RR NOISE – WAYSIDE HORNS

2004 Railroad Noise - Wayside Horns

September 23, 2004

Mr. Jim Pierce
City of Addison
Asst City Engineer
16801 W. Grove Drive
PO Box 9010
Addison, TX 75001

Re: Federal Highway Administration Interim Approval of the Automated Horn System

Dear Mr. Pierce:

Railroad Controls Limited is pleased to announce that the Federal Highway Administration (FHWA) has just issued interim approval for the use of the Wayside Horn System (Automated Horn System.) Under the Federal Railroad Administration's Interim Final Rule on the Use of Locomotive Horns at Highway-Rail Grade Crossings, if a Wayside Horn System (AHS) is considered a traffic control device by the FHWA, then it must also be included in the Manual on Uniform Traffic Control Devices (MUTCD).

The FHWA has determined the Wayside Horn System is a traffic control device, and has granted interim approval until it can be included in the MUTCD. The advantage of this inclusion is it will no longer be required that the Wayside Horn be installed on an Experimentation Basis outlined in section 1.A.10 of the MUTCD. The FHWA also provides additional guidance for the installation of the Wayside Horn.

If you would like additional information in this regard, please feel free to contact me at (817) 820-6347, or if you would like to view the FHWA document online please visit our website at www.railroadcontrols.com and click on the FHWA approval link.

Best regards,

RAILROAD CONTROLS LIMITED

Robert Albritton
National Sales Manager

U.S. Department of Transportation
Federal Highway Administration

Memorandum

Electronic Mail

Subject: INFORMATION: MUTCD – Interim Approval for Use of the Wayside Horn System

Date: August 2, 2004

From: Regina S. McElroy */s/Regina McElroy*
Director, Office of Transportation Operations

Reply to Attn. of: HOTO-1

To: A. George Ostensen, Associate Administrator for Safety
Division Administrators
Resource Center Directors
Federal Lands Highway Division Offices

Purpose: The purpose of this memorandum is to issue an Interim Approval for the optional use of wayside horn system (WHS) at highway-rail grade crossings.

Background Summary: The use of train horns provides an audible indication to road users of the approach of a train at a highway-rail grade crossing. Although this device provides a safety benefit to the road user, the community in close proximity to the railroad crossing can be subject to the sound impact of the train horn, which can occur any time of the day or night. To mitigate this problem, the Federal Railroad Administration (FRA) and the Federal Highway Administration (FHWA) Office of Safety have monitored over the past 10 years the development and implementation of a WHS. The WHS is located at the crossing and directed at oncoming motorists, which (1) simulates the sound and pattern of a train horn; (2) provides similar (or safer) response from road users, and (3) minimizes the audible impact on individuals located near the crossing (the WHS theory of operations is attached to this memo). Additionally, the FRA has documented an Interim Final Rule, entitled "Use of Locomotive Horns Highway-Rail Grade Crossings" (published in the *Federal Register* at 68 FR 70586 on December 18, 2003), which provides the use of train horns at public crossings and the use of the WHS.

Interim Approval for the WHS is hereby granted based on FRA's Interim Final Rule, as well as current deployments and evaluations.

Provisions for the WHS:

Option:

The wayside horn system may be installed in accordance with part 222 of title 49 of the Code of Federal Regulations (49 CFR) to provide directional audible warning at highway-rail grade crossings equipped with active traffic control devices consisting of, at a minimum, flashing lights and gates.

Standard:

The wayside horn system for use at active highway-rail grade crossings shall conform to the FRA's requirements for the wayside horn prescribed in Part 222 of 49 CFR, Appendix E.

As a minimum, the wayside horn system shall be installed for each roadway approach to the highway-rail grade crossing to provide audible warning.

Guidance:

A diagnostic review should be conducted by a diagnostic team to determine the optimal placement of the wayside horn system and to ensure the correct and most effective use of the system. The diagnostic team should be composed of railroad personnel, public safety or law enforcement, engineering personnel from the public agency with the responsibility for the roadway that crosses the railroad, and other concerned parties.

The highway agency or authority with jurisdiction should consider the inclusion of remote health (i.e., status) monitoring capable of automatically notifying maintenance personnel when anomalies have occurred within the system.

The wayside horn system should comply with the same lateral clearance and roadside safety features described in the MUTCD Section 8D.01. When a wayside horn is mounted on a separate pole assembly, it should be installed no closer than 4.6m (15 ft) from the centerline of the nearest track. In addition, a wayside horn should be located where the device will have optimal results, and not obstruct the motorists' line of sight to the flashing-light signals.

Conditions of Interim Approval: Jurisdictions wishing to install the WHS under this Interim Approval of WHS must meet the following conditions:

1. The use of WHS shall comply with provisions described in the above *Provisions for the WHS.*

2. A written request shall be submitted to the Director of the Office of Transportation Operations acknowledging the jurisdiction's agreement to comply with MUTCD Section 1A.10, item F. The request must also state the location(s) where the device will be used.

3. Jurisdictions shall be responsible to notify the FRA of installation of WHS as required in 49 CFR 222, and shall inform the FHWA of such notification in their written request to FHWA for interim approval.

Any questions concerning this Interim Approval should be directed to Ms. Guan Xu at **guan.xu@fhwa.dot.gov** or by telephone at 202-366-5892.

References:

1. 49 CFR Part 222
2. Wayside Horn System Interim Approval Request from A. George Ostensen
3. 2003 MUTCD Section 1A.10

Attachments:
Theory of WHS Operations
WHS Research Summary

Theory of WHS Operations

The WHS system operates in conjunction with train operations. Under normal conditions at an active crossing, the train's locomotive will normally engage its horn approximately one-quarter of a mile from the crossing. The horn will continue to sound several additional times until the train enters the crossing. The WHS focuses the sound of the horn to the road user, thereby eliminating the requirement that the locomotive sound its horn from such a far distance (currently trains typically sound their horns a quarter-mile from the crossing). The WHS is located at the crossing on a pole in close proximity to the Crossbuck. Once the train has approached the crossing where the train horn would begin to blow its horn, the WHS is engaged. The WHS emits a digitized horn sound that is directed in the path of the user. Based on the location and orientation of the WHS, significant sound abatement is created for the general area surrounding the crossing, and provides a warning to road users approaching the crossing. Additionally, a visual signal is placed along the rail corridor's right-of-way in advance of the crossing to notify the locomotive engineer that the WHS is operating. Pursuant to FRA's Interim Final Rule (49 CFR 222, Appendix E), the locomotive engineer has the right to engage the on-board train horn, when it is determined that it is in the best interest in safety (for both the road user and the train).

WHS Research Summary

The effectiveness of the WHS has been studied and documented over 10 years at active highway-rail grade crossings, and has shown substantial benefits to such grade crossings. The studies were conducted by agencies/organizations such as the FRA, Volpe Center; Northwestern University; City of Richardson, Texas; Association of American Railroads; Iowa State University, and Texas Transportation Institute. Key conclusions of the studies include:

- The studies showed significant reduction (more than 50 percent) in the number of motorists' violations of the crossing gates as compared to the baseline data collected with the train horns sounding.
- The WHS was well accepted by both motorists and locomotive engineers.
- The WHS gives equal or greater audible notification as compared to train horns.
- The WHS provides a good balance between providing adequate advance notification to road users and minimizing community noise levels.
- The WHS appears to continue to be an effective alternative to the locomotive horn.

Ri. 'ardson Morning News
4-15-04

City backs using train gates

Continued from Page 1S

wayside horns that take the place of the train whistle and focus the sound at the intersection, build barriers in the roadway medians to prevent motorists from going around the gate or install gates on both sides of the rail in both directions, to prevent motorists from going around.

Richardson has 10 railroad crossings where the quiet zones could be implemented.

The city installed a wayside horn in November 2000 where the Kansas City Southern Railroad crosses Custer Parkway. The quiet zone idea was so fresh back then that former Vice President Dan Quayle visited Richardson for a television news spot.

"At the time, we were cutting edge," Mayor Gary Slagel said.

But now that the new railroad rules are out, the council said the city should go with the more economical median barriers. The city also has a test site for this technique, in place at the Cotton Belt and Custer Road since 1996.

City transportation officials estimate it would cost between $120,000 and $300,000 to put in median barriers citywide, compared with $270,000 to $360,000 for wayside horns. The gates in all directions, called quad gates, are far more expensive, costing as much as $150,000 each.

The city has $240,018 in a capital projects budget for quiet zone construction. More money will probably be needed to finish the project, transportation director Walter Ragsdale said.

Robert Budzinski has pushed for a quiet zone near his neighborhood, south of Centennial Boulevard. The city installed an experimental wayside horn. He collected signatures on a petition opposing wayside horns after the test site was installed on Custer Parkway. His neighborhood has three crossings that could be quiet zones.

City tests showed that noise levels in the neighborhood decreased with the wayside horn, but Mr. Budzinski said that the decrease was not significant and that those who live closest to the horn experience more noise.

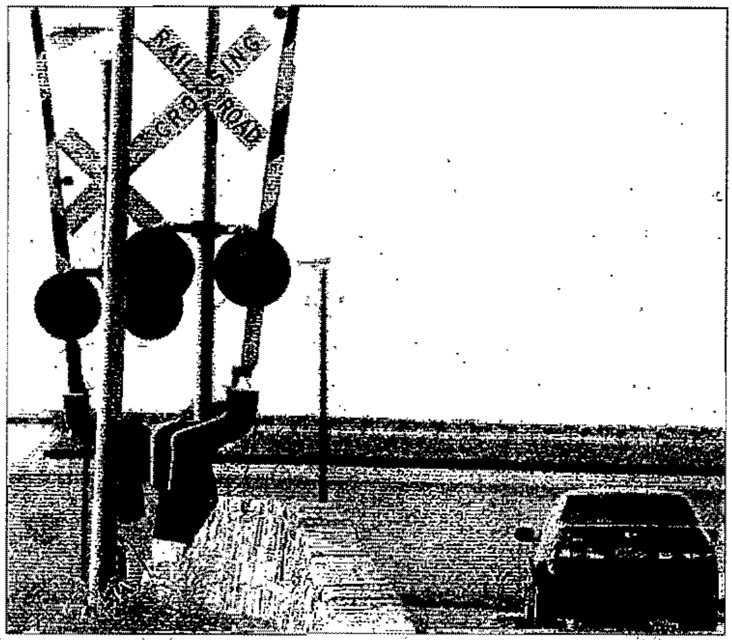
"I'm very happy the council has made a decision not only to save money but to introduce quiet into the neighborhoods," he said.

The median barriers run between traffic lanes near the track. They must be at least six inches tall and 100 feet long.

Mr. Ragsdale said this could pose a problem at three crossings, including the one that has a wayside horn now. Barriers that length would impede turns at Alma Road and the Bush Turnpike and into alleys at two crossings in the Canyon Creek neighborhood.

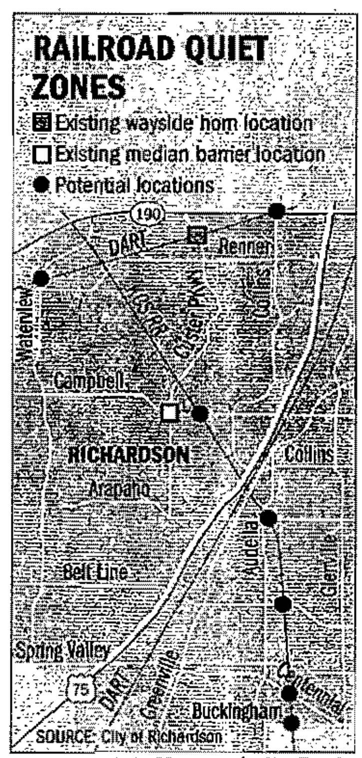
Mr. Ragsdale said a consultant would prepare recommendations and analyze costs for each of the proposed quiet zones, including the three problem ones. He said meetings would be scheduled with homeowners to get input.

John Davis lives on Big Horn Drive and would lose easy access to his alley if a barrier were installed. He said the trade-off would not be worth it. "If that's the price we have to pay for a quiet zone, I'll keep the noisy zone," he said.



VERNON BRYANT/Staff Photographer

Gates with median barriers are being endorsed instead of warning horns for Richardson train crossings. This gate is near the Bush Turnpike and Custer Road.



JAMES A. BLACK/Staff Artist

ITY COUNCIL

Train gates trump horns

Alternative to noisy warnings endorsed as cost-effective, quiet

By SARAH POST
Staff Writer

A train's mournful whistle in the night is not romantic, just noisy, those who live near the track say.

Richardson has been looking at ways to provide quiet zones where neighborhoods and tracks intersect for several years. Monday, the city decided to abandon wayside horns — fixed horns intended to more narrowly focus the sound — in favor of newer, cheaper methods.

Instead, the city will install gates with median barriers, an alternative recently approved by the Federal Railroad Administration.

Mayor Pro Tem John Murphy said Monday that he was glad they did not rush to use the wayside horn technology.

"I always thought wayside horn and quiet zone was an oxymoron," he said.

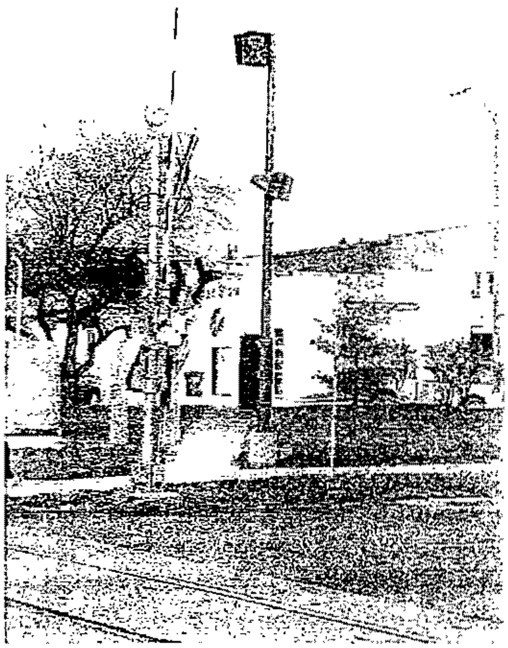
The administration passed rules in December in response to many communities that have pressed for relief from train whistle noise. Officials provided several exceptions to the requirement that trains blast horns at all road crossings, including those with gates.

Under the new rules, cities wishing to ban whistles may install

See CITY Page 11S

AHS™
Automated Horn System

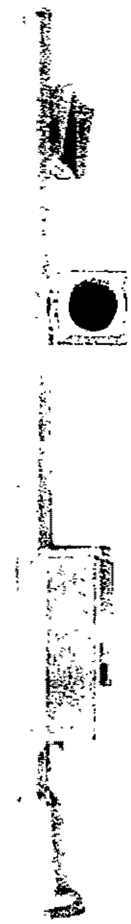
Providing Motorists the Warning They Need



Ames, IA

What is AHS?

AHS, the Automated Horn System, is an innovative railroad signaling device that significantly improves safety for motorists and pedestrians at railroad-highway grade crossings while dramatically reducing the amount of noise pollution created by train horns along rail corridors in populated areas.



Increases Audible Warning by 21%

Train at 1/4 Mile		
Distance	**Train Horn**	**AHS**
50'	78.0 dB	98.9 dB
100'	73.6 dB	93.7 dB
200'	75.0 dB	84.9 dB
300'	67.8 dB	79.5 dB
400'	64.0 dB	73.7 dB

The Technology

AHS is a stationary horn system activated by the railroad-highway grade crossing warning system. The **Automated Horn System** is mounted at the crossing, rather than on the locomotive, to deliver a longer, louder, more consistent audible warning to motorists and pedestrians while eliminating noise pollution in neighborhoods for more than one-half (1/2) mile along the rail corridor.

AHS is designed to sound like a train horn. The tone modules in the Automated Horn System horns were digitally recorded from an actual locomotive horn. Upon receipt of the signal from the railroad's track circuit warning system **AHS** mimics the train horn warning by cycling through the standard railroad whistle pattern until the train reaches the crossing. Once the train has entered the crossing **AHS** stops sounding its horn. A confirmation signal notifies the locomotive engineer that the **Automated Horn System** is functioning properly. When the locomotive engineer sees that the confirmation signal is flashing, he will not be required to sound his horn unless he detects an unsafe condition at the grade crossing. Coordination with the railroad operating company is essential since the **Automated Horn System** is directly connected to the railroad's crossing signal-warning system. Additionally, the railroad operating company must issue instructions to their train crews regarding the sounding or non-sounding of the train's horn.

Automated Horn System
A Division of Railroad Controls LP
7471 Benbrook Parkway
Benbrook, TX 76126

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AHS Research

The **Automated Horn System** has been studied since 1995. The initial study was conducted by John A. Volpe National Transportation Systems Center for the United States Department of Transportation. Since then studies have been conducted by the Iowa Department of Transportation, Association of American Railroads, Texas Transportation Institute and the City of Richardson, TX.

All the research to date has proven the Automated Horn System to be an effective solution for mitigating train horn without compromising driver safety.

Ames, IA

AHS™ Study Conclusions

"The safety evaluation suggests that the wayside horn will not result in behavior that puts the driver at increased risk compared to the use of the train horn. The frequency of violations was lower for the wayside horn than the train horn, while the time to collision and violation time was not statistically or practically different for either warning system." - Field evaluation of a Wayside Horn at a Highway-Railroad Grade Crossing, by U.S. Department of Transportation Research and Special Programs Administration John A. Volpe National Transportation Systems Center, June 1998

""The wayside horn provided an equal or significantly louder audible warning at the point at which motorists most need the warning." - Automated Wayside Train Horn Warning System Evaluation, Prepared for: The City of Richardson, Texas, Prepared by: PB Farradyne Inc., May 2001

Wayside horns are a viable alternative to locomotive horns for audible warning at grade crossings. Wayside horns have the advantage of being closer to the motorist. In addition, they have a more focused radiation pattern and produce less community noise exposure." -Wayside Horn Sound Radiation and Motorist Audibility Evaluation, Prepared for: Association of American Railroads, Prepared by: Mike Fann & Associates, May 2000

"For nearby residents, the automated horn system greatly reduces the negative impacts resulting from the loud train horns; the automated horns are well accepted by both motorists and locomotive engineers; and the automated system appears to provide an equivalent level of safety at the crossings." -Evaluation of an Automated Horn Warning System at Three Highway-Railroad Grade Crossings in Ames, Iowa, by Steve Gent, P.E. (Iowa DOT), Scott Logan, P.E.(City of Ames Iowa), David Evans (Iowa State University), 1998

"The AHS appears to be, after almost 5 years of operation, an effective alternative to the locomotive horn at the Tenth Street crossing in Gering, Nebraska, with a violation rate no greater than that observed during pretest monitoring." -A Safety Evaluation of the RCL Automated Horn System, by Stephen S. Roop, Ph.D. Texas Transportation Institute, May 2000

Trespasser Warning for Bridge Approaches or Other Problem Areas

Trespasser fatalities have recently exceeded fatalities at grade crossings annually. Although trespasser fatalities can occur anywhere on the railroad, there are typically problem areas, such as certain bridges, areas of high pedestrian traffic, near schools where close calls with trespassers are routine. The **Automated Horn System** provides audible warning far enough in advance of the trains arrival to alert trespassers of the trains approach.

