BMW Car Club
of America
Rocky Mountain Chapter

PERFORMANCE DRIVING SCHOOL STUDENT MANUAL

If this is your first RMC BMW CCA driving school, there is a lot of information in this manual that will enhance your learning at the driving school. Read it all, but don't expect to absorb everything. It helps to read it again after the school to reinforce what you experienced at the track. For those students who have been to one of our schools before, it never hurts to review.

The manual is periodically revised to include new information.

Contact dsinfo@rmcbmwcca.org with any questions or comments about this document.

PREPARING FOR THE EVENT

REQUIREMENTS

- Students must be 16 years of age or older with a full and valid driver's license - no exceptions.
    - Students under 18 years old: also see the **Minors** section, below
- Helmets must meet the requirements listed below.
- Front windows must be rolled down while on track, except as directed by event officials during inclement weather.
- Trucks, pickups, vans and most SUVs are not allowed. BMW SAVs (X5, X3, and other X-series) and Porsche Cayenne and Macan are allowed.
- Convertibles are defined as cars with retractable soft tops and/or fully removable hard tops. Vehicles with integrated retractable factory hardtops are not considered convertibles for the purposes of our Driving Schools.
    - Please see "APPENDIX 2: CONVERTIBLES" for a detailed list of requirements that convertibles MUST meet in order to be allowed at our Driving Schools.
    - In addition to the rules at "APPENDIX 2: CONVERTIBLES", RMC BMW CCA also requires:
        - Five (or more)-point harnesses for both driver and passenger.
        - Removable roof panels must be in place while on track.

If you have a question about these requirements please contact dsinfo@rmcbmwcca.org.

STUDENT CLASSING AND RUN GROUPS

Students are assigned to one of four run groups (A, B, C or D) commensurate with their skill level and experience. D is where a new student would begin, and A is the most advanced run group. The groupings are relative and are dependent on the skill mix of students who have enrolled in a given school. Therefore, a student may be assigned to one group higher or lower than what they were assigned in a previous school. Look for your run group when you get your schedule to see when and where you need to be during the day.

A-SOLO RUN GROUP

Experienced A-group drivers have the option to drive solo in the A-group with the approval of a Chief Instructor. Interested drivers must obtain this approval before signing up for A-Solo.

INSTRUCTORS

Each student is paired with an Instructor for on-track sessions and will use an Instructor-provided headset to communicate with them. Students may have the opportunity to ride in the Instructor's car, or allow the Instructor to drive their car.

HELMET

Snell approved (M or SA), 2015 or 2020. The Snell label is inside the helmet under the pads. Current SFI-rated helmets are also allowed, such as SFI 31.1/2015, SFI 31.1/2020, SFI 41.1/2015, or SFI 41.1/2020. FIA 8860 helmets are allowed, and there is an expiration date on the sticker in or on the helmet.

The sticker inside the helmet will look something like the following (Snell, SA2020 rating):

To quote a profound advertising slogan, "If you have a ten dollar head, buy a ten dollar helmet." Use a racing or motorcycle helmet in good condition. If you have an extra helmet, put your name on it and bring it along. Extras are always welcomed. A limited number of helmets will be available for rent, so sign up early if you need one.

CLOTHING

Comfortable, well-fitting garments are recommended. Long pants are strongly recommended regardless of the temperature. All clothing should be cotton, not nylon or other synthetic materials.

DRIVING GLOVES

Driving gloves are optional, however, they are recommended because they may help if your steering wheel is slippery and your palms wet, especially for non-leather steering wheels.

SHOES

Choose a good sneaker or street shoe with a thin, flat rubber or crepe sole. No sandals, flip-flops or open toe shoes. Driving in bulky or loose fitting footwear or bare feet is prohibited.

MISCELLANEOUS THINGS TO BRING

Here are a few things to bring that will help make your day more enjoyable.

For the car: glass cleaner, a quart of oil, rags, a battery operated air compressor, a tire gauge, a tarp to put all the stuff you took out on (and cover it up if it rains), and some basic tools.

For you: a change of clothes, sunscreen and lip balm, reusable water bottle, plenty of water to drink (we recommend at least 1 Gallon of water per person, per day), a cooler, folding chairs, a shade canopy, a camera, and friends to enjoy the driving with (ask them to volunteer at the event!). Make sure you arrive with a full tank of gas. Air and water are available at the track, but fuel may or may not be depending on the track. Lunch will be available from the snack bar/food truck. Please note that you will not have enough time to go out for lunch.

VOLUNTEERS

An event like this takes a lot of volunteer effort to put on. If you, a member of your family, a friend, or coworker would be interested in volunteering, please register online at Motorsportreg.com. Driving school students are particularly encouraged to volunteer on a day they are not in school. It provides a very different perspective and really completes the experience.

MEDICAL INFORMATION

You will be prompted to fill out a medical information form when you register for the school. This information is shared only with the ambulance and the officials in the control tower.

Separately from this medical information, you are required to inform us of any condition that might impair your ability to perform the tasks expected of a student in this school, impede your ability to communicate

with your instructor, or that would impair your ability to exit the vehicle in case of an incident. If you are pregnant, we request you seek the approval of your physician before participating.

DRUGS AND ALCOHOL

It is imperative that each and every person at the track hold themselves accountable to the highest standard regarding substances that impair the body and mind. This includes alcohol, illegal drugs, prescription drugs, and other mind altering and impairing substances.

Until the track is declared closed or “cold” at the end of the day, alcohol may not be consumed by anyone on the track premises.

TECH INSPECTION

On the club website (www.rmcbmwcca.org) is a Tech Inspection form. It is your responsibility to have your car inspected by a qualified individual according to the guidelines on the form. **Both you and your inspector must complete the form, sign and date it.**

Our Tech Inspection is a comprehensive technical inspection related to the safety and mechanical integrity of your vehicle. Any vehicle deemed unfit for track use will not be permitted to run.

Participants should be aware that track driving puts stresses on the drive line, chassis, and brakes beyond what is normally encountered in day-to-day street driving, and even spirited road driving. You do not want one of these parts to break in the middle of a high-speed corner at the track. The results could be disastrous for your car and you.

There may also be a trackside visual check of some vehicles. If your car is determined to be unfit for the school, you will not be allowed to drive that vehicle. Please bring a clean and safe vehicle to the track.

Regardless of the results of the Tech Inspection of your vehicle, the final responsibility is the driver’s to be sure the vehicle is in mechanically sound condition and safe to drive on the track.

More information is provided in Appendix 1 for those interested in more detailed vehicle Tech Inspection guidance.

BASIC CAR PREPARATION

Before coming to the track, remove extraneous items from the interior and trunk. When you arrive at the track, remove EVERYTHING from the trunk and EVERYTHING from the interior of the car including the contents of the door pockets, glove box, under the seats, floor mats and anything attached to the visor. The reason for this is very simple. When you are concentrating on driving your car, you don't want something banging around in your trunk distracting you, or worse, something sliding under your feet and possibly tangling up the pedals.

Ensure your fluid levels are sufficient, double check your lugnut torque, and ensure tire pressures are set.

If any changes to the vehicle have been made between the tech inspection and the school day, we recommend getting your vehicle reinspected (and a new Tech Inspection Form filled out). If you have noticed anything going wrong between tech inspection and school day: do not chance it; get it fixed, and reinspected. Communicate with the event registrar so we can help you out.

TOW HOOKS

All cars must have an attachment point for towing on the front bumper at a minimum. It is recommended that you have them on both front and rear bumpers. You may install the factory-supplied tow hook if your car is equipped with one (all BMWs have them). Aftermarket tow hooks or straps are also acceptable.

AT THE TRACK (RULES)

KNOW THE FLAGS

The track workers and event organizers need a way to communicate with you while you are on the track. To do this, they use flags and sometimes excited pointing.

As you circulate the track you will notice at strategic points: corner workers and flags. Each first time on the track, pay special attention to the location of each flag station, even wave at them on the yellow flag outlap. These corner workers are there for your safety and are to be obeyed and treated with respect; after all, they are looking out for YOU. Your in-car Instructor will help with all flag communication.

What they instruct you to do with their flags or otherwise while on the course **MUST** be obeyed. **PAY ATTENTION TO THE FLAGS DISPLAYED THROUGHOUT THIS DRIVING SCHOOL.** Repeated failure to obey the flags can be grounds for expulsion from the school at the discretion of event officials. The basic flags that we will be using are green, yellow, red, black and checkered.

(images sourced from https://en.wikipedia.org/wiki/Racing_flags)

 **GREEN FLAG:** The green flag indicates that the track session is in progress and there are no problems on the track. This will be displayed only at the start/finish tower.

YELLOW FLAG: The yellow flag indicates trouble such as an unsafe condition on or near the track in the vicinity of where it is displayed. Yellow will likely be displayed during warm-up laps at all flag stations. When you see the yellow flag you need to back your pace down to about 80% and be ready to stop or avoid the situation ahead. Keep in mind that the car behind you may not have seen the flag yet so do not slam on the brakes. Check your mirrors and slow down safely. If the yellow flag is being waved rapidly it is a sign of an obstruction on the track or a rapidly developing unpredictable situation ahead. Waving yellow flags should have you back your pace down to about half. **Passing is prohibited** from the time you see the yellow flag until you pass a corner station where a yellow flag is not being displayed. (more on passing later in this document)

 **RED FLAG:** A red flag indicates a serious or critical condition on or near the track--the track may be blocked. Any time the red flag is used it will be displayed at all corner stations. It also indicates that the session has been stopped. The corner workers will use the red flag to stop the session when they need all the cars to come to a safe stop so that emergency vehicles (tow trucks/fire trucks/etc.) can quickly respond to the incident without endangering anybody else.

