

Castelrotto Meeting of 8th December 2000

ELECTRONICS AND COMPUTER TECHNOLOGY IN ROADWAY SAFETY: INNOVATIVE MANAGEMENT STRATEGIES FOR WINTER ROAD MAINTENANCE

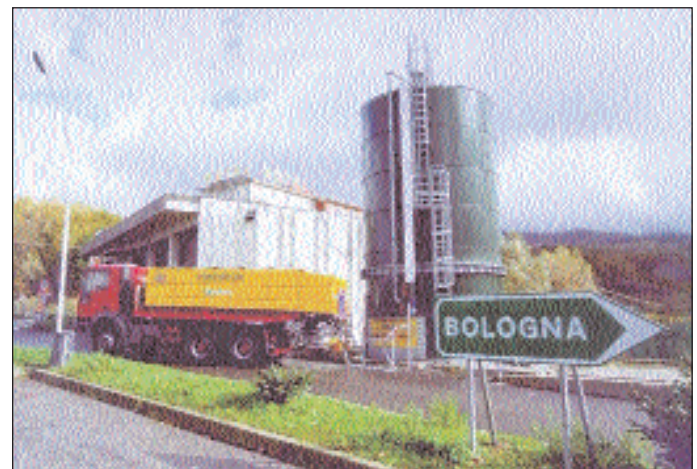


by Noris Strappazon*

Description of facilities and technologies

Two types of facilities with different capacities were chosen according to the sites where they would be installed and to their operating requirements:

- ◆ Large capacity (140 cu m) vertical storage modules built entirely in vitrified steel, whose resistance to corrosion of the deicers, solid or liquid, have been widely demonstrated and statistically proven over their 30 years of use. Because of their high storage capacity, it was decided to use them at the Snow Station of Rioveggio and Roncobilaccio on the rigorous section of motorway crossing the Apennines between Bologna (Emilia-Romagna) and Florence (Tuscany) on the Emilia side.



Today's modern society is characterised by a pressing need to move goods and people as quickly and safely as possible. To help meet this need, the chief goal of administrations or companies responsible for managing roadways is to offer a more effective and reliable maintenance service.

Autostrade SpA, which directly oversees approximately 2,800 km of the Italian motorway network, is well aware of the problems inherent in this effort and has put into action several programs, not the least important of which places focus on winter road maintenance -- specifically the management of chemical deicers, the equipment used for their storage, and the spreading of these substances on the road. For this reason, the Florence section of motorway, known for the orographic characteristics of the territory and for an intense and constant flow of traffic year round (with peaks up to a daily average of 45,000 vehicles on both carriageways, 32% of which categorised as heavy traffic), has adopted advanced technologies to ensure prompt, high quality maintenance operations, determining factors for ensuring rapid and safe travel also during the winter season. Employing solutions such as calcium chloride - the most effective deicer in extreme weather conditions and emergencies - has called for the need to set up regular and strategically placed storage facilities along the tract. To this end, the Società Agristrade based in Bolzano was commissioned to supply for the section 15 facilities with a storage capacity of 560,000 litres that can equip tank truck road sprinklers and spreaders equipped with a salt humidification system.

- ◆ Horizontal storage modules with a capacity of 40 cu m constructed in fibreglass (also a corrosion-proof material) located in the following points:

A1 Motorway - Apennine section ("A1 Nord")

Snow Stations of Sasso Marconi - Barberino - Calenzano





A1 Motorway section from Firenze Nord - Chiusi ("A1 Sud")

Snow Stations of Firenze Sud - Incisa - Romita (two facilities) - Valdichiana - Chiusi

A1 Motorway section from Firenze - Pisa Nord ("A11 Mare")

Snow Stations of Pistoia - Serravalle - Lucca

These facilities, researched and developed using advanced technologies, boast a high degree of automation and guarantee optimum levels of reliability and safety, yet inexperienced personnel (i.e., sub-contracted personnel not directly employed by the Company) often forced to work at night and in adverse weather conditions are able to learn the procedures immediately.

The facilities are computerised to the extent that they feature a highly developed set of remote controls for access to users and the manufacturer in order to optimise operation and achieve the highest standards of reliability.

To achieve these objectives, the facilities have been installed with:

- ◆ Electrical control board including powerful process controller interfaced to the inverter
- ◆ Hydraulic system for handling the saline solutions
- ◆ User-friendly control panel
- ◆ Remote control
- ◆ Remote assistance

Electronic control board

Thanks to the combination of the process controller/inverter, the electronic control board enables full automation of all saline solution handling operations through the use of special software.

