TODT ORGANIZATION

(Engineering and Construction Organization)

WINTER SERVICE MANUAL

1943

Edited by the Todt Organization Central Office
Chief Engineer
Road Construction, Traffic and Winter Service

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FOREWORD

Based on the experiences gained during the winters of 1941/42 and 1942/43, successful methods of combatting snow and ice on the roads in Russia and northern Scandinavia have been developed; this information is here made available to all concerned in the second edition of the OT Winter Service Manual. The combatting of snow drifts by means of snow protection installations as well as the mechanized clearing of snow from the roads have reached a significant degree of perfection in a short space of time as a result of the systematic work of the OT winter service. A new addition is the construction of snow roadways by means of rolling and compressing of snow. This procedure, in addition to being more advantageous for communication, also adds a further protective layer to the roadways of the east, which are continuously exposed to frost, and thereby reduces freezing during the spring thaws.

Dorsch

Ministry Director

July 1943

WINTER WEATHER IN EASTERN EUROPE

In general, the snowfall in the eastern regions is not any heavier than that in the Reich. However, it causes considerably more difficulty because as a rule snow falls in the east at lower temperatures; it is powdery and more susceptible to being blown by the wind into formidable snowdrifts. The unusually low temperatures combined with icy winds make it nearly impossible for man or beast to remain in the open. In comparing air temperatures in the east with those in the Reich it must be considered that in the eastern regions the cold is less penetrating, because of the greater dryness of the air, than is the case in the Reich at equal temperatures where the air is generally more humid due to the proximity of the sea coast. It is further significant that there is comparatively little change from day to day in the Russian winter climate and the frost period, which lasts for months, is rarely interrupted by thaw.

Based on the winds prevailing during the winter months, European Russia is divided into two parts -- the northern part with westerly, and the southern part with easterly air currents. It is interesting to note that easterly winds cause snowdrifts at lower wind strength than winds from other directions, and further, that winds which are particularly dangerous with regard to the creation of snowdrifts appear toward the end of the winter when the blanket of snow has reached its maximum depth and the wind can stir up considerably larger masses of snow than at the beginning of winter. On the south and in the southeastern steppes which are free of

forest, the wind carries tremendous masses of snow and thereby creates drifts. As a result considerably greater snowdrifts can form in the south even if it has had a lighter snowfall because of the steppe-like character of the terrain which is free of forests. Because the snow is swept away, the frost penetrated particularly deeply into the ground in this area.

The most advantageous temperatures for the formation of snowstorms in the west and south of European Russia are from -2 degrees Centigrade to -4 degrees Centigrade; for the central, north, and southeastern parts, at -6 to -10 degrees Centigrade. The regions most likely to be endangered by storms are the northeast and in the central. The danger of snowdrifts, however, is considerably less as there is a great deal of forest in this area.

The Caucasian region adjoining in the southeast, while situated quite far to the south, is affected by the cold of the Russian winter to a considerable degree and consequently has quite severe winters with mean low temperatures of between -10 to -20 degrees Centigrade, with the exception of the immediate coastal areas and the northern foreland. In the western and southwestern parts of this region, frequent and heavy snowfalls are to be expected, while the eastern part has little precipitation. The mountainous character of the area affects snow conditions very ununiformly and unpredictably, and causes great differences in snow conditions within comparatively small areas. It can be stated generally that the depth of the snow and the duration of the snow cover increase with the rise in sea level; however, the above-mentioned difference in precipitation between the west and

the east is a factor. Just as in the highlands of the Alps, the incidence of the greatest snow depth of the winter in the Caucasus moves with increasing sea level more and more from the middle of the winter toward spring. Similarly, avalanches which are particularly common in the mountain road areas and which because of the boulders and rubble carried along, demand particular care during removal with snow clearing equipment, are known to occur here as late as spring; and in deep valleys avalanches occasionally occur even in summer. In areas which are climatically milder occasionally have thaw periods between the seasons and consequently there is increased formation of ice.

The condition of the most unimproved or little improved Russian roads depends upon winter weather conditions to a far greater degree than is the case in central or western Europe. During the course of the year four distinct road conditions can be distinguished: Dust and sand in the summer, snow and ice in the winter, and mud in the transitional seasons. In many parts of the eastern regions the winter road conditions prevail practically half of the entire year. The discussion which follows will deal with the condition of the winter road and its demands on traffic.

WHAT EVERY TODT ORGANIZATION MAN SHOULD KNOW ABOUT SNOW

When the temperature of the air drops to or below 3 degrees Centigrade, precipitation as a general rule appears in the form of snow. There are conditions under which it still rains at temperatures below 0 degrees Centigrade. Such is the case when precipitation originates in air zones which are warmer than those

above the ground. However, those are rare occurrences with which we are not concerned here. The widespread opinion that very low temperatures make it impossible for snow to form is not correct. But it must be noted that during low temperatures there is less of a tendency for snow to form. Snowfall is most likely at temperatures around 0 degrees Centigrade.

Snowfall occurs in many different forms. The first snow usually is wet and heavy. Large snowflakes fall to the ground in the manner of raindrops, though somewhat slower, and melt away. This is not considered real snow. Regular snow consists of smaller flakes which are so light that they sway back and forth and dance during their descent. Under microscopic examination of the small particles which make up the snowflake, we find that they are crystals which appear in a great variety of forms. When there is little or no wind the snowflakes on the ground combine into a layer of snowflakes, the blanket of snow. This snow blanket after a period of time forms a uniform mass consisting of a mixture of snow, air, and water in which individual snowflakes are distinguishable only with difficulty or not at all; this is caused by the changes which occur because of changes taking place on the ground resulting from temperature, humidity, and wind. Science has not examined in detail the processes which occur during the formation of the snow blanket. If there is a strong wind during a snowfall, there occurs a snowstorm which with the increasing wind strength can turn into a blizzard or hurricane. One talks about drift snow (also known as sweeping surface snow) when snow on the ground is being swept along by the wind. Other forms of solid precipitation which occur

infrequently and which have no significant effect on winter maintenance of roads are hail, hailstones, ice needles, and freezing sleet.

It is of utmost importance for the road winter service to determine how much snow falls on the roads. But it is not always possible to express the quantity in depth of snow because snowfall varies greatly and the formation of the snow blanket is not uniform. Snow may be thick and heavy or light and loose. It is therefore desirable to determine not only the thickness of the snow blanket but also its water content (density). This is done by measuring the water column in millimeters which results from the transformation of layer of snow to water. It becomes obvious how widely the different kinds of snow can vary when one sees that the weight per unit volume can be anything between 50 and 300 kilograms per cubic meter.

Freshly fallen snow weighs between 50 and 100 kilograms per cubic meter. Snowdrifts weigh from 200 to 300 kilograms per cubic meter. Older snow deposits have been determined to weigh 160 kilograms per cubic meter in November, 200 in December, 220 in January, and as much as 270 in March. New glacial snow weighs about 500 kilograms per cubic meter; very wet glacial snow can weigh as much as 700 kilograms per cubic meter. The volume per weight of snow can be determined in many ways. The water content of the snow blanket is determined by melting the snow and measuring the water column in the measuring flask or a sample of the snow is weighed in a measuring cylinder which holds exactly one liter. The result is expressed in kilograms per cubic meter or in grams per liter.

The differing composition of the snow must always be noted. We must know whether the snow is powdery or wet, whether it is icy and compressed, or slushy. Depending on its composition the manner in which it will obstruct traffic will differ and that will determine the measures to be employed. Powdery or loose snow tends to cause snowdrifts and the latter can be cleared by fast snowplows; compressed, hard snow causes ruts and iciness, bumps and unevenness in the road which are difficult to remove.

From the above it is obvious that conscientious and systematic observation and recording of snowfalls is necessary. Only observation over a period of years presents a complete picture of snow conditions in a given area and in prevailing wind conditions.

HOW DO SNOW DRIFTS FORM?

Snowdrifts present particularly difficult obstacles to traffic. They occur in Norway, Finland, and the wide flat areas of Russia to a degree unknown in central and western Europe, and present the greatest danger to traffic in the winter. A few basic facts about the formation of snowdrifts are therefore in order here. It is of course impossible to establish definite rules.

When the average speed of the wind exceeds 5 meters per second -- that is, when its tractive force is sufficiently strong, it can carry with it loose (powdery) snow particles which have been picked up directly during a snowfall (snowdrift or storm) or which are whirled up from an existing snow blanket (driven snow); this latter manner of movement of snow forms by far the greatest number

of snowdrifts. The higher the speed of the wind the more snow particles it can carry along with it. Such movements of snow frequently take place when the sky is clear and temperatures are low. When the temperature is above 0 degrees Centigrade, no snow movement is caused by the wind because the snow particles are then stuck together and form a snow blanket. During this movement of the snow the coarser heavier particles are swept away immediately above ground as driven snow (ground layers), they jump or are rolled above ground, while the finer, lighter particles move as snow flurries and are freely suspended. The largest part of all masses of snow transported by the wind is carried in the ground layers.

If this wind, loaded with particles of snow, meets a sudden change in the earth's surface, i.e., such small or large protruding objects as dams, houses, trees, bushes, unharvested fields, stone or sand piles, snow walls, and hedges, or if it encounters indentations such as ditches, gullies, dips in the road, and valleys, a full or partial deviation occurs and the speed of the wind is suddenly reduced (braked). This sudden impact or sudden ability of the wind to expand creates air whirls which are called accumulations of wind in front of the obstacle and wakes behind the obstacle or depression. Snow particles which appear in windless zones, the existence of which is the basic condition for the formation snowdrifts, are not carried along by the wind currents and fall to the ground of their own weight. Snow deposits are formed; their extent, contours, and distance from the obstacle, that is, change in terrain, depend, in addition to the outline of the obstacle itself on the wind's strength (wind velocity) and the composition of the driven snow itself. It has been determined by measurement that snow deposits show an incline of approximately

1:5 to 1:12 on the side facing the wind (the windward or weather side), and an incline of from 1:8 to 1:10 on the side away from the wind (leeward side). The greater the wind velocity, the steeper the incline of the snow deposit on the windward side.

In the wind-free zones of a dense obstacle, snow is deposited on both sides; however, primarily on the windward side and not immediately near the obstacle but at some distance from it; this distance is greater the higher the wind velocity. Gradually the snow piles up on the windward side until it reaches the height of the obstacle. Then it is swept over the upper rim and is deposited in greater quantities behind the obstacle because of the calm which exists there until there too it reaches the upper rim of the obstacle. The angle of the decline of the snow deposits becomes lower and lower until finally the obstacle no longer obstructs the drifting of the snow.

Illustration 10 shows how snow is deposited in the calm zone of the windward portion of the depression, forming so-called "cornices". If the deposits continue, the entire depression will be filled, unless its depth is too great.

In the case of obstructions which partially let the snow pass through (fences, hedges, etc.), snow deposits form immediately on both sides. The wind partially passes through these obstructions and a considerable increase in its velocity (nearly 100 percent) takes place as a result of the cross-sectional contraction which takes place (nozzle effect); its tractive force also increases. In the calm zones of the leeward side of such obstructions wind

velocity falls off sharply and the remainder of the snow is deposited some distance behind the obstruction, not immediately behind it. Finally the snow deposit on both sides reaches the height of the obstruction. As a result of the wind accumulation on the windward side, the snow is more firmly and densely packed on that side than on the leeward side. When walking across a newly formed snow deposit, the foot would hardly sink in at all on the windward side, while it would sink through on the leeward side.

The composition of the so-called foreland of the road and its immediate vicinity are of great significance in the formation of snowdrifts. If the wind cannot sweep over this foreland because of existing forests, hedges, fences, settlements, etc, there will generally be no snowdrift formations on the road.

THE DRIFT-FREE ROAD

In addition to general climatic conditions, the layout of roads is of great importance to their susceptibility to snowdrifts. Within the same area, certain roads become snowbound, while others do not. Poor layout may even cause roads in areas of low snow fall to become snowbound. Based on a number of examples of drift-free road layout proves that it is possible to build a road, taking advantage of the terrain, in such a manner as to reduce drifts to a minimum. There follows a classification of different terrains based on their susceptibility to drifts.

Mostly endangered are:

1. Long and narrow depressions (dips). The snow deposit

surface between the upper rim of the incline and the road surface is particularly small and formation of "self-cleaning" air whirls is impossible.

2. Dips in curves, in which the wind is caught.

3. Dips up to a depth of 6 to 8 meters. The deeper the depression, the less is the danger of it being completely filled, because then the clearing effect of the whirl formation has room for action. Depressions can be artificially deepened and thereby made drift-free by building of banquettes near the upper rim of the inclines.

4. Both ends of the depression.

5. The transition between depression and dam.

Also endangered are:

1. Dams up to a height of 1 meter.

2. Very high dams (over 12 meters). High dams force the wind blowing from the side to a change of direction. This reduces the velocity of the wind over the rim of the dam which in turn results in snow deposits on the road surface. The limit of 12 meters is not firm, but varies depending on local conditions and, particularly, on the degree of incline. The thickness of the snow blanket must also be taken into consideration.

3. Roads cut on the side of a hill, unless they are located on mildly sloping inclines.

The following are generally drift free:

1. Depressions deeper than 6 to 8 meters, since there is more of a possibility for the snow to be deposited on the greater surface area of the slope, before it reaches the road surface. In a deep depression, the air whirl created by the friction of the snow-carrying wind with the upper air layers of the depression fills nearly the entire cross-section of the depression and prevents the deposit of snow. The steeper the slopes, the less snow is deposited. The depth at which a depression no longer can be filled with snow is not determined, but depends on wind velocity and composition of the snow as well as the peculiarities of a given area; this depth increases toward the southern, eastern, and southeastern areas of Russia.

2. Roads which are at the same level as the surrounding countryside, when the wind can blow across them without encountering natural or artificial obstructions such as snow fences.

3. Dams, more than one meter in height (up to 12 meters). Snow is deposited at the foot of the dam on the windward side to about the middle of the dam height. Snow is blown off the edge of the slope and the crown of the dam because the wind currents are not significantly diverted here. On the leeward side of the dam, snow deposits will form because there is a calm zone here. The Russians have made their roads free of drifts by artificially raising them above the level of the terrain.

4. All sections of roads in wooded areas.

5. Roads with very flat slopes having an incline of no more than 1:8 to 1:10. When the road slopes this slightly the wind can blow across it without changing its direction.

Roads through valleys and wooded areas are well-protected. In mountainous terrain, slopes facing the direction of the prevailing winds should be avoided. It is further desirable that road sections should be laid out in the direction of the prevailing winds (the angle between the street axis and the direction of the prevailing winds should be less than 30 degrees) and not perpendicular to the direction of the prevailing winds. Dips in the terrain or the edges of forests in the vicinity of roads frequently affect the wind direction unfavorably and cause the road to be covered by drifts.

Roads in mountainous areas and near watersheds are frequently covered for the following reason: a watershed causes the narrowing of the effective passage cross-section of the air current which increases the latter's velocity so that even if the wind in the valley does not reach the velocities which would cause a snowstorm the velocity necessary is reached at the watershed. In addition the composition of the foreland is of great significance in the formation of snowdrifts.

If the above-mentioned principles are observed it is possible to lay out a road through terrain, with regard to which the danger of snowdrifts can be reduced to a minimum. Tall trees, if planted in the foreland, as well as bushes can effectively prevent the drift snow from reaching the road.

It is frequently necessary in winter, when a road has become

impassable because of extreme snowdrifts, to look for new traffic routes (winter roads). There is of course the danger that the snow walls created by the snow plows would make the new route susceptible to drifts and the new road would have to be abandoned again. Shortly after the thaw set in, only the snow deposits caused by snowdrifts remain for any length of time. When building new roads, this is the most favorable time to lay out drift-free detours for the new road.

PRELIMINARY WORK ON ROADS

By far the greatest part of the roads in Russia are not reinforced; of approximately 3 million kilometers of roads in Russia before the war only 1.5 percent had a gravel bed while the rest consisted of dirt roads of various kinds. During the rains of the transitional period between fall and winter, these unreinforced roads were heavily cut up. When the deep ruts and holes freeze the road becomes so uneven that the use of snow plows is no longer possible because snow plows are damaged and become useless. The roads therefore must be smoothed out before the first snowfall, the ruts must be evened and holes should be filled with sand, cinders, or other suitable material. Road graders are particularly suitable for this purpose. There is frequently very little time for these tasks because the transitional period is frequently very short and the frost sets in quite suddenly. Therefore the roads must be smoothed out quickly and in accordance with a definite plan. Specifically, after inspection of the section of road which is to be maintained, the points of greatest danger must be attended to; later

the remaining section can be dealt with. During the period of night frosts as well as during the time when continuous freezing weather has set in, naturally moist or artificially moistened sand can be placed in the depression. If this sand is well packed, the subsequent freezing will constitute a relatively good passable road. Care should be taken to drain the water from the road surface.