If you see the red flag it is vital that you remain predictable to other cars on track. **Immediately check your mirrors and slow down as quickly as it is safe to do so**. **Come to a complete stop on track**, within line of sight of a corner station so that corner station can further communicate with you. At some tracks you will come to a stop at the next corner station, and at other tracks you will (very slowly) drive to the next staffed corner station before coming to a stop. At the morning meeting, you will be advised of the specifics for where to stop for a red flag for that track.

Do not drive off of the track or block any access roads. Come to a stop off of the normal driving line and well out of the way of any preceding blind corners/hills.

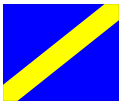
Once the incident has been cleared, the session will be restarted (green flag), or the session will be ended (checkered flag).

While stopped for a red flag incident: **stay in your vehicle with your seat belts fastened. As always, do not exit your vehicle unless your vehicle is on fire.**

 **or**  **BLACK FLAG:** The black flag (or "meatball" flag) is a warning to a particular driver. This flag will be pointed at the driver when passing the tower or a designated corner (you will be told which one in the morning meeting). The designated driver should acknowledge with a hand signal. Once acknowledged, proceed around the track and exit into the hot pit area (not the paddock) where you will meet the steward and discuss the problem. Do not stop on the track. The black flag may indicate either mechanical trouble or incorrect driving procedures have been observed. Failure to respond to a black flag may result in expulsion from the event at the discretion of the event officials.

 **CHECKERED FLAG:** At the conclusion of a session, the checkered flag is displayed at the main tower. After receiving the checkered flag, proceed around the track at a reduced rate of speed to allow your car to cool down. Try to drive a perfect line to further develop this habit. It is customary to wave to the corner workers so they know that you have seen them and appreciate their help. Slow down and signal that you are exiting the track (raise your fist out the window) and enter the pit lane slowly and proceed into the paddock (at some tracks you enter the paddock directly). The pit lane speed limit is 25 mph. Return to your parking place to let the instructor out. If you stop at the paddock entrance, you run the risk of being rear-ended.

Other flags you may see, depending on the track, are:

 **PASSING FLAG** (blue with yellow stripe): The passing flag will be waived or shaken at a specific driver, and indicates that they need to allow cars behind them to pass because they are being held up. Your Instructor will help you keep an eye on your mirrors as well.

 **DEBRIS FLAG** (yellow and orange stripes): The debris flag will be shown when dirt, sand, gravel, or other material is brought onto the track along the normal driving line. This flag may only appear for 1-2 laps, and when removed does not indicate the debris is gone, just that you should be aware of it by now. Take appropriate caution when approaching a corner station with a debris flag for the first time.

Pay careful attention to the flagging instructions you are given. Failure to comply with a flag instruction may result in expulsion from the event at the discretion of event officials.

HAND SIGNALS

Hand signals are used so drivers can communicate with one-another on the track.

Your in-car Instructor will review and help you with passing zones, hand signals, and other information related to passing for that particular day at that particular track. However, only the driver initiates hand signals, so it is imperative that students understand the hand gestures and passing rules (further below).

Passing: Slower cars will signal faster cars to pass at designated areas of the track known as "passing zones". The passing signal is - **Driver's left arm out the window, with finger pointing to the side of the vehicle on which the passing car should overtake.** Hand gestures should be exaggerated and easy for other drivers to see (ie. fully out the window, or over the roof of the car). The car being passed stays on the normal driving line and the passing car goes off the normal driving line to make the pass.

"Pass me on the left" - point your finger out the window to the left

"Pass me on the right" - point your arm out the window, up over the roof of your car

Return to Pits: Use this signal when entering the pits from the track for any reason. The signal is - **Driver's left arm raised out the window, hand making a fist.** Avoid slowing down too much before you give the signal to avoid being rear-ended. Be predictable.

Corner Workers: To acknowledge the signals of corner workers the signal is - **a wave of the hand.** This is your acknowledgement of signals for:

- Yes, I see the black flag and will return to the hot pit to talk to the steward.
- Yes, I see the checkered flag and will return to the pits after the cool-down lap.
- We are OK, (after going off the course) and will wait for your signal to return to the track.
- Thank you to the corner workers, for being there and keeping you safe, as you drive the cool-down lap.

DRIVING RULES AND TIPS

Safety is the most important item for the day. Anyone deemed to be driving in an unsafe manner is subject to expulsion. **NO RACING!** If it starts to rain, slow down to a speed below which you know you can drive safely in the wet. Check the condition of your brakes, tires, and lug nuts frequently. Check oil level before each driving session. You should bring an adequate supply of oil with you. Check your activity schedule and line up on the grid on time - ten minutes before your track time.

The first track session for each run group will be at reduced speeds run under the yellow flag. **The yellow flag means NO PASSING.** Your objective during the first session is to get comfortable in the car, learn the course and observe the flag stations.

Concentrate on being smooth and taking the right line. Do not try for speed! If you have the right line, your speed will come naturally. If you try for speed first you will probably find yourself taking a bad line and being a hazard to both yourself and other drivers. Instructors are much more impressed by smoothness and consistency than speed. The speed comes for free with smoothness and consistency.

If something starts to feel “not quite right”, exit the track and get it checked out in the hot pits or paddock.

PASSING RULES

Pass only in designated passing zones (these will be identified in the morning driver’s meeting). Be sure you have plenty of time to complete the pass before the next turn. **Do not try to pass near the end of the straight**, and if you do not have enough time to complete the pass before the turn, wait until the next passing zone.

DO NOT TAILGATE! The obligation for a safe passing maneuver falls primarily on the passing car; however, the car being passed should never do anything unexpected to interfere. Do not block faster cars. The car being passed should lift off of the throttle slightly to let the other car pass safely.

Watch your mirrors! The driver of the car being overtaken must signal when they want a faster car to pass. Do not pass unless you have been given a point-by from the car in front of you. Give one point-by for each car that you want to pass you. The car being passed stays on line and the car passing goes around. Examples:

- **With the driving line on the driver's right** side of the track: the slower car will stay to the right side of the track and point their finger out the window to the left. The passing car will move to the middle of the track, overtake the slower car, then move back to the right in front of the slower car.
- **With the driving line on the driver's left** side of the track: the slower car will stay to the left side of the track and point their arm out the window, up over the roof of their car. The passing car will move to the middle of the track, overtake the slower car, then move back to the left in front of the slower car.

Don't group together. If you find yourself running in a group, pull into hot pits (as described in the morning driver's meeting) or slow down for a lap or two and let cars pass to disperse the group. That way, you can

concentrate on your own driving and won't have to worry about how close the other driver is all the time.

Remember that driver skill is far more important than horsepower at increasing your pace on track. If a "slower car" is behind you and you can pull away from them on the straights but they catch up to you in the next set of corners you should let them pass you. If you let them pass it is likely you will not see them again that session and you will both have a more enjoyable session.

If you encounter any problems with passing cars or while being passed have a chat with your Instructor or a Chief Instructor.

PIT ENTRANCE AND EXIT

If you want to enter the track after the start of the session, pull in to Grid and wait to be signaled onto the track. Stay to the entrance side of the track, the same as you would a highway onramp, as you accelerate up to speed. Use your mirrors to check for traffic on the track and do not stop on the track entrance but rather blend into traffic..

When you want to pull into the pits, signal before the track exit as indicated in the driver's meeting. Stay all the way over to the side of the track and pull into the pit lane slowly (at some tracks you enter the paddock directly). A 25-mph speed limit on pit lane is strictly enforced. The paddock speed limit is "walking pace".

MINORS

RMC BMW CCA very strongly recommends that Minor Students (16 and 17 years old):

1. Contact the CDIs at cdi@rmcbmwcca.org to discuss their situation before signing up for the Driving School, and
2. Sign up for the Car Control Clinic, which is held a few weeks before the first Driving School

Additionally, here are the requirements from the BMW CCA National Driving Events Manual (as of April 29, 2023):

2.3.1 Driver qualification. By the date of the event, all drivers enrolled in any BMW CCA driving school are required to have a full operator's license that does not require another qualified party to be a passenger in the vehicle in order for the license to be considered valid. Any individual under the age of 18 shall not be allowed to participate in the event unless he or she and a parent/guardian have executed and signed a Parental and Minor Release Waiver.

NOTE: State, local, or the event venue's specific requirements shall supersede the BMW CCA's driver qualifications.

2.3.2 Driver's license. Each instructor and student shall have a valid & full operator's license (not a learner's permit) that is not suspended or revoked by the time of the event.

Minors that are not Students with a valid Parental and Minor Release Waiver for the event are not allowed in any of the "hot" parts of the track property. Please ensure that they are properly supervised in the paddock when you are on-track or in the classroom.

PASSENGERS

Students are not allowed to take passengers on the track except during Parade Laps. Parade Laps are held during the lunch hour and any vehicle, with any driver, with any passengers may drive the track without a helmet. Parade Laps have a STRICT SPEED LIMIT of 50 mph.

INSTRUCTORS

Your instructors are experienced in performance driving. Many of them have obtained competition racing licenses and have driven hundreds of laps around the course at speeds and cornering limits above those which you will experience during your driving sessions. Your instructors will be most impressed by smooth driving and following the proper line. They know that these techniques will result in fast and safe driving. They have been instructed to try to keep you from getting in over your head and may ask you to slow down so that you can better follow the line. LISTEN TO THEM!

Instructors will be available in the grid area. They are to be dropped off and driver changes made only in the hot pit/paddock area. Instructors are mandatory for everyone driving on the track except those in the A-Solo run group. They may make recommendations to a Chief Instructor concerning any student whose driving is deemed unsafe. Students are encouraged to contact a Chief Instructor and comment on instructors' performance. Feel free to ask for a different instructor at any time - simply pull into the pit area and indicate you'd appreciate another perspective.

