Highway Advisory Radio (HAR) Information

Cleveland/Lorain ITS Early Deployment Planning Study

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submitted to
Ohio Department of Transportation
District 12

by
HNTB Ohio, Inc. and TRW Inc.

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1. INTRODUCTION

A comprehensive Intelligent Transportation Systems (ITS) Early Deployment planning study was recently completed that identified where and how ITS technologies and methodologies could best be applied to improve the safety, efficiency, and capacity of the greater Cleveland/Lorain regional transportation network. As such, this study's final report, known as a *Strategic Deployment Plan* , recommended a series of phased actions for achieving these above goals. For example, the following items were identified for "Immediate Action":

- Continue "Road Crewzer" service patrols, and expand/adjust routes;
- Implement an education program for cellular telephone incident reporting;
- Appoint an Incident Management Task Force;
- Pursue legislative actions to eliminate legal barriers to the pushing and towing of disabled vehicles, and the efficient removal of spilled cargo;
- Plan diversion routes;
- Enhance the accuracy and timeliness of media reporting of traffic conditions;
- Purchase portable changeable message signs for use during major incidents;
- Conduct a site location study for highway advisory radio (HAR); and
- Install more closely-spaced reference markers to help callers report incidents and help response personnel locate incidents.

To more effectively achieve the anticipated results of these above deployment recommendations, ODOT commissioned a series of reports to guide the implementation of each such immediate action item. This document is one of those commissioned reports. More specifically, it is provided to answer relevant questions regarding the deployment of highway advisory radio (HAR); including, results from a HAR site location study that was recently completed for the Cleveland/Lorain metropolitan area.

2. PROBLEM STATEMENT

2.1 BACKGROUND

Highway Advisory Radio (HAR) is widely used to provide non-commercial information to travelers in a specific geographic area. This often includes construction, traffic congestion, alternate route, and safety information; traveler advisories; parking information for major destinations; lodging and rest stop availability; and details about local points of interest. To disseminate this information, HARs typically utilize low power level equipment that broadcasts over either the 530 kHz or the 1610 kHz AM frequencies. However, any standard AM broadcast frequency between 530 kHz and 1700 kHz (in 10 kHz increments) can be used, provided that there is no interference with existing stations.

2.2 ISSUES

In order to implement a HAR network, however, a series of questions must first be answered. For example, answers to the following deployment questions are required:

- How many HAR stations, and of what type of HAR transmitters are needed to provide appropriate coverage for the Cleveland/Lorain metropolitan area?
- What frequencies can be used to provide superior listenability, while minimizing interference to/from commercial broadcast stations?
- Should there be one or two high-power HAR transmitters that are synchronized to cover a large coverage area, or should there instead be many low-power HAR stations?

In addition, a series of operational-type questions must be answered. These include:

- How will motorists know when a special HAR messages is being broadcast for a route that they are traveling?
- What magnitude of incidents warrant traffic alert messages to be broadcast via HAR?
- If a traffic alert is placed on a HAR and drivers are to be notified of this special message, for how large of a geographic area should drivers be alerted?

Finally, a series of procurement-related questions must be answered. These include:

- What are appropriate bid specifications for a HAR network?
- Who are potential HAR vendors that have shown abilities to consistently meet specifications for HAR network implementations?

3. SOLUTION

In response to these above needs, the following sections are offered as recommended answers to these above presented questions.

3.1 DEPLOYMENT ISSUES

The following subsections, which have been prepared by TRW Inc. and Information Station Specialists, provide recommended answers to HAR deployment issues regarding available frequencies, RF coverage issues, cost estimates, and the FCC licensing process.

3.1.1 Frequency Availability

To obtain appropriate details for the following subsections, ISS monitored relevant AM frequencies on September 26, 1996 and September 27, 1996, during both the daytime and nighttime periods.

3.1.1.1 Standard HAR Frequencies 530 kHz and 1610 kHz

530 kHz is not available due to the existence of Canadian commercial station 530 CIAO, Brampton, Ontario (Toronto area). More specifically, CIAO presents a listenable daytime signal on the 530 kHz frequency and a nighttime signal between 0.2 MV/M and 0.7 MV/M.

Alternatively, the 1610 kHz frequency is relatively quiet, and is a good choice other than in the vicinity of the following three stations:

- 1610 kHz is not available on the west part of the region due to its use by the Loraine County Convention & Visitors Bureau for visitor information.
- 1610 kHz is not available in the vicinity of the Cleveland Hopkins International Airport due to its use by the airport for patron information. It must be noted, though, that the airport station has been silent in recent years and may have been discontinued. It is recommended that the city be contacted to determine this station's status. Nevertheless, its license is still listed by the Federal Communications Commission and for purposes of this report must be assumed to still exist.
- 1610 kHz is not available in the southeast part of the region due to its use by a licensed traveler information system (TIS) station in Akron, Ohio.