The Technology

The **Automated Horn System**, in this application, consists of a horn, or multiple horns, focused on the area requiring trespasser warning. **AHS utilizes standard train detection circuitry to activate the system. When activated, the horn sounds a series of short blasts designed to sound like a train horn.** If the horn or any other **AHS** component fails to operate properly, a cellular RTU sends an alarm to allow for timely maintenance response.

Improved Audible Warning for High Speed Rail Lines

AHS provides improved audible warning for drivers approaching crossings located on high speed rail lines. As previously discussed, Railroad operating rules and individual state laws require the locomotive engineer to sound the horn 1/4 mile in advance of the crossing. This results in reduced audible warning time for trains traveling 50 mph or faster.

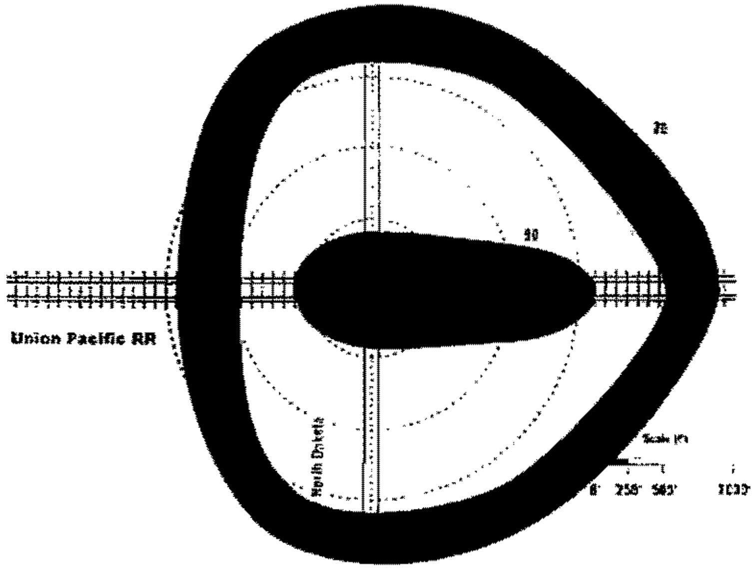
Mundelein, IL

Train Speed (mph)	Warning Time (seconds)	AHS Minimum (seconds)
50	18.0	20
60	15.0	20
70	12.9	20
80	11.3	20
90	10.0	20
100	9.0	20

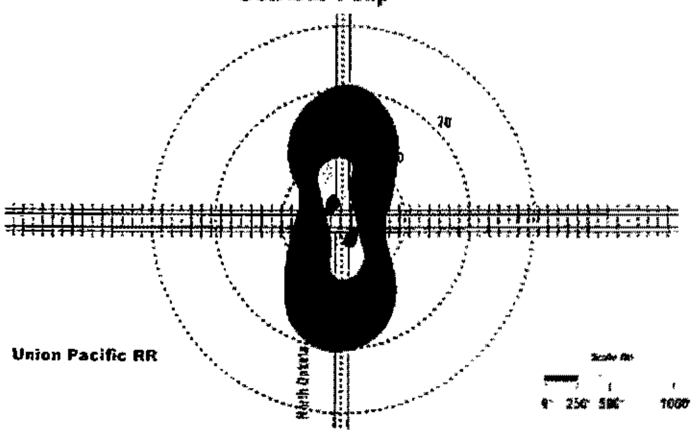
For example, an 80-mph train would provide approximately 11.3 seconds of audible warning, if the driver could hear the horn when it was first sounded 1/4 mile away.

AHS, when installed at locations equipped with constant warning circuitry, **provides a minimum of 20 seconds of warning regardless of the approaching train speed.** Since **AHS** is positioned at the crossing and focused on the roadway approach, **the audible warning is louder than the train horn until the train is very near the crossing.**

Sound Comparison Train Horn vs. AHS



Train Horn Decibel (dBA) Contour Map



Automated Horn System Decibel (dBA) Contour Map

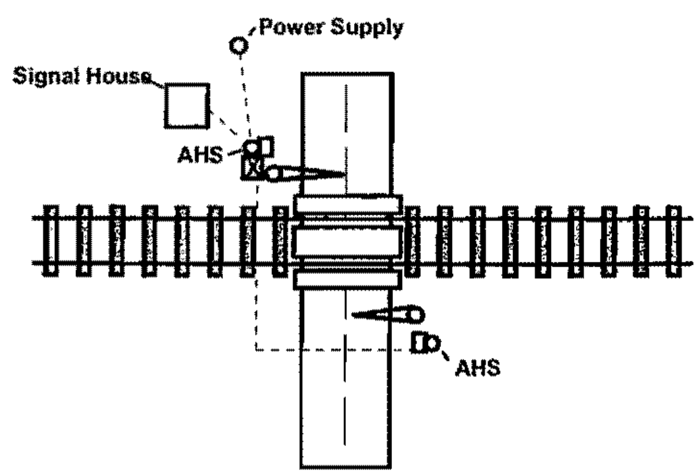
Locomotive engineers are required by state law and the railroad's code of operating rules and regulations to sound the train's horn 1/4 mile in advance of the crossing. They are also required to continue to sound the horn until the train arrives at the crossing.

If the train horn is to be an effective warning device for the motorist, it must provide a sound level capable of initiating a response from the driver when the train is approaching the crossing. Unfortunately the sound level required to achieve that response and the location of the train relative to the crossing creates a significant noise impact on the community.

The two noise footprints to the left depict the area impacted by the sound of the train horn and **AHS** respectively. The comparison of the train horn and **AHS** shows a dramatic difference between the areas that are impacted at specific decibel levels. By examining the 80 decibel contour on the two footprints it can be seen that the area impacted by the **AHS** is a fraction of the size of the 80 decibel contour produced by the train horn.

How AHS Connects to the Railroad

AHS connects with the railroad's crossing warning system in a manner similar to traffic signal preemption connections. Typically **AHS** horns and control cabinets are mounted on their own pole assemblies. The confirmation signal is attached to the top of one of the pole assemblies and must provide a clear line of sight to approaching trains from 1/4 mile away. Power is typically provided by the city.



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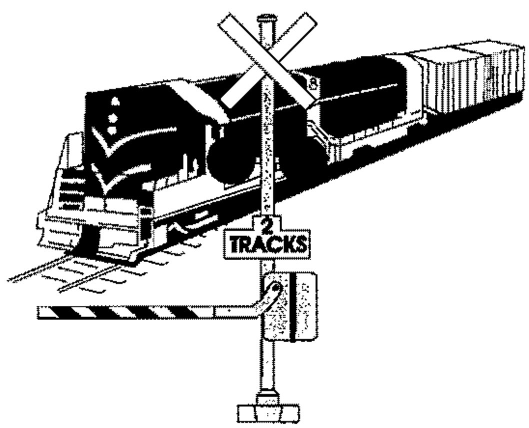
Evaluation of the Automated Wayside Horn System in Mundelein, Illinois Final Report



Northwestern University Center for Public Safety
405 Church Street

Evanston, IL
January 2003

Evaluation of the Automated Wayside Horn System in Mundelein, Illinois Final Report

Executive Summary

Highway-Rail Crossing Safety and Train Horns

At highway-rail grade crossings, the train horn serves to warn motorists of a train's immediate approach. The horn advises motorists, and other crossing users such as bicyclists and pedestrians, that entering on or crossing the tracks would place them in imminent danger. However, because of the loudness and the wide angle of sound radiation, the horn can be an intrusive nuisance, especially in residential areas near the tracks. As a result, an automated wayside horn system (AWHS) has been developed to provide an appropriate warning for those using the crossing, while not annoying those living near the tracks.

A study was carried out in Mundelein, Illinois, that compared the train horn with the AWHS. This report compares motorists' driving behavior at highway-rail crossings and the sound levels of the two types of horns. The results from the evaluation show a significant 70% decrease in violations of highway-rail crossing law with the AWHS. Noise levels in areas near the tracks decreased by up to 85%.

Reducing the number of collisions between vehicles and trains has remained a priority in highway safety. During the past 10 years, collisions nationally have decreased from 4,684 in 1992 to 3,064 in 2001 (Federal Railroad Administration). During this same period, all collisions with trains in Illinois remained fairly constant with an average of 232 per year. Even though there has been a general decrease nationally, these collisions remain the most severe type in terms of producing injuries and fatalities. Crossing gates have the best record at reducing collisions, but a study done in Florida showed that even with crossing gates, a train horn still is needed. The Federal Railroad Administration (FRA) has proposed rules to require that horns be used at all crossings with few exceptions that are expensive to implement. The problem remains that the train horn, which, in Mundelein, starts sounding approximately 17 seconds before the train reaches the crossing, creates very high sound levels in adjoining areas.

As a result of the need to alert motorists and at the same time reduce the effect of sound on adjoining areas, Mundelein experimented with the use of the AWHS. The study reports the results of the evaluation of the AWHS.

Conduct of the Study

Five tasks were undertaken: site preparation, before and after motorist violation studies, before and after sound studies, quality-of-life studies, and surveys of engineers and residents.

At each of the three sites used for studying motorist behavior, utility poles were erected, and cameras and recording equipment installed. The recorders activated when the warning signals activated, thereby recording what motorists did during the period the gates were descending and down before the train arrived.

Drivers are considered to be taking risks (and violating the law) when they attempt to cross the tracks after the crossing gates start to descend. This action was measured by viewing videotapes made at each crossing during the period the gates were activated. Data were taken during the period train horns were in use, then after a period of adaptation, when the wayside horn was in use. The violations were divided into two classes:

Technical violation where the driver crosses the tracks after the gates start to descend but before the gate has been lowered sufficiently to block the vehicle's passage, labeled a "Type 1" violation, and

Deliberate violation in which the driver either drives through or around the lowered gate. These are "Type 2" violations.

Loudness and sound characteristics were measured on approaches to several crossings with train horns in use and then after the wayside horns were activated. A comprehensive assessment of these measures is contained in a separate report; this final report just summarizes the findings.

Measures of quality-of-life derived from two sources: sound studies in residential yards and a survey of the residents. The project team measured sound levels over 24-hour periods at nine locations throughout Mundelein. These measures were made during the period when train horns were used and again after the wayside horns were placed in service. Comparisons included the average sound level in one-second periods, during the time that horns were sounded, and a sound exposure level. The latter takes into account duration and allows direct comparison of sounds between different locations and over different periods.

In addition, surveys were sent to a sample of residents in Mundelein. The survey asked residents how they viewed the new horn system compared to the train horns. Several questions also were directed toward the residents' views of changes in crossing safety.

Finally, a survey was distributed to engineers from both the freight railroad (Canadian National) and commuter rail (Metra). This survey was modeled after the one used in Ames, Iowa, for a similar evaluation. It asked the engineers how they perceived the crossing safety before and after the wayside horns were activated.

Evaluation of Changes in Crossing Violations

From the period September 8 through December 20, 2001, 10,392 gate activations were recorded on videotape at three crossings. During the second period of observations, April 12 through July 16, 2002, 9,112 activations were recorded. Each period averaged 36 closings per day or 3.5 per 1,000 crossing vehicles. The largest percentage of closings, 17%, occurred from 6:00 p.m. through 9:00 p.m.

A total of 367 violations were counted during the period when train horns were in use. Only 97 violations were recorded once the wayside horns were in operation. The average violation rate when train horns were in use was 3.53 per 100 gate closings. This decreased 68% to 1.12 per 100 closings with the AWHS. The decrease is statistically significant. Type 1 violations (driving under a descending gate) occurred 358 times in the before period and 93 in the after period. A combined total of 13 drivers in both periods went around a gate. With few exceptions, most of the Type 1 violations occurred within the first two seconds after the gates began their descent.

Of the Type 1 violations recorded when train horns were in use, more than 90% occurred between 6:01 a.m. and 9:00 p.m. Between 12:01 and 3:00 p.m., 30% of all violations occurred. The largest percentage occurred on Hawley Street. Part of the problem stems from multiple gate activations when Metra commuter trains stop at the Mundelein station near Hawley Street.

A total of 13 instances were recorded where motorists drove around the gates. Nine occurred during the time the train horn was in use, and four occurred when the AWHS was operating. The decrease is not statistically significant. Approximately one-half of the violations happened when a train arrived during the 60-second recording interval. In one case, a driver cleared the tracks just 6 seconds before a freight train arrived. On the average, 17 seconds separated the vehicle from the train. At 50 mph, a train would just have passed the whistle post; therefore, the motorist driving around the gates generally might not yet have heard a train horn if train horns were being used. As with Type 1 violations, a large percentage of Type 2 violations occurred in conjunction with Metra commuter operations.

One problem uncovered with the gate operations was gate closure without a train present. Often, this is referred to as a "false activation." These activations comprised approximately 13% of all closings. Metra stops at the Mundelein station and switching operations accounted for a majority of these activations.

Finally, an unusual situation was videotaped during the spring of 2002 in which drivers stopped on the tracks in an apparent response to the wayside horn sounding without prior warning. This happened on 12 occasions. When the drivers went forward, they generally cleared the tracks after the gates had closed just behind them. In other words, in most cases, the drivers occupied the tracks for 12 or more seconds. In one case, a driver backed up, just clearing the descending gate.

Survey of Residents and Engineers

Two sets of surveys were distributed to examine opinions of both the wayside horn and its perceived safety effectiveness. The respective surveys were administered to more than 1,250 Mundelein residents and to railroad engineers for both the Canadian National Railroad and Metra Commuter Rail.

Residential survey. The 229 residents who responded to the residential survey, by a substantial majority, found the wayside horn much less annoying than the train horns. The exception was persons who lived close to and in a direct line with the wayside horn. More than 15% of respondents found the wayside horn annoying, and a slightly greater percentage responded that "occasionally" the horns interfered with their activities. When compared to the train horn, 88% found the wayside horns either less loud or not even noticeable. A similar percentage also found them less annoying.

When asked about safety, approximately 9% suggested that they were less safe. The same percentage believed that motorists would be more likely to violate crossing laws. On the other hand, the remainder of the respondents believed that the crossings were as safe or safer with the wayside horn than they had been with train horns.

Engineer survey. Both Metra and Canadian National engineers also responded to surveys. One Canadian National and one Metra engineer believed that the crossing was less safe. Neither gave a reason for selecting that answer. However, both also did not like the method of notifying the engineer when the horns were not working. The remaining engineers believed the crossings to be as safe as or safer than when they used the train horn.

Analysis of the Sounds from Train and Wayside Horns

The key element of the evaluation addressed the differences between the train horn and the wayside horn as it might affect safety of the highway-rail crossing. For the village residents, it was of equal importance to compare how the two horns affected their lives. The findings are discussed in greater detail in a separate report produced as part of the project.

In terms of outcomes, the sound level of the wayside horn was equal to or exceeded that of the train horn for a driver approaching a highway-rail crossing. The exception was when the train reached the crossing, where the train horn was louder. This finding held for a motorist approaching the crossing, whether at the last point where the motorist could stop safely or at the sign warning the motorist of the approaching crossing. The two horns had similar frequency components and were of equal loudness at different frequencies. Perhaps the greatest difference was that the wayside horn is produced electronically and the train horn by air passing through tuned horns. As a result, the sound of the wayside horn had a certain artificiality.

The wayside horn had a significant impact on the quality-of-life in areas near the crossings. At the highest decibel levels, the wayside horn covered 85% less land area than the train-mounted horns. Even at lower levels, more than 65% less area was affected. The residential survey clearly bore out the findings from sound measurements. On the other hand, some persons were affected more than before. Some of this occurred because the pattern of the sound dispersion changed. Volume levels were elongated along the roadway so that some persons heard a louder horn than before. More importantly, because the horns were of constant volume and lasted longer than the train horn, this increased their apparent loudness.

Summary and Other Issues

This evaluation of the automated wayside horn system (AWHS) compared the new system to the train horn. It examined three elements for differences:

1. Motorist violations of the law governing gated highway-rail crossings along with perceptions of its safety from drivers and railroad train engineers.

2. The nature of the sound heard by the motorist and the potential effects of any differences on safety at the highway-rail crossing.

3. Quality-of-life for residents as measured both by sound levels, and how the residents perceived the loudness and annoyance of the two warning devices.

With the introduction of the AWHS, motorists' violations of the crossing gates decreased 68%. This difference had less than a 0.0001 likelihood of occurring by chance. The largest change came from Type 1 violations or driving under the closing gates. Because so few motorists drove around the gates during the period the train horns were in use, the decreases occurring during the after period could not be said to be statistically significant. In responses to the surveys, both engineers and residents indicated that they believed the wayside horn created a safer crossing environment for motorists. Because there were no other known changes to the operation of the roadways, the wayside horn is the most likely factor in the reduction of violations.

The sound studies showed that, in terms of nature and quality of sound, what the motorist heard from the wayside horn was generally no different from what he or she heard from the train horn. However, there were two differences in sound delivery. The first was that the train horn provides a sense of movement because it gradually increases in volume. The wayside horn starts and remains at a constant volume. The second difference was that the wayside horn sounds when the crossing warning lights first activate while the train horn is usually not heard until the gates are fully descended.

Residential quality-of-life, as measured by the noise levels in the crossing areas, improved significantly with the AWHS. At all levels, from 70 to 90 decibels, the reductions in area covered by a given decibel level, ranged between 65% and 85%. When residents living near the crossings were surveyed about the wayside horns as compared to the train horns, more than 80% of the respondents indicated that their quality-of-life had improved.

Finally, in referring to Type 2 violations (driving around the closed gates), none occurred at Allanson Road. At this crossing, there is a 6-inch raised concrete median that extends approximately 40 feet back from the tracks. While this does not quite meet the proposed FRA standards, it appears to have been sufficient in preventing drivers from going around the gates. Except for the two drivers on Maple who drove around the queue waiting for malfunctioning gates, all of the drivers who went around the gates were the first vehicles in line. Restricting the driver's ability to pull out around the gates for between 30 and 40 feet back from the gate, along with the presence of the wayside horn, probably would eliminate almost all Type 2 violations.

The conclusion then drawn from this study is that the wayside horn significantly reduces highway-rail crossing violations. It accomplishes this task while improving the quality-of-life for nearby residents.