In the case of roads handling little traffic the crest of the road should be flattened during the fall before the frost sets in. This is done by grading sand or earth from the center of the road toward the sides. This is necessary because the center of the road is raised during the frost and thus the arch in the road would become too great.

Most road construction work in Russia is carried out during the summer. Because of that it will frequently occur that at the beginning of winter not all of the materials supplied for the road construction such as sand, gravel, etc., have been used up and are still piled along the road. These piles even if they are very low, can cause snowdrifts. They must be removed before winter sets in. Sand and gravel can be utilized to fill the holes in the road. Macadam and stones must be distributed evenly along the ground. Even high grass at the edge of the road can cause snowdrifts. Such grass as well as the growths remaining in adjoining fields such as sunflower and corn stalks must be removed. Hedges and fences which are immediately on the side of the road must also be removed. Drainage canals under the road should be secured against freezing by means of wooden covers, rush mats, or thatching.

Of great importance for traffic as well as the execution of

winter service duties are the road markers which indicate the course of the road. Directional signs such as trees, curbstones or markers which are known on German roads, usually absent on Russian roads; the ditches along the road are usually filled with snow in winter so that one cannot be guided by them. Road markers must therefore be installed. The height of these posts should be between 2 and 2.5 meters and the thickness at least .10 meters; in some cases, lower posts will suffice. The posts are to be installed at a distance of one meter from the traffic lane and at intervals of 50 meters on both sides of the road. These intervals must be shortened at curves or points of poor visibility and in areas where inclement weather is frequent. In those cases installation of road markers in pairs is preferable to the alternate grouping of marking posts. At points of passage through localities road markers are also to be installed. All obstructions caused by artificial structures must be marked similarly. Marking posts must also be erected at any artificial structures which to not have a guard (schrammbord). In these cases the posts are erected near the railing supports.

Finished wooden posts will probably be in short supply; in most cases unfinished wooden posts will have to be used. In poorly forested areas it will probably be difficult to procure lumber; therefore procurement must start early. Since these marking posts are desirable also in the summer for aid in night driving it is proper to install the posts permanently in the ground. Of course the danger exists that they will be removed for use as firewood. They must therefore be set in sufficient depth and should have a crossbar or branch stump at the bottom. When sufficient time is

available the posts are to be equipped with a wisp of straw or fir twigs, or they may be tarred and, in the case of unfinished lumber, the top branches should be left on them so that they present a uniform appearance and their significance will be pointed up. This may be further aided by installing posts of equal height and in a straight line. To prevent theft, the posts should not lie around the edge of the road in a disorganized manner.

ROAD WEATHER SERVICE

It is the purpose of the road weather service to keep all those who are concerned with transportation informed about the condition of the roads at all times. It is of great importance for convoy traffic as well as for individual vehicles to know at all times, during the winter as well as during the spring mud period, when the weather changes and to know before starting on a trip whether a road is passable and in what condition it is.

For this reason the Todt organization has established a road weather service. Individual roads are divided into reporting sections of between 60 and 120 kilometers in length with approximately uniform climatic conditions. A number of these reporting sections form a reporting area which is the area of jurisdiction (road section) of the line chief of roads. Reporting area as well as reporting sections are identified by two-digit numbers (for example 01). A number of reporting sections are assigned to a message center (communications point) which transmits the individual messages. Transmission of telephone messages takes place daily at specified times.

Only one report is given for each reporting section. Should weather conditions vary within one reporting section, the worst weather will form the basis of the report. Each road weather report contains, in addition to report date and the reporting section numbers, three more digits, of which the first one denotes condition of the road, the second one road maintenance, and the third passability. These three digits further denote varying degrees of road condition: from normal to soft road surface, from normal level ofmaintenance to absence of maintenance machinery, and from "traffic normal" to "traffic impossible".

It is obvious that these reports must be clear and concise as well as regular and punctual. Incorrect reports or so-called "tailored" reports may cause higher echelons to make erroneous decisions and may result in irrevocable mistakes in operations; besides they are subject to severe punishment.

Particularly hazardous sections may be equipped by the road master, at the most important road crossings, with a road information sign board, kept up to date by the OT road weather service, from which the drivers can learn the road conditions in the immediate vicinity.

SNOW PROTECTION INSTALLATIONS

In areas subject to heavy snowfall, in which roads are exposed to frequent snowdrifts, the installation of protective devices is absolutely essential. The construction of such artificial obstructions at a sufficient distance from the road, and facing the prevailing

winds, will purposely cause snow deposits at these obstructions, that is, the wind will be freed of snow and the road surface proper will remain free of snow.

Of particular importance in all snow protection installations is the correct ratio between their height and their distance from the road. If they are too close, the snow will be deposited right on the road. If they are too distant, their effectiveness is negligible. If they are too low they will be covered too quickly; if they are too high, snow deposits may extend to the road proper.

There are:

A. Permanent snow protection installations

B. Temporary (auxiliary) snow protection installations

C. Portable snow fences (erected only during the winter)

A. PERMANENT SNOW PROTECTION INSTALLATION

1. Live Hedges

Evergreens and trees of the leafy variety may be planted in several rows. Particulary suited to the north of Russia is the fir, and suitable to the climate in southern Russia is the acacia. If the hedge is to serve against snowdrifts without the addition of shields, it must be planted at a distance from the edge of the road which is at least 10 times the height of the future hedge. The hedge must be dense from the ground to the tip. For this reason it is best to plant only two rows of firs since when three or more rows are planted, the center rows are in the shade and will not thrive because of lack of sunlight.

The distance between the individual rows should be .7 to 1 meter; the distance between firs within a row should be .4 to .5 meters. A continuous double row hedge of fir trees, on both sides of the road, will require 9,000 fir plants per kilometer.

To achieve the necessary density, hedges must be cut regularly. They are cut for the first time when the hedge has reached a height of approximately 1 meter. The life span of hedges which are well kept and taken care of, may reach 100 years. In selecting the varieties of trees only those species should be utilized which retain their foliage or needles during the winter and the branches of which will not break as a result of wind or snow load. They must be able to continue their growth with little sunlight, must have needles or leaves all the way to the ground, and must be able to withstand trimming well, as this aids in the formation of new branches. A properly cut hedge will, in 6 to 8 years, constitute a good shield against snow-drifts.

Protective hedges act in the same manner as do snow fences; however, the snow deposits are higher and more dense. One disadvantage is that because of their low height they are covered relatively quickly and so become ineffective.

2. Forest Strips as Snow Protection

These consist of a large number of tall evergreens or trees of the leafy variety, or a mixture of both; their edges are planted with bushes which initially catch the snow. Between rows of taller trees, rows of smaller trees are planted in order to create advantageous

conditions for the deposit of snow as a result of the formation of whirls which are formed by the difference in the height of the tree tops. In addition rows of bushes are planted which form a thick underbrush and thereby lend a certain density to the lower zone of the protective planting.

Such forest strips, if their width and distance between trees are correct afford complete security against snowdrifts and are advantageous because of their long life-span and low maintenance costs. This life-span may reach 50 to 60 years in the case of fir trees, and as much as 100 years in the case of trees of the leafy variety. Such plantings are effective only after many years; careful planning and consultation with forestry experts as well as establishment of large tree nurseries are therefore necessary.

3. Permanent Artificial Fences

As a rule, these are utilized only in mountainous regions.

(a) Solid Fences

These cause particularly strong damming and suction, and therefore, short and sizable deposits. The result is that they are covered very quickly and therefore become ineffective, since when the snow reaches the top of the fence, its protective action is minimized. Solid fences of this kind are not any more advantageous than slatted fences; they also require greater quantities of materials and are therefore used only infrequently.

(b) Slatted fences

These cause snow deposits in the same manner as the portable

snow shields, described below. Snow deposits are more flat than those caused by solid fences, and the fences are never covered completely by the snow. They are built of slats in horizontal and vertical rows. Between the slats the distance is proportionate to the width of the slats but should not exceed 7 centimeters. The height of the fence should be between 3 and 4.5 meters; exceptionally, it may be as much as 6 meters but should not be larger than 1/12 to 1/14 of the distance of the fence from the edge of the road.

(c) Permanent Mesh Fence

These are made, depending on materials available, of branches, reeds, rush, etc.

B. TEMPORARY SNOW PROTECTION INSTALLATIONS

This category includes walls built of snow blocks, snow walls, fences built of reeds or fir branches.

Walls of snow blocks are constructed at a minimum height of 2 meters and utilize snow which has become firm under exposure to repeated thaws and frost. Loose crumbly snow is unsuitable for the construction of snow walls since during strong winds it would be carried to the road and would cause snowdrifts there. The best time for the construction of snow walls is the second half of winter when snow storms and snowdrifts are most frequent. During this period the snow as a result of thaw becomes firm and lends itself to the formation of blocks of uniform size. Blocks 35 x 35 x 20 centimeters in size are cut with a wooden shovel from a ditch outside of the planned wall on the side of the exposed field. The first lower

layer of blocks consists of a solid wall two blocks thick. The following layers are erected with gaps 1/3 of a block long which in turn are covered over by blocks in the succeeding layer.

A snow wall (dam) is erected when the consistency of the snow is not sufficient to permit construction of a snow block wall. The dam is constructed without gaps and is wider than a snow wall. A considerable amount of labor can be saved by using a snow dam stapler. This is a kind of reverse triangular plow, the two blades of which, connected by circular iron rods, consist of five to six individual blades, 1 - 1½ meters high, which are connected at their points of overlap by means of a bolt. At the pointed back end there is an opening about 1 meter wide through which the snow dam, up to 1½ meters high, is formed. Depending on its size, the snow dam stapler is pulled by one or more tractors or by horses.

The construction of snow dams along depressions in the road artificially enlarges the depth of the depression and thereby makes it safe from snowdrifts.

Another form of temporary snow protection installation is a simple earth dam, such as can sometimes be found along the roads in the Ukraine; this type of dam extends on both sides of the road at a required distance of between 15 and 25 meters, depending on the height of the earth dam. To increase its effectiveness, earth should be dug, to provide material for the dam, on the field side. To further increase their effectiveness, earth dams should be planted or equipped with sunflower stalks.

In the construction of temporary snow fences made of reeds,

branches and twigs, strong posts must be installed at not too great a distance from each other before the beginning of the frost period. If baling wire is available, the posts may be installed at intervals of between 2 and 3 meters and may be interconnected with several rows of wire into which leaves or branches are then woven. However if wire is not available, the posts must be set closer together so as to make it possible to weave the reeds in horizontally. Rush, sunflower stalks, etc., can also be used as material for this. At points which are relatively safe from snowdrifts, reeds and fir twigs at least 1½ meters long can, if necessary, be stuck directly into the ground or into the snow, the latter being preferable since in that case the branches, even if they were to be covered up to 3/4 of their height, can be pulled out and again inserted into the newly created snow dam.

C. PORTABLE SNOW FENCES

Portable snow fences are among the best snow protection devices since they are alike, require little material, and can be moved and reinstalled without great difficulty.

(1) Snow Shields Made of Wood

These are constructed of vertical posts or of horizontal slats or boards, with air spaces between them. Illustration 11 shows how they function. The horizontal arrangement of slats is preferable to the vertical arrangement because they cause the snow deposits to form more uniform profiles; on the other hand, the raising of the shields is made more difficult.

The total air space between the individual slats should be about 40 to 50 percent of the entire surface of the shield. The lower the total amount of air space, the closer is the snow deposit to the fence, the shorter is the length of its tongue, and the greater its height.

There must be a gap of about 20 centimeters between the shield and the ground to prevent the shields from freezing to the ground and to prevent the lower part from being completely covered. Thus the shields remain accessible and are not subject to the pressure of the snow which is important when, later, they have to be moved or reinstalled.

(2) Snow Shields Made of Reeds, Birch Branches, etc.

In the Ukraine, a reed-like material, called "Rogozha" is loomed into mats one meter wide and 1-1/2 meters high, 2 of which

are combined into a snow shield 2.20 meters wide and a meter and a half high and installed into reed or wood slat frames, which are diagonally stiffened against the pressure of the wind. The individual bands are about 10 centimeters wide. The width of the gaps differs and increases from the ground upward gradually from 4 to 14 centimeters. Such reed mats could last through at least one winter.

Wicker mats which are also quite durable, also serve as snow shields. They are 2-1/2 meters long, 1-1/2 meters high and as a rule consist of 5 vertical stronger wood posts of 4-5 centimeters in diameter, between which at 25 centimeter intervals thinner posts of two to three centimeters in diameter are woven. The upper and lower band as well as the upper slit are 20 centimeters wide while the remainder of the slits and bands are 15 centimeters wide. Individual wicker twigs, bent upwards, prevent the individual bands from sliding off after the twigs have dried out. Snow shields made of fir and birch twigs have also proved themselves. Fir or birch branches, 5 centimeters thick, are made into a 2 x 2 meter frame with 5-millimeter nails. The twigs are then woven into this frame. Such mats are then mounted on posts to form a snow fence.

(3) Snow Fences Made of Straw Ropes

In areas where lumber is scarce but where sufficiently strong wooden poles can be obtained such as for example the western southern Ukraine, snow fences made of straw ropes may be constructed.

Straw ropes up to 25 meters in length and 5 centimeters thick can be made with special straw rope machines. Since the individual straw ropes made of short Ukrainian straw are not sufficiently strong to withstand the winter storms, the individual ropes are

fastened into bands consisting of three ropes each. The individual ropes are tied together with cross-wise tied wire in such a manner that the width of each band is 15 centimeters. This means that the ropes are not lined up close together. The remaining small gap is closed by the fuzzy edges of the straw ropes so that they act as a solid band. These bands are easily tied to the supporting posts with wire or string; gaps of between 10 and 20 centimeters (Illustration 46) are left between the separate bands depending on the density desired. Materials needed for each kilometer of fence are 282 kilograms of straw and 52 kilograms of strong smooth 1.2 millimeter wire.

Based on experience so far one machine can produce in the course of a 10-hour work day a minimum of 1,500 meters of straw rope which in turn will produce 80 meters of snow fence. This output can be raised considerably with good straw. The preparation and installation of the posts as well as transportation of the straw ropes is not included in this estimate.

In fastening the ropes, the wire ends should not be completely twisted but 5-centimeter-long ends should be left so that when the bands are to be removed or raised, the wire can easily be untwisted. The posts are made somewhat longer than necessary and must be at least three meters long. During the initial installation the fence is constructed at a height of 1.70 meters above ground, whereby the posts are some 70 to 80 centimeters higher than the fence. If the fence is covered by snow up to 2/3 of its height, the lower bands can be removed and fastened at the top.

Construction of portable snow fences

It is not possible to establish firm rules for the correct construction of snow fences. Only long observation of the prevailing wind directions and the locality determine what is necessary; but even when this information is available, one must count on surprises because snow storms appear suddenly from a direction in which no snow fences have been erected.

Erection of snow fences must take place during the time of the first frosts. The Russians have successfully used special post hole diggers. The depth of the post holes should generally be 1/5 to 1/4 of the length of a post and should be at least .65 meters long. Posts are inserted into the ground before it freezes and they then freeze in the ground. Only then the shields are hung. Based on Russian experience two men can insert 220 to 250 poles during an 8-hour work day. The shields are mounted on the posts on the field side, and are fastened with soft wire, reeds softened in steam, or with bast.

Snow fences are always erected perpendicular to the prevailing wind direction.

The necessary distance between the fences and the outer edge of the road ditch can be determined with reasonable exactness from the following formula which is based on experience:

$$A = \frac{11 + 5h}{k} + 5$$

A is the distance of the fence in meters, h -- the height of the fence, and k is a factor dependent on the degree of fill f (ratio of the solid fence area to total area), calculated in the following manner:

Degree of fill	(f)	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75
Factor	(k)	0.74	0.80	0.86	0.93	1.00	1.07	1.14	1.22	1.29	1.53

Example: The required distance for a fence 1.50 meters high with a degree of fill of 0.45 is equal to:

$$A = \frac{11 + 5 \times 1.5}{0.93} + 5 = \text{approximately 25 meters}$$

Figure 44 shows distances required for snow fences of up to 2.5 meters in height and a degree of fill (f) equal to 0.30 to 0.70. The distance can be reduced on the windward side only in cases of steep slopes. The above data are reduced somewhat for solid fences.