You may wish to ask an instructor to drive your car to demonstrate techniques to you. You can learn a lot from this experience but are not required to do this and should not feel any obligation to do so. The instructor will drive smoothly and under control, not abusing your vehicle in any way. Your instructors are also given track time during the day, and will be pleased to take you as a passenger in their vehicles. This can be a very informative and exhilarating experience.

PERFORMANCE DRIVING PRIMER

There are few thrills in life that rival that of performance driving. It is a sport that must be approached with respect. Speeds and g-forces are beyond those experienced during everyday driving. The following material is designed to familiarize you with the proper techniques of performance driving. Understanding these fundamentals will make the total driving experience safer and more satisfying.

A GOOD TUNE-UP

During the driving school you will be placing much more stress on your car than during the typical supermarket run or even spirited canyon driving. A well-maintained car will perform better and will definitely result in a more pleasurable experience for the driver. Follow the guidance in this document under "Preparing for the Event", including getting your Tech Inspection Form filled out and signed by a mechanic. Having to only worry about your driving and having fun is much more enjoyable than having to worry about your car, too!

TIRES AND TIRE PRESSURE

Tires are, in most cases, the single most important factor in determining a car's cornering capabilities. Having good tires, properly balanced and mounted, and on good rims, will increase your car's handling potential. All steering, cornering and braking forces are transferred to the vehicle through the four contact patches, possibly less than two square feet of rubber. A driving school demands a lot from your tires and you can expect to observe noticeable wear. You can minimize this wear, however, by driving smoothly and sensibly without locking the wheels under braking. If your tires are squealing in turns or you can hear them complaining, you are driving incorrectly. Slow down and get on the proper line.

Tighten lug nuts before the first run of the day. The use of a torque wrench is *strongly advised*. Do not tighten lug nuts after a session on the track while they're still hot. This will result in over tightening when they cool.

MALFUNCTIONS

If you feel you may have a malfunction in your car, get some knowledgeable assistance, preferably from your Instructor and/or Chief of Safety. Don't go out on the track to see if your perceptions were accurate; you may be sorry you didn't investigate first. There will be plenty of very knowledgeable people around who will gladly help you.

CONDITIONING

Performance driving demands total concentration, split second timing, and fully coordinated muscle involvement. If a driver is bothered with muscle aches and pains, is uncomfortable, or overly tired, it is impossible to perform at the maximum. You should make sure you get a good night's sleep, eat a good breakfast and lunch, and drink lots of fluids (e.g. water, Gatorade, etc.) to keep yourself hydrated. Know your limits: if you start to become fatigued, pull in and rest. A tired driver makes mistakes and is a hazard to themselves and others. To drive at high speeds in a safe and controlled manner, everything has to be tuned for maximum performance - that includes the driver.

For obvious reasons no alcohol or other drugs (including antihistamines or other drugs that make you drowsy or impaired in any way) should be consumed immediately prior to or during the event. Use of these substances will result in immediate ejection from the event.

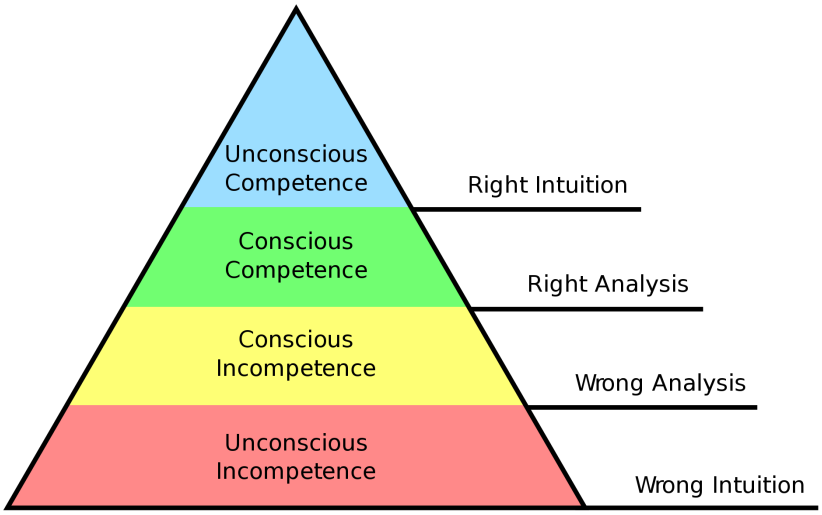
VEHICLE CONTROL

The objective of the driving school is to provide you instruction on how to drive your vehicle safely at speeds

and acceleration levels above those normally encountered during "normal" driving.

In order to do this, we will be focusing on primarily improving your control of the vehicle, which as an added benefit will likely add pace to your laps. However, outright speed or lap time is not the primary goal of this Driving School. You will be required to master the skills of smooth inputs, consistent laps, and situational awareness and decision making in order to progress to a more advanced run group.

Your Instructor will work with you to understand your current performance driving level and to help you improve over the course of your sessions. Understand that "getting better" is not always a straightforward process and requires time and practice. Some improvements feel small but will make dramatic improvements in your driving, and other improvements will feel irrelevant now but be required for more advanced run groups.



Hierarchy of Competence

Refer to the "four stages of learning a new skill" (https://en.wikipedia.org/wiki/Four_stages_of_competence) for the stages that we expect you will go through as you acquire new driving skills.

Some of the important concepts and techniques which will be discussed by instructors during the classroom sessions and while they are with you in your vehicle are highlighted in the following paragraphs.

ADVANCED VEHICLE SYSTEMS

Modern vehicles are equipped with many safety features and systems, such as ABS, traction control, and possibly collision-avoidance systems. Systems that are driver-controllable like traction control may be turned off by the driver only after discussion and agreement with the instructor. It is important that the instructor always be aware of the status of such systems. RMC BMW CCA guidance is to leave all factory safety systems (that are not collision-avoidance systems) enabled until such time as you can explain to your Instructor how and why the system is intervening. It is strongly recommended to reduce your speeds until you are comfortable with how the vehicle will behave with the system disabled.

Active systems that will automatically brake or steer a car without the driver's input, such as, but not limited to, automatic emergency braking, forward-collision warning, lane-departure warning, lane-keeping assist, and adaptive cruise control should be turned OFF when the vehicle is on track. Potential automatic reactivation of such systems on any given car so equipped should be identified and discussed by the participants involved. These systems can reset themselves to the default setting of ON when vehicles are turned off. The system setting should be re-checked each time the vehicle’s engine is turned off and started again before going on course/track.

DRIVING POSITION

Sit in the seat by pressing into it, don't just sit on it. Adjust the position of the seat (and wheel if possible) so you can freely move your feet between the pedals with clearance under the wheel and so that your arms are bent when your hands are placed at the 3 o'clock and 9 o'clock positions. Check that you can completely reach all positions on the steering wheel and all gears without leaning forward from your seated position (with your shoulders pressed against the seat, your wrist should be able to touch the top of the steering wheel). Make sure you can push all pedals to the floor without difficulty. Adjust your seat belt as tightly as possible and confirm you can still go through the required motions. For optimum vehicle control, a tight belt is essential.

TURNING THE WHEEL

Except when shifting you are expected to keep both hands on the steering wheel at all times. For maximum car control your hands should be positioned at or near the 3 o'clock and 9 o'clock positions as much as possible, even through a turn. If you are going to travel through a turn which requires more than 1/4 turn of the wheel, you should position your hands before entering a turn so that they will be in these positions during the turn. In no situation should you ever cross your arms. The following sequence describes how you should move your hands to travel through a tight right hand turn which requires about one half turn of the steering wheel.

1) Just before entering the turn, quickly move your right hand from the 3 o'clock position to the 12 o'clock position while firmly holding the wheel with your left hand at the 9 o'clock position. Immediately slide your left hand to the 6 o'clock position. (This whole sequence should take less than a second.) You will always have at least one hand gripping the wheel.
2) Gradually and smoothly turn the wheel clockwise one half turn to execute the right hand turn.
3) Hold the wheel through the turn with your right hand at or near the 3 o'clock position and your left hand at or near the 9 o'clock position. With your hands in these positions, you have maximum ability to adjust the position of the wheel in response to disturbances such as bumps or tire slippage.
4) Just before exiting the turn, quickly move your left hand from its current position to its original position on the wheel and then immediately move your right hand to its original position. (Again this should take less than a second.)
5) Gradually and smoothly, turn the wheel counterclockwise back to its original straight-ahead position. (Note: properly exiting the turn requires a deliberate unwinding of the wheel. This is a difficult technique for the novice to learn and one that is very important for a smooth exit from the turn while applying power.)

This procedure can be repeated back-to-back on very tight turns requiring more than 1/2 turn. UNDER NO CIRCUMSTANCES SHOULD YOU EVER LET GO OF THE WHEEL COMPLETELY WITH BOTH HANDS. Practice this procedure several times right now by closing your eyes and visualizing yourself in your vehicle at speed approaching and traveling through a tight right hand turn. Try this also for a tight left hand turn, for which the first hand movement is for you to move the left hand to the 12 o'clock position. Continue to practice in your car before coming to the track.

OVERSTEER AND UNDERSTEER

Oversteer is the term used to describe the situation in which a vehicle tends to turn more sharply than intended for the amount the steering wheel is turned - the tail gets loose and feels like it wants to come around to the front. This is usually caused by more traction at the front of the vehicle than at the rear, possibly because of spinning or sliding rear tires due to too much throttle or locked rear wheels due to too much braking. Oversteer can be corrected by reducing brake pedal pressure to unlock the rear wheels

and/or applying steering input in the direction the rear of the car is sliding (as you would on ice in a skid) and/or by reducing throttle.

