

Off-Road Driving

The decision to take vehicles off improved surfaces has inherent and unique risks to the vehicle and personnel. When travel surfaces are unpaved the reaction of the vehicle to various forces can be unpredictable or quickly beyond the control of the driver. Further compounding the hazards the fire service historically makes modifications to off-road vehicles that can impair or alter the original off-road design features. These modifications often impact ground clearances, tire characteristics, center of gravity, total vehicle weight, and auxiliary vehicle components that are exposed to damage. A conservative approach is required even for personnel with off-roading experience in privately owned vehicles.

In general, off-road driving techniques mirror those used during poor conditions on paved roadways:

- Slow down!
- Manage acceleration, braking, and turns to smooth out the maneuvers. Avoid sudden shifts in the center of gravity that can destabilize the vehicle or reduce traction.
- Anticipate sharp steering wheel reactions as obstacles are crossed. Grip the wheel at 9 and 3 with thumbs outside of the wheel. Do not grip the steering wheel spokes.
- Identify your route before you commit the vehicle to a path.

Go/No-go Assessment

Every hazard or obstacle needs to be evaluated before committing the vehicle to a path or action. Remember that water from pumping apparatus and/or weather changes can alter the ground conditions within the duration of an incident, so the original Go/No-go Assessment may have to be revised upon exit. With regard to choosing a travel route, the Go/No-go Assessment answers the following questions:

1. Can you safely cross this hazard with this vehicle?
2. If you cross or enter the hazard can you return on the same path?
3. Is there another route you can use that is safer, less complex, and easier on the environment?
4. Do you need to cross at this location? Can you make a simple detour?
5. If you get stuck or break down will you be able to get out of this location without any other assistance? What other assistance is available?
6. Have you scouted the path you are going to take?
7. What is on the other side of the hazard? How much farther can you go?
8. What effect will a “no-go” decision have on completion of your assignment?
9. Does anybody know where you are? Do you have radio or cellular communication?

Off-Road Vehicle Characteristics

The off-road features of a vehicle vary by manufacturer and personnel are encouraged to research their assigned apparatus. Specifically, personnel need to become familiar with the process to transition from 2-wheel to 4-wheel or all-wheel drive BEFORE they enter an off-road situation. Equally important is recognizing that damage to the vehicle may occur if all-wheel drive is engaged at inappropriate times, such as while driving on pavement or at high speeds. Later model vehicles have interlock systems to prevent engagement of off-road features when damage may occur. If a parameter is not met to enable engagement there is usually a flashing indicator light to signal the attempt to shift has failed.

Front Hubs

All-wheel drive vehicles are equipped with either automatic or manual locking hubs on the front axle. The hubs must be locked for the wheels to receive power from the drive train. Manual hubs require a person to be outside the vehicle to physically turn the lever or knob to engage or disengage. Never use a tool to turn the hub lever – it should operate freely by hand. Automatic hubs engage when the all-wheel drive is engaged.



Some vehicles may need to travel a few feet forward or backward before the all-wheel drive mechanisms fully engage or disengage. Again, this characteristic is unique to each vehicle or manufacturer.

All-wheel, 4WD-High, 4WD-Low

Personnel may encounter a variety of off-road modes in their vehicle. The following generally describes these features:

All-wheel drive – These systems deliver torque to all four wheels in a manner similar to traditional four-wheel drive systems, however they are electronically controlled to vary the torque based upon the amount of wheel slippage detected. These systems are not generally designed for heavy off-road use and are less likely to cause damage to the vehicle on paved surfaces. They can be particularly useful in situations where traction conditions vary frequently throughout a trip.

4WD-High – This mode engages the wheels at the same gear ratio as a 2-wheel mode and allows for higher speeds, therefore is more applicable to situations encountered on improved or semi-improved travel surfaces such as snow, ice, gravel, or shallow mud. Unlike all-wheel drive systems, the travel surface needs to allow wheel slippage to avoid damage to the tires, suspension, and drive train because power is continuous delivered to all four wheels.

4WD-Low – This mode utilizes a lower gear ratio than 2-wheel mode and is intended for slow speeds and true off-road situations where maximum vehicle control is required to cross obstacles or manage uneven terrain.

