CPRC

CANADIAN POLICE RESEARCH CENTRE

CCRP

CENTRE CANADIEN DE RECHERCHES POLICIERES

TM-I2-94
Railway Evaluation of Emergency Alert

By: G. Forester, NRC
M. Krzyzanowski, NRC
W. Paulette, CP Rail

TECHNICAL MEMORANDUM

Submitted by
G. Forester, National Research Council

May, 1994

NOTE: Further information about this report can be obtained by calling the CPRC information number (613) 998-6343

COMMERCIALLY CONFIDENTIAL

EXECUTIVE SUMMARY

This memorandum describes the February 1994 testing of the prototype device called Emergalert system, built to NRC specifications. The system was evaluated earlier in the emergency vehicle situation which is described in the technical report TR-06-92, "Emergalert Testing".

The main purpose of the project was to evaluate the system in a train and motor vehicle railway crossing situation. The primary objective was to delineate the effective range of the transmitter/receiver combinations when used in the field under a variety of conditions on the CP Rail line - Prescott Subdivision between the city of Ottawa, Canada to Bedel, a small town thirty miles south of the city.

RÉSUMÉ

La présente note porte sur le prototype du dispositif Emergalert créé selon les specifications du Conseil national de recherches du Canada et mis à l'essai en février 1994. Une evaluation du dispositif avait deja été effectée dans un vehicule de secours. Les résultats de cette evaluation sont present& dans le rapport technique TR-06-92 intitulé *Essai du disposifif Emergalert.*

Le but premier était d'évaluer l'efficacite du dispositif dans une situation où un train et un vehicule motorisé s'approchent d'un passage à niveau. Le premier objectif de l'essai était de determiner la portée efficace des elements emetteur et recepteur, dans diverses conditions, sur la voie ferrée de CP-Rail, dans la subdivision Prescott, située entre la ville d'Ottawa et Canada to Bedel, un petit village à trente milles au sud d'Ottawa.

BACKGROUND

Trains approaching level crossings are, by law, obligated to sound an auditory warning. This is done by sounding the train horn. The indication to sound the horn depends on the engineer acting on the designated distance from the crossing and operating the horn. The horn is sounded at all level crossings whether they be protected or not. Accidents have been documented at both protected and unprotected crossings.

At protected crossings with barriers, the fault in accidents most often lies with motorists who ignore the crossing barrier and attempt to go around them and “beat the train”. In the case of protected crossings with visual and audio signals, such as flashing lights and bells, motorists either do not see or hear the warnings, or again “try to beat the train”.

The majority of level crossings in Canada are UNPROTECTED. A significant number of accidents occur at these crossings. Since the accidents at these sites are usually non-recurrent, there is little incentive to upgrade protection at these unprotected sites.

The accident occurrences at unprotected sites usually involve vehicles driving across the track in front of a train, or even into the side of a train. Most unprotected crossings are at rural farm locations or at industrial sites and involve construction vehicles. Unfortunately, we have no information, at the moment, to relate the incidence of accidents at unprotected crossings to night or day use.

Since many of today’s vehicles are soundproofed, and drivers use high quality audio systems and travel in air-conditioned vehicles in summer or heated vehicles in winter with the windows closed, the external audio systems for warning of approaching trains are a disadvantage. Statistics indicate that more than 46% of passenger automobiles sold in Canada in 1988 had air-conditioning systems, implying that they would travel with the ventilation systems operating year round and with the windows closed, creating a partial sound barrier to the outside environment. US statistics indicate that more than 75% of passenger vehicles were sold with the air-conditioning option. The number of vehicles with closed climate control systems has increased since 1988. This has probably resulted in an increased number of collisions between trains and non-suspecting traffic.

THE EMERGALERT SYSTEM

A direct on-board warning system would offset this situation. Housing an on-board receiver sensitive to trains within a defined radius would allow drivers to be instantly aware of the presence of an approaching train. Added by the automobile manufacturing industry as an inexpensive add-on or later as a mandatory device, train crews would be safe in the knowledge that vehicles approaching level crossings would be warned of their presence. The drivers would also be secure in the knowledge that it was possible to be directly informed of approaching trains.

The tested device consists of a low power transmitter operating on a designated frequency. A coded signal is sent out which is received by a receiver in the path of the transmitter, within a designated radius. The receiver contains a logic circuit which, upon reception of the correct coded signal, activates an audio warning alarm and a visual alarm on board the vehicle which, in turn, advises the occupants/driver of the presence of a train in the vicinity.

