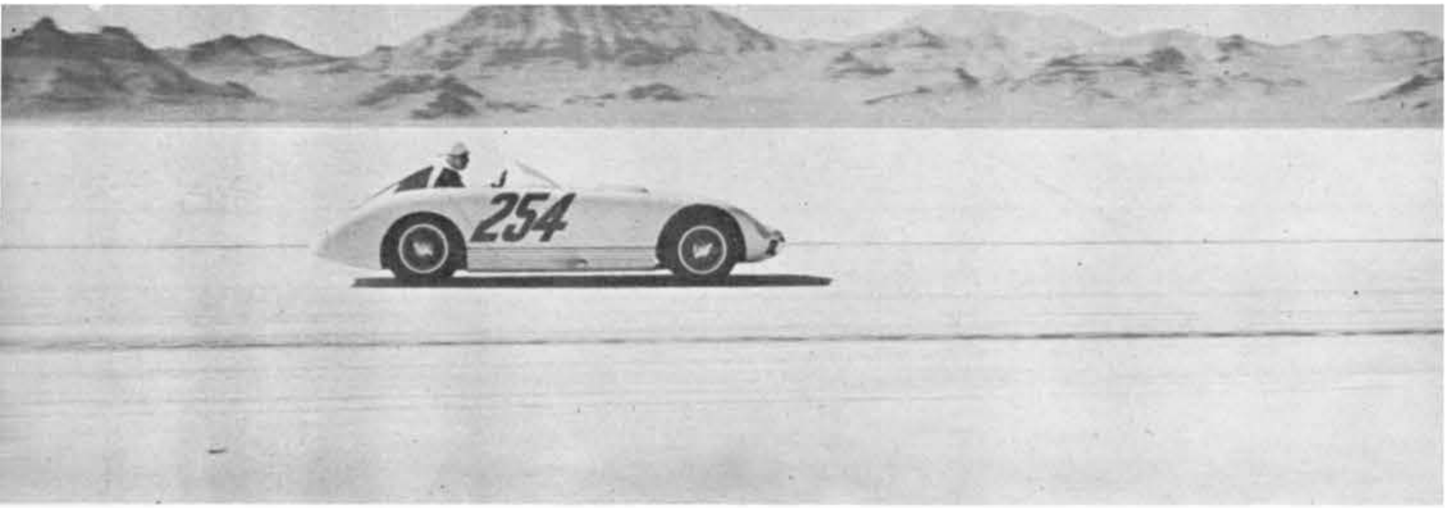
SAND vs SALT

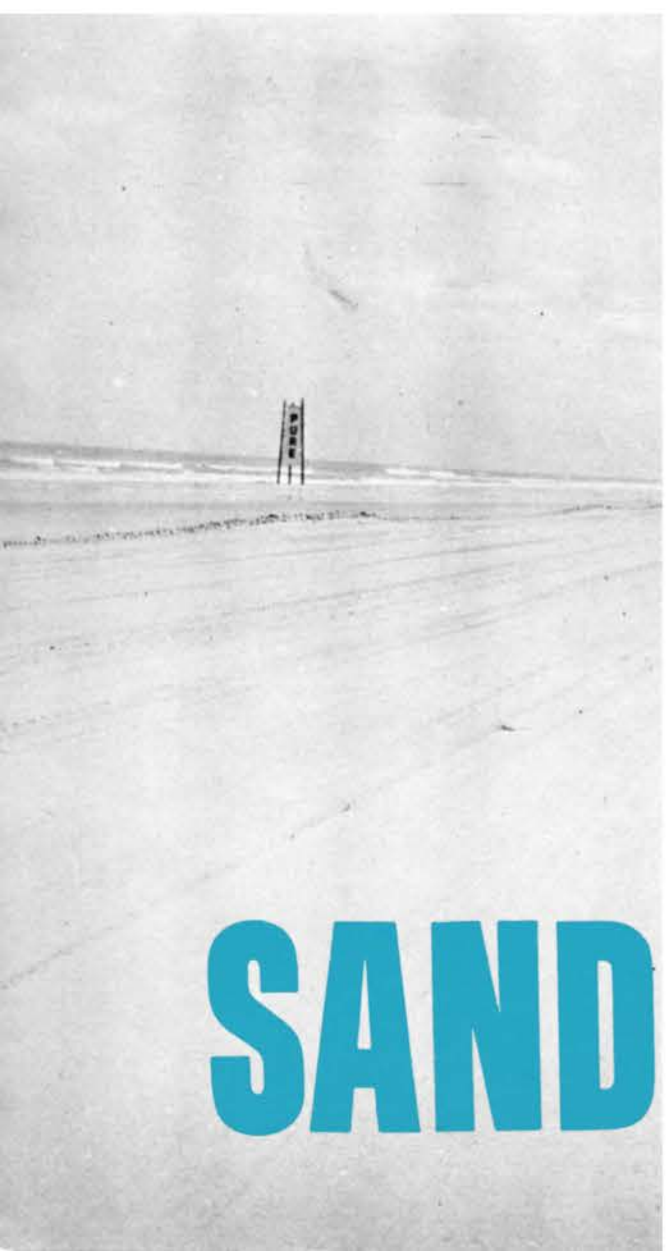
The two most famous record courses in the world are right here in the U. S. A. Here's how they compare.

by Roger Huntington, SAE

On big, flat, wide-open Bonneville there is plenty of room, consequently few accidents. If the car spins, releasing the wheel allows it to straighten itself out. However as speeds increase, even the flats seem to be getting a lot smaller.



Very poor beach conditions at Daytona; a direct off-shore wind has cut 15 inch deep dips in the beach, cresting each 50 feet. Road graders tried; no use.



THERE are very few places in the world today where you can drive a really fast car flat out with a high degree of safety. Top-speed jobs out-grew normal highways forty years ago. (The Germans clocked as high as 270 mph on a superhighway in the late '30s, but only at the price of one fatality and a couple of near-misses.) No, for today's speeds we need wide open spaces—as much width as possible, a course length of anywhere from four to twenty miles can be used; we need an extremely smooth, level surface, and a high traction coefficient between the course surface and an automobile tire.

There's no such place in the world today, but the two best compromises are apparently right here in America—the Bonneville Salt Flats in Utah and Daytona Beach, Florida.