The number of rows of fences to be erected is determined by the size of the area and its terrain (bare, flat, or partly wooded surfaces). Not only the road itself but particularly the forefield must be secured by a number of fence rows standing 30 to 50 meters apart so that the snow will not be deposited en masse near the road itself. The large masses of snow must be held back and made harmless in the forefield.

In areas with changing wind direction fences must be erected on both sides of the road.

Erection of snow fences between houses which are less than 20 meters from the road has proved to be useless because it has

caused serious drifts. Such rows of houses are protected better by means of continuous fence rows erected at sufficient distance from them.

Natural but undesirable deflectors of wind are formed by mountain tops, edges of forests, and buildings which deflect the wind from its main direction and force it against the road so that snow is deposited in areas which are not normally in danger. Protection is obtained by means of fences erected perpendicularly to the deflected wind direction. Areas where depressions and dams occur frequently are well known as danger spots.

From the beginning of the installation of snow protection devices the establishment of a regular inspection service, consisting of skiers, if possible, who will observe the condition of the protection installations and the correctness of the distance selected from the roads, is necessary. Snow fences were erected correctly if toward the end of the winter there remains along the outer edge of the road a narrow strip not covered with snow.

Based on Russian experience snow fences are effective only so long as the snow deposits on the leeward side reach a height of about 2/3 of the fence height, since then the snow begins to fill the fence ditch. If at that point further drifts are expected, the shield must be moved. The first move consists of mounting the shields, by sections, at a higher point on the posts, whereby the fence ditch which is located under the shield is filled with snow up to about 20 centimeters under the lower edge of the shield. During consequent moves, the shield is placed in a ditch the width of a shovel and 25 to 40 centimeters deep at the crest of the dam. After the shields are installed, the ditch is filled

with snow and the shields freeze firmly. If strong winds are expected every sixth shield is covered with snow up to a height of one meter and the individual shields are fastened together at the upper overlap edge with wire. A second series of posts are kept in readiness.

This moving of shields is continued and repeated throughout the winter or until such time as the snow walls which have been built on top of each other have reached such a height that the road section which is to be protected begins to form a deep drift-free depression. The most important point in moving snow fences is the selection of the correct distance of the first row of snow fence from the edge of the road. That is based on the number of moves necessary every year which fact is based on local experience. In cases of five annual moves, not unusual under Russian conditions, a distance of 40 to 50 meters is generally sufficient. If the width of the foreland is insufficient for the snow deposits, the first move is made not in line with, but opposed to the wind direction, at a distance of about 10 meters from the first fence row whereby the first row initially is erected only about 30 meters from the edge of the road.

At road sections where shields frequently have to be moved, shields may have to be remounted on the posts after strong thaws.

Snow Tunnels

In the mountains, particularly in the far north, normal protective installations and snow clearing machinery are not sufficient to keep the roads open for traffic in high mountain plateaus and moors where snow storms and blizzards of great intensity occur.

Roads may be rendered impassable because of lack of visibility resulting from these intense snow storms.

In such cases, and also where roads on the side of a mountain must be protected against avalanches, the safest device that can be provided to keep the traffic rolling is a wooden snow tunnel. These tunnels are built, depending on traffic to be accommodated, as single-track tunnels with passing space at regular intervals, or as a double-track tunnel. It is important to construct these tunnels as weather-tight as possible to prevent wind-driven snow from entering. The outer covering must overlap on the sidewalls, and must be tightly packed on the roof. Inside the tunnel there must be a good roadbed and good drainage, so that the road can be used during the thaw period. Similarly, the wooden framework must be secured against the danger of being jarred by the frost since the entire structure could then easily collapse in the spring.

Active Snow Protection

The active snow protection method utilizes certain devices which change the wind direction; the increased wind velocity is then utilized to guide the snow into the desired direction.

Snow protection shields are designed and installed in such a manner that they increase the velocity of the wind and direct it so that it intensively blows the snow across the road or blows it off the surface of the road and thus prevents snow deposits from forming.

However, this method is presently still in its experimental stage and should be applied only with caution.

EMPLOYMENT OF SNOW SHOVEL COLUMNS

In spite of all precautions taken to prevent snow drifts and in spite of all preparations for the utilization of mechanical snow clearing equipment, it frequently becomes necessary to remove the snow manually. Manual labor becomes necessary both as auxiliary work in conjunction with machine clearing but is also employed separately in cases when mechanized equipment cannot be used because of road conditions or when adequate equipment is not available. It is recommended to employ manual labor on bridges where the residual blanket of snow should not be thicker than 5 centimeters.

In the east, manual labor is still the predominant method employed and it is safest when all other facilities break down. The tools necessary are easily obtainable, or can be manufactured from materials available in the east. The following tools are used to loosen, shovel and load the snow: wood or metal snow shovels, picks, hoes, and snow saws. Wood shovels are being used with good results in Russia; they are also used to cut blocks of snow. It must be noted, however, that [redacted] compressed and icy snow cannot easily be handled by wood shovels. Picks and crow-bars have to be employed as well.

In general, the civilian population -- men and women -- are to be employed in manual snow clearing operations. Since the use of civilians is a matter of organization which has to be solved differently in differing local conditions and must be determined under conditions existing at the time labor is to be recruited, no definite guide lines or principles can be laid down.

The roadmaster must make all necessary preparations in time

and must take advantage of the possibility of utilizing available labor. Arrangements must be worked out in cooperation with German civil and military authorities, agricultural leaders, German Police authorities, and the mayors of the separate municipalities so that the population, under the leadership of German or native supervisory personnel, will proceed to previously determined designated areas without special notification by the roadmaster and will proceed with clearing operations. These operations are to be carried out in such a manner as to clear initially a single track, with the necessary passing zones, so that traffic can proceed and the roadmaster can make a tour of his section in order to determine the situation and to be able to utilize the equipment and labor at his disposal to the fullest extent.

After a single track with passing zones has been cleared on the leeward side of the road, the passing zones are extended, widened, and, if necessary, new ones are added by the second work shift. The third work shift clears then the entire road. Depending on the extent of the snow-bound area and the labor available, the operations of the second and third work shifts may be combined. The fourth and last work shift willthen proceed to grade the snow walls resulting from the clearing operation; the grade will be in the ratio of 1 : 10. If the snow is compressed and hard, cubes [blocks] will be cut and moved aside. If necessary, the snow will be carted away. The last work shift is important because, if the snow is not removed from the side of the road, it will only cause new and higher snow drifts and will make later removal more difficult. There is frequently only a short period of time available to carry out these clearing operations, because

in many areas in Russia snow drift periods are frequent, and work must be accomplished during the few days between drift periods, if good results are to be obtained. Therefore all available resources must be employed and must remain in constant operation for days. The individual work groups are to be employed at such distance from each other that they are able to complete their assigned section within one day, otherwise traffic is endangered by the presence of not yet cleared areas along the road. For this reason the road sections are kept relatively short, and work shifts are rotated. It must be made sure that the laborers remain at their work throughout the day and they work at an adequate distance from each other (about 2 meters). An adequate number of supervisory personnel must be assigned (at least one for every 20 workers).

In addition, portable fences for protection of the laborers against the wind must be erected, so that the wind cannot blow the snow from their shovels.

Snow drifts are cleared only when the storm has abated somewhat, since otherwise cleared areas would immediately be covered over again. Use of a wedge plow to break up drifts 0.60 to 1.00 meters in height is advantageous. Initially, an area twice the width of a shovel is cleared in the center of the drift, with cleared cross paths, 1.0 to 1.5 meters wide, at intervals of 8 to 12 meters, depending on the height of the snow; this is done to provide a space for the snow which has been loosened by the plow and to prevent the plow from getting stuck.

Ruts and ridges on the road must be filled with snow or smoothed with picks and removed. Existing holes are filled with

snow, sand and are made to freeze solid by addition of water.

To increase work output, it is necessary to provide the laborers with hot soup or beverages. Cooking facilities must be provided and some provisions and thermos flasks are to be held in readiness. Such installations can be made in villages or houses along the road, which can also serve to provide heated quarters and storage for shovels, hoes, and other tools; otherwise, temporary warm-up shacks or at least walls for protection against the wind must be erected of lumber and snow.

CLEARING OF SNOW WITH WOOD PLOWS AND HORSES

Nonmechanized removal of snow with the aid of wood plows and horses can be effected successfully if the snow is not very deep, not, deeper than 20 centimeters, and is not very firm. This method has the advantage of providing excellent snow surfaces on the road if the snow has been removed reaching not quite to the surface of the road. However, the speed with which snow is removed is moderate and the radius of action is small.

As a rule two successive work operations are carried out. Initially, preplowing is carried out with the aid of a small plow which clears a track of about one meter in width; the second operation consists of wider plowing, to a width of about 2 meters. Hardwood is most suitable in the construction of these plows. The plowing angle is between 30 and 40 degrees. The point and the lower edge of the moldboard are covered with sheet metal. The sides are connected with boards. The plow is guided by the laborer by means of a pole in the rear of the plow. These plows are weighed down with sand or stones or, better, by laborers who

carry out various additional jobs. Shovels and picks are to be carried along for this purpose. The foreplow is pulled by one horse, the widening plow -- by two horses.

Wider plows may be used if more horses are available.

Wood plows can be used with excellent results when these are tied to motor vehicles. In this way lengthy road sections can be cleared in short order. These wood plows can be heavier and wider than those pulled by horses. The jaws of the triangle may be as wide as 3 to 6 meters; the plowing angle may be as high as 50 degrees. The points must be entirely covered with sheet metal; the lower edge of the moldboard must also be covered with sheet metal or angle iron. Figure 54 depicts a plow with adjustable jaws. This design is advantageous because one side of the plow may be swung out of the way when other vehicles are encountered on the road. Because of the side wings, the center of gravity of these plows is located toward the rear. The front part must therefore be balanced and here again laborers may be used to weigh it down.

These heavier wood plows may also be pulled by horses if proper arrangements can be made.

Snow removal results in the creation of snow walls on the sides of the road which may cause the road to be covered by snow drifts if these walls are not removed in time. It is therefore necessary to grade them immediately after the snow plow has passed.

The wood plow also serves to smooth down uneven roads, and when heavily weighed down, wood plows can gradually smooth out the road surface so that speeds up to 80 kilometers per hour can be attained. Such winter roads often constitute the best road conditions of the entire year.

SNOW PLOWS WITH CATERPILLAR TRACTORS

There is considerable utilization of caterpillar tractors in the east for maintenance of the Russian dirt roads; these tractors are of great importance also for the winter service. Both types of equipment are mainly copies of American machines. In addition to the little-known Comintern and Communar types, the Soviets produce two basic types: the heavy Stalinets caterpillar tractor and the new lighter NATI caterpillar tractor.

The Stalinets tractor is the copy of an American machine and is equipped with a heavy gasoline carburetor engine or a diesel engine. The diesel engine is started by means of a two-cylinder carbureted engine.

The NATI tractor is of Russian design, developed with the aid of foreign engineers, and has a heavy gasoline engine which can be started with light gasoline and which is equipped with a heated carburetor.

Since both models are encountered frequently and their characteristics are not too well known by the Todt Organization, the basic technical data are given below:

	Technical Data on the Stalinets Diesel Caterpillar Tractor (65 HP) Type Y T 3 Chelyabinsk Tractor Plant	Technical Data on the NATI Caterpillar tractor (52 HP) Type S Kh T 3 Kharkov Tractor Plant or Stalingrad Tractor Plant
Length	4.086 meters	3.698 meters
Width	2.416 meters	1.601 meters
Height	2.803 meters	2.211 meters
Radiator Height	2.151 meters	1.575 meters
Total weight with fuel	11,200	5,115
Fuel consumption	220 grams per HP/hour	315 grams per HP/hour
(At maximum output, approximately):	17.5 kilograms per hour	16.7 kilograms per hour
	SPEED: (kilometers per hour)	
First gear	3.6	3.8
Second gear	4.8	4.5
Third gear	6.9	5.2
Fourth gear	-	6.0
Reverse gear	2.5	3.0

TRACTION AT DRAW BAR

(Kilogram)

First gear	4,000	2,500
Second gear	2,800	2,000
Third gear	1,800	1,600
Fourth gear	-	1,000

A number of models of each tractor have been equipped for wood-burning generator gas. Russian wheel tractors need not be discussed here because they are almost exclusively utilized in agriculture and are not considered for road maintenance and the winter service.

Russian tractor plows, pushed or pulled by powerful caterpillar tractors, have been used to good advantage in snow removal operations. The tractor plow is advantageous because the power of the tractor makes it usable even under the most difficult working conditions, such as deep snow, in the removal of heavy snow deposits. Since most of the tractors used in road construction are of the Stalinets type, most of the tractor-plows encountered are adapted for use with the Stalinets and particularly for the Stalinets 60, the heaviest type. The tractor-plow too has been copied from American prototypes. The operating speed of the tractor-wedge plows during snow clearing operations is approximately 3 kilometers per hour. Two men are required to operate them.

MAXIMUM DIMENSIONS OF TRACTOR PLOWS:

Overall length	6,650
Overall width during transport	3,640

Overall height	3,150
Clearance width of the fore-plow	3,300
Greatest clearance width with sides fully extended	6,000
Maximum weight	6,200

The tractor-plow consists of the clearing shares, the raising and lowering devices, and the traction frame. One blade each is added in rear of the wedge plow on both sides of the tractor to increase the clearance width and to grade the snow walls which are formed on both sides of the road. This affords full utilization of the heavy tractors during snow clearing operations.

The side blades move along a slide piece in vertical supports which are rigidly fastened to the traction frame of the snow plow which is placed around the caterpillar tractor. The side-wings can be raised or lowered hydraulically or mechanically, by means of a two-drum winch which is mounted on the rear of the tractor. When both wings are fully extended the over-all clearance width is 6 meters.

The entire snow clearing device is mounted on the traction frame, a steel framework consisting of beams and angle-irons. To facilitate attachment of the snow clearing apparatus to the caterpillar tractor, the rear beam of the frame is detachable. The draw bar of the caterpillar tractor is then connected to the rear beam of the traction frame of the snow clearing apparatus; the latter is not pushed by the caterpillar tractor, even though it is mounted in front of it, but is being pulled by it.

The Russian caterpillar tractors mentioned above are frequently also used to pull graders which are of two kinds, those with and without self-propulsion. As a rule only non-self-propelled road graders are found in Russia; their use in snow clearing work is limited, since it depends on whether or not the tractor which is in front of the road grader gets stuck in the snow. Therefore the grader is suitable only for the clearing of moderate quantities of new snow, of roads under thaw conditions, clearance of embankments, removal of packed down layers of snow, smoothing of uneven road surfaces as well as for preparation of the dirt roads for snow clearance. The grader blade should have a length of three to four meters. Under certain conditions that blade can be lengthened by mounting of an additional wing.

Self-propelled road graders are more suitable for snow clearance; among them the American caterpillar is particularly suited for the winter service in the clearance of moderate to medium high layers of snow; this caterpillar is extensively utilized also in the Nordic and Baltic countries.

The caterpillar road grader is a universal piece of road machinery which can be effectively used during the winter maintenance of roads as well as for continuous maintenance of roads during the spring, summer, and fall. This model is equipped with either a 44 or 60 horsepower diesel or gasoline engine, with one or two driving rear axles. The weight of the individual models varies between 7,020 to 8,450 kilograms. Normal length of the grader blade is 4 meters. Special models have a blade of 3.0 to 5.3 meters. The diameter of the grader blade rotator is 1.66 meters. Since the engine is mounted above the rear axles its weight furnished friction

pressure to the rear wheels. The driver has good visibility and the forward part of the machine is free for the attachment of the grader aggregate or the snow plow.

USE OF TRUCKS IN SNOW PLOWING

General

A layer of snow 5 centimeters high has no effect on the usability of the roads by motor vehicles. However, with increasing height of the loose snow the speed of the vehicles is reduced, and when the layer reaches 25 centimeters, traffic is stalled.