3.1.1.2 In-Band HAR Frequencies 540 kHz to 1600 kHz

The following frequencies are available in the traditionally commercial-oriented portion of the AM radio spectrum:

- 1080 kHz and 1120 kHz are excellent during the daytime, but are not useable at night.
- 1160 kHz and 1240 kHz, which both require permission of area broadcasters in order to be used, are excellent during the daytime but are not useable at night.
- 1280 kHz, which also requires permission of an area broadcaster in order to be used, is good in the daytime, but is only somewhat better than the previously listed stations at night (i.e. its nighttime noise level is from 0.2 MV/M to 0.3 MV/M). As such, this is the only "in-band" frequency that could be considered for HAR. However, it should only be considered as a second choice due to its nighttime noise levels that will result in a reduced listening range.

3.1.1.3 Expanded Band HAR Frequencies 1620 kHz to 1700 kHz

All frequencies in the expanded AM radio band (1620 kHz to 1700 kHz) are open and quiet. 1620 kHz is available across the entire Cleveland area and is highly recommended due to its presence on most automobile radios built since the early 1980s. It must be mentioned, though, that all of the other frequencies that are part of the expanded band are

also open. However, these other frequencies (1630 kHz to 1700 kHz) are not as favored because they are received on a smaller number of radios than is 1620 kHz.

3.1.2 RF Coverage

The above analysis indicates that only two frequency choices are currently available for HAR in metropolitan Cleveland. This includes 1620 kHz (throughout the entire area) and 1610 kHz (in the eastern areas only). Since coverage is desired in the circled areas of Figure 1, and since it is assumed that messages to drivers arriving from the northeast may be significantly different than those from other directions, the following is recommended:

- It would be logical to use the 1610 kHz frequency, which is only open on the east side of the metropolitan region, for the coverage areas required in the northeast portion of the region (see Figure 1). Or better, a 1610 kHz or 1620 kHz frequency SuperStation (see Figure 2) would be most appropriate for this northeast portion of the region. Replace this page with Figure 1

Replace this page with Figure 2

- It would be logical to employ the 1620 kHz frequency, which is the quietest and more universally available frequency, for the majority of the stations required for the western and central portions of the metropolitan region. However, due to the excellence of the 1620 kHz frequency coupled with the tight grouping of the required coverage areas in the western and central areas of the metropolitan region (see Figure 1), a 1620 kHz SuperStation with enhanced coverage would be the most logical option (see Figure 2).
- A third alternative (see Figure 3) would employ conventional, synchronized 1610 kHz signals on the east side of the metropolitan region, all with the same program, in order to present less interference to the existing 1610 kHz TIS stations in the area. Though, this alternative should not be a preferred option as it would involve higher cost and provide more limited 1610 kHz coverage.

Please note that all HAR coverage maps (see Figure 2 and Figure 3) have been plotted to the 0.25 MV/M level.

3.1.3 Cost Analysis

Costs listed below are estimates of hardware and labor to install, based on ISS's ITS6000 Transmitter System at suggested retail prices. Actual bid costs would be lower. Finally, these costs do not include the $3,099 per flashing HAR alert sign that must be included as a constant for each alternative in order to account for costs associated with the Flashing Sign Control Systems that are required for the HAR alert signs.

- Alternative 1 -- Two SuperStation 3000 Systems, 1620 kHz and 1610 kHz

2	ITS6000 Transmitter Systems (both masters)	$34,388
2	SuperStation 3000 Antenna Systems	$21,896
1	StationMaster Software Program with Workstation	$ 5,400
1	Installation, estimated	$20,000
	TOTAL:	$81,684

- Alternative 2 -- Two SuperStation 3000 Systems, both at 1620 kHz (synchronized)

2	ITS6000 Transmitter Systems (Master/Slave)	$30,665
2	SuperStation 3000 Antenna Systems	$21,896
2	Cel/SYNCH 3 Options	$ 9,000
1	StationMaster Software Program with Workstation	$ 5,400
1	Installation, estimated	$20,000
	TOTAL:	$86,961

- Alternative 3 -- One SuperStation 3000 System at 1620 kHz and Conventional Synchronized HARs on 1610 kHz (see Figure 3)

5	ITS6000 Transmitter Systems (2 masters, 3 slaves)	$78,801

1	SuperStation 3000 Antenna Systems	$10,948
4	Conventional HAR Antenna Systems	$ 6,552
5	Cel/SYNCH 3 Options	$22,500
1	StationMaster Software Program with Workstation	$ 5,400
1	Installation, estimated	$40,000
	TOTAL:	$164,201

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3.1.4 Federal Communications Commission (FCC) License Process

Federal Communications Commission (FCC) licenses may be applied for either through Information Station Specialists (ISS) or independently by the organization(s) applying for the license(s). Waiting time is 3 (three) to 4 (four) months, unless a special temporary assignment is requested, which is obtainable in 1 (one) to 2 (two) weeks. Waivers to use additional field strength via the SuperStation 3000 system can be applied for at the time of application, but may take six months for approval. Total cost for application through ISS is $180.00.