With NASCAR's annual Daytona "Speed Week" and Southern California Timing Association's Bonneville Nationals getting bigger every year, the poor auto enthusiast is being bombarded by "records" from all sides. He hardly knows what to swallow and what to chew. The big Detroit manufacturers, jumping into past years' Daytona events to pitch a little publicity hay, haven't helped matters any, either. Not only have the ad men exaggerated certain records and performances out of all proportion to their real importance, but emphasis on Daytona Beach as a speed course for the "big-time" boys may have left the impression that it's greatly superior to Bonneville. How about a yardstick for comparing performances turned on the two courses?

Let's do a little sifting . . .

Noboby is claiming that Daytona is suitable for super-speed cars anymore—or, say, over 200 mph cars. Campbell all but killed himself when he turned 276.8 mph with his Bluebird back in 1935. The big six-ton monster took off like a kiddie car on the dips in 30-foot leaps, zigzagged on the course, knocked down marker flags, and just barely threaded a 42-foot opening under a pier near the north end of the beach. Daytona is not smooth enough, wide enough, nor long enough for this heavy artillery. (Actually, NASCAR uses only about five miles of the south end of the beach for Speed Week, but 9 to 11 miles have been used by the old record-breakers.)

How suitable is Daytona for speeds *under* 200 mph?