The electric pump is started up on the control panel according to the function selected by the operator and is pre-programmed at different motor rpm according to the different pressures and flow rates demanded of the pump. At the same time, the absorption of current is optimised and the system automatically carries out following: the

loading of the silo and the circulation of the solutions by delivering the maximum pressure and maximum flow rate; the loading of the tank truck road sprinkler by supplying a flow and pressure slightly reduced to allow rapid execution of this operation; the loading of the small tanks of the dry salt spreaders installed with a humidification system, delivering a greatly reduced flow and pressure in order to avoid overpressures and hazardous overflows.

The capacity and flexibility of the inverter enables instant modification of the operating parameters of the elec-

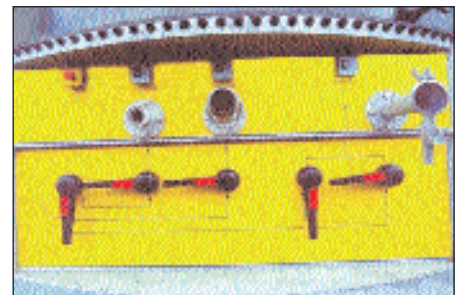
tric pump by adapting them to any new requirements. This also ensures optimum efficiency of the electric pump's motor and avoiding overheating and unnecessary strain on the motor, while optimizing power consumption.

The management software also contains a feature for automatic circulation regardless of what is input manually by the operator: the electric pump is activated cyclically during the intervals when the facility is not in use in order to maintain a correct mixing of the contents and as a result to limit the deposits of insoluble materials on the bottom of the tanks, which are known to be very substantial in CaCl₂ solutions. This important feature greatly reduces the risk of clogging in hydraulic system and electric pump.

Hydraulic system for handling saline solutions

This system comprises a special electric pump equipped with a stainless steel shaft and bronze impeller to resist the accentuated chemical aggression of the CaCl₂ solutions.

It also includes a pressure switch to safeguard it from involuntary "dry" start-ups and the resulting damage, as well as a system of intake, delivery and circulation pipes constructed in corrosion-proof material (PVC). A set of corrosion-proof throttle valves (in polypropylene) with a large handle enables gradual opening and closing, thereby reducing the risk of water hammering, which can compromise the integrity of the pipes and, most importantly, the electric pump.



Control panel

The control panel is positioned outside the storage modules at a height allowing easy and safe access by the operator. Built in an identical version for the two different types of facilities (40 cu m and 140 cu m) and bearing a silk-screened plate in the Società Autostrade colours of yellow and blue, it has been designed with simple graphics that are easily comprehended even by outside personnel who may not have received specific training. The operator therefore receives "guidance" while performing the service: he need only to carry out the manoeuvres for setting up the facility, such as opening the intake and delivery gate valves pertaining to the selected procedure, make connection to the corresponding hydraulic

quick coupling and press the start-up button. All functions are well marked and easily identifiable by clear, simple graphics. A mushroom-head stop button and/or emergency button with rotation resetting enables interruption of the flow.

Remote control

In recent years, enormous technological developments in the field of electronics and data communication systems have resulted in advanced management options and remote controls.





Peripheral Control Centres	Position no.	Monitoring station	Monitored remote facilities	
	1	PIAN DEL VOGLIO	Sasso Marconi	40 m ³
			Rioveggio	140 m ³
			Roncobilaccio	140 m ³
	2	BARBERINO	Barberino	40 m ³
			Roncobilaccio	140 m ³
	3	CALENZANO	Calenzano	40 m ³
	4	INCISA	Firenze Sud	40 m ³
			Incisa	40 m ³
	5	AREZZO	Romita 1	40 m ³
			Romita 2	40 m ³
	6	CHIUSI	Valdichiana	40 m ³
			Chiusi	40 m ³
	7	MONTECATINI	Serravalle Sud	40 m ³
			Pistoia	40 m ³
	8	LUCCA	Lucca	40 m ³
	MAIN CONTROL CENTRE	DIREZIONE DI TRONCO DI FIRENZE	ALL	

Management software

The architecture of the interactive remote control software, developed for a Windows environment, is powerful and versatile and enables managers of the service to query the remote facilities using a menu that can activate the telephone connections between the Control Centre and the peripheral facilities, and as a result to obtain updated information regarding their filling status and eventual loading and discharge operations that have been performed since the date of the last connection.

The queries can be of three types: single call-up, call-up for groups of facilities (A1 Nord section - A1 Sud section - A11 Mare section) or a general call-up of all controlled tanks.

The system activates the direct connection with the module or groups of storage modules, acquiring all data relative to the quantity of solution stored and its eventual handling (loading and discharge).

The software will make three automatic call attempts; as soon as connection is made, a special box adjacent to the call button turns red (instead of remaining green) to confirm that connection has been made.