It is very important that licenses be applied for as soon as it is known how the project is to proceed. They are available to any governmental entity on a first-come-first-served basis, and can become unavailable at any time. We would recommend that the state begin the licensing process for (even) arbitrary locations within the general area as soon as possible, merely to secure the frequencies.

3.2 OPERATIONAL ISSUES

The following subsections provide recommended answers to HAR operational issues regarding the method for making drivers aware of special HAR-broadcast traffic alerts; the magnitude of incidents that should warrant special HAR-broadcast traffic alerts; and the geographic range to which drivers should be notified of the existence of these special HAR-broadcast traffic alerts.

3.2.1 Notification Method for HAR Alerts

It is recommended that fixed signage be placed throughout the Cleveland/Lorain metropolitan area to indicate the presence of the highway advisory radio station(s). In addition, it is recommended that these signs include a pair of flashing lights that can be activated on a localized basis to indicate to motorists in the affected area(s) of an important HAR message.

3.2.2 Incident Magnitudes for HAR Alerts

Non-recurring congestion typically results from incidents or special events of varying severity and duration. In addition, the impacts of seemingly “identical” incidents are often significantly different based upon where and when they take place. For example, a stalled vehicle during rush hour will most likely cause more congestion than a stalled vehicle at midnight. Thus, the appropriate amount of traffic management actions necessary to effectively counter non-recurring congestion should depend upon the time-of-day, day-of-week, number of lanes impacted, and “expected time to clear” specifics for a particular incident. With this in mind, Table 1 provides a sample matrix of incident level / response

definitions for guiding actions to be taken by traffic operations staff in response to non-recurring congestion along monitored roadways. In fact, this particular plan is similar to one being used as part of the ARTIMIS project (Advanced Regional Traffic Interactive Management Information System), which is currently being deployed throughout much of Metropolitan Cincinnati/ Northern Kentucky.

Table 1. Incident Level / Response Definitions

			Lanes Impacted/Action Level			
Time of Day	**Estimated Duration**	0 Lanes	1 Lane	2 Lanes	>2 Lanes	
0000 - 0600	< 2 hours	0	0	1*	3*	
	2 - 4 hours	0	0	2*	3*	
	> 4 hours	0	0	2*	3*	
0600 - 1000	< .5 hours	1	1	2	3	
	.5 - 2 hours	1	1	2	4	
	> 2 hours	1	2	3	4	
1000 - 1500	< 2 hours	1	1	2	3	
	2 - 4 hours	1	1	2	3	
	> 4 hours	1	2	3	3	
1500 - 1900	< .5 hours	1	1	2	3	
	.5 - 2 hours	1	1	2	4	
	> 2 hours	1	2	3	4	
1900 - 2400	< 2 hours	0	0	1*	3*	
	2 - 4 hours	0	0	2*	3*	
	> 4 hours	0	0	2*	3*	
Level 0	No special action required					
Level 1	Implement Response Plan to notify appropriate PSAs					
	Turn on Level 1 CMS and HAR					
Level 2	Implement Response Plan to notify appropriate PSAs					
	Turn on Level 2 CMS and HAR					
	Turn HAR flashing lights on at level 2					
Level 3	Implement Response Plan to notify appropriate PSAs					
	Turn on Level 3 CMS and HAR					
	Turn HAR flashing lights on at level 3					
	Provide Advisory Alternate Routing					
Level 4	Implement Response Plan to notify appropriate PSAs					
	Turn on Level 4 (and above) CMS and HAR					
	Turn HAR flashing lights on at level 4 Provide Mandatory Alternate Routing					
Level n CMS	n = number of decison points prior to the incident corridor					
Level n HAR	n = number of times the related advisory is repeated in a HAR cycle (e.g. within a 3 minute cycle)					
Level n*	* = notification of operations personnel may be required to implement outside normal duty hours					

For example, if an incident occurs between the hours of 6:00 am and 10:00 am, blocks one lane of traffic, and is expected to be cleared in less than two hours, a "Level 1" situation is declared. This would dictate activating the alert flashers on all HAR signs within one major interchange in the direction of the incident. However, if an incident impacts a single lane between the hours of midnight and 6:00 am, it would only be considered a "Level 0" situation (i.e., no special action required) because of the limited amount traffic that is typically on the roads during the overnight period. Additional examples are as follows:

- If an incident occurs between the hours of 10:00 am and 3:00 pm, blocks one lanes of traffic, and is expected to take greater than four hours to clear, then a "Level 2" situation exists. This would dictate activating the alert flashers on all HAR signs within two interchanges of the incident.
- If an incident occurs between the hours of 3:00 pm and 7:00 pm, blocks more than two lanes of traffic, and is expected to take between 0.5 and two hours to clear, then a "Level 4" situation exists. This would dictate activating the alert flashers on all HAR signs in the direction of the incident.

