4 WHEEL DRIVE SKILLS

THE BASICS

Purpose:

To enable an individual to drive a 4WD on-highway, but more especially off-highway, in a safe and environmentally responsible manner.

Recommended Prerequisites

- Introduction to 4WD Course
- 4WD Systems Course
- Vehicle Recovery Course
- The courses above provide a detailed understanding of what you need to know about your vehicle, how it works, how to avoid getting stuck and what to do when you get stuck.
- These aspects should be well understood BEFORE you go off-highway. This way your driving experience will be that much safer and more fun.

Vehicle 360

The purpose of the Vehicle 360 is to ensure as driver [and spotter or passenger] that:

- You know how the vehicle 4WD system works
  - Part-time vs. Full time etc.
  - High range vs. low range
- You know the vehicle is road worthy
  - Licensed, insured, road worthy condition, well maintained, etc.
- You know the vehicle is recoverable
  - Recovery points front and rear, etc.
- You know the vehicle's limitations / vulnerabilities w.r.t.
  - Approach angle, departure angle, break over angle, side slope angle, climbing angle, ground clearance, turning radius, track width, wheel base, articulation, component protection, etc.

Vehicle 360 cont.

- Make sure you know what the 4wd system is and how to use it and when to use it.
  - Read the owner's manual
- Make sure the 4WD system works
  - Test the 4WD system

Vehicle 360 cont.

Outside - start at the bottom and work up

- Tires – size, type, condition, signs of uneven wear, spare, pressure, lug nuts present and secure
- Under carriage – check for low points, items hanging down, brake lines, fuel lines, transmission lines, wet spots, damage
- Drive train – check axel off-set [front & rear], drive shafts, universals, leaks on transmission, transfer case, axles, inside of wheels, fluids in all components [≥ 4], brakes, emergency brake
- Suspension – bounce vehicle, springs, control arms & bushings, track bars and bushings, frame and bracket cracks, grease
- Engine – engine oil and color, transmission oil, brake fluid, clutch fluid, power steering fluid, coolant level, washer level, oil leaks, exhaust leaks, air cleaner, fuses, battery terminals, battery secured, sound of engine, smoke from exhaust, wiring
- Body condition – doors, glass, rust, damage, seams, mounting points, hinges, mirrors,
- Electrical – all lights, horn, radio, windows, volt meter, oil pressure, MIL, hazards lights, odometer, speedometer, rpm, wiring, fuse boxes,

Vehicle 360 cont.

Inside

- General
  - Seat belts for all passengers
  - Seats are secure
  - No loose objects
  - Jack and toolkit - check the lug wrench fits
- Vehicle controls
  - Seat position, seat belt position, mirror position,
  - 360° visibility [know where your blind spots are]
  - Lights [dim and bright], turn signals, hazard, wipers, heat, air,
  - 4WD control system including traction aids
  - Air bags w.r.t. hands on steering wheel
  - Gear levers – purpose and operation
  - Steering – check with assistant – loose joints, bent components, line-up w.r.t steering wheel

Test drive

- Test steering, brakes, emergency brake, gears, 4WD, transfer case, back-up
- Check for Bump Steer
- Listen for strange noises
- Check handling behavior when braking
- Check tracking
- Check suspension – zig zag
- Check smooth throttle operation - response and lag
- Do emergency stop to check brakes
- Check all gages for correct function.
- Check fuel level

On-highway Driving

- Know your vehicle boundaries
  - Height, width, length
  - Establish points of reference
- Know where your wheels are
  - Stop point going forward and backwards w.r.t your wheels and the vehicle body
  - Wheel cheat
  - Visible distance shortfall – forward and backwards
- Hand Position of steering wheel
  - Prior to airbags 10 and 2
  - With airbags 9 and 3
- Practice
  - Cones – Circle and Figure 8 – forwards and backwards driver and passenger side