January 24, 2003

Mr. Jim Pierce
Asst City Engineer
City of Addison
16801 W. Grove Drive
PO Box 9010
Addison, TX 75001

Re: Automated Horn System Press Releases from Mundelein, IL

Dear Mr. Pierce:

In an effort to keep you updated as to the continued progress of the Automated Horn System (AHS) in eliminating noise pollution in neighborhoods located near railroad tracks while improving the safety at railroad crossings, Railroad Controls Limited is pleased to provide you with copies of press releases from Congressman Mark Kirk, 10th District, Illinois, Lake County and the Village of Mundelein regarding the results of Northwestern University Center of Public Safety's evaluation of the AHS. Also included are the executive summaries from the report "Evaluation of the Automated Wayside Horn System in Mundelein, Illinois".

The scope of the study was to determine the reduction in noise pollution to neighborhoods located adjacent to the railroad tracks and to evaluate the overall safety at the crossings once the AHS was installed. The report concluded that the AHS reduced noise pollution by 80% and decreased highway violations by 70%. The findings of this report indicate that the AHS improved railroad crossing safety while decreasing noise pollution created by trains sounding their horns.

Congressman Kirk plans to deliver the findings of this report personally to Federal Railroad Administrator Allan Rutter in Washington DC

If you have any more questions or would like to obtain information on the AHS please visit our web site at www.railroadcontrols.com/ahs or contact Kurt Anderson or myself at (817) 820-6347.

Best regards,

Robert Albritton
National Sales Manager
Railroad Controls Limited

Enc.

MARK STEVEN KIRK
10TH DISTRICT, ILLINOIS

COMMITTEES:
BUDGET

TRANSPORTATION AND INFRASTRUCTURE
SUBCOMMITTEES:
AVIATION
HIGHWAYS AND TRANSIT

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January 21, 2003
For Immediate Release

Congressman Kirk Says New Federally Funded Study Found Automated Wayside Horn System Increased Safety, Improved Quality of Life and Costs Less Than Proposed Alternatives To Meet Train Whistle Mandate

Mundelein, IL -- As part of his continuing efforts to prevent implementation of a proposed federal regulation that would require trains to blow their horns at all railroad crossings, U.S. Rep. Mark Kirk (R-Highland Park) joined members of a multi-jurisdictional task force to announce the results of an "Automated Wayside Horn System" study. The task force, convened by the Village of Mundelein, hired Northwestern University's Center for Public Safety to conduct the automated train horn evaluation.

"Safe railroad crossings are a top priority in our communities," said Congressman Kirk. "I am very encouraged by the results of this comprehensive study which revealed that use of the Automated Wayside Horn System resulted in a 70 percent decrease in highway violations at rail crossings and an 80 percent noise level reduction near the tracks. According to this report, wayside horns increased public safety, reduced the impact of train horns on our quality of life and will save money as communities work to comply with the FRA train whistle mandate. I applaud the Villages of Mundelein, Libertyville and Vernon Hills for taking the lead in initiating the task force which lead to this study that I intend to hand deliver to Federal Railroad Administrator Allan Rutter in Washington."

- more -

In August of 2001, Congressman Kirk brought FRA Administrator Rutter to the 10th District to emphasize local opposition to the federal train whistle mandate and for a first-hand look at communities where implementation of the current FRA regulation would mean that a train traveling through some communities where intersections are very close would be continuously blowing its' horn.

"Our suburban mayors and village presidents have joined the effort to prevent this train whistle mandate from destroying our quality of life and diminishing our property values," said Congressman Kirk. "The study being released today indicates we do not have to forgo safety to protect our quality of life and still comply with federal law. I will ask the FRA to consider the Automated Wayside Horn System as an alternative to train horns proposed to satisfy the federal mandate."

The task force, which began meeting in June 1999, consists of the Villages of Mundelein, Libertyville and Vernon Hills, the Federal Railroad Administration, Illinois Commerce Commission, Illinois Department of Transportation, Metra, Wisconsin Central, Canadian National Railroad, Lake County Department of Transportation, Northwestern University, and Railroad Controls, Ltd. After numerous meetings, the task force succeeded in obtaining state and federal funding to install nine automated horns on an experimental basis (from Paterson to Butterfield Road), and federal funding to conduct a study of the effectiveness of the horns as a safety device and at reducing the noise disturbances to the community. The Village of Mundelein, and members of the task force, asked the Northwestern University Center for Public Safety to evaluate the effectiveness of a demonstration installation of wayside horns.

The study was conducted with federal and local matching funds under auspices of the Federal Railroad Administration and Volpe National Transportation Research Center. Although the horns are installed at all nine crossings in or near the Village, only three were used in evaluation. The horns were installed at an average cost of $52,000 per location and activated in March 2002.

- more -

To satisfy the safety and quality of life objectives of the study, data was gathered for five measures: motorists violations of the crossing gates, sound levels at various distances along the roadway approaching the crossing, sound levels in occupied areas at various distances from the railroad crossings, train engineers' perceptions of safety, and residents' perceptions of quality of life as related to the sound levels.

The Automated Wayside Horn System is a stationary horn system activated by the railroad-highway grade crossing warning system. The automated horn system, which is designed to sound like a train horn, is mounted at the crossing, rather than on the locomotive, to deliver a more consistent audible warning to motorists and pedestrians while eliminating noise pollution in neighborhoods for more than half a mile along the rail corridor.

For more information on Automated Train Horns, visit www.railroadcontrols.com/ahs.

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Village of Mundelein
440 East Hawley Street
Mundelein, IL 60060

NEWS RELEASE

FOR DISTRIBUTION JANUARY 21, 2003

Contact: Larry Hasvold, Regional Administrator
Federal Railroad Administration
(312) 886-9634

or Beth Bosch
Office of Public Affairs
Illinois Commerce Commission
(217) 782-5793

EVALUATION OF THE AUTOMATED WAYSIDE HORN SYSTEM IN MUNDELEIN, ILLINOIS FINAL REPORT

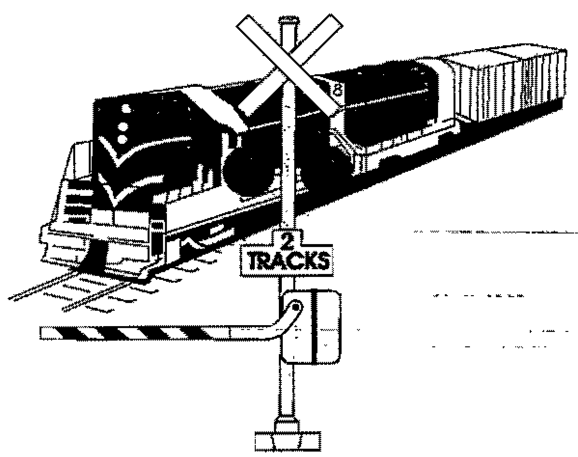
On January 21, 2003 the Northwestern University Center for Public Safety delivered its Final Report on the *Evaluation of the Automated Wayside Horn System in Mundelein, Illinois* to the Village of Mundelein. The study was commissioned by the Village and the Wayside Horn System Task Force to determine if the Wayside Horns that were installed at 9 crossings in, and adjacent to, the Village were effective safety devices and significantly reduced noise levels from train horns within the community.

The Final Report will now be sent to the Illinois Commerce Commission (ICC) and the Federal Railroad Administration (FRA) for critical review and analysis. In the months ahead both the Illinois Commerce Commission and the Federal Railroad Administration will independently evaluate the findings of this study.

The Illinois Commerce Commission has permitted the current installations in Mundelein on an experimental basis. The ICC Order authorizing the Mundelein installations expires April 25, 2003. If the Wayside Horns are to remain in Mundelein beyond this date, the ICC will have to extend the current Order following a hearing before the Commerce Commission.

The Federal Railroad Administration is in the process of reviewing an Administrative Rule that could require trains to sound an audible warning at all crossings unless approved safety devices are in place. At the present time Wayside Horns are not included on the FRA's list of such approved safety devices.

Comparison of Train and Wayside Horns in Mundelein, Illinois: Analysis of Sounds at Highway-Rail Crossings and in Residential Neighborhoods



Northwestern University Center for Public Safety
405 Church Street

Evanston, IL

January 2003

Comparison of Train and Wayside Horns in Mundelein, Illinois: Analysis of Sounds at Highway-Rail Crossings and in Residential Neighborhoods

Executive Summary

Introduction

Railroad train horns appear to improve safety at highway-rail grade crossings, even ones with crossing gates. However, the loudness of these horns can be a significant nuisance for residents living near the crossings. For this reason, the Village of Mundelein, Illinois, tested the use of an Automated Wayside Horn System (AWHS), which is mounted at the crossings and directs the horn sound down the roadway. The purpose is to alert the motorist of an approaching train while reducing the noise directed toward residential areas.

Current Federal Railroad Administration (FRA) rules require that railroad train horns be capable of generating 96 decibels (dB) at 100 feet (30.5 meters) in the forward direction of the train. While the horns are aligned with the direction of train travel, directivity plots of sound levels show that these sounds radiate with minimal decrease up to 60 degrees to each side. This would mean that persons residing away from the railroad would be subject to approximately the same sound volume as those near the tracks.

The analysis of sound levels and acoustical characteristics heard by motorists show minimal differences between the railroad horn and the wayside horn. Motorists approaching the crossing when the gates are being lowered are more likely to hear the wayside horn because it is much louder than the approaching train's horn. Once the motorist is at the gate, the train horn becomes louder than the wayside horn only when the train is within a few seconds of reaching the crossing.

Frequency and temporal characteristics of both horns are similar, with patterns over the normal ranges for hearing. Finally, residential areas experienced a significant reduction in sound levels once the wayside horns were introduced. In many cases, the wayside horn could not be distinguished from background noises.

Brief Introduction to Measuring Sound

Sound and noise often are used interchangeably to describe a sensation that can be detected by the ear. However, the study of sound (acoustics) often distinguishes between noise as "unwanted sound" and sound as an "auditory sensation produced through the ear by alteration in pressure..."

Sound travels through most media, e.g. air, water, and metal, as a wave that has both amplitude defining loudness, and a cycle length that defines frequency.

Amplitude is the "strength" of a sound wave, and it represents loudness. It is measured as sound pressure. The common measure is decibels and it is known as the sound pressure level (SPL).

When comparing similar sounds, a useful set of relationships can be employed in describing the change in loudness of a sound. These are: a 3 dB increase represents a just noticeable difference, a 5 dB change is considered a significant increase, and a 10 dB change represents a doubling of loudness.

Sound also is described by the number of oscillations or cycles per second (notated as Hertz – Hz); this is the frequency. Although the frequency range of hearing is considered to be 20-20,000 Hz, the ear is not equally sensitive to all these frequencies. Frequencies from 1,000 to 4,000 Hz are heard best.

The length of time the sound is heard makes a difference in how the listener perceives the sound. A very loud sound with a very short duration, e.g., a gunshot, may not be as noticeable as a sound with a lower decibel reading but heard over a longer period.

For this study sound was measured using digital audio tape and an "integrating sound level meter." This device captures the sound in a manner similar to how the human hears. It calculates the sound pressure levels over various periods, usually one second, weights the reading, and stores the weighted result for each period.

While the integrating sound level meter can produce many metrics, two are commonly displayed: the "equivalent continuous sound level" denoted by L_{eq} and the maximum sound level, L_{Max}. The L_{eq} is the constant level of sound, in dB, that contains the same *energy* as the actual fluctuating noise over a stated time interval. The maximum SPL (denoted by L_{max}) is a metric used to capture the greatest noise level observed over the sampling period. Various levels are used to describe the sound heard over a given period, but the two most common are L_{90} – the level exceeded 90% of the time (often referred to a the background or ambient level) and L_{10} – the level exceeded 10% of the time (or intrusive noise levels).

Finally, the exposure level (SEL) is an energy average of noise over a certain time interval (like the L_{eq}), but it is normalized to one second. For example, a one-hour L_{eq} is found by averaging the one-second L_{eq}'s for the period, where as the SEL for that period is a summing of the same one-second L_{eq}'s. Because of its normalization the SEL is useful for comparing the effect of events with different maximum levels and durations.

Acoustical Comparison of Train vs. Wayside Horns

This is a comparison of the acoustical parameters of sound generated by conventional train-mounted horns with the wayside pole-mounted horns. To assess the sound levels generated by train-mounted horns vs. wayside horns, sound level data were collected by digital recordings. Two locations within the Village of Mundelein, Illinois, were selected for the recording sites. The Hawley Street crossing was selected because of its location downtown near reflective buildings and residential properties. The second site at the Winchester Road crossing was selected because of its location away from reflective buildings and is also more distant from residential properties.

Two monitoring stations were used; one at 110 feet from the centerline of the crossing and the second location at 300 feet. These represented two different points at which motorists would be expected to respond to train or wayside horns. Data sampling for the locomotive horns were made on in December 2001. The sapling for the wayside horns occurred late May/early June 2002.

Train-mounted horns are typically multi-tone, air-driven devices intended to emit a high sound intensity level. Each horn produces a different fundamental frequency (pitch). Usually, these sounds are dissonant meaning that the fundamental frequencies are not musically aligned. This dissonance adds to its alerting function. The wayside horn sound was created from a digital recording of a typical train horn. As such, few differences between the harmonic structures of the two types of horns were expected. However, there are other acoustical characteristics of a train horn that make it different from a wayside horn. This includes a ramp effect - the increase in amplitude as the train approaches, the Doppler Effect - a slight upward shift in frequency as the train approaches the crossing, and interference effects - the fluctuation in amplitude as the sound arrives at the listener by various direct and reflective paths that provide constructive and destructive interference.

It was not the purpose of this study to perform an exhaustive analysis of train and wayside horns. However, it was important to verify that the spectral energy in both cases is similar. These data confirm that, although the angle of incidence is a factor, because the amplitude and frequency content of the two types of horns are similar, the audibility inside a vehicle should also be similar. In other words, the sound transmission loss provided by a vehicle to diminish the intensity of the wayside horn would have the same effect on a train horn signal as well.

Train horns typically produce A-weighted sound levels of about 105 dB(A) at 100 feet. The typical horn is a blast of "long-long-short-long." For the second and third long blasts (when the train is close to or at the crossing) the average SPL was 92 and 103 dB(A), respectively. The 2nd blast is lower simply because of a greater distance to the recording station. The blasts from the wayside horn were uniform. Each ranged from approximately 94 to 97 decibels. The single greatest difference was that the loudness of the train horn increased as the train approached. The wayside horn was constant.

The sound levels at 300 feet from the crossing approximated those at 110 feet. Both horns were slightly lower in volume because of the added distance from the source. Variability of the train horns was greater at this distance because of the opportunity for more factors to influence the sound levels.

One major difference between the two horns was duration. While the sequences from the train and wayside horn were each approximately 17 seconds, the wayside horn sounded over two or more complete sequences, some as long as 45 seconds. These findings are important if the purpose of the wayside horn is to match the purpose of the train horn. In other words, it may be insufficient to simply reproduce the static amplitude, frequency, and duration of a train horn blast. Of importance may also be mimicking the dynamic features of a train horn, which would be to include only one sequence, adjusting the onset of the sequence, and providing an amplitude ramp to avoid startling pedestrians.

Comparison of Sound Levels in Residential Areas

To obtain a better understanding of changes in the sound levels in areas near crossings from when the train horn was being used to after the wayside horn began operating, the Northwestern University Center for Public Safety (NUCPS) conducted sound studies in residential yards. The research team used an integrating sound level meter for the recordings. These were taken in one-second intervals over a period of 24 hours for each location. Residents were located between 500 and 1,500 feet from that portion of the tracks where use of a train horn was expected. Sound samples were taken at a set of residences over a two-week period, in the fall of 2001 and again in the spring of 2002.

With availability of videotapes for drivers at crossings near the sampling sites, the arrival of a train could be linked to the actual recordings. For the train horns, their horn patterns were loud enough to present distinct differences in the loudness of the recorded data. This was not the case for wayside horns where many times, their volume was only slightly louder than the background noise..

Although the readings were taken a varying distances from the tracks and subject to varying levels of influence on their loudness (buildings, vegetation, etc.), when the L_{eq} was converted back to an expected level at 100 feet from the front of the train horn, the resulting adjusted dB readings were very similar. They differed by 6 dB from 99 dB to 105 dB. For the wayside horn, conversion back to the horn was within 3 dB of that level recorded at the selected distance of 110 feet.

A four-hour nighttime block from 8:00 p.m. to midnight was chosen for making comparisons because that is when the horns are most likely to be heard by the residents. The maximum decibel reading with train horns during the four nighttime hours for any location was 84 dB at two locations; the highest SEL was 95 dB. Background levels (L_{90}) ranged from 42 dB to 52 dB. The average sound levels of train horns during the four hours ranged between 10 dB and 30 dB above the 10% level, and generally were 30 dB higher than the background level.

The maximum reading of 75 dB for the wayside horn occurred at the Village Hall. It also was the closest location to the wayside horn, as well as directly in line with the direction of the speaker. The lowest maximum reading was 61 dB. On several occasions at a number of locations, the wayside horn could not be distinguished from the background level even when the train was known to be present in part because of the lower level of sound detected at a location and an increase in background noise levels during the spring. With the exception of the Village Hall, all median SEL's decreased. At three locations, the decrease was 3 dB or less; the largest decrease was 27 dB.

Equal contours of loudness were mapped using five contours representing 70, 75, 80, 85, and 90 dB. For example, the 70 dB contour produced by the train horns covered 4.29 square miles (mi^2) representing 37% of the 7.79 mi^2 computed for the entire village. The 90 dB coverage was 0.36 mi^2 or approximately 230 acres. This represented 3.8% of the village area. Because the sound from the train horn radiates fairly constantly over a 180-degree sector, the sound pattern for both directions of travel approximates a slightly flattened circle decreasing by one-half for each 5 dB decrease. Based on the attenuation of sound, a decrease in area by one-half for each 5 dB increase would have been expected.

On the other hand, the wayside horn is very directional with most of the sound energy occurring along the primary speaker axis. Outside that axis, the drop-off in sound is rapid. This is evident in the plot of contours based on sound readings from the wayside horns. The 90 dB reading for the wayside horn cover 0.02 mi^2, approximately 14 acres or 93% less area than the train horn. The decrease in area covered at 70 dB was somewhat less.

Concluding Comments

Use of the wayside horn, from an analysis of sound, is no different from the train horn. It is of equal loudness and covers the same frequency spectra. Given its directionality, the wayside horn may be more likely to be heard by the motorist and less likely by the residents. For those people living in Mundelein, the wayside horn has generated a significant improvement in quality of life in terms of a substantial reduction of noise pollution.