Please note, however, that these are only guidelines. The shift supervisor is always authorized to dictate higher response levels in support of public safety agency requests, and/or if past experience deems it necessary.

3.2.3 Sign Locations for HAR Alerts

To apply this philosophy to the Cleveland/Lorain ITS, it is first necessary to define a series of driver decision points so that real-time information concerning incidents occurring along any included corridor can be appropriately disseminated as per the incident level / response definitions of Table 1. To facilitate this process, the recommended locations for variable message signs as per the Cleveland/Lorain ITS Early Deployment Planning Study's Strategic Deployment Plan were coupled with information regarding major freeway junctions and potential access points to possible alternate routes. In the end, fifteen major driver decision point interchanges for trips into and out of the "Initial Deployment Area" of a Cleveland/Lorain ITS were defined (see Table 2). Figure 4 illustrates these driver decision points such that upstream corridors will become the information dissemination locations for incidents occurring downstream of these driver decision points.

For example, if a "Level 1" incident occurs on northbound I-77 between I-490 and I-90, then alert flashers on the following highway advisory radio notification signs should be activated (see Figure 5):

- Northbound I-77, upstream of the I-490 interchange
- Eastbound I-490, upstream of the I-77 interchange

Similarly, if a "Level 2" incident occurs on northbound I-77 between I-490 and I-90, then alert flashers on the following highway advisory radio notification signs should be activated in addition to the above-mentioned "Level 1" alert flashers (see Figure 6):

- Northbound I-77, upstream of the I-480 interchange
- Eastbound I-480, upstream of the I-77 interchange
- Westbound I-480, upstream of the I-77 interchange

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REPLACE THIS PAGE WITH FIGURE 4
"MAJOR DRIVER DECISION POINTS"
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REPLACE THIS PAGE WITH FIGURE 5 / FIGURE 6
" ACTIVATED FLASHERS ON HAR SIGNS..."
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Table 2. Major Driver Decision Points

DECISION POINT	DESCRIPTION
A	I-71 and US-42 in Middleburg Heights
B	I-71 and I-480
C	I-71 and US-42 in Cleveland
D	I-71 and SR-176F (Jennings Freeway)
E	I-71 and I-90 / I-490
F	I-77 and I-480
G	I-77 and I-490
H	I-77 and I-90
I	I-90 and West 117th Street
J	I-90 and US-42 (Pearl Road)
K	I-90 and SR-2 (Cleveland Memorial Shoreway)
L	I-90 and East 72nd Street
M	I-480 and SR-176F (Jennings Freeway)
N	US-20 and West 117th Street
O	US-20 / SR-2 and US-42 (Pearl Road)

3.3 PROCUREMENT ISSUES

Appendix A is a set of draft bid specifications for a metropolitan Cleveland/Lorain highway advisory radio network. Table 3, below, is a list of HAR vendors whom have consistently demonstrated their ability to meet similar HAR specifications.

Table 4. Potential vendors for HAR systems as described in this report

COMPANY NAME:	ADDRESS / PHONE NUMBER:
Information Station Specialists	3368 88th Avenue Zeeland, Michigan 49464-9716 (616) 772-2300
Digital Recorders, Inc.	4900 Prospectus Drive Durham, North Carolina 27713-4451 (919) 361-2155

4. DISCUSSION

4.1 PAGER-TYPE SIGN CONTROL

As specified in Appendix A, control of the flashers on HAR traffic alert signs is based on a recommendation for a single coordinated method of sign control that utilizes the commercial paging network rather than the AM carrier of the HAR signal. This technology, which is referred to in the recommended HAR specifications (see Appendix A) as a "Broad Area Sign Controller" (BASC), will control all signs through paging, and will continue to meet the HAR network's operational strategy requirements of multiple addresses for each sign in order that they may be grouped by route or area.

The following summarizes the reasons that the traditional AM method of flashing sign control has been eliminated and replaced with a superior method that utilizes the commercial paging network instead:

(1) The reliability of AM signaling to activate traffic alert flashers is dependent upon field strength, which translates into band quieting and "signal to noise" level. Since it is impossible to know at this stage exact AM signal levels, reliability is called into question. Without waivers, sign placement more than four miles from the HAR stations is likely to cause non-response to broadcast touchiness. With waivers, sign placement more than nine miles is likely to cause non-response.

(2) In addition to the Canadian commercial station CIAO, the 530 kHz frequency is currently receiving some nighttime heterodyne (interference exhibits itself as a tone) from a broadcast station in the Turks Islands in the Caribbean. It is not known if this heterodyne will affect proper detection of the tones. Beyond this generally, nighttime noise levels on AM are much higher, decreasing, in any event, the mileage figures in (1) above.

