= Winter service vehicle =

A winter service vehicle (WSV) , or snow removal vehicle , is used to clear thoroughfares of ice and snow . Winter service vehicles are usually based on a dump truck chassis , with adaptations allowing them to carry specially designed snow removal equipment . Many authorities also use smaller vehicles on sidewalks , footpaths , and cycleways . Road maintenance agencies and contractors in temperate or polar areas often own several winter service vehicles , using them to keep the roads clear of snow and ice and safe for driving during winter . Airports use winter service vehicles to keep both aircraft surfaces , and runways and taxiways free of snow and ice , which , besides endangering aircraft takeoff and landing , can interfere with the aerodynamics of the craft .

The earliest winter service vehicles were snow rollers , designed to maintain a smooth , even road surface for sleds , although horse @-@ drawn snowplows and gritting vehicles are recorded in use as early as 1862 . The increase in motor car traffic and aviation in the early 20th century led to the development and popularisation of large motorised winter service vehicles .

= = History = =

Although snow removal dates back to at least the Middle Ages , early attempts merely involved using a shovel or broom to remove snow from walkways and roads . Before motorised transport , snow removal was seen as less of a concern ; unpaved roads in rural areas were dangerous and bumpy , and snow and ice made the surface far smoother . Most farmers could simply replace their wagons with sleds , allowing the transport of heavy materials such as timber with relative ease . Early communities in the northern regions of the United States and Canada even used animal @-@ drawn snow rollers , the earliest winter service vehicles , to compress the snow covering roads . The compression increased the life of the snow and eased passage for sleds . Some communities even employed snow wardens to spread or " pave " snow onto exposed areas such as bridges , to allow sleds to use these routes .

However , with the increase in paved roads and the increasing size of cities , snow @-@ paving fell out of favour , as the resultant slippery surfaces posed a danger to pedestrians and traffic . The earliest patents for snowplows date back to 1840 , but there are no records of their actual use until 1862 , when the city of Milwaukee began operating horse @-@ drawn carts fitted with snowplows . The horse @-@ drawn snowplow quickly spread to other cities , especially those in areas prone to heavy snowfall .

The first motorised snowplows were developed in 1913 , based on truck and tractor bodies . These machines allowed the mechanisation of the snow clearing process , reducing the labor required for snow removal and increasing the speed and efficiency of the process . The expansion of the aviation industry also acted as a catalyst for the development of winter service vehicles during the early 20th century . Even a light dusting of snow or ice could cause an aeroplane to crash , so airports erected snow fences around airfields to prevent snowdrifts , and began to maintain fleets of vehicles to clear runways in heavy weather .

With the popularisation of the motor car , it was found that plowing alone was insufficient for removing all snow and ice from the roadway , leading to the development of gritting vehicles , which used sodium chloride to accelerate the melting of the snow . Early attempts at gritting were resisted , as the salt used encouraged rusting , causing damage to the metal structures of bridges and the shoes of pedestrians . However , as the number of motoring accidents increased , the protests subsided and by the end of the 1920s , many cities in the United States used salt and sand to clear the roads and increase road safety . As environmental awareness increased through the 1960s and 1970s , gritting once again came under criticism due to its environmental impact , leading to the development of alternative de @-@ icing chemicals and more efficient spreading systems .

= = Design = =

Winter service vehicles are usually based on a dump truck chassis , which are then converted into

winter service vehicles either by the manufacturer or an aftermarket third @-@ party . A typical modification involves the replacement of steel components of the vehicle with corrosion resistant aluminium or fibreglass , waterproofing any exposed electronic components , replacement of the stock hopper with a specially designed gritting body , the addition of a plow frame , reinforcement of the wheels , bumpers to support the heavy blade , and the addition of extra headlamps , a light bar , and retroreflectors for visibility .

Other common changes include the replacement of the factory stock tires with rain tires or mud and snow tires and the shortening of the vehicle 's wheelbase to improve maneuverability . For smaller applications smaller trucks are used . In Canada pickup trucks are used with snow removal operations with a blade mounted in front and optional de @-@ icing equipment installed in the rear . Underbody scrapers are also used by some agencies and are mounted between axles , distributing plowing stresses on the chassis more evenly .