Understeer is the term used to describe the situation in which a vehicle tends to turn less sharply than intended, resulting in driving off the outside of the turn. Understeer is often described as "plowing." This situation may be caused by locked front wheels. Understeer can be corrected by reducing brake pedal pressure to unlock the wheels or easing off the throttle to transfer weight to the front tires (or to stop them from spinning on a front-wheel-drive car).

SHIFTING

Treat the gearshift, linkage and transmission with respect, as if they were made of glass. Don't force anything. Move the lever smoothly and deliberately through the shift pattern with your fingers and palm of your hand. Speed shifting, power shifting and slamming the lever from gear to gear are ineffective and can be very expensive.

Downshifting for a turn should be executed before entering the turn. This will preclude upsetting the balance of the car caused by depressing and releasing the clutch for a lower gear in the turn and will allow you to apply power in the lower gear as soon as possible to exit the turn. Unless you have revved the engine while the clutch is depressed, releasing the clutch after shifting to the lower gear will cause the engine to come up to speed abruptly. This may tend to cause the rear wheels to briefly lock up and will have the effect of additional braking from the rear wheels. This can be very upsetting to the balance of the car if it occurs in a turn. The technique of "heel and toe" shifting eliminates these problems. This technique takes practice and will not be taught in depth at the school. If you desire to learn this very effective method for smoothly braking, downshifting and accelerating through a turn, ask an instructor to help you focus on it during one of your sessions. You can then practice and apply these techniques everyday until they become a habit. Double-clutching is not generally needed in modern cars.

BRAKING

Brakes on a typical street vehicle can decelerate the vehicle much more quickly than the engine can accelerate it. Perhaps the most noticeable difference between what we experience during normal highway driving and the driving you will be doing during the driving school is the level of braking entering a turn and the repetition of this level as you circulate around the track. Your brakes may get hot and begin to fade (more about this later).

This situation is referred to as "threshold braking." Locked wheels during braking are to be avoided. Not only is this less effective, but it will flat-spot your tires and potentially ruin them. Proper maximum braking results in just a faint squeal from the tires, not a loud screech. If you have ABS, the system will induce this situation for you. Without ABS, if you do lock a wheel, you should reduce pedal pressure slightly until the wheel unlocks and then reapply pressure.

In a panic situation on the highway, you will probably slam on the brakes in reaction to the situation. (With the front wheels locked, you cannot steer the vehicle because a sliding tire is just a hunk of rubber that has no preference for direction.) In a panic, don't hesitate to stand on the brake pedal. Hopefully, you will be able to slow down enough to eventually back off enough to unlock the wheels and steer if necessary. ABS does this automatically to maintain some steering control.

On the track or highway when approaching a corner, however, you are in a controlled situation. Initiate braking early enough so you DO NOT HAVE TO SLAM ON THE BRAKES. Instead, squeeze the brakes on, gradually building pressure until the wheels are on the threshold or at a lower level at which you feel comfortable. This allows vehicle weight to be transferred to the front tires, providing more down force and therefore allows them to generate more braking force.

Braking should be done as much as possible in a straight line when approaching a turn. If the tires are braking at or near the braking threshold, they cannot be expected to do even more work of turning the car. One objective of performance driving is to provide a smooth transition from braking for the turn and turning into the turn. Ideally, after maximum braking on the straight, the brakes should be gradually released as turning of the steering wheel is initiated. This keeps the loading on the front tire on the outside of the turn constant and avoids rocking of the vehicle on the suspension that would disturb the balance of the vehicle. The term "trail braking" is used to refer to the technique of gradually reducing braking force (trailing off the braking) and perhaps even keeping the brakes on slightly longer than necessary. It will cause the rear end of the car to come around slightly (oversteer) so that power can be applied sooner. Trail braking is particularly effective with front wheel drive cars that inherently understeer with the application of power.

Pay attention to the mark where you start braking. If you feel that you could have braked later, move the braking point incrementally (not dramatically) the next time around.

In performance driving, you should use the brakes hard for as brief a time as possible without locking the wheels. This allows air to cool the brakes as much as possible while the brakes are released. Because you will be braking hard and often, your brakes may get hot and start to fade as evidenced by a spongy or soft pedal that requires more and more pressure. (This is why good pads and fresh fluid are so important.) Be very alert to this situation. Slow down or come into the pits to let your brakes cool. During the last lap, at the end of the session on the track, slow down enough so you don't have to use your brakes allowing them to cool. When you do stop, put the car in gear and do not set your handbrake so the brakes can cool without warping rotors.

THE PROPER LINE

A general technique used in performance driving is to take the path of maximum possible radius through every turn. This yields the fastest speed through the turn. However, the high performance driver is interested in not just the maximum speed through a particular turn, but the safest, most comfortable minimum time and maximum speed through a section of highway or around a track. Because of particular characteristics of the track, this path may not simply be the path of maximum radius. Through every turn on a racetrack or a highway, there is an optimum path that yields one or more of the following:

- Maximum comfort for occupants for a given vehicle speed,
- Minimum wear on the tires and suspension,
- Minimum time and maximum speed through the turn,
- Greatest margin of safety through the turn and exiting the turn.

This line is a function of the shape of the turn, the banking (camber) of the turn, the characteristics of the section of track or road leading into and out of the turn, and sometimes, the condition of the track surface. Except for racing situations where every fraction of a second may be critical, the correct line is essentially independent of vehicle type and characteristics.

APEX OF A TURN

The theoretical apex of a turn is the point where the largest possible radius through a turn touches the inside of the turn. A vehicle takes an "early apex" if it follows a path that results in the wheels touching the inside of the track upstream or earlier than the theoretical apex. A vehicle takes a "late apex" if it follows a path that results in the wheels touching the inside of the track downstream or later than the theoretical apex.

Except in unusual situations in which a series of tight turns follow a long straight, the late apex is the preferred path. This is the path that you will be encouraged to follow through all turns at your driving school.

This is likely the fastest, smoothest and safest path on the course. This path allows you to apply throttle before you reach the late apex and therefore results in maximum exit speed from the turn and down the following straight. It also avoids the problem with an early apex in which you run off the outside edge of the track after passing by the early apex point. These situations can be observed in the attached diagrams on the next few pages.

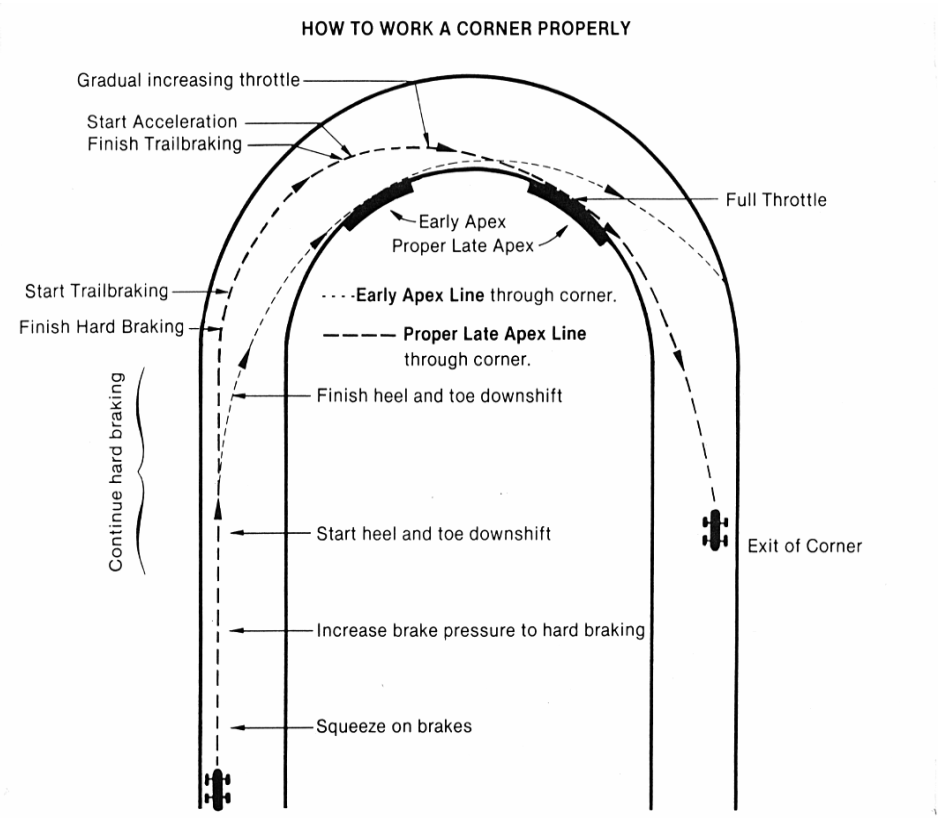
It is important to use all of the available track width to generate the largest possible arcs through every turn. As long as the pavement is in good condition, don't hesitate to "clip" the apex of every turn with your inside wheels. As you approach a turn and initiate braking, you should already be looking ahead for the apex. Well before you pass the apex, you should be looking ahead for the exit. Looking well ahead of your current location on the track is one of the most important and effective techniques of high performance driving.

OFF-TRACK EXCURSIONS

You may find that you cannot stay on the track because you have entered a turn too fast or your brakes have faded. In this situation, you should not panic, but go ahead and drive off the course in a straight line, continuing to apply the brakes to reduce speed. If you slide sideways off the track rather than straight ahead, the tires may dig into the dirt and tend to roll your vehicle. Also, if you attempt to return to the track at high speed, the tires on one side of the vehicle may really grip on the asphalt and spin you to the other side of the track.

By driving straight off and greatly reducing speed before returning, you will avoid unnecessary excitement. Don't attempt to return to the track until you are traveling very slowly and are sure there is no approaching traffic. ESTABLISH EYE CONTACT WITH THE CORNER WORKERS AND LET THEM ASSIST YOU AS YOU RE-ENTER THE TRACK.