Basic Principles

- Learn to “pick a line”
  - Look for path of least resistance
  - Keep vehicle as level as possible
  - Ensure tire contact with ground
  - Don’t drive blind! [crests, water crossings, mud holes, snow etc.]
  - Pick progressive points and the drive to them
  - Use brake throttle modulation for increased control
  - Go straight up or straight down hills
  - Drive over rocks rather than straddling them
  - Better to stall than to loose traction
  - Pick the right gear for the obstacle
  - Avoid over revving the engine
  - Avoid spinning the wheels
  - Always keep recovery in mind
- Tread Lightly

Off-highway Driving

- Off-highway driving requires an understanding of applying power to the vehicle's wheels through the vehicle's 4WD system in conjunction with the influence of terrain types and obstacle types on the ability of the tires to gain traction.
- Requires knowledge of terrain types
- Requires knowledge of obstacle types

Terrain Types

- The main point with terrain types [and obstacle types] is their influence on tire traction.
- Traction > rolling resistance
- Traction is a function of the tire type, contact area, and contact area load
- Contact area is a function of tire pressure [and tire width]
- Contact load is a function of suspension articulation [and vehicle angle]

Terrain Types cont.

- Soft terrain
  - Increases rolling resistance with variable traction
  - Floatation is key [depending on depth] to reduce rolling resistance
  - Sand [50-60%], Mud[25%], Snow[25%]
- Hard terrain
  - Decreases rolling resistance with variable traction
  - Dirt roads[10-15%], rocks[25%], dry pans[15%], grasslands[15%]
- Loose terrain
  - Generally does not decrease rolling resistance as much as decreasing traction.
  - Gravel[20%], stones[20%], shale[30%],

Tire Pressure and Traction

- Reduced tire pressure = larger surface area
- Tread length is most significant contributor
- Tire gains flotation for soft terrain
- Tire forms over rocks on hard terrain
- Higher profile tires better suited to deflation
- Tire serves as additional shock absorber
- Get reduced ground clearance
- Side wall damage
- Can damage rims
  - Steel vs. Alloy
- Risk of unseating bead
  - Bead locks – Internal vs. External

Soft Terrain

- Sand
  - Dunes, Tracks, Beach,
  - Sand grades – fine through course
  - Moisture content
  - Hard packed vs. drift
- Floatation and speed
  - BACKOFF when forward progress stops – you will dig in
  - Rock vehicle
- Steering and cornering
  - Under steer – front washes/ ploughs and does not turn
  - Over steer – back slides away from corner
  - Can lead to roll over as outside wheels bite into sand
  - Allow vehicle to follow tracks – track exit technique

Sand Driving Techniques

- Braking
  - Generally better compared with mud and snow
  - Varies with sand type
  - Can cause sand build up in front of wheels [especially front wheels]
- Starting
  - Try and position vehicle so that can start down hill
  - Back up to get running start
- See
    - http://www.youtube.com/watch?v=tjn1-FnmpKs&NR=1
    - http://www.youtube.com/watch?v=03CEBphWlSI&feature=fvw
    - http://www.youtube.com/watch?v=KHI_cMrvsrM&feature=related
    - http://www.youtube.com/watch?v=gCK8_TCgK08

Mud driving techniques

- Mud types
  - Clay, swamp, peat, loess
- Techniques
  - Stop and decide on best route
  - Select low range and second or third gear
  - Use wind shield washers in waterhole
  - Avoid sudden braking
  - When loosing traction – BACKOFF and saw steering
  - Rock vehicle where possible
  - Stick to wheel ruts
  - Check bog hole for hidden obstacles – rocks, logs etc.
  - After deep mud clean brakes by applying light brake pressure
- Wheel speed to clean tires
- Generally need power, clearance, and aggressive tires
- Use of chains is advisable on hard clay

Snow Driving Techniques

- Snow consistency
  - Drift, powder, heavy, packed
- Snow chains offer best traction aid
- KNOW WHERE YOU ARE GOING!
  - Snow hides everything – rocks, gulley, etc.
  - Snow drifts can disguise the edge of a road
- Avoid sudden cornering and braking
- Avoid excessive speed
- BACKOFF when loosing traction
- Rock vehicle
- Lockers can be a disadvantage on ice
- Use Extreme care as ice can be beneath the snow

