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National Cooperative Highway Research Program

RESEARCH RESULTS DIGEST

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Subject Area: IIIC Maintenance Responsible Senior Program Officer: Amir N. Hanna

Winter Maintenance Technology and Practices—Learning from Abroad

An NCHRP digest of the findings and recommendations of an International Winter Maintenance Scanning Tour conducted under the auspices of FHWA's International Programs and NCHRP Project 20-36, Highway Research and Technology—International Information Sharing. Tour participants were Messrs. Gary Hoffman, Leland Smithson, and Clayton Sullivan of Pennsylvania, Iowa, and Idaho Departments of Transportation, respectively; Mr. Larry Frevert of Kansas City Public Works Department; Mr. Guy Puccio of County of Erie (New York) Department of Public Works; Dr. Rand Decker of the University of Utah; and Mr. Andrew Mergenmeier of the Federal Highway Administration.

INTRODUCTION

The direct costs of snow and ice control on the U.S. highway system consume a staggering amount of money—over $1½ billion a year. Furthermore, these expenditures do not include the indirect costs associated with corrosion, water quality degradation, and other environmental impacts that total more than $5 billion a year. Optimization, leading to even a small increase in efficiency or effectiveness, will lead to significant savings, improved mobility, and reduced environmental and societal impacts.

An International Winter Maintenance Technology Scanning Tour was organized jointly under the auspices of the Federal Highway Administration's International Outreach Program and the AASHTO-sponsored National Cooperative Highway Research Program to examine snow and ice control operations in Japan and Europe for technology with potential for domestic application. The scanning team travelled to Japan and Europe in March 1994 and discovered important differences in snow removal equipment, anti-icing/deicing materials and methods, weather monitoring, winter hazard mitigation, and road user information services. Also, the team discovered important differences in the public perception and responsibility for participation in snow removal operations, the methods employed for financing winter maintenance operations, and the cooperation between public agencies and private enterprise in research and development efforts.

Many of these winter maintenance technologies are appropriate for application in U.S. domestic environments and have the potential to provide the cost savings and benefits sought. To become accepted into practice in the United States, these winter maintenance technologies will require rigorous operational acceptance testing and evaluation in an operational setting commensurate with that found in specific states and municipalities. A center and process are needed to accomplish the testing, demonstrations, and dissemination of the results and conclusions. The lack of such a center or an agency empowered with ensuring implementation is one cause of the great disparity in the styles and quality of winter maintenance as it is performed by various, often adjacent states and municipalities.

RECOMMENDATIONS

It is the primary recommendation of the Winter Maintenance Technology Scanning Tour that a Winter Maintenance Program (WMP) be developed.

A principal mission of the WMP will be to ensure that the requisite testing and evaluation of potentially implementable winter maintenance technologies are performed and that the results of these efforts are presented and disseminated in such a manner that modern winter maintenance technologies are easily understood and integrated into individual state and municipal operational programs. Beyond this principal mission, the WMP should work toward establishing a systems approach to snow and ice control in the United States—one involving the vehicle, the driver, and the equipment, the materials, and practices—for managing roadway and bridge snow and ice.

The goals of the proposed WMP are to (1) sustain or improve levels of winter maintenance service with significant benefit/cost improvements, (2) provide an enhanced level of environmental protection, and (3) place technology in service on operational maintenance sections within two winter seasons.

Seven projects have been identified for evaluation (rear delivery snow blowers; innovative snow plows and snow plow accessories; finer NaCl gradation and corresponding prewetting equipment; road user information centers; winter motorists natural hazards mitigation project; fixed snow and ice control liquid spray system; and global technical information exchange). The duration and cost of the program will depend upon several factors, including weather and the interest of the participants.

FINDINGS

As part of the winter maintenance scanning tour, snow and ice removal equipment, control materials and methods, and information and traffic management systems were observed. Also, issues pertaining to winter maintenance policy and financing were examined.

Snow and Ice Removal Equipment

Next Generation Snow Plow

A next generation snow plow is under development in Japan through a joint venture between government and private enterprise. A test vehicle, built for the purpose of component evaluation and system's integration (Figure 1), features an optimized mold board configuration, an undercarriage-mounted plow with down pressure sensing and automated control loop, and a hydraulically actuated wing plow with height adjustments to and above the guard rail height. Many of the operator's tasks are automated, including down pressure of the plows and steering resistance such that the lateral plow forces are not felt by the operator. A set of video cameras provides the operator with multiangle views of the snow removal operation.

Single-Lane-Obstructing Rotary Snow Plow

To reduce the snow removal process to a single-lane operation, a standard rotary snow plow has been improved by adding a rearward conveying system (Figure 2). This snow plow has a 1700-ton/hour capacity and is in operation in the city of Sapporo, Japan. The equipment is operated by two individuals: one drives the truck and maneuvers the rotary plow while the other manipulates the conveyor system with remote controls in the cab. The articulation between the front and rear axles makes the equipment very maneuverable. Closed-circuit video cameras mounted on the rear section of the conveyor and a monitor mounted in the cab provide the operator with adequate views of the operation. The machine operates at a forward speed of 8 to 15 km/h and is capable of picking up and conveying about 12 cubic meters of compacted, frozen snow and ice to the trailing dump truck in 60 to 90 seconds.