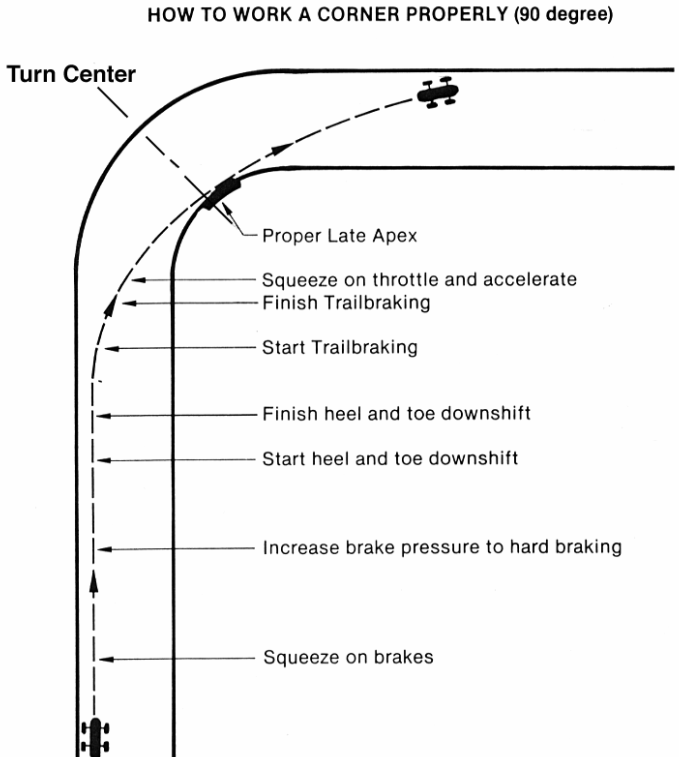
REMEMBER SMOOTHNESS, CONSISTENCY, CONCENTRATION, AND MOST IMPORTANTLY - HAVING FUN! WE HOPE YOU HAVE A GREAT DAY!



The **early apex** is the usual line through a corner that most drivers take. It is the **shortest** way, but **not the fastest or the most stable**.

The proper **late apex is the fastest way out of a corner and the most stable.** The car will get most of its cornering done during the first third of the corner under trailing brake, and therefore, you will be able to use full throttle much earlier. This will allow you the maximum exit speed. In most cases you will be able to achieve full throttle around the apex area rather than waiting for the exit area.

NOTE: TRAIL BRAKING IS AN ADVANCED TECHNIQUE



DRIVING SCHOOL INITIAL EXERCISE

Based on student experience and track layout, this exercise may not be conducted at every driving school or given to all students at a school.

LINE ORIENTATION, or "BRUSH THE CONE"

This exercise demonstrates where the favored line is on a given track and through precise demonstration (instructor driving) to instill in the student the notion that driving the correct line consistently is a prerequisite to further learning of performance driving techniques. This exercise is preceded by a class session where students are introduced to the concept that speed through corners is a function of grip and radius. Grip factors are covered later in the day. The object of this exercise is that if the student observes how deliberately and consistently the instructor drives “the line,” the student will be inclined to do the same. It is a simple exercise where the instructor first drives the student’s car for a few laps at slow speeds immediately followed by the students driving at the same slow speeds.

Step One: This is a class session. The grip and radius factors of performance driving are introduced along with the principle that, while grip factors can often be somewhat driver enhanced, the radius considerations are truly at the core of one’s ability to drive at higher speeds. Shapes of corners are described as well as the necessity to diligently learn the track’s favored line. Little or no learning occurs unless and until the student is able to consistently (i.e., every lap) navigate the circuit on the right path (line). This path is extremely simple to follow as large, orange construction cones define it.

The cones are positioned to show the fastest way through the corners -- the line. The class session further, and most importantly, emphasizes the notion that patience and discipline are required to adhere to this line as speeds increase throughout the day. If the student does not learn to drive the line every lap of the day, it will be nearly impossible to learn the other exciting and rewarding aspects of performance driving. Students must develop consistency in driving to the points (cones) because these are the points where important inputs such as braking and turning are made. If these inputs are made at different points, different and maybe unwanted results occur. Finally, the notion is introduced that a student who most patiently and deliberately learns the favored line around the track will be in the position to have learned the most and have had the most fun at the end of the day. Patience precedes speed.

Step Two: After class, during the student’s first session on the track, the instructor drives a couple of laps in the student’s car at very slow speeds (almost stopping in the corners for emphasis), to show where the cones are and how close to them one drives. To highlight this proximity, the instructor may show that if the car door were opened on the appropriate side it would, in fact, knock the cone over. That close. The instructor also shows that eyes are high approaching corners and that it is necessary to look through the corner to be smooth. Finally, the instructor shows that, as corners become better known, the first baby steps of speed will be made in accelerating slightly from the middle of the corner to the exit. Throughout this exercise, the instructor underscores the fact that, at either walking speeds now or at near race speeds later in the day, the student should drive this same, very precise line. Every lap.

Step Three: The student drives! During the remainder of this track session, students are trying to mimic the instructor’s wonderfully precise path as defined by the big orange cones. It may not feel like you “need” to go all the way to the cones because of the speed you are driving, but later, as speeds increase it is necessary, so one should always practice being on the Line. The student should hopefully feel the temptation to cheat a

little by turning in early as speeds increase at which time the patient instructor will suggest slower speeds and higher eyes until the student learns the track better. By the end of this session, the student should understand that:

- It will take more laps (there'll be plenty) to really memorize the track, and,
- by driving the same path every time, increased speeds come very easily and naturally.

Successful completion of this exercise really sets the student up for a rewarding day. Impatience here (too much speed too early, not getting close enough to the cones) puts the student at a big disadvantage as far as more learning is concerned.

CLASSROOM COURSE OUTLINE

A FEW IMPORTANT WORDS FROM YOUR INSTRUCTORS

Relax, and that's an order! There are rumors of new students who are "anxious"; that maybe they won't be very good and that everybody will snicker at their slow pace. Please be aware of a few things. First, most of your class/track mates are also first timers who also have some trepidation about driving on a racetrack. Second, anxiety is normal. In fact, if you weren't at least a little anxious, we'd be concerned. The fact is that we have developed some very sophisticated ways to ensure that all of your nervous energy is quickly transformed into grins of satisfaction from having developed new skills so quickly and so easily. Virtually every new student leaves the school exhausted from having learned so much and having had so much fun. And it's legal!

As is stated elsewhere, instructors may drive your car during the track sessions with your permission. Many students, of all levels, find this very helpful -- not just to experience your car's high limits but to study the calmness and precision with which advanced drivers drive. This precision is largely a function of driving the correct line, which is the foundation of good driving. We feel that this concept (driving the correct line) is so vital to your learning that we ask that you allow your instructor to drive your car for several laps. He or she will drive at such a silly slow speed and in such close proximity to our reference cones that you will immediately realize that we are very serious about our expectations of you doing the same when you get behind the wheel.

Speed is the enemy your first time out. It precludes learning. Experience has shown that this early dedication to such an important aspect pays big dividends -- forever. Please trust us that the slowest drivers early will be the quickest to learn the layout of the track and will be the first to drive the correct line consistently. It is only from this platform that all the other elements of performance driving can be learned. We cannot overstate this. It may be well into your second track session that you finally know your way around with precision. But thereafter, with the help of your intrepid instructors, a whole lotta good stuff is going to happen. Don't miss it by going too fast too soon.

- **Chris Roth**

Groups C and D Curriculum Outline (New and less experienced racetrack drivers)

Expectations:

- That groups meet together in classroom twice in the morning and twice after lunch.
- That an orientation/safety meeting and possibly a track walk is held.
- That the welcoming letter received prior to the school is read.
- That the day's goal is to learn "The Line". Consider the importance of starting the day at very low speeds, with intense focus on learning and driving The Line consistently and precisely. Speed will build, and braking points, turn in points, and shifting will flow naturally and quickly from understanding The Line.
- That the classroom instructor will have a steering wheel, car model, track diagram, and flip chart available.

Glossary Of Terms:

Breathe it: Partial easing of throttle to point where the car is neither accelerating nor decelerating. It is in this steady state that a car will reach its highest cornering limits.

Contact Patches: The 4 places where the rubber meets the road. Think of these as connected to very powerful springs which are loaded by the chassis. Every input of steering, accelerating, and braking affects these 4 patches.

Early Turning in: before turn in point (see The Line) and usually too gently. This is the most common mistake at all levels.

Late Turning in: later than proper turn in point.

Footwork: Heel and toe technique. A blip of the throttle in order to match revs of both engine and drive wheels on downshifts - with practice - will eventually ensure much smoother and faster driving.

Friction Circle: A model used to explain the (limited) ability of tires to provide grip under combinations of acceleration, braking and lateral loading.

Fully Loaded: Refers to one or a pair of contact patches which, given any additional input of steering, braking or accelerating would result in too much slip angle. Tires can only do 100% of their work in any combination of braking or acceleration and turning. When the car is fully loaded laterally (in a corner) the 2 outside contact patches are fully loaded, working at 100%.

In a Spin - Both Feet In: Lock up the brakes to prevent a dangerous sudden hook up of the tires and push in the clutch to prevent stalling. Use this technique in all cars, even those with ABS brakes because, while the wheels won't be 'locked up', they will not be rolling freely and therefore won't be able to hook up. The danger in a spin is that at some point in the spin, free rolling wheels/tires can hook up and very quickly send the car in an unintended direction. By maintaining high brake pressure in a spin, this possibility is minimized.

In Slow - Out Fast: The time proven concept that entering corners at a reasonable, controllable, repeatable speed, on The Line every time, is the most important first step to becoming consistent and ultimately, fast. Car control, late and hard braking, corner and exit speed can only develop where consistency and comfort exist.

