles for the SCORE series. Realizing the potential "unfair advantage" the turbo-diesel's phenomenal fuel mileage could deliver for the proposed "Baja Touareg" over the conventionally fueled Trophy-Trucks, Bill Savage mandated a 65 gallon restriction on the size of the fuel cell in VW's new racer.

## RADICAL TRUCK, RADICAL GEARBOX

While the use of a LeMans-perfected racing powerplant came into fruition (see sidebar below), it was also decided that the engine's comparatively low and narrow effective RPM power-range necessitated the use of an English-built Xtrac six-speed, sequential transmission. Since the world-renown English firm already had considerable experience building sequential gearboxes for both the LeMans-winning Audi R10 road racers and VW's Dakar rally machines, they readily agreed to share the development costs of the Baja Touareg's new paddle-shifted six speed.

Mexico's unforgiving roads represented an unmatched test for the proposed transmission, with a major problem being the need to place such serious engine torque through any type of transmission in Baja – not to mention being hindered by the absence of any device to attenuate the sudden and extreme shock loads created by the rugged terrain. Trophy-Trucks spend a considerable amount of time in the air that results in pressure spikes upon touchdown, a situation that creates serious metal fracturing conditions never imagined by Xtrac's pavement-savvy engineers before they began manufacturing off-road gearboxes.

Traditional practice with many Trophy-Trucks is to use a beefed-up automatic transmission, as the fluid coupling of the torque-converter tends to lessen these shocks. This widely accepted compromise also limits ratios and the slight delay in throttle response. Since American V8s have a fairly wide usable RPM range compared to the V12 turbo-diesel, automatics are used almost exclusively the Trophy-Truck class. In VW's proposed racer, the use of the Xtrac gearbox, at least in theory, sounded good, but again, the risk of relying on unproven technology was great. However, tenths of a second saved on the exit of every corner in a thousand mile race could add up to minutes at the finish line.

Once the project was underway, General Manager Don Tebbe brought in famed American race-car designer Trevor Harris to help pen the chassis and lay-out the suspension geometry for the new racer. Both men were naturally concerned about the durability of an unproven sequential transmission in Baja. It would have been easy to reject the Xtrac and opt for the proven reliability of an automatic, but "easy" isn't in the Tebbe/Harris playbook. These two veteran players always carefully evaluate all the options and make their final selections on what might be an improvement over existing technology. Their solution, after considerable discussion with Xtrac's engineers, was the use of a second "slipper clutch" sandwiched

**TRANS FORMED.** Xtrac's English transmission techs prepare the Baja Touareg's six-speed sequentials for preliminary testing. The exotic "slipper clutch" is mounted directly to the crankshaft between the engine and transmission. A seperate multi-plate clutch is mounted externally, so the clutch can be repalced in minutes. Proper preload for the trick slipper is determined by studying electronic data gathered during testing.

**SOPHISTICATED THINKING.** From renderings to clay to full-size foam, VW's California design studio in Santa Monica did a beautiful job of clothing AMR's tube-framed chassis.

integrally between the engine and transmission. The slipper, preset to release automatically under instantaneous spike-loads, would, theoretically, prevent destruction of the transmission's internals.

Tebbe and Harris also elected to use some unusual ideas in the Baja Touareg's chassis design, cleverly combining them with proven elements. The mid-chassis-mounted V12 engine, for example, has power coming off the front end, going forward, through the slipper to the transmission. A quickly replaceable multi-disc clutch is mounted in a separate case on the side of the transmission housing. The transmission, mounted under the driver's seat, delivers power laterally to a long propeller shaft that, in turn, transfers power back to the severely offset ring and pinion in the live rear axle. The use of a conventional solid rear axle is often questioned by those unfamiliar with off-road racing, as the penalty of seemingly excessive unsprung weight might be solved by the use of an independent rear suspension. IRS is the usual choice of most teams racing rear or mid-engined "Unlimited" Class 1 open-wheel "buggies". As tempting as it would seem to fit an IRS unit, the limitation of less rear suspension travel usually deters this decision. Forward motion depends on rear wheel contact with the ground. Trophy-Trucks spend much time in the air, so the ability of a live rear axle to maintain more terrain contact, even if it only amounts to tenths of a second per jump, adds up over the long run. A live rear axle requires an extra long propeller-shaft and massive radius-rods to control geometry but no one has yet come up with a proven, viable alternative.

