VII. EVT-300 COMMISSIONING

The EVT-300 CWS radar system is marketed primarily through heavy vehicle manufacturers for new truck deliveries, but it is also offered as an aftermarket system with options depending on the customer application. For the ADOT research snowplows, the aftermarket unit was the only possible approach. However, the off-the-shelf design would have to be modified due to the geometry of the snowplow equipment, and this became a long and complicated process.

ADOT's original Eaton VORAD EVT-300 unit was procured in Phase Two of this research for Gray Mountain's snowplow F342. As the ADOT-3M snowplow, this truck was set up to functionally duplicate the Caltrans ASP as much as possible so that trainee operators would have comparable driving experiences with both snowplows. Although the Caltrans design had integrated the CWS radar into the ASP's lane-position display, the goals and functions of the warning systems as installed on each snowplow were the same.

Unfortunately the ADOT-3M snowplow experienced commissioning problems soon after the CWS radar installation was completed in November 2000. The series of installation problems are detailed in the ATRC Phase Two project report. [2] This snowplow's forward radar system had hardware problems and was not functional in the first winter, although the side warning was effective. This unit was restored to full operation for the subsequent phases of the project, and the EVT-300 has performed effectively on snowplow F342 through the past two winters.

As described earlier, the research project focus was shifted to on-board systems in mid-2002, and three additional off-the-shelf Eaton VORAD units were assigned to regional maintenance yards at Seligman, Chambers, and Flagstaff.

EVT-300 COMMISSIONING ACTIVITY

The basic EVT-300 CWS radar system employs a single antenna that is normally mounted at bumper height to detect all objects and obstructions directly ahead of the vehicle. This antenna mounting position provides an unobstructed view down the roadway of any obstacle for the full range of the system. It is also the only position in which the SmartCruise adaptive cruise control feature can function effectively.

A different, non-standard mounting concept was required for snowplow trucks. In the case of the ADOT equipment design, the snowplow blade is nearly six feet above the road surface in the travel position, so a rooftop mounting was the only practical approach. This antenna location still left a minor blind spot in antenna coverage at the road surface for roughly 30 feet ahead of the snowplow blade, and Eaton VORAD initially had concerns about that gap (see Figure 13).

After some discussions, and based on the success of the initial mounting and CWS calibration, it was found that the system functioned completely effectively with the antenna in this position, where it approximates the driver's own field of view over the plow blade from the truck cab. The original Gray Mountain antenna unit was mounted on a standard light bar and worked well, while the three newer systems procured for Phase Three were mounted directly to the cab roof with a fabricated bracket.

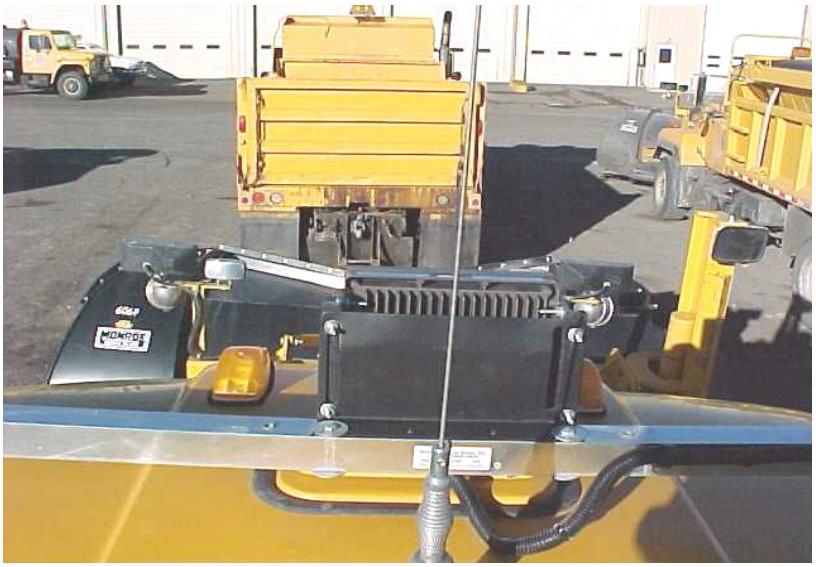

Figure 13. Radar Antenna on Bar: View of Roadway Over Snowplow Blade

With the successful installation of four EVT-300 units for the 2002-03 winter, ADOT was in a position at last to evaluate the collision warning radar concept across northern Arizona under winter storm conditions. The research snowplows were assigned to four routes, including two sites along I-40 in open wind-swept high desert terrain in both eastern and western Arizona. A third plow would patrol on I-40 in the forested areas both east and west of Flagstaff, and the fourth would plow US 89 over a 7,200-foot pass at Sunset Crater to the northeast of Flagstaff.