The simplest version would simply warn of the train's presence. A more advanced version could

1. shut off the radio stereo system in the receiving vehicle, enhancing the warning alarm;

2. indicate a train, fire, police, ambulance, or other designated warning, through the logic circuit and the coded signal;

3. indicate the direction from which the emergency vehicle or train is approaching.

With Emergalert, the protection of the level crossing is a shared process between the railway and vehicular traffic. A signal is sent from the locomotive to the area covered by the crossing. A receiver specific to the transmitted signal then warns the occupant/driver of the vehicle that there is a train in the vicinity of the crossing. There is specificity: no false alarms due to the nature of the coding in the signal and its interpretation by the decoder.

Receivers have been designed, built and tested on motor vehicles in urban settings for Emergalert operation (police, fire, ambulance). The results of this testing is issued as a separate report, TR-06-92, Emergalert Testing.

TRAIN TESTING OBJECTIVES

The two main objectives in this evaluation were:

1. to determine the validity of Emergalert device in the protection of UNPROTECTED and PROTECTED level crossings against train/vehicular collisions;

2. to determine if the device can be used in level crossing protection either as primary or adjunct to existing protection or as stand-alone operation for the protection of crossings.

EMERGALERT TEST CONDITIONS

The transmitter was mounted in the cab of the lead locomotive and used an external magnetic mount quarter wave omnidirectional unity gain antenna placed on the roof of the lead unit. The locomotive surface acted as the ground plane. Power for the transmitter was supplied by a large capacity rechargeable gel cell unit supplying 12 V D.C.

The two receivers were placed in Ford Aerostar Minivans behind the windshield on the dash and had the option of internal antenna configuration or external antenna configuration with a magnet mount omnidirectional antenna on the roof of the vehicles. The receiver units were powered from the vehicles' 12 V D.C. cigarette lighter plugs.

PRELIMINARY TEST AT THE NATIONAL RESEARCH COUNCIL

The effect of power output on the effective emergalert range was tested at the NRC Uplands site to determine the power requirements in the field. The transmitter was placed in the cab of the NRC yard locomotive and the receivers were mounted in a Mercury Grand Marquis behind the windshield on the dash using the internal antenna configuration. The units were powered as described above.

Power output was varied by placing calibrated attenuators at the output of the transmitter in order to limit antenna power to the omnidirectional antenna.

Figures 1 to 5 indicate the effective range and outputs obtained during the initial setup tests. The test area was at the Uplands (Ottawa) location of the Centre for Surface Transportation Technology at the National Research Council of Canada. The transmitter antenna was mounted on the roof of the locomotive situated at the south of building U-90. From this location, concentric circles are drawn at 100 metre increments, with a circle with a cross indicating whether the transmitted signal was received or not. A circle shaded in black indicates that the signal was received at that particular location. The first five figures indicate the trigger reception distance of the 200 milli-watt transmitter with no attenuation, 10 db attenuation, 20 db attenuation, 26 db attenuation and 35 db attenuation respectively.

Based on the above, it was decided to test the units with as little as 2 milliwatts of output power and progressively increase power to 200 milliwatts during the Bedel line testing of Emergalert.

In addition to the calibrated attenuators used at the NRC Uplands facility, power levels were tested using the RF calibration facilities at NRC. The results are shown in Figure 6 indicating the transmitter outputs used in the Bedel Line test.

BEDEL LINE TEST

For these tests, the distance from the locomotive to the crossing was used as the basis for fair-warning by the receiving vehicle. The test vehicle was placed at the level crossing. When the Emergalert was triggered, a verbal signal was passed by VHF radio to the locomotive. The test engineer in the cab of the locomotive noted the distance to the crossing, in feet, from the digital readout in the cab. The test distances at power output levels of 2, 6 and 200 milliwatts are shown in Figure 7.

As indicated in Figure 7, the average warning distances across the 15 level crossing sites for the lowest power used was less than 500 feet. However, at 200 milliwatts, the average warning distances increased to 1500 feet.

CONCLUSION

Three days of testing the Emergalert system on the Walkley to Bedel run demonstrated the potential utility of the device as a level crossing warning device. No failures of the device were encountered. An output power of 200 milliwatts with the present antennae configuration appears to provide adequate warning with a minimum warning distance of 1000 feet.

Since the unit is a proof of concept package, it is expected that re-engineered versions would be robust. Since the definitive frequency allocation is yet to be determined, it is premature to specify output power or the antenna configuration, since these will ultimately be determined by the final design.

It was concluded that:

1. Emergalert can be used as either a stand-alone or adjunct unit.

2. The present proof-of-concept unit demonstrates a capability of producing an adequate warning to vehicular traffic at train/road crossings.