The rearward conveying system is especially suited for urbanized areas with considerable lengths of bridge decks, elevated roadways, and viaducts. Also, this machine is particularly suited for those situations where occupying more than one lane is impossible, undesirable, or would have an adverse impact on traffic flow, such as city streets.

Melting Hauled Snow

Snow melting facilities that utilize the treated water from city municipal waste water facilities are used in Japan to provide an alternative to dumping hauled snow. Accumulated hauled snow occupies urban real estate and requires manipulation during the melting season. Snow melting facilities allow for snow removal using traditional load and haul techniques without the need for seasonal snow spoils storage. A bar code reader is used to identify the trucks as they enter the facility and to provide information for contract monitoring and payment. In these facilities, hauled snow is dumped into melting tanks containing water that is being agitated to accelerate snow melting. The melted snow and melting water are then piped to a nearby river. Because of the little use of salt in winter maintenance operations in Japan, the environmental consequences of dumping melted snow in the river might not be serious.

Hydraulic Conveyance of Urban Snow

A novel urban snow removal system, known as the "snow flowing gutters," provides a means for hydraulic conveyance of snow accumulated on urban streets, sidewalks, curbs and gutters. This system utilizes storm sewer runoff and/or recirculated river water or treated waste water to convey and melt snow spoils. A network of box channel conduits with grated openings is laid specifically for the purpose of snow removal. Business and residential property owners adjacent to the snow gutter work voluntarily to provide the labor needed for the facility. The high installation cost of the system is partially offset by the elimination of labor and handling expense.

Sectional Plows on Standardized Mounts

Snow plows used in Europe differ from those used in the United States. Universal snow plow mounts are used in Europe to allow better utilization of plow/truck resources (Figure 3). For example, different plow types can be easily mounted on a given vehicle depending on the storm characteristics and duration. Generally, a truck can be equipped with two, sometimes three, different plow blades that can be used during the same storm event depending on the prevailing condition. Because plows and trucks are generally furnished by different competing vendors, the use of universal mounts encourages public/private sector cooperation. In Europe, public agencies frequently provide public-owned plows and spreaders for use on privately-owned rental trucks.

In addition to sectional plow design, typical German winter maintenance vehicles are equipped with a spreader and include other features such as the use of rubber shock/return springs on each individual segment of the plow and airflow spoilers mounted near the top of the plow moldboard. These features allow the vehicle to better respond to road surface irregularities, reduce snow cloud, improve motorists visibility of the snow plow truck, and enhance operator visibility. The plow truck is also equipped with a wing plow and a dual head prewetting anti-icing/deicing slip-in material spreader inserted in the truck bed. European and Japanese practices tend to maximize winter maintenance operation efficiency by equipping each vehicle with different plows and material-spreading capabilities and allowing the operator to select the options best suited for the prevailing conditions.

Snow and Ice Control Materials and Methods

European Snow and Ice Control Vehicles

The European experience with both snow and ice control material spreaders and material management is well advanced. European spreaders feature many noncorrosive parts, including stainless steel and plastics. Many spreaders have self-contained, free-standing, storage features normally consisting of telescoping or folded legs. Also, some spreaders are equipped with an antenna to inform the operator when spreading operation is in progress. Figure 4 shows a set of snow and ice control material-spreading vehicles and bed inserts. Some of these vehicles feature the use of aerodynamic spoilers to create a favorable airflow field for material spreading to help mitigate the "bounce and scatter" and to maintain a clean motorist message board. Also, some of the equipment is capable of applying liquid agents or dry material that is wetted just prior to application onto the roadway surface. The use of prewetted salt is cited for the approximately 50 percent reduction in salt consumption in the Bavarian State of Germany, while maintaining the same levels of service achieved with dry salt. Approximately 10 percent of the Bavarian snow and ice control material-spreading equipment fleet is being converted annually to allow the use of prewetted, liquid, or mixed materials. It should be noted that a substantial effort is allocated to the maintenance and calibration of the deicing material spread-rate controls.

Automated-Fixed Snow and Ice Control Liquid-Spray System

Bridge decks often freeze before the adjacent roadway condition becomes hazardous and the mobile, truck-mounted anti-icing/deicing operations of the roadway are initiated. A guardrail-mounted system has been used in Europe for spraying snow and ice control materials onto a bridge deck. In such installations, the process is controlled by an automated loop that

Figure 1. A next generation snow plow.

Figure 2. Single-lane-obstructing rotary snow plow.

Figure 3. Sectional plow.

monitors both pavement and climate conditions, and responds by spraying materials that control ice and snow control on the deck when needed. Although this fixed snow and ice control technique has been used on bridges, it could be adapted for other situations, such as on/off ramps, tunnel entrances, and hazardous intersections.