Soft snow up to .40 meters high is most easily cleared with the aid of trucks (LKW) to which snow plows have been attached. German snow-foreplows, attached to the front of the trucks are best used on paved roads. They can be used on dirt roads only when those have been sufficiently smoothed down in the fall.

Snow-foreplows

These plows are attached to the front of motor vehicles either rigidly or so that they are movable, and are pushed by the motor vehicle. The method of rigid attachment with lowering device is applicable for smooth well-graded roads while the movable method is employed on uneven and bad roads. In using the first method, the road is cleared down to its surface; the latter method does not allow for complete clearing.

There are two kinds of foreplows, those which clear the snow to one side (one-sided plows) and those which deposit the snow on

both sides (wedge plows). Both kinds are produced in light, medium, and heavy models. These plows weigh up to 950 kilograms. One-sided plows are used to clear wide roads by stages, as well as for the clearing of mountain roads and roads cut on the side of a mountain where it is only possible to deposit the snow to one side. Wedge plows, provided they have a plow share of sufficient height, are particularly well-suited to breaking up snowdrifts. The clearing width of one-sided plows ranges from 2.60 to 3.50 meters; that of the wedge plows, from 2.20 to 3.00 meters.

Both models are produced by the individual plants in differing weights. The foreplows can be serviced by an easy-to-handle raising and lowering device operated by the assistant driver (plow operator) from the cab of the truck; this device can be adapted to changing road conditions. It is particularly important to place the shares in such a manner as to form as great as possible a sideways motion of the snow. Demountable scraper blades are mounted at the lower end of the blade surface. In order to protect the blade surface from scraping along the road when the scraper blades have been used up, adjustable slide or scraper skids are attached which are covered with replaceable metal. These skids protect the plow against being lifted up as a result of unevenness of the road and they therefore prevent accidents. To avoid damage to the plow when it hits obstructions in the road there are usually additional safety devices such as shearing bolts.

The snow plows must be maintained carefully. Repairs must be carried out immediately after damage has occurred and used parts, especially scraper blades and skids, must be replaced with new ones.

Vehicles Used to Push Plows

The necessary vehicles must be drawn from stocks of available trucks which are used for other purposes. Because of the difficulty in obtaining spare parts it is desirable, in larger areas, to use trucks of one type as far as possible. Generally light to medium heavy trucks of from 80 to 100 horsepower are usable. The 3-ton Allrad-LKW is generally the smallest vehicle which can be used for snow clearing. However, it is not too suitable behind one-sided plows. Under normal conditions the 4.5-ton Allrad-LKW is best suited for snow clearing with the most common German foreplows. In addition, vehicles which can travel cross-country and have a strong frame construction and sufficient road clearance are well-adapted to this work. The power necessary for snow plowing can be increased by coupling two LKW's one behind the other with the attachment of a special push coupling. In addition it must be noted that the outside dimension from rear wheel to rear wheel must be smaller than the clearing width of the snow plow since otherwise the rear wheels especially in curves would be in the not yet cleared snow or in the snow which has slid back into the road.

The vehicles to be used must be in excellent condition so as to be able to withstand the heavy use.

Since the snow plow which is attached in the front of the vehicle causes the weight to be distributed on the front axle, the vehicle must be loaded to about 3/4 of its load capacity over the rear axle. Gravel or sand are best suited for this purpose since it can be used when the need arises for spreading on slippery roads.

In addition to their normal tires, the vehicles must be equipped with strong snow chains (if possible, square chains, not ladder chains) as well as with frost free windshields and effective electric windshield wipers; the caps should be insulated and heated. The constant forward and reverse movement, mostly at slow speeds as well as the pushing against high walls of snow is extremely hard on clutches and gears. Parts depots must therefore stock sufficient numbers of the necessary spare parts. Similarly, lighting equipment for night work (spotlights, blackout lights, headlights, and tail-lights) must be in good order; colored storm lanterns in sufficient quantities must be carried. Headlights must be set somewhat higher than usual because the snow dust raised by the plow reduces the driver's visibility.

Hitching of Snowplow to Truck

Because of the difference in design of the front frame end of the various models of trucks a special connector piece called the vehicle connector plate (car plate) is necessary to hitch the snow plow to the vehicle. This plate is of standard dimensions. The back of the vehicle plate is permanently connected to the vehicle frame by means of an angle iron.

The vehicle plate and connecting parts are delivered by the manufacturer separately because these connecting parts between the plate and the vehicle frame must be adapted to the frame end of the particular truck model to be utilized. The following must be noted in attaching the vehicle plate: The vehicle must be on a level surface and the front tires must be inflated to the prescribed

pressure. The vehicle plate must be mounted vertically.

Every snowplow is equipped with the counterpart to the vehicle plate, the so-called plow plate, the form of which may vary but which has holes drilled in positions corresponding to those on the vehicle plate. The side of the plow plate which faces the plow is equipped with straps and the spindle box for raising and lowering of the plow and is rigidly attached to the plow. Vehicle plate and plow plate are connected by 3/4 inch bolts and nuts.

Preparations

Prior to the onset of winter thorough overhaul of vehicles and equipment is necessary. An adequate supply of easily used or damaged parts, such as scraper blades and the necessary connecting bolts, is laid in. Of great importance also is the storage of vehicles and equipment in sheltered, even though only auxiliary, garages or carports because only then are they instantly usable. Service personnel must be trained in the speedy attaching of snowplows to trucks, even in the dark. All unpainted parts of the snow clearing equipment must be well greased. Of particular importance are joint couplings and parts which are threaded. In the case of movable parts, gasoline, kerosene, or diesel oil must be added to the grease so that it will not become too thick in extremely cold weather. Clutch and brake pedals must be wrapped with burlap to prevent the foot from slipping. It is also recommended that there be in the cab a small sack made of soft cloth containing salt for the cleaning of windshields. It is frequently advisable to pour water over the clearing surface of the snowplows which will form a thin layer of ice and there-

by reduce friction.

Drivers just out of driving school should not be employed in snow clearing operations but must first gain sufficient experience in driving trucks without snowplows; they can initially be used as assistant drivers. The physical and mental condition of driver personnel must be such that they will be able to withstand the great exertion and many demands of the winter service.

Clearing

Of great importance for successful snow clearing operations is the ability to recognize the most advantageous time for putting the equipment to work. Paved roads should be cleared as soon as possible after the beginning of the snowfall so that the snow will not be compressed on the road by traffic. Clearing it then would be extremely difficult. When thaw has set in and is followed by slippery ice these compressed tracks would form an extreme obstacle to traffic. If in spite of all precautions such icy tracks should appear, they must be removed manually immediately the next time thaw sets in. As long as snow continues to fall the road must be cleared to prevent the layer of snow from becoming too thick and impossible to handle. Additional service personnel must be held in readiness for relief if snow clearing operations are expected to be lengthy. If the wind blows across the road the snow must be cleared toward the leeward side of the road. In the case of dirt roads one should wait for some time before commencing clearing operations since a somewhat thicker layer of snow is desirable here to smooth out existing unevenness in the road.

If the snow is sticky it is important that no clumps of snow collect on the surface of the blades because they then hinder the thrust motion. In such cases frequent stops are necessary in order to clean the plow blades and oil them carefully.

The success and quality of snow clearing with foreplows depends to the greatest extent on the ability of the truck driver. Extreme care must be exercised when snow or ice conditions exist as well as in curves as braking and steering ability is extremely reduced. Particular attention must be paid to timely change in power transmission, that is, in mountainous terrain and on icy roads one must shift into the lower gear in time and clutch and accelerator pedals must be handled carefully. The snow plow attached to the front of the truck is extremely hard on the vehicle so that additional abuse of these vehicles resulting from careless action and conduct of the drivers must be avoided under all circumstances.

As much as high speed in clearing is desirable since it reduces the time in which the road will be cleared and throws the snow further sideways, the disadvantages of driving at great speed are equally pronounced; when driving at high speed there are, in addition to increased danger of accidents, certain vibrations to be considered which transmit themselves in greater strength to the snowplow which is rigidly attached to the truck. As a result snow deposits remain on the road in the form of waves which are then compressed by the vehicles which follow. The result is a very uneven road. Increased wearing out of scraper blades and damage done to the road must be added to the list of disadvantages. The most advantageous speed for clearing is about 25 kilometers per hour since

topnotch drivers are needed for higher speeds. In negotiating steep inclines the power of the truck is frequently insufficient to reach a satisfactory speed during the upward climb. In such cases it is advisable, particularly when plowing to widen the clearing area, to clear inclines in the down hill direction. This must be taken into consideration when planning utilization of snow clearing vehicles.

It is further important to service the raising and lowering devices properly; even on paved roads the plow must not be lowered to its lowest position because even the surfaces of paved roads may be uneven. When using empty trucks and when obstacles in the road are encountered the snowplow must be raised sufficiently high above the surface of the road. The scraper blades should not be used up too much but must be replaced in time so that damage to the blade will be avoided. Should a snow clearing vehicle slide off the road, the plow must be disconnected and a tow rope must be attached at the back of the plow supports and the vehicle must then be pulled back to the road.

Of importance is also the post-clearing operation (removal of the snow, grading) of the snow walls created by the snow plows, so as to prevent them from causing new snowdrifts.

Rear Moldboards

These clearing devices are attached as side-plows (widening plows) on special wing frames which are adaptable to every truck with loading platform and can be mounted and dismounted in a few minutes. The opening and closing of these flaps is best done

hydraulically.. These attachments have been used successfully in Germany; additional development work has to be done before they can be used in the east.

The snow-throwing attachment is designed to throw the snow beyond the edge of the road and thereby to eliminate the walls of snow on the side of the snow. In order to reach a throwing distance of 6 - 8 meters a speed of more than 20 kilometers per hour is necessary. To keep up such a speed is possible only on wide roads when there is not too much snow, and when vehicles with an engine output of at least 120 horsepower are used.

An ordinary widening blade normally used for the clearing of roads is used to trim the tops off the snowbanks. When performing widening, the blade is on the surface of the road. To trim the snow-banks on the side of the road, which is done in layers, the device is raised to the appropriate height. This operation is best done immediately after the banks have been formed since it can be done at reasonably good speed and a throwing effect is obtained.

The snow lift cuts through the foot of the snowbank on the side of the road, lifts it to the top of the bank, or, at sufficiently high speed, throws it over the top. If this operation is followed by the attachment which trims the top of the banks the banks can be eliminated completely.

Mobile Snow Clearing Units

While in the rear areas winter service is carried out from permanent bases, conditions in operational areas, where the emphasis

of deployment of forces constantly changes, present circumstances in which it is frequently necessary to make the roads passable as rapidly as possible in areas where no preparations for snow clearing could have been made in advance in order to enable transports to reach their objective without delay.

Special mobile forces, such as those used in rear areas for disaster relief, must be organized and made available to the commands affected. The method of employment prescribes the composition of the snow clearing units. In order to be equal to their difficult tasks these units must be well-disciplined and must function as a reliable tool in the hands of their leaders.

Particular attention must be paid to the maintenance service since it must be assumed that the repair work which will be made necessary under such conditions must be done on the spot as it would otherwise endanger the accomplishment of the objectives. Repair and maintenance of snow clearing vehicles runs about 50 percent higher than maintenance of other vehicles operating under similar weather conditions.

Care of Clearing Equipment

This is most important. After returning from road work, snow clearing equipment must be checked for loosened nuts, scraper blades, skids, and movable parts. The spindles and raising devices must be greased along with other lubrication points. Parking must be effected in such a manner as to facilitate immediate departure. The plow plate must be left on the plow. Before storage in the spring, damaged places must be cleaned of rust and painted. Lubrication

points must be marked with red paint. The front blade should not be painted. All unpainted parts must be cleaned of rust and greased. Vehicles should not be stored in the open during the summer.

SNOW CLEARING MACHINES

Snow clearing machines, unlike the snow plows, lift the snow off the road and deposit it at some distance from the road, so that it can no longer cause snowdrifts. These machines are used where snow plows cannot be utilized effectively: in the case of strong snowdrifts, heavy snow deposits, avalanche snow and, occasionally, to remove snow walls on the side of the road. There is a distinction between machines designed to remove old snow, the so-called snow-milling machines, and those designed for new snow removal, the snow-slinging machines. When using these snow clearing machines, it is of great importance to have available heated sheds with repair facilities as well as highly skilled motor mechanics who would be able to carry out minor repairs which are frequently necessary.

Snow clearing machines available to date, even though they consume a great deal of fuel, are capable of speeds of 8 to 20 kilometers per hour only, and their clearing speed is only a few kilometers per hour. Their radius of action is therefore quite limited, unless they can be transported more quickly on special flat cars.

Firmly settled or icy snow deposits which cannot be removed

by snow clearing machines, or the manual removal of which is too time consuming, can be loosened by blasting. Vertical holes, about 1.50 meters deep, are made in the snow, and the explosive (about 700 to 1000 grams) is inserted immediately above ground. This procedure will cause the explosive effect which acts sideways and up to break up the snow mass on the road, and it can then be cleared without great difficulty. If necessary, this operation is repeated further along the road.

Based on experiences so far, it may be stated that in order to break up one cubic meter of snow of 450 kilograms unit weight, about 100 grams of explosive are required. Firm, hard snow is best suited for blasting. In soft, thawing snow the explosive action loses its effect for the most part.

Grading of high and steep snow banks which show deep grooves cut by milling machines can also be effected by blasting to reduce the danger of cave-in. Charges 0.30 x 0.40 in size, filled with 5 kilograms of explosive each are placed at intervals of from 4 to 6 meters. Snow banks on the side of the road, consisting of old snow, can also be removed by blasting. Blasting tests should be carried out before commencing the actual blasting operation; their results will determine further operations.

The Peter Snow-Milling Machine

Scoops with interchangeable steel blades (knives), mounted on a horizontally placed revolving drum, cut (mill) very thin layers of snow and carry it through their worm arrangement from both sides toward the snow bins located in the center of each drum half. From

here the snow is thrown through the discharge openings which are equipped with adjustable stacks in the desired direction.

The outside dimensions of the machine are:

Clearing width	2.50 meters
Length	6.76 meters
Height	2.96 meters
Diameter of milling drum	1.20 meters
Weight	13 tons

Propulsion of the machine is diesel- or gasoline-electric, while the drum is driven directly by a Diesel or Otto engine. Driving speed is about 20 kilometers per hour, while the operating speed, depending on the composition and height of the snow, is 0.5 to 2 kilometers per hour; the snow is thrown up to a distance of 15 meters. The height of the snow bank to be cleared should not greatly exceed the diameter of the drum. Only expert drivers should be used. If the wheels are replaced with caterpillars, the machine can climb firm snow and can thereby handle higher snowbanks.

To achieve good visibility under inclement weather conditions, the attachment of high speed wipers on the windshield of the cab is recommended.

The Peter milling machine is one of the most outstanding today and being a specialized piece of machinery should be used only where deep snow deposits or firm and hardened old snow can be expected; this applies particularly to mountainous regions. Special care must be taken in the removal of avalanches. It must be determined initially

whether in places where an avalanche has occurred further avalanches may be expected. In addition, avalanches must first be probed with long steel probing poles for existence of rock or large pieces of wood.

Roads with snow deposits of more than 2 meters in height cannot in the long run be cleared by milling machines alone without the aid of auxiliary equipment, since the deep depressions cut by free milling will be covered up again if snowdrifts continue. In such cases it may be proper to use cover plates over these cleared sections or to construct vaults made of snow blocks over them (for which purpose scaffolding must be held in readiness) to prevent continued snowdrifts from covering the cleared area. It is sometimes possible, by using the caterpillar miller or the hollow slinger described below to produce a smooth road surface without deep cuts; this surface may, if properly rolled, be made so firm that it can be used by wheeled vehicle traffic.

The Snail Slinger

This snow slinging machine is attached to the front of slow moving vehicles by means of an attachment plate; it is suitable only for the clearing of new snow, as it is raised by hard firm snow, or clogged by wet sticky snow.