Since the transmitter was functional at all times during the tests, the receivers emitted a warning even when the trains were not at level crossings, such as when the train line was parallel to the road. This problem may be cured by switching on the transmitter for level crossings either automatically or in conjunction with the whistle/horn.
The length of the test train was approximately 30 cars. For longer trains, complete head to tail protection may be afforded by using a tail-end slave transmitter.

The cost of Emergalert could be spread over the private and public sector. The railway might be responsible for the installation/maintenance on locomotives. The public could cover the costs of the receivers in the vehicle. This is estimated to be less than $40 per vehicle. Initially, it could be considered as an add-on, much like the rear window brake light. After this retrofit period, the system could be legislated into mandatory use, at which time mass production and installation costs would be in the order of $10 per receiver.

The proposed Emergalert system would increase public safety. For instance, increased protection by conventional means at all level crossings is prohibitive in cost. These conventional methods include signal lights at crossings, crossing carriers, overpasses and underpasses. With Emergalert, the device as an add-on and inclusion as a legislated safety unit could be shared by both the driving public and government.

Emergalert has the potential for other safety warnings such as school buses and snow plows, to name two. There is a possibility of creating a North American and world standard for these warning devices. A large market exists, if such devices were to become standardized.

With the advent of high speed passenger trains, the need for level crossing protection might disappear because of the dedicated trackbed. However, for the next couple of decades, the continued use of conventional passenger and freight rail traffic will still use the current roadbed, with its current crossing problems. Furthermore, increased rail speed could be accommodated by the appropriate use of this warning system.

ACKNOWLEDGEMENT

The authors wish to acknowledge the following for their assistance in this evaluation:

Mr. Terry MacLeod, Supervisor, CP Rail System, Walkley Yard, and the train crew: Mr. Jim MacKenzie, Mr. Steve Bridson, Mr. Jacques Lamothe and Mr. Andrew LittleJohn; Mr. Ron Senn, Centre for Surface Transportation Technology, National Research Council of Canada.

LIST OF FIGURES

Table 1 Level Crossing Locations

Site Number	Location
0	Walkley Yard
1.	Lester Road
2.	Leitrim Road
3.	Bowesville Road
4.	RR#8 Adam's and Kennedy Lumber Yard
5.	Manotick Station Road
6.	RR#8 West of Manotick Station Road
7.	Osgoode , Main Street
8.	Nixon Drive
9.	RR#4
10.	River Road at Boundry Road
11.	Heckston Road
12.	Highway 16
13.	Highway 43 at Harvex
14.	Van Burren Street, Kemptville
15.	Prescott Street, Kemptville at Kemptville College
00	Bedel