Snow and Ice Control Materials and Storage

In Europe, snow and ice control materials are handled and stored in covered enclosures. Because of the fine gradation and long storage periods, sometimes as long as 6 months, dry materials are often treated with an anti-caking admixture. Also, liquids are protected from the natural elements by covered enclosures. Noncorrosive treated wood products are frequently used in these storage facilities. To maximize the storage volume, dry materials are often conveyed by being blown into the facility and are later removed through a conventional loader access or by a self-propelled auguring conveyer. The latter option frees the end loader for use as a plowing unit when it is equipped with a blade.

Table 1 compares the gradation of granular NaCl used in the United States, Sweden, and Finland. The European gradation is finer than that used in the United States, as stipulated in ASTM D632, Standard Specification for Sodium Chloride, and is more narrowly constrained about a range of 1 to 2 mm.

Other Snow and Ice Control Techniques

In Japan, at locations where pavement freezing causes serious hazards or other problems, such as at tunnel entrances, sharp curves, and intersections, the pavement is heated using electric resistance wiring or pipes embedded in the road that carry hot water from nearby manufacturing plants or naturally occurring hot springs. This same technique has been used in urban areas for crosswalks and sidewalks.

Another technology employed in Japan involves the use of sprinkler systems to control snow accumulations. In this process, low-velocity, low-pressure systems are activated during snowfall when the ambient and pavement temperatures are just above or approach the freezing point. The constant flow of water over the pavement surface prevents snow accumulation and melts the deposited snow to allow runoff into the conventional storm sewer system.

Winter Maintenance Management Systems

Managing Natural Hazards to Winter Motorists

During the winter season, a unique set of environmental hazards to motorists arise including loss of visibility in blowing and drifting snow conditions, loss of mobility in accumulated drifts, and the potential for snow avalanches on routes through the winter alpine regions. These hazards are further exacerbated by the very remote nature of the rural settings in which these processes often take place. This is especially true in the intermountain west. The danger to motorists goes beyond the increased probability of an accident and/or loss of mobility; death and injury may result from exposure, hypothermia, and other cold-related maladies.

Blowing and Drifting Snow

Blowing and drifting snow constitutes a major winter hazard in the northern part of Japan. The mitigation of this hazard is managed with storage-type and innovative snow fence technology.

The use of storage-type snow fences, i.e., fences that encourage the deposition of the snow in the lee of the fence by decelerating the airflow, is a common practice in the United States. Improvements in visibility are realized by decreasing the amount of snow in transport downwind of the fence. In addition, snow that may have otherwise deposited on the roadway is "trapped" in the lee of the storage snow fence before it can reach the roadway. The effectiveness of these storage snow fences depends on the accumulation area in the lee of the fence. When the fence becomes "full" and no longer has excess storage capacity, it will no longer be effective in enhancing visibility and/or mitigating drift snow accumulations on the roadway. Although it depends on terrain, fence geometry, and aerodynamics in the vicinity of the snow fence, most storage snow fences will become full during the winter season and will remain full until spring melting.

An alternative fence type—a "blower" fence—is used to both mitigate drifting snow accumulation and enhance visibility. These blower snow fences, as used in Japan (Figure 5), are designed to accelerate the airflow in the immediate vicinity of the roadway and reduce snow accumulations in the lee of these fences by the vigorous wind action. In addition to providing an enhanced visibility in the immediate lee of the

Figure 4. Material–spreading vehicle.

TABLE 1 Comparison of salt (NaCl) gradation

Sieve Size	Weight Percent Passing		
	U.S.*	Finland	Sweden
½ in. (12.5 mm)	100		
⅜ in. (9.5 mm)	95-100		
No. 4 (4.75 mm)	20-90	100	
No. 5 (4.00mm)		90-100	
No. 6 (3.35 mm)		70-100	95-100
No. 8 (2.36 mm)	10-60		
No. 10 (2.00 mm)		40-90	65-100
No. 18 (1.00 mm)		15-55	26-50
No. 30 (600 μm)	0-15		
No. 35 (500 μm)		3-25	5-26
No. 100 (50 μm)			0-5

* Per ASTM D632, Standard Specification for Sodium Chloride

fence, this fence type is placed next to the pavement thus requiring substantially less right of way than is needed for conventional snow fences.

Modeling and analyzing blowing and drifting snow would help the design of highway facilities. The facilities of the Hokkaido Development Bureau's Construction Machinery Engineering Center include a blowing- and drifting-snow windtunnel for modeling and analyzing highway cuts, structures, and facilities in a simulated blizzard using clay particles. This windtunnel analysis provides guidance for designing new structures or evaluating and modifying existing roadside facilities. Also, the Hokkaido Office of the Japan Weather Association has developed a computational simulation capability for modeling blowing and drifting snow. The results, presented in high quality graphics to facilitate interpretation of findings, will help to determine areas of decreased visibility, drift scour, and accumulation.

Snow Avalanche Hazards

Snow avalanches represent a major hazard to motorists in winter alpine regions. Winter maintenance equipment operators are frequently the victims of snow avalanches in the United States. Both Japan and Europe have introduced extensive avalanche hazard mitigation programs for winter/alpine roadways. Roadway avalanche defense is achieved through the use of permanent structures designed to pass the avalanche over the roadway, to divert the direction of the avalanche flow, or to slow and shorten the runout distance of the avalanche by dissipating the energy of the avalanche flow. A joint research effort by the Nagaoka Institute for Snow and Ice Studies, Niigata, Japan, and the Department of Civil Engineering at the University of Utah is currently underway to help optimize the design of Japan's permanent avalanche defense structures. The Europeans and Japanese have developed manuals of practice detailing criteria and guidelines for design of avalanche defense structures. Also, snow-supporting "rakes" may also be installed in the avalanche starting zones to reduce the initiation of avalanching.