Two horizontal screw conveyors, one above the other, 0.40 meters in diameter, carry the snow toward a slinging wheel mounted in the center; this wheel discharges a solid stream of snow through a rotary discharge stack. The drive is powered by a special engine

(Ford V-8) which is mounted directly behind the slinger, in front of the radiator of the vehicle. The apparatus is raised and lowered hydraulically. The outside dimensions of the machine are:

Clearing width	2.50 meters
Height	1.60 meters
Weight	3.0 tons

The machine can handle a snow bank up to 0.80 meters high and can throw the snow a distance of 15 to 30 meters. During clearing operations, the machine which is attached to the vehicle by means of joints in the form of a parallelogram is pushed forward on two sliding skids which are attached to the bottom of the screw-housing, to the right and left of it. Behind the blade which is located underneath the bottom screw there is an additional sliding skid, adjustable in height, which serves to move the slinger from one clearing area to the next provided the distance is not too great. To negotiate greater distances, special rubber tires are fitted, and the slinger is transported as a trailer.

The difficulty in using this snow-slinging machine lies in the fact that the speed of the vehicle pushing it must be very low (0.3 to 2 kilometers per hour).

The Hollow Slinger

This machine is used in the removal of freshly fallen snow. By means of the plow-like shaped front of its housing, the so-called spectacles, the snow is carried to the two slinging wheels whose axes are parallel to the direction of movement and is slung outward through

two adjustable discharge stacks. The advantage of this machine over earlier models is in that the snow particles on their way out no longer hinder each other as the slinging, depending on the depth of the slinger, takes place in different planes. The two slinging wheels are driven by two special Otto engines which are mounted on the loading platform. The slinging wheels are driven by means of chain drives and a shaft. When sticky snow has to be cleared, special conveyer screws are mounted in front of the slinging wheels to facilitate the movement of the snow to the slinging wheels.

The outer dimensions of the machine are:

Length	6 meters
Width	2.70 meters
Height	2.30 meters
Total weight	8 tons

The machine can be driven at speeds up to 17 kilometers per hour, the operating speed, depending on snow conditions, is up to 10 kilometers per hour, and the slinging distance is up to 15 meters.

SANDING SERVICE

Winters in the east and northeast of Europe are usually constant; that is, snow and frost can almost always be expected. Roads become icy when the blanket of snow melts during the midday sun or when during the thaw period water flows over the roads and freezes overnight. During that period snow must be removed from the roads and good drainage must be provided on the sides of the road.

Since the complete removal of the snow during clearing operations is usually not possible and not always desirable, there remains a layer of snow on the road which when exposed to traffic becomes icy, that is, the so-called icy snow surface is formed which usually lasts for months.

To avoid accidents and traffic bottlenecks, a planned sanding service which can go into action immediately and effectively is absolutely necessary. When using manual labor, the sanding service is best done in two work shifts. Initially the more dangerous sections such as curves and inclines are sanded, and then the second shift sands the straight and flat sections of the road. Sanding must be done in such a way that sled traffic is not obstructed. The local population must be drafted into this service by means of timely organization of the necessary often very numerous, labor forces. Mayors of villages located along the road are signed up and bound by agreement to carry out the sanding service in predetermined sections of the road in the immediate vicinity. It is usually possible to get teams of horses and sleds in the villages. In addition, shovels, spades, picks, and carrying cases for the material to be spread as well as suitable containers to transport the material on the sleds must be procured in advance. In sparsely populated areas necessary labor must be recruited from the more distant settlements and must be housed along the road in camps; the procurement of the necessary food, fodder, heating fuel, etc., must be arranged for in advance. In general the preparation of a work plan is necessary providing for subdivision of the road section, appointment of section leaders, distribution of labor and teams, information on the more dangerous spots, supply dumps, etc.

Dry sand, gravel, slag, etc., are materials used for sanding. To avoid damage to tires, the material should not be too coarse, but on the other hand it should not be so fine that it can be blown off the road by the wind. The road masters must assure sources of supply of the materials to be used.

Considering that such sources may be inaccessible during the winter because of heavy snow or because they may be frozen so that they cannot be hauled, supplies of the materials to be spread should be stored near the danger spots as well as in predetermined storage areas. In storing these materials care must be taken that the piles themselves will not cause snowdrifts. The piles are established in cone shaped form to reduce the danger of freezing; they must be covered with fir twigs, straw or reed mats, cardboard, boards or other suitable materials. These covering materials must be weighed down against the wind. In addition the restocking of these material piles must not be forgotten.

If lumber is available in sufficient quantities, storage boxes should be prepared; these in turn should be covered with straw as added protection against the cold. Such boxes may be free-standing; larger ones may be constructed along depressions or slopes. Similarly ordinary auxiliary silos may be established as long as they are near the road and accessible. Only dry material should be stored; if that is not available the addition of calcium chloride may be necessary.

For direct protection against icy roads calcium chloride or, in an emergency, sodium chloride may be mixed with sand and spread on the road. The proportion is 30 to 40 kilograms of calcium

chloride or sodium chloride per cubic meter of sand.

Of importance also is the timely transmission of weather forecasts through the nearest weather station. Similarly local weather conditions should be ascertained by questioning local authorities and population.

In order to reduce the large amounts of labor and materials which may be necessary if icy conditions continue, it is advisable, when no snow falls are expected for a lengthy period of time, to remove the firm layer of snow entirely from the particularly dangerous sections of the road. This is done either by using a road grader or by loosening the snow with the sharp treads of a caterpillar tractor; the use of picks and shovels may also be advisable in some cases.

In order to alert drivers to the danger of icy roads, wooden signboards with the inscription "Icy Road" should be erected at intervals; they must also be removed when no longer needed.

It is frequently necessary to use sanding machines. A piece of equipment made for this purpose consists of a disk mounted on and driven by an axle. A funnel-shaped container with worm is mounted above the disk and delivers the sanding material to the disk while the vehicle is in motion. The worm can be operated by the assistant driver from the cab. The screw is chain driven by the axle simultaneously with the spreading disk. The screw has three speeds so that the density of the material spread can be adapted to ice conditions. This machine can be attached in a matter of minutes to any truck. Any kind of spreading material may be used including frozen or dry material.

WINTER MAINTENANCE OF AIR FIELDS

Winter maintenance of airfields includes snow removal, compression of snow, and measures taken against icing over. Application of these measures depends on local conditions as well as the purpose for which the airfield is to serve; measures to be taken can be determined only on the spot. It is possible that both compression of snow and snow removal operations have to be carried out simultaneously on the same field; this is quite common during the thaw period.

Measures which must be taken before the snow fall sets in: smoothing out of unevenness on the runway, cleaning of drainage fields of mud, and staking out of at least two take-off and landing strips, each of which should be 1,200 meters long and 200 meters wide and should face the prevailing wind direction.

It must be noted that aircraft with wheels can operate under snow conditions only if runways are rolled.

Rolling of runways is begun when the snow has reached a height of 5 centimeters; if fresh snow falls the rolling must be continued. The new layer of snow must not exceed 8 centimeters in height since then the rolling operations become exceedingly difficult and the necessary bearing capacity of the snow cannot be reached. The snow must be rolled until the aircraft no longer leave significant tracks, which is the case when the volume weight of the rolled snow reaches at least 500 grams per liter. If normal rollers are not available, auxiliary rollers may be constructed in accordance with instructions and illustrations attached. A special rig as shown in Figure 97 may be used. Light rollers

are to be employed during the initial rolling operation. After the special rig has been used initially, the rolling operation is completed with heavier rollers filled with sand. Depressions in the layer of snow must be smoothed out and compressed.

Snow in front of hangars and in the immediate surrounding area must be completely removed. High snowbanks should be avoided since they may cause snow drifts and damage to the planes. Snow fences should be erected as protection against snow drifts. Arrangement of the fences may have to be altered in accordance with weather conditions.

When icing occurs, pronged rollers and harrows, as well as sanding material must be used. If the layer of snow is thin, sanding material alone will be sufficient.

Greatest care must be exercised in the use of thawing salts because of the danger of corrosion of the airplane parts and the damaging effect on the turf.

The compressed mass of snow causes mud conditions during the thaw period which may render the runways useless. Shortly before the beginning of the thaw period two runways, each 1,200 meters long and 200 meters wide must be prepared by removing the snow down to a layer of about 5 centimeters. These runways must be oriented toward the prevailing wind direction during the thaw period. In selecting sites for these runways, drainage conditions must be taken into consideration. It may be necessary to dig shallow drainage ditches. If no possibility exists to arrange for drainage, dips and depressions must be pumped out.

When snow removal is being considered, the following operations are possible: (a) Plowing of the snow into banks of a maximum width of 2 meters and height of 1 meter, which at the latest must be loaded and carted away at the end of the working day. If large quantities of snow are dealt with the use of snow clearing machines must be considered. If the snow is packed hard it may have to be loosened by means of weighted-down harrows or other agricultural machinery.

(b) The snow may be carted away on special transport sleds of Russian construction, on ordinary sleds, or on available trucks. Up to 7 such snow transport sleds can be pulled by a caterpillar tractor. The snow must be removed to a point where it will in no way hinder air operations.

(c) Speeding up the thaw of the remaining layer of snow so that when the thaw period sets in, the runway will be completely free of snow, and icing will be avoided. This can be done with charcoal dust or peat dust because dark areas warm up more quickly than light ones in the sunshine.

WINTER ROADWAYS

While roads in Germany are cleared of snow and ice as thoroughly as possible, snow constitutes a welcome building material in the eastern regions of Europe which makes it possible to maintain dirt and auxiliary roads in passable condition during the winter. Complete removal of snow and ice from the roads is not desirable for other reasons also.

Even a very thin layer of snow and ice affords considerable

protection against frost cracks during the spring and also causes the roads to thaw much later than those from which snow has been removed completely; therefore such roads will remain passable even through part of the muddy season. This is also the reason why winter roadways are laid out next to summer roadways and frequently they are at considerable distance from them. While sled traffic is possible even in loose snow because of the weight distribution over a greater area of snow caused by the sled runners, snow must be specially packed or iced over for wheel or caterpillar traffic because of the great pressure it must withstand (up to 8 kilograms per square centimeter).

Snow Roads

The friction coefficient between a wheel with a rubber tire and the correctly packed snow road is not smaller than it would be on a good dirt road which is wet, and would be only slightly lower than on a wet macadam road. Thus snow chains are not necessary on snow roads and would only cause their rapid deterioration. An exception to this rule must be made during the thawing season.

Non-wooded areas are not too suitable as winter roads because of snow drifts and exposure to the sun during the spring. When a choice must be made between field and meadow, meadows are to be preferred, because in the spring snow melts earlier in the fields than in the meadows. The number of curves must be limited as far as possible. River and stream crossings must be located where, according to information gathered from the local population, the freezing of the water can be expected with certainty. Thus construction of bridges is avoided. The area must be prepared before

the winter season by removal of trees, bushes, large rocks, and uneven spots.

The greatest permissible longitudinal slope of snow roads is 3 percent; latitudinal slope is generally not recommended. The thickness of the packed layer of snow should be at least 10 centimeters but preferably 15 to 20 centimeters.

Tractors, rollers, and so-called triangles (snow-plows) are used to pack the snow. Tractors and rollers are effective when the layer of snow is not too thick. When the snow is very deep, it must first be partially removed with the aid of a "triangle". Particularly effective is the so-called "reverse triangle", which obviates the need for cumbersome turns which on narrow wood roads is sometimes impossible.

Packing should be commenced, whenever possible, at temperatures of -5 to -15 degrees Centigrade, and the layer of snow is about 15 to 20 centimeters thick. A section of road about one to 2 kilometers in length is packed by repeated rolling. Generally, a roadway about 4 to 5 meters wide must be rolled. The weight of the rollers to be used depends on the power of the vehicles employed for towing. Auxiliary rollers, weighted down with sand or stones, can easily be constructed from simple materials such as boards or old gasoline drums. Rollers with too small a diameter make it difficult to achieve the desired vertical compression and transmit a strong horizontal thrust to the snow layer. Wet snow can be prevented from sticking to the roller by covering the latter with sheet metal or painting it with waste oil. Based on previous experience, the pre-rolling with light rollers and post-rolling with

heavier rollers is advisable. Difficulties arise when rollers are pulled by tractors, since the latter create tracks which the roller which is being pulled after it can smooth out only with difficulty. It is best to pull the roller with a vehicle equipped for cross-country travel. For details on constructing rollers, see appendix. In order to avoid the creation of tracks in the rolled snow road, it is imperative to leave the rolled road untouched overnight before turning it over to traffic, so that the snow particles have time to freeze together. The road must be packed (compressed) again after each snowfall. The packed snow layer should be immediately on the ground. If rolling operations are started only when the layer of snow is quite high, there remains under the packed layer still a layer of very loose snow, and the packed layer above it will remain weak because of lack of a substantial base.

Occasionally, snow roads with heavy layers of snow are reinforced with wooden rods which are placed perpendicularly to the road axis at intervals of 60 to 75 centimeters (snow rod roads).

Progress achieved in the packing of snow can be measured by means of determining its volume weight (density of the snow). This is described in detail in the chapter "What every OT-man should know about Snow". The greater its volume weight, that is, the denser the snow, the greater is its bearing capacity. When the density is below 300 to 400 kilograms per cubic meter, traffic consisting of wheeled vehicles is no longer possible. A density of a minimum of 500 kilograms per cubic meter is necessary for heavy truck traffic.

Snow roads must be continually maintained. Holes, ridges, etc., must be filled with snow which must be tamped. To remove waves in the road caused by horse traffic, the so-called snow-harrow is used. Road graders are also used to smooth out the roads.

Snow roads on the surface of which a layer of ice has not formed as a result of continued traffic or thaw, become impassable after a short thaw period. Observation of iced roads have shown that, if during the thaw period it freezes during the night, approximately 8 millimeters of ice thaw out daily; should rains occur, this figure reaches 4 centimeters. If adequate drainage is available, the layer of ice up to a thickness of one centimeter remains passable.

Ice-Track Roads (Snow-Ice Roads)

Ice track roads, compared with snow roads, have a considerable lower tractive resistance; therefore considerably greater loads can be transported over them with equal tractive power. However, they take a great deal more effort to construct and only sleds of equal track width can be used on these roads.

In order to construct these roads, the snow must be compressed, the tracks must be cut and iced over. Two tracks are cut with a track-cutter in the packed layer of snow, the preparation of which was described above. The packed layer must be 10 to 15 centimeters thick. The tracks are cut at least 10 centimeters deep and 17 centimeters wide for horse-drawn sleds, and at least 12 centimeters deep for tractor-drawn sleds; the track-width depends on the width of the sled runners. Tracks on

the straight road are at least double the width of the runners, and on the curves -- at least 4 times the width of the runners.

To achieve the desired depth, the cutting of tracks is carried out in three or four steps. About 10 kilometers of track road can be cut daily with a track cutter. The base of the track must be hollow-round (concave) in cross-section. After the tracks have been cut in the snow, they are wetted down with water from water containers mounted on sleds.

The ice track is most serviceable when the snow underneath it is completely soaked with water, so that the ice is immediately on the ground.

In order to obtain the correct track cross section, it is recommended to drive across the track with a special track sled after the track has been wetted down and before it freezes. Tracks must be soaked every 1-2 days when traffic is heavy, otherwise they can be wetted down every 2 to 4 days. Single track ice roads which carry tractor-sled traffic will require a water consumption of 50 to 60 cubic meters per kilometer of road, and those with horse-drawn sled traffic -- 30 to 60 cubic meters of water per kilometer. Rivers, lakes, and wells must be available approximately every one to 2 kilometers to furnish a source of water which can be counted on throughout the winter. When wells are drilled, it must be determined whether they can be counted on to provide sufficient water and whether the groundwater does not freeze in winter.

Continuous maintenance of ice track roads consists in the repair and filling of holes and ruts, local repairs of the tracks and repair of the waves in the center of the road caused by horses'

hooves; and the wetting down of the ice tracks. In the spring, when damage to the road becomes more serious as a result of the sunshine, repairs can only be carried out at night or early in the morning. To repair the layer of snow damaged by horses' hooves, the above-mentioned snow tractor and harrow are used.

CONSTRUCTION OF BASES FOR THE WINTER SERVICE

To assure uniform administration of the winter road service, it is necessary to assign a winter service officer to each road construction administration or, where such an organization does not exist, an officer should be assigned to each larger region. This officer will be fully responsible for timely preparation and rendering of the winter service. A mechanical engineer should be assigned to him to keep winter service equipment and vehicles in running order.

During the summer months, it is the task of the winter service officer to construct facilities for the winter service, as well as to carry out preparatory operations (detailed preparation of action plan). Depending on climatic conditions, bases and facilities must be established along the roadways at intervals of 30 to 50 kilometers. These usually consist of a service building with accomodations for the entire personnel and the necessary sheds and storage buildings to house the winter service vehicles and equipment, and storage sheds for fuel, building materials, etc.