Hard Terrain

- The main difference between hard and soft terrain is that soft terrain allows a vehicle to sink into it thereby increasing rolling resistance. Traction is variable in both cases.
- High traction surfaces
  - “Slick rock” in Moab
- Low traction surfaces
  - Tellico – “Slick Rock”, wet clay, ice, some sand stone

Hard Terrain Driving Techniques

- Low traction
  - Momentum “bump it”
  - Picking line is critical
  - Low range - first or second gear
- High Traction
  - Low range - select appropriate gear

Obstacle Techniques

- Steep Slopes
- Side Slopes
- Ridges
- Troughs and Gulley
- Axle twisters
- Ruts – across and down
- Rough tracks
- Boulders and Loose Rocks
- Slick Rock
- Bridges
- Wading and River beds
- Ledges
- Logs
- Salt Pans
- Grasslands
- Corrugations / Washboards

Steep Slopes

- Descending a steep slope
  - Use engine compression – select lowest gear
  - Never step on the clutch and/or change gear
  - Slippery descent – steer in the direction of the slide and gently accelerate
  - If braking is required apply short sharp jabs [mimicking ABS] to avoid locking the wheels and loss of steering
  - If engine stalls – start engine in gear and foot off the clutch
  - Use HDC if available

Steep Slopes cont.

- Ascending a Steep Slope
  - “Momentum” or “Control”
  - Dunes = momentum; rocks = control
  - Select appropriate gear, pick your line
  - In loss of traction, BACKOFF accelerator gently
  - Decelerate at crest
- Engine stall
  - Allow the engine to stall – do not depress the clutch
  - Depressing clutch results more off-road accidents
  - Failed ascent procedure
    - Depress foot brake firmly and engage emergency brake
    - Depress clutch ***slowly*** ensuring brakes are sufficient to hold vehicle
    - If not and it is possible, have wheels chocked
    - Engage reverse gear and release the clutch
    - Remove wheel chocks
    - Release the emergency brake and then start the engine (may need to use clutch bypass switch)
    - Simultaneously gently remove your foot from the foot brake and reverse down the hill

Side Slopes

- Avoid where possible
- Drive slowly and consistently
- Avoid high areas [ridges, rocks] on high side
- Avoid low areas [holes, gulley] on low side
- If you slide
  - Steer towards the slide [down hill] and gently accelerate
- If you begin to roll
  - Accelerate aggressively and turn down hill
  - Once heading down hill use cadence braking technique
- On sand side slopes use speed and full power

Ridges

- Steep ascents and descents are separated by valleys and ridges
- Know your break over angle
- Ridge crossing challenges
  - Getting high centered
    - Feathering over with momentum – friend or foe
    - Taking the ridge at an angle
  - Getting launched by a crest
  - Steep drop off on the down side
  - Sliding sideways on slippery climbs
  - Loosing traction of front axle as springs extend
- Running in line with ridge
  - Ensure there is sufficient firm ground for track width
  - Know where the trail goes – backing up presents a different dynamic w.r.t steering and wheel cheat

Troughs and V Gulley

- Crossing V-Gulley
  - Straight on approach works if the vehicle has sufficient approach and departure angles
  - If not, take at an angle dropping one wheel in at a time
  - This keeps at least one wheel [usually opposing] from each axle on firm ground
  - Use brake throttle modulation [or lockers]
- Running in line with V-Gulley
  - Use extreme caution as roll can easily result
  - Enter at an angle and drop one wheel in at a time
  - Exiting from driving down a V-Gulley can be very difficult and invariably requires lockers or winching