A lot depends on the weather. The beach surface is very sensitive to weather and wind conditions—much more so than Bonneville. Campbell had to wait as long as eight weeks at a stretch for beach conditions suitable for speeds in the neighborhood of 250 mph. Practically the whole first week's program was wiped off the Speed Week calendar last year because of bad beach conditions, necessitating a crowded and generally unsatisfactory schedule the second week. This is a little-publicized problem of the Florida speed course — (maybe because they've been fantastically lucky in the past!).

What happens is this: there must be a fairly stiff wind in a more or less *coast-wise* direction (parallel with the shore line) that will blow the surf in circular swirls. This levels and smooths the sand just like you'd work concrete with a trowel. An off-shore wind blowing nearly vertical to the shore line will just cut dips in the beach. Under the worst conditions these dips are about 50 feet between crests and maybe 15 inches deep. Speeds over 40 mph will throw you out of the seat.

On the other hand, too much wind parallel to the shore line will set up small ripples in the sand across the course. These aren't dangerous at speeds below 150 mph, but the tires tend to plow through them rather than glide over, and

Look at all that room. The salt is usually quite damp and does not give a solid tire bite. Tire traction is about equal to Daytona sand; however it doesn't dig up.

This is what happens to tire traction when the sand starts to get loose. It digs up just like gravel.

Finish of the standing quarter at Daytona. Frequently cars must evade pools of water to cross the pneumatic tube finish line, often misplaced as much as 8 feet.

When tires pass over pneumatic hoses, elaborate mechanism inside NASCAR tower records the times of day at both ends. Hours, minutes and seconds are computed—mathematically—then are converted into mph—to nearest thousandth. (Oh!)

ATAA crew at its post, timing official runs. Note precise arrangement of timing stand, tower, and equipment.

Daytona boasts excellent facilities for both people and cars; DePaolo Engineering Fords at their garage.

this extra drag can easily knock 5 or 10 mph off your speed. (One way to fight this "ripple drag" is to use softer shocks, to allow the wheels more up-and-down freedom.)

Anyway, you can see that Daytona Beach, as a speed course, is pretty much at the mercy of Mother Nature—and it will be obvious that a "perfect" beach is a rare animal. When you get one you've got a very smooth, level, firm speedway; quite safe and reliable, I think, for most any car up to 200 mph. Most serious limitations then are width and hardness. At low tide—a condition that can be figured on only for two one-hour periods in each 24—we have at least 100 ft. between soft sand and the water. This doesn't leave a lot of room to move around especially if control of the car is lost due to a sudden sidewind gust, steering failure, blowout, etc. A number of world record cars crashed into the soft sand and into the water when the drivers lost control for one reason or another. The danger is increased by the more or less soft consistency of the wet sand surface. If a tire blows, the wheel will tend to dig into the sand and flip the car, rather than just skid to a stop. This has happened, too.

Safety-wise, we've got to rate Daytona well below Bonneville.

A vital factor in all performances turned at Daytona is the *rolling resistance* of the tires on the sand surface. Some drivers say they can even tell by the seat of the pants that this is holding them back a lot; others disagree—say the sand is a lot of driving on pavement. Our tests, using an accelerometer to measure the deceleration of the car at various speeds when coasting on the sand, suggest that—with a given tire, load, speed, and inflation pressure—total rolling resistance on the beach is roughly *three to four times* what it would be on hard pavement.

The sand is not as solid as it looks and feels. It's wet, and it *packs down* under pressure. This packing is not apparent when the tire is rolling, but as soon as the car comes to a stop the tire will slowly sink down a fraction of an inch. Actually, this packing is present to some extent when the

J. Otto Crocker, grand old man of timing with clock unit and the glow-tube electronic timer, accuracy attested to by Bureau of Standards to milliseconds.

car is moving, and the resulting "bow wave" effect ahead of the tire causes the extra rolling resistance. At higher speeds the tires seem to get into some kind of "planing" condition, where the packing is reduced, and the drag increment apparently levels off some. In other words, the added rolling drag seems to be greater at low speeds than at the top end.