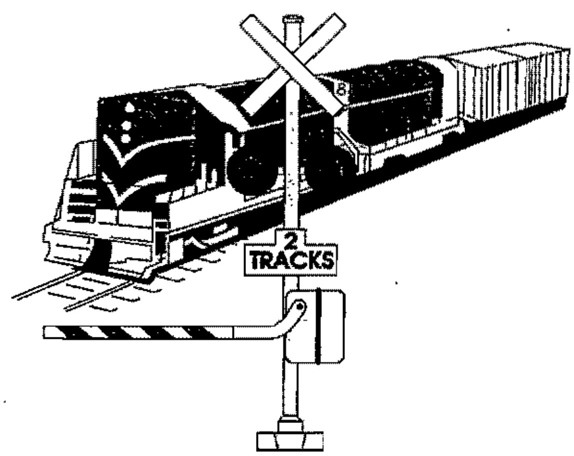
Train Horns, Wayside Horns, and Motorists. The sound levels at various frequencies from the wayside horn closely match the train horn. While the wayside horn sounds similar to the train horn, the operation of each is different. With few exceptions, motorists approaching a gated highway-rail crossing always are alerted to the presence of a train prior to when the train horn sounds. The bells, flashing lights, and descending gates serve this function. The train horn normally is not heard until 3 to 5 seconds after the gates fully descend. On the other hand, the motorist approaching a crossing with a wayside horn immediately hears the horn when the signals activate.

One problem is that because the wayside horns sounds at the same time the signals start to operate, the motorist has no warning for the loud noise. As a result, the wayside horn has startled and confused people. On at least 12 occasions, motorists stopped on the tracks and proceeded only after the gates had begun to descend.

Residential Sound. Implementation of wayside horns has made a significant difference in the residential quality of life from when the train-mounted horns were used. Some residents who were located several hundred feet from the tracks were hearing sounds above 90 decibels (similar to a jackhammer at 5 feet) at all times of day and night. Because of the relatively low background noise level, the train horns were of the magnitude of 8 to 16 times louder than the background. Moreover, the loud sounds were not limited to a relatively small area. The 85 dB curve, for example, covered approximately 0.71 square miles of the village.

Once the wayside horns were installed, sound coverage, especially at higher volumes, decreased by a factor of 10. Those benefiting the most lived at angles of 45° or more from the wayside horn. The problem that has arisen, of course, is that not everyone benefited. In a few cases, the volume recorded actually has increased. More importantly for a larger number of persons the sound exposure level also has remained approximately constant, or, perhaps, even increased. If the wayside horn more closely mimicked the train horn, this would reduce the length of its use as well as gradually increasing in volume.

Evaluation of the Automated Wayside Horn System in Mundelein, Illinois Final Report



Northwestern University Center for Public Safety
405 Church Street

Evanston, IL
January 2003

Evaluation of the Automated Wayside Horn System in Mundelein, Illinois Final Report

Executive Summary

Highway-Rail Crossing Safety and Train Horns

At highway-rail grade crossings, the train horn serves to warn motorists of a train's immediate approach. The horn advises motorists, and other crossing users such as bicyclists and pedestrians, that entering on or crossing the tracks would place them in imminent danger. However, because of the loudness and the wide angle of sound radiation, the horn can be an intrusive nuisance, especially in residential areas near the tracks. As a result, an automated wayside horn system (AWHS) has been developed to provide an appropriate warning for those using the crossing, while not annoying those living near the tracks.

A study was carried out in Mundelein, Illinois, that compared the train horn with the AWHS. This report compares motorists' driving behavior at highway-rail crossings and the sound levels of the two types of horns. The results from the evaluation show a significant 70% decrease in violations of highway-rail crossing law with the AWHS. Noise levels in areas near the tracks decreased by up to 85%.

Reducing the number of collisions between vehicles and trains has remained a priority in highway safety. During the past 10 years, collisions nationally have decreased from 4,684 in 1992 to 3,064 in 2001 (Federal Railroad Administration). During this same period, all collisions with trains in Illinois remained fairly constant with an average of 232 per year. Even though there has been a general decrease nationally, these collisions remain the most severe type in terms of producing injuries and fatalities. Crossing gates have the best record at reducing collisions, but a study done in Florida showed that even with crossing gates, a train horn still is needed. The Federal Railroad Administration (FRA) has proposed rules to require that horns be used at all crossings with few exceptions that are expensive to implement. The problem remains that the train horn, which, in Mundelein, starts sounding approximately 17 seconds before the train reaches the crossing, creates very high sound levels in adjoining areas.

As a result of the need to alert motorists and at the same time reduce the effect of sound on adjoining areas, Mundelein experimented with the use of the AWHS. The study reports the results of the evaluation of the AWHS.

Conduct of the Study

Five tasks were undertaken: site preparation, before and after motorist violation studies, before and after sound studies, quality-of-life studies, and surveys of engineers and residents.

At each of the three sites used for studying motorist behavior, utility poles were erected, and cameras and recording equipment installed. The recorders activated when the warning signals activated, thereby recording what motorists did during the period the gates were descending and down before the train arrived.

Drivers are considered to be taking risks (and violating the law) when they attempt to cross the tracks after the crossing gates start to descend. This action was measured by viewing videotapes made at each crossing during the period the gates were activated. Data were taken during the period train horns were in use, then after a period of adaptation, when the wayside horn was in use. The violations were divided into two classes:

> Technical violation where the driver crosses the tracks after the gates start to descend but before the gate has been lowered sufficiently to block the vehicle's passage, labeled a "Type 1" violation, and
>
> Deliberate violation in which the driver either drives through or around the lowered gate. These are "Type 2" violations.

Loudness and sound characteristics were measured on approaches to several crossings with train horns in use and then after the wayside horns were activated. A comprehensive assessment of these measures is contained in a separate report; this final report just summarizes the findings.

Measures of quality of life derived from two sources: sound studies in residential yards and a survey of the residents. The project team measured sound levels over 24-hour periods at nine locations throughout Mundelein. These measures were made during the period when train horns were used and again after the wayside horns were placed in service. Comparisons included the average sound level in one-second periods, during the time that horns were sounded, and a sound exposure level. The latter takes into account duration and allows direct comparison of sounds between different locations and over different periods.

In addition, surveys were sent to a sample of residents in Mundelein. The survey asked residents how they viewed the new horn system compared to the train horns. Several questions also were directed toward the residents' views of changes in crossing safety.

Finally, a survey was distributed to engineers from both the freight railroad (Canadian National) and commuter rail (Metra). This survey was modeled after the one used in Ames, Iowa, for a similar evaluation. It asked the engineers how they perceived the crossing safety before and after the wayside horns were activated.

Evaluation of Changes in Crossing Violations

From the period September 8 through December 20, 2001, 10,392 gate activations were recorded on videotape at three crossings. During the second period of observations, April 12 through July 16, 2002, 9,112 activations were recorded. Each period averaged 36 closings per day or 3.5 per 1,000 crossing vehicles. The largest percentage of closings, 17%, occurred from 6:00 p.m. through 9:00 p.m.

A total of 367 violations were counted during the period when train horns were in use. Only 97 violations were recorded once the wayside horns were in operation. The average violation rate when train horns were in use was 3.53 per 100 gate closings. This decreased 68% to 1.12 per 100 closings with the AWHS. The decrease is statistically significant. Type 1 violations (driving under a descending gate) occurred 358 times in the before period and 93 in the after period. A combined total of 13 drivers in both periods went around a gate. With few exceptions, most of the Type 1 violations occurred within the first two seconds after the gates began their descent.

Of the Type 1 violations recorded when train horns were in use, more than 90% occurred between 6:01 a.m. and 9:00 p.m. Between 12:01 and 3:00 p.m., 30% of all violations occurred. The largest percentage occurred on Hawley Street. Part of the problem stems from multiple gate activations when Metra commuter trains stop at the Mundelein station near Hawley St.

A total of thirteen instances were recorded where motorists drove around the gates. Nine occurred during the time the train horn was in use, and four occurred when the AWHS was operating. The decrease is not statistically significant. Approximately one-half the violations happened when a train arrived during the 60-second recording interval. In one case, a driver cleared the tracks just 6 seconds before a freight train arrived. On the average, 17 seconds separated the vehicle from the train. At 50 mph, a train would just have passed the whistle post; therefore, the motorist driving around the gates generally might not yet have heard a train horn if train horns were being used. As with Type 1 violations, a large percentage of Type 2 violations occurred in conjunction with Metra commuter operations.

One problem uncovered with the gate operations was gate closure without a train present. Often, this is referred to as a "false activation." These activations comprised approximately 13% of all closings. Metra stops at the Mundelein station and switching operations accounted for a majority of these activations.

Finally, an unusual situation was videotaped during the spring of 2002 in which drivers stopped on the tracks in an apparent response to the wayside horn sounding without prior warning. This happened on 12 occasions. When the drivers went forward, they generally cleared the tracks after the gates had closed just behind them. In other words, in most cases, the drivers occupied the tracks for 12 or more seconds. In one case, a driver backed up, just clearing the descending gate.

Survey of Residents and Engineers

Two sets of surveys were distributed to examine opinions of both the wayside horn and its perceived safety effectiveness. The respective surveys were administered to more than 1,250 Mundelein residents and to railroad engineers for both the Canadian National Railroad and Metra Commuter Rail.

Residential survey. The 229 residents who responded to the residential survey, by a substantial majority, found the wayside horn much less annoying than the train horns. The exception was persons who lived close to and in a direct line with the wayside horn. More than 15% of respondents found the wayside horn annoying, and a slightly greater percentage responded that "occasionally" the horns interfered with their activities. When compared to the train horn, 88% found the wayside horns either less loud or not even noticeable. A similar percentage also found them less annoying.

When asked about safety, approximately 9% suggested that they were less safe. The same percentage believed that motorists would be more likely to violate crossing laws. On the other hand, the remainder of the respondents believed that the crossings were as safe or safer with the wayside horn than they had been with train horns.

Engineer survey. Both Metra and Canadian National engineers also responded to surveys. One Canadian National and one Metra engineer believed that the crossing was less safe. Neither gave a reason for selecting that answer. However, both also did not like the method of notifying the engineer when the horns were not working. The remaining engineers believed the crossings to be as safe as or safer than when they used the train horn.

Analysis of the Sounds from Train and Wayside Horns

The key element of the evaluation addressed the differences between the train horn and the wayside horn as it might affect safety of the highway-rail crossing. For the village residents, it was of equal importance to compare how the two horns affected their lives. The findings are discussed in greater detail in a separate report produced as part of the project.

In terms of outcomes, the sound level of the wayside horn was equal to or exceeded that of the train horn for a driver approaching a highway-rail crossing. The exception was when the train reached the crossing, where the train horn was louder. This finding held for a motorist approaching the crossing, whether at the last point where the motorist could stop safely or at the sign warning the motorist of the approaching crossing. The two horns had similar frequency components and were of equal loudness at different frequencies. Perhaps the greatest difference was that the wayside horn is produced electronically and the train horn by air passing through tuned horns. As a result, the sound of the wayside horn had a certain artificiality.

The wayside horn had a significant impact on the quality of life in areas near the crossings. At the highest decibel levels, the wayside horn covered 85% less land area than the train-mounted horns. Even at lower levels, more than 65% less area was affected. The residential survey clearly bore out the findings from sound measurements. On the other hand, some persons were affected more than before. Some of this occurred because the pattern of the sound dispersion changed. Volume levels were elongated along the roadway so that some persons heard a louder horn than before. More importantly, because the horns were of constant volume and lasted longer than the train horn, this increased their apparently noise.

Summary and Other Issues

This evaluation of the automated wayside horn system (AWHS) compared the new system to the train horn. It examined three elements for differences:

1. Motorist violations of the law governing gated highway-rail crossings along with perceptions of its safety from drivers and railroad train engineers.

2. The nature of the sound heard by the motorist and the potential effects of any differences on safety at the highway-rail crossing.

3. Quality of life for residents as measured both by sound levels, and how the residents perceived the loudness and annoyance of the two warning devices.

With the introduction of the AWHS, motorists' violations of the crossing gates decreased 68%. This difference had less than a 0.0001 likelihood of occurring by chance. The largest change came from Type 1 violations or driving under the closing gates. Because so few motorists drove around the gates during the period the train horns were in use, the decreases occurring during the after period could not be said to be statistically significant. In responses to the surveys, both engineers and residents indicated that they believed the wayside horn created a safer crossing environment for motorists. Because there were no other known changes to the operation of the roadways, the wayside horn is the most likely factor in the reduction of violations

The sound studies showed that, in terms of nature and quality of sound, what the motorist heard from the wayside horn was generally no different from what he or she heard from the train horn. However, there were two differences in sound delivery. The first was that the train horn provides a sense of movement because it gradually increases in volume. The wayside horn starts and remains at a constant volume. The second difference was that the wayside horn sounds when the crossing warning lights first activate while the train horn is usually not heard until the gates are fully descended.

Residential quality of life, as measured by the noise levels in the crossing areas, improved significantly with the AWHS. At all levels, from 70 to 90 decibels, the reductions in area covered by a given decibel level, ranged between 65% and 85%. When residents living near the crossings were surveyed about the wayside horns as compared to the train horns, more than 80% of the respondents indicated that their quality of life had improved.

Finally, in referring to Type 2 violations (driving around the closed gates), none occurred at Allanson Road. At this crossing, there is a 6-inch raised concrete median that extends approximately 40 feet back from the tracks. While this does not quite meet the proposed FRA standards, it appears to have been sufficient in preventing drivers from going around the gates. Except for the two drivers on Maple who drove around the queue waiting for malfunctioning gates, all of the drivers who went around the gates were the first vehicles in line. Restricting the driver's ability to pull out around the gates for between 30 and 40 feet back from the gate, along with the presence of the wayside horn, probably would eliminate almost all Type 2 violations.

The conclusion then drawn from this study is that the wayside horn significantly reduces highway-rail crossing violations. It accomplishes this task while improving the quality of life for nearby residents.

LakeCounty

Village of Mundelein

For Immediate Release
Tuesday, January 21, 2003

Contact:
Joe Chekouras, Communications Specialist
(847) 377-2155
jchekouras@co.lake.il.us

Residents' Quality of Life Improved Thanks to Federal, State and Local Cooperation

MUNDELEIN, IL – Thanks to intergovernmental cooperation between federal, state and local government officials and partnerships with private corporations, the Mundelein area received a reprieve from the disturbing noise of train horns that can be heard up to two miles from railroad tracks. With six railroad crossings in Mundelein, two in neighboring Libertyville and one in Vernon Hills, and proposed Federal regulations requiring trains to signal at the crossings, residents frequently found their quality of life affected by the unwanted noise.

In an effort to minimize the disturbance for residents and downtown businesses, the Village of Mundelein partnered with the Federal Railroad Administration, Illinois Commerce Commission, Illinois Department of Transportation, Lake County Division of Transportation, Metra, Railroad Controls Ltd., Villages of Libertyville and Vernon Hills and Canadian National.

This task force worked towards the implementation of an Automated Horn System at each of the village's six railroad crossings. The system was activated on April 12, 2002, and the Northwestern University Center for Public Safety began studying the safety and quality of life benefits of the horn system.

- MORE -

The Automated Horn System refers to a stationary warning device mounted on a pole to sound an audible warning at the time an approaching train triggers activation of the railroad-highway crossing device.

Results of the Northwestern University study, as announced at a news conference on Tuesday, January 21st, demonstrate the quality of life benefits the horn system brings to Mundelein.

A survey of residents, conducted as part of the study, shows that more than 80% of residents feel their quality of life has improved as a result of the new horn system. Comments on the survey and letters to Mundelein officials express residents' gratitude and support for the automated horn system.

One resident wrote to officials, "...for the past ten years the noise has been unbearable. I am no longer awakened by the deafening sound of the trains..."

The Northwestern University study, which used video and sound recording devices to measure noise levels, show that noise levels decreased by up to 80% near the tracks and the area recording noise levels of approximately 90 decibels decreased by 87% from approximately 120 acres to 13 acres.

According to the conclusion from the Northwestern study, "...the wayside horn significantly reduces highway-rail crossing violations. It accomplishes this task while improving the quality of life for nearby residents."

Funding for the study came from a $150,000 grant obtained by the Village of Mundelein through the Federal Unified Work Program. A 20% funding match was shared by Lake County, Metra, Railroad Controls, Ltd., Villages of Libertyville, Mundelein and Vernon Hills and Canadian National.

- MORE -

"This project would not have enjoyed such success without the partnerships, both monetarily and through time and labor, that our task force members put into it," said Village of Mundelein Administrator Ken Marabella, who chaired the task force. "We in Mundelein are thankful that so many levels of government and private businesses were able to come together to make this project work. It's a tremendous benefit to the people of Mundelein."

Federal, state, county and village officials worked with the railroad companies and other private corporations for both the installation and study of the Automated Horn System.

- ### -

LakeCounty

Village of Mundelein

For Immediate Release
Tuesday, January 21, 2003

Contact:
Joe Chekouras, Communications Specialist
(847) 377-2155
jchekouras@co.lake.il.us

Automated Horn System Improves Safety at Railroad Crossings

MUNDELEIN, IL – A study by the Northwestern University Center for Public Safety demonstrates the safety benefits of the automated wayside horn system being utilized at six railroad crossings that traverse the Village of Mundelein and at two crossings in neighboring Libertyville and one in Vernon Hills. As a pilot program, the study has national implications on proposed future Federal law and has attracted interest from communities across the country.

Per proposed Federal Railroad Administration (FRA) law, trains would be required to audibly signal at all railroad crossings, resulting in a significant noise disturbance and a diminished quality of life for residencies and businesses. The Village of Mundelein, in an effort to reduce noise from passing trains, installed automated horns at its railroad crossings.

Standard crossing gates represent an effective means of preventing crashes at railroad crossings, resulting in a 60% decrease in vehicle-train collisions over the past two decades. Accidents continue to occur, however, because drivers ignore warnings, underestimate the speed of approaching trains and drive around closed gates.

- MORE -

In two separate studies, the Federal Railroad Administration found that when trains sounded their horns at crossings, crashes decreased compared to when there is no audible warning.

The Swift Rail Act of 1994 requires trains to sound their horns at crossings unless communities utilize four-quadrant gates, median barriers extending from tracks or camera systems to picture and ticket violators. The FRA's administrative rules are still pending.

Because these physical barriers and camera systems can cost up to $200,000 per crossing, trains horns continue to sound in most communities, causing a deterioration in quality of life for residents and businesses residing up to two miles from crossings.

As an alternative, wayside horns cost approximately $50,000 per crossing and significantly decrease noise disturbances.

According to the Northwestern study, crossing violations decreased by 70% after the automated horn signals went into place. The study recorded 367 violations when train horns were in use and only 97 once wayside horns went into operation.