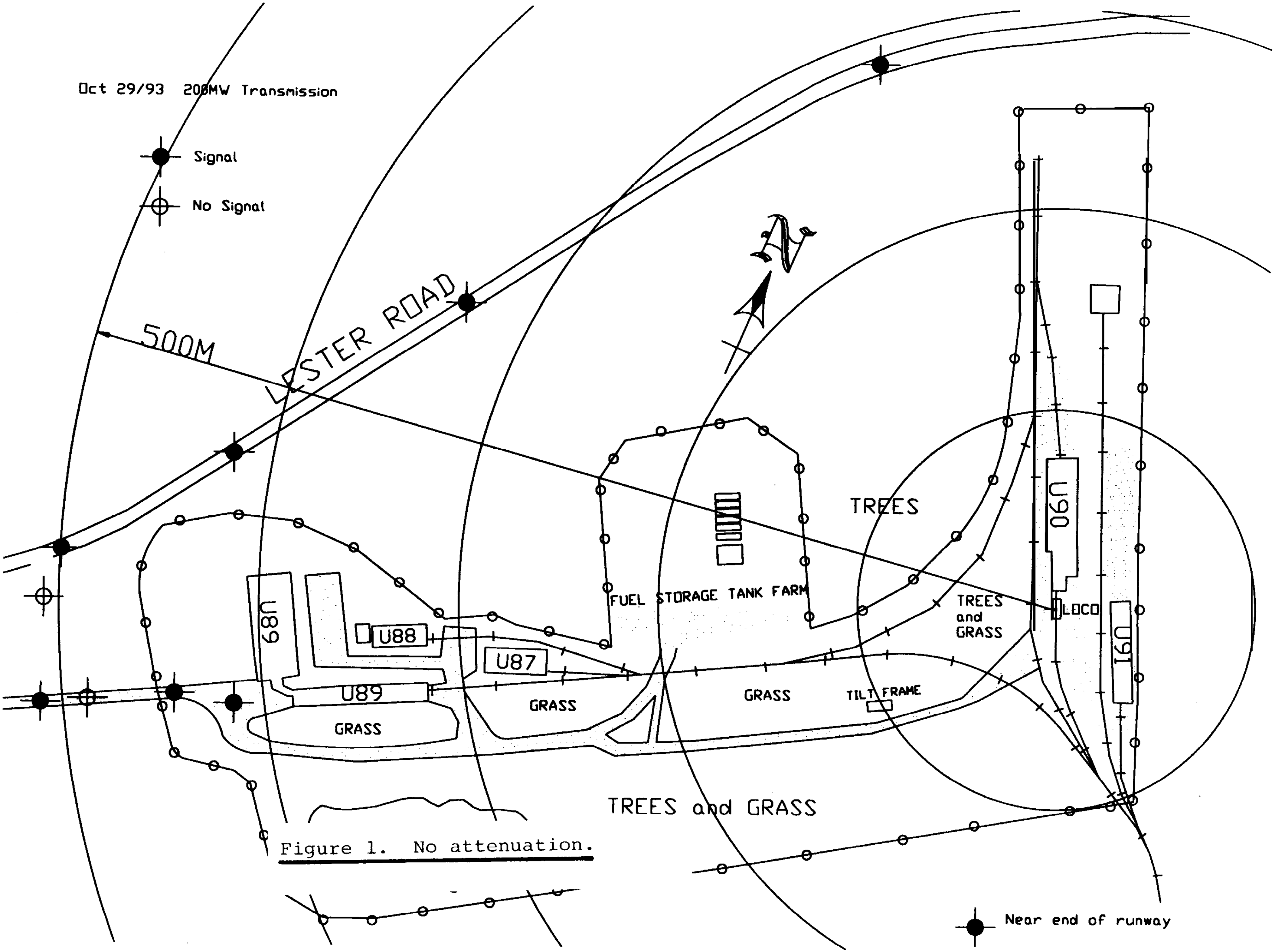

Figure 1. No attenuation.