Axle Twisters - Moguls

- Axle twisters occur in multiple scenarios including crossing V-gulley and Moguls
- Opposing wheels on the front and rear axles are fully compressed and fully extended
- The result is the fully extended wheels lose traction
- Brake throttle modulation [or lockers] may be used.
- In the case of moguls, momentum may be used to carry the vehicle through
- Rocking can be used
- Push pull can be used
  - Synchronize throttle application with front wheels pulling and rear wheels pushing
  - Ease into the hole with minimal throttle allowing front wheel to pull instead of spin
  - Apply throttle as first front wheel recoils from entering twister – opposing rear wheel is able to push due to weight transfer
  - As rear wheel enters hole use minimal throttle allowing rear to push instead of spin
  - Apply throttle as rear wheel recoils allowing opposing front to pull due to weight transfer
  - Use slow speed as excessive speed causes to much bouncing
  - Slow methodical approach with minimal momentum but critical throttle timing works.
- Alternatively use lockers or ETC

Ruts – Across and Down

- Allow vehicle to steer itself down the rut
- Watch for high points that you may get hung up on
- Exiting sand ruts requires a technique
  - Jerk steering wheel turn away from and then back in exit direction
- Exiting mud ruts requires digging exit path
- Depending on rut width, use previously described V-Gulley crossing techniques
- Remember with more than one rut to cross pay attention that both front and rear wheels don't get caught in rut at same time.
- Use momentum if this is a possibility and feather the throttle to carry your vehicle through the multiple ruts

Rough Tracks

- 4WD may not be required but engage it anyway for increased control
- Use slow steady speed avoiding excessive braking and acceleration
- Slow and steady pace wins the day
- For very rough tracks travel just inside torque rpm closer to lugging speed
- Look well ahead and pick you line
- Watch for tire side wall damage
- Use reference points on road side to identify obstacles – holes, rocks, sharp edges, etc.

Boulders and Rocks

- Rock crawling is an art and requires superb vehicle knowledge, control, and an excellent ability to pick a line.
- Challenges
  - Getting hung up on rocks – damage can result
  - Rocks moving and causing vehicle to roll
  - Drive train breakage – drive shaft damage
- Really slow and steady will win the day – lowest gearing
- Exact wheel placement to keep vehicle level is important
- Pick a line on top of the rocks
- Avoid large rocks and voids – find the path of least resistance
- Use vehicle weight distribution to your advantage and know when to brake and when to accelerate
- Automatics are better and easier to control
- Spotting is recommended in tough conditions
- Check that rocks you plan to drive on are secure
- May require stacking rocks to build a road
- Use winch before damaging vehicle or to keep you on your line

Slick Rock

- Moab “slick rock”
  - High traction surface so extreme obstacles are achievable – rolls are very frequent
- Tennessee “slick rock”
  - Tellico – when wet has very little traction so momentum is helpful

Bridges

- Crossing old bridges can be dangerous and should be avoided where possible.
- Best to unload vehicle and carry equipment across to reduce weight and send lightest vehicle first to “test” bridge
- Depending on drop – attach strap to vehicle
- Have observers and establish communication and command channels
- Use bridging ladders for reinforcement if available
- Use other materials – trees – for reinforcement if in doubt
- Slow and steady – if bridge starts to go better to be on the side where the other vehicles are if possible

Wading and Riverbeds

- Check manufacturers wading depth
- Slow speed is required for most wading – can train if required
- In deep water, create clean bow wave – this can push the vehicle if it loses traction and helps keep water out the engine.
- Test the depth and current strength prior to crossing [knee deep is OK]
- Check the exit point – in fast water have a down stream contingency
- Go with the flow. To avoid a roll, exit vehicle on down current side
- Check the surface for traction and obstacles prior to crossing
- After wading check all fluids for contamination, remove drain plug from bell housing, inspect air filter.
- Oil floats so allow vehicle to stand for some time and then remove water by removing drain plugs [engine and drive train]

Wading and Riverbeds

- If engine ingests water and gets hydro-locked, do not attempt to restart
- Remove plugs and cycle the engine to remove water in the cylinders
- Dry all electrical components and clean air filter.
- Replace plugs and restart. Replace all fluids as soon as possible
- Add extended breathers and snorkel
- Petrol engines usually stall when they ingest water
- Diesel engine usually get destroyed if they ingest water