(3) When synchronized HAR is utilized, certain areas of the region, from time to time, will experience mild signal cancellation or "fade" due to the reception of both AM signals at once. These areas are very limited and the fade is very brief. However, if a HAR traffic alert sign with flashers is located in such an area temporarily, it may not recognize its tones to activate the flashers if broadcast via AM rather than through the commercial paging network.

(4) In using a pager-based tone system, the necessity to broadcast touchtones into listeners' car radios in order to activate signs will be eliminated. Thus, increasing the listenability of the AM programming.

Finally, please note that it is believed that two methods of sign control -- one via AM and an alternate for outlying signs -- is not logical, and is therefore not recommended.

4.2 LONGITUDINAL PLACEMENT OF TRAFFIC ALERT SIGNS

Based upon research results on the design and use of supplemental message signs, including published reports from the Federal Highway Administration and the Arizona

Department of Transportation, the following criteria for site specific placements of HAR traffic alert signs have been generally adopted:

1. The minimum spacing between a HAR traffic alert sign and other guide signs not co-located with the traffic alert sign should not be less than 1000' (one-thousand) feet.
2. A HAR traffic alert sign should be located no less than 4000' (four-thousand) feet from a potential diversion exit.

5. SUMMARY / CONCLUSIONS

As has been documented in the appropriate sections of this report, Metropolitan Cleveland has a limited number of AM frequencies that are currently available for highway advisory radio services. Since this limits the number of potential HAR deployment options, a strategy for obtaining necessary FCC licenses "as soon as possible" has also been provided in order that these recommended HAR deployment options are not further limited.

This document has also presented a methodology for notifying motorists on specific sections of roadway whenever a traffic alert is broadcast that contains relevant information for the particular route(s) being utilized by said drivers. Furthermore, it must be noted that this notification method has been developed in a manner that it is consistent with methods already recommended as part of a special report that was produced for the Cleveland/Lorain ITS Early Deployment Planning Study regarding fixed/portable variable message signs. More specifically, the adherence to these parallel recommendations will enable drivers to maintain their experience-based expectations of where and when advisory messages might be disseminated for various types of incidents; thus, shortening the long-term "learning curve" of how to best utilize this information for improving the overall efficiency and enjoyment of their trip-making experience.

Finally, this document has presented procurement-related recommendations, which include a method for activating HAR traffic alert flashers via the commercial paging network, and a set of recommended draft specifications for a highway advisory radio system (see Appendix A). Thus, to this end, agencies that are considering to utilize highway advisory radio can feel confident that their efforts/investments can achieve positive results.

6. APPENDIX A. Draft HAR Specification

DRAFT SPECIFICATION

FOR

HIGHWAY ADVISORY RADIO (HAR)

1.1 GENERAL

1.1.1 Purpose

1.1.2 Current Services

1.1.3 General Requirements

1.2 WIDE AREA HAR

1.3 PORTABLE HAR

1.4 PAGER-TYPE TONE DECODERS

1.5 INSTALLATION

1.6 TESTING

1.7 METHOD OF MEASUREMENT

1.8 BASIS OF PAYMENT

1.9 EXHIBITS

SECTION 1.0

HIGHWAY ADVISORY RADIO (HAR)

1.1 GENERAL

The objectives of the system are to improve traveler safety, improve traffic efficiency by minimizing congestion, and to minimize environmental impacts in terms of traffic-generated pollutants.

The maintenance of the HAR system will be administered by the Ohio Department of Transportation. Day-to-day oversight and maintenance needs determination will be performed by the staff of the Operations Control Center (OCC) in Metropolitan Cleveland, Ohio.

1.1.1 Purpose

The purpose of this section is to define the Specifications for the Highway Advisory Radio (HAR) component of the Cleveland/Lorain ITS project.

1.1.2 Current Services

There is presently one HAR / Traveler Information Station (TIS) system operating within the Greater Cleveland/Lorain Urbanized Area. It operates on a frequency of 1610 KHz and is located at the Cleveland - Hopkins International Airport.

1.1.3 General Requirements

The HAR system will consist of two major components: a stationary, wide-area system and a portable, localized system. The wide-area HAR system will operate on a frequency of 1620 KHz while the portable HAR system will operate on a frequency of 1280 KHz. License applications for both systems are already being processed. ***Please note that the frequency may have to be changed depending upon the response received from the FCC concerning the license applications.***

1.2 WIDE AREA HAR

The Wide-Area HAR shall consist of _____ fixed-site transmitters graphically dispersed about the Greater Cleveland/Lorain area. The following specifications apply:

Frequency: 1620 KHz

Locations: The master transmitter shall be located in Ohio approximately at latitude of _____N and a longitude of _____W. This location is approximately ___ feet _____ of the _____ Road overpass and is in the median between northbound and south bound _____ near milepost ____.