Methods of temporary construction should be employed as a rule, Locally available materials should be used. In heavily forested areas, particularly in central and northern Russia, as well as in Scandinavia, the block-house method of construction is recommended along with the regular method of barracks construction. The block house method uses round timbers, and roofs are covered with reeds, straw, wood shingles, etc.

If lumber is not available, as, for example, in the south of Russia, or coal is unobtainable for the production of brick, clay construction may be employed. The thickness of the walls should be about 40 centimeters. Sand or other aggregate or straw must be added to fatty clay to "thin" it sufficiently.

It is of particular importance to keep the vehicle shed well heated even during the coldest winter days, so that the vehicles and equipment can be instantly used. During the coldest outside temperature, the temperature in the center of the vehicle shed should be at least + 10 degrees Centigrade, so that the temperature above the floor will still be near + 5 degrees; the temperature in the shop should be somewhat higher, near 12 or 15 degrees Centigrade. To maintain such temperatures, the heat supply should be about 40 to 60 thermal [BTU?] units per hour per cubic meter of volume in the vehicle shed.

Installation of several brick ovens is recommended so that the heating of the lower levels of the shed is assured, since primarily engines and gears of the vehicles must be kept warm. Experience, as well as theoretical and practical experiments with brick ovens during the last winter have shown that the horizontal brick oven, in particular, was most suitable. The oven is installed as a partition between two vehicle stands in the shed and is heated from the outside.

A heating stove which, though primitive, is very effective, is one made of a gasoline drum. Its disadvantage is that it is heated inside the shed and therefore there exists a fire hazard in case of carelessness; however, the primitive and simple construction method

has advantages over more complicated systems. Two used gasoline drums, placed one on top of the other, form the heat chamber; the firebox is made of brick or, better yet, of fire brick. Dampers and oven doors can be made of scraps of metal. The openings must be tight and the stove must be carefully fitted to the chimney.

In placing the stoves, attention must be paid so that the heat radiation can penetrate unobstructed in as many directions as possible. Contrary to the brick oven, the gasoline drum stove does not store heat.

The best and most effective heating system for vehicle sheds is the hot air system. The hot air blower (Wagner System) has proved itself exceptionally suitable for heating of temporary vehicle sheds. The heater has a capacity of 40,000 or 80,000 thermal units. and can be fuelled by gasoline, wood, coal, or pressed coal. It consists of a firechamber, air heater, fan with motor, and warm air ducts. The hot air, which is free of combustion gases, is forwarded into the shed with the aid of a pipe or flexible duct. The heater is installed in a small lean-to shed (about 3 x 3 meters) in the rear of the shed; the hot air ducts are piped into the shed from the outside.

The heater can be equipped with either an air recirculating device (the fan sucks the inside air in), or a fresh air system, whereby the cold outside air is sucked in; the former system, of course, saves more fuel. The warm air ducts or pipes must be placed inside the shed in such a manner that the warm air will be evenly distributed over the floor or will be blown directly underneath the vehicles and a complete changeover of air can take place.

In the heating of smaller spaces the OT-bunkerstove has been found to be very satisfactory. It can be fuelled with all hard fuels and is economical. Its heating capacity normally is 2,500 thermal units per hour and is sufficient for a room of about 50 cubic meters.

In the construction of vehicle sheds care must be taken to insulate outside walls and make them tight to avoid heat loss. Doors and windows must shut tightly. Cracks and openings must be filled with hemp or moss. The roof can be insulated with clay or other insulating material. Several layers of newspaper or wrapping paper will improve the insulation of the shed. The height of the garage doors and that of the shed should be relatively low, so as to avoid heat loss. Garage doors should be placed opposite the main wind direction.

In cases where, due to lack of suitable building materials, or for other reasons vehicle sheds or parking places cannot be constructed, the construction of simple carsheds of straw, grass or reed mats has proved quite satisfactory. Heather and other long fiber materials which are locally available can be used. Such compressed mats are also suitable for improving the installation of temporary vehicle sheds; they are nailed on the interior walls and the ceiling. Additional uses are window shutters and erection as protection against the wind for vehicles which must be parked in the open. In particular, these mats are used to cover engine hoods, to hang across garage doors in vehicle sheds, to insulate truck cabs as well as living quarters, as floor and wall coverings.

Because they are strongly compressed these mats are relatively noncombustible; they can be easily plastered with clay, lime or cement mortar; this can eliminate fire hazards in vehicle sheds and workshops completely. Specially designed machines (presses) are used in the manufacture of these compressed mats.

The material used in the manufacture is smooth straw or reeds which are woven together or tied together with thin wire in one of many different ways.

Ordinary bunkers in the ground can also be used for vehicle sheds. Drainage of ground water and surface water seeping in from above is of great importance.

In addition to the working pits, vehicle sheds should also have a car washing area made of concrete or bricks as well as a simple ramp which can be constructed of unfinished lumber. The entire road service facility is strongly fenced with either a wood or barbed wire fence. Only one entrance for pedestrians and vehicles should be provided which can easily be guarded by a sentry and overlooked from the office of the roadmaster.

To repair and maintain vehicles and equipment stationed in the road service facility, a small shop with repair stand and built-in workpit as well as a small shop with all the necessary tools and equipment must be provided. A mechanic and necessary auxiliary personnel must be provided here.

FINAL ACTIVITIES OF THE WINTER SERVICE

In the spring there are two separate stages of road condition:

1. The period of thaw

2. The period when the roads are soft after the snow has thawed.

There is a direct connection between the condition of dirt roads in the spring and that during the winter.

The duration of the thaw as well as extent of the period during which traffic is impossible as a result of the softening of the roads in spring depends on the thickness and density of the layer of snow on the roadway. During the thaw which usually takes place very rapidly the snow on the surface of the road loses its bearing ability and can no longer support vehicles. Even if the layer of snow were 15 centimeters thick, motor vehicle traffic during the thaw period would no longer be possible.

A prerequisite for establishment of favorable traffic conditions during the thaw period is the correct snow removal during the winter; for example high snow banks should not be left on the sides of the road. If two separate traffic lanes are located on a road such as is the case in Russia sometimes, it is advisable to route winter traffic over the unimproved dirt lane and to leave the improved dirt lane closed to traffic. At the beginning of the thaw period the latter must be quickly cleared of snow so that it has a chance to dry out while traffic is still routed on the clean dirt road. At the point where the clean dirt road begins to soften,

traffic is routed over the improved dirt road. If only one lane is available the snow must be deposited behind the ditches, at the latest, at the onset of the thaw period, since otherwise the melted snow could not be drained off the road and would soak and soften it. In the case of dirt roads it is unavoidable to temporarily close the road to traffic or at least to establish a weight limit for vehicles.

With the onset of the thaw period, care must be taken to keep all drainage facilities free and unclogged. The ditches, drains, etc, must be cleaned of snow and ice up to two-thirds of their depth. Water cannot drain off since the frozen ground begins to melt only gradually. Melting of the ice in the drainage pipes can be speeded up by hanging a sack of salt (about 5 kilograms) into the top opening. The soluble salt prevents the water from freezing again at night. A drain pipe which is completely frozen can be opened with an ice drill or a special ice pick with long handle. This can be done even more quickly by applying hot steam from a steam kettle mounted on a truck and fed through a hose or long pipe. Drainage slits should be cut in the snow banks on the side of the road.

Since dark surfaces heat up more quickly in the sunshine, earth, coaldust ashes or sand can be spread on the road to speed up the melting. Ice collecting at pillars of bridges must be loosened, by blasting, if necessary, so that it can be floated away and floods can be prevented.

To speed up the drying of the surface of dirt roads, it is sometimes advisable to resurface them after the snow has melted by

using road graders. This is to be repeated until an even and firm surface is obtained after the road is completely dry. These operations can be begun only when the surface dirt of the road is moist.

The softened road surface, damaged by traffic and effects of the frost must, where necessary, that is where traffic can not be rerouted, be repaired and maintained in passable condition by covering it with branches, sand or by construction of corduroy roadways.

Snow is removed from the road ditches either by hand, or with wooden or metal ditch cleaners. The snow must be removed from the roadway beyond the road ditches, especially in low spots or places which are in the shade.

At points which are exposed to frost, the sides of the road must be cleared of snow immediately after the end of the frost period so that the ground at the edges will thaw out at the same time as the ground under the clear roadway. Thus better drainage and drying of the road bed will be achieved.

At this time also the portable snow fences must be removed. Snow shields which are still usable as well as those which were damaged and repaired, are stored in piles of up to 50 and are placed on saw horses so that the shield will not begin to rot. Such shields can ordinarily be used an average of from 5 to 6 years.

The poles are removed after the ground has completely thawed out, and those which are still usable are arranged in cone shaped bunches of 100 to 150 each; they are stored near villages to prevent theft. The bunches are tied together with wire up to 3/4 of their height.

The piles of shields and poles are surrounded by a 30 centimeters deep ditch to provide for drainage.

APPENDIX

MEANS OF CLOTHING, FEEDING, HEALTH AND ORIENTATION IN WINTER

Clothing

Good usable winter clothing does not necessarily mean that one must clothe oneself with particularly thick and heavy materials; it is much more important that several layers of air are provided near the body and that they be surrounded by air- and water-tight outer covering, whereby complete water tightness is undesirable because of the collection of evaporation moisture (condensation water). Winter clothing should be warm, light, loose, comfortable, yet porous, that is, permitting the passage of air or retaining the air; in addition it must leave sufficient freedom of movement for work. For these reasons wool and cotton should be used as underclothing, and sailcloth, leather, etc, as outer clothing.

To avoid a tight fit, trousers, coats, etc, are worn two sizes larger than under normal conditions. In the case of riding breeches particular attention must be paid to freedom of movement at the calves and at the knee. Loose clothing is good protection against pneumonia, freezing, etc; pieces of clothing soaked with sweat should not stick to the body.

To prevent and reduce the moisture created by the evaporation of one's one perspiration, only absolutely necessary clothing should be worn when working or moving inside or outside, so that more pieces of clothing can be put on during periods of rest, precipitation, wind, or greater cold. Perspiration of the feet must be avoided by all available means such as washing, rubbing with formalin and frostbite salves, as well as frequent changing of socks.

The best protection against cold is a second set of underclothing under the loosely fitting outer clothing. Wide-meshed undershirts allow for an air-filled space which keeps one warm. The usual long-sleeve pullover should reach below the waist. This way or by means of wool or fur-lined body wraps diseases of the abdomen and kidney area can be avoided. When driving in motor vehicles it is recommended to stuff trousers with newspapers as protection against cold; similarly the chest should be protected against the wind with several layers of newspapers.

As protection against the entry of snow, sleeves are tied off; paper, hay, or straw wrapped around the foot inside the boot, and the trouser leg is worn over the boot and tied at the bottom.

Marching and ski boots or felt boots should be two sizes too large so that two or more pairs of clean socks and inner soles made of cloth or paper can be worn. Feet and toes should be able to move comfortably. An additional pair of felt boots can be worn over the socks when marching or ski boots are worn; foot wrappings of newspaper or straw provide good protection against the cold. If felt boots are not available, straw shoes may be worn. In the case of leather shoes, rubber soles are better than leather. Leather soles should not have heavy hob nails since the nails attract the cold and fall out easily in severe cold. Generally particular attention should be paid to the danger of frost-bitten feet; the wet foot is particularly exposed to freezing.

Of great importance is correct shoe care. Shoes should be cleaned of dirt daily with brush or rag. The shoe is to be lightly

greased up to ankle height; the grease should be slightly warm and should be vigorously rubbed into the leather with a rag or the palm of the hand. Under no circumstances should so much grease be used that it will penetrate the leather and soil socks and feet. It is recommended that leather be greased only during the thaw period because greased leather conducts cold better than ungreased . Rubbing leather with kerosene will prevent it from freezing at very low temperatures. The groove between shoe and sole should be well greased to make it waterproof. Application of leather fat will keep shoe leather soft. Shoe polish alone will render the leather hard and brittle and will stop up the leather pores so that inside the boot the moisture resulting from evaporation will condense and bring about freezing. Special preparations for impregnation of the soles (leather soles only) make them more watertight and resistant to wear.

Felt boots are best for snow and very low temperatures; however they must be kept dry and may not be worn as soon as the snow becomes watery, because wet felt boots no longer offer the foot protection against the cold and may cause freezing even at relatively minor cold temperatures.

If possible, wet shoes should be changed. The inside of the boots should be wiped with a rag and should then be filled with paper, straw, or other moisture absorbing materials. Shoes should be dried gradually in moderately warm places; the wetter the shoes are, the greater is the danger that as a result of rapid drying in very hot places, such as ovens or near the open fire, the leather will become brittle.

Head and ears are protected, in addition to the regular headgear, by a hood or fur cap.

Mittens made of sailcloth or leather are worn over regular woolen gloves. Drivers require a firm fur-lined glove of sailcloth or leather. All gloves should be long and wide enough to reach over the sleeve. If gloves have to be temporarily removed one should insure against loss, which can have very unpleasant results, by tying the gloves to one's clothing, Knitted wrist-warmers also afford successful protection against the cold.

The only eye protection against snow-blindness are snow glasses. In an emergency such glasses can be made from a piece of birch bark or cardboard 18/7 centimeters in size into which two slits of 2 to 4 millimeters are cut. A cut out for the nose is necessary at the lower edge, and on the sides, holes are punched for the strings. The inside of the glasses should be covered with cloth.

Warm boots can be made of felt and old blankets. The boot tops can be sewn by hand or by machine, and the sole is sewn with shoemakers thread. To make the boots moisture resistant, old inner tubes can be attached around the foot of the boot. Similarly, very useful caps can be made out of old overcoats, fur coats, or fur pieces; if possible a thin inner layer of wool should be included.

Feeding

Normal rations issued to troops in the field or in camp are equally suitable for issue to winter-service personnel. It is desirable to issue hot food at least twice daily and to always keep warm beverages ready. Food-carrying containers and thermos bottles have been found to be adequate. Unpeeled fruit, raw meat, or milk are

frequently carriers of disease germs. If water filters are not available, only boiled water should be used for drinking even in the winter. The widespread opinion that alcohol is the best protection against cold is completely erroneous. Frequent consumption of alcohol renders the body less resistant to cold; alcohol should be used only in exceptional cases for medicinal purposes.

Grape sugar and similar foods in small quantities are stimulating; equally desirable is the supplementation of rations with vitamin C ("Cebion" pills). Also of great importance is dry storage of food supplies and their protection against frost. Consumption of provisions having a temperature lower than 3 degrees Centigrade is harmful. Ready-baked bread can be best protected against cold by carrying it in the trouser pocket.

Health Care

In addition to correct clothing, sanitary measures are of great importance.

Countless cases of frostbite of the face and hands result from the fact that the skin had been made sensitive before being exposed to the cold by washing (particularly with warm water). One should not wash with water in extreme cold. Cleaning with fats has been found to be best. The safest protection against freezing is the treatment of the skin with animal fats (frost protection salves, pork fat, goose fat, etc); vegetable fats should be used only in emergencies. The fats must be unsalted. Since perspiration cannot be avoided even during extreme low temperatures, special care must be taken to avoid catching cold during rest periods.

A thorough cleansing of the body during the winter is possible only in the easily prepared Sauna. Its use, in addition, strengthens the whole organism.

In this connection it is pointed out again that cleanliness is the best protection against epidemics. Under all circumstances care must be taken to keep clothing free of lice. Clothing seams must be inspected daily and if necessary the lice eggs must be eliminated by ironing. Underwear must be frequently changed and boiled. Woolen underwear should not be boiled but washed in luke warm water. Hanging of clothing in the cold does not in itself result in delousing. If no special delousing station is available the above-mentioned Sauna can be used as a delousing chamber for clothing. The louse is the carrier of the dangerous spotted typhus.

If frostbite occurs, which is first noticeable by white spots on the skin, it must be remembered that rapid warming is harmful. The patient should be brought to a place which is protected from the wind and the frostbitten area should be rubbed lightly with soft snow or cold water. Hardened snow injures the skin and causes infections. After slow warming the patient should initially be brought into a moderately warm room and only later into a well-heated place. Only luke-warm beverages should be consumed. Artificial respiration should initially be avoided since in cases of serious freezing the tissue fluid of the body freezes and the members would break. Moist bandages and salves should be avoided. In all cases a doctor (Only in exceptional cases, a pharmacist) should be consulted because only a doctor can determine the degree of freezing and advise on the treatment to be undertaken.