Lift: Taking the foot completely off the gas (which introduces compression braking on the rear tires).

Loading: The increased weight on the contact patches as a result of weight transfer such as loading the front tires under braking, side of tires in a corner (lateral loading) and rears under acceleration.

Low eyes: When the driver is not looking far enough ahead, early enough. Most common cause of spins.

Shuffle Steering: The feeding of the steering wheel from one hand to the other, eliminating the arms crossing over.

Slip Angle: The amount, in degrees, that a tire is skidding sideways rather than rolling forward. Street radials have the most grip at a little more than 10 degrees slip. Related to this are:

Understeer: aka pushing, plowing - When front tires have too much slip angle and won’t steer. Corrected by easing off the throttle and lessening steering input (if necessary)

Oversteer: aka fishtailing, hanging it out - When rear tires have a big slip angle and the rear of the car is coming around faster than the front, aka rotating.

Trailing throttle oversteer is oversteer caused by lifting off the throttle as steering is inputted, ie., when turning. This can be very good (e.g. to get you around a tight corner) - or bad (see “In a Spin…”).

Power oversteer is induced by hard acceleration which reduces the rear tires' ability to maintain lateral grip.

Targets: What each of the points on The Line (see below) becomes when the preceding one has been passed.

The Line: A very specific path the car takes around the track. Points on the path are:

- braking point - point where braking begins
- turn in point - where steering for the corner begins
- apex - the most inside point (sometimes arc) in the corner
- exit, track out point - the most outside point of the corner past the apex.

(The last three of these are part of the corner proper and are connected with a smooth arc, everything else is a straight line.)

Trail Braking Rotation: Achieved by 1) continuing braking into the early part of a corner and 2) trailing off the brakes as steering is inputted: the car will rotate on its front/rear axis (slightly increased slip angle in the rear tires). This rotation helps turn the car. It is enhanced by more abrupt brake release, later in the corner, combined with more abrupt steering input.

7/10ths: The driving level of most sane club drivers - most of the time. To attempt to drive harder, closer to 10/10ths is to leave less room for learning, and more for surprises.

Groups C and D - Class 1

This session precedes the first time that group C&D students drive on a track. It is designed to relax them and build their confidence. It is also designed to encourage them to take both the school and their driving one step at a time. "In slow, out fast" is key, as is focusing on learning one easy concept and then moving on to the next. Students are encouraged to pace themselves throughout the day and to learn good habits, which can then be translated to driving on the street.

Subjects Covered

- Introduction of the day's schedule. Relax and inspire. Highlight track instructors' expertise and dedication.
- Driving is done in the following order: with EYES, feet and hands. Fatigue today will result not from wild use of hands and feet but from intense use of eyes and processing visual inputs. Driving is much more mental than physical. Knowledge and anticipation are much more important than reactions. So all day long - KEEP THE EYES HIGH and the speeds low enough (7/10ths) that mental processing, not just reacting, can occur. Learn to shuffle steer properly and shift cleanly. Build good habits and stay hydrated - drink plenty of water to avoid "brain fade".
- Speed is a function of tire grip and radius of the turn. We'll focus on radius now.
- Eyes are used to find and follow THE LINE. Define points (bp, ti, apx, exit) Discuss different shapes of turns i.e. big arc, early and late apex. Radius equals speed BUT there are safety concerns.
- Introduce LATE APEX, emphasizing safety (an example is seeing the exit on public roads), higher exit speeds, easier car control and necessity in driving unknown corners, even on racetracks.

What the students are directed to work on in their first track session:

Brush the Cone exercise. Instructor drives first to show LINE using a slightly exaggerated late apex. At each reference point show that opening a door would knock over the cone.

This will be done VERY SLOWLY to emphasize importance and precision. Students then drive, SLOWLY. Learn the line. High eyes. This will be a SLOW but critical session. Very likely that the slowest, most deliberate driver in this session will be the most advanced at the end of the day. Braking and downshifting is done early and in a straight line. The student's is to consistently get to the cones and maybe work on a little exit speed.

WATCH OUT FOR: Nervousness and anxiety, bad lines, low eyes. Going too fast - too soon. Questions/Comments?

Groups C and D - Class 2

This session congratulates students for their steadfastness and patience in track session 1 and prepares them for their quick ascension up the ladder of performance driving.

Subjects Covered

- Questions/Comments? Is the track flowing? Are you lost? Are you seeing just cones, a general shape of the track, or a specific (late apex) shape?
- The concept of grip through CONTACT PATCHES is introduced. All inputs (hands and feet) affect grip. Describe the vertical loading of tires and springs and increased grip.
- Contact patches are drawn and discussed at rest, accelerating, braking, and turning. Define slip angles, turn in (TI), oversteer (OS) and understeer (US).
- Show the specific differences in contact patches between braking and turning. How to achieve the transition?
- Draw Friction Circle (ball bearing in a salad bowl idea) and introduce the concept that braking into the corner enhances grip on the front (turning) wheels and the turn proper is made by smoothly reducing braking level while adding steering. Visualization exercise wherein students (in their seats) imagine themselves easing off the brakes while they gradually add steering.
- Drink water.

What the students are directed to work on in the next track session:

Big learning and big fun start here, but it's critical to continue driving the line. No laziness, no cheating. No advancement will happen unless you have developed the confidence that you are consistently where you are supposed to be on the track, especially as speeds increase. Otherwise your time and energy will be spent reacting to your unplanned whereabouts, rather than learning. Keep your eyes high and don't early apex. Drive at 7/10ths, which leaves 3/10ths for recall and learning. With higher speeds you will still be as close to the cones as you were in the first session.

- Brake and downshift early.
- The track is still new to most students and speeds will still be relatively slow. Don't worry.
- In slow, out fast.

NEW this session: Carry braking a little ways into the corner and feel how the car wants to corner better as you release the brakes and add steering. This release/add is done especially smoothly in faster corners. The better students should be driving a good line, consistently, use braking to initiate the turn and drive with some vigor right to the corner exit.

WATCH OUT FOR: early apex, no apex, inconsistencies, over aggression, understeer at turn in.

Groups C and D - Class 3

Address fatigue, present and pending. Questions: How did it feel braking into the corner? Did you feel the car want to turn? Anyone overdo it? Any uneasiness about when and how to downshift?

Subjects Covered

- Use contact patches and friction circle to review smoothness required in transitions, especially from braking to turning. Introduce footwork as a necessary element to maintain smoothness and balance while downshifting and braking.
- Use contact patches to introduce the concept of rotation, which can be useful in certain situations. Describe how to maximize or minimize rotation.
- Drink water.

What the students are directed to work on in the next track session:

Still and always: a good and consistent line. 7/10ths, high eyes, go all the way to apex.

By knowing the track well at this point, work on braking/turning balance. Feel the car go to the apex and then drive it out to the exit...good balance turning in and good speed coming out.

NEW this session: Discuss and try a 4 to 3 heel and toe down shift after the straight(s) if confident (slow down first, there is no rev limiter on downshifting). Work on heel and toeing during the coming weeks and months until you can do it. Be conscious of how different brake releases and steering inputs help turn in. Work on high exit speeds and somewhat higher turn in speeds. Additional five minutes added to this session for the instructor to drive your car - with your permission. What the instructor says and demonstrates will make more sense to you now.

WATCH OUT FOR: Fatigue, inconsistency, over aggression, bad lines.

Groups C and D - Class 4

Last class of the day. Emphasize dangers and symptoms of fatigue. Questions/Comments?

Subjects Covered

- Light review of lines, grip, radius. Define type 1, 2, and 3 corners. Use track map.
- Relate what we've learned today to driving on public roads, esp. late apex for safety. Where is grip on public roads? Define camber and show why and where it's a critical factor in safe driving on roads and useful for track speed.
- Performance Driving. Show steps (like rungs on a ladder) to becoming a competent performance driver.
    1. The Line and good use of eyes.
    2. Balance, including footwork.
    3. Exit Speed.
    4. Turn in speed.
    5. Corner speed.
    6. Late/hard braking.
    7. Consistency.

- Drink water.

No one gets all the way there. There's always something left somewhere. Where are you? Instructor anecdotes about personal barriers.

TIME PERMITTING: in no particular order. Why are BMWs so good? Discuss: motor, good and safe chassis, good brakes, etc. FWD vs. RWD. Rain and snow considerations. Mirror placement. Tire pressure changes for understeer and oversteer. SUV particulars e.g. high center of gravity, big contact patches, etc.

Encourage students to do another school. A & B drivers will tell you - the fun's just begun.

Next (all remaining) track sessions:

- Beware fatigue - be SMOOTH
- 7/10ths - follow The Line - try and drive the perfect line - every lap, including the cool down lap.
- In slow, out fast. Consistency precedes speed.

NEW: higher exit speeds, attention to footwork, higher turn in speeds, some trail braking rotation in slower corners, higher corner speeds and somewhat later/harder braking. Student goal: be consistent, with a balanced car, and have great fun in the last session.

WATCH OUT FOR: Fatigue leading to inconsistency (big trouble at end of day) evidenced by varying brake points (lack of focus), missed shifts, lack of smoothness, and low eyes. Too much speed. Not getting to apexes. In other words - Not Following THE LINE.

