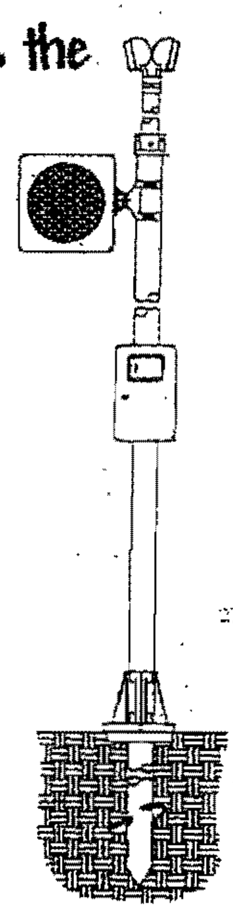
RCL

Railroad Controls Limited

AHS™

Railroad Controls Limited (RCL) presents the Automated Horn System



KURT ANDERSON WWW.RAILROADCONTROLS.COM

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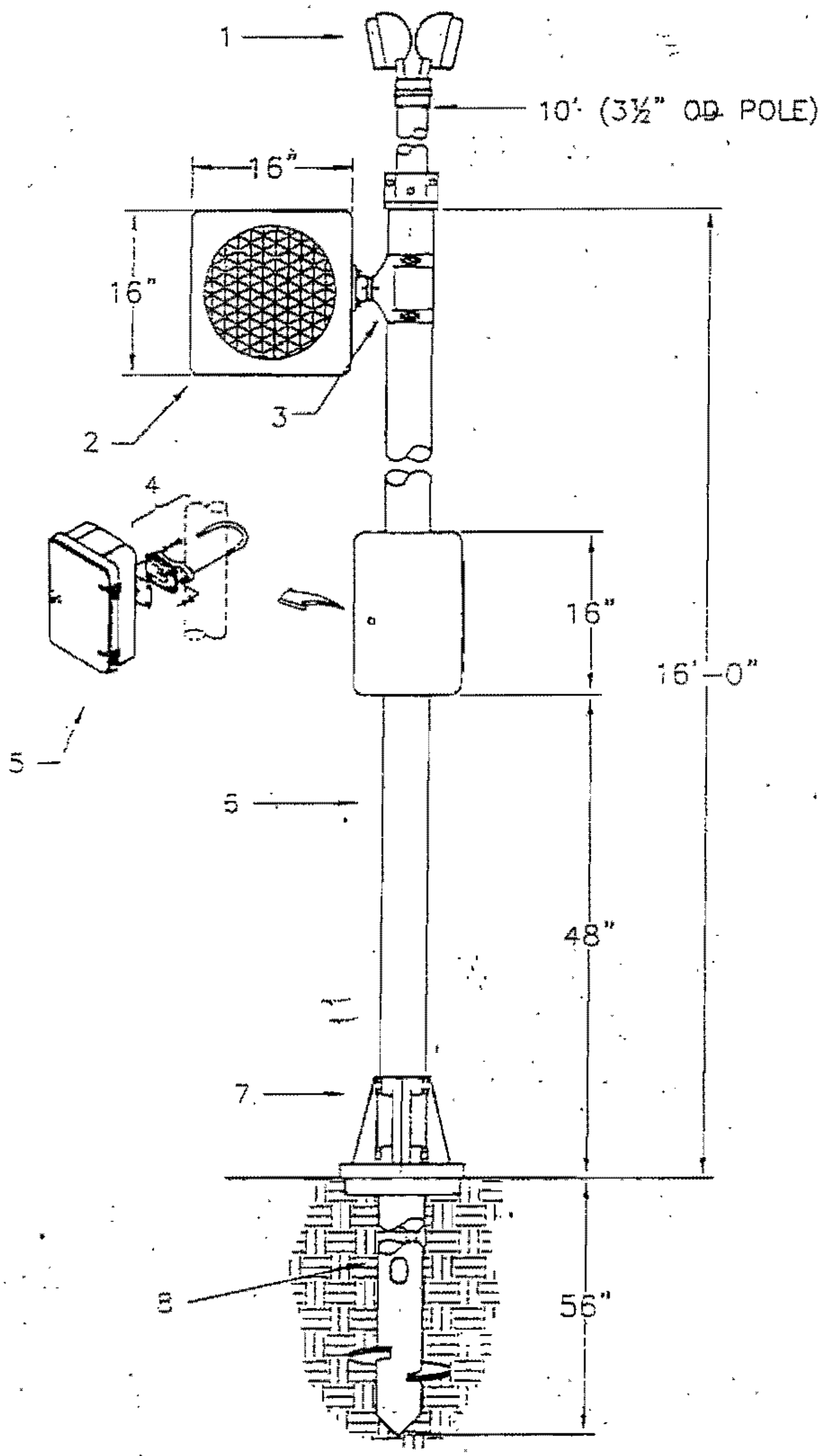
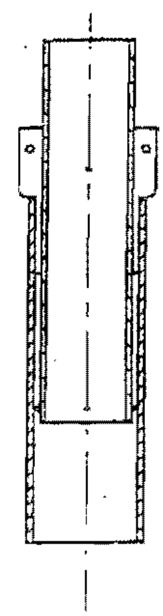
SPECIFICATION SHEET

PELCO PRODUCTS, INC.
[illegible] S. W. 15TH [illegible], OKLAHOMA [illegible] (405) 340-[illegible] FAX (405) [illegible]

AGENCY:	REF.:	PELCO NO.:
	WAYSIDE HORN & POLE ASSY.	RR-0806



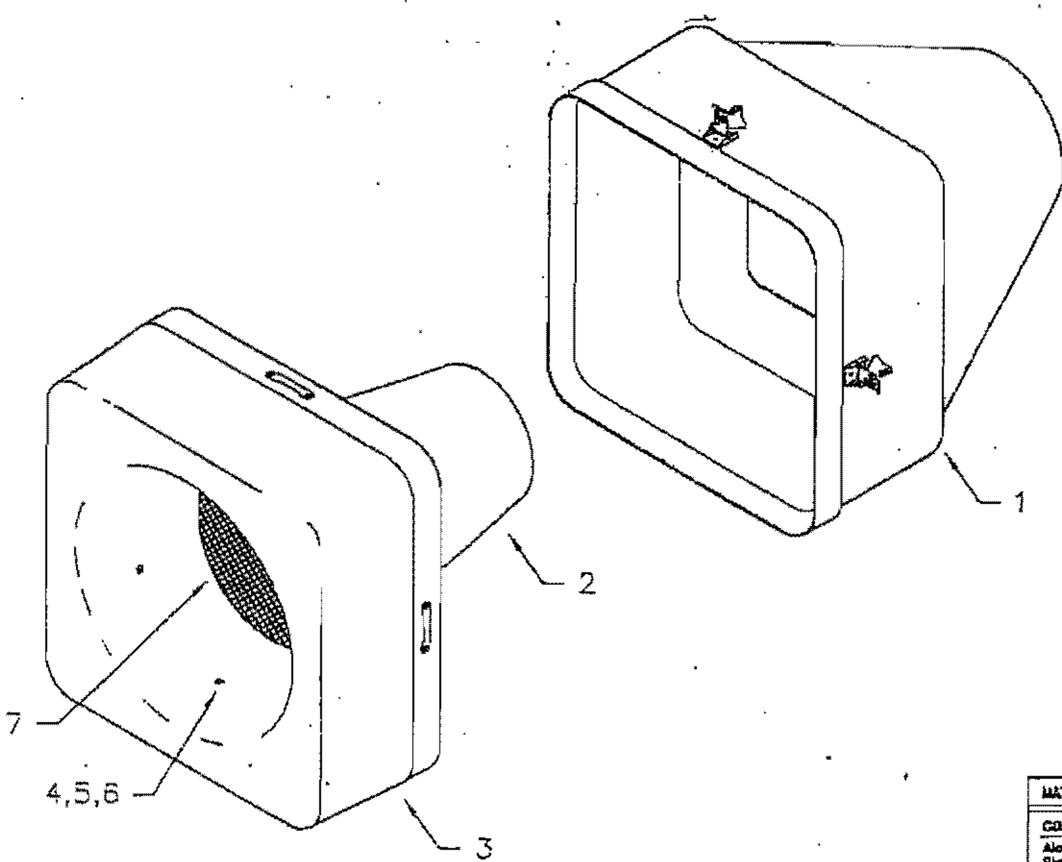


EXTEND-A-POLE

SPECIFICATION SHEET

PELCO PRODUCTS, INC.
320 S. K. 18TH EDMOND, OKLAHOMA 73013 (405) 340-3434 FAX (405) 340-3435

AGENCY:	REF.:	PELCO NO.:
	HORN ENCLOSURE ASSEMBLY	RR-8005



MATERIAL COATING LEGEND	
COATING	CODE
Alodine	ALD
Black Oxide	BOX
Brass	BRS
Chrome	CRM
Galvanized	GLV
No Coating	PNC
Zinc, Bright	ZN1
Zinc, Yellow	ZN2
Zinc, Ultra-Seal	ZN3
Painted	PXX

ITEM	PELCO PART NO.	DESCRIPTION	COAT	QTY
	RR-8005	HORN ENCLOSURE ASSEMBLY		1
1	RR-8012	BODY, HORN ENCLOSURE W/ STABILIZING INSERT & HARDWARE	PNC	1
2	RR-8013	REMOTE CONE, HORN ENCLOSURE	PNC	1
3	RR-8014	COVER, HORN ENCLOSURE	PNC	1
4	FS-3900-SS	SCREW, PHIL PAN HD. #10-32 x 5/8", STAINLESS	SS	4
5	FS-4103-SS	FLATWASHER, #10 STAINLESS	SS	4
6	FS-1203-SS	LOCKNUT, NYLON, HEX., #10-32, STAINLESS	SS	4
7	___-_____	SCREEN, FIBERGLASS, 14" DIA.	PNC	1

Evaluation of an Automated Horn Warning System at Three Highway-Railroad Grade Crossings in Ames, Iowa

by

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Evaluation of an Automated Horn Warning System at Three Highway-Railroad Grade Crossings in Ames, Iowa

By Steve J. Gent, Scott Logan and David Evans

Executive Summary

In September of 1998, the city of Ames, Iowa (population 48,000) began operation of three automated horn warning systems. These systems were installed after nearby residents repeatedly expressed their concerns over the disturbance created by the loud train horns.