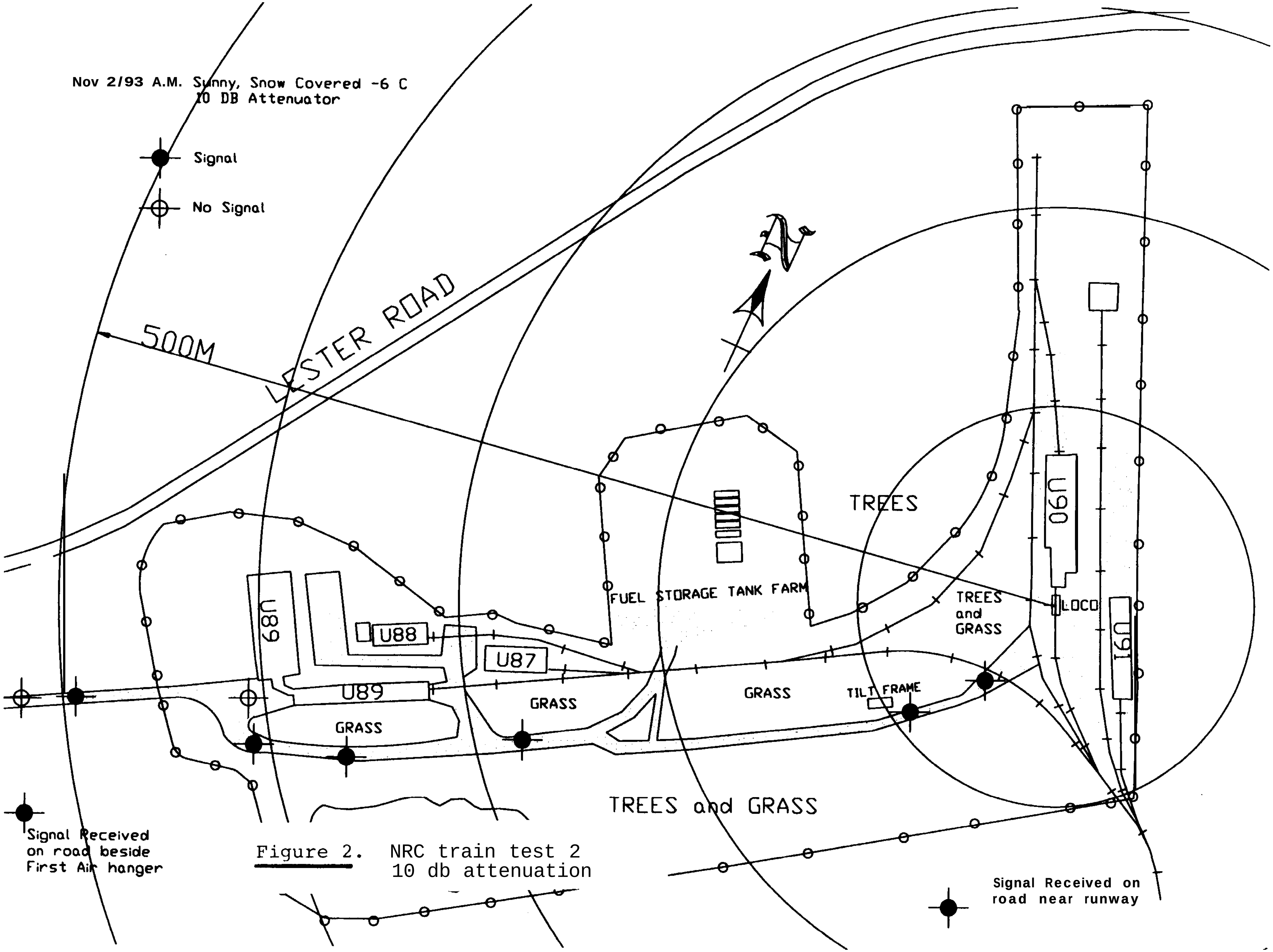

Figure 2. NRC train test 2
10 db attenuation

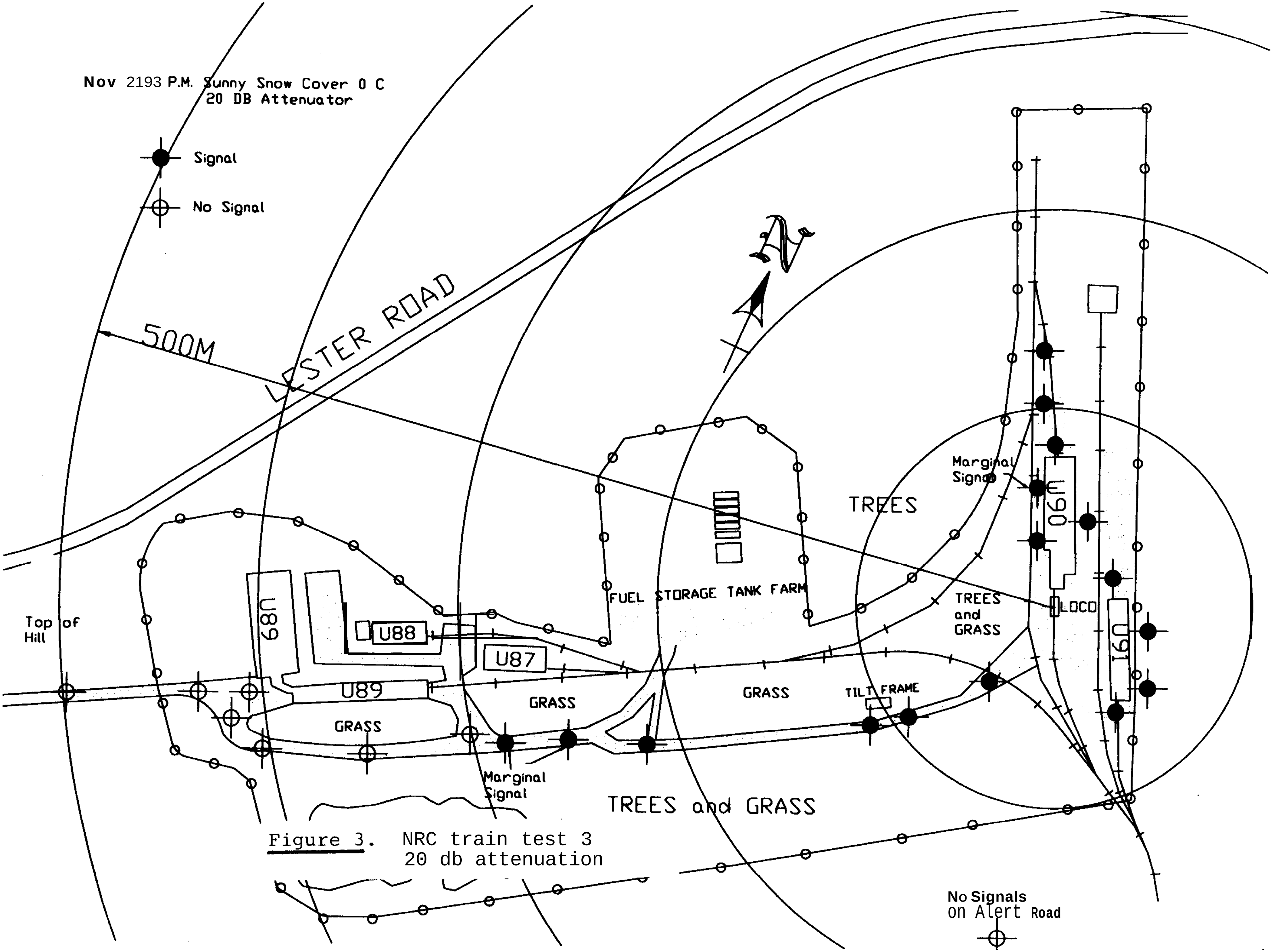