In most countries , winter service vehicles usually have amber light bars , which are activated to indicate that the vehicle is operating below the local speed limit or otherwise poses a danger to other traffic , either by straddling lanes or by spreading grit or de @-@ icer . In some areas , such as the Canadian province of Ontario , winter service vehicles use the blue flashing lights associated with emergency service vehicles , rather than the amber or orange used elsewhere . Many agencies also paint their vehicles in high @-@ contrast orange or yellow to allow the vehicles to be seen more clearly in whiteout conditions .

Some winter service vehicles , especially those designed for use on footpaths or pedestrian zones , are built on a far smaller chassis using small tractors or custom made vehicles . These vehicles are often multi @-@ purpose , and can be fitted with other equipment such as brushes , lawnmowers or cranes ? as these operations are generally unable to run during heavy snowfalls , there is generally little overlap between the different uses , reducing the size of the fleet required by the agency or contractor .

Modern winter service vehicles will usually also have a satellite navigation system connected to a weather forecast feed , allowing the driver to choose the best areas to treat and to avoid areas in which rain is likely , which can wash away the grit used ? the most advanced can even adapt to changing conditions , ensuring optimal gritter and plow settings . Most run on wheels , often with snow chains or studded tires , but some are mounted on caterpillar tracks , with the tracks themselves adapted to throw the snow towards the side of the road . Off @-@ road winter service vehicles mounted on caterpillar tracks are known as snowcats . Snowcats are commonly fitted with snowplows or snow groomers , and are used by ski resorts to smooth and maintain pistes and snowmobile runs , although they can also be used as a replacement for chairlifts .

Military winter service vehicles are heavily armoured to allow for their use in combat zones , especially in Arctic and mountain warfare , and often based on combat bulldozers or Humvees . Military winter service vehicles have been used by the United Nations , Kosovo Force , and the US Army in Central Europe during the Kosovo War , while during the Cold War , the Royal Marines and Royal Corps of Signals deployed a number of tracked vehicles in Norway to patrol the NATO border with the Soviet Union .

= = Operation = =

Winter service vehicles are operated by both government agencies and by private subcontractors . Public works in areas which regularly receive snowfall usually maintain a fleet of their own vehicles or pay retainers to contractors for priority access to vehicles in winter , while cities where snow is a less regular occurrence may simply hire the vehicles as needed . Winter service vehicles in the United Kingdom are the only road @-@ going vehicles entitled to use red diesel . Though the vehicles still use public highways , they are used to keep the road network operational , and forcing them to pay extra tax to do so would discourage private contractors from assisting with snow removal on public roads . Winter service vehicle drivers in the United States must hold a Class A or Class B commercial driver 's license . Although some agencies in some areas , such as the US state of Minnesota , allow winter service vehicle drivers to operate without any extra training , most

provide supplemental lessons to drivers to teach them the most effective and safe methods of snow removal . Many require that trainee drivers ride @-@ along with more experienced drivers , and some even operate specially designed driving simulators , which can safely replicate dangerous winter driving conditions . Other organisations require that all staff have a recognised additional licence or certificate ? the United Kingdom Highways Agency for example requires that all staff have both a City & Guilds qualification and a supplemental Winter Maintenance Licence .

Winter service vehicle drivers usually work part time , before and during inclement weather only , with drivers working a 12- to 16 @-@ hour shift . Main roads are typically gritted in advance , to reduce the disruption to the network . Salt barns are provided at regular intervals for drivers to collect more grit , and bedding is provided at road maintenance depots for drivers to use between shifts in heavy or prolonged storms .

Weather conditions typically vary greatly depending on altitude ; hot countries can experience heavy snowfall in mountainous regions yet receive very little in low @-@ lying areas , increasing the accident rate among drivers inexperienced in winter driving . In addition , road surface temperatures can fall rapidly at higher altitudes , precipitating rapid frost formation . As a result , gritting and plowing runs are often prioritised in favour of clearing these mountain roads , especially at the start and end of the snow season . The hazardous roads through mountain passes pose additional problems for the large winter service vehicles . The heavy metal frame and bulky grit makes hill climbing demanding for the vehicle , so vehicles have extremely high torque transmission systems to provide enough power to make the climb . Furthermore , because the tight hairpin turns found on mountain slopes are difficult for long vehicles to navigate , winter service vehicles for use in mountainous areas are shortened , usually from six wheels to four .

= = Equipment = =

= = = De @-@ icer = = =

De @-@ icers spray heated de @-@ icing fluid , often propylene glycol or ethylene glycol , onto icy surfaces such as the bodies of aircraft and road surfaces . These prevent ice from forming on the body of the aircraft while on the ground . Ice makes the surface of the wings rougher , reducing the amount of lift they provide while increasing drag . The ice also increases the weight of the aircraft and can affect its balance .