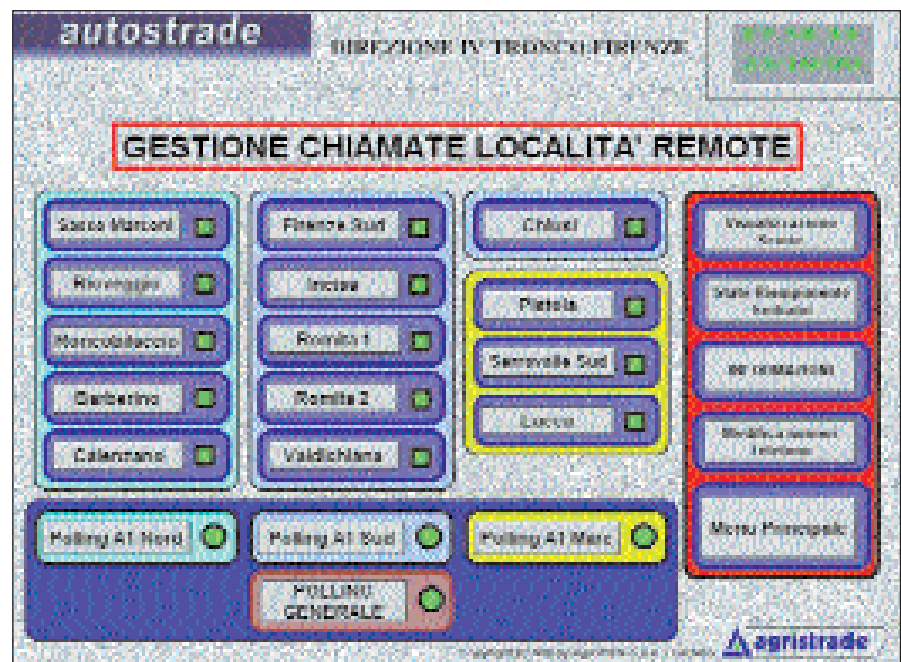
If connection is not made, a crossed-out telephone is displayed in the same position; however, the call can be tried again.

At the end of each call, a set of univocal archives for each facility is automatically generated and stored, with record of all data on the loading and discharge operations.

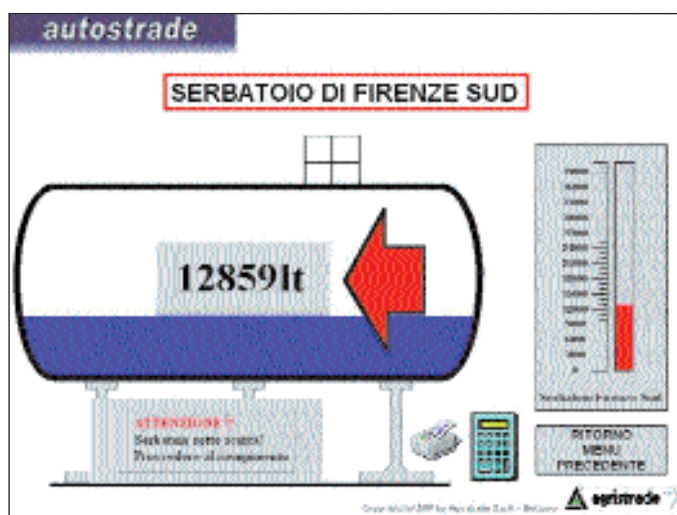
The importance of using of data concerning the status of the tanks from a remote location and in real time has stimulated further development for the facilities. Nine remote control stations were hence set up to monitor peripheral facilities, specifically a main control centre at the Direzione di Tronco di Firenze (Florence motorway section management headquarters) for an overall supervision of all 14 tanks and 8 secondary Control Centres at 8 Maintenance Stations, which perform monitoring of the assigned facilities as exemplified in the following table.

Each station is equipped with a PC and dedicated remote control Agristrade software, customised according to the instructions provided by the Technical Management of Florence, which enables management of the communications and data transmissions from the peripheral units.

The peripheral facilities, for their part, have been previously installed with a special sensor for measuring the pressure of the liquid inside the tanks, as well as a software program that enables the automatic chronological storage of the operations (filling and withdrawal) performed by the facility in special memory areas that can be queried from a distance. This allows a constant availability at any of the remote monitoring centres and updated report on the filling status of all the tanks, in addition to the statistical and control management on the use of the facilities.



The software also allows managers to modify at any time the telephone numbers of each remote system. The monitor displays the tank's filling status (general or individual) with indication of any understocked tanks. To view the actual quantities in the tanks, this function is enabled only after the call-up(s) are performed.



*Technical Director of Agristrade SpA