# Japanese and European Winter Maintenance Technology

Leland D. Smithson, *Iowa Department of Transportation*

Snow and ice control operations in the United States differ from those of other countries. A Winter Maintenance Scanning Panel visited Japan and Europe to study these differences. The visits were sponsored by the U.S. Department of Transportation's Federal Highway Administration's Office of International Outreach Programs, the American Association of State Highway and Transportation Officials, and the National Cooperative Highway Research Program of the Transportation Research Board. The panel consisted of six United States managers responsible for snow and ice control operations. They came from federal, state, county, and municipal authorities. General topics of interest to the panel included anti-icing operations, road weather information systems, weather forecasting services, equipment, public information systems, policy, roadway level-of-service criteria, visibility, and environmental issues. The panel visited Japan from March 12 to March 19, 1994, and Germany and Austria from March 20 to March 27, 1994. While in Austria the panel attended the 9th Permanent International Association of Road Congress, the International Winter Road Congress, and the International Road Weather Conference. The panel proposes the development of a winter maintenance program to demonstrate, evaluate, and acceptance-test promising U.S. and foreign technologies. This program should be a joint effort of federal, state, and local authorities with snow and ice control responsibilities.

Japan, one of three countries visited by the Winter Maintenance Scanning Panel in March 1994, deals with complex winter maintenance conditions. Population density, terrain, and weather are the major contributors to these conditions. Japan has a high urban population density. Its population is half that of the United States in an area $1/30$ the size of the United States, with $2/3$ of the area covered by mountains. In addition to the high population density, Hokkaido, the northern island of Japan, receives more than 500 cm (more than 16 ft) of snow each winter. Heavy snowfall and high traffic volumes create difficult snow and ice control conditions.

Studded tires were introduced in Japan in 1962 to provide winter mobility. Before 1962 mobility was achieved by putting chains over summer tires. By the late 1970s nearly all drivers were using studded tires. The studs rapidly eroded the road surface, creating a heavy concentration of dust and causing an air pollution problem. To solve the problem, the Japanese Ministry of Trade and Industry introduced a studless tire in 1982. The government joined with private industry to promote studless tires by offering rebates on new studless tire purchases. The government also provided winter driving training courses. This program changed motorists' driving and buying habits so that today very few vehicles use studded tires and the air is much cleaner.

Snow removal standards were established to make mobility possible without chains and studded tires. Main trunk roads are kept clear of snowpack while lesser-traveled roads are allowed to develop snowpack and ruts several centimeters deep. Trucks and plows similar to those found in the United States are used on the main roads, and motor graders with serrated blades, scarifier, or milling heads are used to smooth and texture snowpacked and rutted local streets. Sand (because of air pollution problems) and salt (because it costs $200 per short ton and contributes to groundwater problems) are used very sparingly.

Japan has developed some unique high-performance snow-control equipment to combat the 500 cm of snowfall

the country receives each winter. The Hokkaido Development Bureau used a partnering relationship with private companies, universities, and research institutes to produce heavy-duty snow-removal trucks, plows, blowers, and blower/loaders. The use of mechatronics (joysticks, display panels, and video cameras) makes possible one-person operation of a three-plow (forward, underbody, and rear plows) heavy-duty truck. An open-vane snowblower auger allows for cutting through and loading hard-packed snow. Packed and plowed snow is hauled to snow-melting facilities or stored outside the city in huge piles, which melt during the following summer. Snow-melting facilities use warm effluent water from the wastewater treatment plant to melt the snow. The result is an environmentally sound, colder effluent entering the river water.

Japan uses an advanced global positioning satellite (GPS) system to track vehicles and provide location information for management systems. Nearly every government vehicle that transported the panel in Hokkaido used GPS technology to control a video display of the vehicle's position and direction of travel on a moving screen grid background.

## European Winter Road Technology

The panel visited road maintenance facilities in Germany and Austria. They found that roads, bridges, equipment, and support facilities in Japan and Europe were of high quality and well maintained. Fuel taxes in excess of $2 per U.S. gallon and tolls of approximately 25 cents per kilometer (combined with a $1.50 terminal fee) provide an excellent funding base for roadway construction and maintenance. The equipment display at the Permanent International Association of Road Congresses meeting in Seefeld, Austria, was the largest display and demonstration in Europe. Snowblowers, plows, trucks, loaders, and spreaders demonstrated advanced technology and greater capacity than found in the United States.