The second transmitter shall be located in Ohio approximately at latitude of _____N and a longitude of _____W. This location is on a small plateau approximately ____ feet northwest of _____ (near milepost _____) along westbound _____ and approximately ___ feet north of _____ (near milepost _____).

Message Control: All transmitted messages shall be capable of being generated, downloaded, and controlled from the Operations Control Center (OCC) in Cleveland via a fiber optic communication link and a cellular phone interface. In addition, message generation and control shall be available at each transmitter site. The following requirements apply for message programming:

- All solid state - DRAM storage
- Up to fourteen minutes of recording time available
- Up to 250 variable-length messages may be recorded or deleted independently
- Maximum of 100 message sequences can be programmed
- Storage of up to 20 messages
- 200 - 5000 Hz minimum frequency response
- Message sequences can be scheduled on a 24 hours/7 day week basis
- Capability to program an alternate audio source to play continuously when no messages scheduled
- Security access code required
- Inputs for XLR microphone, cassette player and control phone
- Rechargeable battery backup capable of maintaining messages for a minimum of seven days
- On air messages shall not be disturbed while the system is being programmed
- DTMF control tones shall be used to control transmitter functions and audio loading. In addition, the transmitter shall be capable of generating combinations of DTMF tones as part of a transmitted message.

Synchronization: All messages shall be phase-locked synchronized between the multiple transmitters with the first location noted previously as the master.

Transmitter: The following requirements shall apply:

- Transmitter shall have a power output range of 0-10 watts maximum with an overall capacity of 30 watts
- FCC certified for Travelers' Information Service
- Built-in audio limiter and visual peak indicator
- Built-in power supply
- Headphone jack to allow direct RF output monitoring
- Continuously adjustable power control (0-10 watts)

Enclosure: Each transmitter enclosure shall be of NEMA-4X grade, gasketed, built of 14 gauge steel, have a locking hasp, and contain a terminal block, 120VAC outlets, and a back panel. Finish shall be gray enamel. All seams shall be continuously welded with a rolled lip around the enclosure door to prevent dripping. Door shall be properly designed to provide a watertight seal. The groundplane connection lug shall be recessed. Mounting shall be such that the enclosure can not be detached from the mounting without first gaining access to the enclosure. Pressure-sensitive, adhesive-backed property tags made of .003" aluminum foil shall be provided with enough space to indicate the Cleveland/Lorain ITS program name, serial and model number of the unit, and a property identification number (maximum of eight (8) alphanumeric characters).

Surge Protection: Each transmitter shall be protected against lightning strikes and power surges. The following surge requirements shall apply:

- Power surge arrestor: 13 Kamps max surge < 5 nS
- Telephone line arrestor: 13 Kamps max surge < 5 nS
- RF surge arrestor: 18 Kamps max surge < 5 nS

Antenna: The antenna shall be of a type functionally equivalent to that specified and shown in Exhibit 1A. To the maximum extent possible, all antenna cable shall be enclosed in weatherproofed, flexible, steel conduit. All exposed cable shall have weatherproof, rubberized insulation.

Cellular Interface: Each transmitter shall have all necessary equipment for a cellular phone interface to provide remote access and control in the event the main communication path is lost.

Software Interface: All software and specialized computer hardware required for controlling the HAR transmitter shall be provided. The protocol shall also be documented and provided. The Cleveland/Lorain ITS will have UNIX-based computers. It is acceptable to provide control software which can be linked into software being developed under the Cleveland/Lorain ITS program. If this approach is taken, the supplier must provide information as to how this is accomplished as well as provide technical support at no additional cost.

1.3 PORTABLE HAR

The portable HAR shall consist of two, trailer-mounted transmitters operating at a frequency of 1280 KHz. Synchronous operation is not required. The following specifications apply:

Frequency: 1280 KHz

Locations: These shall be portable, trailer-mounted devices to be stored at locations to be determined later. Trailers shall be solar and generator powered to provide a minimum of maintenance.

Message Control: All transmitted messages shall be capable of being generated, downloaded, and controlled from the Operations Control Center (OCC) in Metropolitan Cleveland via a cellular phone interface. In addition, message generation and control shall be available at each transmitter site. The following requirements apply for message programming:

- All solid state - DRAM storage
- Up to fourteen minutes of recording time available
- Up to 250 variable-length messages may be recorded or deleted independently
- Maximum of 100 message sequences can be programmed
- Storage of up to 20 messages
- 200 - 5000 Hz minimum frequency response
- Message sequences can be scheduled on a 24 hours/7 day week basis
- Capability to program an alternate audio source to play continuously when no messages scheduled

- Security access code required
- Inputs for XLR microphone, cassette player and control phone
- Rechargeable battery backup capable of maintaining messages for a minimum of seven days
- On air messages shall not be disturbed while the system is being programmed
- DTMF control tones shall be used to control transmitter functions and audio loading. In addition, the transmitter shall be capable of generating combinations of DTMF tones as part of a transmitted message.