Rubberized Traction Chains

Since the recent prohibition of studded tires on Japan's winter roads, winter motorists often carry and use rubberized tire chains—a traction aid that consists of a mat of rubberized steel cable. Although the service life of these traction aids is shorter than that for conventional steel-link chains, these aids are easy to install and provide better driving quality. These traction aids would be useful to the winter motoring public in the United States particularly in the intermountain west and maritime costal regions.

Roadway Weather Information Systems

Roadway weather information systems (RWIS) provide information to centralized locations regarding the microclimatic condition along a given section of roadway to help respond to the situation in a timely and appropriate manner. In Japan, roadway weather information is collected, processed, and provided to the public over the car radio at assigned frequencies and at roadside rest/information areas to allow for route and trip planning. In Europe and Japan, data from roadway weather information and other sources are used to change speed limits and variable message signs.

Sensors for roadway weather information systems typically include those required for monitoring ambient air and pavement temperature, windspeed and direction, humidity, and precipitation rates. Sensors for monitoring freezing point and precipitation are being considered. Data from these sensors are transferred to a central location via land line or by radio datalink. In many cases, the RWIS hardware is augmented by regional weather prediction software or by meteorologists to make predictions based on data interpretations. Generally, roadway weather information systems are used to support the maintenance manager's decision.

The high capital expenditures needed for installing RWIS are being justified in Europe by the improvement in winter maintenance operations and use of anti-icing/deicing materials. If properly timed, based on effective RWIS forecasts and condition updates, anti-icing chemicals will be effective in preventing ice bonding to the pavement surface thus reducing overall chemical usage. Also, by better predicting the anticipated start, duration, and type of storm conditions, managers would be able to make better decisions regarding the quantities, types, and duration of needed resources.

Winter Traffic Management Systems

Traffic monitoring and management systems have been installed in Japan and Europe to enhance public safety through timely intervention during deteriorating driving conditions. Such systems make extensive use of video cameras to monitor traffic and roadway conditions. The primary intervention feature of these systems is the ability by remote control to change speed limit signs, provide information to motorists via radio and/or changeable message signs, and limit access to or close a section of roadway. In addition, these centers are equipped to handle emergency services such as fire, ambulance, and police.

In addition to the systems of fixed sensors and images, a winter maintenance information vehicle is under development by the Construction Machinery Engineering Center of the Hokkiado Development Bureau. A set of on-board sensors and images provides data to allow an assessment of roadway weather and pavement conditions. The vehicle has a capability to radio datalink the information to a central location.

Motorist Information Systems

In Europe and to a greater extent in Japan, the motoring public is frequently informed about the anticipated winter driving conditions and those winter maintenance operations in progress. Variable speed limit signing (Figure 6) is one of the dominant means for informing and involving the public in winter driving hazard mitigation. These fixed installations may be activated remotely from a central traffic management location to advise motorists of expected delays or closures allowing them to chose alternatives before each interchange. Also, winter maintenance vehicles are often equipped with either a set message or changeable message board to inform the public about the operation in progress and any associated hazard. In this manner, the public is likely to be more sympathetic to the delays associated with the operation. In addition, use of IVHS technology is contemplated. For example, elements of this technology allow coupling of intermittent/minimum zone mode communication with digital route maps to inform motorists of ongoing winter maintenance operations or anticipated winter driving hazards. Thus, motorists will be able to plan alternative routes.

Winter Maintenance Policy and Funding Issues

In Japan and Europe, social and cultural factors influence the decisions made by states and municipalities regarding winter maintenance. For example, in Japan there is an abiding sense of "ownership" and pride in public infrastructure and participation by citizens in projects, such as snow and ice removal. Also, citizens and public officials are involved in establishing snow removal standards, developing facilities, and clarifying the roles of public sector organizations and citizens.

Level of Service

Contrary to normal operations in the United States and Central Europe, snow and ice control operations in Japan begin when snow/ice accumulation on the roadway surface reaches 5 cm. However, winter maintenance managers point out that many drivers, particularly those from mild climate areas, assume that a bare pavement policy is always in effect and complain when it is not achieved. The Germans have established requirements for the level of service to be expected for different classes of roads under different storm conditions. In Bavaria, snow-clearing operations continue during the morning and evening traffic peaks; but they are discontinued between 8:00 p.m. and 4:00 a.m. In the Scandinavian countries, level of service and snow-removal operation performance is monitored by measuring the coefficient of friction on snow-packed surfaces using a self-contained, truck-mounted friction meter that operates at roadway speeds.