Figure 3. NRC train test 3
20 db attenuation

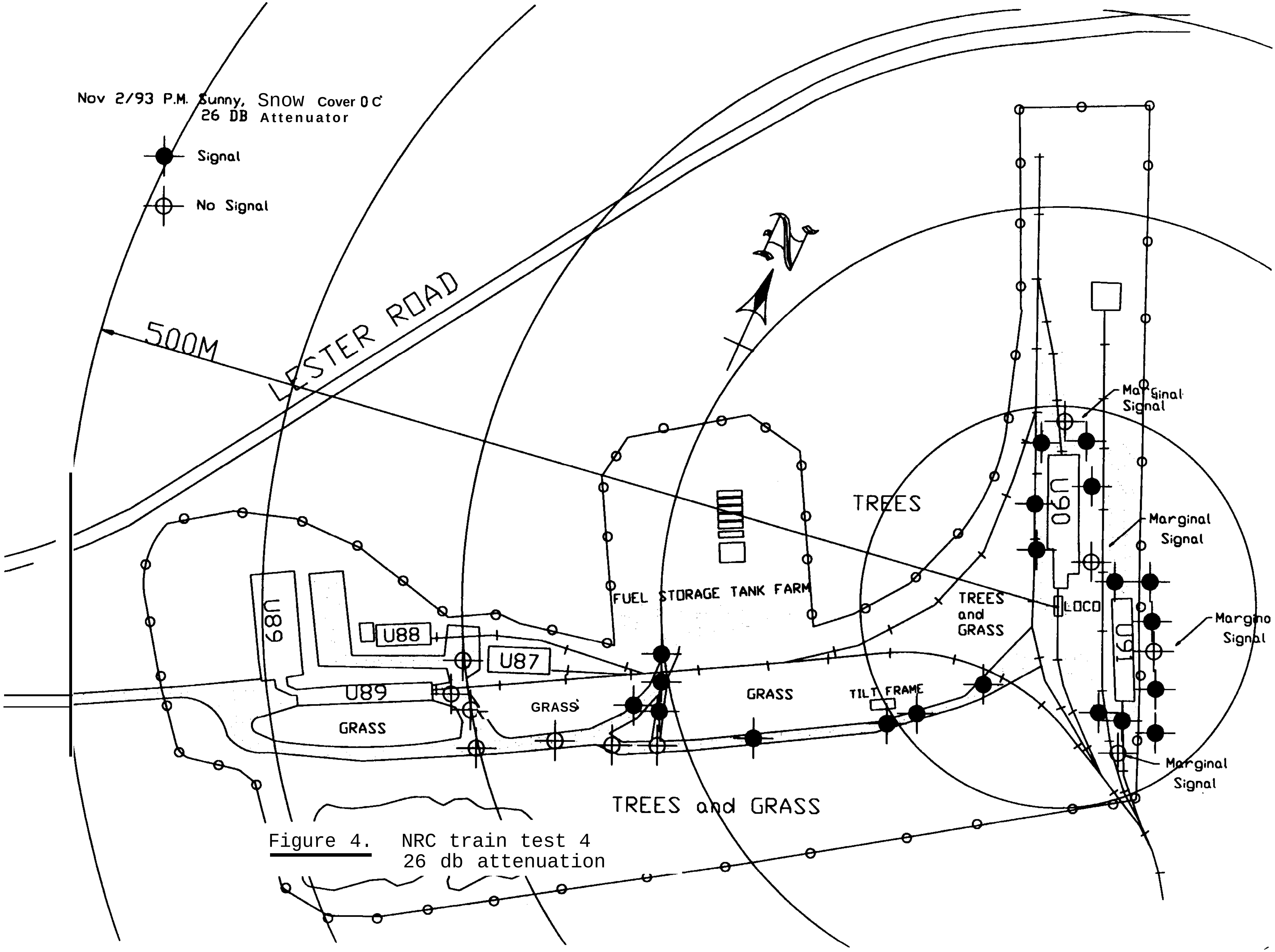

Figure 4. NRC train test 4
26 db attenuation