The study utilized mounted cameras to record train, vehicle and pedestrian traffic at Maple Avenue (Illinois Route 176), Hawley Street and Allanson Road. During the before period of the study, taped from September 8 – December 20, 2001, researchers taped 10,392 gate activations at the three crossings. After the wayside horns went into operation, researchers taped 9,112 gate activations from April 12 – July 16, 2002.

A task force of national, state and local government agencies and private corporations studied and partially funded the automated horn system installation and Northwestern University study.

- MORE -

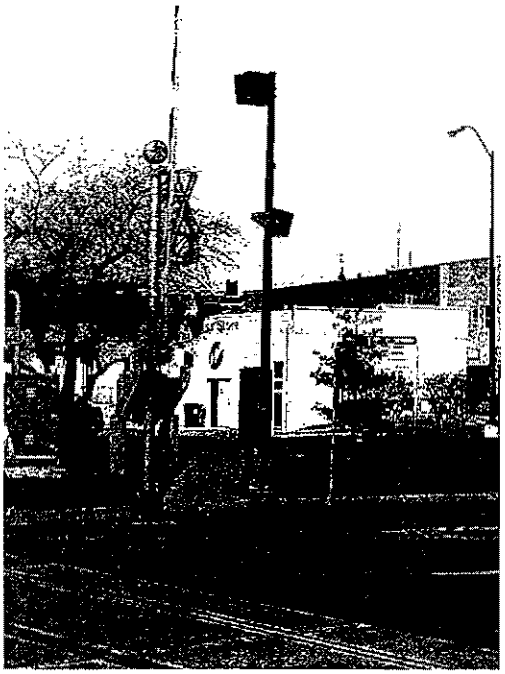
The Federal Railroad Administration, Illinois Commerce Commission, Illinois Department of Transportation, Lake County Division of Transportation, Metra, Railroad Controls Ltd., Volpe National Transportation System Center, Villages of Libertyville, Mundelein and Vernon Hills and Canadian National comprised the task force.

According to Mundelein Village Administrator Ken Marabella, who chaired of the task force, "This project clearly shows that cooperative partnerships at all levels of government and the private sector can effectively come together and successfully address important safety and quality of life issues."

- ### -

AHS™
Automated Horn System

Improve the Quality of Life In Your Community



What is AHS™ ?

AHS™, the Automated Horn System, is an innovative railroad signaling device that significantly improves safety for motorists and pedestrians at railroad-highway grade crossings while dramatically reducing the amount of noise pollution created by train horns along rail corridors in populated areas.

Reduces Noise by 98%

Sound Level (dBA)	Train Horn Area(acres)	AHS Horn Area(acres)	Percent Reduction
>70	265	37	86%
>80	171	5	97%
>90	31	<1	98%

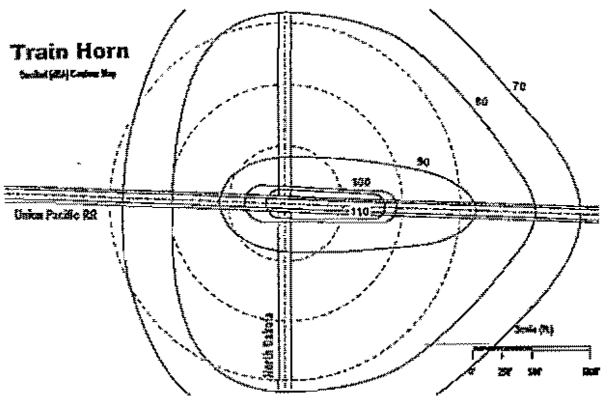
The Technology

AHS™ is a stationary horn system activated by the railroad-highway grade crossing warning system. **AHS™** is mounted at the crossing, rather than on the locomotive, to deliver a longer, louder, more consistent audible warning to motorists and pedestrians while eliminating noise pollution in neighborhoods for more than one-half (1/2) mile along the rail corridor.

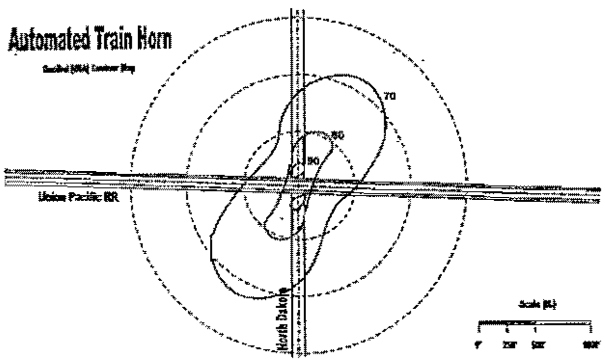
AHS™ is designed to sound like a train horn. The tone modules in the **AHS™** horns were digitally recorded from an actual locomotive horn. Upon receipt of the signal from the railroad's track circuit warning system **AHS™** mimics the train horn warning by cycling through the standard railroad whistle pattern until the train reaches the crossing. Once the train has entered the crossing **AHS™** stops sounding its horn. A confirmation signal notifies the locomotive engineer that **AHS™** is functioning properly. When the locomotive engineer sees that the confirmation signal is flashing, he will not be required to sound his horn unless he detects an unsafe condition at the grade crossing. Coordination with the railroad operating company is essential since **AHS™** is directly connected to the railroad's crossing signal-warning system. Additionally, the railroad operating company must issue instructions to their train crews regarding the sounding or non-sounding of the train's horn.

Railroad Controls Limited
500 South Freeway
Fort Worth, TX 76104

Phone: (817) 820-6300
Fax: (817) 820-6340



Train Horn



Automated Horn System

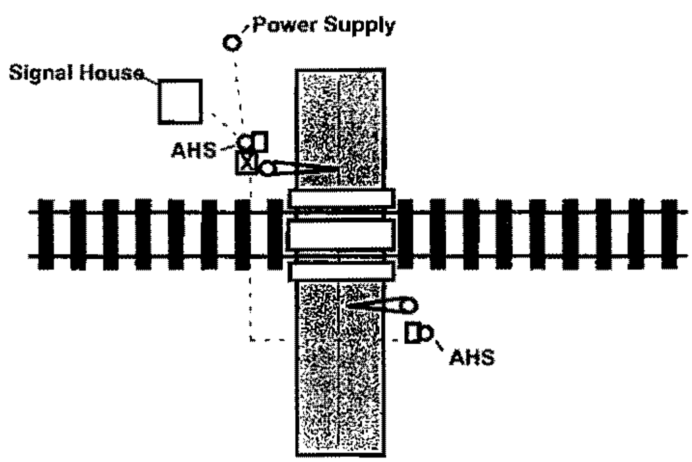
Sound Comparison Train Horn vs. AHSTM

The two noise footprints to the left depict the area impacted by the sound of the train horn and **AHSTM** respectively. The comparison of the train horn and **AHSTM** shows a dramatic difference between the areas that are impacted at specific decibel levels. By examining the 80 decibel contour on the two footprints it can be seen that the area impacted by the **AHSTM** is a fraction of the size of the 80 decibel contour produced by the train horn.

Note: The noise footprints were developed with actual data collected by the Iowa DOT in Ames, IA. The **AHSTM** footprint is skewed because the horns were aimed at the first four cars at the crossing. In actual installations the horns are focused as far down the roadway approach as possible, to create a symmetrical noise distribution along the roadway.

How AHSTM Connects to the Railroad

AHSTM connects with the railroad's crossing warning system in a manner similar to traffic signal preemption connections. Typically **AHSTM** horns and control cabinets are mounted on their own pole assemblies. The confirmation signal is attached to the top of one of the pole assemblies and must provide a clear line of sight to approaching trains from 1/4 mile away. Power is typically provided by the city.



Railroad Controls Limited
500 South Freeway
Fort Worth, TX 76104

Phone: (817) 820-6300
Fax: (817) 820-6340

CW 1-15-01

Re est. contact with Cesar 972-466-3050

Set up a Demos

Check w Lonnie re RR "acceptance" of
Quiet zones -

1-15-01

Report - FRA Rulemaking to be
included in report. rulemaking
Ammend that postponed, to July 1st

Report out this week

Weeks - This week
1st Feb thru 9th

Need a bucket truck

Cesar - Havn't done much - cap projects list
has too many demands on it

1-5-01

Kurt Anderson - Feb 9th OK - 10:30 but conflicts w Ron & Chris. 11 OK w Ron

Paul McRae is contact @ Champions
Need a Bucket Truck 972-490-5600
Need to come off
Setup meter in
Suite 100 - in Paul's Office

Richardson Morning News 2-25-01

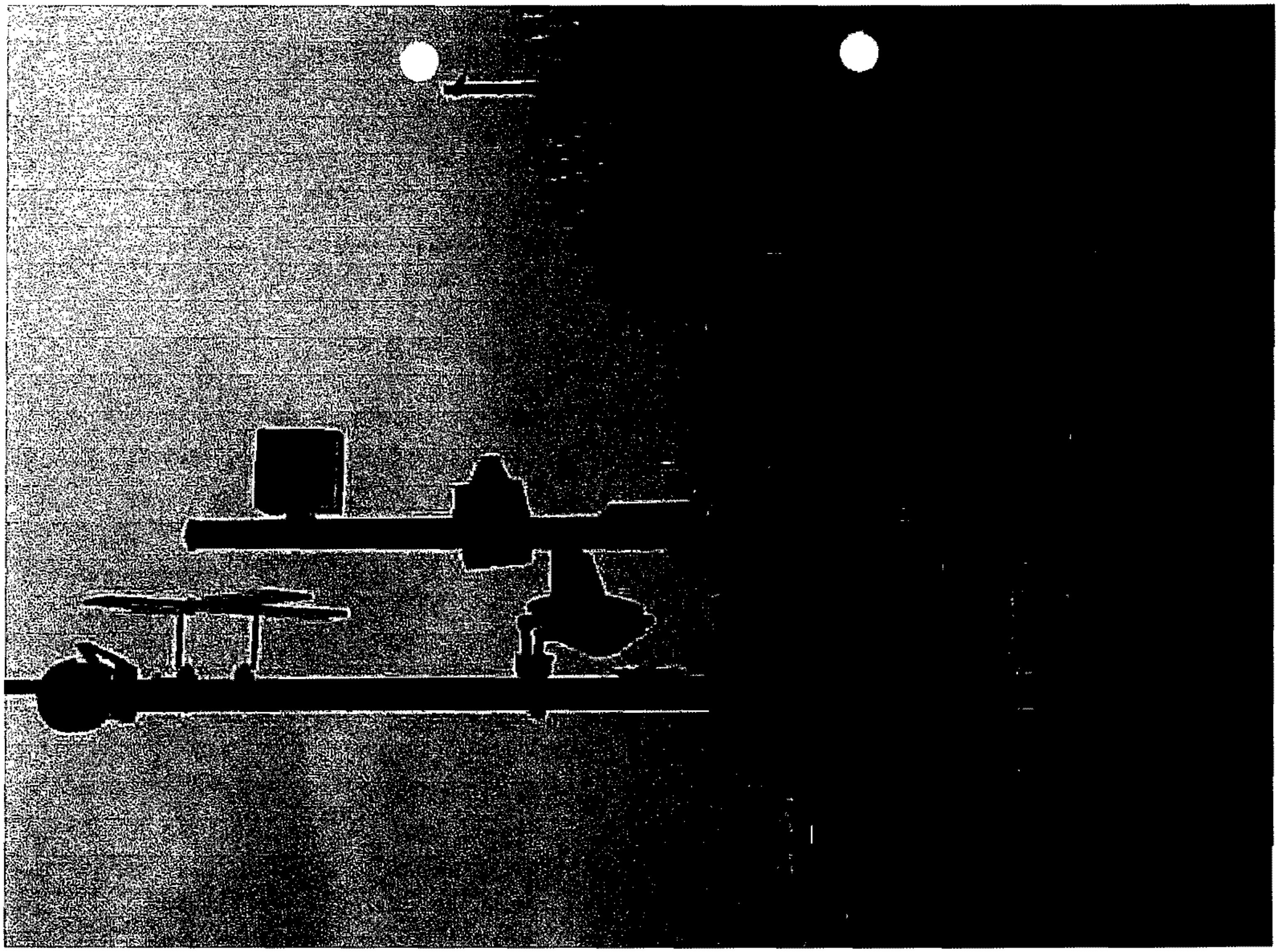
Making the rounds

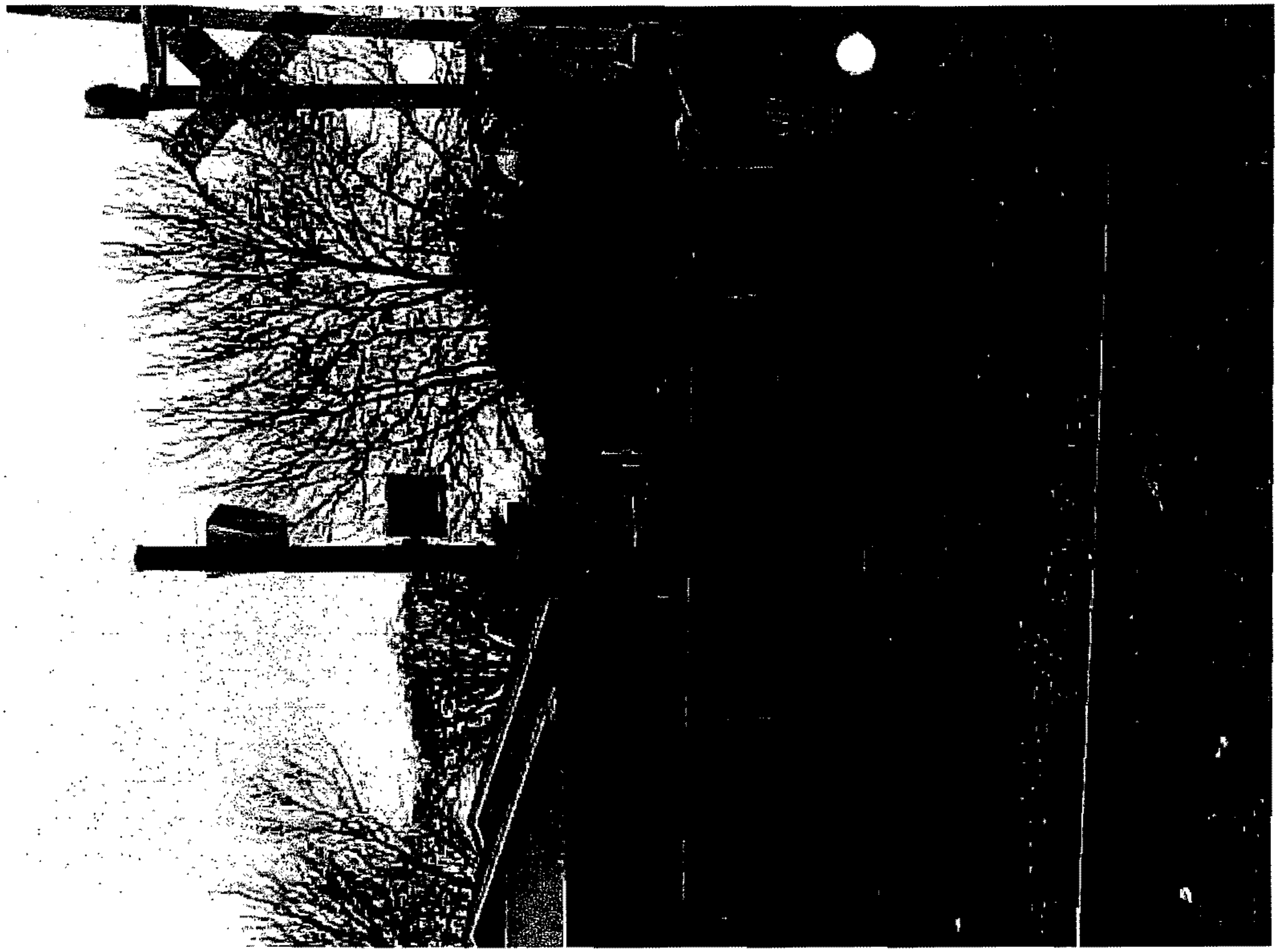
MARK M. HANCOCK/Staff Photographer

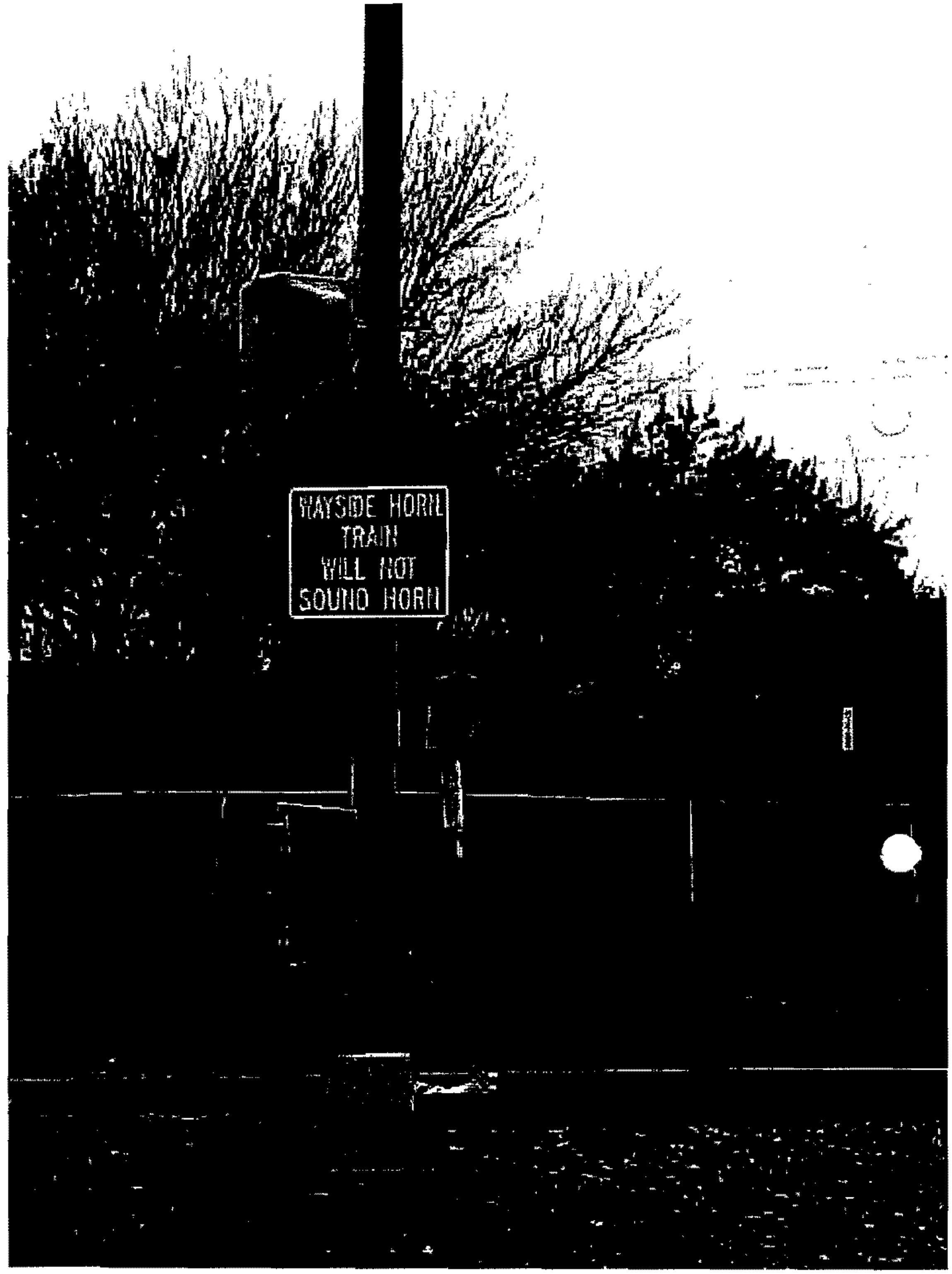
Former Vice President Dan Quayle examines the Wayside Horns during a visit to Richardson. The system, designed to reduce train horn noise, was tested Thursday at a Custer Road railroad crossing. The owner of the company that makes the device is a friend of Mr. Quayle's.