Some wading guidelines

- Only acceptable time not to wear a seatbelt
- In fast water open windows
- Going into water is never a problem – its getting back out
- Avoid ravines where flash floods can occur
- Avoid rivers with power station – water releases could catch you
- Fixing a rope to a vehicle before it crosses fast water is advisable
- Do not hold a rope if you are swept down stream – you will be drowned
- Know how to read water – eddies and the holes caused down stream from large rocks
- Back out before if it gets too deep – know, set, and stick to your limits

Some wading guidelines

- Light, low vehicles are a greater risk of being washed away
- Take your time and plan the crossing – this also allows time for components to cool. Sudden cooling can cause a vacuum and suck water into differentials.
- If shifting gear, increase rpm to clear water from clutch
- Avoid crossing flooded rivers or crossing rivers when it is raining
- If a tidal river, know the tide time.

Ledges

- Cresting ledge
  - Approach at an angle and climb one wheel at a time – slight angle
  - Stack rocks in front of the ledge to reduce the climb
  - Watch for [rear] drive shaft damage
  - Always try and crawl first, then stack rocks
  - Bumping [momentum] should be a last resort
- Dropping off a ledge
  - Approach at an angle and drop one wheel off at a time – slight angle
  - Watch for [front] drive shaft damage – departure angle
- Considerations
  - Wheelbase - climbing and dropping off ledges is better with LWB
  - Clearance – ground clearance is good
  - Good approach, departure [break over] angles advantageous

Logs

- Again – approach at an angle
- Have one front wheel [one closest to differential] climb first
- Just before it goes down, the other front wheel should be climbing – watch vehicle hood as indication.
- This way the tires pinch the log as they climb
- Slowly drop each wheel down taking care of ground clearance
- Repeat the process with the rear axle

Salt Pans

- Salt pans [& tidal mud flats] can swallow a vehicle.
- Driving on salt pans requires experience and luck.
- Generally salt pans have a crust that in places may be sufficient to support the vehicle weight
- Maintaining floatation is key to avoiding breaking trough the surface crust.
- Once a vehicle breaks through the surface it can sink without sufficient time to remove valuables
- Recovery can risk the rescue vehicle
- Digging can make the vehicle sink faster
- Avoid mud flats or take shortest route across

Salt Pans cont.

- Walk out and if your feet break through do not cross
- Dig a hole about 2’ deep – if it is still dry you should be safe
- Engage 4WD, low range, lockers and pick a straight line across
- Sharp cornering can cause outside wheels to break through due to added weight distribution
- Follow other vehicle tracks - unless they disappear!
- If you break through you have two choices
  - Floor it and hope you get to firmer ground
  - Stop and hope you can get out the way you came – my choice
- Start recovery without delay
  - Unpack stuck vehicle – remove all food, water, gear
  - Place spare wheels, mats, poles, etc. under the stuck vehicle to save it from sinking
  - Watch rescue vehicle very closely
- Better to walk on salt pans than drive
- Salt pans claim vehicles every year

Grasslands

- Like salt pans, grass lands consume vehicles [and passengers] every year
- Grass lands represent two main dangers
  - Hide logs, rocks, gulley, etc. a bit like snow
  - Grass and grass seeds cause over heating and fires
- Radiator protection
  - Grass seeds can get clog the radiator
  - Washing them out does not work as the swell with moisture
  - Must be blown out from the back of the radiator
  - Install a fine screen to prevent them entering the radiator
- Exhaust protection
  - One must know where grass accumulates on one's vehicle and clean it away regularly. Failure to do so will cause a fire.
  - Even fresh grass will soon dry out and catch alight if next to the exhaust
- Environment protection
  - Manufacture a spark arrestor and avoid setting the grassland alight
  - Use fine stainless mesh wrapped around the exhaust and folded over at the end

Corrugations / Washboards

- Washboards exist on most dirt roads
- Washboards can cause loss of vehicle control, especially when cornering
- Air down the tires about 20% from highway pressure and drive at a speed that minimizes the effect while maintaining vehicle control
- Expect shocks to overheat and result in loss of control, so allow time for shocks to cool
- Learn where to expect washboards on dirt roads – areas of acceleration and braking tend to cause washboards.