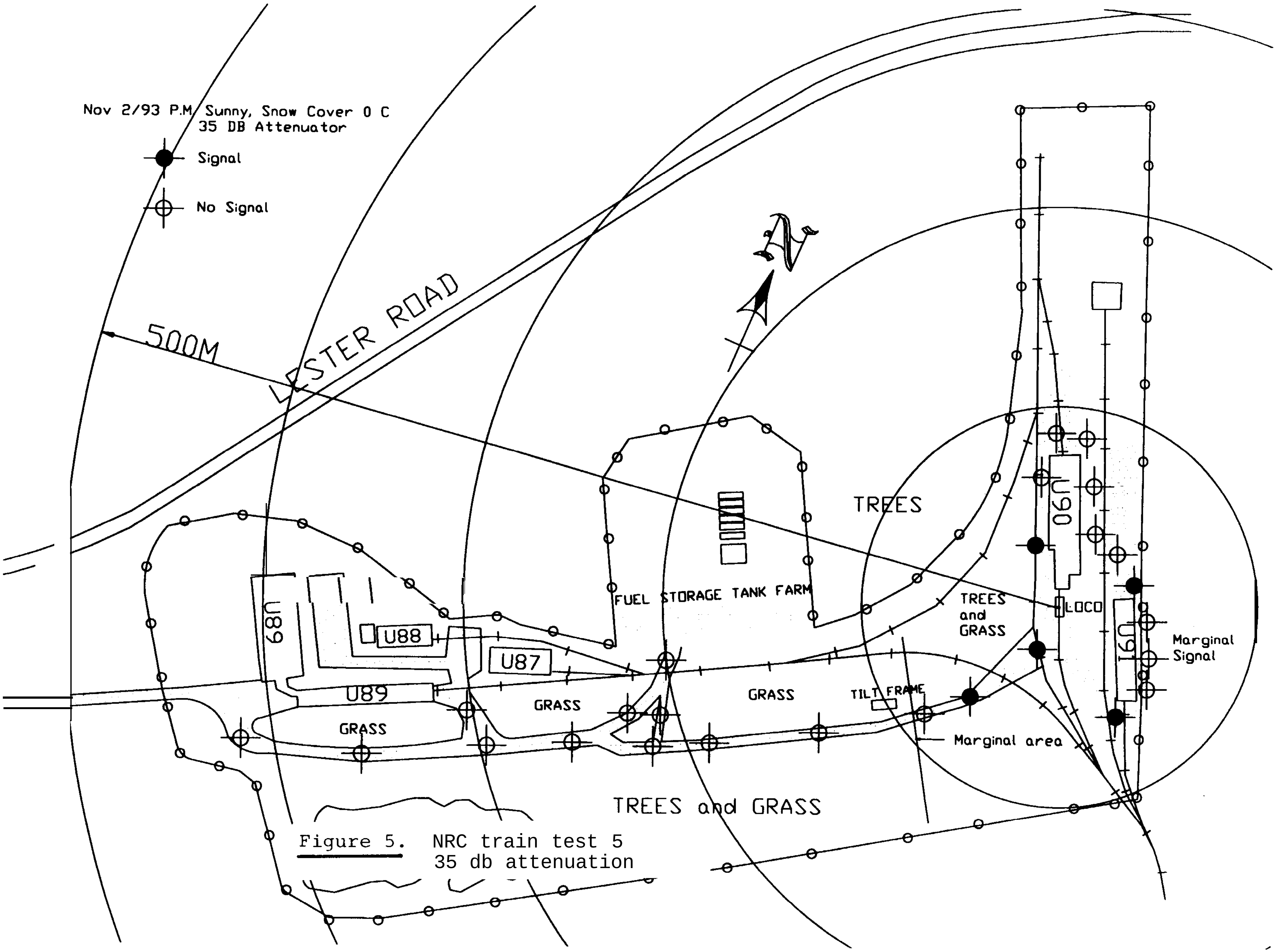

Figure 5. NRC train test 5
35 db attenuation

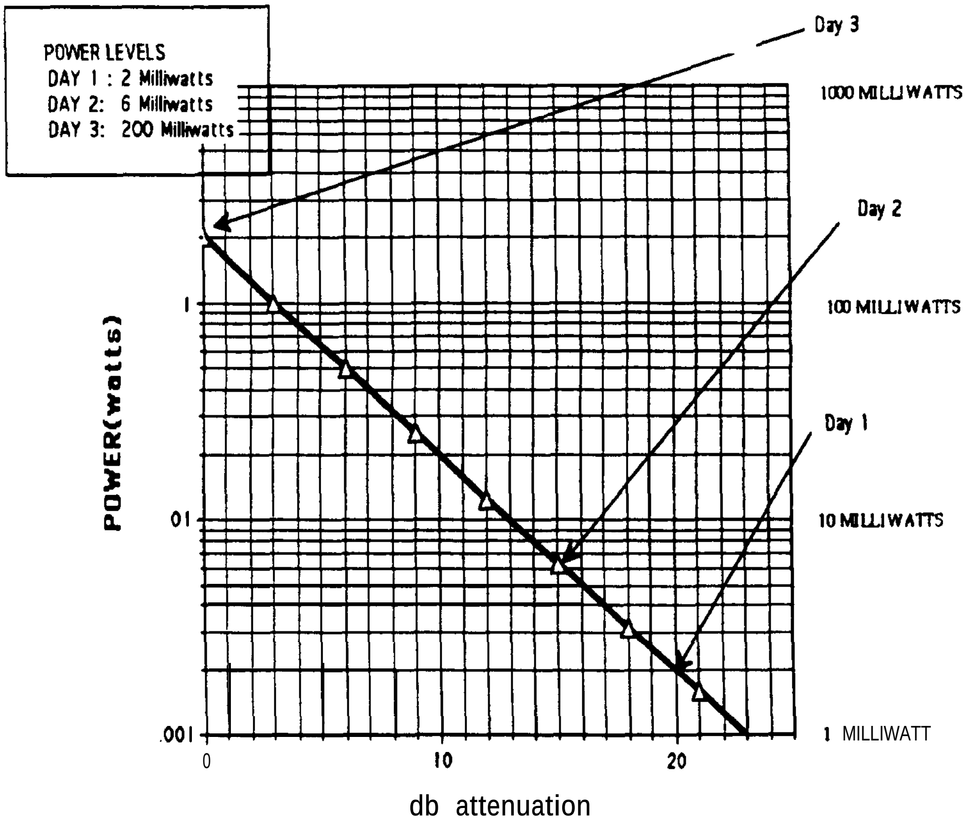