AT END OF LAST SESSION: **Thanks and Congratulations!**

TRACK PRACTICE ON THE STREET

DRIVING AUNT TILLY

Steve Williams, Rocky Mountain Chapter, BMW CCA

Aunt Tilly is a very special 85-year-old “character” who also happens to be your favorite aunt. She loves to ride - you love to drive - on twisty mountain roads and high passes. Yea! A relationship made in heaven. However, she doesn’t like to be “jerked” around - and you like to drive fast. What to do? Maybe try the performance driving school advertised in the last Motorsport Report. You have often thought it would be fun to drive the M3 on a racetrack; and some instruction at the driving school just might help quiet Aunt Tilly during your next adventure through Left Hand Canyon. So you attend the school which leads to:

Track Practice Translated to the Street

Throttle - DON’T FLUCTUATE - MODULATE

Which means to smoothly roll on and off the throttle vs. suddenly jamming on it or suddenly lifting off of it, because that upsets the car’s balance and Aunt Tilly’s too. This is due to the fact that weight is shifted front to back and vice versa through use of the throttle. For example: the quicker the lift the faster weight is transferred onto the front tires which helps turn at speed on the race track or on twisty roads due to increased traction on the front tires. Simultaneously, lifting also reduces the weight on the rear and therefore helps “rotate” the car when at speed; **however** lifting may also induce a spin or create a “loose” rear end on ice or when at the limit of adhesion. This loose rear condition can happen to any car but many front drive ”pilots”, especially, have become acquainted with this important lesson. Because their cars are significantly lighter in the rear compared to the front, it is easier to break the rear loose when abruptly lifting the throttle; this frequently occurs in slick conditions thus causing accidents and creating much embarrassment for the driver.

Too much throttle can also cause problems on slick roads. Weight is shifted to the rear when accelerating. An abrupt weight shift coupled with too much power may also upset the car’s balance causing the rear drive wheels break traction, spin, thus causing the rear end to skid - maybe into the curb - or a ditch. Smooth and slow throttle movements on ice is the key.

> *Self Check*: Does the passenger’s head bob, or do stomach twitches become reported when you drive, due to excess throttle movements such as on-off-on-off-the throttle-ad-infinitum? Have you “lost it” in a turn due to a skidding rear end or when starting out on, or climbing a slick hill?

Steering - *DON’T TURN THE WHEEL.*

It upsets the car’s balance and Aunt Tilly’s. Of course you must - so minimize the turning action. Visualize **The Line** and smooth steering inputs. Practice. Any turning of the steering wheel also slows the car, this is why racers try to find **The Line** and practice smoothness when driving it.

> *Self Check:* Watch the steering wheel after initial turn-in. Jiggles and corrections of the wheel while in the turn indicate a lack of smoothness. Smoothly initiate your turn, set the steering wheel, and attempt to keep it in one position throughout the turn.

Shifting - *DON’T SHIFT*.

Of course you must - so when you do shift, make the transitions so smooth that Aunt Tilly cannot tell when clutch engagement occurs. Down shifting is of special concern because if the engine’s revolutions are not matched to wheel speed then both the car’s and Aunt Tilly’s balance are upset. She then glowers at you and the car may chirp its tires at you or even start to spin if on ice or at the limit of adhesion.

> *Self Check:* Does your passenger’s head nod when you shift? Have your tires ever chirped or the

rear end kicked out when you down shifted?

Braking - DON'T BRAKE.

Of course you must - so minimize the amount of time you spend on the brakes and use them like you mean it when you do have to; i.e., don't let up only to immediately reapply the brakes again during a single stop.

Self Check: Does Aunt Tilly's head bob back and forth as you come to a stop because you alternately press and release the brakes? Is she aware of the exact moment that you come to a complete stop?

And - DO LEARN THE KEYS TO THE GAME:

- Cues and Clues: the steering wheel jiggles when making corrections in a corner, shifting jerks, wheel squeal, head nods/bobs, hand grabs, dirty looks, unfavorable comments, screams . . . as well as abnormal tire/brake/clutch wear.
- Look Ahead - Anticipate. What is developing ahead (like brake lights ¼ mile ahead) - how are the corners revealing themselves to you?
- Look to the next corner while transiting the current one - **Think Smooth**.
- Smoothness and Consistency is the major key - **Be Smooth**.
- Visualize - **The Line** (taught at the driving school).
- And more - for more comprehensive guidance consult performance driving books, attend schools, go racing, and above all **Think about the Process** and practice as you learn about heel-and-toeing, trail braking, trailing throttle oversteer, straights and apexes, etc.

PRACTICE:

- **Cornering**: Notice the speedometer, "out faster than in" is a major key.
- **Mountain roads**: Smoothness = no jerks. Try to not use the brakes when within the speed limit; use a smooth throttle lift to "set" the car instead; late apex for safety unless you really know the road; out faster than in, and stay within your lane.
- **Rush hour**: Attempt to negotiate rush hour traffic without once using the brakes in a stop-and-go situation. How? Become butter smooth. Look ahead and anticipate as you drive, watch for brake lights and leave a margin in order to back off the throttle and then get back on it -fluidly- and shift smoothly so that Aunt Tilly is unaware of anything but a velvet ride.
- **On ice**: A great place to feel and learn to control the rear end kicking out, is an empty parking lot during or after a heavy snow storm; or especially at the BMW car club's annual ice gymkhana on Georgetown Lake.

FINAL COMMENTS:

- Jerky driving **feels fast**. It may look fast, is often fun, but it is certain to upset Aunt Tilly.
- Smooth driving **IS FAST**, can look slow, yields great satisfaction, and is less likely to upset Aunt Tilly.
- Tires talk - learn the language. "Silence is Golden" is key. A low moan at a very high speed is to be expected, but howls, squeals, yowls, yelps and chirps are not.
- Put it all together and go have fun with Aunt Tilly.

APPENDIX 1: VEHICLE TECH INSPECTION

In most of the areas covered by the Tech Inspection, a visual inspection is all that is needed, but BE THOROUGH. This is not time-consuming, and is inexpensive insurance for your safety. These guidelines are written for BMW owners but, with few exceptions, will be applicable for owners of all cars. If something seems questionable, talk to your mechanic or a club member about the problem.

TIRES AND RIMS - Visually check all tire sidewalls, inside and outside for signs of age, cracking or curb scrubs that have damaged the sidewall integrity. Run your hand over the surface of the tread checking for any bulges or belts popping to the surface. Tread depth must be 3/32-inch minimum. Last but not least, tighten all wheel lug nuts to the manufacturer's recommendation.

If you have any of the above warning signs, remember that your wheels and tires are your only link to the road.

BRAKES - Brakes are of paramount importance at a track event. Check the pads, and if they are worn more than 1/2 from new, replace them. Many people have come to these events with new pads and gone home with pads worn down to the metal backing. This, of course, depends on the driver and the speeds being carried, but replacing a brake pad is easier and less expensive than replacing a rotor scored by a worn out pad. Check rotors for overall thickness and replace if under-spec.

IT IS IMPERATIVE THAT YOU FLUSH YOUR BRAKE SYSTEM BEFORE COMING TO THE TRACK. Brake fluid must have been changed within the last 120 days (4 months) before the school. This does two things. First, it purges the system of any air, and second, it is an opportunity to change your brake fluid. This is very important because old fluid performs poorly under hard braking (brake fluid is hygroscopic - it absorbs water and becomes more compressible and boils easier). Use a high quality brake fluid, DOT-rated as per your vehicle owner's manual, and completely bleed old fluid. This, like oil, should be changed before and after a track event. Dirty fluid like dirty oil causes undue wear on your braking system's moving parts. This is a good practice once a year even for those who do not participate in track events. It is amazing how much better the brakes will perform with clean fluid.

SEAT BELTS/HARNESSES - Those supplied with newer cars are adequate. A minimum of a three-point belt is required for the school. Weak, frayed, stained or brittle belts must be replaced. Check that the inertia reels lock while braking. Also check to make sure the attachment points aren't so rusted that they might pull out.

If you plan on doing this type of driving frequently, consider buying an approved competition harness set, which includes lap belt, sub belt(s) and shoulder harness belts. If you upgrade *your* seat belt, you must upgrade the passenger side as well with an equivalent (e.g. if five points or higher on the driver's side then must have at least five points on the passenger side). Four point harnesses are NOT ALLOWED. Some instructors do not like to use harnesses in a street car, so try to leave your stock 3 point seatbelts available.

If you have harnesses it is also recommended that you have a rollbar that is properly built and secured.

SEATS - Check seats at the attachment points to make sure they are secure. The seat back should feel strong.

If you plan on doing this type of driving frequently, consider installing competition seats with higher side bolsters and possibly a non-reclining seat back. It is recommended, but not required, that you provide an equivalent seat on the passenger side. Some instructors do not like to ride in a stock seat when the driver has a competition seat so this might slow down gridding and getting onto the track.

ENGINE, RADIATOR AND BATTERY - BMW builds its engines well enough that they will run perfectly at track outings without any problems or undue wear if a few simple rules are followed. Change the oil and filter before and after each event. Operating temperatures sometimes run slightly hotter than normal, so the

oil breaks down more quickly. Check all hoses, clamps and belts for wear or cracking. It would be a shame to miss track time due to a simple cracked hose.

If the radiator is questionable or leaking, have it repaired. Track officials are very strict about not letting any slippery liquids drip on the track surface as fluids on the track are a hazard to other cars. Check the water pump by grabbing the impeller shaft and moving it from side to side. If there seems to be excessive play, have it checked. Make sure the fan is tight.

Check the motor mounts. To check these, grab the valve cover and move the engine from side to side. If movement seems excessive, visually inspect the motor mount rubber and metal brackets for cracking. A good tune-up is optional but good insurance for a well running car. Another thing to consider is a valve adjustment. If you can't do it, it is an inexpensive thing to have done at a garage.

Check the battery to be sure it is fastened down properly. It's amazing how many people overlook this point. In a slalom exercise, a loose battery could easily cause damage to your vehicle.

If your car has 50,000 miles or more, you might want to consider changing transmission and differential oil if it has never been changed before. One final point is the gas tank. Spilled fluids are bad for asphalt and traction, so check the gas tank for leaks and make sure the gas cap is tight and has a good gasket.