Aircraft de @-@ icing vehicles usually consist of a large tanker truck , containing the concentrated de @-@ icing fluid , with a water feed to dilute the fluid according to the ambient temperature . The vehicle also normally has a cherry picker crane , allowing the operator to spray the entire aircraft in as little time as possible ; an entire Boeing 737 can be treated in under 10 minutes by a single de @-@ icing vehicle .

In road snow and ice control , brine is often used as an anti @-@ icer rather than a de @-@ icer . A vehicle carries a tank of brine , which is sprayed on the road surface before or at the onset of the storm . This keeps snow and ice from adhering to the surface and makes mechanical removal by plows easier . Solid salt is also wetted with brine or other liquid deicer . This speeds de @-@ icing action and helps keep it from bouncing off the pavement into the gutter or ditch . Brine acts faster than solid salt and does not require compression by passing traffic to become effective . The brine is also more environmentally friendly , as less salt is required to treat the same length of road .

Airport runways are also de @-@ iced by sprayers fitted with long spraying arms . These arms are wide enough to cross the entire runway , and allow de @-@ icing of the entire airstrip to take place in a single pass , reducing the length of time that the runway is unavailable .

= = = Front @-@ end loader = = =

Front @-@ end loaders are commonly used to remove snow especially from sidewalks , parking lots , and other areas too small for using snowplows and other heavy equipment . They are

sometimes used as snowplows with a snowplow attachment but commonly have a bucket or snowbasket , which can also be used to load snow into the rear compartment of a snowplow or dump truck . Front end loaders with large box @-@ like front end attachment are used to clear snow in parking lots in malls and other institutions .

= = = Gritter = = =

A gritter , also known as a sander , salt spreader or salt truck , is found on most winter service vehicles . Indeed , the gritter is so commonly seen on winter service vehicles that the terms are sometimes used synonymously . Gritters are used to spread grit (rock salt) , onto roads . The grit is stored in the large hopper on the rear of the vehicle , with a wire mesh over the top to prevent foreign objects from entering the spreading mechanism and hence becoming jammed . The salt is generally spread across the roadway by an impeller , attached by a hydraulic drive system to a small onboard engine . However , until the 1970s , the grit was often spread manually using shovels by men riding on the back of the truck , and some older spreading mechanisms still require grit be manually loaded into the impeller from the hopper .

Salt reduces the melting point of ice by freezing @-@ point depression , causing it to melt at lower temperatures and run off to the edge of the road , while sand increases traction by increasing friction between car tires and roadways . The amount of salt dropped varies with the condition of the road ; to prevent the formation of light ice , approximately 10 g / m2 (2 @.@ 0 lb / 1000 sq ft ; 0 @.@ 018 lb / sq yd) is dropped , while thick snow can require up to 40 g / m2 (8 @.@ 2 lb / 1000 sq ft ; 0 @.@ 074 lb / sq yd) of salt , independent of the volume of sand dropped . The grit is sometimes mixed with molasses to help adhesion to the road surface . However , the sweet molasses often attracts livestock , who lick the road .

Gritters are among the winter service vehicles also used in airports , to keep runways free of ice . However , the salt normally used to clear roads can damage the airframe of aircraft and interferes with the sensitive navigation equipment . As a result , airport gritters spread less dangerous potassium acetate or urea onto the runways instead , as these do not corrode the aircraft or the airside equipment .

Gritters can also be used in hot weather , when temperatures are high enough to melt the bitumen used in asphalt . The grit is dropped to provide a protective layer between the road surface and the tires of passing vehicles , which would otherwise damage the road surface by " plucking out " the bitumen @-@ coated aggregate from the road surface .

= = = Snow blower = = =

Snow blowers , also known as rotating snowplows or snow cutters , can be used in place of snowplows on winter service vehicles . A snow blower consists of a rapidly spinning auger which cuts through the snow , forcing it out of a funnel attached to the top of the blower . Snow blowers typically clear much faster than plows , with some clearing in excess of 5 @,@ 000 tonnes (4 @,@ 900 long tons ; 5 @,@ 500 short tons) of snow per hour , and can cut through far deeper snow drifts than a snowplow can . In addition , snow blowers can remove snow from the roadway completely , rather than piling it at the side of the road , making passage easier for other road users and preventing the windrow from blocking driveways .