(Incidentally, tricks that reduce rolling resistance—high inflation pressures, special racing tires, thin treads, etc.—are especially effective on the beach. The Firestone "Bonneville" tire, pumped to 60 psi, was the talk of the town at Daytona.

Then there's traction. This can depend a lot on beach conditions, too. The damp sand close to the water is quite solid, and traction is fair. Surprisingly enough, it doesn't dig up badly where the cars blast off from a standing start. But if dips in the beach force you up onto drier sand, there's no bite; the stuff throws around like so much gravel, and traction takes a nosedive. Tests show that the effective traction coefficient, under good conditions, will run in the neighborhood of .55—or roughly two-thirds of what you would get on dry pavement. Slicks and cleated treads will help – (Duntov had "Town & Country" treads recapped on Firestone "Super Sports 170" casings for his record Corvette) – and the same rules about holding down wheelspin that apply on pavement seem to apply here; the less spin the better. Traction isn't so bad, though, that it would pay to load down the rear end of the car with ballast.

Actually, in my opinion, standing-start acceleration tests on the beach are useless and inconclusive. No car can even approach the times it could turn on pavement under similar conditions. Not only are they sacrificing traction, but the rolling resistance factor is holding them back all the time. The worst part about it is that this traction and rolling drag are greatly influenced by car weight, tread pattern, inflation, and tire size . . . so these secondary factors can have more of an influence on the standing-mile time than horsepower and driving technique! It's a big waste of time for my buck.

But Bonneville is another story.

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In spite of skid marks at starting line, salt is not torn up. Occasionally, however, surface must be scraped.

Top speed/elapsed time Chrondek unit, similar to Bonneville's, is extremely accurate and available.

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BONNEVILLE

Here is certainly the finest natural speedway in the world. It has worlds of space—at least in terms of speeds up to 350 mph; the surface is as hard and level as a billiard table, comparatively smooth, easy on tires, and traction is fair.

The Bonneville Salt Flats form one section of a 7,000 square mile wasteland in the western part of Utah—what was once the bottom of a huge pre-historic salt water lake that geologists have named Lake Bonneville. The water level of the lake dropped, leaving a large salt deposit in the lowest section and a larger area of unvegetated mud flats on the higher ground. Great Salt Lake to the northeast is the remaining body of water. The area of the Salt Flats is about 200 square miles.

Unfortunately, a railroad and U.S. Highway 40 cut just about through the center of the salt area, so the maximum usable straight length for speed runs is only about 15 miles. This is ample for cars running up to 350 mph, but it would be a serious limitation if you were trying to make over 400 with the thrust transmitted through the tires. (Not necessarily so with jet or rocket thrust.) Cobb was accelerating clear through the measured mile on his 403-mph run.

Surface-wise, Bonneville offers much more than the Daytona sand. The depth of this fantastic sea of solid crystalline salt will vary from a fraction of an inch at the edge of the lake to about four feet at the deepest. It is very dense, almost non-porous, when compared to sand, and the surface is about as hard as concrete. Variable expansion and contraction of this solid block of salt causes the surface to be criss-crossed with small—and sometimes rather large—cracks or fissures. Sometimes it's necessary to scrape the course before high-speed runs. These surface conditions are also affected by the moisture content of the salt mass. The salt, of course, absorbs water, and we have a weird "water table" that rises and falls below the surface — (that is, you can drill down into the salt and strike brine a few inches below the surface). If the water table gets too low and the surface salt is too dry, it will get loose and dig up under hard pounding. Surface conditions were relatively poor during most of last year's Nationals.

Traction on the salt is not appreciably better than on damp sand at Daytona. Rubbing pressure on the surface will grind off the top salt crystals somewhat like sandstone, so there's really no solid bite available here. Slick treads should be very effective on the salt; but with any type of casing and tread suitable for high top-speeds your effective traction coefficient couldn't be much over .60, or about what we get at Daytona.