## DRESSING THE BEAST WITHIN

Once the basic chassis was laid out the computerized skeletal drawings were handed off to VW's Design Center in Santa Monica, California where off-road enthusiast Alex Earle took over the task of creating a svelte body for the new Baja racer. This was no small aesthetic challenge, as the large-tube, chrome-moly space fame with its huge 37" diameter BFGoodrich tires was much larger in every dimension than a stock Touareg. Even though the

SCORE rules place no restrictions on final appearance of a TT's body, other than it should "resemble" its origins, it was vitally important from VW's marketing standpoint that this new racer be instantly identifiable as a VW Touareg. The entire exercise included making three clay models of the body (a long-held tradition in the design of production cars) for approval by Volkswagen, but the resulting lines from VW's Design center are so successful that it's difficult to ascertain the racer's true size until it's parked alongside a stock Touareg.

Once the bare chassis was completed at AMR's facility it was taken, in the dark of night, to a secret location in California's high desert near Victorville for shake down tests. *Dirt Sports* was invited along to record the initial runs. Even without its skin the numbers were impressive. Tebbe and Harris had comparative data from earlier tests with previous projects to overlay the new numbers. Most impressive was the Baja Touareg's acceleration. Both had been told what to expect in terms of torque from the V12 but the times were still impressive — so much so there was some concern about the durability of the ring and pinion. Some initial, drive-line vibration problems were encountered with the articulated, off-set, drive line, but Tebbe cleverly resolved these issues with a simplification of the propeller shaft path. Once these tests were completed the chassis returned to AMR for fitment of the new body.

To ease service, the entire body can be installed or removed in a matter of minutes. The aesthetic transformation, when the body was first fitted, was remarkable and exciting, especially once the new Red-Bull sponsorship signage was applied by former PPI painter Chris Hukill.

A few hours of photography were devoted to photographer Boyd Jaynes and our Masterpiece in

Metal feature (see page 54) and then a final, quick test in the high desert, to insure all systems were operational, as planned, with the body in place. Almost immediately, upon its return, the Baja Touareg was rushed north for its public debut at the Los Angeles Auto Show and then, even before the world's press had enough time to finish shooting, it was again loaded on a trailer and sent south across the border, to Ensenada for the start of the SCORE Tecate Baja 1000 for the car's first "real world" test.

Arciero and Miller drew the 14th starting slot, with Arciero talking the green flag about 11 am. The VW showing good speed until it was slowed unexpectedly by clutch problems. A minor hydraulic leak, caused by the failure of a simple, 25 cent crush-washer, temporarily sidelined the VW at race mile 44. The team's support crew arrived within minutes. For good measure the entire clutch mechanism was replaced and Arciero was back on the road. The resulting damage caused to the transmission gears eventually lead to a complete transmission replacement at race mile 130.

Miller took over at the team's halfway point and overcame night, dust and heavy traffic to get the new racer to the Ensenada finish line, a performance good for 13th in class and 74th overall. "We didn't get a chance to duplicate those silt conditions in our tests, so we learned what's needed for our next outing" said Arciero after the race. "The main thing is we completed the full 631 miles and finished." That was, in fact, the team's stated goal prior to the 1000, so development is proceeding on schedule.

The Arciero-Miller crew has already analyzed the data from the 1000, re-prepped the Touareg and gone back down to Baja to duplicate the conditions that gave them problems. The team's next competition will most probably be the Baja 500 in June. This time the team will run two race Touaregs and with the fevered development program the expectancy is good that the team will finish in the top ten.