Means of Orientation

It is frequently necessary to orient oneself. One of the safest means of orientation is the march compass. The so-called watch-compass may be used as an auxiliary means of orientation. The small hand of a pocket watch is pointed in the direction of the sun; the line which bisects the angle between the small hand and the figure 12 denotes the southerly direction, reading clockwise during the forenoon, and counterclockwise during the afternoon.

At night orientation can be effected in accordance with the polar star. If a line is drawn through the last stars of the Big Dipper, a five-fold extension of the distance between these last two stars will coincide with the North Star in the Little Dipper. The direction from the observer to the North Star is north; west is to the left of it, and east is to the right.

HINTS FOR DRIVING MOTOR VEHICLES IN WINTER

General

Preventive maintenance is better than repairs!

Every effort exerted by the operator of a vehicle when the vehicle is put up for any period of time will be amply repaid when the vehicle is to be used again.

Starting and operating difficulties in winter are the result of the slow flow of lubricants which become sticky in cold weather; water, in the form of ice or snow, also causes difficulties. The strength of the component parts, particularly of castings, is reduced

at low temperature. Stresses appear in the component parts which can easily result in breaks. The battery, in extremely cold weather, furnishes only a fraction of its capacity, particularly since the starter must do very hard work at low temperatures.

Preventive maintenance should start at home. Numerous small repairs which at home would probably have been overlooked, cause breakdowns of vehicles and equipment when they are put into action.

Measures Necessary for Operation of Motor Vehicles in Winter

It often happens that individual vehicles operate day-in day-out without trouble, even when, because of weather conditions, other vehicles experience considerable difficulties. A closer investigation will reveal that faultless operation always results from the conscientiousness of the driver. A vehicle which is in good mechanical condition renders good service until long into the winter without any additional work.

Defects, such as difficulty in starting, do not usually originate just in the winter; it is because of the cold weather that already existing defects show up more distinctly. Such difficulties as faulty sparkplugs, contacts, injection pumps, incorrectly adjusted timing of Otto- and Diesel engines, corroded battery connections, and defective cables will always be the result of poor maintenance and will result in breakdowns.

Thus, before special measures are taken as protection against the winter, vehicles must be generally put into good mechanical condition.

The most important and most effective aid in the operation of motor vehicles during winter is the cold starting method.

It is assumed that difficulties caused by the cold concern not the metal component parts (bearings or cylinder pistons), but affect the lubricant.

Only cold, thickened oil is the cause of the engine's failure to start.

There are two remedies: oil should be warmed or thinned. Thin oil retains its flow even in cold weather.

Thinning of Oil

The thinning of oil must be specifically ordered by the unit leader.

Engine

If one were to think of one's own efforts to crank an engine with stiff oil by means of a hand crank, one can easily understand that the thin oil must be not in the crankcase, but in the bearings and piston sleeves, in order to make starting of the engine possible. This can simply be accomplished in the following manner:

Prior to putting up a vehicle for a lengthy period of time, gasoline should be added to the engine oil. Since gasoline does not immediately mix with the engine oil, the motor should be run for a short period of time. This will cause the two lubricants to mix and all points of lubrication will have been reached by the thinned oil.

The vehicle may then be put up for long periods in extreme cold and will start easily without the need to let engines run the whole time.

The extent of thinning necessary depends on the degree of the temperature outside and the kind of oil used. The following rule of thumb has been found to be practical:

The thinning, in percentage, equals the number of degrees of temperature.

For example, a 15 percent dilution is necessary when the temperature is minus 15 degress Centigrade. This applies to regular issue Army oil; Army winter oil should be capable of starting and should retain its flow up to temperatures of minus 20 degrees Centigrade, but should also be thinned in half the measure mentioned above.

When the engine heats up during operation, the added gasoline evaporates almost completely in one or 2 hours and normal conditions are reestablished. The temporary drop on the oil pressure indicator again rises to normal. This procedure must be repeated every time the vehicle is parked for any period of time.

Unprotected cooling liquid must be drained as before.

If after the engine containing diluted oil has been started and only a short trip is undertaken, the oil remains diluted. Only the balance of the dilution must be added for the next start.

Gears and axles

The thinning of transmission grease with crude oil up to 50 percent is also recommended. Axle and transmission gears thereby

remain ready for operation and damage is avoided which may be caused by hard shifting or blocking of the wheels.

Central Lubrication

All other lubrication points should not be neglected during the winter. If the lubricant used during the summer is left in during the winter, it will freeze quickly, and bolts and joints will move without lubricant. If, in spite of all cautioning, the oil has not been changed to winter oil, all lubrication points and tubes must be carefully warmed and completely drained, and kerosene must be pumped through the entire lubrication system. Next, lubrication is applied, consisting of a mixture of engine oil and 20 to 30 percent kerosene or crude oil; this lubrication is retained throughout the duration of the cold period. The most dangerous enemy of all thin tubes and tube connections is water. Therefore filling of the oil container must be carried out very carefully. A similar procedure is adopted at points which are to be lubricated manually; that is, the lubricant, depending on the weather, is thinned sufficiently so that it can supply the lubrication point in the prescribed manner.

Shock Absorbers

Shock absorbers are almost always neglected, and are only thought of when a break manifests itself through noise. Frozen oil in the shock absorber hinders its necessary movement; it becomes stiff and either breaks or a break appears at one of its points of attachment.

Shock absorber oil must be thinned with crude oil up to 50 percent.

Thinning of oil should also be carried out in all other similar places. Oil which will become sticky should be thinned at all points where the cold will hamper the mobility of machine parts; the degree of thinning should be such as to achieve mobility which would be normal under normal weather conditions. So, for example, the oil in oilbath airfilters should be thinned, depending on outside temperature, with crude oil up to 50 percent or, better yet, with gasoline.

Battery

When a battery is left in a vehicle parked in cold weather, it will hold back a large portion of the stored-up energy which will be released only when the storage battery is slowly warmed up. This is achieved by storing in a warm place, but not too near the stove or the open fire. It is however much better to remove the storage battery before it cools down and place it in a heated room.

Manufacture of Distilled Water

Great difficulties are always encountered in procuring distilled water, that is, water free of chemical or mechanical impurities. If this condition cannot be fulfilled, batteries are in danger of being rendered useless.

The use of ordinary water is prohibited.

It may not even be used if it is boiled, because boiling does not remove damaging particles such as lime, iron, etc.

The only proper method of producing distilled water during operations is the melting of snow, which must be done with extreme care. The upper layer of snow only should be used, and the snow

should be pure. Collected rainwater, while chemically pure, is rarely free of mechanical impurities. It must be filtered before use.

Brakes

Brakes with their many component parts are greatly exposed to the danger of freezing in winter. This may cause operational dangers if measures are not taken ahead of time. Fine particles of snow and splashing water seep in and cause freezing of the joints and moving parts.

Brakes must be maintained and lubricated during the winter with the greatest care.

Lubricating oil should be thinned about 50 percent with engine oil and a little gasoline.

Mechanical Brakes

The hand brake should not be left on in the parked vehicle, since the brake drums may freeze as a result of condensed or splashed-on water. The vehicle should be secured with the aid of blocks. The mechanical brake cables are especially endangered. Proper operation in winter can be achieved only as a result of careful lubricating. Damage to the outer protective cover should be repaired by wrapping with friction tape. Frozen clumps of ice should be carefully knocked off. Coating with waste oil or fat will reduce the danger of ice formation.

Hydraulic Brakes

These brakes are also endangered by water which may enter and freeze. Brake fluid should be added inside the vehicle shed, if possible, and should be kept in clean containers; thus the danger of snow falling into the brake fluid will be avoided.

Frozen conduits and connecting parts are best thawed out by using a blowtorch or hot air blowers. Next, the brake is freed of water, which is done in the same manner as ventilating; that is, the bleeding nuts are loosened to let brake fluid escape until traces of water in the brake fluid disappear. Ice formation on the outside of the brake hose should be removed by hand only if it is not possible to let the brakes thaw out inside a closed shed.

The brake fluid may not be thinned under any circumstances.

Air Brakes

Air brakes cease to function when the regulating or steering valves, conduits, and taps freeze. In this case even greatest care cannot prevent the condensation of water within the brakes; therefore greatest attention must be paid to the removal of water.

The brakes should be drained of water at least twice daily at all indicated points, and a check should be made to see whether the drain openings are frozen.

It is recommended that one-quarter of a liter of anti-freeze be added through the pressure system which leads from the air chamber. The anti-freeze must be of best quality, since otherwise great damage may be done to the sensitive parts of the brake mechanism. After the anti-freeze has been added, the brake should be actuated a number of times. In this case, water does not have to be removed for about two weeks; at that time the anti-freeze is drained off and newly filled.

Warming Devices

Hot Air Warming Devices

Larger units may use power-driven hot air warming devices. These operate in the following manner:

A blower, powered by a gasoline engine or an electric motor, sucks up cold air and distributes it through a system of pipes. These pipes are heated from without and transmit their heat to the air flowing through them. The heated air is conducted through flexible metal or fabric ducts to the vehicle, and engine, gears, axles, tubing, etc, which are thus warmed as required.

Gas Heat Devices

These devices are much simpler in design. The sucked-up air is not separated from the flame in the system of pipes, but is compressed with it into a combustion chamber. There the air is rapidly heated through direct contact with the flame and is then conducted through ducts to the vehicle. These devices have the disadvantage that the hot air is filled with soot and poisonous combustion gases. They should be used only in the open.

Water Heating Devices

These serve not only to heat radiator water, but can be used everywhere where warm water is needed. They consist of a water tank heated by means of liquid or solid fuel. The hot water is pumped into the vehicle by a hand pump. If the heating devices are set up in the open, they must be protected against rain or snow and particularly against frost. Water must always be drained off when the device is not being heated and the temperature of the water falls

below 20 degrees Centigrade. In closed sheds care must be taken to let exhaust fumes escape.

In order to avoid renewed freezing of the warm water in the radiator, the water is sucked up by the same pump into the heating device, reheated, and again conducted into the vehicle.

Other Emergency Methods

It will happen frequently that the driver will have to depend on himself, and will not be able to fall back on the suggestions made above, because none of the necessary materials will be available. In such cases tricks used by experienced drivers will have to be relied upon. Several are listed below:

One of the most important methods of starting is the use of carbide. The wise driver always carries a small quantity (about one-half kilogram) in a well-closed container. Several small pieces are placed on a plate in front of the air filter, so that the gases which form will be sucked in. If everything else is in good shape, the engine will start immediately.

Sparkplugs can be heated with good results; however they are soiled in the process and must be cleaned.

In the case of Diesel engines, quick firing can be obtained by letting the engine suck up not air, but a gasoline mixture. The firing which follows is quite strong, therefore this method is dangerous and must be used only in emergencies. Gasoline can be introduced by injection or by placing gasoline soaked rags on the air filter.

A better method, equally effective, is the introduction of hot

air which aids the initial self-ignition of the engine. This can be done in two different ways: (1) The air filter can be warmed with a blowtorch; (2) a gasoline-soaked rag is lighted and held in front of the air filter by means of a wire. Care must be taken that when the engine starts no fibers are sucked up.

Parking of Vehicles

In addition to normal maintenance, the following measures must be taken:

1. Lubricating oil must be thinned with gasoline in accordance with the rules discussed above. Engine should be run approximately 2 minutes thereafter at increased idling speed. The thinned oil need not be drained for heating.

2. Brakes must be released; the vehicle must be secured by blocking.

3. Clutch should be depressed and secured by means of wooden wedges.

4. Radiator should be drained, and engine should be run briefly.

5. If anti-freeze is used, it must be checked.

6. Air brake cylinder and filter should be drained and anti-freeze added, if necessary.

7. The storage battery must be removed and kept overnight in a warm place.

8. Valve openings, particularly those of Diesel engines, should be injected with Caramba or kerosene.

9. Lubricating oil in gears, differential, and central lubricating system should be thinned; thinned lubricant to be applied by hand, where necessary.

10. Snow and ice accumulations on wheels, steering mechanism and brake system must be removed.

11. When storing vehicles in sheds: gates and windows must be weather tight, stoves must be looked after and supervised. Fire security must be observed and fire-fighting apparatus must be protected from frost.

12. If vehicles are parked outside:

(a) Walls, slopes, planks, and bushes should be used as protection against wind; if necessary, snow walls should be built.

(b) Engines should be run periodically. If lubricant is thinned, radiator water is heated, or mechanical means of heating is applied, engines need not be run.

(c) If engines must be run for other reasons, it is not necessary to thin the lubricating oil at night.

In such cases -- depending on the temperature -- engines should be started every 2 to 4 hours and should be idled until the temperature reaches 70 degrees Centigrade (charging light must not be on). They should then be allowed to cool to 15 degrees Centigrade. Or, in extremely cold weather, engines should be allowed to run continuously at increased idling speed. Vehicles must be covered and tended at all times. The engines must run rapidly enough to permit the generator to charge. The control light must be out.

Fuel

Many kinds of vehicle breakdowns can be avoided if greater attention is paid to the fuel before it is put into the tank.

During the winter, fuel will generally be cleaner, but will contain more water. If water is present in the fuel, it is best to let the fuel drums stand out in the cold so that the water which will collect at the bottom will freeze.

Rubber hose attached to fuel pumps must never reach the bottom of the barrel, since they will pick up dirt and water. If fuel has to be pumped during rain or snow, filters, fuel drum and tank openings must be covered with cloth which will prevent water or snow from penetrating into the tank.

Before opening drums, caps and openings must be cleaned of snow and ice. Water separators must be cleaned regularly, otherwise their purpose is lost.

As far as possible, fuel lines should be wrapped with friction tape. Placing boxes around fuel tanks which are mounted on the outside is recommended. Frozen fuel lines should not be thawed out by blowtorch while still in the vehicle; they should be removed first.

SHIPMENT OF WINTER SERVICE VEHICLES AND EQUIPMENT

Preparation of Vehicles and Equipment for Shipment

Batteries of all vehicles which are to be shipped must be checked, refilled, and charged if necessary.

Tires are to be checked for correct pressure. If pressure is too low, it is not possible to secure the vehicles firmly; this

results in constant rubbing and bruising when the railway flat car starts and stops; this could result in damage to the tires.

All bolts and nuts must be tightened. All safety devices must be checked and tightened if necessary; otherwise there is danger of loosening and loss resulting from the constant vibration during the trip.

Objects which may easily fall off should be removed and packed separately. This applies particularly to heating panels which are attached to the windshield by means of rubber suction cups. Tarpaulins must be especially well secured against wind.

Easily detachable parts such as blackout lights, spare tires, and winches should be removed and packed separately, either inside the vehicle, or, in the case of equipment, in separate locked containers (crates). As far as possible, vehicles should be locked or otherwise secured against intruders. Tools should always be removed, even from locked containers. and should be separately packed and locked in the cab together with inventory lists. Vehicle papers and keys should be turned in to the train leader or should be sent by messenger to the units to which vehicles are being shipped.

If crates, boxes, or other equipment is loaded on the vehicles, they must be tied down and secured against rattling.

When loading in winter, the following should be observed: in temperatures below minus 30 degrees Centigrade batteries must be protected against the cold. If the transport is to be of long duration, it is recommended that the batteries be removed and carried

in the coaches in which troops are transported. After the vehicle is loaded, radiators should be drained and engine and lubricating oil should be thinned. If there is anti-freeze in the radiator, it need not be drained. A tag, placed conspicuously, should carry a note to the effect that there is anti-freeze in the radiator, so that it will not be drained by mistake. After the radiator is drained, the engine should be run briefly (about one half minute) and should then be immediately shut off. This will remove the water in the water pump completely.

These measures must also be taken when the weather is warm at the point of loading but is expected to be very cold at the destination point. In this case, batteries which cannot be placed in the vehicle should be taken out and stored separately and well packed in the cab.

Loading

Regulations on loading of cars published by the Railways (Regulations, Chapter II to Paragraph 62) are applicable.