Transmitter: The following requirements shall apply:

- Transmitter shall have a power output range of 0-10 watts maximum with an overall capacity of 30 watts
- FCC certified for Travelers' Information Service
- Built-in audio limiter and visual peak indicator
- Built-in power supply
- Headphone jack to allow direct RF output monitoring
- Continuously adjustable power control (0-10 watts)

Enclosure: Each transmitter enclosure shall be of NEMA-4X grade, gasketed, built of 14 gauge steel, have a locking hasp, and contain a terminal block, 120VAC outlets, and a back panel. Finish shall be gray enamel. All seams shall be continuously welded with a rolled lip around the enclosure door to prevent dripping. Door shall be properly designed to provide a watertight seal. The groundplane connection lug shall be recessed. Mounting shall be such that the enclosure can not be detached from the mounting without first gaining access to the enclosure. Locks shall be provided such that all enclosures are keyed alike. Pressure-sensitive, adhesive-backed property tags made of .003" aluminum foil shall be provided with enough space to indicate the Cleveland/Lorain ITS program name, serial and model number of the unit, and a property identification number (maximum of eight (8) alphanumeric characters).

Surge Protection: Each transmitter shall be protected against lightning strikes and power surges. The following surge requirements shall apply:

- Power surge arrestor: 13 Kamps max surge < 5 nS
- Telephone line arrestor: 13 Kamps max surge < 5 nS

- RF surge arrestor: 18 Kamps max surge < 5 nS

Antenna: The antenna shall be physically mounted on the trailer with the transmitter and be capable of supporting a low power transmission (0.5 mile).

Cellular Interface: Each transmitter shall have all necessary equipment for a cellular phone interface to provide remote access and control.

Software Interface : All software and specialized computer hardware required for controlling the HAR transmitter shall be provided. The protocol shall also be documented and provided. The Cleveland/Lorain ITS will have UNIX-based computers. It is acceptable to provide control software which can be linked into software being developed under the Cleveland/Lorain ITS program. If this approach is taken, the supplier must provide information as to how this is accomplished as well as provide technical support at no additional cost.

1.4 PAGER-TYPE DECODERS

As part of the Cleveland/Lorain ITS program, fixed signage will be placed throughout the system to indicate the presence of the HAR. In certain cases, these signs will include a pair of flashing lights which will be activated on a localized basis to indicate to motorists in the affected area(s) of an important HAR message. The intent of the program is to allow a central control point to remotely turn on or off a pair of top-mounted flashing amber lights on dual-post type highway signs. Therefore, each broad area sign controller (BASC) shall include a paging receiver, tone sequence decoder, two retrofittable amber 12” (twelve) inch top-mount sign lights, flasher, wiring, weatherproof enclosure, and instructions. They shall also have the following requirements:

1) Be DTMF controlled via pager for remote operations, and field programmable for on-site operations.

2) Must be pre-programmable to respond to up to four (4) DTMF turn-on tone sequences.

3) On receiving a valid, individual sign-addressable turn-on sequence, the BASC shall close the relay powering the flashing lights; thus, turning on the flashing lights.

4) On receiving a valid, individual sign-addressable turn-off sequence, the BASC shall open the relay powering the flashing lights; thus, turning off the flashing lights.

5) Be solar-powered with a Photovoltaic (PV) powered unit including 75 (seventy-five) watt, 12 (twelve) volt PV panel power source, charge controller with low voltage disconnect, 12 (twelve) amp array / 8 (eight) amp load current, digital voltmeter and ammeter, and angled pole mount. In addition, a dual 170 (one-hundred seventy) AH, 12 (twelve) volt DC gel cell storage battery pack in a vented battery cabinet with strap mount shall be included to provide at least four days of continuous flashing operation before requiring to be refreshed.

6) Be able to retain all programmed information (i.e. turn-on sequences and timer settings) in the event of power loss.

7) Be provided, with sign light relays, in a NEMA-4 enclosure suitable for mounting on the rear of the support structures of the HAR fixed signage.

8) Be capable of supporting two (2) MUTCD-compliant, 12" (twelve) inch diameter Wig-Wag format flashing lights with photoelectric night-dimming circuitry to conserve battery power.

9) Be timer controlled. Upon decoding a tone that activates the flashers, a timer shall be activated such that, when the timer expires, the flashers are turned off. The timer shall be user-adjustable from one (1) to five (5) minutes.

The central control point shall be capable of supporting up to 64 different tone sequences. The pager-type tone decoders shall be able to decode any of the sequences, but as noted above, are only required to respond to four (4) at any given time.