Traditionally, locomotive engineers begin sounding the train horn approximately 1/4 mile from the crossing to warn motorists and pedestrians approaching the intersection. To be heard over this distance, the train horn must be very loud. This combination of loud horns, and the length along the tracks that the horn is sounded, creates a large area adversely impacted by the horn noise. Unfortunately, in urban areas, this area likely includes many nearby residents.

The automated horn system provides a similar audible warning to motorists and pedestrians by using two stationary horns mounted at the crossing. Each horn directs its sound toward the approaching roadway. The horn system is activated using the same track signal circuitry as the gate arms and bells located at the crossing. Once the horn is activated, a strobe light begins flashing to inform the locomotive engineer that the horn is working. If the strobe light is not flashing, or the locomotive engineer has a reason for concern regarding safety at the crossing, the engineer simply sounds the train horn.

The purpose of this research was twofold: 1.) determine the effectiveness of the automated horn system in reducing the annoyance level for nearby residents; and 2.) determine the overall safety at the crossings with the new automated horn warning system. The research included collecting horn volume data to develop noise level contour maps, using before-and-after surveys to document opinions of nearby residents and motorists, and a survey of locomotive engineers to document their perception of the new systems. The following paragraphs summarize the information collected during the study.

Horn volume readings were collected on a grid pattern and noise level contour maps were developed for the train horns and automated horn system. Use of the automated horn system reduced the area with noise levels greater than 80 dBA by 97 percent, from 171 acres using the train horns to less than six acres using the automated horn system. (For reference, a person shouting from a distance of three feet would produce a decibel reading of approximately 78 dBA.) The contour maps (shown on page 6) give a visual representation of the land areas impacted

by the two warning systems. When reviewing the contour maps, note that a typical person would perceive a 10 dBA increase as a doubling of "loudness."

The residents overwhelmingly accepted the automated horn system and appreciated the city staff for attending to their needs. In the before condition, 77 percent of the residents indicated the train horns had either a "negative" or "very negative" impact on their quality of life, compared to only 3 percent in the after condition. Regarding horn volume, 76 percent felt the train horn volume was "too loud" as compared to the after condition where 82 percent indicated that the automated horn volume was "no problem".

When the motorists were asked which system they preferred, 78 percent preferred the automated horn system, 8 percent preferred the train horns and 14 percent had no opinion. Their responses also indicated that each of the warning devices (gates, flashing lights and train/automated horns) located at the crossings provide a value-added safety benefit.

Ninety-two percent of the train engineers rated the overall safety at the crossings with the automated warning system to be "about the same" or "safer," compared to the before (train horn) condition. Seventy three percent of the engineers admitted to blowing the train horn at least once at the subject crossings after the automated horns had been installed. The two primary reasons stated for blowing the train horns were: 1.) concern related to motorist or pedestrian behavior at the crossing; and 2.) old habits are hard to break.

In summary: 1.) for nearby residents, the automated horn system greatly reduces the negative impacts resulting from the loud train horns; 2.) the automated horns are well accepted by both motorists and locomotive engineers; and 3.) the automated system appears to provide an equivalent level of safety at the crossings.

Introduction

In September of 1998, the city of Ames, Iowa (population 48,000) began operation of three automated horn warning systems located at the North Dakota Avenue, Scholl Road and Hazel Avenue crossings. The systems were installed at three crossings in the western and central parts of the city. Each of these crossings was already equipped with automatic flashing light signals with gate arms and constant warning time circuitry. By installing the new warning systems the city was hoping to improve the quality of life for the residents living near the crossings by reducing the volume of the train warning. Many residents had complained about the loud train horns and how adversely they had affected their lives. Currently about 60 trains per day pass through Ames, and this number is expected to increase to around 100 trains per day within five years.

The purpose of this research was twofold: 1.) determine the effectiveness of the automated horn system in reducing the annoyance level for nearby residents; and 2.) determine the overall safety at the crossings with the new automated horn warning system. The research included the following four initiatives.

Horn Volume Data - Noise level readings were collected before and after the automated horn systems were installed. This data was used to develop noise contour maps showing the maximum noise levels at various locations near a crossing.

Resident Survey - A written public opinion survey was developed and distributed to approximately 1000 residents living near the crossings. The residents were given the surveys before and after the automated horn system were installed.

Motorist Survey - Motorists waiting for stopped trains were asked several questions to determine their opinions regarding the train horn and the automated horn system.

Locomotive Engineer Survey - Twenty-six locomotive engineers completed a written questionnaire regarding the automated horn system.

The city of Ames was only the third community to install an automated horn warning system, with the other locations being Gering, Nebraska and Parsons, Kansas. All of the systems were designed by, and purchased from, Merrill Anderson of Railroad Consulting Services Inc. The city is currently negotiating with the Union Pacific Railroad on outfitting other crossings with the new automated horn systems. In its current agreement with the Union Pacific, the city is responsible for the purchase, installation, maintenance, and electrical power needed for the automated horn system. The agreement also states that the city is liable if an accident can be traced to one of the horns. Each system costs approximately $20,000 per crossing, not including installation.

Horn Volume Data Collection

As illustrated by the noise decibel contour maps (Figures 1 & 2) on the next page, the land area affected by the two types of audible warning systems at the same crossing is vastly different. The automated horn system not only reduces the land area adversely affected by the louder train horns, it also reduces the maximum decibel reading (horn volume) at all locations including properties in-line with, or in the path of the automated horn system. Table 1 shows quantitatively the land areas affected by the two types of audible warning systems.

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

Table 1

The contour maps represent the maximum volume obtained by the audible systems during the warning period. Figure 1 shows the noise contours for a train using the traditional train horn system and travelling in the westbound (right to left) direction. Figure 2 shows the maximum automated horn system volumes are being detected off the roadway, which would indicate that the automated horns need to be realigned.

After conducting this part of the study, it became apparent that two additional issues related to horn volume should be addressed through a future research project. The issues are: 1.) what horn decibel volume is required to adequately warn an approaching motorist; and 2.) at what distance from the crossing does that volume need to be provided? To give a reference to the first question, some typical decibel readings are listed below.

Food blender at 3 feet	87 dBA
Person shouting at 3 feet	78 dBA
Gas lawn Mower at 100 feet	70 dBA
Normal speech at 3 feet	65 dBA

When assessing the relative loudness of a given decibel level, it is helpful to understand the relationship between these two terms. The above typical decibel levels, and the following excerpt, were taken from the 1987 AASHTO Guide on Evaluation and Attenuation of Traffic Noise publication. It states, "An increase of 10 dBA in sound level will nearly double the loudness as rated subjectively by typical observers...A decrease of 10 dBA will appear to an observer to be a halving of the apparent loudness. For example, a noise of 70 dBA will sound only half as loud as 80 dBA, assuming the same frequency composition and other things being equal."