Installation Schedule

As noted elsewhere, the ADOT decision to conclude the Caltrans test program and shift to on-board systems was confirmed in TAC surveys and meetings in late July 2002. The procurement of the new commercial warning systems began in early August, in a complex internal process. With regard to the Eaton VORAD radars, there were issues as to vendor status, contract basis, ADOT plow truck compatibility, and factory installation support for the units.

The fiscal issues were resolved by October, and orders placed. Eaton VORAD's plant delivered the radar units in mid-November. As might be expected, scheduling the selected snowplows for two or three days of travel and installations in Flagstaff was not easy. While mid-December was the goal, January was the reality due to snowstorms, holidays, and limited staff resources.

Additionally, there were initial calibrations needed with Eaton field support for snowplow F342 to refine its performance and to provide a base case for installing the new CWS units. The three additional EVT-300s were actually installed between January 14 and February 4, 2003.

TRAINING & TESTING

The Eaton VORAD EVT-300 is a sophisticated warning system that has significant potential to improve driver safety year-round in darkness and conditions of poor visibility. As noted earlier, the Eaton system requires the driver to be fully informed and aware of the range of warning tones

and lights, and what message each progressive warning conveys. With a radar range of approximately 350 feet, and with vehicle speeds of 100-plus feet per second in good weather, driver interpretation and action must be instinctive. For ADOT to consider employing CWS on its fleet units in the future, the system must prove itself to be effective, simple and reliable.

Eaton provides a wide range of EVT-300 technical and training materials to its customers. These resources include detailed installation, troubleshooting, and driver reference manuals and training aids, including an operator's video filmed in Arizona. For the ADOT snowplowing application and evaluation effort, the Eaton materials were effective and comprehensive.

The ATRC utilized these materials extensively to introduce new drivers to the EVT-300 system, beginning with previews and feedback from the project TAC members. Videos and operator's manuals were provided to each participating Org (local maintenance camp or yard) with the radar system, and to each district's Equipment Services shop as well. It was emphasized repeatedly that all snowplow drivers in each project-partner Org should be introduced to the system, in case they were assigned in mid-season to the research snowplow. The primary drivers were requested to make frequent dry-road familiarization runs on their assigned snowplow routes.

This extra effort would help develop driver confidence, and help identify any roadside features or conditions that might repeatedly produce false alarms or missed warnings. With foreknowledge of any problem sites, drivers could be more reactive to any other CWS warnings.

The ATRC's 2002-03 winter testing plan, due to the wide dispersal of the four test plows, was not based on group training and group evaluations. It depended instead on feedback at the local level using snowplow shift activity reports, system incident reports, and periodic driver surveys. The season's evaluation plan and results are detailed further in later sections of this report.

2002-03 CWS RADAR OPERATIONS

As noted above, all four project snowplows were equipped with operational EVT-300 radar units by early February. More than half of the season's snowfall was still yet to come, so valid field testing efforts in operational conditions were certainly still possible.

ADOT's in-house PECOS data management system allows the tracking of winter maintenance activities such as snowplowing, chemical or abrasive applications, and winter storm patrolling. Table 5 shows the extent of evaluation usage for the four project snowplows with Eaton's CWS, while Appendix D provides a complete summary of the storm-related operations and weather observations for both radar and night vision-equipped ADOT plows during the 2002-03 winter.

These figures show that through this winter evaluation activity, ADOT operators acquired more than 70 collective days of snowplow experience in nearly 18,000 miles of highway driving. Only one of the four plows was in commission before mid-January, so the total driving time could have been much higher for a full winter. From the time that all four plows were in service, the Flagstaff region received approximately half of the total snowfall for the season.