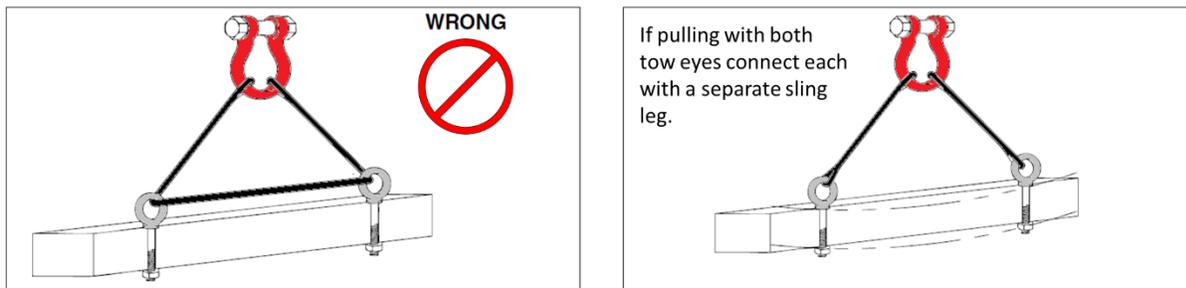
Skid Plates

Most off-road vehicles are equipped with protective underbody shields to reduce the potential to damage to sensitive components. Those should be checked during pre-trip inspections to ensure they are still secured to the vehicle.

Tow Hooks or Eyes

Off-road driving periodically results in the vehicle becoming stuck. The forces required to pull a stuck vehicle from a situation are much greater than those encountered during vehicle stabilization on a collision scene or even towing a vehicle on its wheels, therefore the use of proper anchor points for attachment of hauling or winching lines is imperative to the safety and success of the operation. Generally, stock bumpers, suspension components, axles, and other vehicle components are not suitable anchors when pulling a stuck vehicle. Personnel must recognize that anchor points typically found on the undercarriage of a vehicle that would be suitable during a vehicle stabilization situation may not hold up to the stresses of a winching operation.

Most fire apparatus and heavy equipment is equipped with towing eyes or hooks on both the front and rear of the vehicle. Those eyes are fastened to the vehicle frame for maximum strength. If using more than a single tow eye to pull it is important to connect the eyes independently and not reeve a line through them.



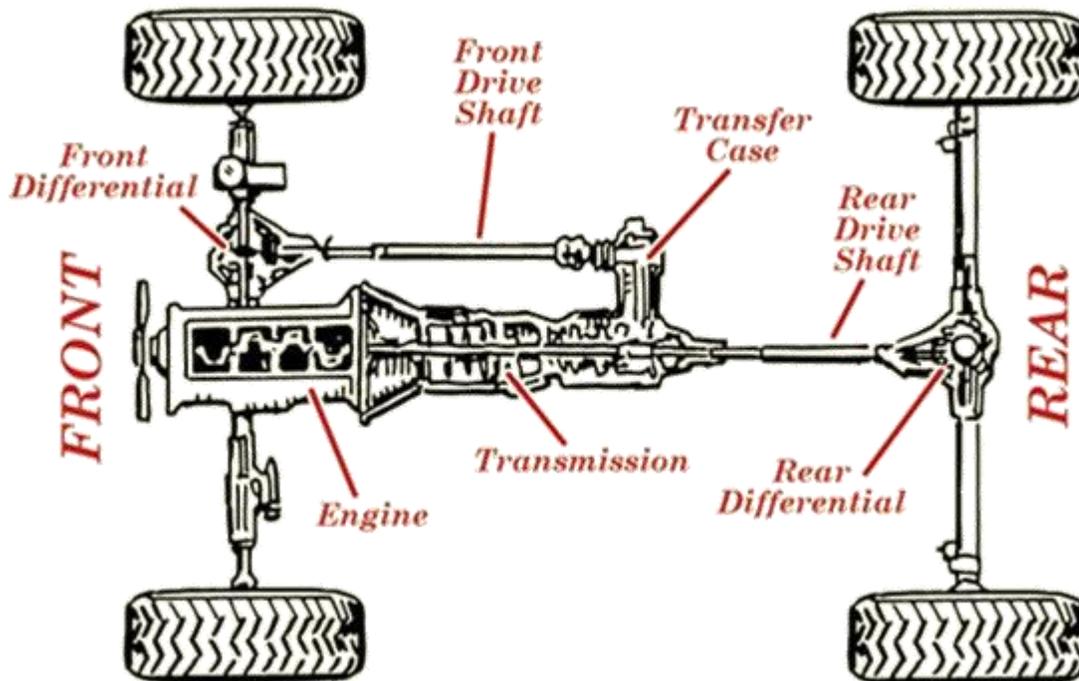
Note that when recovering a stuck vehicle, the vehicle weight, the terrain slope, and the terrain itself are all factors that effect the force required to pull the vehicle. Soft surfaces and uphill grades increase the force required. A vehicle stuck in mud up to the body may require pulling forces of 3 to 4 times the actual weight of the vehicle. A rule of thumb for tow straps is a capacity of 3 times the weight of the vehicle being pulled.