What's important to remember is that the whole project is revolutionary. If the turbo-diesel is as fast as some predict, it may establish a whole new level of competition. Should that happen it could well obsolete every other Trophy-Truck in the field and re-establish the name Volkswagen as the new king of Baja — a position long held in the beginning history of this famous race. DS

## FINDING TWELVE CYLINDERS OF PERFECT POWER

Audi R10 TDI at LeMans

GETTY IMAGES

Since the production, iron block, V10 Touareg turbo-diesel had never been intended for racing and was ending its production run, an alternate TDI powerplant would be needed for the Baja project. Thankfully for all concerned, the Volkswagen Group had at its disposal a brilliant solution in the form of the all-alloy V12 TDI turbo-diesel racing engine used in Audi's LeMans-winning prototypes.

While Volkswagen is hesitant to disclose just how much of that engine is used for the Baja Touareg project, the complexity and sophistication of group's 5.5 liter, diesel-powered, V12 made it an unusual choice for the Baja project as it is closer in concept and construction to an F1 racing engine rather than a traditional big-bore off-road stormer. With some 550 BHP on tap and 625 ft/lbs of torque (in Baja configuration) it would easily provide incredible acceleration, as well as good sustainable top speed, but the downside was its actual suitability to the task. Could such an exotic piece of machinery survive in Baja's harsh environment without constant attention?

On paper the engine looked absolutely fantastic but its basic dimensions meant that a decision to integrate it into the new chassis would probably cancel out any other immediate choice if it didn't work. Another oddity was the fact that the diesel engines rely on pressure and heat for ignition, and sensitivity to operating temperature is an issue. Since the mechanical tolerances were so close and precise the engine would have to be warmed from an external source prior to start. No problem in a race engine for circuit racing where its vital signs could be constantly monitored by telemetry, but there would be no jumping in and firing the engine on a moment's notice. Startup required almost half an hour of warming with a pre-heater. What if some unexpected event in the middle of nowhere required the engine to be shut off in the bitter cold of a Baja night? Without the three German specialist engineers assigned to the engine, and its bulky pre-heater, would the V12 be a mechanically frozen, unstartable mass?

Instead of looking at what could possibly go wrong and then trying to recover the AMR team looked only at winning; nothing would go wrong if everything went to plan. It was decided, because of the obvious positives, that the temperature issue was an acceptable risk. Besides, it was a proven, high-tech engine within the corporate Volkswagen family that had already claimed the top prize at the longest and most prestigious sports car marathon on earth. What could go wrong? As it turned out over thousands of test miles and one long SCORE Baja 1000 – thankfully not a thing.

MASTERPIECE IN METAL

Since its inception, the wide open rules package behind SCORE Trophy-Truck racing has been a welcome counterpoint to the increasingly constrictive regulations that guide (some say hinder) the rest of today's motorsports universe. What was once a viable proving ground has, in many cases, become a homogenized theater of competition often stifling true advancements in automotive technology.

For forward-thinking companies like Volkswagen, that restrictive environment is thankfully absent from off-road racing's showcase class. In what history may remember as the most paradigm-changing desert vehicle ever built, Volkswagen's radical Baja Touareg refines the game to stratospheric new levels of technology and engineering.

*Dirt Sports* was recently invited by Volkswagen to take an exclusive tour of the Arciero-Miller Racing (AMR) facility, home to the Baja Touareg race program. Team Owner and Driver Ryan Arciero and General Manager Don Tebbe allowed us unprecedented access to gaze in awestruck wonder at both the partially disassembled Baja Touareg and the initial steel tubes of a sister car. Every passing moment brought increased realization that the fascination surrounding this outstanding factory effort is more than justified — it is demanded.

At the heart of it all is Volkswagen's crown jewel; the incredibly sophisticated Baja Touareg. Incorporating the genius of designer Trevor Harris, the real world practicality of Tebbe, the thousands of desert racing miles shared by Arciero and Mark Miller and Volkswagen's collective infusion of technical wizardry and science, six Masterpiece in Metal pages only hint at what is really going on behind the highly-secured doors of AMR.