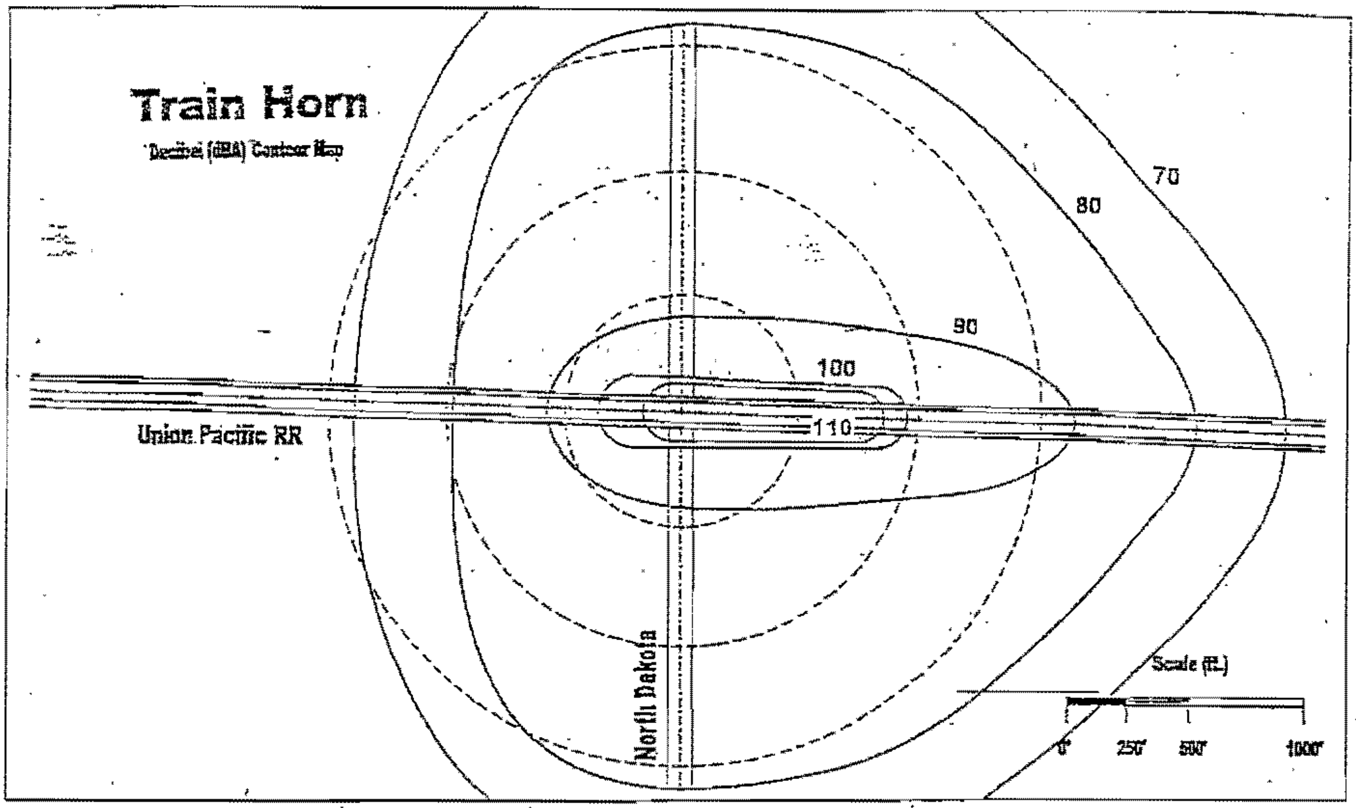


Figure 1

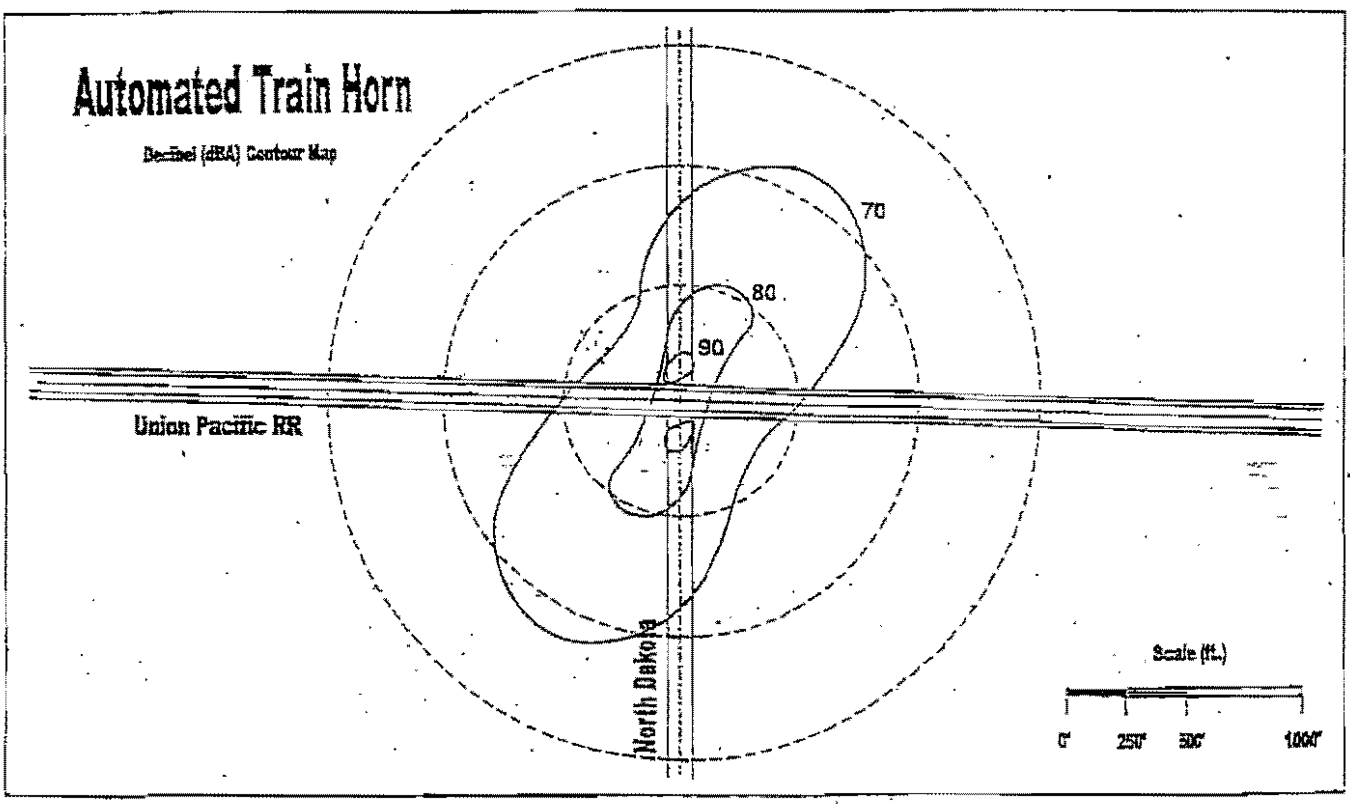


Figure 2

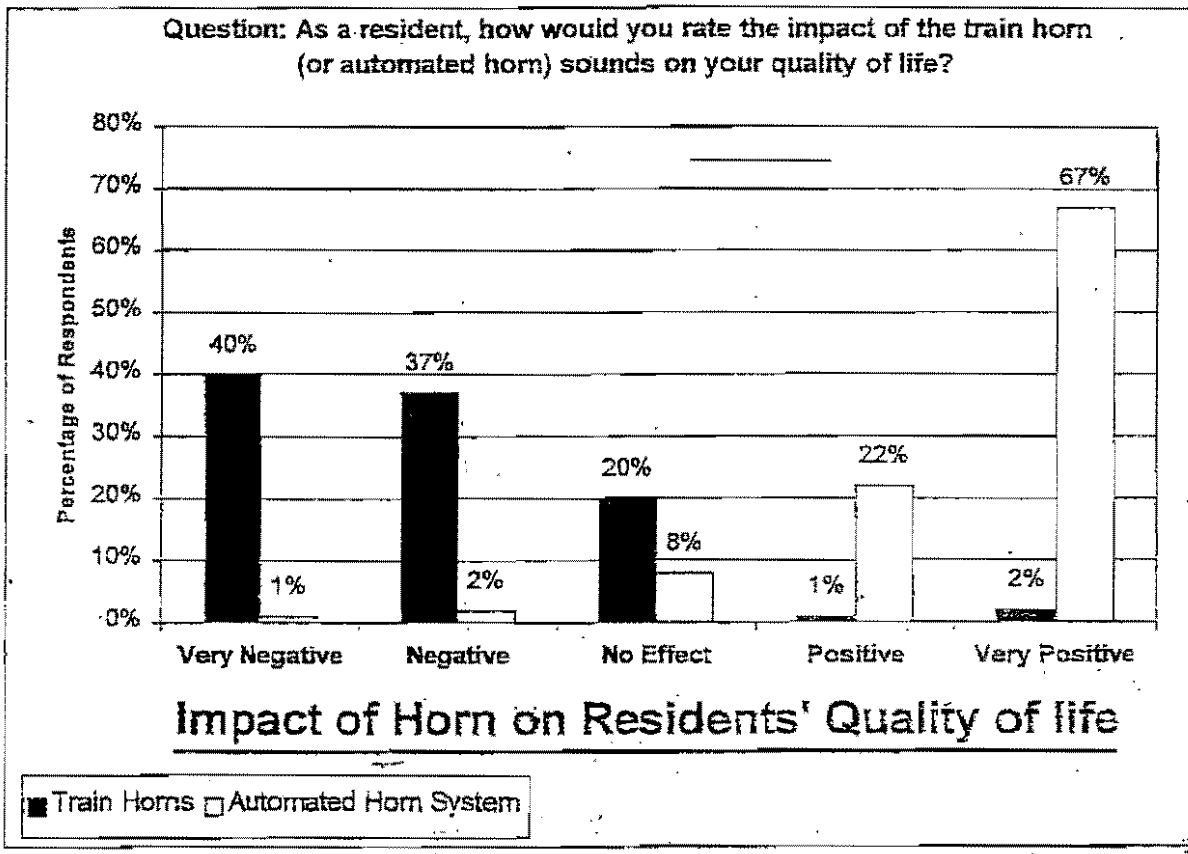
The issue related to distance may be approached by looking at Table II-1, A Guide for Advance Warning Sign Placement Distances found in the Manual on Uniform Traffic Control Devices. This table gives a minimum sign placement distance of 450 feet for a "STOP AHEAD" sign on a 55 mph roadway. The distance is 300 feet for 45 mph roadways and 150 feet for 35 mph roadways. These distances provide adequate time for the driver to perceive, identify, decide and perform the necessary maneuver. For highway-railroad intersections, these minimum distances present a reasonable starting point for the establishment of a requirement for an audible warning distance.

The noise level readings were taken using a Bruel & Kjaer, Model 2231, Type 1 Sound Level Meter. All readings were taken in the northeast quadrant of the North Dakota Avenue crossing and transferred to other quadrants to develop the contour maps. This quadrant provided a reasonably flat and open terrain with the approaching tracks being perpendicular to North Dakota Avenue. Two noise decibel readings were taken at the data collection stations in the before (train horns) and after (automated horn system) conditions. For the train horns, one reading was taken for an eastbound train and one reading was taken for a westbound train.

To look at the variability in train horn volumes, from one train to another, 12 readings were collected on North Dakota Avenue 250 feet from the tracks. The twelve readings averaged 95.5 dBA, with a low of 90.6 dBA, a high of 102.8 dBA and a standard deviation of 3.63.

Resident Survey

Survey questionnaires were distributed to all residents living within an area located 1,000 feet perpendicular to the tracks and 1500 feet longitudinal (each way) from the crossings. Surveys were distributed approximately two months before and two months after the automated horn systems were installed. The responses were overwhelmingly positive regarding the automated horn system. Graph 1 shows the before condition where 77 percent of the residents indicated the train horns had either a "negative" or "very negative" impact on their quality of life, compared to only 3 percent in the after condition.



Graph 1

At the end of each survey, the residents were solicited to write additional comments on the back of the form. Over half of the 550 returned surveys (approximately 1000 total surveys distributed) provided comments. The following examples provide a good cross-section of the issues and observations listed by the residents.

Before condition (train horns):

I understand the need for trains to make noise at intersections – to make their presence known to avoid accidents – but I don't appreciate the engineers who feel the need to blow the horn for the entire length of their trip. I feel that is unneeded, especially at 3 a.m. when there is nobody out on the roads anyway!

The train whistles are way too loud and long in my estimation. If I'm on the phone or listening to the TV, the loud whistles are especially annoying. Also my sleep is often interrupted many times during the night because of the loud whistles. It would be very much appreciated if the noise could be greatly softened and still keep the crossing safe.

It is essential to have adequate warning of approaching trains, however, the existing train whistles seem unnecessarily long and loud. I think a town the size of Ames with so many railroad crossings should be looking at building more overpasses, which would provide for more safety, convenience, and would allow the trains to be more quiet.

