We run our drag race engines on the oxygen in the air. The air is only 23% oxygen by weight, so we have to run a lot of air to get an ample supply of oxygen to burn with our fuel. We run our gasoline engines at about 12 parts of air to one part of gasoline. We run our methanol engines at about five parts of air to one part of methanol for normally aspirated engines and about four parts of air to one part of methanol for supercharged engines. We run our nitro engines at a little over one part of air to one part of nitro. With each of these fuels, we have a launch enrichment and high speed lean out in some cases.

Each of our engines runs best on a specific ratio of air to fuel. In fact, it is a specific ratio of oxygen and fuel. Unfortunately the amount of oxygen in the air varies with the air density. Standard air is 100% air density. It occurs at sea level, 60 deg. F. (motor sports temperature standard), barometer of 29.92 inches of mercury and no humidity. A new “closet ghost” into that tuning task is smog. While the science of the effect of smog on race engine air is still unreported, I believe it is a growing concern. I have seen lost racecar performance on smoggy days with no other explanation. The air density rating for standard air would be with the absence of smog.

Unfortunately, we race in conditions that change the air from the 100% density value. We can race in hotter weather and that reduces the air density. We often race racetracks that are above sea level and that reduces the air pressure. We also race in humid air and, of course, smog from time to time. All of these reduce the air density. Racers call that bad air. In a similar manner, cool weather or high barometric pressure increase the air density. Racers call that good air.

NEW CARS DO IT AUTOMATICALLY: In recent highway vehicles with electronic fuel injection, most are equipped with sensors in the exhaust. They read the amount of oxygen in the exhaust. Presence of too much oxygen indicates a lean condition. In this case, the vehicle computer richens the fuel to correct for this condition. Presence of too little oxygen indicates a rich condition. In this case, the vehicle computer leans the fuel to correct for this condition. As the vehicle is driven in different weather conditions and altitudes, the fuel system controls for the vehicle automatically compensate. The vehicle air to fuel ratio is continually adjusted for the best result in the exhaust. It automatically compensates for changes in air, altitude and the fuel.

DRAG RACE VEHICLES OPEN LOOP: IHRA drag racing vehicles with carburetors or mechanical fuel injection do not have provisions for this automatic compensation. Also, the mechanical fuel injection usually do not have provisions as a result, the tuner uses weather and altitude information to set the fuel. A good tuner richens the fuel for good air and leans the fuel for bad air. The amount of fuel adjustment is a tuner skill acquired from experience and cleverness. Weather conditions for good or bad air are tracked with information from local weather reports, Internet weather information on the race track weather and the race track weather stations.

DRAG RACE TUNING FOR MAX: Two methods of compensation for air density are done. One is to adjust the engine for best power for the changing weather conditions. This would be common in open elapsed time classes where there is no breakout. Examples are Top Fuel, Alcohol Funny Car, Pro Mod, and Pro Stock. In these classes, the performance will vary for good and bad air. The racers adjust for that. However, everyone in the class has a boost or handicap from the air.

DRAG RACE TUNING FOR REPEATABILITY: The other method is often used for the bracket classes with a target breakout elapsed time. It is to determine how much the air density effect on performance from good air or bad air. Then the racercar is adjusted to compensate for that effect from air density to reproduce a bracket elapsed time target. The car is turned down in some manner for good air that would otherwise increase the power and performance. It is turned up in some manner for bad air that would otherwise decrease the power and performance. This common method is to change the shift point. It is raised for bad air to recover performance. It is lowered for good air to retard performance back to a target. Some race tuners change a throttle stop, the spark advance, or blower overdrive in blown applications. In any of the later, the intent is to compensate for air density changes where a specific elapsed time target is needed.

DRAG RACE RECORD KEEPING FOR PREDICTING: In some classes, such as Top Sportsman or Top Dragster with an elapsed time dial-in, many competitors do not change anything. They simply use experience or records from previous similar air density conditions to predict an elapsed time. Then they dial that elapsed time as the target. They adjust a faster elapsed time dial-in for good air and a slower elapsed time dial-in for bad air.

MEASUREMENT: AIR DENSITY GAGE: One simple method of determination of air density is to use a calibrated air density gage. This gage is equipped with a mechanism that responds to pressure and temperature changes. It produces an air density reading from typically 60% to 110% depending on the air pressure and temperature. Tuners use the reading from the gage for the previously mentioned tuning routines.

RECALIBRATE: Often tuners use that old air density gage that they bought 20 years ago with the base gage. In the long term, the reading from this will drift and the reading will be off. In fact, vibrations from storage in the trailer on a long tow may throw it out of calibration. Several of the fuel system suppliers who advertise in DRM can supply an air density gage as well as recalibration. It is one tool you may want to carry in your “luxury” tow vehicle, on a soft pillow, or wrapped in a large plastic bag on a seat. Air density gages do not provide information about the effect of humidity or smog.

WEATHER STATION: Another method of determination of air density is to use barometer and temperature values. They can be obtained from racer’s instrumentation and more recently from hourly weather predictions from the Internet. With some simple math, those values can be used to determine air density also.

CALCULATION -- PRESSURE & TEMPERATURE EFFECT: The calculation for air density from barometer and temperature data is as follows:

1) First determine the barometric pressure in inches of mercury.
2) This has to be an accurate barometer. Unfortunately most local weather reports give barometric pressure in corrected values. These are adjusted for the altitude of the weather station. A reading of 30.05 inches of mercury from the local weather information center is an example of a corrected barometric pressure. Norwalk Raceway altitude is about 700 feet above sea level. The correction for that altitude is about -0.7 inches of pressure. Therefore the uncorrected barometric pressure for Norwalk on a day with a local weather report of 30.05 inches of mercury is 30.05 - 0.7 = 29.35 inches of mercury. The corrected barometer is above the standard that would be thought of as an increase in performance. However, the uncorrected barometer is below the standard that actually decreases performance.

Altitude correction charts are available from Internet sources as well as some weather reporting services. Uncorrected barometric pressure values are available from some sources as well, although most barometer readings are corrected. Care is needed in sorting out the difference. According to Kinsler Fuel Injection, a rule of thumb is a reduction of one inch of mercury for every 1,000 feet of elevation.

3) Next, determine the temperature in deg. F.
4) Next, convert the temperature to absolute. That is done by adding 459.67 to the value.
5) Do the following calculation: Air density % = 1,738.86 x uncorrected barometer / absolute temperature

CALCULATION EXAMPLE -- PRESSURE & TEMPERATURE EFFECT:

1) Assume a local barometer reading at Norwalk is 30.05
2) Determine an uncorrected value. Either find that value from a source that has uncorrected barometric pressure in inches of mercury or convert the value from a correction table or chart. The correction for 700 feet elevation is approximately - 0.7 inches or mercury. The uncorrected value is: 30.05 - 0.7 = 29.35
3) Assume a temperature of 90 deg. F.
4) Convert to absolute: 90 deg. F = 459.67 = 549.67 deg. Absolute
5) Air density % = 1,738.86 x 29.35 / 549.67 = 92.7%