Resources and Funding

To allow a reasonable comparison of resources available for winter maintenance in Japan and Europe to those available in the United States, available expenditures, labor, and equipment were divided by the lane kilometers of maintained roads and by the average total snowfall in centimeters. This comparison revealed that expenditures for winter maintenance in Japan and Austria are nearly 2 to 3 times higher than those in the United States. The equipment responsibility was as low as 7 lane-km/vehicle in Austria compared to a high of 58 lane-km/vehicle in the state of Pennsylvania. Maintenance field employee responsibility was as low as 2 lane-km/person in Austria compared to a high of 32 lane-km/person in the state of Idaho.

Many European countries and Japan augment their own full-time resources with temporary employees, rented equipment, and contractor assistance when needed. The following observations describe some of these practices.

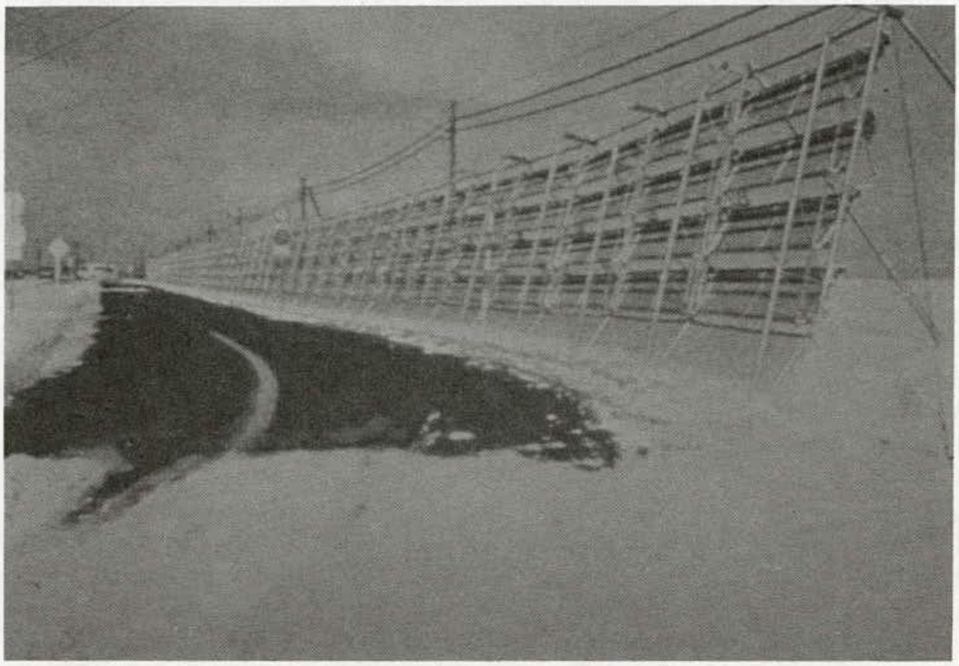

Figure 5. Blower-type fence.

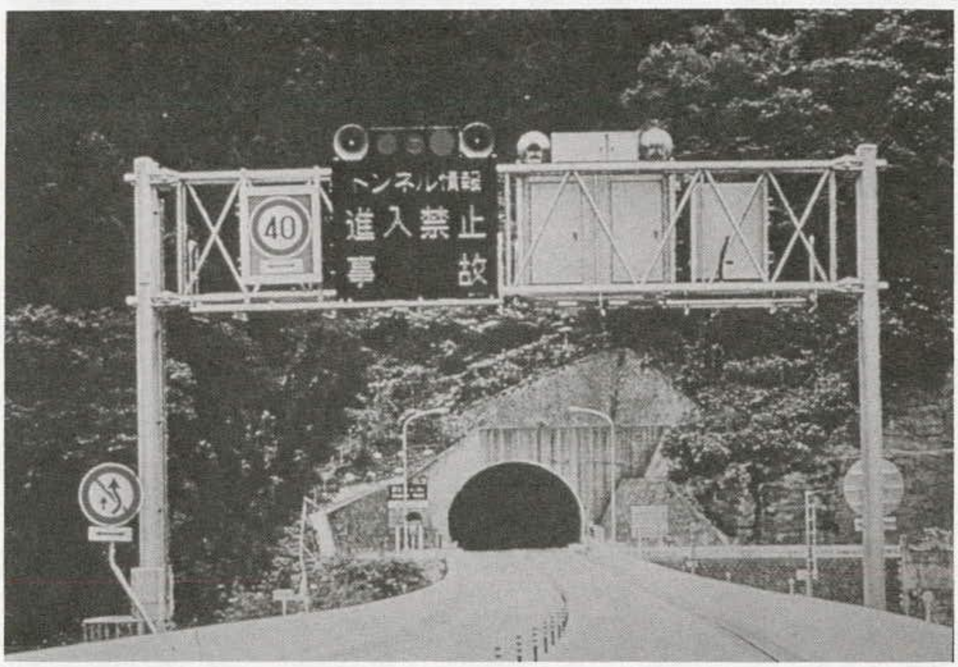

Figure 6. Variable speed limit system.