After condition (automated horn system):

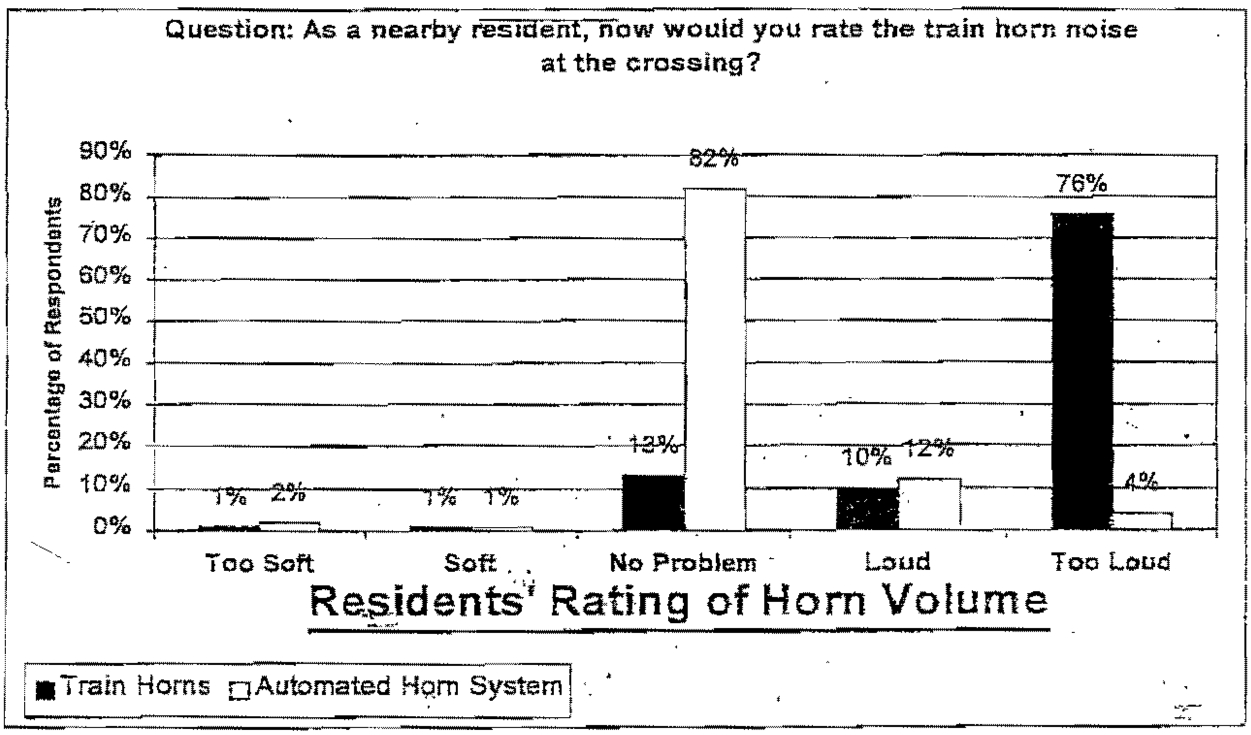
Installation of the automated horn system was a very positive step. There is an occasional train operator that still uses the train-mounted horn to make a statement as he/she passes through our neighborhood. This just reminds us of how much better the noise level is a majority of the time. Thank you for continuing to support our neighborhood in its efforts to improve the quality of life of the residents.

I have lived in this neighborhood nearly my entire life. I thought I was used to the train noise. However, with the many trains that go through now, and with the noisy horns, it was affecting my lifestyle. These new automated horns are great and I really appreciate their installation. I used to worry when I had overnight company that they would be kept awake by the noise, and often they were. Now they aren't, thank you.

Thank you very much for your work on this. It has been a great improvement. I am reluctant to say it is 100% solved since it is winter and our house windows are all closed. I don't know how it will feel in the summer. I live about 150 yards from the crossing at an angle, and can just hear the horns inside the house with the windows closed. But I can now choose to ignore them and continue my phone conversations. This is a major improvement.

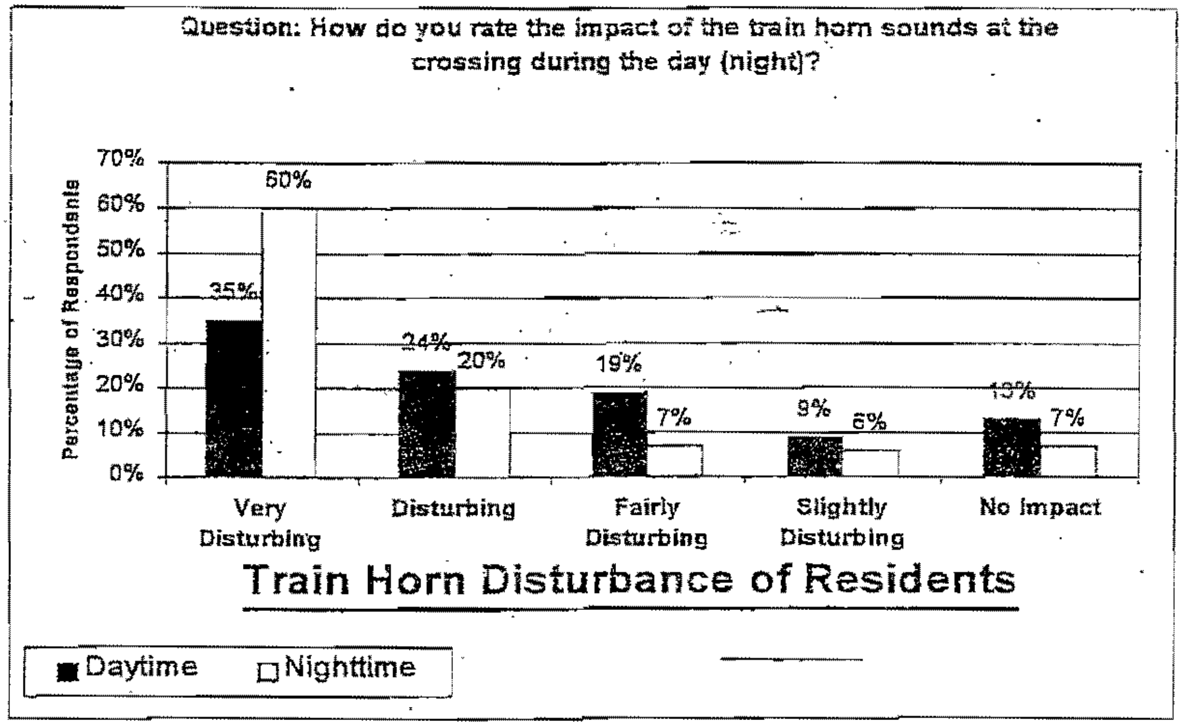
The comments received leave little question as to how appreciative the residents were of the automated horn system. To determine if the perpendicular distance from the tracks affected the survey responses, the distributed surveys were differentiated between the residents living within 500 feet of the tracks, and the residents living between 500 and 1,000 feet of the tracks. The residents living closer to the tracks were slightly more "extreme" in their survey responses. However, the residents living further from the tracks shared the same concerns regarding the train horns and shared the same positive responses regarding the automated horns. Residents living further than 1,000 feet were not included in the survey.

Graph 2 shows the resident's rating of the before and after horn volume. In general, they felt the train horns were too loud, and the automated horns were not a problem.

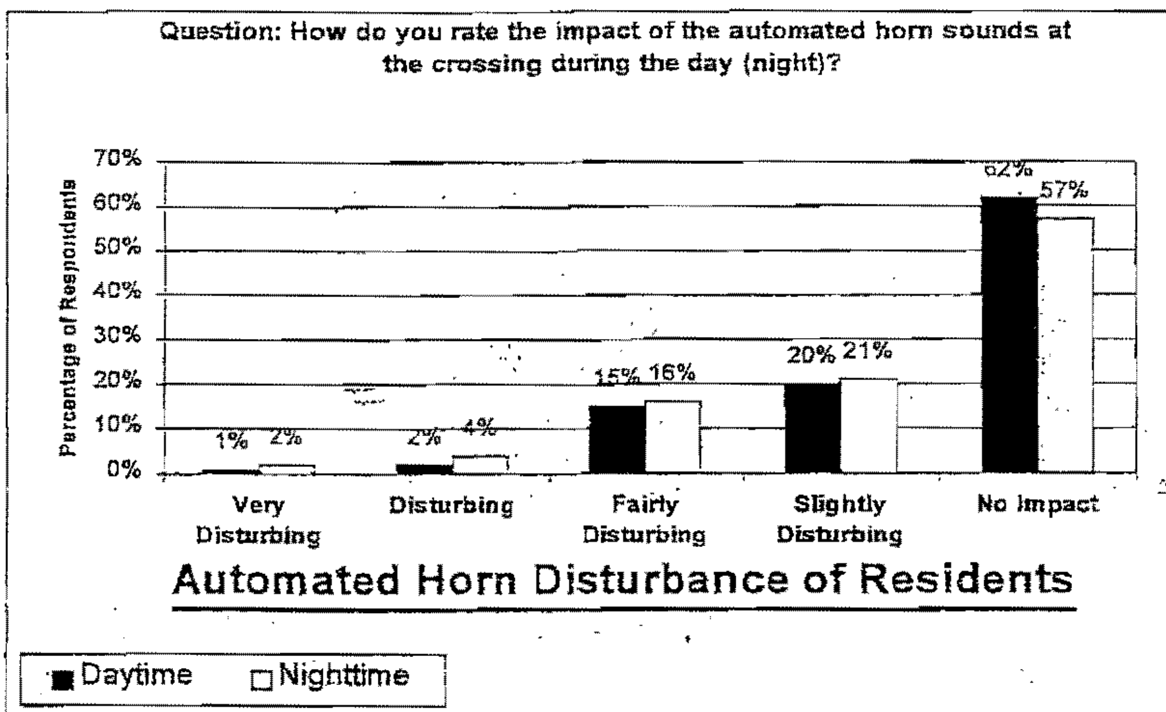


Graph 2

The survey also showed that residents were more disturbed by the train horns at night, compared to the daytime condition. Graph 3 shows the daytime vs. nighttime impact during the before condition. Graph 4 shows the daytime vs. nighttime impact during the after condition. These graphs also reconfirm the acceptance of the new system by the residents.