Fortunately, Volkswagen's Clark Campbell carved out enough time in the intensely hectic days leading up to the Baja Touareg's world-wide Los Angeles Auto Show unveiling to allow us to capture this stunning new Trophy-Truck. Volkswagen's Baja Touareg is one for ages; a technological wonder that may indeed be the ultimate game changer.

# TROPHY-TRUCK REDEFINED

## WITH THE INTRODUCTION OF THIS TECHNICAL TOUR DE FORCE, VOLKSWAGEN'S NEW TOUAREG TROPHY-TRUCK IS THE ULTIMATE GAME CHANGER

STORY BY MARTY FIOLKA | PHOTOS BY BOYD JAYNES

MASTERPIECE IN METAL


**TOP:**
**With exacting attention to detail, line and proportion, distinguishing the new Baja Touareg's race body from the production version is difficult — and that is by design. Yes, the grill is a factory piece, but the real story lies just behind it. In order to keep that stock appearance as long as possible, four Hella HID lights are mounted just behind the grill, which comes off during late afternoon pits stops.**

**RIGHT:**
**Baja Touareg's space-aged drivetrain system is anchored by this exotic new Xtrac transmission. Six-speed gearbox is a specially engineered derivative of the Xtrac units VW uses in its Dakar factory program. Transmission features completely integrated transfer case (note driveshaft) and a Sachs slipper clutch designed to reduce harmful torque spikes.**


**BELOW RIGHT:**
**Designer Trevor Harris' touch is evident in the Touareg's simple and very lightweight front suspension. What appears to be an upper "A-arm" is an articulating support for Fox bump stop. Low mass, tube upper "A-arm" is light and strong. Truck's lower arms use more traditional plate construction. AMR-specified, Fox-supplied dampers consist of one 3.0 inch coil-over and one 3.0 inch, five tube bypass shock per corner.**

**TOP:**
**This view of Touarag "undressed" reveals striking dual exhaust system. No, that's not a muffler but Volkswagen's high-tech, specially-made racing particulate filter that captures final emissions exiting from Touareg's exotic V12 diesel. Volkswagen's commitment to being environmentally respectful is a crucial cornerstone to the entire project.**

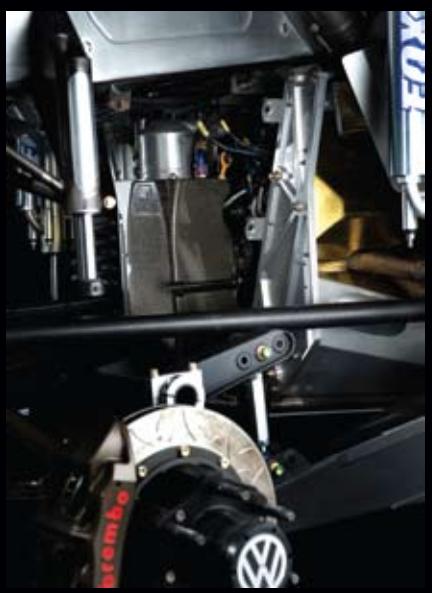
**LEFT:**
**A glance at Touareg's rear suspension shows solid rear end that houses and 10" ring and pinion. Trevor Harris-designed sway bar assembly is mounted to rear end using trailing arms for leverage via short, adjustable links. Fox-supplied 3.0 inch bypass shock is just behind 3.0 inch Fox coil-over. Use of single rate Eibach spring with short Eibach "tender" spring is unusual.**

**BELOW LEFT:**
**Careful packaging of dual Garrett turbochargers and waste gate are keys to avoiding off-road damage. Interestingly, the Baja Touareg uses a water-to-air (instead of air-to-air) intercooling system to increase throttle response. The truck's 5.5 liter V12 is feed via two huge AFE-designed air filters. (not shown).**