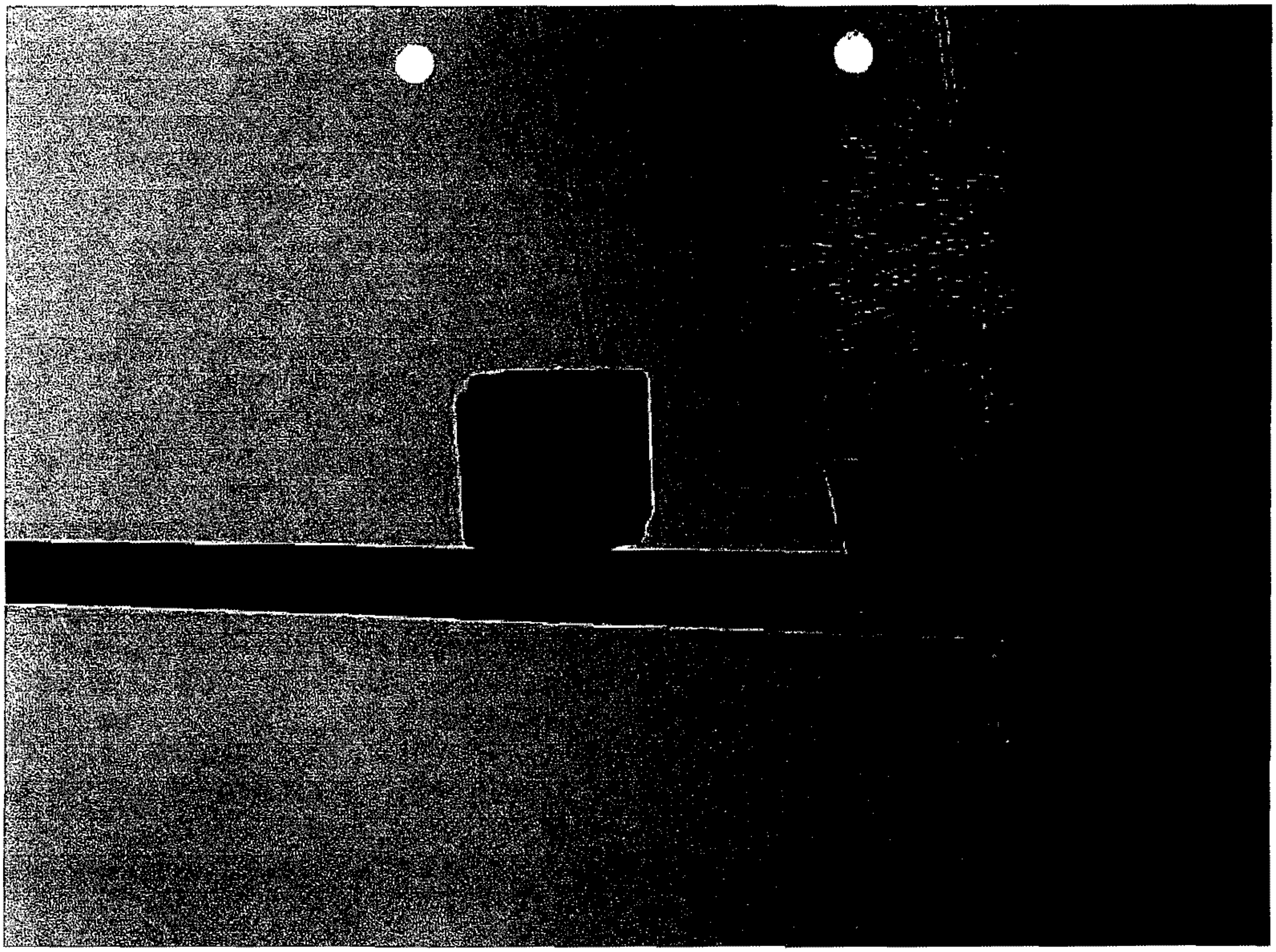
Cotton Belt RR @ Custer Road

1-2-01






WAYSIDE HORN
TRAIN
WILL NOT
SOUND HORN



Wayside Horn Sound Radiation and Motorist Audibility Evaluation

Prepared for:

Association of American Railroads
50 F Street
Washington D.C. 20001

Prepared by:

MIKE FANN & Associates
Consultants in Noise & Vibration
1701 W. Northwest Highway
Grapevine, TX 76051

May 24, 2000

Wayside Horn Sound Radiation and Motorist Audibility Evaluation

Executive Summary

Wayside horns are a viable alternative to locomotive horns for audible warning at grade crossings. Wayside horns have the advantage of being closer to the motorist. In addition, they have a more focused radiation pattern and produce less community noise exposure.

Previous FRA studies[1,2] have been encouraging but less than totally favorable. Consequently, RCL (Railroad Controls Limited Inc.) increased the warning volume capacity and added low frequency tones, seeking more resemblance to the classical train horn.

The current RCL horn was tested on May 3, 2000 to demonstrate both dBA and one third octave bands at 22.5° angular increments. This data allows more accurate community noise exposure forecasts and motorist audibility evaluations.

The Volpe Center evaluated the wayside horn as an audible device for approaching motorists prior to gate closure. With this perspective, they concluded that the historical horn volumes were insufficient. Consequently, RCL increased horn volume capacity in current systems by 6-10 dB. This change alerts 99% of approaching drivers with only partial anticipation of a train event. The system is just as successful at lower volumes, if the driver is at rest behind the gates.

The wayside horn is usually applied only to gated crossings with constant warning time control. Previous installations have constant warning time control which activate gates 25 seconds prior to train arrival. Gates are fully closed in 5 seconds, forcing the cars to stop. This is 20 seconds before the train arrives. In this situation, the wayside horn is not the primary warning device, but a secondary confirmation of train arrival. Horn audibility requires less volume because the car is at rest and closer to the horn location. The first car and fourth cars are 16' and 61' from the horn , respectively. In this example, the horn is audible to 99% of the population in the fourth car, with a volume of 83 dBA, outside the car. This is 19 dB less than maximum volume, which improves community compatibility.

With stationary cars, a wayside horn reference of 78 dBA at 100' is as good as a more distant train horn with a 96 dBA reference. Although unnecessary, louder wayside horn volumes up to 92 dBA can insure warnings as good as the full range of locomotive horn inventory. The focused radiation pattern minimizes community intrusions, making it a viable alternative to louder locomotive horn warnings.

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1 *Railroad Horn Systems Research*, U.S. Department of Transportation Federal Railroad Administration, Report No. DOT-VNTSC-FRA-98-2, January 1999

2 *Field Evaluation of a Wayside Horn at a Highway-Railroad Grade Crossing*, U.S. Department of Transportation Federal Railroad Administration, Report No. DOT-VNTSC-FRA-97-1, June 1998.

Introduction

The Volpe Center authored the first two references. The FRA publication "Railroad Horn Systems Research" is referenced many times. This publication provides current car noise reduction characteristics (insertion loss) and interior noise levels. It also provides a pivotal understanding of horn detection theory, based on driver's expectation and horn S/N values. The same basic methodology is used to calculate the warning level inside the car and to forecast motorist response. This report in part updates those conclusions based on the most current wayside characteristics. It also seeks to elaborate more on the wayside horn attributes at a gated crossing with constant warning time control.

The Volpe Center examined the audibility of approaching motorists, pointing out that the horn may be the first alerting characteristic of gate activation. The horn sounds at the same time as the gates start to close. Therefore, a driver might hear the warning before they saw the gates in a partially closed position. Their analysis of the horn is based on audible warning alone, without any synergistic contribution from visual observations.

The wayside horn application has only been applied to a crossing with constant warning time control. The electronic crossing circuitry activates gate closure, 25 seconds before the train arrives. The controls sense and account for train speed. Gates close fully 20 seconds before the train arrives.

The Volpe Center worries about motorists who stop at the gates and then drive around them without waiting for the train to pass. They determined that this motorist needs 10 seconds to accomplish that task. In this example, the wayside horn provides an additional verification that the train is coming to encourage re-evaluation.

In fact, this is the primary function of the wayside horn. The gates are always down before the train arrives. This perspective allows a lower horn volume because the drivers are closer, more attentive, with less interior car noise.

Wayside Horn Tests in Fort Worth, TX on May 3, 2000

The current wayside horn design produced 98 dBA (100'), on May 3, 2000 in Fort Worth, TX. The test site was a large parking lot, east of IH35. Highway traffic background noise averaged 65 dBA and 70 dBL. The lot provided 600' of clear space, except for one single building located 400', 22.5° counter clockwise, off centerline. The wayside horn was mounted 12' high on a parking lot light pole. Measurement heights are 4'.

Measurements were made at 100' and 200' distances in 22.5° increments, in front of the horn. The horn was then turned 180° for measurements on the back side. The table below presents these sound levels not only in overall, dBA, but also in one third octave frequency bands.

A type one, Quest model 1400 sound level meter provided the microphone input to a Rion Model SA 27 analyzer. The microphone has recent lab certification. A Quest Model QC-20 calibrator also provided field checks. Calibration checks included both 250 Hz and 1000 Hz and amplitudes of both 94 dB and 114 dB.

The horn software sounds two longs, a short and a long. Amplitudes were consistent in level and one or two events provided data at each of the 32 measurements. The data provides current reference amplitudes as well as typical radiation patterns.

Sound Levels, dBA

The current horn levels are 98 dBA at 100'. The level was 90 dBA at 200'. This result is unexpected because it deviates from the expected 6 dB change with distance doubling. It is premature to conclude that the fall off with distance is 8 dBA, with each doubling. Reflective interference unique to some hard surface test sites most likely causes the 2 dB difference. Reflective waves off hard surfaces can interact with sound that propagates directly to the microphone and cause additional reductions because of phase mismatch. This condition is a function of distance, measurement height, and surface reflective characteristics.

It is more likely that sound consistently reduces by the classical 6 dB with each doubling of distance. Later calculations use this assumption.

Wayside Horn Sound Levels 5/3/00

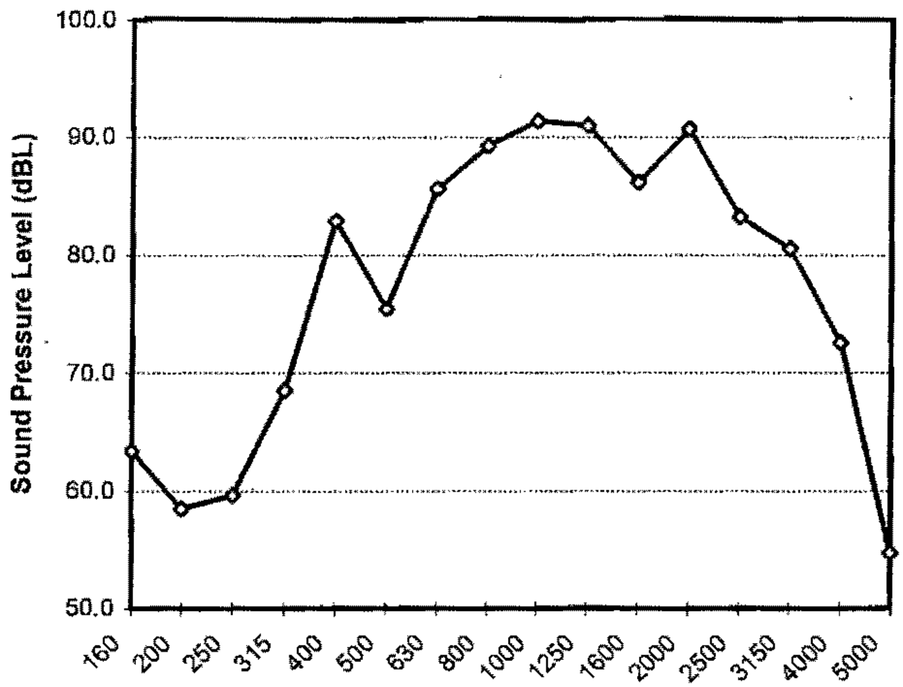
Table 1

Orientation	dBA	160 Hz	200 Hz	250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2500 Hz	3150 Hz	4000 Hz	5000 Hz
@100'	dBA	dBL	dBL	dBL	dBL	dBL	dBL	dBL	dBL	dBL	dBL	dBL	dBL	dBL	dBL	dBL	dBL
0.0°	98.0	63.4	58.5	59.6	68.6	82.9	75.5	85.7	89.3	91.4	91.0	86.2	90.7	83.3	80.5	72.6	54.7
22.5°	95.6	60.9	56.5	58.0	71.4	79.8	72.6	77.7	88.8	89.2	91.0	81.2	85.3	73.8	72.3	63.8	47.2
45.0°	91.5	62.8	57.7	58.8	69.8	73.8	71.5	76.6	87.9	86.5	83.9	71.2	73.4	70.0	59.7	53.0	45.3
67.5°	85.1	65.9	60.7	58.5	65.7	70.6	68.4	69.6	83.3	77.7	68.4	67.3	71.9	58.6	56.3	50.0	45.4
90.0°	78.7	61.4	56.8	56.7	63.9	71.1	66.4	74.9	74.0	71.4	66.0	63.6	65.5	55.2	52.5	48.5	45.2
112.5°	76.8	63.5	59.1	55.4	60.3	74.1	68.2	70.8	69.2	67.7	68.0	63.4	60.5	54.2	50.3	48.3	45.3
135.0°	76.4	60.9	56.6	55.3	63.2	74.5	67.1	62.3	69.9	68.8	66.8	61.0	61.5	54.6	50.3	47.8	45.3
157.5°	75.7	61.5	58.5	55.6	64.5	72.2	64.6	68.4	70.2	66.7	65.1	62.6	61.2	55.4	50.2	48.3	45.8
180.0°	77.9	64.6	60.3	57.3	61.7	76.1	70.7	67.0	71.9	68.9	67.7	64.4	57.5	54.9	50.2	48.9	45.0
202.5°	75.8	63.3	60.7	57.3	62.3	74.9	69.8	70.8	67.1	65.4	62.1	59.4	58.0	52.6	48.1	47.6	45.9
225.0°	75.7	62.6	58.0	55.1	61.7	74.9	69.3	67.6	69.0	62.8	63.4	61.3	57.7	53.8	49.3	48.7	45.4
247.5°	76.9	61.9	58.9	55.9	61.4	75.1	68.7	70.5	68.2	68.9	64.8	62.9	64.0	54.7	50.4	48.5	46.0
270.0°	79.6	65.9	62.6	56.9	60.4	78.1	71.8	71.6	74.1	68.9	64.7	66.5	61.9	55.0	50.4	48.7	46.4
292.5°	83.0	65.4	60.8	57.4	67.4	80.4	75.3	70.0	77.6	74.2	73.2	69.6	65.3	60.4	51.9	48.8	47.3
315.0°	86.6	65.6	59.0	57.4	69.2	74.7	72.7	74.1	80.4	81.5	81.2	70.4	68.7	69.0	53.6	51.8	52.2
337.5°	93.9	67.1	59.5	60.7	72.2	77.6	72.4	82.5	87.2	87.4	89.5	80.7	81.2	71.3	65.2	62.0	66.0
360.0°	98.0	63.4	58.5	59.6	68.6	82.9	75.5	85.7	89.3	91.4	91.0	86.2	90.7	83.3	80.5	72.6	54.7
200'	dBA	160 Hz	200 Hz	260 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1000 Hz	1250 Hz	1600 Hz	2000 Hz	2600 Hz	3150 Hz	4000 Hz	5000 Hz
0.0°	89.8	60.3	55.6	55.1	68.5	83.5	83.5	84.1	83.0	79.0	73.3	77.1	80.8	77.1	73.8	66.7	60.0
22.5°	86.8	63.0	60.3	55.5	66.2	85.8	81.0	76.6	79.4	73.4	70.9	74.4	75.4	64.5	60.0	54.6	47.1
45.0°	83.2	70.3	63.1	60.9	66.3	83.0	76.7	77.5	76.3	66.8	64.6	65.6	65.2	64.4	49.6	49.9	45.4
67.5°	79.6	63.0	56.4	56.3	66.2	76.5	75.2	73.2	75.0	63.9	55.9	65.8	64.4	54.7	48.6	47.8	45.8
90.0°	75.0	65.4	63.0	61.0	61.6	74.4	70.4	69.7	66.4	60.4	58.1	58.6	55.5	50.3	47.9	47.1	45.3
112.5°	76.1	60.9	54.5	51.7	61.0	73.7	70.7	74.0	69.5	58.4	59.3	56.6	53.8	50.2	48.8	47.7	45.3
135.0°	73.8	63.4	58.1	53.9	62.6	72.8	70.1	69.8	64.5	56.6	54.3	56.5	53.7	48.8	47.6	47.0	45.6
157.5°	73.0	60.4	55.7	54.0	61.8	72.8	68.4	66.0	62.8	58.6	55.5	60.3	55.3	49.2	47.4	47.1	45.2
180.0°	76.7	59.4	54.2	53.6	63.1	76.4	73.1	70.6	68.2	55.7	58.8	59.2	56.2	50.2	48.3	48.0	45.8
202.5°	76.9	65.9	61.8	58.7	62.1	78.0	71.9	70.7	65.0	56.5	55.5	57.2	54.5	50.3	47.9	47.7	44.4
225.0°	75.0	59.5	56.1	53.3	59.8	75.9	71.0	65.1	63.7	55.0	55.7	58.9	54.7	50.6	47.5	47.6	45.2
247.5°	76.2	62.7	60.1	54.2	63.2	74.9	71.2	72.8	67.5	56.1	58.3	60.9	60.7	52.8	48.9	48.3	45.5
270.0°	75.7	68.2	64.5	63.4	63.5	76.2	70.5	66.0	66.1	61.1	58.7	60.4	58.9	53.1	49.6	48.1	45.9
292.5°	80.5	63.8	58.5	56.6	65.8	78.4	77.6	72.3	73.2	68.8	67.0	65.8	64.2	56.4	51.2	47.7	46.3
315.0°	83.6	64.0	59.4	57.6	65.2	81.2	77.5	77.7	77.3	71.1	70.4	72.1	67.7	62.6	53.2	50.3	45.8
337.5°	87.1	60.7	53.0	56.4	67.7	78.9	76.0	83.8	76.9	72.5	76.0	80.4	78.2	66.3	58.1	57.7	47.4
360.0°	89.8	60.3	55.6	55.1	68.5	83.5	83.5	84.1	83.0	79.0	73.3	77.1	80.8	77.1	73.8	66.7	60.0

Frequency Content

Figure 1 presents the horn frequency content. The chart shows tonal amplitudes in one third octave band frequencies. There are significant differences in this chart from the frequency spectrum found in Figure 11, page 32 in "Railroad Horn Systems Research". Figure 1 includes a new low frequency tone. In addition, the levels are 10 dB higher and more closely resemble the train horn signature. This makes the frequency spectrum similar, in both frequency content and amplitude to a train horn.