The price of salt in Europe is about the same as in Japan ($200 to $300 per short ton). Both European and Japanese authorities use chemicals sparingly and prewet salt at the spinner with brine or liquid calcium chloride to reduce deicing chemical loss from the road surface and speed up the melting process. Hopper spreaders are commonly designed with plastic liquid storage tanks in the sloping undersides. Many have fifth-wheel sensing to monitor chemical spread rate with improved accuracy. Japanese and European snowplows are usually heavier than U.S. plows and are often made of independent 1-m sections to improve conformance to pavement cross section or varying crown. The cutting edges incorporate tripping action and are made of metal, plastic, or rubber. Foldout wings are used to extend plowing width. To reduce snow overspray and increase operator visibility, a canvas snowshield is installed 30 to 50 cm above the snowplow. This shield traps the snow spray and forces it under the truck.

## Winter Traffic Management Systems

Roadway weather information systems in Europe and Japan provide impressive amounts of information to road maintenance operators and the motoring public. The typical climate sensors monitor ambient air and pavement temperature, wind speed and direction, humidity, and deicing chemical concentration. This information is brought to a central processing and control station via land line or radio data link. The traffic management center also makes extensive use of video monitoring of traffic and roadway conditions. Experienced meteorologists are on staff at these management centers. The dominant intervention feature of these systems is the ability to remotely change the speed limit and information signs on a section of roadway or selectively close or limit access to sections of roadway from the management center.

The traffic management center is also equipped to handle automated call-down for locally managed emergency services such as fire, ambulance, and police. In addition to the roadway weather sensors and imagers, the Construction Machinery Engineering Center of the Hokkaido Development Bureau has a winter maintenance information vehicle under development. This vehicle has a suite of sensors and visibility imagers on board, allowing a roving assessment of roadway weather and pavement conditions. Among the sensors' capabilities is infrared imaging of pavement and pavement friction. The ability to link the information from this winter maintenance management vehicle to a central location via radio is an integral element of this novel system.

In Europe and to an even greater extent in Japan, the motoring public is actively educated about current and anticipated winter driving conditions and winter maintenance operations. One motorist information center the panel visited had nine television monitors with the latest road and weather information, plus dial-up information for hundreds of monitoring stations along the national expressways.

## Intelligent Vehicle Highway Systems for Winter Motorists

A major thrust in traffic management in Japan is the integration of intelligent vehicle highway systems technology into the vehicle fleet. Though not the dominant force in the introduction of this technology, winter maintenance and winter driving hazard elements are planned for this

future system. These include intermittent/minimum zone mod communication (I/MZMC) coupled with digital route maps that will provide the motorist with information on winter maintenance operations in progress, winter driving hazards, and alternative route planning.

## Technology Transfer

The panel prepared a brief summary of international practices identified with technology transfer recommendations. One of the proposals is the establishment of a winter maintenance program (WMP) where technologies developed in the United States and other countries can be demonstrated, evaluated, acceptance-tested in an operational setting, and compared with the current practices in the United States. The WMP has three goals:

- Achieve equal or improved levels of winter maintenance service with benefit/cost improvements;
- Provide an enhanced degree of environmental sensitivity; and
- Increase the safety of winter driving.

Implementation of a comprehensive WMP will involve four steps:

- Conduct of a national workshop to develop a work program;
- Establishment of a voluntary funding pool for snow and ice control;
- Establishment of a snow and ice technical working group to develop test protocols, evaluate testing, and approve test reports for national distribution; and
- Establishment of a policy coordinating committee—with membership drawn from federal, state, and local organizations—to monitor and advise on the development and implementation of the WMP.

Candidate technologies and policies identified by the panel for evaluation by the technical working group are as follows:

- Snow and ice control: Japanese rearward (one-lane) snow-conveying rotary snowplows, European spreaders with prewetting equipment and aerodynamic tailoring, European snowplows, and improved anti-icing and deicing materials and application management;
- Winter maintenance management systems: improved roadway/weather information system technology, coupling weather information with GIS/GPS, improved road user information systems, and fleet management;
- Blowing snow and avalanche hazard: blower-type snow fence demonstration project and hazardous-highway traffic-management systems demonstration project; and
- Policy: translation of foreign-language snow-engineering manuals, work process management in winter maintenance, strengthened public/private sector partnering, and public education, cooperation, and involvement.

The winter maintenance policy coordinating committee and the snow and ice technical working group will actively develop research problems statements and provide direction for further winter maintenance research.

## Summary

Both Japan and Europe provide road users with a higher level of service on major highways than does the United States. Environmental sensitivity is emphasized in Japan and Europe. Japan uses public/private partnering in achieving winter maintenance technology advances, and achieves public cooperation in dealing with winter's perils through education and citizen involvement. The advanced international technology used by Japan, Germany, and Austria can be economically transferred to domestic use through the proposed winter maintenance program.