**TOP:**
**Another unique feature of the Baja Touareg is the use of dual "discriminator" fuel check valves run in-line that vent each side of the Harmon Racing Products-built 65 gallon fuel cell. This system allows single (instead of traditional dual) dry brake refueling. Just ahead of massive 21" EFE cooling fans are dual C&R radiators needed for the VW diesel engine's dual cooling systems that are driven by two separate water pumps!**

**RIGHT:**
**Protecting the Touareg's V12 and its all-important Bosch fuel injection system from high exhaust temperatures and rock damage necessitates the extensive use of costly heat reflective film (seen in gold).**

**FAR RIGHT:**
**Like many modern off-road racers, use of massive billet engine plate is the key to easing transmission removal by allowing the engine to stay put. Also visible just above the tubular rear link arm is Volkswagen's carbon composite oil tank. Brembo six-piston calipers and specially grooved Brembo rotors (that dissipate brake pad gasses) provide world-class stopping power.**



**BOTTOM:**
**Without its sleek Red Bull bodywork, AMR's Don Tebbe admits that Touareg's cab-forward chassis looks slightly "goofy." Keeping the production body's roof lines led to radiused corners in the roll cage. Trick new KMC forged beadlock wheels are wrapped in 37" BFGoodrich Baja T/A race tires.**


**ABOVE:**
**Here is the interior view of carbon fiber dash team co-drivers Willie Valdez Jr. and Ben Metcalf enjoy. Dual steering column-mounted paddle shifters control both upshifts and downshifts via a still-in-development "no lift shift" fuel cut-off system. Driver's side features Bosch electronic dash that provides all-important engine data acquisition, while Racepak IQ3 dash handles chassis and shock data. A huge 10" Lowrance 9200 GPS and Sparco carbon-fiber seats complete the package.** ds

## SPECIFICATIONS: VOLKSWAGEN BAJA TOUAREG TDI

### POWERTRAIN

**ENGINE:**
Volkswagen V12 TDI Turbo Diesel 5.5-liters

**BUILDER:**
Volkswagen Group (in Germany)

**MAX HORSEPOWER:**
550 bhp.

**MAX TORQUE:**
625 ft.lbs.

**INDUCTION:**
Garrett twin turbos, fuel injection and engine management system by Bosch.

**TRANSMISSION:**
Specially built six-speed sequential by Xtrac. Includes integrated transfer case and carbon slipper, engine clutch by Sachs.

### SUSPENSION

**FRONT:**
Trevor Harris-designed double A-arm with Fox Shox 3.0-inch coil-over damper and Eibach springs plus 3.0-inch, five-tube bypass by Fox Shox and Fox 2.0 bump stop. 25 inches of wheel travel.

**REAR:**
Custom four-link rear suspension and live rear axle housing a custom 10" ring and pinion. AMR trailing arms incorporating Trevor Harris sway bar assembly and Fox Shox 3.0-inch coil-over damper with Eibach springs plus 3.0-inch, five-tube bypass by Fox Shox and Fox 2.0 bump stop. 30 inches of wheel travel.

### BRAKES

**FRONT:**
Brembo six-piston calipers with 14" Brembo "gas grooved" rotors.

**REAR:**
Brembo six-piston calipers with 14" Brembo "gas grooved" rotors.

### WHEELS/TIRES

**WHEELS:**
Custom, AMR-specified, 17x8 inch forged alloy wheels by KMC

**TIRES:**
37x12.50R17 BFGoodrich KRT

### INTERIOR

Custom AMR carbon-fiber dash, Sparco carbon-fiber race seats, Bosch digital dash, Racepak IQ3 data acquisition dash, Lowrance 9200 color GPS unit, Performance Technology radio system, wiring by AMR

### GENERAL

**CHASSIS:**
Custom design by Trevor Harris, fabricated from Chromoly by AMR.

**BODY:**
Lightweight fiberglass body by CCCI.

**PAINT:**
Hukill Graphics

**DIMENSIONS:**
Wheelbase: 125 inches
Overall Length: 213 inches
Overall Height: 6 feet 6 inches
Track Width: 92 inches
Weight: 5,650 pounds