RCL Wayside Horn Frequency Spectrum on Centerline at 100' Distance
Figure 1



A Union Pacific mainline track was located 1000' to the west of the test site. Several trains passed during several hours of testing, blowing the horn at grade crossings. The subjective resemblance to the wayside horn is remarkably similar.

Radiation Patterns

The physical characteristics of this warning device limit efficient radiation at frequencies below 500 Hz. Figure 1 infers that radiation is most efficient at frequencies around 1000 Hz. The wavelength of 1000' is approximately 1' and has directional tendencies. This is beneficial for limiting side radiation and minimizing community intrusions.

Figure 2 shows the change in levels with orientation at 200'. The shape is symmetric in front of the horn. Site background noise causes the symmetry deviation on the back side. The lower levels were not consistently 10 dB above the highway noise on the site.

RCL Horn Radiation Patterns
Sound Levels (dBA) at 200' Distance
Figure 2

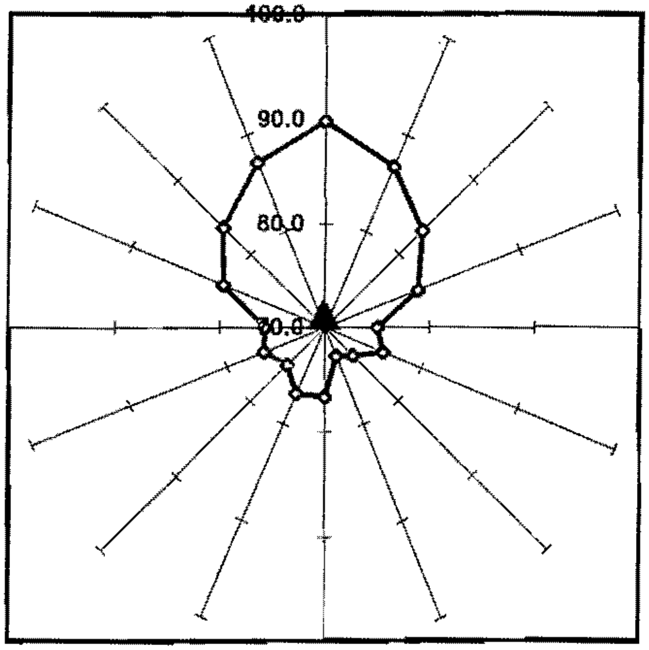


Table 2 lists the change in noise level with centerline orientation. The change is 3 dB, 22.5° either side of centerline. It progressively reduces another ~3 dB with successive 22.5° increment, up to 90° and then is fairly constant in level behind the horn.

Noise Reductions with Changes in Orientation for Horn Centerline
Table 2

Orientation	22.5°	45°	67.5°	90°	112.5°	135°	157.5°	180°	202.5°	225°	247.5°	270°	292.5°	315°	337.5°
Noise Reduction	3 dBA	6.6 dBA	10.2 dBA	14.8 dBA	13.7 dBA	16 dBA	16.8 dBA	13.1 dBA	12.9 dBA	14.8 dBA	13.6 dBA	14.1 dBA	9.3 dBA	6.2 dBA	2.7 dBA

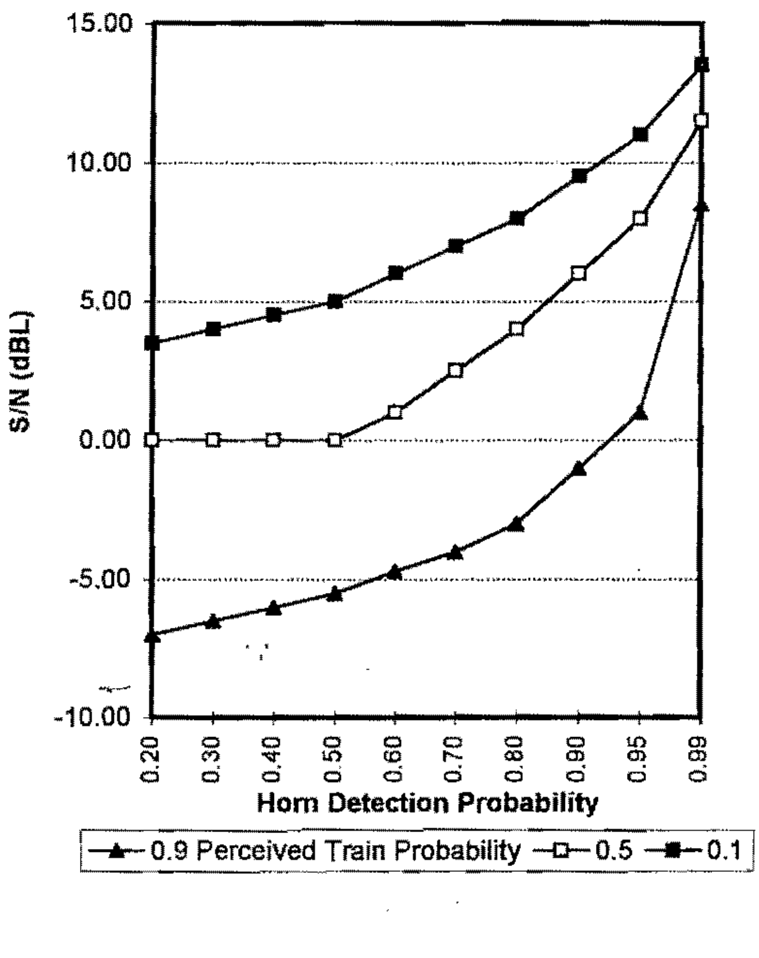
The horn level is substantially quieter on the back side. Levels reduce approximately 15 dB and are more omnidirectional.

Approaching Motorist Warning Detectability

An approaching motorist will hear the warning if there is sufficient amplitude based on car interior noise and the motorist's attention level. The FRA publication, "Railroad Horn Systems Research" presents a methodology for making this determination. The concept of tonal detection as a function of background noise level has been studied for many years. H. Fletcher published the concept of critical bandwidth in 1940.[3] Critical bandwidth recognizes that the human ear acts like a filter to hear a specific tone. Only a limited bandwidth of background noise tends to mask or cover up that tone.

Sanford Fidell made the concept more applicable to wayside horns in his publication, "Effectiveness of Audible Warning Devices on Emergency Vehicles".[4] He pointed out like Fletcher before, that audibility occurs with sufficient horn signal at only one tone (one 1/3 octave band). Other work in detection theory led to Figure 4 on page 24 of "Railroad Horn System Research". Figure 3 below is a reproduction.

Horn Detection Probability vs S/N
Figure 3



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[3] H. Fletcher, *Auditory Patterns*, Revs. of Mod. Phys., 12:47-65 (1940).

[4] Potter, R.C., Fidell, S.A., Myles, M.M., and Keast, D.N. *Effectiveness of Audible Warning Devices on Emergency Vehicles.* Report No. DOT-TSC-OST-77-38, August 1977.

Perceived train probability is defined as the motorist's expectation of a train. The motorist's previous driving experience may formulate an expectancy that he will see a train. This is similar, if not the same as the probability that the driver will actively look and listen for a train. The lower curve shows the expected result if the motorist looks and listens for a train, 9 out of 10 times. The results are similar to lab detectability tests when the subject expects a tone. Lab detection subjects routinely identify tones that are lower in level than the background noise. Figure 3 forecasts that this driver would hear the warning half the time if the horn signal inside the car were 5 dB less than the background noise. This is a -5 S/N (signal to noise). He would hear it 95% of the time if the horn signal were only 1 dB above the background noise level.

A preoccupied driver would actively look and listen for the train less often. Even so, they would hear the warning 50% of the time, with a +0 S/N (any one 1/3 octave band), if they only anticipate the train half the time.

Table 3 is a sample calculation of the horn S/N value. It is the same format used in Appendix E of "Railroad Horn Systems Research". The first tabular line item is the horn level from testing on May 3, 2000. Item 2 is the level at 358'. The calculation uses the classical change in distance of 6 dB with each doubling of distance. This distance is suggested as the necessary warning distance for a car traveling 40 mph (Table 12, page 34)[1] for a wayside horn application.

The car insertion loss is a measure of the car shell noise reduction characteristics. The values in item 3 are from Figure C-11 of Appendix C[1] and are an average of seven vehicles tested. Item 4 determines the horn level inside the car by subtracting the car insertion loss from the outside horn level.

The car interior noise is also an average of seven tested vehicles (Figure C-2)[1]. It is a classic shape with higher amplitudes at lower frequencies and a gradual reduction in amplitude with increased frequencies. Vehicle speed for interior noise is 30 mph with no ventilation fan operating.

Example Calculation of Motorist Horn S/N Values
Table 3

1.) Spectrum values from 5/3/00 testing

Freq	Hz 160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
@100'	63 dBL	59	60	69	83	75	86	89	91	91	86	91	83	81	73	55

2.) Calculating the horn level at 358' uses the levels at 100' and adjusts them for distance. This adjustment is 20*log(100/358)=-11 Subtracting 11 dBL from item 1.)

Freq	Hz 160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
@440'	52 dBL	48	49	58	72	64	75	78	80	80	75	80	72	70	62	44

3.) Car insertion loss[1]
These values will be subtracted in the next line from item 2.)

Freq	Hz 160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
IL	18 dBL	20	18	18	22	26	29	29	27	30	34	32	34	34	34	35

4.)Horn level inside the car. Item 2)-item 3)

Freq	Hz 160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
interior horn	34 dBL	28	31	40	50	38	46	49	53	50	41	48	38	36	28	9

5.) Average interior car noise

Freq	Hz 160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
Interior noise	61 dBL	59	58	56	53	51	47	45	44	42	40	36	34	31	30	26

6.) Horn S/N value inside the car

Freq	Hz 160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
S/N	-26.3	-31.7	-27	-16.8	-3.3	-12.2	-1.1	4.5	9.5	8.0	1.4	11.3	4.5	4.2	-2.2	-17.2

Comparison of the horn interior level with the car noise shows a positive signal to noise in seven consecutive bands from 800 Hz - 3150 Hz. Figure 3 shows that a 11.3 dB signal to noise in the 2000 Hz, one third octave band assures that 99.9% of the drivers hear the warning with only a 50% train expectancy. Even with this conservative assumption that the driver only looks for the train one half the time, 99.9% of motorists should hear the warning.

Stationary Motorist at Gated Crossing Audibility

At a gated crossing with constant warning time control, the wayside horn activates at the same time the gates start to close. Gate closure begins 25 seconds prior to train arrival and takes 5 seconds to close fully. Gates are down 20 seconds prior to train arrival. In this situation, the wayside horn is not the primary warning device, but is a secondary confirmation of train arrival. Horn audibility requires less volume because the car is at rest and closer to the horn location. The first car is 16' from the horn instead of 358' away traveling 40 mph. The fourth car in line is 61' away.

This calculation, in contrast to the last example, begins with the S/N necessary in any one third octave band and works backward to determine the necessary exterior horn levels. Item 1 is the average interior car noise at 30 mph. This includes tire noise which is too high for a stationary car. However, it is used for consistency.

Example Calculation of Necessary Horn Volume for Stationary Motorist
Table 4

1.) From Figure C-2 the average interior noise level is

Freq	Hz 160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
interior	61	59	58	56	53	51	47	45	44	42	40	36	34	31	30	26

7 dB signal to noise requirement
2.) Adding 7 dB to item 1.) for 99% detection rate

Freq	Hz 160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000

interior	68	66	65	63	60	58	54	52	51	49	47	43	41	38	37	33

3.) Car insertion loss

These values will be added in the next line to item 2.) to obtain exterior horn level requirements

Freq	Hz 160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
IL	18	20	18	18	22	26	29	29	27	30	34	32	34	34	34	35

4.) Adding 3.) + 2.) determines the exterior horn requirements for the fourth car in line at 61' distance.

Freq	Hz 160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
@61'	86	86	83	81	82	84	83	81	78	79	81	75	75	72	71	68

5.) Horn level needed at 100', adjusts for distance correction. Adjustment is 20*log(61/100)= -4.3 dB

Freq	Hz 160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
@100'	81	82	78	77	78	79	79	77	74	75	77	71	70	68	67	64

6.) 5/3/00 testing at 100'

Freq	Hz 160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
@100'	63	59	60	69	83	75	86	89	91	91	86	91	83	81	73	55

Wayside volume headroom

7.) Subtracting item 5.) from item 6.)

Freq	Hz 160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
Headroom	-18.0	-23.4	-18.7	-8.5	5.0	-3.9	7.2	12.8	17.8	16.3	9.7	19.6	12.8	12.5	6.1	-8.9

Item 2 calculates the necessary horn signal inside the car by adding 7 dB to each of the interior car noise levels. Figure 3 shows that this increase is sufficient to alert 99% of the drivers who listen 9 out of 10 times. Item 4 calculates the necessary horn level outside the car and item 5 calculates the corresponding reference distance at 100' from the horn. This is compared to the maximum levels tested on 5/3/00. Item 7 shows that the maximum levels are 19.6 dB higher than they need to be for alerting the fourth driver in line.

This is good news to residents immediately at the crossing. At gated crossings with constant warning time control, a volume of 78 dBA @ 100' (98 dBA -19.6 dBA) is sufficient. This 78 dBA reference level produces 83 dB outside the car because the fourth car is closer at 61'. The lower volume maximizes community compatibility without sacrificing warning effectiveness.

Train Horn Comparisons

With the gates down, the wayside horn is as effective as the more distant train horn. Table 4 demonstrates that 83 dBA outside the car is sufficient warning. This is achieved with a wayside horn reference of 78 dBA at 100'. Table 5 shows the corresponding train distance from the crossing, with the gates fully closed, 20 seconds prior to train arrival. It also shows the train horn level outside the cars for different volume train horns.

Train Horn Levels at Fourth Car : 20 Seconds Before Crossing
Table 5

Train speed	20 mph	22 mph	24 mph	26 mph	28 mph	30 mph
Train Distance to Crossing	587'	645'	704'	763'	821'	880'
96 dBA train horn	81 dBA	80	79	78	78	77
104dBA train horn	89 dBA	88	87	86	86	85
108dBA train horn	93 dBA	92	91	90	90	89
111dBA train horn	96 dBA	95	94	93	93	92
Wayside Horn	82 dBA	82	82	82	82	82

The wayside horn is as good as the FRA required train horn certification (96 dBA @ 100'). Although the lower wayside horn level is sufficient, higher level adjustment can match and exceed the higher train horn inventory.

Wayside Horn Reference Volume (100')
Necessary to Match Train Horn Volume Levels
20 Seconds Before Crossing
Table 6

Train Horn Level (100')	Wayside Horn (100')
96 dBA	77 dBA
104 dBA	85 dBA
108 dBA	89 dBA
111 dBA	92 dBA

Table 6 presents corresponding wayside horn volumes that match the level produced by different volume train horns, 20 seconds before train arrival. The wayside horn achieves the same result at a lower volume because the fourth car is only 61' away from the horn instead of the 587' comparative distance from the train horn traveling 20 mph.

Conclusions

Wayside horn applications have had favorable community responses at several installations. The maximum horn levels demonstrated on May 3,2000 are 6-10 dB louder than previous installations. Although unnecessary, this increased volume is available, if desired.

The focused radiation patterns maximize residential compatibility. This system is a good balance between adequate warning of motorists and minimizing community noise levels.

A SAFETY EVALUATION OF THE RCL AUTOMATED HORN SYSTEM
A Report from the Texas Transportation Institute

by

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May, 2000

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Background

Safety at highway-rail intersections (HRI's) has been dramatically improved since the 1970's through concerted public and private efforts. According to the Bureau of Transportation Statistics (BTS) accidents, injuries, and fatalities decreased between 1975 and 1995, by 38%, 49%, and 36%, respectively, even in light of increased traffic on both roads and rail. Ton-miles of freight increased by approximately 57% during the same period (BTS). This feat was accomplished through a multi-pronged attack on both grade crossings and drivers. The Federal Highway Administration (FHWA) estimates that between 1974 and 1995, the investment of over $3 billion in grade crossing safety for nearly 30,000 projects helped save almost 9,000 lives and prevent nearly 40,000 accidents. Federal funding, including the Section 130 Program, allowed most states to install active warning devices at high-priority crossings at a fairly steady rate. Coupled with public awareness programs like Operation Lifesaver, this one-two punch has proven that cost-effective safety gains can be made at HRI's.

Importantly, the improved safety record at HRI's has been achieved largely without much innovation in the *presentation* of warning systems themselves. Standard lights and gates remain the front line in safety, augmented by advanced warning signs, pavement markings, and the locomotive horn. This last element in the warning system arsenal, the locomotive horn, has been shown to be effective by its selective omission. In a rather unique and unintended demonstration of warning system efficacy, "whistle bans" in some communities have resulted in increases in accidents. In 1984, Florida imposed a whistle ban between the hours of 10pm and 6am on the Florida East Coast Railroad in cities along its operating corridor. In a subsequent study of the effects of the ban, the Federal Railroad Administration (FRA) reported that accidents increased by 84 percent across the 2,000 impacted intersections. In spite of increased accidents, however, Florida counties choose to maintain the whistle ban.