Throughout Japan, nearly all winter maintenance activities are performed by private or quasi-private organizations although the government owns a substantial amount of winter maintenance equipment that is leased to the private contractor. However, some contractors provide their own dump trucks but use government-owned plows and spreaders. Many contractors are responsible perennially for maintaining roads in certain small areas to promote familiarity and consistency of service. The government establishes an hourly rate for each type of equipment for all contractors in each area, and payment is based on the number of equipment-worked hours. Although no performance requirements are stipulated, government quality assurance staff monitor the roads and encourage improved performance when needed.

The state of Bavaria in Germany consists of seven districts, which are divided into 23 county-like areas, which are subdivided into 102 maintenance work areas. Each work area is responsible for about 230 km of roadway, has two plow trucks and two "Unimogs" with blower attachment, and employs 30 full-time state personnel including a head master, several foremen mechanics, and clerical staff. During the winter, each maintenance work area is augmented with five rental trucks with operators furnished by contractors. Similar to Japan and other European countries, the Bavarian state supplies the plows, attachments, and hydraulics needed for the rental trucks. All contractors are paid the same rate of 90 DM/hour and are guaranteed a minimum 10 hours per month, i.e., 900 DM. A 3- to 5-year contract that guarantees a minimum of 4500 DM per year is being considered for future contracts.

The city of Sapporo, with 1.8 million people; 9200 lane-km of street, and 5.0 to 6.4 meters annual snowfall, allocates 10 percent of its maintenance budget (approximately $100 million) to winter maintenance activities. City officials are seeking a 40 percent increase in winter maintenance budget. One-half of these funds is derived from the national road user funds and the other half is derived from locally imposed taxes, including city income tax. The Bavarian state authority for highways allocates approximately 14 percent of the autobahns maintenance budget and 22 percent of two-lane roadway maintenance budgets for winter maintenance, i.e., 22,800 and 19,500 DM/km/year for four-lane autobahns and two-lane motorways, respectively. The Austrian autobahn authority uses a portion of the tolls collected for travel on the 13-km long autobahn through the Brenner Pass to provide for snow and ice removal operations. This autobahn is divided into 27 sections each of which is maintained by 11 snow plows, including rental trucks.

Partnership in Research and Development

In Japan and Western Europe, much of the innovative winter maintenance equipment is developed jointly by industry and government agencies. This partnership and shared risk encourage the industry to devote efforts for developing the equipment that are likely to be used by government agencies. One example of the joint partnership between government and private enterprise in Japan is the ongoing development of the next generation snow plow. Another example of such partnership is found in Europe where public agencies often provide public-owned plows and spreaders for use on privately owned rental trucks. Also, government and industry cooperation in Japan was instrumental in introducing the use of studless tires. In an effort to solve the road deterioration and air pollution problems associated with the use of studded tires, the Japanese Ministry of Trade and Industry introduced studless tires and joined with the private industry in providing winter driving training courses. This government/industry cooperation contributed to changes in motorists driving and buying habits such that only very few vehicles use studded tires today resulting in improved air quality.

CONCLUSIONS

Snow and ice control operations in the United States differ from those used in other countries. European and Japanese winter maintenance technology and practices appear superior to those of the United States, especially in the areas of equipment, anti-icing operations, road weather information systems, weather forecasting services, public information systems, policy issues, and environmental concerns. An evaluation of potential foreign developments is needed to identify those suitable for adaption or incorporation in domestic practices. The establishment of a Winter Maintenance Program (WMP) is envisioned to provide the means for identifying and evaluating promising foreign and domestic technologies and practices and to help make possible the timely application of cost-effective systems. The goals of the WMP are to (1) sustain or improve levels of winter maintenance service with significant benefit/cost improvements, (2) provide an enhanced degree of environmental protection, and (3) place technology in service in a timely manner. Although a comprehensive work program may be developed in a national workshop, the following items have been identified for possible consideration and evaluation as part of the WMP:

1. Snow and Ice Control
   a) Rearward (one-lane) snow-conveying rotary snow plows
   b) Spreaders with prewetting equipment and aerodynamic tailoring
   c) Improved snow plows
   d) Improved anti-icing/deicing materials and application management

2. Winter Maintenance Management Systems
   a) Improved roadway/weather information system technology
   b) Coupling weather information with GIS/GPS
   c) Improved road user information systems
   d) Fleet management (borrowing from Transit Cooperative Research Program)

3. Blowing Snow and Avalanche Hazard
   a) Demonstration: blower-type snow fence
   b) Demonstration: hazardous highway traffic management systems

4. Policy Recommendations
   a) Translation of "snow engineering" manuals
   b) Work process management in winter maintenance
   c) Strengthen private/public sector partnership
   d) Public education, cooperation and involvement

Because the activities of the WMP are of value to states, cities, counties, and other government agencies, funding for the program could be derived from pooled funding by AASHTO, FHWA, National Association of County Engineers (NACE), American Public Works Association (APWA), defense conversion grants, and industry.

At its July 1994 meeting, AASHTO Highway Subcommittee on Maintenance (SCOM) endorsed the winter maintenance scanning tour recommendations for establishing a winter maintenance program. An action plan (Appendix A) that outlines the scope and objectives of the winter maintenance program along with proposed duration and estimated cost was prepared by SCOM and submitted to the AASHTO Standing Committee on Highways (SCOH). SCOH endorsed the action plan and submitted an administrative resolution to the AASHTO Board of Directors supporting the establishment of a winter maintenance program. The resolution (Appendix B) was approved by the Board of Directors at its November 1994 meeting. The resolution also endorsed the concept of establishing a voluntary AASHTO Snow and Ice Pooled-Fund Cooperative Program to support the program.

