



Unit	1027
Title	Describe Hazards and Vehicle Dynamics Related to Operating Light Trucks
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BC Forest Safety

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Feedback is welcome and may be sent to training@bcforestsafe.org.

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Unit Introduction

What you will learn in this unit

By the end of this unit, you will be able to demonstrate knowledge of:

- hazards and distractions
- vehicle dynamics and design
- implications of vehicle weight

This unit is an industry guideline only. It is the responsibility of the employer to ensure competence is achieved.

Why it's important for you to learn this unit

You are not just a passive participant in the health and safety of your work area. You have responsibilities and rights when it comes to your own health and safety and that of your fellow workers, particularly in the woods where the potential hazards are high.

You have the right to a safe workplace. You need to know what the hazards are and understand your right to refuse unsafe work. You also have a responsibility to follow safe work procedures, be alert to hazards and report them, and use protective clothing and equipment.

It is always the responsibility of any person using these materials to inform him/herself about the Occupational Health and Safety Regulations related to the work being conducted.

A full list of OHS Regulations related to this unit can be found in the relevant package.

Are you ready to take this unit?

There are no prerequisites for this unit.

Does this unit apply to you?

This unit applies to all forest industry occupations as required.

Section 1027-01: Hazards and Distractions

What you need to know about this section

By the end of this section, you will be able to demonstrate knowledge of the following key points:

- 1.1 Hazards related to driving
- 1.2 Road surface hazards on resource roads
- 1.3 Engineering hazards on resource roads
- 1.4 Heavy industrial traffic hazards on resources roads
- 1.5 Distractions

Key Point 1.1: Hazards Related to Driving

Motor vehicle incidents are a leading cause of worker fatalities in British Columbia.



Video 1:15

YouTube

Review: If You're Driving for Work, You're on the Job

www.youtube.com/watch?v=MX_xOCGWLk&feature=youtu.be

When you are finished, continue in this section.

Reduced Visibility

Reduced visibility can be caused by the following factors:

- glare
- sunlight and shadow
- dust
- darkness
- brush

Glare

Changing light conditions can reduce ability to see. Glare can be blinding during the day. Bright headlights from oncoming vehicles can be equally blinding at night. Dark shadows can hide hazards.

Sunlight and shadow

Sun strike or sun dazzle is when the sun is low on the horizon and your sun visors are not low enough to prevent it from getting to your eyes. When it is on the horizon, blocking the sun can mean blocking the view of traffic ahead, which makes it dangerous. Shorter drivers are at more risk of experiencing sun strike because the sun visor is less effectively placed.

Here are some common times when sun strike occurs:

- Seasonally – During certain times of the year drivers may experience sun strike during both the morning and afternoon parts of their drive.
- Exiting from a shaded to a sunny area – Upon exiting into bright light, the difference in light will be dramatic and your eyes won't be able to adjust quickly enough and you may have trouble seeing.

- Reflections – Sun reflecting off water, other vehicles windshields, and the road surface when wet can also be a sun strike hazard.

Dust

Dust can be an issue in both the summer and the winter. Dust results in poor visibility. It may be impossible to see both oncoming traffic and vehicles travelling in the same direction ahead due to concealment from dust.

Darkness

Driving at night is a challenge for all drivers. Vision is limited ahead of the vehicle, shortening reaction time. It is difficult to see hazards on the side of the road such as wildlife, pedestrians, or road hazards.

Brush

Sightlines can be obstructed when driving on roads where the brush has grown in, especially around corners.

Overcoming Reduced Visibility

Drivers must be alert and practice *SEE-THINK-DO*.

What is *SEE-THINK-DO*? ICBC defines it as follows:

- See — Scan for hazards. Pay attention to other road users and the areas where hazards could occur.
- Think — Decide which hazards are the most dangerous. Think quickly about possible solutions. Decide on the safest solution.
- Do — Do manoeuvres to keep yourself and others safe.

Using headlights

You must use the appropriate headlights for the driving conditions. During reduced visibility conditions, use your headlights. Headlights (and taillights) improve your vehicle's visibility to other drivers.

In darkness, low beam headlights will light up a path up to 30 metres straight ahead and high beams provide about 100 metres of light. Be sure to use your headlights properly according to the Motor Vehicle Act:

- You must use your headlights from 30 minutes after sunset until 30 minutes before sunrise.
- It is illegal to drive at night with parking lights or daytime running lights instead of headlights.
- You must dim your high beam headlights when you are within 150 metres of another vehicle, either when meeting or following a vehicle. Do you have trouble judging distances? Most people do. Be courteous and dim your lights early.
- You must also use headlights if visibility is reduced to less than 150 metres (for example, in fog or heavy rain).

Weather Impacts

In BC, fog, heavy rain, and snow can create difficult driving conditions. Rain, snow, and ice can make road surfaces unpredictable. Slippery road surfaces are dangerous for drivers and their passengers and may lead to crashes involving several vehicles.

Weather conditions like fog, rain, or snow can also be blinding. If you can't see clearly ahead or behind, your information about the road is dangerously reduced. You can't make good driving decisions in these conditions.

Other Factors

Other factors that bring hazards top driving include the following:

- speeding
- using cruise control
- hydroplaning
- limited line of sight
- slope
- switchback
- wildlife collisions
- other vehicles
- recreational traffic
- road maintenance activity
- loose objects in cab
- vehicle blind spots
- vehicle failure
- non-haul road or inactive roads
- barriers (deactivation)
- lack of signage
- variable road widths
- bridge approaches

Speeding

Speed limits are generally posted at the beginning of resource roads.