No significant performance problems were reported with the Eaton VORAD collision warning radar system during this 2002-03 winter operational testing program. However, the operators' acceptance of the system varied, and their shift activity reports were not consistently completed.

More detailed information on the EVT-300's performance, and on the operators' perceptions of the system, will be provided in later sections of this report.

Table 5. ADOT Winter Storm Activity with EVT-300 CWS Radar

Project 473 Winter 2002 – 2003				
PLOW DATA	F326	F342	F291	F269
MAINT ORG:	Seligman	Gray Mtn	Flagstaff	Chambers
Total Reports:	*13*	*61*	*33*	*16*
System:	Radar	Radar	Radar	Radar
Highway:	I-40	US 89	I-40	I-40
Mileposts:	121–146	420-440	185-230	347-360
Installed:	22-Jan-03	21-Sep-01	14-Jan-03	04-Feb-03
Dates / Miles Summary				
Sum of Miles:	1,830	8,484	4,452	3,021
Use-Days:	10	32	20	11

THE SMARTCRUISE OPTION

The SmartCruise adaptive cruise control feature was also of significant interest to ADOT for its ability to reduce the potential for rear-end crashes. This feature functions in addition to the proximity and closing rate warnings of the basic roof-mounted EVT-300. However, the EVT-300 cannot provide the SmartCruise functions with a rooftop antenna, due to its installation angle relative to the roadway, and the gap in radar coverage at ground level in front of the bumper.

To test SmartCruise on an ADOT snowplow, the project team developed a redundant on-board system with both roof and bumper antennas. The solution was to use one system control processor unit with two wiring harnesses, one for winter use of the rooftop antenna without SmartCruise, and another at bumper level for both collision warning and SmartCruise operation in summer, when the plow blade has been removed.

As described in prior reports, the EVT-300 radar system on F342 was installed in the 2000-01 winter, but the forward antenna was not operational for most of that initial season. The radar system was then repaired and it functioned effectively on the Gray Mountain plow routes through both winter 2001-02 and winter 2002-03, establishing a high level of confidence among the primary drivers. However, it was not until the end of the 2002-03 winter that ATRC and the Flagstaff Equipment Shop were finally able to resolve several key system issues and proceed with the upgrades required for SmartCruise phase of the evaluation later in the summer.

A variety of factors had stalled the full commissioning of the SmartCruise feature on plow F342. The original procurement had defined the basic engine and electrical specifications of this 1999 Mack snowplow truck, and there did not appear to be any problems with initiating the various modifications to the engine control system. When the three new EVT-300 units were purchased, Eaton VORAD provided technical support for those installations in Flagstaff. However, the initial tasks were to recalibrate the forward CWS on F342 as a baseline for the other units, install the required additional hardware, and fully commission the SmartCruise feature for testing.

The installations were to start in mid-December, but a series of storms and the holidays slowed the process. Modifying snowplow F342 with SmartCruise was the first objective, but numerous problems arose. ADOT had acquired diagnostic and calibration software from Eaton but did not have all of the needed system components to utilize it in the equipment shop. The project therefore acquired the necessary Eaton systems card for the shop's ProLink diagnostic system.

As the initial work progressed to install the second bumper-mounted antenna and wiring harness for SmartCruise on F342, further discoveries were made. The truck's engine had been upgraded earlier, but the vehicle computer and engine control computer, while functional, were not equally compatible with the VORAD system. This problem required extensive consultations between ADOT, Eaton, and Mack, and initially there was discussion of replacing the truck's camshaft and turbocharger. This process also delayed the installations of the other three systems into January and February.

Ultimately the Mack factory team determined that reprogramming of F342's engine computer software was possible, and advised ADOT through Eaton as to how to proceed. This was not the immediate resolution, however, as in the interim, ADOT had developed further concerns about doing modifications to individual truck engine control systems. This question was finally resolved in late February for the project snowplow, and the upgrades were completed by the Mack dealership.

From that point, the commissioning progressed and SmartCruise was operational at last on March 11, 2003; ATRC's evaluation of this feature is described in Chapter XIII.