Tires

Off-road driving increases the importance of monitoring the condition, inflation, and tread depth of vehicle tires. No vehicle, regardless of other off-road features, will perform well off-road without a suitable set of tires. Unfortunately, the tires that provide the best performance in the most common situation of paved roads are often not optimum for unimproved road surfaces. In addition to an aggressive tread pattern, off-road tires are also reinforced, particularly in the sidewall, to resist punctures from sharp rocks or branches. As noted later in this document, there are situations where reducing inflation pressure may be advantageous during off-road situations, however be prepared to restore the tires to higher pressures before prolonged driving on paved surfaces. Know the types of tires on your vehicle before committing to difficult terrain.

Drivetrain Components

While a typical rear-wheel drive apparatus has a single drive shaft that sends power to the rear axle, an all-wheel or 4-wheel drive vehicle requires extra components to provide power to all four wheels. Below is an overview of the typical drivetrain of a 4-wheel drive vehicle.



Off-Road Driving Scenarios

The following are general guidelines for negotiating the most typical obstacles found during off-road driving. Every situation begins with a Go/No-go Assessment. Avoid blindly entering any challenging terrain without determining the actual need to do so.

Sand or soft ground

- Proceed steadily and avoid spinning tires; spinning tires will cause the vehicle to sink to the frame; a vehicle resting on its undercarriage no longer has traction
- Reduce tire pressure to increase the surface area of the tires; return tires to proper pressures before returning to a hard surface
- Stop on a level or downhill position to take advantage of gravity to resume travel
- Make wipe sweeping turns to avoid digging into the soil
- Spread the vehicle weight by using ground pads, plywood, or other materials

Gravel or Rocks

- Low speeds are required due to low traction
- Dust may impair visibility when traveling in a procession
- Anticipate moguls/bumps/washboard surface that can break traction
- Position tires on level spots to allow the suspension to adjust to the terrain and permit tire tread to have a good contact area
- If driving a vehicle with an empty cargo bed or lack of ballast over the drive wheels consider reducing tire pressure to soften the tires
- Expect gravel or rocks to tumble or roll and break traction
- Avoid straddling rocks or identify ground clearance before committing; position tires on large rocks or obstacles rather than straddling them

Mud

- Proceed at a slow steady pace
- Beware deep or “bottomless” holes concealed by water or slurry
- Scout the path and probe for deep holes and debris concealed by the mud
- Clear debris before entering if possible
- Expect the vehicle to slip and slide; avoid oversteering or sharp acceleration
- Consider tire chains if conditions are severe or tire treads are no aggressive
- Back out if conditions appear to be worsening or clearance cannot be maintained to the undercarriage
- If losing progress, turn the steering back and forth to attempt to gain traction or transfer torque between different wheels

Gullies, Ditches, Logs, Culverts

- Scout the path to decide if you need to actually go over the obstacle or the obstacle can be avoided or may be easier to cross in another location
- Approach and engage the obstacle at a 45-degree angle with one tire at a time to aid with clearance and traction; allows three tires to be in ground contact to push or pull the one tire over
- Proceed at a slow and steady pace to ease into the obstacle; power out of the obstacle
- Use a spotter to guide the driver and watch for unseen problems
- Consider removing or filling in the obstacle if that option exists

- Where a wash-out or gully has formed that runs parallel within a travel path position to straddle the gully rather than riding with two wheels in the gully; keep the vehicle level and centered over the gully as much as possible
- When crossing logs, watch for branches that could puncture tires or damage vehicle components