The central issue regarding whistle bans revolves around the intrusive and very disruptive impact of locomotive horns on the surrounding community. Federal regulations (CFR 49 Part 229.129) ensure that the volume of the horn is sufficient to reach motorists on roadways perpendicular to the trains and well enough in advance of the intersection to be able to respond safely to the train (i.e., stop). Herein lies the dilemma: to reach motorists at the proper angle to the HRI with enough time to provide for adequate stopping distance, the horn has to be loud. The intensity of the horn allows the sound to reach far beyond a desirable range, impacting everyone, whether in a vehicle or not. Community critics suggest that the locomotive horn works too well and alerts everyone, day or night, proximate to the intersection or not. The FRA and the railroads see the locomotive horn as an effective means of alerting motorists to the immediate presence of a train and consider the safety benefits gained worth the intrusive noise.

Federal regulations require the train horn to be 96 db at a centerline point 100 feet in front of the locomotive, and four feet above the track. This intensity is judged to be sufficient enough to reach down intersecting roadways, penetrate any barrier presented by the automobile itself, overcome other internal or external environmental auditory competitors, and alert the driver of the train's approach. Most of the time it seems to work, although as vehicles become better insulated, the challenge of alerting motorists increases. Unfortunately, reaching other people who happen to be in the vicinity seems far easier.

An innovative solution to this problem supported by some is a stationary horn mounted at the grade crossing. The stationary horn or automated horn system (AHS) is sounded in place of the train horn. Activated by the same mechanisms that trigger the active warning system, the AHS is designed to direct sound down the roadway rather than down the track. In this way, horns with less overall intensity may be able to deliver a more effective warning to vehicle operators approaching an HRI.

The Gering, Nebraska Study

A recent study of the automated horn system in operation in Gering, Nebraska, suggests that the AHS is effective in warning motorists (Volpe, 1998). In fact, with the AHS in place, motorist violations were shown to initially decrease over the rate seen with standard locomotive horn warnings. The Volpe report also examined the community response to the AHS relative to locomotive horns, performed some acoustic analyses, and observed driver behavior at the intersections where the AHS was installed. The results of the study suggest that the AHS was an effective substitute for the locomotive horn in warning motorists.

The AHS evaluated in Gering in 1995 consisted of a Federal Signal Selectone horn (model 302-GCX), a tone module (Federal Signal Universal Tone Module 13) containing the sound recording of an air horn and a control board which received the signal from the track circuitry and activated the horn. Mounted on the top of the horn case was a Federal Signal strobe light (model 131ST) that provided a visual confirmation for the locomotive engineer that the wayside horn was appropriately sounding. A detector installed inside the horn case activated the strobe light if the horn emitted a signal of at least 80 dB. If the wayside horn was less than 80 dB, the strobe light remained off and the engineer was instructed to manually blow the train horn. The system was subsequently enhanced with a digital recording which more closely resembles the 3-tone sound of a locomotive horn. This enhancement was prior to the data collection period in March and April, 2000.

The activation of the wayside horn was tied to the same circuitry that activated the crossing gates, flashing lights, and crossing bells. Gate descent began approximately two seconds after activation of the flashing lights, bells and wayside horn. When the track circuitry activated the AHS, the system repeated the sequence shown in Table 1 until the train reached the grade crossing. When the train reached the grade crossing the wayside horn sounded for five seconds. The system was designed to produce a sound pressure level of 114 dB at 10 feet and 98.9 dB at 50 feet.

Table 1. Wayside Horn Temporal Sequence

Sequence	Duration On (s)	Duration Off (s)
1	3.0	1.5
2	3.0	1.5
3	1.5	1.5
4	3.0	1.5

(from Volpe, 1997)

In the Volpe report, motorist violations at grade crossings were described as Type 1 or Type 2 violations. Type 1 violations were defined as those where the motorist is observed to drive through the grade crossing after gate descent is initiated, but before the gates were completely down. Type 2 violations were those where the driver proceeded through the crossing after the gates were completely down. In Gering, Type 1 violations were reduced by a statistically significant amount with the AHS over the rate observed with a standard locomotive horn. There were no clear differences between the locomotive horn and the AHS relative to Type 2 violations, perhaps in part since motorists are less likely to commit Type 2 violations in any event.

Problem Statement

"Whistle-bans," because of the negative safety ramifications, present a problem for railroads and any public agency responsible for the well-being of the traveling public. Currently, the Federal Railroad Administration, through its rule-making process, has plans to recommend five safety measures that "fully" compensate for locomotive horns and may therefore be substituted under whistle-ban conditions.

These supplementary safety measures (SSMs) are:

- four-quadrant gates
- photographic enforcement systems

- median barriers
- 1-way streets
- temporary closure (e.g., nighttime closure)

Further, under the proposed rule, alternative safety measures (ASMs) may be employed in combination with SSMs to "fully compensate for the absence of the audible warning provided by the locomotive horn." The ASMs include:

- variations of SSMs variations of SSMs
- long-tern programmatic law enforcement efforts and initiatives, and
- targeted public awareness efforts and initiatives

Thus, under the condition of a local ordinance banning locomotive horns, it is proposed that one or more of these sanctioned measures may be employed to compensate for the loss of the auditory warning. There are no plans to include the AHS as one of these measures due to lingering reservations about the long-term effectiveness of the system. The principal issue, therefore, seems to focus on the credibility of the AHS warning for motorists – do motorists learn that the AHS is just a device and not really a train and thus become more likely to disregard it, with a corresponding increase in the likelihood of accidents?

It is not suggested by proponents of the AHS that it is necessarily superior to the locomotive horn as a warning to motorists, but rather that evidence to date strongly indicates that the system is *as effective* as a locomotive horn system in alerting motorists to the potential hazard at an HRI and therefore should be included among the array of fully compensatory systems listed above.

Study Objective

The objective of this evaluation is to revisit the AHS installation at the Tenth Street location in Gering to assess the level of driver compliance with the warning system after approximately six years of operation. Initial AHS implementation was in July of 1994. The original posttest period was from May 24, 1995 to October 22, 1995. Data for this follow up evaluation was collected for 16 days from March 25, 2000 to April 9, 2000. TTI was engaged by RCL to examine the data collected at the site and report on the observed rate of driver compliance (Type 1 and Type 2 violations) with the AHS still in place.

Evaluation of AHS at the Tenth Street Crossing

RCL used equipment provided by Transit Surveillance Systems, Inc. to video traffic in both directions at the Tenth Street crossing. Each activation of the track circuit mechanism controlling the warning system (lights, gates, and AHS) also activated the digital video system and recorded the warning system behavior (lights and gates) as well as the behavior of motorists in both lanes of traffic on the approach to the crossing. The recording system continued in operation until the train had fully occupied the HRI. The collected digital video was stored on a computer for later analysis.

The collected data was delivered to TTI for processing and analysis in early May, 2000. TTI evaluated the behavior of motorists under the condition of extended exposure to the AHS at the Tenth Street crossing in Gering, Nebraska by recording Type 1 and Type 2 violations of the warning systems. The motorists in the vicinity of the Tenth Street crossing have been exposed to the AHS for over five years and thus the question of central importance to this evaluation is,

> "Do motorists, after extended exposure to the AHS, continue to heed the warning systems at the Tenth Street crossing at a rate which is at least as compliant as with the locomotive horn and thus may be considered as a fully compensatory system?"

The collected digital video data was scored by trained observers at TTI's facility in College Station, Texas. Rated violations were verified by both a second and third observer to ensure the accuracy of scoring. Appropriate statistics were used to assess the rate of violations at the target crossing during the post-posttest phase relative to that recorded during pre and post test by Volpe researchers.

Results

TTI evaluated 826 digital video records from the Tenth Street HRI in Gering, Nebraska. Of these, 815 observations were included in the analysis. Eleven activations of the recording equipment were omitted and scored as "false activations" due to no observed train activity at the intersection. The intersection tallied approximately 50 trains per day throughout the data collection period.

Volpe's 1997 report defines a Type 1 violation as, "vehicle went through the grade crossing during gate descent" and a Type 2 violation as, "vehicle went through the grade crossing after gate descent." These criteria were applied to the current evaluation to ensure consistency and allow meaningful conclusions to be drawn from the results.
The 1997 Volpe study of the AHS in Gering, Nebraska showed that Type 1 violations decreased following the introduction of the system at two roadways. Type 2 violations were not statistically different between the two systems (i.e., locomotive horn and AHS). It should be noted that

Volpe pooled the data from two intersections, the Tenth Street crossing and the Country Club Road, to derive the following table (Table 14, page 40, Volpe, 1997), which is reproduced here for comparative purposes. The Volpe report also evaluates "time to collision," which measures how far away the train is from the grade crossing when the motor vehicle is in the intersection. They found no significant difference in this measure between the two systems and, therefore, we are not reconsidering this measure in the current evaluation. The Volpe report also examines the frequency of false activations between the two systems, which is a function of track circuitry and not warning system and thus is omitted from the current evaluation as well.

Table 2. Frequency of False Activations and Violations for Two Warning Devices

	Actual Frequency		Frequency/1000 Trains		Chi-square Value	Significance Level*
	Train	Wayside	Train	Wayside		
False Activations	53	41	21	10	10.50	.0012
Type 1 Violations	48	35	19	9	11.22	.0008
Type 2 Violations	4	18	2	5	3.31	.0688

* Critical Value at 1 degree of freedom = 3.84 (from Volpe, 1997, Table 14, page 40)

The data presented above, specifically for Type 1 violations, shows the effectiveness of the AHS relative to the locomotive horn across a combined 6,481 train events. The differences observed suggest that, at least initially, the AHS may be *more effective* in alerting motorists of oncoming trains. The lack of statistical difference between the two systems for Type 2 violations suggests that the two systems perform equally well.

Table 3, below, presents data from the current post-posttest period relative to the pretest data collected by Volpe. This allows an indirect comparison of the AHS after a lengthy operational period with the baseline violation rate seen at the Tenth Street site in 1995. The results show that, while Type 1 violations with the AHS have risen over the rate seen following system implementation, they remain approximately on par with the rates seen with the locomotive horn. The statistical analysis indicates no significant difference.

Table 3. Frequency of Violations for AHS in 2000 Relative to Locomotive Horn in 1995

	Actual Frequency		Frequency/1000 Trains		Chi-square Value	Significance Level*
	Train	Wayside	Train	Wayside		
Type 1 Violations	48	15	19	18.4	.0062	.96
Type 2 Violations	4	0	2	0	1.28	.27

* Critical Value at 1 degree of freedom = 3.84

A comparison of the AHS in 2000 with the same system in 1995 (Table 4) shows that Type 1 violations are higher now than were observed in the original posttest period. It must be reemphasized that this increase in Type 1 violations is an increase in the frequency over the depressed rate observed after system implementation and not an overall increase.

Table 4. Frequency of Violations for AHS in 2000 Relative to AHS in 2000

	Actual Frequency		Frequency/1000 Trains		Chi-square Value	Significance Level*
	Wayside 1995	Wayside 2000	Wayside 1995	Wayside 2000		
Type 1 Violations	35	15	9	18.4	5.83	.015
Type 2 Violations	18	0	5	0	3.74	.06

* Critical Value at 1 degree of freedom = 3.84

Conclusions & Discussion

TTI's evaluation of the AHS data at the Tenth Street highway-rail intersection from March and April, 2000 in Gering, Nebraska suggests the following conclusions:

1. The AHS appears to be, after almost 5 years of operation, an effective alternative to the locomotive horn at the Tenth Street crossing in Gering, Nebraska, with a violation rate no greater than that observed during pretest monitoring.

2. The observed reduction in Type 2 violations at this site may even indicate that the AHS is a higher fidelity warning system than the locomotive horn, although examining only one site makes broad generalizations difficult.

Speculation regarding the initial drop in Type 1 violations following system implementation in 1995 cannot be substantiated without further study of the phenomenon, but it may be due to the greater "delivered" decibel level found with the AHS. An understanding of the affects of distance and physical obstructions on auditory intensity may help explain the effect. With distance, the diminished auditory intensity of a locomotive horn is a cue to the motorist, signaling the relative remoteness of the train. For very low intensities at grade crossings, this remoteness translates into time and thus a perceived safety margin for drivers. As the intensity increases, the perception of closeness of the source and "less time" for traversing an HRI heightens motorist vigilance. This intuitively obvious relationship helps explain the effectiveness of the train horn as a warning mechanism.

The distance-intensity effect may also explain why this warning strategy may break down from time to time, not always serving the motorist well, as environmental obstructions alter the locomotive horn intensity and thus may alter the motorist's perception of source distance and safety margin. Better insulated vehicles, loud stereos, buildings, trees, and other obstructions may contribute to the non-linearity of the distance-intensity cue provided by the horn. In Gering, Nebraska, after installation of the AHS, motorists were alerted to train presence by a higher intensity horn, accompanied by an understandable perception of source proximity. The observed behavior, perhaps, indicates that motorist's perception of the closeness of the source led to safer driving at the HRI and a significant reduction in Type 1 violations.

It could be further speculated that as motorists became experienced with the AHS, they learn that the distance-intensity cue is now a different type discriminator; one clearly associated with train presence, but no longer a good indicator of train distance. This uncertainty leads more motorists to stop rather than risk traversing the HRI. In fact, this cue to train distance has been replaced by activation of the warning system itself, which motorists learn precedes the train by a full 20 to 30 seconds. Motorists witnessing system activation may therefore be the only drivers likely to risk a hurried crossing of the HRI — not unlike motorist behavior at most active HRIs.

The fact that Type 1 violations at the Tenth Street crossing rebounded over time to locomotive horn levels is not seen by the author as indicative of a system weakness, but rather as confirmation that the AHS is an effective alternative to locomotive horn systems. Were the Type 1 violations in March and April, 2000 significantly higher than pretest locomotive horn levels in 1995, serious reservations concerning system effectiveness would have to be stated. This is particularly true given the high level of false activations seen at this busy site, both in 1995 and again in the spring of 2000 where motorists could be expected to have questions about the reliability of the warning they receive.

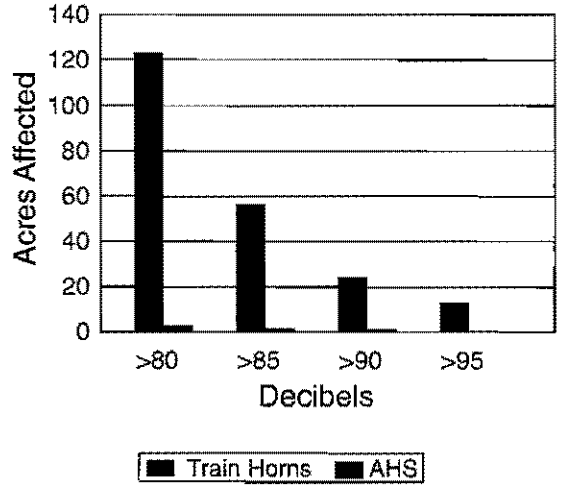
In summary, the AHS at the Tenth Street crossing in Gering continues to be effective as an alternative to the more disruptive locomotive horn. The system has been in place for almost six years at a site that is very heavily traveled (50 trains per day). It appears the measures of effectiveness, i.e., Type 1 and Type 2 violations, employed to assess every other SSM and ASM, indicate that the Automated Horn System is an effective alternative to the locomotive horn in warning motorists of the proximity of a train. Ancillary questions posed by some concerning factors beyond bottom-line system effectiveness, such as Doppler effect cues or horn directionality and intensity, seem to be holding the AHS to a standard different than that applied to other SSMs and thus appears unwarranted given the performance of the system in Gering.

Improve the Quality of Life in Your Community

Railroad Controls Limited is proud to offer an innovative railroad signaling device that significantly improves safety for motorists and pedestrians at railroad-highway grade crossings while dramatically reducing the amount of noise pollution created by train horns along rail corridors in populated areas. This product is called **AHS**™, the Automated Horn System.

What is AHS™?

AHS™ is a stationary horn system, which is actuated by the railroad-highway grade crossing signal warning system. **AHS**™ is mounted at the crossing, rather than on the locomotive, in order to deliver a longer, louder, more consistent audible warning to motorists and pedestrians while eliminating noise pollution in neighborhoods for more than one-half (1/2) mile along the rail corridor.

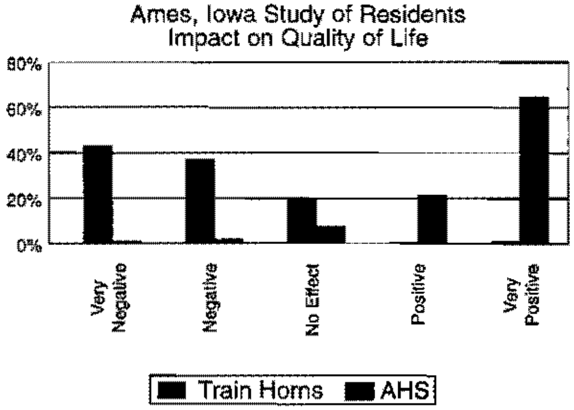


The Technology

AHS™ is designed to sound like a train horn. The tone modules in the **AHS**™ horns were digitally recorded from an actual locomotive horn. Upon receipt of the signal from the railroad's track circuit warning system **AHS**™ mimics the train horn warning by cycling through the standard railroad whistle pattern. This pattern continues to be repeated until the train reaches the crossing. Once the train has entered the crossing **AHS**™ stops sounding its horn.

Train Operations

When a train activates the crossing signal system, **AHS**™ activates its horns. When the internal fail safe detector determines the horns are working properly, it actuates the interconnected confirmation signal. When the locomotive engineer sees the appropriate confirmation signal he will not be required to sound his horn unless he detects an unsafe condition at the grade crossing. Coordination with the railroad operating company is essential since **AHS**™ is directly connected to the railroad's crossing signal-warning system. Additionally, the railroad operating company must issue instructions to their train crews regarding the sounding or non-sounding of the train's horn.



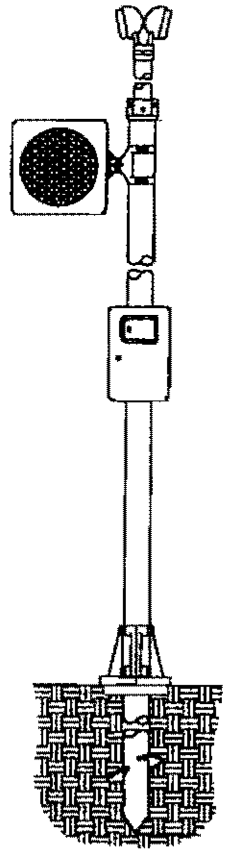
WHAT THE AMES, IOWA RESIDENTS SAY:

- "We had thought about selling our home because the trains bothered us so much. Then, Glory be to God, you installed the automated horns and we have a new life."

  "The automated horns are a very positive improvement for the neighborhood. ...take the next step and provide automated horns at all crossings in town."

- "This is the best thing the city has ever done to increase the quality of life in the residences."

- "We can think of nothing in 18 years of residence that has so much improved our quality of life."



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