ACKNOWLEDGMENT AND FURTHER INFORMATION

The information contained herein was prepared based on a compilation, by Dr. Rand Decker of the University of Utah, of information furnished by members of the scanning tour and additional information provided to NCHRP by members of the scanning tour and AASHTO. Readers desiring further information on the tour findings may contact Mr. Leland Smithson, Office of Maintenance, Iowa Department of Transportation, 800 Lincoln Way, Ames, IA 50010.

APPENDIX A

A Proposal to the AASHTO Standing Committee on Highways for the Establishment of a National Winter Maintenance Program (NWMP)

submitted by

Don Lucas, Chair
AASHTO Highway Subcommittee on Maintenance

November 11, 1994

PROBLEM STATEMENT:

The direct costs of snow and ice control on the U.S. highway system consumes a staggering amount of money; over $1 1/2 billion a year. Furthermore, these expenditures do not include the indirect costs associated with corrosion, water quality degradation, and other environmental impacts which total to well over $5 billion a year. Optimization, leading to even a small increase in efficiency or effectiveness, will lead to significant savings, improved mobility, and reduced environmental and societal impacts.

An International Winter Maintenance Technology Scanning Tour was organized jointly under the auspices of the Federal Highway Administration's International Outreach Program and the National Cooperative Highway Research Program to examine snow and ice control operations in Japan and Europe for technology with potential for domestic application. The Scanning Team travelled to Japan and Europe in the late winter of 1994, and discovered important differences in snow removal equipment, anti-icing, and deicing materials and methods, weather monitoring, winter hazard mitigation, and road user information services.

Many of these winter maintenance technologies are appropriate for application in U.S. domestic environments and have the potential to provide the cost savings and benefits sought. To become accepted into practice in the U.S., these winter maintenance technologies will require rigorous operational acceptance testing and evaluation in an operational setting commensurate with that found in specific states and municipalities. A center and process to accomplish this testing, demonstrations, and dissemination of the results and conclusions are needed. A lack of such a center is one cause of the great disparity in the styles and quality of winter maintenance as it is performed by various, often adjacent states and municipalities.

PROPOSED SOLUTION:

It is the primary recommendation of the International Winter Maintenance Technology Scanning Tour that a National Winter Maintenance Program (NWMP) be developed. A principal mission of the NWMP will be to assure that the requisite testing and evaluation of potentially implementable winter maintenance technologies are performed and that the results of these efforts are presented and disseminated in such a manner that modern winter maintenance technologies are easily understood and integrated into individual state and municipal operational programs. Beyond this principal mission, the NWMP should work toward establishing a systems approach to snow and ice control in the United States, one involving the vehicle, the driver, and the equipment and practices for managing roadway and bridge snow and ice.

The goals of the proposed NWMP are simple and concise: sustain or improve levels of winter maintenance service with significant cost/benefit improvements; provide an enhanced level of environmental protection; and place technology in service on operational maintenance sections within two winter seasons.

OBJECTIVES:

In order to achieve the objectives of this program, a NWMP steering committee should be formed comprised of representatives from various transportation funding agencies to advise and guide the activities of the NWMP, help coordinate demonstrations, and perform other administrative functions. Initially, this committee may include members of the International Winter Maintenance Technology Scanning Tour members.

The staff of the NWMP is proposed to consist of an executive director and ultimately perhaps three full time employees. These personnel might be provided in several ways and will provide the components necessary for successful implementation of the plan, including: 1) Implement the directives of the management body of the NWMP, train and provide test/evaluation methodology to the participating maintenance section personnel; 2) Evaluate the results and measure the improvement in winter maintenance; and 3) Disseminate the results and information on the successful projects and lessons learned from those where anticipated benefits were not realized. An integral element of this dissemination effort will include "marketing" those successful technologies into routine operational practice.

It is envisioned that the NWMP organizational structure could also serve as a model for similar activities for other maintenance areas. New technology could come from international and domestic sources.

FUNDING:

A critical element of this proposal is to achieve and maintain a funding base. Since the tasks of the NWMP include those of value to states, cities, counties, and other governmental agencies, funding should reflect this participation and be developed from multiple sources. Potential pooled funding opportunities include; AASHTO, FHWA, NACE/NACO, APWA, defense conversion grants, and industry.

PROJECTS AND ESTIMATED COSTS:

Seven projects have been identified for evaluation (rear delivery snow blowers; innovative snow plows and snow plow accessories; finer NaCl gradation and corresponding pre-wetting equipment; road user information centers; winter motorists natural hazards mitigation project; fixed snow and ice control liquid spray system; and global technical information exchange). Program cost is estimated at about $5 million over the first three years. The duration and cost of the program will depend upon several factors, including weather and the interest of the participants.