Graph 3

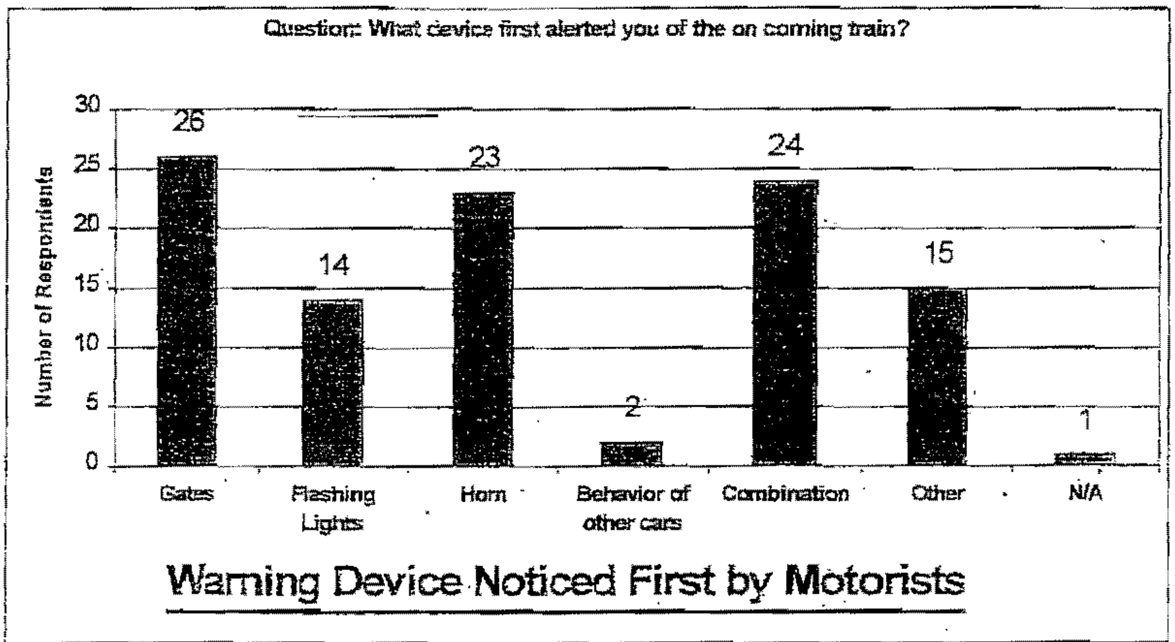


Graph 4

Motorist Survey

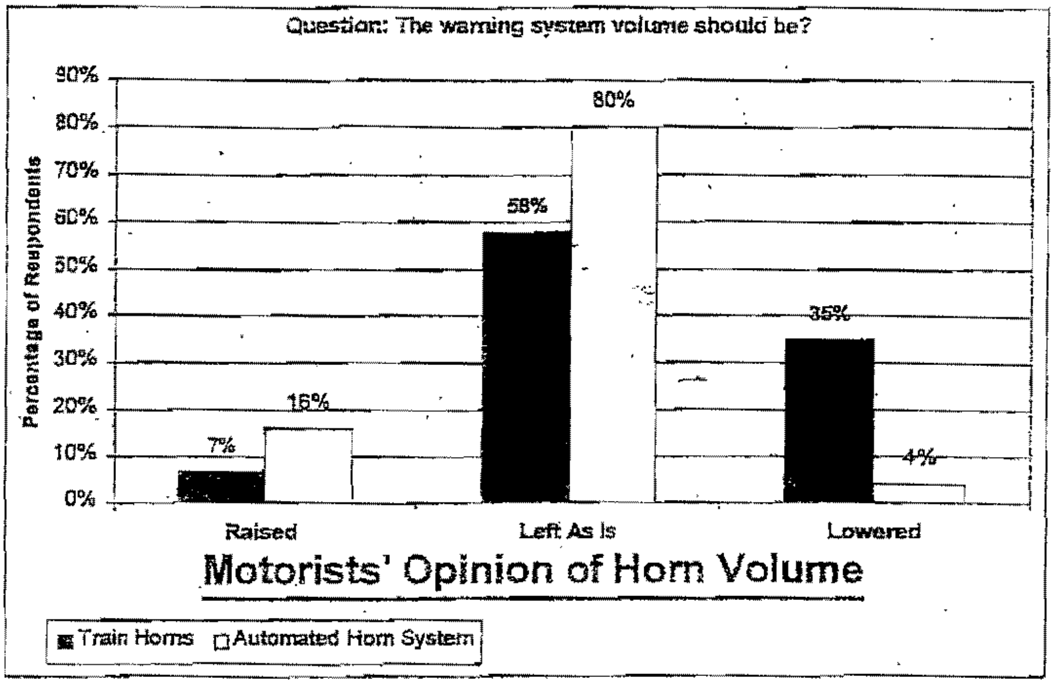
The motorists surveyed at the crossings generally liked the automated horn system and preferred this new system over the train horns. However, they did not feel as strong as the residents about the need to reduce the volume of the train horns.

Graph 5 shows the results of the question, "What device first alerted you of the on coming train?" The mix of responses indicates that each of the various warning devices (gates, flashing lights, horn, etc.) located at the crossings provides a value-added safety benefit.



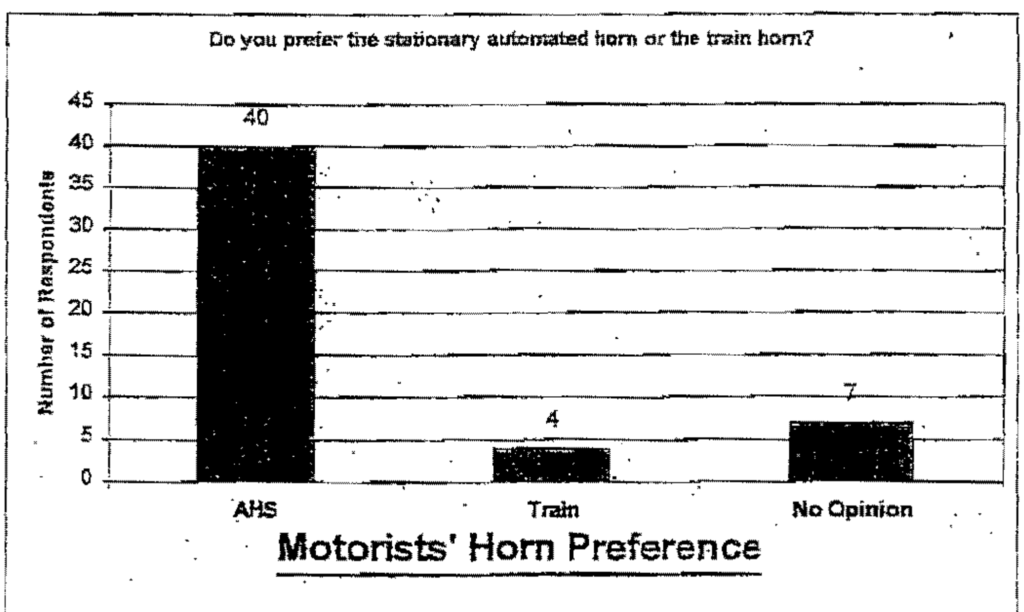
Graph 5

Graph 6 shows the motorist opinion of the horn volume in the before (train horn) and after (automated horn warning system) situations. In both cases the majority of motorist felt the volume should be left as is. It should be noted that some of the surveyed motorists were also residents living near the crossing. The number of residents was not determined during the survey.



Graph 6

One hundred and five motorists were surveyed in the before condition and fifty-one motorists were surveyed in the after condition. The after survey was conducted approximately one month after the automated warning system was installed. Seventy five percent of the respondents indicated that they were aware that the automated horn system had been installed. Graph 7 shows that 78 percent of the motorists preferred the automated horn system over the train horns.



Graph 7

Locomotive Engineer Survey

In general, the locomotive engineer survey provided positive responses regarding the automated horn warning system. The engineers completed the surveys in April of 1999, which was seven months after the installation of the automated horns. A total of 26 surveys were completed.

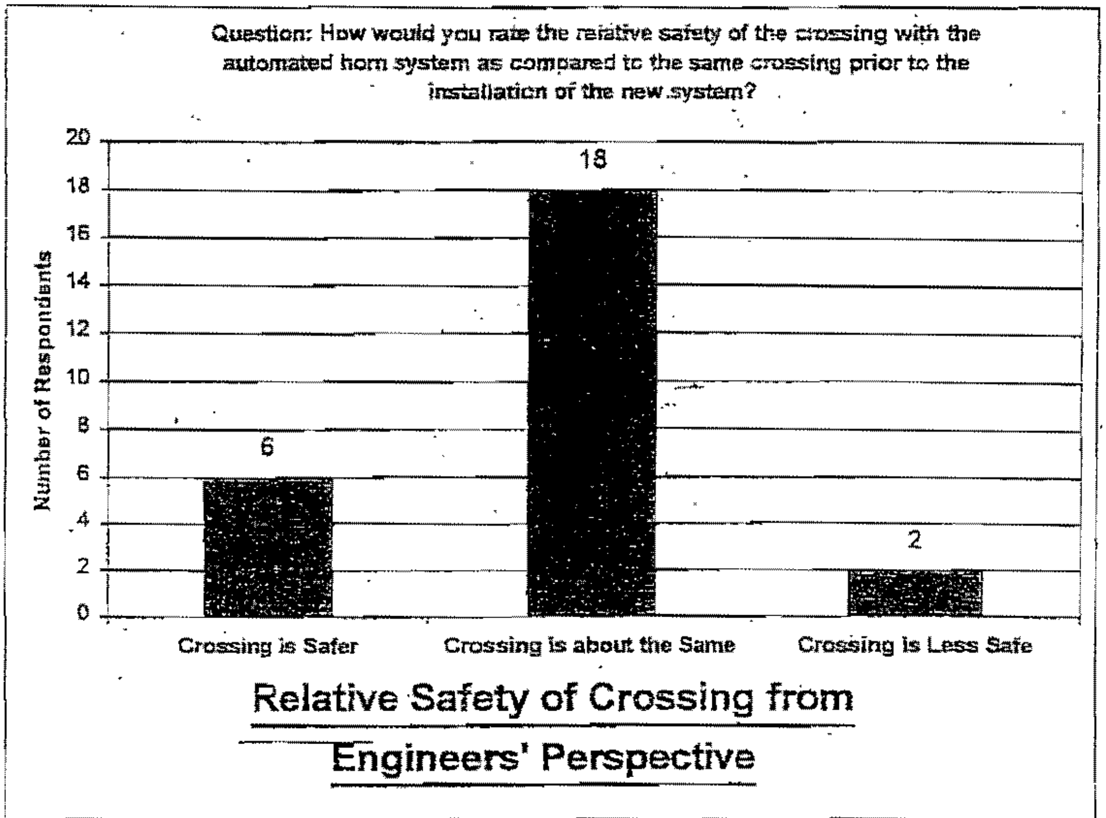
Some highlights from the surveys include:

- Ninety-two percent of the locomotive engineers rated the overall safety at the crossings with the automated warning system to be "about the same" or "safer" as compared to the before (train horn) condition