Even though there may be limited law enforcement on resource roads, we are all responsible for our own safety. An incident in a remote location can leave you stranded.

In B.C. in 2014, speed was a factor in about 27 per cent of all reported fatal collisions. 4,942 people were injured and 167 died in collisions involving speed.

Source: Police Traffic Accident System

Using cruise control

Avoid cruise control on resource roads due to unpredictable traction on gravel surfaces. Road sections that are under shade may be frozen and slippery while sections under sunlight may appear fine.



Reference

TranBC

Refer to Lose the Cruise Control in Winter

<https://www.tranbc.ca/2015/01/15/lose-the-cruise-control-in-winter/>

When you are finished, continue in this section.

Hydroplaning

Crossing an expanse of shallow water on the road can break contact between the tires and the road, resulting in hydroplaning. Your wheels are surfing. Slow down in wet conditions to reduce the risk.

If you feel your vehicle start to hydroplane, take your foot off the gas and allow the vehicle to slow down until it gets traction.

Limited line of sight

Resource roads can be narrow and have sharp corners. There are often lots of brush growing by the roadside or rock outcrops so the line of sight is shorter compared to paved roads and highways.

A short sight line reduces the time a driver has to react to a hazard.

Slope

Driving on steep slopes presents a serious hazard in the form of equipment rollover which can result in serious injury or death.



CAUTION!

Steep hill ahead—slow down



Switchbacks

Switchbacks are sharp corners that are generally found on steep mountain resource roads. Switchbacks can be hazardous to drive on during winter conditions or while carrying a heavy load.

Wildlife collisions

Collisions with wildlife can occur anytime, but the following are the peak times when they are most likely:

- 40% of collisions with wildlife occur between 7:00 p.m. and midnight
- 80% of all wildlife collisions involve deer. High-risk times are May and November
- spring is particularly high-risk as new green forage in roadside ditches attracts animals
- bear collisions peak in September and October as bears forage closer to communities

- December and January are the high-risk times for moose collisions



Reference

Refer to Frequently Asked Questions about Wildlife Vehicle Collisions

<http://www.safetydriven.ca/wp-content/uploads/2017/03/FAQs-about-Wildlife-Vehicle-Collisions-.pdf>

When you are finished, continue in this section.



Video 1:02:08

Road Safety At Work Webinar
Preventing wildlife collisions

<https://register.gotowebinar.com/recording/7557367128088916994>



Note: You must provide your name and email address to view this webinar.

When you are finished, continue in this section.

Other vehicles

On resource roads, there is always the risk of other vehicles not having radios, or drivers who are unfamiliar with radio-assisted road practices.

Specific times of the year increase the possibility of meeting other road users such as during hunting season, snowmobile season, etc.

Drivers who are not used to driving on gravel roads (with no center line) may be driving on the opposite side of the road to avoid potholes.

Recreational traffic

You may encounter ATVs, dirt bikes, campers, trucks, and trailer on resource roads. It is common practice when you pass a recreational vehicle with no radio to advise other drivers that a recreational vehicle is on the road.

Road maintenance activity

Graders and heavy equipment will routinely be completing road maintenance activities. There may not be flag people to warn drivers of this activity.

Loose objects in cab

The OHS Regulation states that all loose objects in the cab must be secured so that the risk of injury to the driver and passengers is minimized in the event of an accident.

Vehicle blind spots

If you are turning around and there is limited visibility, remember that there may be rocks and stumps that are difficult to see around the vehicle.

Vehicle failure

Vehicle failure such as a dead battery or low fuel conditions can create an increased risk to the driver and passengers because the consequence of failure is much higher in remote locations.

Non-haul road or inactive roads

Many inactive roads may have water bars or modified drainage structures to control water, prevent erosion, and protect the road stability. Drivers should drive slowly and with caution when entering an inactive road.

Barriers (deactivation)

Some roads may not be passable by pickup truck if the road has been deactivated to protect environmental values. For example, stream crossings such as culverts and bridges may have been removed. Larger barriers with rocks or even gates may be constructed to restrict public access.

Be aware of safety issues such as landslides.

Lack of signage

If the signage is not maintained then there may not be a sign to warn of upcoming steep slopes, curves, or bridges. It is common for signs to be shot with guns, which makes them unreadable.

Kilometer markers may be absent on older roads making it difficult for the driver to tell where they are.

Variable road widths

Resource roads are often newly constructed and may have soft shoulders. They are often narrow single lane roads with deep ditches. Wide areas or turn outs are usually constructed to allow vehicles to pass safely.

Bridge approaches

Bridge approaches can often involve navigating a sharp corner before getting on to the bridge. Many bridges are narrow and are only a single lane wide. Bridge approaches may also be brushed in with vegetation.

Hazards Related to Driving— Self-Quiz

1. Driving hazards fall into which of the following categories:

- Weather
 - Reduced visibility
 - Road conditions
 - Other vehicles on the road
 - Wildlife
 - All of these answers
-



Now check your answers on the next page.

Hazards Related to Driving— Self-Quiz Answers

1. Driving hazards fall into which of the following categories:

Answer: **All of these answers**

Key Point 1.2: Road Surface Hazards on Resource Roads

When driving on resource roads, expect rough surfaces, potholes, sinkholes, and washouts. Damage might not be marked, and the roads might not be drivable if they are overgrown or not maintained.

Common Hazards

The following are some of the common hazards:

- potholes
- washouts
- mud holes
- soft shoulders
- obstacles
- changes to road conditions
- ruts
- sink hole
- sight lines
- snow on the road
- ice on the road
- water on the road
- rocks and loose gravel

Potholes

Potholes are depressions or holes on the road surface. They can vary in size and shape.

Driving on resource roads that have potholes can cause loss of handling and driver fatigue. While small potholes may only cause minor problems, larger ones can cause an incident or vehicle damage and possibly severe injuries to anyone who is involved.

Washouts

Heavy rain can impact access to the work area. It can cause swollen creeks, road washouts, debris torrents, landslides in and above the work area, and flooding.



Reference

BC Forest Safety

Read Safety Alert: A log truck driver was fatally injured when his log truck was caught in a landslide and carried down a steep slope.

<http://bcforestsafes.org/node/2746>

When you are finished, continue in this section.



Reference

BC Forest Safety

Read Safety Alert: A log truck travelling empty on a resource road near Lake Cowichan went off the road and the cab of the truck was submerged in standing water at the side of the road.

<http://bcforestsafesafe.org/node/3040>

When you are finished, continue in this section.

Blowdown

Blowdown also occurs more readily in saturated ground. When the ground is saturated, shallow-rooted trees and trees growing in shallow soils can fall or blow down easily.

Mud holes

A mud hole is often caused by excessive wet conditions or newly constructed roads.

A mud hole can cause a truck to become stuck and in some cases to tip over. It can be very hard to assess the depth of these holes.

Soft shoulders

Soft shoulders can occur on the edges of newly constructed roads or wet road conditions.

Use extra caution when moving, especially when loaded. In wet or unknown conditions, take extra precautions on resource roads when close to the shoulder.

Washboard

A washboard is a corrugated pattern of evenly spaced bumps that make a vehicle chatter rather than bounce. It is caused by traffic on dry roads.

The rolling and bouncing motion of the tires amplify irregularities in the road materials until they organize themselves into regular scallops. The process repeats and spreads.

Washboarding can cause loss of traction and control when the wheels leave the ground.

Obstacles

Be aware of unforeseen obstacles such as trees that have blown down, or large rocks that have fallen off the slope above the road.

Changes to road condition

During the shoulder seasons (spring and fall), road conditions may be quite different in the afternoon than they were in the morning.

While they may be frozen in the morning, by afternoon they can be wet and muddy.

During heavy rainstorms, roads can deteriorate throughout the day and drivers could end up behind a washed-out culvert.

Ruts

Rutting or grooving is mainly caused by repeated rainfall and erosion of the roadbed with heavy use of the road while wet, and a lack of grading. It may also result from a poor drainage system. Ruts can cause a loss of handling ability.

Sink hole

Sometimes, heavy weight on soft soil can result in collapse of ground, resulting in a sinkhole. Sinkholes can also form when the land surface is changed or when erosion takes place under the surface of a road. Areas that have bedrock made of limestone, salt deposits or carbonate rock are most susceptible to erosion and the formation of such holes.

Sight lines

You may not always have adequate visibility due to narrow roads, sharp corners, or approaches to steep hills.



Video 2:45

YouTube

Review: Steep Grades and Switchbacks

<https://www.youtube.com/watch?v=66s316glNrw>

When you are finished, continue in this section.

Snow on the road

Snow can make driving difficult especially when there have been large accumulations. Snowplows can find it difficult to keep roads clear. Too much snow can make it hard to clear the entire road. When the road is plowed over, the ditch can create an over plow situation. In these situations, it is difficult to tell where the road shoulder and ditch are.

Snow accumulations cause limited traction and impact the ability of workers to travel in and around their work area. It may also conceal ground hazards and impact visibility which increases the risk of tripping and slipping incidents. The snow load can also increase instability of trees.



Reference

BC Forest Safety

Read Hazard Alert: Truck Tips Over Due to Over plowed Road <https://www.bcforestsafety.org/node/1586>

When you are finished, continue in this section.

Ice on the road

Conditions get tricky in the winter especially when the temperature hovers around zero. Ice or compact snow will make up most road surfaces during the winter hauling months. These surfaces when maintained provide for a smooth road surface.

Care must be taken as these roads can become slippery very easily. For example, as weather warms up, moisture will form on these surfaces making traction difficult.

Note: Be aware of elevation changes as this will affect temperature and thereby traction.



Reference

BC Forest Safety

Read: A loaded log truck struck an empty, stationary log truck that had lost traction on a hill.

<https://www.bcforestsafe.org/node/3059>

When you are finished, continue in this section.



Reference

BC Forest Safety

Read: 10 Winter Driving Tips for BC Log Haulers

http://bcforestsafe.org/files/ps_10WinterDrivingTipsBrochure.pdf

When you are finished, continue in this section.

Water on the road

Rain can affect different road surfaces differently. Wet clay is more slippery than wet gravel or soil, but wet soil may shift more, especially along shoulders. Puddles may be deeper than they appear.

Rocks and loose gravel

Large rocks can be an obstacle located on a roadway. Loose gravel or rocks can cause loss of traction. They can also be a hazard to other road users if they spray and strike other vehicles.

Road Surface Hazards on Resource Roads—Self-Quiz

1. Which statements describe how road surface hazards can impact a driver?
- They interrupt in the regular running of the work process, equipment, or other planned activity.
 - They distract you from the task at hand.
 - They greatly increase the risk of harm or injury while doing your work.
 - All of these answers
-



Now check your answers on the next page.

Road Surface Hazards on Resource Roads—Self-Quiz Answers

1. Which statements describe how road surface hazards can impact a driver?

Answer: **All of these answers.**

Key Point 1.3: Engineering Hazards on Resource Roads

Resource roads are built to different design standards and purposes than the paved public highways most of the population travel on. Some resource road characteristics include:

- built for tonnage. Think of them as conveyor belts for commodities
- made from onsite materials, variable by region (clay, silt, sand, gravel)
- unsurfaced and narrow (4 to 8 metres), often for one-way traffic, especially at bridges
- intended for low speeds and low traffic volume
- guardrails and road markings are rare
- few posted signs for speed or direction
- often rough and not regularly maintained
- managed by multiple jurisdictions and laws
- inconsistent design and maintenance standards

Some of the engineering hazards that may be encountered when driving on a resource road include the following:

- corners
- crowning
- super elevation
- slope or gradient
- road material

Corners

Corners on resource roads can be hazardous in all seasons. In colder months, ice and snow can make corners slippery, reducing traction and steering ability. Even when ice and snow are not present, loose gravel can cause similar reductions in traction and steering.

Visibility through resource road corners can be reduced by sharpness of the corner, dust, overgrowth of vegetation, or terrain features and can increase hazards associated with meeting other vehicles or wildlife with limited room to manoeuvre to safety.

Corners should be approached with caution on all resource roads.

Crowning

Crowning is also known as road camber. Crowning is building the road with a raised centre so that rainwater will drain off to the ditches on either side of the road and not pool in the road.

It is common for resource roads to be graded flat leading to increased potholes and pooling water which may freeze or cause a driving hazard. Grading should be completed in a way that leaves the centre of the road crowned.

Super elevation

On a curve, the outside edge of the road should be higher than the crown and opposite edge. This allows vehicles to keep stable while rounding curves.

A curve without a super elevation can be dangerous, especially at high speeds. Curves on some resource roads may not be built with any super elevation, so speed must be greatly reduced around curves.

If a heavy vehicle stops in a super elevated corner, the load may shift or the truck may slide downslope to the inside of the corner, or even tip over.

Slope or gradient

Resource roads are often constructed on steep grades. Steep grades may be associated with loss of traction and ability to control the vehicle. Extra caution should be taken while driving on steep grades.

Road material

Resource roads are often built with local materials that are available onsite. This results in changing road materials along the roadway, which may affect vehicle traction and control.

In some cases, roads are surfaced with suitable gravel materials which helps to reduce the inconsistency of the materials used at the surface of the road.

Engineering Hazards on Resource Roads—Self-Quiz

1. Steep grades may be associated with loss of traction and ability to control the vehicle.
 - True
 - False
 2. Curves on some resource roads may not be built with any super elevation, so speed must be greatly reduced around curves.
 - True
 - False
-



Now check your answers on the next page.

Engineering Hazards on Resource Roads—Self-Quiz Answers

1. Steep grades may be associated with loss of traction and ability to control the vehicle.

Answer: **True**

2. Curves on some resource roads may not be built with any super elevation, so speed must be greatly reduced around curves.

Answer: **True**

Key Point 1.4: Heavy Industrial Traffic Hazards on Resource Roads

There are many different types of equipment moving on BC highways and resource roads. Some types to be aware of include the following:

- wide bunks or off highway trucks
- long loads
- empty and loaded low beds
- slow moving equipment

Wide bunks or off highway trucks

Some forestry and mining trucks are purpose built to haul larger loads than would normally be legal on public highways. Due to the large size of these vehicles extra caution should be taken when approaching or passing.

Long loads

Often logs used for utility poles or specific purposes will be transported in full tree or extra-long lengths. These long ends extend past the trailer and may be a hazard on corners as they may sweep out onto oncoming traffic as the truck is turning.

Note: Any part of a load that extends more than 4 feet past the rear of the trailer must have a long load flag on it or a red light during dark hours.

Empty and loaded low beds

Low beds transport forestry and mining equipment to various job sites. Extra care should be taken when driving near low beds due to the large size and heavy weight being carried. Loose rocks or debris may fall from empty or loaded low beds causing an increased hazard to other drivers on the road.



Lowbed truck with equipment on board

Slow moving equipment

Road maintenance or heavy equipment may travel slowly along resource roads. Other users should expect to meet this equipment and be prepared to slow down and stop when necessary.

Heavy Industrial Traffic Hazards on Resource Roads—Self-Quiz

1. Care should be taken when approaching or passing a wide bunk or off highway truck because:
 - They are usually carrying a larger load
 - They are larger than vehicles that take up more space on the road
 - The bunks can obstruct visibility
 - All of these answers
2. A long load that extends more than 4 feet beyond the end of the trailer must have a red light during dark hours or have a long load flag on it.
 - True
 - False



Now check your answers on the next page.

Heavy Industrial Traffic Hazards on Resource Roads—Self-Quiz Answers

1. Care should be taken when approaching or passing a wide bunk or off highway truck because:

Answer: **All of these answers**

2. A long load that extends more than 4 feet beyond the end of the trailer must have a red light during dark hours or have a long load flag on it.

Answer: **True**

Key Point 1.5: Distractions

Activities that impact a driver's ability to focus on the road come in a wide range of forms, from visual distractions inside and outside the vehicle, to cognitive distractions when using electronic devices. Research indicates that drivers fail to process approximately 50 per cent of the visual information in their driving environment when they are using electronic communication devices.

While texting on a mobile phone is often recognized as the riskiest behaviour, distractions such as looking for preferred music or attending to personal grooming can significantly divert a driver's attention.

Research has also concluded that telephone conversations are much more distracting than in-vehicle conversations – maybe because passengers can observe the road, provide warning, and adjust conversation tone according to traffic conditions – while telephone conversations contain fewer pauses and demand greater cognitive resources. In vehicle conversations should be avoided, especially when listening for critical radio communications on busy resource roads.

Approximately one-quarter of crashes can be attributed to the driver's attention being diverted from driving tasks. This can result in tragic loss of life, serious injuries, health expenses, property damage and increased insurance rates.

Activities that impact a driver's ability to focus on the road include the following:

- Other activity on road
- Other passengers
- Radio traffic
- Eating and drinking
- Pets in cab
- Checking loads (cargo)
- Electronic devices (such as phones, tablets, GPS, radio, etc.)

Other activity on road

Recreational traffic, hunters, hikers, and animals can distract a driver from the task at hand.

Other passengers

Never look at a passenger to talk to them. Get passengers to act as co-drivers to help watch for hazards and listen to radio communications. Ask them to look far ahead as they can see and keep their eyes moving. Watch ditches, bushes, and any approach roads or intersections.

Radio traffic

Avoid distractions while on resource road channels. This includes:

- not making unnecessary radio chatter
- noise distractions such as AM/FM radios, phones, music, passengers
- staying on designated road channel at all times while traveling

Do not hold the radio in your hand when you're not using it.

Eating and drinking

To maximize your alertness and the ability to anticipate and react to hazards, do not eat while driving and do not talk on your cell phone. Keep both hands on the wheel when you are not shifting.

If you are hungry or thirsty, stop the vehicle and take a break.

Pets in cab

According to WorkSafeBC OHS Regulation 17.7, "An animal must not be carried in the operator's cab or passenger compartment of a vehicle transporting workers unless appropriate facilities are provided for this purpose."

Checking loads (cargo)

When a driver pulls over to the side of the road to check a load, being parked partially on the road may present a hazard for other drivers or themselves. Find an appropriate wide spot in the road to stop and notify other road users over the radio.

Looking at loads in the rearview mirror and not paying attention to what is in front of them can cause a driver to drive off the road. It is better to stop and check the load.

Electronic devices – phones, tablets, GPS, radio

The Motor Vehicle Act (MVA) prohibits the use of hand-held electronic devices while driving.

The following document provides examples of permitted and non-permitted electronic devices and uses while driving in accordance with Part 3.1 of the MVA and the Use of Electronic Devices While Driving Regulation.

Even if some electronic devices may be allowed by law (for example hands free phone use), they are not acceptable for travel on resource roads where a high level of attention is needed to listen to radio calls and to watch for hazards.



Reference

Road Safety BC: Use of Electronics While Driving
<https://www2.gov.bc.ca/assets/gov/driving-and-transportation/driving/publications/electronic-devices-while-driving.pdf>

When you are finished, continue in this section.

Distractions—Self-Quiz

1. Which of the following are distractions that can cause the driver to lose control of the vehicle?
- Texting on a mobile phone
 - Looking for preferred music
 - Eating while driving
 - All of these answers
-



Now check your answers on the next page.

Distractions—Self-Quiz

Answers

1. Which of the following are distractions that can cause the driver to lose control of the vehicle?

Answer: **All of these answers**

Section 1027-02: Vehicle Dynamics and Design

What you need to know about this section

By the end of this section, you will be able to demonstrate knowledge of the following key points:

- 2.1 Vehicle dynamics
- 2.2 Four-wheel drive
- 2.3 Brake systems including anti-lock brakes
- 2.4 Electronic components found in a modern vehicle

Key Point 2.1: Vehicle Dynamics

Vehicle dynamics describes how the vehicle will react to driver inputs on a given solid surface. Some important vehicle dynamics to consider include the following:

- Dynamic load transfer
- Three axes of movement
- Centre of gravity
- Rollovers
- Spring rebound
- Secondary reaction
- Tripping
- Skid

Dynamic Load Transfer

At rest, a vehicle has the load, and therefore traction, evenly distributed among the four contact patches of the tires. The variations are from the inherent front-rear weight distribution of the design.

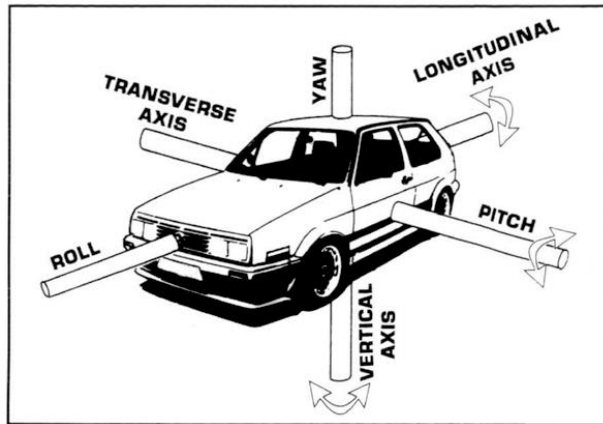
Use of any major control, such as steering, power, or brakes, transfers load, and therefore traction, among those four contact patches.

Done deliberately this is a skill. Done inadvertently it can cause a spin or crash. With a trailer, the effect is multiplied. For example, pitch from a high trailer load can prevent the tow vehicle's front tires from braking effectively in an emergency.

Load transfer causes traction changes. In a vehicle's suspension, spring compression and rebound creates movement which must be dampened or otherwise dealt with. When cornering, a vehicle is combining all three movements of roll, pitch, and yaw.

Three Axes of Movement

The three axes of movement for a vehicle are yaw, roll and pitch as shown in the diagram below.



Any load placed above a vehicle's roll axis will amplify roll, pitch, and yaw. Because light trucks can be heavily loaded, there will be a significant change in handling and stability. Adding the thrust and pull of a towed trailer will further compromise stability. A driver must take these handling changes into account when operating the vehicle.

Centre of Gravity

The center of gravity is the average location of the weight of an object. The center of gravity of a vehicle moves towards where weight is added.

Rollovers

Pay attention to load positioning on vehicles. The vehicle may rollover more easily if the centre of gravity is higher when unloaded.

Spring Rebound

Metal leaf springs in vehicles may cause momentary loss of traction after hitting a large bump as they spring to rebound.

Secondary Reaction

Secondary reaction can be the result of suspension spring rebound, for which the driver may not be prepared. This leads to fishtailing, a "hook slide", and sometimes to rollovers.

Tripping

When driving on a gravel road the wheels slide or drift a little bit on corners, but sometimes the tire may catch when it hits hard material causing the vehicle to trip or possibly rollover.

Skid

Skids are generally caused by driving too fast for conditions, or by the driver inadvertently unbalancing the vehicle's chassis through incorrect control use, such as trying to accelerate through a turn.

To avoid skids, slow down and work on correct timing of control applications. ABS brakes may not respond properly when the vehicle is locked in four-wheel drive.

Understeer and Oversteer

Understeer and Oversteer conditions include the following:

- Understeer
- Power Understeer
- Oversteer
- Trailing Throttle Oversteer (TTO)
- Rear wheel skid

Understeer

Understeer is a condition where the front tires have less traction than the rear tires and begin to slide towards the outside of a corner. This is also known as push, or plough.

Power understeer

Power understeer is caused by the driver beginning to accelerate too soon, too hard, or both, in a corner.

The load transfers to the rear tires, giving them more traction, while the front tires, which are trying to turn the car, have less. The result is that the front of the vehicle will start to run wide since the ability to steer is reduced.

Oversteer

Oversteer means the back tires have lost traction. If it goes too far, the back of the vehicle swings around beyond the driver's ability to correct resulting in a spin-out.

Trailing Throttle Oversteer (TTO)

TTO is oversteer caused by an abrupt release of the throttle, or gas pedal, while cornering. This transfers traction to the front tires at the expense of the rear tires.

Correct timing of throttle application, as well as learning how to squeeze the power on gradually, will reduce the chance of this sort of incident.

Rear wheel skid

If you are driving a rear wheel vehicle and there is not much weight in the back the rear wheels can lock up during braking, especially when there is limited traction.

Vehicle Dynamics—Self-Quiz

1. Load transfer causes traction changes.

- True
- False

2. Which of the following conditions can contribute to rollovers?

- Oversteer caused by an abrupt release of the throttle
- When the centre of gravity is higher than during an unloaded condition.
- When driving on a gravel road the wheels slide or drift a little bit on corners, but sometimes the tire may catch when it hits hard material
- All of these answers



Now check your answers on the next page.

Vehicle Dynamics—Self-Quiz Answers

1. Load transfer causes traction changes.

Answer: **True**

2. Which of the following conditions can contribute to rollovers?

Answer: **When the centre of gravity is higher than during an unloaded condition and When driving on a gravel road the wheels slide or drift a little bit on corners, but sometimes the tire may catch when it hits hard material**

Key Point 2.2: Four Wheel Drive

Four-wheel drive is a transmission system that provides power directly to all four wheels of a vehicle.

Generally, four-wheel drive should be engaged when there may be reduced traction, such as when driving during slippery road conditions such as with winter driving conditions.

Four-wheel drive increases forward traction and can help when towing and hauling heavy loads. The added weight of a large payload or trailer can destabilize a vehicle and create problems with traction, which four-wheel drive can work to correct.

- Light trucks with four-wheel drive transmissions can deliver drive power to both the front and rear axles. Like the rear axle, the front axle on a four-wheel drive vehicle has a differential and a drive shaft attached to a transfer case connected to the transmission.
- The front axle is given power from the transmission by the driver shifting the transfer case into four-wheel drive.
- Depending on the type of four-wheel drive the driver may have to manually engage front wheel locking hubs for the force from the drive shaft to reach the wheels.

Four-wheel drive can increase traction for both acceleration and braking during load shifts or while driving on uneven surfaces.

Four Wheel Drive—Self-Quiz

1. Four-wheel drive should be engaged when:

- Driving in the city in the summer
- Driving on gravel roads
- Driving on the highway in good weather
- In slippery winter driving conditions



Now check your answers on the next page.

Four Wheel Drive—Self-Quiz Answers

1. Four-wheel drive should be engaged when:

Answer: **In slippery winter driving conditions**

Key Point 2.3: Brake Systems Including Anti-lock Brakes

Anti-lock braking systems (ABS) are an important safety feature in modern vehicles.

Some older vehicles may not have ABS, which may cause the wheels to lock up during braking. Vehicles less than 10 years old have ABS.

Anti-lock Braking Systems (ABS)

An anti-lock braking system is a safety anti-skid braking system used on aircraft and on land vehicles, such as cars, motorcycles, trucks, and buses. ABS operates by preventing the wheels from locking up during braking, thereby maintaining tractive contact with the road surface.

Anti-lock braking systems should be used like standard brakes in normal driving conditions.

ABS makes it easier for a driver to maintain steering control during emergency braking, particularly on wet and slippery road surfaces. Electronic sensors control the braking force to each wheel so that it decreases when the wheel begins to lock up or skid. It is an electrically governed form of threshold braking, but with faster pressure modulation than any human footwork can manage.

To stop effectively using ABS in an emergency brake situation, press hard to get through initial pedal movement quickly. The goal is to activate the anti-lock function early, so threshold braking is achieved as soon as possible.

Drivers can be surprised by the pulsing feel and grinding noise of certain ABS designs. As a result, they may release the brakes, which is not the correct response.

Brake Systems—Self-Quiz

1. ABS makes it easier for a driver to maintain steering control during emergency braking, particularly on wet and slippery road surfaces.

True

False



Now check your answers on the next page.

Brake Systems—Self-Quiz

Answers

1. ABS makes it easier for a driver to maintain steering control during emergency braking, particularly on wet and slippery road surfaces.

Answer: **True**

Key Point 2.4: Electronic Components Found in a Modern Vehicle

Electronic components found in modern vehicles are intended to provide additional layers of safety. Some of these components include the following:

- ABS
- Electronic Stability Control (ESC)
- Tow/haul
- Differential lock
- Back up cameras and backup assist
- Blind spot and lane control sensors

Electronic Stability Control (ESC)

ESC is a computerized technology that improves a vehicle's stability by detecting and reducing loss of traction (skidding). When ESC detects loss of steering control, it automatically applies the brakes to help "steer" the vehicle where the driver intends to go. Braking is automatically applied to wheels individually, such as the outer front wheel to counter oversteer, or the inner rear wheel to counter understeer. Some ESC systems also reduce engine power until control is regained. ESC does not improve a vehicle's cornering performance; instead, it helps to minimize the loss of control.

Tow/haul

Tow/haul is usually an electronic switch that signals the computer to change transmission gearing to allow more torque at the drive wheels and to assist in braking power of the vehicle.

Differential Lock

Differential lock is an electronic switch that signals the truck computer to engage the differential to offer full time power or limited slip of both drive wheels on the axle.

Exhaust Brake

Exhaust braking systems include a mechanical valve that will partially close at the exhaust port of the engine to assist in braking applications. When the valve is in the closed position combustion pressure will build up and resist crank shaft and axle rotation, which helps provide braking power at the wheels.

Caution should be used when using exhaust brakes during slippery conditions because the wheels may lose traction even if the vehicle is equipped with ABS.

Backup Cameras and Backup Assist

Many modern vehicles are equipped with a backup camera and display screen on the dashboard. The display will often show guidance lines to illustrate turning radius on the rear-view camera backup image.

Backup cameras can be useful when connecting a trailer to the vehicle.

Blind Spot and Lane Control Sensors

Some modern vehicles will be equipped with object sensors positioned to view 360-degrees around the vehicle. In the event the vehicle is driven near an object, a warning device will be activated advising the driver of the object in the blind spot or behind the vehicle.

Lane control sensors detect pavement markings and warn the driving if the vehicle drifts outside of the laneway.

Electronic Components—Self-Quiz

1. The electronic components in modern vehicles are designed to provide:
- New features
 - Additional safety
 - Convenience
 - All of these answers
-



Now check your answers on the next page.

Electronic Components—Self-Quiz Answers

1. The electronic components in modern vehicles are designed to provide:

Answer: **Additional safety**

Section 1027-03: Implications of Vehicle Weight

What you need to know about this section

By the end of this section, you will be able to demonstrate knowledge of the following key points:

- 3.1 Ability to identify a vehicle's Gross Vehicle Weight Rating
- 3.2 Vehicle weight and insurance requirements
- 3.3 Safety implications of operating an overweight vehicle
- 3.4 How to calculate a vehicle's payload

Key Point 3.1: Gross Vehicle Weight Rating

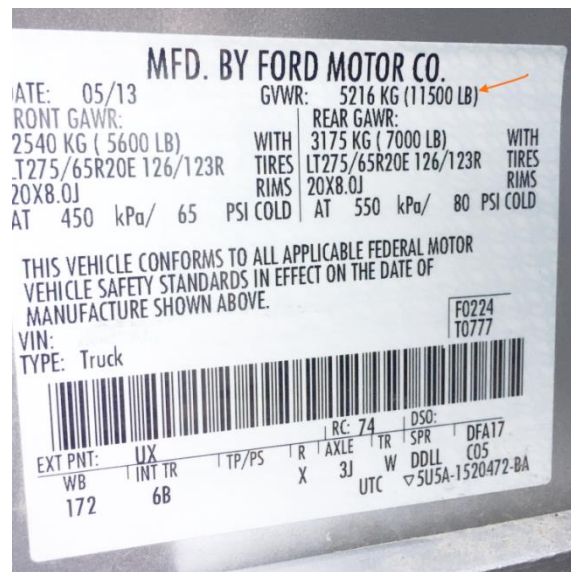
The Gross Vehicle Weight Rating (GVWR) is a limit for safe operation. A vehicle that is being run heavier than its GVWR is unsafe.

The GVWR is also a legal limit. Both the Motor Vehicle Act Regulations and the Occupational Health and Safety Regulation prohibit any use of a vehicle that exceeds the GVWR. Police officers can ticket you for operating an overloaded vehicle.

The GVWR is the maximum weight recommended by the manufacturer for the vehicle, including:

- The weight of the vehicle itself
- Fuel and other fluids
- Passengers
- Trailer
- All cargo

A vehicle's GVWR can be found by looking at the label located on the driver's door post.



Most light vehicles and pickups are licensed at a GVWR less than 5,500 kilograms; however, some larger pickup trucks may be registered at a GVWR of greater than 5,500 kilograms in order to pull heavy trailers or haul cargo such as welding units.

In BC any vehicle with GVWR exceeding 5,500 kilograms must be registered with a National Safety Code (NSC) number and must stop at every highway scale facility.

Gross Vehicle Weight Rating—Self-Quiz

1. The GVWR does not include cargo.

- True
- False

2. The GVWR is a legal limit.

- True
- False



Now check your answers on the next page.

Gross Vehicle Weight Rating—Self-Quiz Answers

1. The GVWR does not include cargo.

Answer: **False**

2. The GVWR is a legal limit.

Answer: **True**

Key Point 3.2: Vehicle Weight and Insurance Requirements

Vehicle loads in BC must meet legal requirements for load dimensions, including weight. They must also meet insurance requirements.

Requirements that must be met include the following:

- Valid insurance
- Load Capacity
- Gross vehicle weight (GVW)
- Tare weight
- Net weight or Payload

Valid Insurance

Insurance is provided by the truck owner or representative. Current proof of insurance must be kept in the truck and be easy to find.

Load Capacity

The load capacity of your truck is determined by weight, not by available cargo space. It is important to understand some of the different terms used that describe how much load your vehicle is designed to carry or tow.

Gross Vehicle Weight (GVW)

The GVW of the vehicle means the licensed maximum weight as per the vehicle's certificate of registration.

Tare Weight

Sometimes called the "unladen weight of the vehicle," it is the weight of your empty truck. This will include all its fluid, such as oil, coolants, and a minimal amount of fuel.

Net Weight or Payload

The net weight or payload refers to the weight of your cargo alone. For example, if your pickup truck crosses the scales at 4,000 kilograms when loaded, and it weighs 3,000 kilograms when you cross the scales when your truck is unloaded, your net weight would be 1,000 kilograms.

The formula for determining the net weight is:

Gross weight – Tare weight = Net weight

Vehicle Weight and Insurance Requirements—Self-Quiz

1. Why is it necessary to know the gross vehicle weight rating (GVWR) of the vehicle you're operating?
- Required as part of class 1 training
 - To ensure you don't exceed the vehicles licensed load limits
 - It's a WorkSafeBC requirement
 - So you know how much weight to put on each axle
-



Now check your answers on the next page.

Vehicle Weight and Insurance Requirements—Self-Quiz

Answers

1. Why is it necessary to know the gross vehicle weight (GVW) of the vehicle you're operating?

Answer: **To ensure you don't exceed the vehicle's licensed load limits**

Key Point 3.3: Safety Implications of Operating an Overweight Vehicle

There are safety implications when a vehicle is driven when the load is greater than the manufacturers recommended GVWR. They include:

- braking
- suspension and handling
- steering
- tires

Braking

The braking distance required to stop may be up to 100% longer (doubled) when the load on a vehicle is doubled.

Vehicles that are overloaded beyond the manufacturer's GVWR may be difficult to stop when necessary, and braking components may overheat or break and fail to stop the vehicle.

Suspension and handling

Vehicle handling will be adversely impacted when the suspension is overloaded. In addition to excessive wear on the vehicle, loss of traction may occur when the vehicle's suspension system is inoperable due to excessive weight.

Rollovers may also occur when suspension does not function properly.

Steering

If the rear of the vehicle is overloaded due to cargo or a heavy trailer, the reduced weight on the steering axle may cause steering loss. This occurs when the front of the vehicle is cantilevered upward due to the heavy load at or behind the rear axles.

Tires

An overloaded vehicle will have an increased risk of tire failure, especially if the tires are not inflated to the correct tire pressure. Unexpected tire failure may result in loss of control of the vehicle.

Safety Implications of Operating an Overweight Vehicle—Self-Quiz

1. When the load on a vehicle is doubled, how much longer will it take to stop?
 - 50%
 - 100%
 - 150%
 - 200%
2. The manufacturer's GVWR is a guideline.
 - True
 - False



Now check your answers on the next page.

Safety Implications of Operating an Overweight Vehicle—Self-Quiz Answers

1. When the load on a vehicle is doubled, how much longer will it take to stop?

Answer: **100%**

2. The manufacturer's GVWR is a guideline.

Answer: **False**

Key Point 3.4: How to Calculate a Vehicle's Payload

Payload is the combined, maximum allowable weight of cargo and passengers that the truck is designed to carry. The vehicle's payload must include the following:

- truck
- trailer
- cargo
- passengers

To calculate the payload of a vehicle, take the Gross Vehicle Weight Rating and subtract the Tare Weight.

To review, tare weight is:

- the weight of the vehicle, including a full tank of fuel and all standard equipment. It does not include passengers, cargo, or any optional equipment
- the tare may be in the vehicle manual or on the Internet. Otherwise drive the vehicle over a set of scales

Using the example from earlier, if a pickup has a Gross Vehicle Weight of 4,000 kilograms and a Tare Weight of 3,000 kilograms, then the maximum payload allowed would be 1,000 kg.

Individual Axle Loading

The manufacturer will specify the maximum loading weight for each axle. The combined vehicle and trailer weight must not exceed the maximum weight allowed for that individual axle. For example, a pickup truck with dual-rear wheels (and a higher load rating) may be required to safely tow a heavy trailer even if the GVWR is less than the maximum allowed by the manufacturer due to the position of the load at the front of the trailer.

Additional Weight Licensing

An additional licensing fee can be paid to increase the amount a vehicle is licensed to carry and tow, as long as the amount does not exceed the Gross Vehicle Weight Rating.

Calculate a Vehicle's Payload—Self-Quiz

1. Payload is the combined, maximum allowable weight of cargo and passengers that the truck is designed to carry.

True

False



Now check your answers on the next page.

Calculate a Vehicle's Payload—Self-Quiz Answers

1. Payload is the combined, maximum allowable weight of cargo and passengers that the truck is designed to carry.

Answer: **True**