Railway cars are designated as follows:

Passenger coaches:
- B - second class
- C - third class
- BC - second and third class

} Capacity is noted on each coach

Freight Cars:
- G - covered freight car
- M - covered freight car for troop transports (38 men)
- R - flat car with 40 centimeters high detachable wooden sidewalls

Rs - flat car with detachable metal sidewalls

F - open flat car with borders (O-car) for vehicles

S - special car for extremely heavy or long vehicles

Spikes and similar fastening devices should not be used, as they will damage the railway car. The net inside width of the car should be wider than the outside width of the vehicle to be loaded. Observation of rules governing the permissible clearance width should be strictly enforced. Vehicles which are too high may have to have the wheels removed and set on their axles. Railway cars should be loaded in proper balance both longitudinally and latitudinally.

The railway car should be secured by placing blocks or wedges against its wheels. This precaution is especially important when cars are loaded with vehicles which mount the front ramp under their own power. If loading is carried out from car to car, each car must either be secured individually, or the cars which are next to the first car, which has already been secured, must be coupled with it and with each other so tightly that they will line up bumper to bumper.

Loading bridges must be placed between loading ramp and railway car. These are supplied by the railroad at no additional cost. These loading bridges must also be used when loading from car to car. The use of sidewalls as bridges is prohibited and must not be practiced since they will break under the load of the vehicle, and the latter will fall off.

In order to prevent bending of the longitudinal beams of the freight cars, these should be blocked on both sides from the free-standing cradle toward the front ramp by strong wood blocks, or ties placed on top of each other in cases where the wheel pressure of the loaded vehicle exceeds 3,000 kilograms. In the case of certain kinds of flat cars the wheel pressure may be somewhat higher. Supports should be erected also when loading is carried out from car to car.

The weight loaded should not exceed the bearing ability (load limit).

When the load limit is not indicated, the load weight marked may be exceeded up to 5 percent.

The wheels of the vehicles must be secured by placing at least two blocks beneath each wheel; in the case of heavy or very wide vehicles, each wheel must be secured by blocks from the outside. Movable front axles or wheels must equally be secured against side movement. Wedges or blocks must be fastened to the floor of the car. Blocks or any other pieces of lumber may be nailed down only with ordinary nails. These must be removed by the recipients and must under no circumstances be hammered into the floor of the car, nor may they be bent. Other types of equipment should be secured in a similar manner. Blocks should be nailed while pressure of the vehicle pushes against them.

During the winter, the floor of the cars must first be cleaned of snow and ice. The floor surface on which the vehicle or the piece of equipment will be standing should be spread with sand, to prevent the possibility of slippage. Brakes of the loaded vehicles should be

tightened and motor vehicles should be put in gear. In addition, vehicles must be secured by means of chains, steel cable, or ropes against movement. Tie-rings of vehicles are to be used for this purpose.

The tying has to be carried out on all four sides of the vehicle, and particular care must be taken. Only annealed wire should be used to tie vehicles down, since unannealed wire breaks easily.

The ropes must be neither too taut nor too loose; the line must run directly from point of attachment on the vehicle to point of attachment on the railroad car. If vehicles are equipped with a hitch, such as trailers, the hitch should be fastened down as well to both sides. The milling drum of snow milling machines should be secured on the floor of the car.

After loading and fastening has been completed, fuel valves of motor vehicles should be shut off and ignition keys removed. Lights should be turned off, and, in cases of vehicles with special battery switching (such as the Laffly), switch connections should be disconnected. Sidewalls and boards belonging to the railway car are to be replaced.

The posting of railway guards must not be forgotten, particularly in occupied areas.

Unloading

Before unloading a check must be made to determine whether damage has been done during the transport, or whether vehicles have

been broken into and theft has occurred. If either is the case, the railroad must immediately be notified so that the circumstances can be noted. Only then should unloading be started.

Blocks and tie-ropes are to be removed. Nails and bits of wire must be completely removed from the railway car. Hammering in of nails into the floor of the car is prohibited. Railway cars have to be supported from below in the same manner in which this was done during loading. This also applies to the securing of the cars against rolling and to the use of loading bridges.

Radiators of vehicles which have been drained of water must be refilled. Brakes must be released and gearshifts placed into neutral.

After unloading, the sidewalls of the railway car must be replaced.

CONSTRUCTION OF SNOW ROLLERS

Rollers Made of Logs. The roller is constructed of logs or roughly hewn tree trunks. Such a roller, with a diameter of 1.50 meters weighs about 2.5 tons. The logs must be hewn so that they cannot roll against each other in the roller. A scaffolding is used in constructing this roller. The individual logs are held together by wheel rings or building staples. To protect the wood washers of 1 to 2 millimeters thick sheetmetal are inserted between the roller and the frame. Bearings are to be greased with fat. To protect the roller against moisture, it should be painted with carbolineum [creosote?] or with oil paint.

Rollers made of hollow drums consist of two or more circular disks with an outer skin. The disks are made from several boards. A cross made of square posts serves both to stiffen the disks and to hold the axle. The corners of the cross are braced by boards which are tenoned into the cross. The triangular space between the cross and the brace serves as the opening through which the sand necessary for the ballast is filled in.

Rollers made from old gasoline drums used as a triple roller. The rim of the drum prevents the slipping of the wooden cross. It is not necessary to wedge the cross firmly between the rim. The point of the axle may not extend over the cross against the bottom wall of the drum so that damage to the drum will be avoided. The axle is located either in the center of the cross or is held within the frame by a bolt; or it can be fastened in the cross and can then be secured in its bearing on the frame. The drums should be filled with sand.

APPENDIX

LIST OF ILLUSTRATIONS

1. Examples of highest monthly snow levels in Germany, Russia, and Norway.

2. Absolute maximum snow levels in eastern Europe

3. Growth of snow cover at start of winter

   Shaded areas:

   a. alternating cover
   b. predominantly solid snow and ice cover
   c. snow cover less than 15 centimeters
   d. snow cover more than 15 centimeters

4. Stages of softening of the ground in the spring

   Shaded areas:

   a. initial thaw
   b. alternating thaw and frost
   c. continuously melting snow
   d. slush, soaked ground, inundated
   e. hardening of the ground
   f. moist, but firm ground

5. Beginning (solid lines) and end (broken lines) of passable snow cover on roads in European Russia

6. Snow crystals

7. Russian road covered by snow drift; one lane has just been cleared

8. Snow deposits near a dense obstruction (schematic diagram)

9. Stages of snow deposits near a dense obstruction which is already completely covered on the windward side

10. Snow deposits in a depression

11. Snow deposits in front of and behind an obstruction through which snow can pass (schematic diagram)

12. Snow drifts on a road cut into the side of a mountain

13. Moderate snow deposits in depressions of more than 6 to 8 meters in depth with air currents (air whirls) indicated

14. Snow deposits near dams higher than 1 meter

15. Cross-section of the Minsk-Smolensk Road. The road is located on a low dam. The outer edges of the excavations on the sides are slightly raised which creates on both sides of the body of the road a natural snow fence.

16. A drift-free Russian road. The road (dam) is swept clean by the wind itself.

17. Snow banks on the side of a road always cause snow drifts.

18. Rutted Russian dirt road

19. Placing of marking posts

20. Division of two reporting areas (road areas) into reporting sectors

Sitz des linienchefs - Location of the line chief

21. Submission of a road weather report

22. Board erected by OT road weather service with interchangeable signs

23. Snow protection hedge

24. Snow protection strips of forest

25. Solid fence

26. Solid slatted fence

27. Solid slatted fence erected in rocky terrain in northern Norway. The top-flange causes increased reverse whirl and thus increases snow deposit.

28. Permanent fence made of birch branches in rocky terrain in northern Norway.

29. Wall built of snow blocks

30. Snow wall stapler

31. Snow deposits behind a reed fence

32. Snow shields erected in the shape of a roof

33. Temporary snow fence made of vertically woven reeds

33a. Snow fence with vertical slats

34. Snow fence with horizontal slats

35. Snow shield with horizontal slats and increasing intervals between slats

36. Snow shield with vertical slats which can be raised

37. Erection of snow shields in straddled position when posts are not available

38. Fence made of rush mats

39. Snow fence made of wicker

40. Snow shields made of fir or birch branches

41. Machine for straw rope twining

42. Snow fence made of straw rope bands 15 centimeters wide

43. Russian post hole diggers

44. Determination of necessary distance between snow fences and the road to be protected

45. Moving of snow fences

46. Moving of snow fences when foreland is not sufficiently wide

47. Snow tunnel with passing zones

48. Snow tunnel. Construction and layout of a passing zone

49. Examples of an efficient shovel and pick for the OT winter service

50. Wooden Russian snow shovel

51. Manual removal of snow

52. Clearing of a road by manual labor

Arbeitsgang - work stage

53. Russian snow plow (foreplow) made of wood

Blechbeschlag - sheet metal cover

Rundholz - wooden pole

Grundriss - plan

Schnitt - section

54. Russian snow plow, made of wood with expandable side blades

Gelenk - joint

Angeklappter Flügel - attached wing

Flügel in Arbeitstellung - wing in operating position

Ausgeschwenkte Flügel - wings extended

55. Two-sided Russian wooden triangle for use with horses

56. Side-view of the Stalinets caterpillar tractor

57. Section through the Stalinets caterpillar tractor (65 horsepower)

1. engine 2. radiator 3. clutch 4. gears 5. steering couplings 6. drive wheel mount 7. caterpillar carriage 8. caterpillar chain 9. fuel tank

58. Section through the NATI caterpillar tractor

59. Side-view of the NATI caterpillar tractor

60. Side-view of the Stalinets caterpillar tractor with drag plow

61. Drag plow viewed from above and from the side

62. Front view of drag plow

63. Caterpillar road grader with 60 horsepower Diesel drive (2-axle drive)

64. Russian dirt road

Not suitable for snow removal with rigidly attached foreplows

65. Snow plow clearing snow to one side (foreplow) manufactured by the Alfred Schmidt Company, St. Glasien

1. plow share 2. mount 3. raising and lowering device 4. skids 5. locks 6. center piece 7. upper and lower swivel arm 8. upper and lower swivel arm bolt 9. knee lever 10. center piece spring 11. steering shaft 12. drive chain 13. chain sprocket 14. shearing bolt 15. locking device

66. Wedge plow (foreplow) manufactured by Alfred Schmidt, St. Blasien (side view and top view)

1. vehicle plate 2. spindle housing 3. knee lever 4. swivel arms 5. skids 6. bracing 7. raising and lowering device

67. Wedge plow (foreplow) manufactured by the Grasmuck Company, Vienna (side-view and top view)

1. vehicle plate 2. bracing 3. mounting flanges 4. ring 5. winch 6. snow plow 7. chain 8. skid 9. reverse position

68. Coupling of two light trucks to clear snow drifts

69. OT push coupling employed in the coupling of two light trucks This consists of the head mounted on the vehicle plate of the rear vehicle, and of the push plate which is mounted on the

hitch and the rear frame ends of the front vehicle; it is easily detachable. Its concave design prevents the head from sliding off when curves are negotiated.

70. Vehicle plate

Befestigungskonstruktion - brace

71. One-sided snow plow in operation

72. Blade removing top of snow bank

73. Snow blasting

74. Loosening of icy snow banks by blasting

75. Peter milling machine with 4-wheel drive

76. Peter milling machine with caterpillars

77. Peter milling machine loaded on flat car

78. Peter milling machine in operation. Note great clearing distance.

79. Removal of high snow wall in sections

80. Step-wise clearing of a road on the side of a hill by snow milling machine with caterpillar

81. Diagram of Peter milling machine

82. Arch built of snow bricks over a depression cleared of snow

83. Portable scaffolding for construction of arches made of snow brick

84. Screw [redacted] snow clearing machine

85. Attachment of screw clearing machine to a low-slung vehicle

86. Screw snow clearing machine in operation

87. Hollow slinger attached to a caterpillar tractor, equipped with conveyer screws

88. Hollow slinger in operation

89. Hollow slinger and caterpillar tractor in process of being attached

90. Spreading of sand from horse drawn sleds

91. Spreading of sand from truck

92. Sand pile covered with branches

93. Box for sanding material

94. Schematic diagram of OT spreading device with worm conveyor

95. Warning sign for icy road; designed to fold down

96. OT sanding device

97. Special rig for rolling of airfields [tractor, harrow, snow drags, rollers].

98. Snow clearance of airfields with foreplows

snow wall: not wider than 2 meters, not higher than 1 meter

snow transport train: in the first round, in the second round

99. Uncompressed loose snow (8 times natural size)

100. Artificially compressed snow (8 times natural size)

101. OT snow drag (weighted down with rocks) to compress snow

101a. Snow drag, primitively constructed, horse drawn

102. Small roller made of log, 60 centimeters in diameter
Large roller (weight 500 to 600 kilograms)

103. Reversible triangle. This can be reassembled by removing outer cross-beam, moving the rear ends together, and reattaching cross-beam at the front.

104. Building an ice track road: Freshly fallen snow, firmly rolled snow, cut or rolled track, sprinkling and forming of the track.

105. Ice track cutter

106. Block house

107. View of a road service facility

108. Schematic diagram of a road service facility for eastern or northern Europe

Fahrzeughalle - vehicle shed

Werkstatt - shop

Schmiede - Smithy

Brunnen - well

Dients- und Unterkunftsgebäude - Offices and living quarters

Schuppen - Shed

Gerate - Equipment

Betriebsstoff - Fuel

109. A road service facility in Russia

110. Vehicle shed

111. Example of a small service installation

112. Horizontal stove between two vehicle stands

113. Stove made of gasoline drum

114. Diagram of hot air blower installation for heating of vehicle shed

115. OT bunker stove

116. Insulation of gates, windows, and ceiling of vehicle (cardboard or thin layers of newspaper placed on interior of ceilings, walls, and gates)

Lehm - clay

Pappe - cardboard

Vorhang - curtain

Mit Draht aufgebundenes Stroh - straw tied with wire

Strohmatte - straw mat

117. Hood made of straw mats to keep engine warm

Individual mats can be fitted together as needed and can easily be carried in the vehicle since they take up very little space.

118. Engine and radiator covered with straw mats

119. Horizontal press for straw mats

120. Vertical press for straw mats

121. Ground bunker for motor vehicles

122. Ground bunker for motor vehicles in cross-section

123. Simple shop in a vehicle shed

124. Softened road in the spring

125. Manual removal of drift ice near a bridge

126. Removal of drift ice by blasting

127. Storage of snow protection shields

128. Storage of poles

129. OT men in the winter service

130. Felt boots

131. Emergency goggles

132. Home made boots and cap

133. Watch compass

134. Orientation to North Star

135. When unthinned lubricant is used, the starter at a temperature of -20 degrees C needs $2\frac{1}{2}$ times the power which it would ordinarily need at +20 degrees C. The capacity of the battery at -20 degrees is only 40 percent of the capacity at +20 degrees. The number of revolutions at starting therefore falls below what it should be. Engine will not start. Solution: heat. Engine and battery should be heated. Lubricant should be thinned with gasoline.

136. Reduction of battery capacity at increasing cold. Power demands on starter, however, increase with increasing cold.

137. Approximate behavior of oil temperature and evaporation of gasoline in the thinned lubricant within a light truck engine (20 percent dilution of lubricant with normal gasoline)

138. Storage battery. To be stored in a wooden box as protection against the cold, placed under the driver's seat, heating with warming lamps during parking.

139. Simple air warming device with blower for all solid fuels. Can be made out of gasoline drums

140. Warming box for radiator water. This is installed at the lowest point in the radiator circuit and consists of a double-walled container with small water tank. The warmed water rises within the radiator, transmits heat to the walls of the engine and flows back into the warming box. The device serves not only to heat the water but to keep it warm.

141. OT warming device

Sammler - storage battery
Heizkasten - warming box
Kraftstoff tank - fuel tank
Schwimmerventil - float valve
Heizlampen - heater lamps
Kraftstoff - fuel
Kühlwasser - cooling liquid

142. Carbureted engine sucks up carbide gas

143. Warming of spark plugs

144. Suction openings of Diesel engine are covered with gasoline soaked rags

145. Clutch is depressed and secured by wooden wedge

146. Load limits and railroad car dimensions

147. Loading bridges. Supports [under railroad car]

148. Auxiliary bridging between railroad cars

149. Correct nailing of blocks

150. Tying down of vehicles

Richtig - right

Falsch - wrong

151. Snow roller constructed of logs, covered with sheet metal

152. Snow roller in form of a hollow drum

153. Snow roller constructed of old gasoline drums