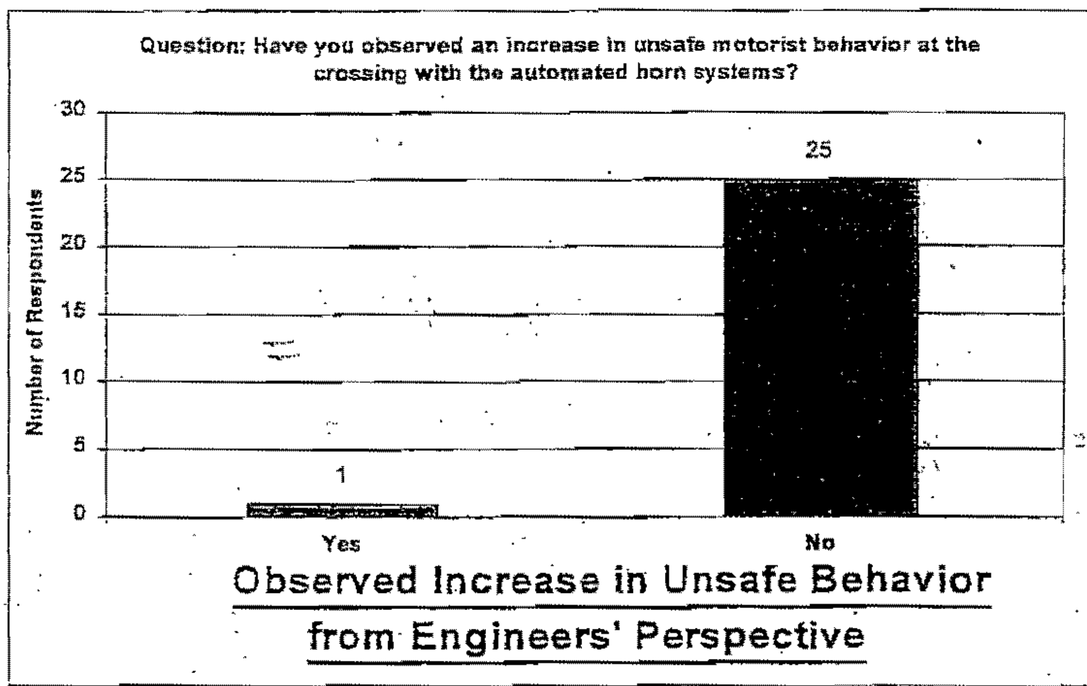
- Only one locomotive engineer noted an increase in unsafe motorist behavior. The other 25 (96 percent) did not observe an increase.

- Seventy-three percent of the engineers admitted to blowing the train horn at least once at the subject crossings. There were two primary reasons stated for blowing the train horns: 1.) concern related to motorist or pedestrian behavior at the crossing; and 2.) old habits are hard to break. Several engineers also noted, "another train passing through the intersection" (double tracks) as a reason for sounding the train horn. This latter reason occurs because the automated horn warning system is activated using the same circuitry as the flashing light signals and gate arms. Therefore it does not reactivate the horn (or strobe light) when the other warning systems are active. The engineers are responsible for ensuring that an audible warning occurs (either with the automated horn system or with the train horn) every time they approach a crossing. Because of this responsibility, they are forced to sound the train horn in this situation. Consideration should be given to redesigning the automated horn system so it can independently detect approaching trains on each set of tracks.

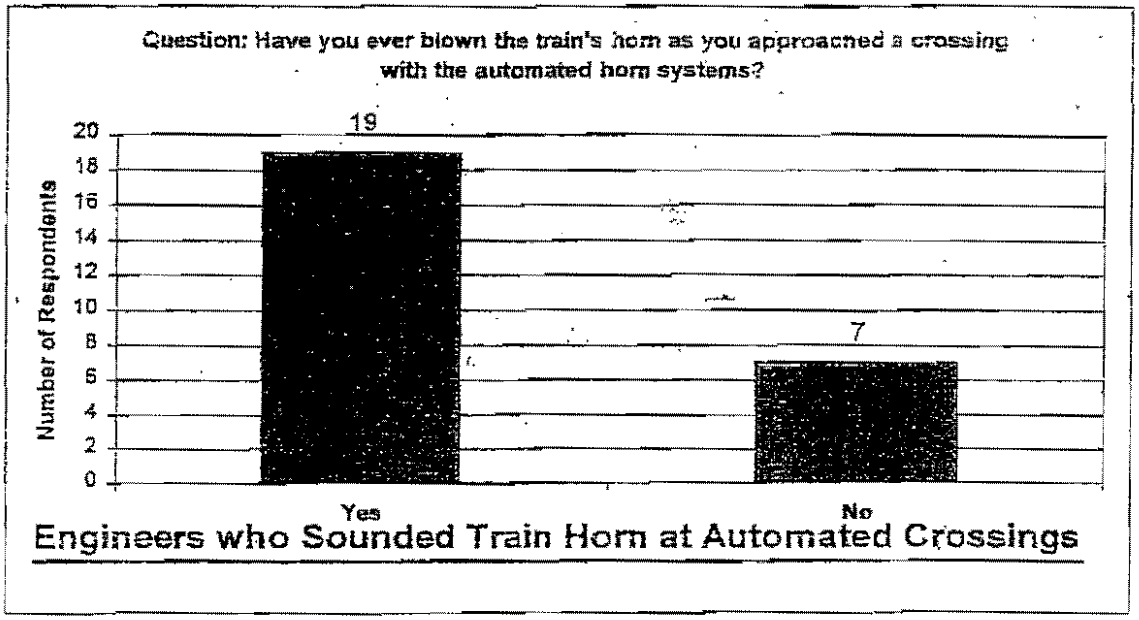
Following are Graphs 8, 9, 10 and 11 showing the responses to the locomotive engineer survey questions.



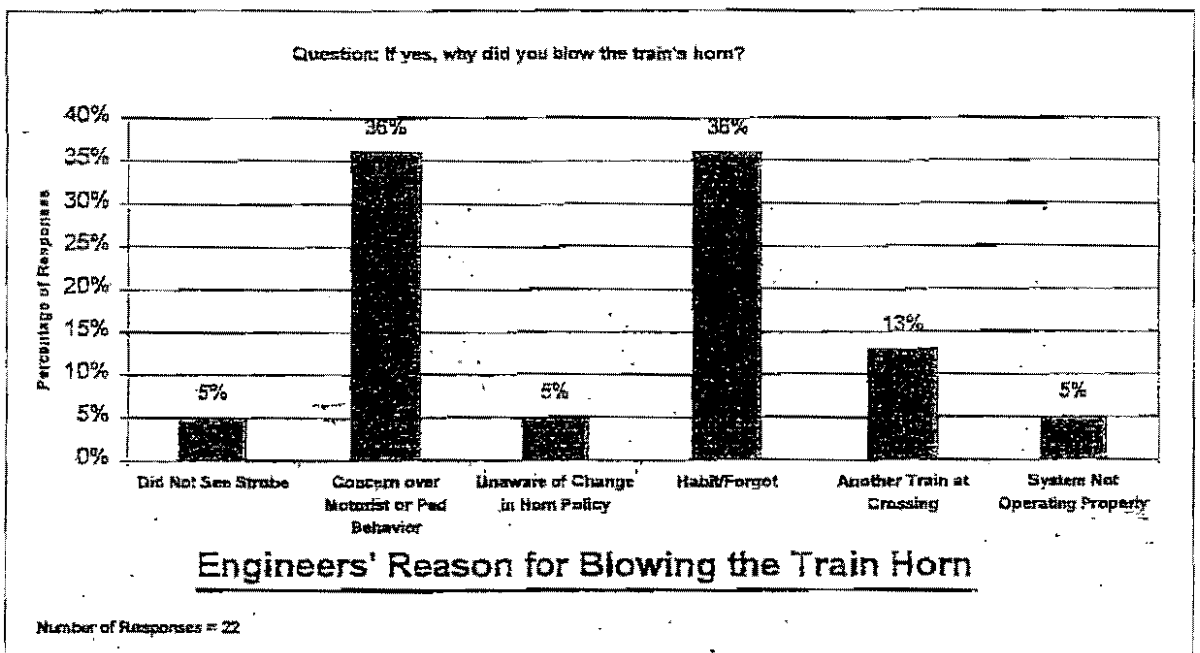
Graph 8



Graph 9



Graph 10



Graph 11

Summary

This research project was initiated for the purpose of evaluating the effectiveness of the automated horn warning systems. This purpose was twofold: 1.) to determine the effectiveness of the new system in reducing the annoyance level for nearby residents; and 2.) to determine the overall safety at the crossings with the automated systems.

The effectiveness of the automated horn in reducing the annoyance level for nearby residents was addressed through the field collection of horn noise levels and through the surveys of residents. The horn volume data that was collected near the crossings clearly demonstrates the significant reduction of land area negatively impacted by using the automated horns. In fact, the automated horn system reduced the area with noise levels greater than 80 dBA by 97 percent, from 171 acres using the train horns to less than six acres using the automated horn system. (For reference, a person shouting from a distance of three feet would produce a decibel reading of approximately 78 dBA.) The residents overwhelmingly accepted the automated horn system and appreciated the city staff for attending to their needs. In the before condition, 77 percent of the residents indicated the train horns had either a "negative" or "very negative" impact on their quality of life as compared to only 3 percent in the after condition. Regarding horn volume, 76 percent felt the train horn volume was "too loud" as compared to the after condition where 82 percent indicated that the automated horn volume was "no problem".

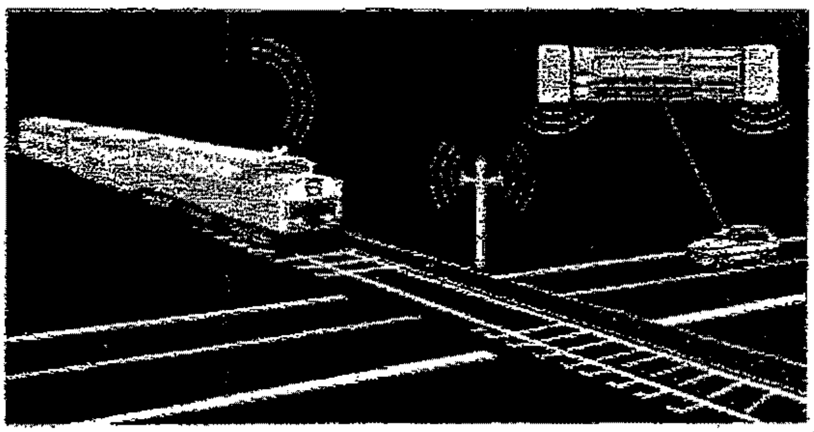
Because the city of Ames is only the third community to install automated horns, it is impossible to accurately determine the overall safety of the crossings. Only after more systems are installed can a study be conducted comparing the collision rates of crossings with similar exposures. Nonetheless, the motorist and locomotive engineer surveys provided valuable input into this issue. When the motorists were asked which system they preferred, 78 percent preferred the automated horn system, 8 percent preferred the train horns, and 14 percent had no opinion. Their responses also indicated that each of the warning devices (gates, flashing lights and train/automated horns) located at the crossings provides a value-added safety benefit. Twenty-three percent of the locomotive engineers rated the crossings "safer," 69 percent rated them "about the same," and only 8 percent rated the crossings with the automated warning systems to be "less safe" as compared to the before (train horn) condition.