This traction problem is going to get tougher as speeds go up. (I'm thinking now in terms of hot rod-type cars, using modified production parts and amateur construction. These cars have hit as high as 255 mph on the Flats, and are shooting at 300.) The problem isn't one of getting enough traction to accelerate up to maximum speed in the available distance — there's plenty of room to get up to at least 325 mph, even with poor traction. It's simply a matter of developing enough *forward thrust* to overcome the drag at high speed on a light car with lots of horsepower.

Suppose we have a small coupe with average streamlining, a total weight of 2200 pounds, and we have 55 percent of this total weight on the rear wheels under full power (this includes the effect of front-to-rear weight transfer due to torque reaction). Then the maximum forward thrust we can possibly get at any speed will be approximately 2200 x .55 x .60 = 726 lbs. At the same time, the total drag of our coupe may be 726 pounds at a speed of 190 mph. This would be equivalent to 368 hp. In other words, wheelspin would keep us from using more than 368 hp in this car at Bonneville, regardless of nitro, cubic inches, cams or anything else. This is a very real problem.

Furthermore, any abnormal aerodynamic lift on the body at high speed only aggravates the problem. Bill Kenz' twin-engine streamliner started leaving long black rubber streaks on the salt above 230 mph where the tires broke loose due to tail lift. Four-wheel drive will help a lot, but I fear we'll always have a traction problem at Bonneville.

Atmospheric conditions throw another strike on the Flats as a speed course. The altitude here is 4228 ft above sea level—which means a low ambient barometric pressure—and the air temperature is generally high during the fall season when the salt is suitable for racing. Average figures might be 25.6 inches Hg. absolute barometer and 90° F. air temp. Now we all know that low air pressure and high temperature combine to *reduce* both the air drag on the car *and* the horsepower output of the engine. Compared with standard sea-level conditions, the above temperature and pressure would reduce air drag by 19 percent, and HP by from 15 to 25 percent, depending on the engine (engine friction is a factor in this figure).

Does this mean, then, since the percentage drop in air drag and horsepower are about the same, that top speed would also be the same as at sea level? Not quite. Remember, tire rolling resistance makes up anywhere from 1/10th to 1/2 of the total drag of the car at top speed—and this doesn't change appreciably with atmospheric conditions. This means that the percentage drop in *total* car drag (wind resistance plus tire drag) due to atmospheric conditions on the Flats will be a good deal less than the percentage drop in horsepower output. Given optimum gearing, a car will go anywhere from 2 to 10 percent faster at sea level.

But this still beats Daytona. If tire rolling resistance on the sand is three or four times higher than on the salt under similar conditions—which is what all the evidence suggests—then this will more than offset the loss in horsepower on the Flats. My slide rule says a car should go maybe 3 to 7 percent faster on the Flats, other fac-

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tors equal. That should settle — (or start) — a few arguments!

And one other word about Bonneville: We have a weather problem here, too. In a normal year the Flats are under a six-inch sea of water for about nine months out of twelve. Only in September and parts of August and October is it dry enough for speed runs.

TIMING

No comparison of Bonneville and Daytona would be complete without mention of the timing methods. One ought to consider timing procedures carefully when he evaluates "official" speed records.

We're going to have to give the nod to Bonneville here. The timing equipment and general procedures used by the California hot rod bunch—both at Bonneville *and* the drag strips—are far and away the most advanced, accurate, and reliable in the world . . . and that includes the official F.I.A. timing of international records! The amateurs have tackled and solved this complex problem with equipment that makes everything else obsolete by comparison.