Spotting

- Hand signals – many options exist but ***keep it simple***
- Generally a spotter needs to communicate the following:
  - Turn left – point left with one hand
  - Turn right – point right with one hand
  - Drive forward – beacon with other hand
  - Reverse – push back with other hand
  - Stop – raise both hands with clenched fist
  - Drive faster – lift both hands palms up
  - Drive slower – lower both hands palms down
- Initially, at least until you become practiced, establish the direction [left or right] and extent of the turn by pointing in the direction you wish the driver to turn. Once the driver has set the steering wheel to the extent you select, then advise on driving forward or backwards.
- Turns – use one hand and point in the direction you wish the wheels to turn. Continue pointing until the steering wheel is set.
- Once you become more practiced you can provide instructions simultaneously
- Drive – use other hand to indicate forwards or backwards
- Use both hands [closed fists] to indicate stop

Spotting cont.

- As you become more practiced you will become more fluid in providing instructions and picking the line for the particular vehicle
- Be sure to position yourself so that the driver can always see you
- Be sure to position yourself so that you can always see the vehicle and its wheels BEFORE you give the next instruction
- Take your time - walk around the vehicle and re-examine your line
- As a spotter your task is to develop trust from a driver
- If in doubt, lock the vehicle down and ask the driver to get out and examine the line and agree on a mutually acceptable strategy.
- Develop the plan, execute the plan, allow for contingencies
- Rather be safe than sorry – use recovery techniques to better ensure successful navigation through an obstacle
- Always remain calm and never fight with the driver
- Very few people are actually really good spotters
- It is a bit like drivers – everybody thinks they are above average drivers – the same holds true with spotters
- As a driver feel free to accept or decline the advice.
- Safety remains the driver's responsibility – don't blindly trust a spotter

Spotting cont.

- As a spotter you should as far as possible explain to the driver what will occur with their vehicle during the next maneuver
- Describe what the driver will experience so they can expect it.
- Provide clear sequential instructions on what to do and when to do it.
- Pick who you want to spot for – you don't have to spot if you don't want to
- ESTABLISH COMMUNICATION CHANNELS
- ONLY HAVE ONE PERSON INSTRUCTING THE DRIVER
- OBSERVERS COMMUNICATE WITH THE SPOTTER
- SPOTTER COMMUNICATES WITH THE DRIVER

Picking a Spotter

- For a driver this is an important decision
- If on an organized trail, don't assume the designated "spotter" is capable
- Get out and watch other vehicles – preferably similar to yours – go through the obstacle
- Examine the line they took and pick your reference points
- Watch the spotter carefully – you will soon tell whether they know what they are doing or not.
- If you choose not to use them then pick someone you know, show them your line and have them spot you
- Do not feel forced into following a line is you are unsure
- Find a reliable friend to go 4 wheeling with and work as a team – this is always your best option

Convoy Considerations

- You are responsible for the person behind you.
- Wait at turns make sure following vehicle sees where you go
- Wait to assist following vehicle through the obstacle
- Communication between vehicles – CB
- Trail Leader, Mid Gunner, Tail Gunner – follow instructions
- Don’t block trail / don’t drive off trail into sensitive areas
- Travel at speed of slowest vehicle
- Travel with head lights on
- Spread vehicle abilities
- Following distance
  - Dust, mud, rain, snow, etc.
  - Obstacles – one vehicle at a time
- Warn convoy of all oncoming traffic – from front or back
- Separate men and women w.r.t potty break
  - Men to left, women to the right [“women are always right”]
  - Find suitable cover
- Pass slowly – signal number following if possible

Safety is everyone’s responsibility