Steep Slopes – parallel

- Whenever possible avoid traveling across (parallel) a steep slope
- Beware that the ground clearance of an off-road vehicle often raises the center of gravity and there is no “rule of thumb” for a safe slope
- Traction and control of the vehicle will be reduced
- Use established or improved paths across slopes when available
- Avoid obstacles on the uphill side that will increase the angle of the vehicle, i.e. stumps or rocks; likewise avoid downhill holes
- Vehicles tend to slide before they overturn; do not overreact to a sideways slide; stop and then decide the next move
- Keep tires straight and do not turn uphill unless it is necessary to follow tracks
- Do not attempt to turn around on a slope; be prepared to back to more level ground
- If the vehicle becomes unstable turn downhill

Steep Slopes – perpendicular

- Scout ahead to identify an exit after the slope
- Forward view of the driver may be obscured when climbing a steep grade; use a ground spotter to help guide the driver
- Evaluate the surface for traction or obstacles; choose a path of least resistance that avoids stumps, logs, trees, or large rocks that require steering across the slope. The most desirable path allows travel up or down the slope without turning the wheel.
- Apply steady power to climb the slope and avoid stopping; use lower gears
- Keep the vehicle straight up and down the slope; do not get sideways
- Use lower gears when descending a slope
- Avoid applying too much braking when descending a slope; avoid sliding as this results in loss of steering and uncontrolled momentum
- On extreme slopes, stopping and resuming travel may require use of the parking brake or concurrent application of the service brake and accelerator to hold the vehicle as power is applied to the transmission. When the transmission begins to pull the vehicle forward and prevent rollback the brake may be released.

Water Hazards

- Determine water depth and velocity before entering; be mindful of holes that may not be visible from the surface
- Scout the entry and exit points before committing to the water; beware of soft embankments or sediment areas that will cause the vehicle to sink or get hung up
- Try to cross where others have crossed before
- Identify the type of bed: stone, sand, boulders, mud/sediment
- A rule of thumb for slow moving or still water is not to enter depths above the tires; do not enter above air intakes
- If water stalls the vehicle do not attempt to restart; restarting the motor will only result in additional damage; the vehicle will need to be recovered by other means such as winching, towing, or pushing
- Once exiting the water beware that brakes may not be as effective until they dry

Vegetation

- Identify the reinforcement built into the vehicle before attempting to drive over or through vegetation or brush; know the limitations of the equipment versus the density of the vegetation; beware of fire pump or vehicle exhaust components that may be exposed below the frame rails
- Scout ahead for the path of least resistance so that manually clearing trees or brush is minimized or eliminated; realize that small diameter woody vegetation that is cut will leave stumps that can puncture vehicle tires
- When cutting brush for access it should be cut as close as possible to the ground; brush that is cut too high will bend over and then spring back up below the vehicle; also give consideration to elevated branches that may obstruct the vehicle path
- Vehicle exhaust systems may ignite dry vegetation beneath the vehicle; be very cautious about driving through or parking over tall grasses or light flashy fuels
- Manage clearance to tree branches that may damage warning lights, mirrors, scene lights, or other vehicle components; in tight areas consider folding down adjustable scene lights to reduce the vehicle profile
- Beware of branches that are pushed aside and may spring into vehicle windows as the vehicle travels; consider eye protection for occupants when driving through these environments

If You Get Stuck

Since off-road driving can be unpredictable there will be situations where the vehicle becomes stuck. Getting out of these situations requires additional assessment and there is no absolute correct solution for every situation. Below are some guidelines should your vehicle become stuck:

- Identify if you or the vehicle are in danger, i.e. rising waters, fire spread, rollover. Provide a CAN report to the Incident Commander or PSCC.
- Avoid the urge to immediately apply more power to the motor. This may actually worsen the situation by digging the vehicle deeper into the soil. Smooth acceleration is necessary if traction is to be maintained.
- If stuck on a slope, keep the vehicle traveling up and down the slope and not across the slope. Attempting to turn around on a slope may result in a rollover.
- Before continuing, should the vehicle be taken back toward the path already traveled or do conditions improve ahead? Will the vehicle become stuck again if forward progress continues?
- Alternating between forward and reverse may provide enough momentum or traction to free the vehicle.
- Implement a towing or winching operation using adequate rigging and anchor points to reach a surface that will allow resumption of travel.
- As soon as practical, inspect the vehicle for damage that may have occurred when stuck. The undercarriage, wiring, suspension, brake components, and tires are all areas of concern. Clean out accumulated debris to avoid unnecessary wear and tear on vehicle components.