The California boys use two basic systems. In both cases the timer is tripped by a photo-electric switch when the car breaks a light beam, and both depend, for their accuracy, on maintaining a fixed frequency of an AC power supply. This frequency is controlled by a temperature-compensated tuning fork vibrator with a total error of less than .18 second in 24 hours. The Crocker variation of this basic layout has the clock driven by a synchronous motor. The motor runs continuously, but the clock is connected and disconnected (started and stopped) by a super-sensitive electric clutch. This type of clock reads to 1/100th of a second. It is very responsive, and any slight lag in the relays or mechanism is consistent, and cancels out in the final result.

The new "Chrondek" millisecond timer, developed by O. V. Riley of LaVerne, California, reads to 1/1000th second. This timer eliminates all mechanical linkage, and elapsed time between light beam signals is totalled up by electronic *counting* circuits—similar to those "electronic brain" machines. The time is indicated by glow spots under numbers on circular dials. One dial has each number lit a thousand times each second, and the last number glowing is the thousandth reading. The next dial counts hundredths—and so on. The Riley electronic timer is one of the most advanced for automotive work in the world.

By comparison, the famed "$10,000 clock" used by NASCAR at Daytona looks like a Mickey Mouse watch! The basic system was designed some thirty years ago, and has been in use to time speed runs on the beach ever since. It's now owned by the Daytona Beach Chamber of Commerce. The clock itself is mechanical, indicating to 1/100th second; start and stop actuation is by electro-magnetic clutch action. The car trips the clock by running over a pneumatic tube stretched across the beach. The tube contains current-conducting wires that are held apart by the air pressure inside. The weight of the car closes a circuit and actuates the clock.

Needless to say, this Rube Goldberg gimmick has been the source of more than one argument at Daytona. It's not widely known, but the big "overbore" hassle between Chevrolet and Ford at the recent Speed Week centered around timing. Here's about the way it went:

The beach was in quite bad condition for the standing mile runs on Feb. 19th. The area around the starting line was getting loose, and the pneumatic tube was being thrown around a lot by the spinning tires. Then somebody got the bright idea of pulling the tube off to one side and having one of the officials *jump on it* when the starter flagged the car off! Everything proceeded smoothly. Chuck Daigh went through in the factory Thunderbird for an average speed of 92.1 mph, which was the best time of the meet up to then. Then a few minutes later Duntov blasted through in the modified Corvette . . . and the clock showed an average of *112 mph!!*

Impossible. That's what NASCAR officials thought anyway, and the time was erased off the record sheet. This action brought the protest from Chevrolet: either credit the Corvette with 112 mph or re-run the whole event with normal timing procedure. Apparently NASCAR wasn't anxious to have their timing procedures publicized, as they hustled around and managed to disqualify *both* the T'bird and Corvette for being "fractionally oversize" on the bore. (The whole deal didn't help to improve timing methods, though. Some later standing-mile runs were made with an official pressing a button when the starting flag was dropped.)

So don't ever forget the timing method when you look at the record sheet.

To sum up on Daytona vs. Bonneville, then: *neither* course can demonstrate the true potentiality of a given car, because of atmospheric conditions at Bonneville and rolling resistance at Daytona, and Bonneville is a few percent faster than the sand despite the altitude. Bonneville is suitable for much higher speeds than Daytona because of more space and a smoother surface. Neither course offers decent traction. Daytona Beach is more sensitive to daily weather conditions, though the Flats are only usable about eight weeks out of the year. Bonneville is safer if the car should go out of control.

I suppose Daytona's clinching advantages, though, are the plentiful living accommodations, shop facilities, recreation spots, and their accessibility. This is an out-and-out *resort* town, with all the trimmings . . . ocean beach, hotels, night clubs, restaurants. The big boys can live it up while they're playing with their cars. Bonneville is out in the middle of nowhere, with little (other than racing) to offer 'em but salt, silence, and stars. I realize this aspect has nothing to do with the comparative merits of the two places as speed courses . . . but it's one good reason why the Bonneville Nationals will never run NASCAR's Speed Week out of business!

Of course, there *is* legalized gambling in Wendover . . .

Roger Huntington