The Supplier shall demonstrate that the pager-type tone decoders work in accordance with the requirements, however, actual installation of the decoders will be performed under another contract such that their installation can be coordinated with the Roadway Contractor(s) who are providing the signs.

1.5 INSTALLATION

The Supplier shall provide the construction/installation of the HAR systems as described below. Notification must be provided to the Engineer at least 30 (thirty) days prior to the intended start of installation. Successful installation depends upon the availability of equipment not provided under this contract. Therefore,

schedule coordination shall be made with the Engineer within thirty (30) days of contract award.

1.5.1 Wide-Area HAR

The Supplier shall be responsible for complete installation of the transmitter sites which shall include, at a minimum, the following:

1) Installation of a fenced enclosure. This enclosure shall be of sufficient size to completely enclose the area covered by the ground plane antenna. It shall be made of chained link, and shall stand eight (8) feet tall with angled-out barbed wire at the top. Each enclosure shall have one gate of a minimum width of four (4) feet that shall be securable with a hardened, keyed padlock. All enclosure padlocks shall be keyed alike.

2) Installation of the transmitter and antenna. Conduit will be supplied under a separate contract to the center of each site and a pull-box installed. Power and communications cables will be supplied up to the pull-box. The conduit, pull-box, and incoming cables ARE NOT the responsibility of the HAR Supplier. The Supplier shall be responsible, however, for making the proper connections. The Engineer shall be advised before any connections to the incoming cables are made and will be in attendance when such connections are made. It is possible the pull-box and conduit will not be in place. Therefore, any ground installation of HAR equipment shall allow for later trenching of conduit without interference from HAR equipment.

3) If any portion of the installation involves removal or disturbance of the ground area, those areas shall be restored to the satisfaction of ODOT before installation shall be considered complete.

4) As built drawings shall be provided to indicate subsurface structures/equipment.

1.5.2 Portable HAR

The portable HAR stations shall be provided as fully-trailer installed units with appropriate towing hardware. Trailers shall be two-wheeled trailers and shall be structurally adequate to serve both as a carrier and as and operating platform for all components of the complete unit. The base structure shall be fabricated from structural rectangular steel tubing of sufficient dimension and thickness to provide an adequate foundation for the unit. The tongue shall safely handle a 6,000 pound load. All tubing

shall be joined by welding and all structural welds shall be continuous bead welds. All tubing ends shall be closed.

Axle and suspension systems shall be rated at 3,500 pounds minimum. Wheels and tires shall be a minimum of 15 inches, 4 ply and shall be rated for towing at highway speeds of 65 miles per hour. A steel fender of 11 gauge (minimum) steel shall be installed over each wheel. The overall width of the trailer shall not exceed 96 inches.

Each trailer shall be equipped with a hydraulic brake actuator system and a two inch, ball type coupler. The braking system and coupler shall be designed for a 6,000 pound maximum load. Double safety chains shall be provided for use when the unit is being towed.

Four crank type, heavy duty, industrial leveling jacks, one at each corner of the trailer deck, shall be installed. A swing jack shall be provided to support the tongue when the unit is parked. The swing jack shall have a capacity of 2,000 pounds and provide for a minimum of 15 inches travel.

A lighting system shall be provided for the trailer to include tail lights, stop lights, turn signals, license plate light and reflectors. A trailer electrical cable and connector compatible with towing vehicles shall be installed. To eliminate internal tubing installation chaffing, all wiring shall be routed and clamped underneath the structural tubing.

1.6 TESTING

The Supplier shall perform on-site testing after installation to ensure the HAR systems are operating properly. A documented set of test procedures shall be submitted to the Engineer a minimum of two (2) months prior to testing. Feedback will be provided within thirty (30) days of submission. Testing shall be open to the Engineer.

1.7 METHOD OF MEASUREMENT

- Wide area HAR shall be measured as a complete unit, in place, and shall include message control, synchronization and software, enclosure, transmitter, antenna, cellular interface, surge protection, fencing, all mounting hardware, excavations, site construction and equipment necessary to furnish and install the unit complete, tested and accepted.

- Portable HAR shall be measured as a complete unit and shall include message control and software, enclosure, transmitter, surge protection, antenna, cellular interface, and trailer and all hardware and incidentals necessary to furnish the unit complete, tested and accepted.

- Pager-type HAR Tone Decoders shall be measured as a complete unit, in place, and shall also include a NEMA-4 enclosure with relays and mounting hardware furnished and installed complete, tested and accepted.

1.8 BASIS OF PAYMENT

Payment will be made at the contract unit price bid for each of the items specified and shall be full compensation for all labor, materials, tools, equipment and incidentals necessary to furnish and install the items complete, connected, tested and accepted.

1.9 EXHIBITS

Exhibit - 1A Typical HAR Antenna Specification