# # #

APPENDIX B

As approved by the AASHTO Board of Directors on November 13, 1994

ADMINISTRATIVE RESOLUTION AR-3-94
TITLE: ESTABLISHMENT OF WINTER MAINTENANCE PROGRAM

WHEREAS, state, county and city transportation agencies across most of the nation are commonly faced each winter with the need to control snow and ice on their highways and roads, and conditions such as occurred in the winter of 1993-94 can raise severe safety hazards for those who are travelling; and

WHEREAS, while public sector transportation agencies and private sector companies in the United States have developed and applied an array of practices and techniques for snow and ice control to alleviate winter hazards and make our highways, roads and streets safer for travel, the officials of these agencies are continually seeking better ways to handle snow and ice problems; and

WHEREAS, in an effort to seek such better ways of snow and ice control, under the sponsorship of AASHTO's National Cooperative Highway Research Program (NCHRP Project SP20-36) and the Federal Highway Administration's International Outreach Program, a group of state and local government winter maintenance experts, together with representation from the Federal Highway Administration, was constituted as a Scanning Team and conducted an International Winter Maintenance Technology Scanning Tour in early 1994, visiting winter maintenance road officials in Japan and Europe; and

WHEREAS, technology and winter maintenance systems were observed by the Scanning Team during the Scanning Tour that are not now used in the United States, and which the team members believe might be of significant benefit to Americans; and

WHEREAS, the Scanning Team developed a proposal for a Winter Maintenance Program, one purpose of which would be to conduct rigorous operational acceptance testing and evaluation of international winter maintenance technologies to determine their value for use in the United States, and to support introduction of those technologies that show promise of success in our nation; and

WHEREAS, the Scanning Team has presented its findings and its proposed Winter Maintenance Program to the Highway Subcommittee on Maintenance, which has endorsed the proposed Program; and

WHEREAS, on November 12, 1994, the Standing Committee on Highways considered the recommendation of its Subcommittee on Maintenance, and based thereon adopted this Proposed Administrative Resolution and agreed to forward it to the AASHTO Board of Directors with a favorable recommendation:

NOW, THEREFORE, the Board of Directors of the American Association of State Highway and Transportation Officials, having considered the report of the Scanning Team and the recommendations of the Standing Committee on Highways, does hereby adopt this Administrative Resolution, approving the following Winter Maintenance Program:

WINTER MAINTENANCE PROGRAM

1. AASHTO subscribes to the concept that Member Departments, and appropriate agencies in the nation's counties and cities, should consider developing and adopting for their respective jurisdictions a system

concept for snow and ice control on their highways, roads and streets, addressing the vehicle, the driver, and the equipment and practices for managing roadway and bridge snow and ice, and designed to assure that the best technologies in the world are properly and effectively used in the United States.

The goals for such a system concept should be to:

- sustain or improve levels of winter maintenance service with significant cost/benefit improvements;
- provide an enhanced level of environmental protection; and
- increase the safety of driving under winter conditions.

2. The AASHTO Board of Directors supports establishment of a project under the National Cooperative Research Program (NCHRP) to develop a comprehensive guide for establishing a systems approach to snow and ice control that addresses the vehicle, the driver, and equipment and practices for managing roadway and bridge snow and ice, for use by Member Departments and local governments to provide them guidance suitable for their geographic and weather conditions.

   The AASHTO Board of Directors recommends that the first phase of this effort begin as soon as possible, by utilizing funding under NCHRP Project 20-7 to establish a broadly based NCHRP snow and ice panel and conduct a national workshop leading to development of a work program to produce the guide.

3. In order to experiment with snow and ice technology and systems not now in use in this nation, to determine their suitability to the United States and to help introduce the use of those with the most promise, the AASHTO Board of Directors endorses the concept of establishing a voluntary AASHTO Snow and Ice Pooled Fund Cooperative Program, under which testing by AASHTO Member Departments volunteering to sponsor and conduct tests can be supported financially with public sector funds voluntarily contributed by AASHTO Member Departments, Federal agencies, toll authorities, counties and cities.

   To assure fairness and credibility in carrying out such experiments with new snow and ice technology, the AASHTO Board of Directors believes that the Transportation Research Board should establish a Snow and Ice Technical Working Group to help develop protocols for such tests, evaluate their conduct and approve test reports for national distribution under the AASHTO Snow and Ice Pooled Fund Cooperative Program. The Working Group might be formed under an NCHRP project, either that described above or a separate one.

4. The AASHTO President, with the advice of the Chairman of the Standing Committee on Highways and the AASHTO Executive Director, is requested by the AASHTO Board of Directors to establish a standing Winter Maintenance Policy Coordinating Committee to monitor and advise on the development and implementation of the Winter Maintenance Program and the Snow and Ice Pooled Fund Cooperative Program, with membership drawn from AASHTO, the National Association of County Engineers and the American Public Works Association.

5. The AASHTO Executive Director is authorized by the AASHTO Board of Directors to take such actions as are necessary to implement this Administrative Resolution, under the oversight and with the approval of the Standing Committee on Highways, including the authority to establish and manage the AASHTO Snow and Ice Pooled Fund Cooperative Program as a self-supporting AASHTO technical service program.

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