Figure 6. Transmitter power levels used in testing.

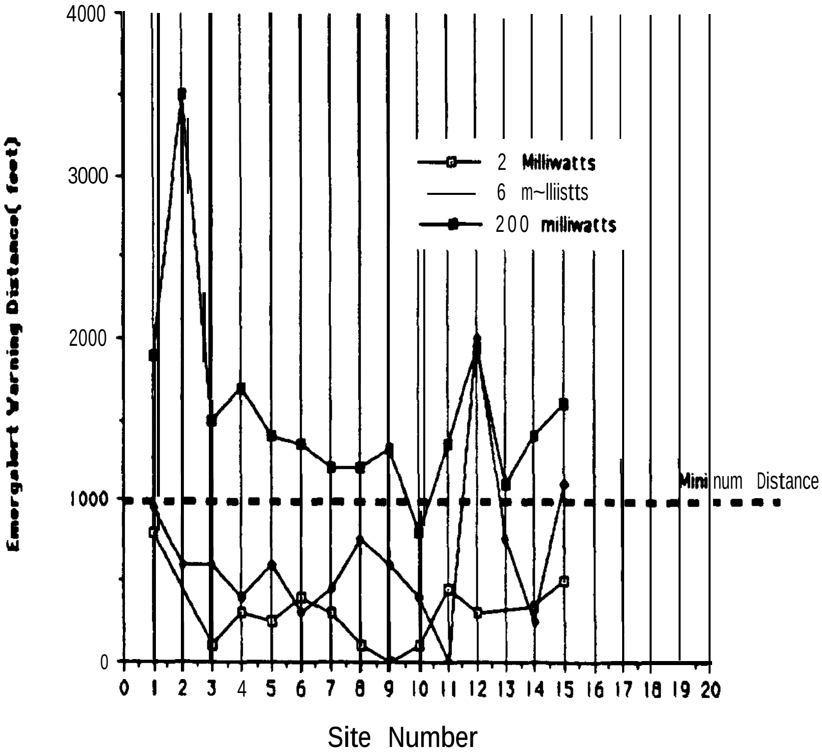

Figure 7. Warning distances versus transmitter power levels.