In summary, the project found no evidence to suggest that the automated horns are less safe than the current practice of using train-mounted horns. The automated horn system provides the locomotive engineer with the option of sounding the train's horn if unsafe behavior at the crossing is observed. This option may enhance the safety at the crossing because it provides an additional

level of warning. For pedestrians and bicyclists, the automated horns appear to provide a better audible warning because of the intense nature of the horn volume during the early stages of the warning time. However, the automated horns do not provide an indication as to the direction of the approaching train, which is one of the reasons why these systems should only be considered at locations already equipped with automatic flashing light signals with gate arms and constant warning time circuitry. Other jurisdictions considering these systems may also want to use other supplementary safety measures, such as median barriers.

U. S. Department of Transportation
Federal Railroad Administration

Field Evaluation of a Wayside Horn at a Highway-Railroad Grade Crossing



Safety of Highway-Railroad Grade Crossings

DOT/FRA/ORD-98/04
DOT-VNTSC-FRA-97-1

Final Report
June 1998

This document is available to the public through the National Technical Information Service, Springfield, VA 22161

always expect a train

EXECUTIVE SUMMARY

Noise from the train horn is perceived by many residents living near grade crossings as highly annoying. Railroad operating rules require locomotive engineers to sound the train horn as they approach a highway-railroad grade crossing. Locomotive engineers begin sounding the horn approximately 1/4 mile from the highway-railroad grade crossing. This warning exposes a segment of the local community near the tracks to the sound of the train horn as well as motorists and pedestrians who may be approaching the grade crossing. However, residents living near the grade crossing are not the intended target of this auditory warning.

One alternative that has been proposed by some to address the adverse effects of train horn noise is a stationary horn mounted at the grade crossing. The stationary horn, referred to here as a wayside horn, is sounded in place of the train horn as the train approaches the grade crossing. Previous research addressing wayside horns has examined whether the wayside horn is detectable by motorists. Wayside horns evaluated in the past were less detectable than commonly used train horns (Keller and Rickley, 1993).

Previous research on wayside horns centered on their acoustic characteristics. Safety and community noise impact was not addressed, leaving important questions unanswered. One critical question that needs to be answered is whether the wayside horn reduces annoyance to the local community compared to a train-mounted horn or whether it simply moves the area of impact to a different part of the community? Another question that needs to be answered is whether safety is maintained when a wayside horn serves as the auditory warning in place of the train horn? The purpose of our research is to answer both these questions.

The current study evaluates the viability of the wayside horn as a warning concept. Although the study evaluated one particular device in terms of its effectiveness in warning motorists and minimizing community noise impact, the study is intended as a test of a class of auditory warnings located at the grade crossing. To the extent other auditory warnings are designed similarly, comparable performance would be expected.

The study compared the performance of train horns on Union Pacific locomotives (Leslie 3 chime) to a prototype wayside horn. For the current evaluation, two wayside horns were mounted on a utility pole with each horn directed toward oncoming traffic, at each of three grade crossings in Gering, Nebraska.

Community Noise Impact

To evaluate the community noise impact of the wayside horn, two surveys were administered by telephone. The first survey measured the impact of the train horn on community noise. The second survey measured the impact of the wayside horn on community noise. Data from the two surveys were compared to evaluate the difference between the two warning devices on community noise impact.

The wayside horn tested was considerably less annoying to survey respondents than the train horn. The wayside horn reduced noise to levels that were more acceptable to the community. The wayside horn was less likely to interfere with activities inside or outside the home and generated fewer actions to minimize the noise. The variable that best predicted if someone was highly annoyed was the frequency with which the horn was heard. The greater the horn count, the more likely a resident was to be highly annoyed. High annoyance level was also related to the activities which were interfered with. The relationship between activity interfered with and high annoyance varied by time of day. During the day, interference with conversation contributed to high annoyance. During the evening, inference with both conversation and reading contributed to high annoyance. Finally, during the night, only interference with sleep contributed to high annoyance.

Acoustic Analysis

The acoustic analysis was performed to document the sound level and frequency content of the in-service locomotive horn and the wayside horn being evaluated for their effects on driver safety and community noise impact in Gering, Nebraska. In addition, the acoustic data collected was compared to the community noise impact data collected from the survey of the local residents to examine the relationship between noise level and annoyance. The objectives were met by conducting sound level measurements of both the locomotive horn and the wayside horn at fourteen sites surrounding the three grade crossings in Gering, NE.

At peak sound levels, the wayside horn was approximately 13 dB quieter than the train horn. The lower sound level of the wayside horn compared to the train horn was a significant factor in explaining why the wayside horn was perceived as less annoying than the train horn. Unlike the train horn, the wayside horn did not meet the minimum sound level required of train horns. The frequency distribution of the wayside horn was similar to the train horns measured in this study.

For the 14 sites where sound measurements were collected, the wayside horn had a negative community impact only during nighttime hours using guidelines developed by the Federal Transit Administration (FTA). Only the sites defined as severe impact resulted in community annoyance high enough to require action to mitigate the noise. For the wayside horn, the location of the sights defined as severe were all within 100 feet of the track. By contrast, locations defined as severe impact for the train horn were located up to 1000 feet from the track. Clearly, the wayside horn impacted residents over a smaller geographical area.

Evaluation of Driver Behavior

The use of an alternative warning device to the train horn must also provide an effective warning to the motorist, if accidents are to be prevented. The primary objective of the driver behavior evaluation was to assess the safety of the wayside horn. To meet this objective, we observed driver behavior at the grade crossing for both the train horn and the wayside horn. Using video cameras, we observed when motorists drove through the grade crossing following activation of the warning systems. We measured both the frequency of the violations and the time to collision.

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.

In both the train horn and wayside horn conditions, driver behavior was determined in part by the presence of the gates. To the extent that gate behavior controls motorist behavior, differences between the two warning devices may have been masked. Data from Richards et al's (1991) study on optimal warning times indicate that as the time delay increases between when the warning is initiated and the gates completely descend, motorists are more likely to continue through the grade crossing without stopping. The gate descent time in this study was relatively short (10 s).

This short descent time may have reduced the overall violation rate compared to grade crossings with longer descent times.

Implementation Issues

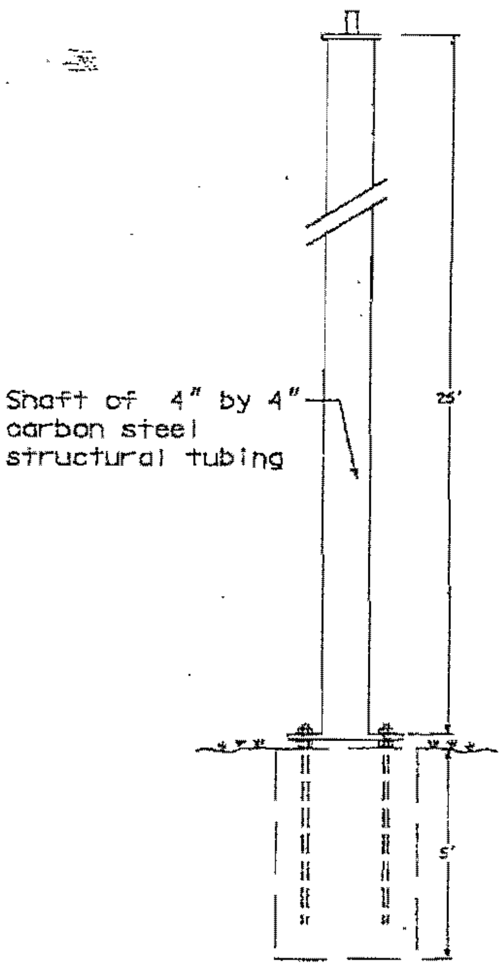
The current study did not set out to evaluate how the wayside horn *should be implemented* to maximize safety while minimizing community noise impact. Nevertheless, a variety of implementation issues will impact safety at the grade crossing as well as community noise. Some of these issues were identified, along with issues they raise and potential solutions. These issues included method of activation, hardware design and standardization.

Two methods of activation were identified: track circuitry and engineer activated. There are tradeoffs that must be considered in selecting either method. The engineer activated method has not been subjected to evaluation in revenue service, but remains a promising approach. Activation by track circuitry, with constant warning times, is a viable approach if the track circuitry is reliable. Assuming the track circuitry is reliable, the opportunity to use this method will depend upon the availability of grade crossings with constant warning track circuitry. Currently, constant warning time track circuits are available at only a small percentage (13%) of the grade crossings protected by active warning systems. Although the auditory warning could also be activated by fixed block track circuits, this approach is problematic. As the time between activation of the warning device and the actual presence of the train increases, motorists are less likely to heed the warning.

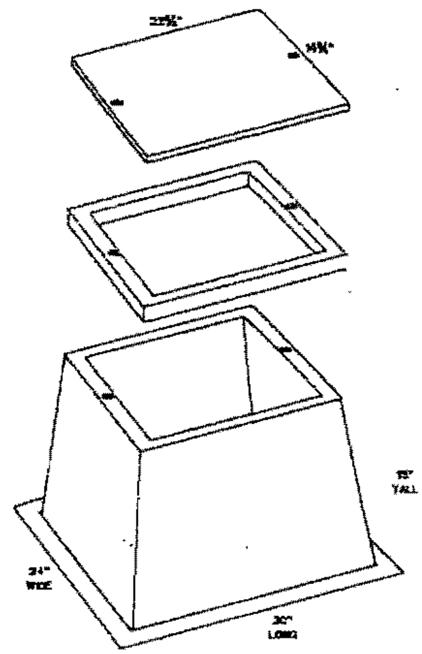
The current evaluation also identified several design and maintenance issues related to the wayside horn evaluated for this test. Exposure of the elements impaired the performance of several hardware components. The components of the wayside horn must be designed to withstand the extremes of weather found in the United States. The system also needs to be designed to facilitate ease of maintenance. Important design features that contribute to ease of maintenance include: minimizing the number of components, using modular components that are easy to replace, and designing the housing to facilitate ease-of-access.

As demonstrated by the annoyance measures in the two surveys and the driver behavior data, the wayside horn shows promise as a warning device that can reduce community noise impact without adversely affecting safety. However, there are still important questions that need to be answered before implementing this device as a substitute for the train horn. The implementation issues indicate the need for clarifying how the activation method will impact safety at the grade crossing. The wayside horn also needs to be evaluated at other locations to confirm the benefits of reduced community noise impact and to insure that driver safety is not compromised. Finally, an answer is also needed to the question of what an appropriate sound level is to maintain safety while minimizing community noise impact. Until these questions are answered, the wayside horn is not recommended as a substitute for the train horn at highway-railroad grade crossings.