= = = Jet @-@ powered snow blower = = =

Some railroads occasionally use air @-@ blowing machines , each powered by a jet engine to clear snow from tracks and switches . In addition to physically blowing snow with the force of the air , they melt recalictrant precipitation with exhaust temperatures over 1 @,@ 000 degrees Fahrenheit (538 ° C) . Approximately 100 are believed to have been manufactured in the 1960s , 1970s , and 1980s ; they are used so rarely that they are generally maintained indefinitely rather than being replaced . For example , in the Boston area the MBTA uses two model RP @-@ 3 Portec RMC Hurricane Jet

Snow Blowers , nicknamed " Snowzilla " to clear heavy snows from the Ashmont ? Mattapan High Speed Line and Wellington Yard . The jet snow blowers can be faster and gentler than conventional removal methods , but consume a large amount of fuel .

= = = Snow groomer = = =

A snow groomer is a machine designed to smooth and compact the snow , rather than removing it altogether . Early snow groomers were used by residents of rural areas to compress the snow close to their homes , and consisted of a heavy roller hauled by oxen which compacted the snow to make a smooth surface for sledging . With the invention of the motor car , snow groomers were replaced by snowplows and snow blowers on public thoroughfares , but remained in use at ski resorts , where they are used to maintain smooth , safe trails for various wintersports , including skiing , snowboarding and snowmobiling . Snow groomers remained unchanged throughout the 20th century , with most consisting of heavy roller which could be attached to a tractor or snowcat and then hauled across the area to be groomed .

The development of more advanced electronic systems in the 1980s allowed manufacturers to produce snow groomers which could work on and replicate a much wider range of terrains , with the most modern even able to produce half @-@ pipes and ramps for snowboarding . Snow groomers are also used in conjunction with snow cannons , to ensure that the snow produced is spread evenly across the resort . However , snow groomers have a detrimental effect on the environment within the resort . Regular pressure from the grooming vehicle increases the infiltration rate of the soil while decreasing the field capacity . This increases the rate at which water can soak through the soil , making it more prone to erosion .

= = = Snow melter = = =

A snow melting vehicle works by scooping snow into a melting pit located in a large tank at the rear of the vehicle . Around the melting pit is a thin jacket full of warm water , heated by a powerful burner . The gases from the burner are bubbled through the water , causing some of the heated water to spill over into the melting pit , melting the snow instantly . The meltwater is discharged into the storm drains .

Because they have to carry the large water tank and fuel for the burner , snow melting machines tend to be much larger and heavier than most winter service vehicles , at around 18 metres (59 ft) , with the largest being hauled by semi @-@ trailer tractor units . In addition , the complicated melting process means that snow melting vehicles have a much lower capacity than the equivalent plow or blower vehicle ; the largest snow melter can remove 500 metric tons of snow per hour , compared to the 5 @,@ 000 metric tons per hour capacity of any large snow blower .

Snow melters are in some ways more environmentally friendly than gritters , as they do not spray hazardous materials , and pollutants from the road surface can be separated from the meltwater and disposed of safely . In addition , because the snow is melted on board , the costs of transporting snow from the site are eliminated . On the other hand , snow melting can require large amounts of energy , which has its own costs and environmental impact .

= = = Snowplow = = =

Many winter service vehicles can be fitted with snowplows , to clear roads which are blocked by deep snow . In most cases , the plows are mounted on hydraulically @-@ actuated arms , allowing them to be raised , lowered , and angled to better move snow . Most winter service vehicles include either permanently fixed plows or plow frames : 75 % of the UK 's Highways Agency vehicles include a plow frame to which a blade can be attached . Winter service vehicles with both a plow frame and a gritting body are known as " all purpose vehicles " , and while these are more efficient than using dedicated vehicles , the weight of the hopper often decreases the range of the vehicle . Therefore , most operators will keep at least a few dedicated plowing vehicles in store for heavy

storms .

In the event that specially designed winter service vehicles are not available for plowing , other service or construction vehicles can be used instead : among those used by various authorities are graders , bulldozers , skid loaders , pickup trucks and rubbish trucks . Front @-@ end loaders can also be used to plow snow . Either a snowplow attachment can be mounted on the loader 's arm in place of the bucket , or the bucket or snowbasket can be used to load snow into the rear compartment of a snowplow or dump truck , which then hauls it away . Snowplows are dangerous to overtake ; often , the oncoming lane may not be completely free of snow . In addition , the plow blade causes considerable spray of snow on both sides , which can obscure the vision of other road users .

= = = Snow sweeper = = =

A snow sweeper uses brushes to remove thin layers of snow from the pavement surface . Snow sweepers are used after plowing to remove any remaining material missed by the larger vehicles in areas with very low snow @-@ tolerance , such as airport runways and racing tracks , as the flexible brushes follow the terrain better than the rigid blades of snowplows and snow blowers . These brushes also allow the vehicle to be used on the tactile tiles found at traffic lights and tram stops , without damaging the delicate surface . Unlike other winter service vehicles , snow sweepers do not compress the snow , leaving a rough , high friction , surface behind them . This makes snow sweepers the most efficient method of snow removal for snow depths below 10 centimetres (4 in) . Snow deeper than this however can clog the brushes , and most snow sweepers cannot be used to clear snow deeper than 15 centimetres (6 in) . A more advanced version of the snow sweeper is the jet sweeper , which adds an air @-@ blower just behind the brushes , in order to blow the swept snow clear of the pavement and prevent the loosened snow from settling .

= = = Surface friction tester = = =

The surface friction tester is a small fifth wheel attached to a hydraulic system mounted on the rear axle of the vehicle , used to measure road slipperiness . The wheel , allowed to roll freely , is slightly turned relative to the ground so that it partially slides . Sensors attached to the axis of the wheel calculate the friction between the wheel and the pavement by measuring the torque produced by the rotation of the wheel . Surface friction testers are used at airports and on major roadways before ice formation or after snow removal . The vehicle can relay the surface friction data back to the control centre , allowing gritting and clearing to be planned so that the vehicles are deployed most efficiently . Surface friction testers often include a water spraying system , to simulate the effects of rain on the road surface before the rain occurs . The sensors are usually mounted to small compact or estate cars or to a small trailer , rather than the large trucks used for other winter service equipment , as the surface friction tester works best when attached to a lightweight vehicle .

= = Materials = =

To improve traction and melt ice or snow , winter service vehicles spread granular or liquid ice melting chemicals and grit , such as sand or gravel .

The most common chemical is rock salt , which can melt snow at low temperatures , but has some unwanted side effects . If the salt concentration becomes high enough , it can be toxic to plant and animal life and greatly accelerate corrosion of metals , so operators should limit gritting to an absolute minimum . The dropped salt is eventually washed away and lost , so it cannot be reused or collected after gritting runs . By contrast , the insoluble sand can be collected and recycled by street sweeping vehicles and mixed with new salt crystals to be reused in later batches of grit .

Sea salt cannot be used , as it is too fine and dissolves too quickly , so all salt used in gritting comes from salt mines , a non @-@ renewable source . As a result , some road maintenance agencies have networks of ice prediction stations , to prevent unnecessary gritting which not only

wastes salt , but can damage the environment and disrupt traffic .

The US state of Oregon uses magnesium chloride , a relatively cheap chemical similar in snow @-@ melting effects to sodium chloride , but less reactive , while New Zealand uses calcium magnesium acetate , which avoids the environmentally harmful chloride ion altogether . Urea is sometimes used to grit suspension bridges , as it does not corrode iron or steel at all , but urea is less effective than salt , and can cost up to 7 times more weight @-@ for @-@ weight .

In some areas of the world , including Berlin , Germany , dropping salt is prohibited altogether except on the highest @-@ risk roads ; plain sand without any melting agents is spread instead . Although this protects the environment , it is more labour @-@ intensive , as more gritting runs are needed ; because the sand is insoluble , it tends to accumulate at the sides of the road , making it more difficult for buses to pull in at bus stops .

Grit is often mixed with hydrous sodium ferrocyanide as an anticaking agent which , while harmless in its natural form , can undergo photodissociation in strong sunlight to produce the extremely toxic chemical hydrogen cyanide . Although sunlight is generally not intense enough to cause this in polar and temperate regions , salt deposits must kept as far as possible from waterways to avert the possibility of cyanide @-@ tainted runoff water entering fisheries or farms .

Gritting vehicles are also dangerous to overtake ; as grit is scattered across the entire roadway , loose pieces can damage the paintwork and windows of passing cars . Loose salt does not provide sufficient traction for motorcycles , which can lead to skidding , especially around corners .