CHASSIS/SUSPENSION - Check the wheel bearings to make sure they aren't loose, and that steering rack and linkage components don't have excess play either. This can be done while the front of your vehicle is safely jacked up and resting on jack stands.

With the rear of your vehicle on jack stands, you should visually inspect the exhaust system for any loose pieces that might be about to fall off. Check all U-joints and CV joints on the drive shaft and rear axle half shafts by turning the shaft clockwise, then counterclockwise while watching for any play at the joint. These should not have any play in them. While under the car, check the rubber transmission mounts for cracking. Check the drive shaft guibo and center support bearing for cracking.

Check all frame members and rear control arms for structural integrity. While checking for rust, check all four upper shock mounts to make sure rust damage isn't going to pop the shocks loose during hard cornering. Check shocks for wear with the car on the ground, by bouncing the car at each end. When you stop pushing on the car, if it doesn't stop immediately, the shocks are worn.

INTERIOR AND LIGHTS - Check all lights, especially the brake lights. We don't want another car not to see them under hard braking. Make sure lenses are clean; older cars tend to get road dirt buildup inside the light housings. In the interior, check the pedal pads to make sure they aren't going to fall off or your feet aren't going to slip off them at a bad moment. If they look bad, replace them - they are very inexpensive. Push the accelerator to the floor a few times and let it return. Make sure there is no binding in its action.

Also make sure your windshield has no major cracks in it.

The school is a lot of fun and very worthwhile. These suggestions will continue to enhance the safety record of the Rocky Mountain Chapter Driving Schools. If you aren't a driving school enthusiast, all these checks are excellent for everyday driving. Complete this routine once a year to catch problems before they happen.

This may seem like a lot of trouble for a few hours on the track, but at the track is where you don't want these parts to break.

APPENDIX 2: CONVERTIBLES

[Copied from https://www.bmwcca.org/system/files/Driving-Events-Manual_0_0_0_0_0_0_0_0_0_0_0_0_0_0.pdf, 2/1/2023 revision]

2.3.18 **Convertibles**.

2.3.18.1 Convertibles are defined as cars with retractable soft tops and/or fully removable hard tops. Vehicles with integrated retractable factory hardtops are not considered convertibles for the purposes of this section 2.3.18.

2.3.18.2 Convertibles are not allowed to participate in sessions driven when helmets are required unless the car is equipped with the following minimum requirements:

- A roll bar or roll cage meeting the requirements in Appendix 1, Roll Bars for Convertibles.
- Arm restraints in soft-top vehicles.
- Recommendation: Five (or more)-point harnesses for both driver and passenger.

2.3.18.3 At the discretion of the chapter, cars with factory-installed, fixed rollover protection and removable roof sections may be allowed, but only if this protection meets the clearance distance of the Helmet Reference Plane described in Appendix 1 for both the driver and the passenger.

2.3.18.4 Chapters may elect to exclude convertibles or cars with removable roof sections entirely from sessions requiring helmets, regardless of roll bar/cage, fixed rollover protection, or any other provision of this section.

(from "Appendix 1 Roll Bars for Convertibles" in the BMW CCA National Manual)

These specifications are for inspecting convertible roll bars and represent minimum requirements. The words “shall” and “shall not” indicate that the specification is mandatory. Convertible roll bars shall be inspected by and are subject to approval by the chief technical inspector at each event.

1. **Basic Design Considerations**. The basic purpose of the roll bar is to assist in the protection of the driver and passenger if the car turns over or is involved in a collision. This purpose should not be forgotten.

1.1. With the driver and passenger seated normally and restrained by the seat belts/harnesses, a plane (the “Helmet Reference Plane”) drawn from the top of the roll bar (excluding padding) to structural parts of the chassis in front of the base of the windshield (e.g., top of front suspension strut towers) shall pass at least two (2) inches above both the driver’s and passenger’s helmets. See Figure 1.

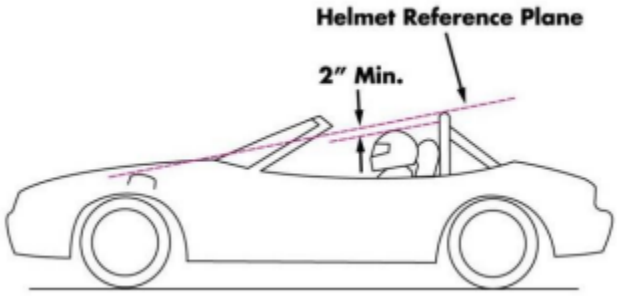


Figure 1. Helmet Reference Plane

1.2. The roll bar shall be designed to withstand compression forces resulting from the weight of the car coming down on the roll bar, and to take fore, aft, and lateral loads resulting from the car skidding along the ground on the roll bar.

1.3. The roll bar shall extend the full width of the cockpit.

1.4. Any portion of the roll bar or bracing that might be contacted by any occupant's helmet shall be covered with non-resilient material such as Ethafoam or Ensolite, or other similar material, with a minimum thickness of one-half inch (½"). The energy-absorbing material shall be firmly attached.

2. **Material**. The roll bar hoop and all braces shall be seamless ERW (Electric Resistance Welded) or DOM (Drawn Over Mandrel) mild-steel tubing (SAE 1010, 1020, 1025, or equivalent), or chrome molybdenum alloy-steel tubing (SAE 4125, 4130, or equivalent). It is recommended that mild-steel tubing be used, as chromium alloys present difficulties in welding and must be normalized to relieve stress. Proof of the use of alloy steel shall be the responsibility of the participant.

2.1. The size of the tubing shall be determined based on the vehicle curb weight as follows:

Vehicle Curb Weight	**Roll bar Mild Steel** **(Outside diameter x wall thickness in inches)**
Under 2,000 lbs.	1.50x0.120 or 1.75x0.075
2,001 lbs.–3,500 lbs.	1.75x0.120 or 2.00x0.075
Over 3,500 lbs.	2.00x0.120

2.2. The minus tolerance for tubing diameter and wall thickness shall not be less than 0.010 inch below the nominal value.

2.3. An inspection hole of at least 3/16-inch diameter shall be drilled in a non-critical area of the roll-bar hoop in order to facilitate verification of tubing wall thickness.

2.4. Where bolts and nuts are used, the bolts shall be at least ⅜-inch diameter SAE Grade 5 or equivalent.

3. **Welding**. Welding shall conform to American Welding Society D1.1, Structural Welding Code, Chapter 10, Tubular Structures. Welds shall be visually inspected and shall be acceptable if the following conditions are satisfied:

- The weld shall have no cracks and shall go all the way around joining pieces.
- Thorough fusion shall exist between weld metal and base metal.
- All craters shall be filled to the cross-section of the weld.
- Undercut shall be no more than 0.01-inch deep.

4. **Roll-bar hoop**. One (1) continuous length of tubing shall be used for the roll-bar hoop with smooth, continuous bends and no evidence of crimping or wall failure. The radius of the bends in the roll-bar hoop (measured at centerline of tubing) shall not be less than three (3) times the diameter of the tubing. The roll-bar hoop shall have a maximum of four (4) bends totaling 180 degrees, ± 10 degrees. Whenever possible, the roll-bar hoop should start from the floor of the car.

5. **Bracing**. Roll bar hoops shall have two (2) fore/aft braces with tubing diameter and wall thickness as listed in the table above. The fore/aft braces shall be attached as close as possible to the top of, but not more than six (6) inches below, the roll-bar hoop. The included angle between the fore-andaft brace and the vertical part of the roll bar hoop shall be no less than 30 degrees. The fore-and-aft braces shall have no bends.

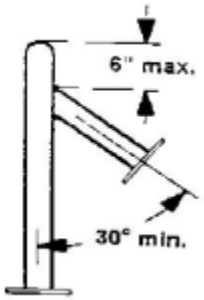


Figure 2. Bracing

5.1. Roll bar hoops shall have a diagonal brace with tubing diameter and wall thickness as listed in Section 2 to prevent lateral distortion of the hoop. The diagonal brace shall be attached at the bottom corner of the roll bar hoop on one side and the top corner of the roll bar hoop on the other side. The diagonal brace shall have no bends.

6. **Mounting plates**.

6.1. Roll bar hoops and fore/aft braces shall be attached to the chassis of the car with mounting plates that are at least 3/16-inch thick.

6.2. Carpet/padding/insulation shall be removed under the mounting plates.

6.3. Mounting plates shall be either welded or bolted to the chassis.

6.4. Mounting plates bolted to the chassis shall have a back-up plate of equal size and thickness on the opposite side of the chassis with the plates through-bolted together. Whenever possible, the mounting plate should extend onto a vertical section of the chassis panel.

6.5. If welded, mounting plates must have full welds along the entire plate.

6.6. If bolted, there shall be a minimum of three (3) bolts per mounting plate.

6.7. The through holes for the bolts shall be a minimum of ⅜-inch from the edge of the mounting plate.

6.8. Each mounting plate shall be no more than 100 square inches in area and shall be no greater than 12 inches, nor less than 2.5 inches, on a side.

6.9. The mounting plate may be multi-angled.

7. **Other roll bar designs**. Any roll bar design that does not comply with the specifications in this appendix shall be accompanied by engineering specifications signed by a registered Professional Engineer (PE), which attest that the installation is able to withstand the following stress loading applied simultaneously to the top of the bar: 1.5X laterally, 5.5X longitudinally (fore/aft) in either direction, 7.5X vertically, where X= Curb weight of the vehicle, with no permanent deformation to any part of the roll bar or the chassis, and with no greater than ½-inch deflection of any part of the roll bar or the chassis as referenced to the unstressed condition. The induced loads must be carried over into the primary structure of the chassis.