Automated Train Horn Installation Details



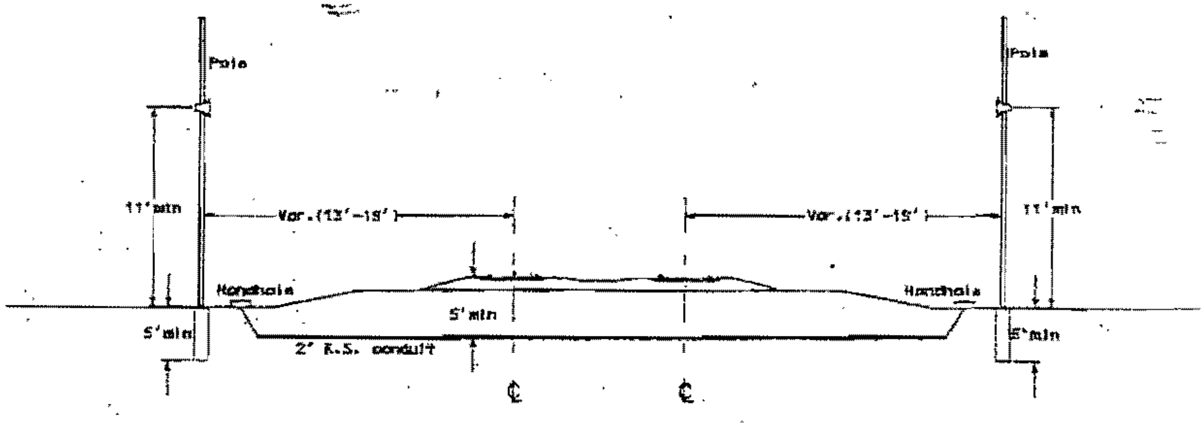
PEDESTAL MOUNTED POLE



TYPICAL HANDHOLE

STANDARD GRADE LEVEL BURIED CABLE ENCLOSURE

OF THE TYPE SIMILAR TO PENCELL PLASTICS PE-20-6HDX MADE OF HIGH DENSITY POLYETHELYNE U.V. STABILIZED.



UNDERGROUND WIRELINE CROSSING

Agreement Number ________

THIS AGREEMENT, is made and entered into this 30th day of July, 1998, by and between UNION PACIFIC RAILROAD COMPANY, a Delaware corporation (hereinafter the "Railroad") and the CITY OF AMES, a municipal corporation of the State of Iowa (hereinafter the "City"), WITNESSETH:

RECITALS:

The City has requested the Railroad to participate in the cost of installation of an Automated Horn System (hereinafter "AHS") at the locations described in Exhibit A, hereto attached and hereby made a part hereof, as such locations are located on the Railroad's Boone Subdivision in Ames, Iowa, to which the Railroad is agreeable, but solely upon the terms and conditions hereinafter set forth.

AGREEMENT:

NOW, THEREFORE, in consideration of the premises and of the promises and conditions hereinafter set forth, the parties hereto agree as follows:

1. The City agrees to provide and install, at its sole cost and expense, the utility poles, the AHS and power supply for each installation.

2. The Railroad, at its expense, shall provide the electrical connection from the crossing signal control systems to activate the AHS at each installation and cooperate with the City in the testing of these systems.

3. The City, at its expense, will own and maintain the AHS at each location and will be solely responsible for ensuring the reliable operation of each system and preventing any malfunctions.

4. The City has requested that the Railroad not sound its locomotive horns when its engineers observe the activated strobe light, and the Railroad agrees to comply with such request, provided that City indemnifies and insures Railroad with respect thereto as provided in this Agreement; and provided further that Railroad shall have the free and unrestrained right to resume sounding its locomotive horns under either of two conditions; 1) when vehicles, pedestrians, or animals are visibly present and in immediate peril; or 2) if the Railroad and City mutually agree to resume sounding the train horns to enhance and protect the public's safety. If the consent of any other governmental entity is required for Railroad's compliance with this Agreement, the City agrees to obtain such consent at its sole cost and expense.

5. The City shall indemnify, defend and hold the Railroad harmless from and against all claims, actions, fines, costs, liability and expense whatsoever (including, without limitation, attorneys' fees, court costs and expenses) arising out of (a) the existence of the AHS, (b) the Railroad's compliance with the terms of this Agreement, (c) the City's noncompliance with the terms of this Agreement, or (d) any act or omission of the City, its contractors, agents and/or employees, that causes or contributes to (1) any damage to or destruction of any property (including, without limitation, property of the Railroad), (2) any injury to or death of any person (including, without limitation, employees of the Railroad), or (3) any claim or cause of action for alleged loss of profits or revenue, or loss of service, including the negligence of the Railroad, its officers, agents and employees, whether sole or partial, passive or active, direct or imputed.

6. As provided in this Agreement, the City shall not be liable to the Railroad on account of any failure of the AHS to operate properly nor shall the Railroad have or be entitled to maintain any action against the City arising from any failure from the AHS to operate properly. The Railroad shall not be liable to the City on account of any failure of the AHS to operate properly nor shall the City have or be entitled to maintain any action against the Railroad arising from any failure of the AHS to operate properly. The City expressly waives its sovereign and governmental immunity, and any statutory limitation on its liability, to the extent necessary for the enforcement of this Agreement, and agrees that it will not assert any defense of sovereign or governmental immunity or limitation of liability in response to a claim by Railroad under this Agreement; provided, however, that nothing contained in this Paragraph shall inure to the benefit of, or be enforceable by, any third party.

7. If at any time any work needs to be performed on Railroad's property by the City's contractor(s) or their subcontractor(s), the City shall require its contractor, or a subcontractor, to execute the Railroad's form Contractor's Right of Entry Agreement which is attached hereto as Exhibit B. The City acknowledges receipt of a copy of the Contractor's Right of Entry Agreement and understanding of its terms, provisions, and requirements, and will inform its contractor(s) of the need for them and their subcontractor's to execute the Agreement. Under no circumstances will City's contractor(s) or their subcontractors be allowed onto the Railroad's property without first executing the Contractor's Right of Entry Agreement.

8. Before any work begins, each of City's contractors/subcontractors will provide the Railroad with a certificate issued by their respective insurance carrier providing the insurance coverage required pursuant to Exhibit A-1 of the Contractor's Right of Entry Agreement, in a policy containing the following endorsement:

> "Union Pacific Railroad Company is named as additional insured with respect to all liabilities arising out of Insured's performance of work related to the installation of the automated horn systems in Ames, Iowa.

The City WARRANTS that this agreement has been thoroughly reviewed by its insurance agent(s)/broker(s) and that said agent(s)/broker(s) has been instructed to procure insurance coverage and an endorsement as required herein.

9. All insurance correspondence shall be directed to Union Pacific Railroad Company, Attn: Murray Nelson, 903 Story Street, Boone, Iowa 50036.

10. The City, for itself and for its successors and assigns, hereby waives any right of assessment against the Railroad, as an adjacent property owner, for any and all improvements made under this Agreement.

11. Covenants herein shall inure to or bind each party's successors and assigns; provided, no right of the City shall be transferred or assigned, either voluntarily or involuntarily, except by express written agreement acceptable to the Railroad.

12. The City shall, when returning this agreement to the Railroad (signed), cause same to be accompanied by such Order, Resolution or Ordinance of the governing body of the City, passed and approved as by law prescribed, and duly certified, evidencing the authority of the person executing this agreement on behalf of the City with the power so to do, and which also will certify that funds have been appropriated and are available for the payment of any sums herein agreed to be paid by the City.

IN WITNESS WHEREOF, the parties hereto have duly executed this Agreement as of the date and year first hereinabove written.

Approved as to Form
General Attorney

UNION PACIFIC RAILROAD COMPANY,

By [signature]
Title: CHIEF ENGINEER

CITY OF AMES,

By [signature]
Its: Mayor

Pursuant to Resolution/Order dated July 30, 1998, hereto attached.

EXHIBIT A

LIST OF AHS LOCATIONS IN AMES, IOWA

Hazel Avenue
DOT No. 190706U
MP 189.41, Boone Sub

Scholl Road
DOT No. 190711R
MP 181.60, Boone Sub

North Dakota Avenue
DOT No. 190712X
MP 192.23, Boone Sub

EXHIBIT B

CONTRACTOR'S RIGHT OF ENTRY AGREEMENT

THIS AGREEMENT is made and entered into as of the ________ day of ____________________, 199____, by and between UNION PACIFIC RAILROAD COMPANY, a Delaware corporation (hereinafter referred to as the "Railroad");
and ____, a ____________________ corporation (hereinafter referred to as the "Contractor").

RECITALS:

Contractor has been hired by ____________________ (hereinafter "____________") to perform work relating to ____
____
____ (the "Work"), partially located on property of Railroad in the vicinity of______________________________________[, which Work is the subject of a Contract dated ____________________ between Railroad and ______________________].

Contractor has requested Railroad to permit it to perform the work on Railroad property, and Railroad is agreeable thereto, subject to the following terms and conditions.

AGREEMENT:

NOW, THEREFORE, it is mutually agreed by and between the Railroad and Contractor, as follows:

ARTICLE 1 - DEFINITION OF CONTRACTOR

For purposes of this agreement, all references in this agreement to the Contractor shall include the Contractor's contractors, subcontractors, officers, agents and employees, and others acting under its or their authority.

ARTICLE 2 - RIGHT GRANTED; PURPOSE

The Railroad hereby grants to the Contractor the right, during the term hereinafter stated and upon and subject to each and all of the terms, provisions and conditions herein contained, to enter upon and have ingress to and egress from the property described in the Recitals for the purpose of performing any work described in the Recitals above. The right herein granted to Contractor is limited to those portions of Railroad's property specifically described herein, or as designated by the Railroad Representative named in Article 4.

ARTICLE 3 - TERMS AND CONDITIONS CONTAINED IN EXHIBITS A AND A-1

The terms and conditions contained in Exhibits A and A-1, attached hereto, are hereby made a part of this agreement.

ARTICLE 4 - ALL EXPENSES TO BE BORNE BY CONTRACTOR; RAILROAD REPRESENTATIVE

The Contractor shall bear any and all costs and expenses associated with any work performed by the Contractor, or any costs or expenses incurred by the Railroad relating to this agreement. All work performed by Contractor on Railroad's property shall be performed in a manner satisfactory to the Railroad's ______________________________ or his authorized representative (hereinafter the "Railroad Representative") identified below: