A HOLE IN THE WEATHER WARNING SYSTEM
Improving Access to Hazardous Weather Information for Deaf and Hard of Hearing People

BY VINCENT T. WOOD AND ROBERT A. WEISMAN

Survey results reveal that people with hearing loss still have difficulty accessing weather warning systems, although the situation has improved during the past few years.

“A deaf Florida resident didn’t evacuate her trailer as Hurricane Floyd approached because she was watching a television station that did not flash storm warnings on the screen. Late that night, she awoke to water washing through her trailer and spent the night on the roof to escape flood waters until she was rescued by a helicopter.

“This is a story of life and death for millions of Americans. There are about 28 million people in the U.S. with hearing disabilities.”

— WILIAM KENNARD
Federal Communications Commission Chairman
(Dow Jones newswires, 13 April 2000)

THE PROBLEM. When inclement weather approaches a community, hearing people often obtain the warnings from a variety of sources—television and radio announcements, word of mouth, civil defense or tornado warning sirens. However, deaf and hard of hearing people have limited access to these sources and often have difficulty receiving weather warning information. They cannot hear a tornado warning siren’s ear-piercing wail when a tornado has been sighted. Nor can they hear noise from incoming storms. While driving or at home, there is little or no access to emergency information on the radio because they cannot completely hear or understand radio weather broadcasts. They also have difficulty gathering hazardous weather information from television due to the lack of closed captioning and also due to either the covering up of weather crawls by closed captioning of regular programming or captions that are covered up by the crawls. Uninformed individuals who are deaf and hard of hearing experience much difficulty in making appropriate decisions about when to seek

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E-mail: Vincent.Wood@noaa.gov
DOI: 10.1175/BAMS-84-2-187
In final form 27 September 2002
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1 Closed captioning is similar to captions or subtitles that are encoded (hidden) in the blanking interval of the TV signal; that provide information about spoken dialogue, background noise, and sound effects; and that are invisible without a special decoder (Robson 1997). The Television Decoder Circuitry Act of 1990 states that since July 1993, all American television sets with screens 33 cm (13 in.) or larger diagonally must contain built-in decoder circuitry.
shelter or assistance. A policy statement on tornado preparedness and safety, published in BAMS (81, 1061–1065), notes this problem and points out that "providers of first-warning services should also consider the special requirements of hearing- and sight-impaired persons .. ."

The Federal Communications Commission (FCC 2000) has documented many letters describing the accounts of persons with hearing disabilities who survived weather disasters only through luck and self-determination. Several examples of such accounts follow:

- When Hurricane Fran (1996) was bearing down on North Carolina, local TV meteorologists warned residents to take cover. A deaf man in the warned area did not receive needed information and slept in his bed, while everyone else sought shelter under their beds or in another safe place. He had no idea that he was in danger because he did not receive closed-captioned information regarding hurricane warnings. Fortunately, he survived the disaster, but his town of Greenville, North Carolina, was part of the region later declared a federal disaster area.
- A deaf woman, not realizing that a tornado warning had been issued, went out in a severe thunderstorm.
- During the 1997 Sacramento, California, floods, none of the local television stations provided captioned information regarding evacuations, road closures, or other dangers.
- Due to a lack of television captioning regarding a flood, a deaf man departed for home without knowing that a river was approaching flood level. He barely made it across the one accessible bridge before the bridge was washed out.
- A child-care aide with hearing loss discounted a hearing child’s report that the tornado sirens were sounding because the child often played tricks on her, and she had no access to any television tornado warning. The evacuation of the children to a safe place was delayed until another staff person returned to the building and informed the aide about the warning.

The lead author conducted personal interviews with deaf people who have experienced tornadoes and other dangerous weather situations in which deaf residents received no warnings. An Oklahoma deaf man lip-read a weather broadcaster’s tornado report and got one word: “closet.” This word saved his life as he sought shelter.

In another such interview, the author learned that a deaf couple narrowly escaped the deadly F5 tornado of 3 May 1999 that ravaged the Oklahoma City area. The couple reported that they were unaware of the approaching tornado until they looked outside and saw their neighbors frantically fleeing their houses. Realizing that the tornado was approaching their home and with very little time to respond, they raced to their bedroom and hid under the bed. Fortunately, the tornado missed them by a block-and-a-half, although their home and the surrounding houses suffered damage from the debris. The deaf couple wondered why no hearing neighbor warned them. The lead author also documented a letter from deaf Arkansas residents (Wood 1998). They reported that they were unaware of a tornado passing by their residences at night because no one warned them of the approaching tornado.

Other frustrating scenarios similar to those described previously have been experienced by many deaf and hard of hearing people across the nation who have been hit hard during inclement weather. We strongly believe that unawareness or ignorance of deaf and hard of hearing individuals’ weather alerting needs has created a deficiency or “hole” in the nation’s weather warning system. Communities involved with this system need to be informed about the deficiency and need to correct it.

The FCC has attempted to partially fill this hole by establishing new broadcast rules during emergency situations. The 2000 revision of Section 713 of the Communications Act, as added to the Telecommunications Act of 1996, now requires that broadcasters provide critical details about the emergency in a visual format such as closed captioning, open captioning, scrolling words, crawls, or by using an alternative method of visual presentation. The text information must include details of the emergency as well as safety actions recommended to the public. These rules apply to emergency information given during a regularly scheduled newscast, an unscheduled break during regular programming, as part of

\[\text{Captions that have been decoded so that they have become an integral part of a television picture, like English subtitles in a foreign movie (Robson 1997). Open captions cannot be turned on and off, like closed captions can.}\]

\[\text{Displayed text that scrolls up like words on a computer screen (Robson 1997).}\]

\[\text{Text that scrolls slowly along the bottom part of a television screen (Robson 1997). Crawls are often used for emergency notification, breaking news stories, or financial data. They are created by character generators.}\]
continuing coverage of a situation, or any other method that puts an audio description of the information on the television screen. There may be rare cases, however, where an emergency affects the broadcast station or nonbroadcast network or distributor and it may not be possible to provide accessible emergency information. The FCC has granted broadcasters a great deal of discretion in deciding the form in which the visual information appears. The FCC does not mandate captioning, crawls, scrolls, or any other specific method; they encourage broadcasters to use whatever technologies they have at hand, so long as they provide the emergency information visually.

Before the FCC emergency ruling went into effect on 29 August 2000, the usual method of displaying weather alerts during severe weather coverage was along the bottom of the television screen via crawls. These crawls went unnoticed or were illegible when covered by the closed captioning that displayed a show’s dialogue or vice versa. The ruling mandates that “emergency information provided by means other than closed captioning should not block any closed captioning and any closed captioning provided should not block any emergency information provided by means other than closed captioning.” Captioning placement must allow any local weather crawls to be viewed unblocked or vice versa.

This requirement can benefit more than just the deaf and hard of hearing community. Increasingly, it is bringing about improvements for hearing people who have difficulty hearing television broadcasts in noisy sports bars, arena athletic events, health clubs, restaurants, offices, airports, and other places. Thus, emergency information can reach a broad spectrum of people in large groups.

The barriers faced by deaf and hard of hearing people in obtaining emergency and even routine weather information go beyond the anecdotes described previously. In a survey of deaf and hard of hearing people in Minnesota and Oklahoma, we asked questions about the accessibility of hazardous weather information during a 9-month period beginning in September 1999. A survey methodology and a list of survey questions are available online (http://dx.doi.org/10.1175/BAMS-84-2-Wood). Interested readers can access this information for the full details. This paper uses the results of the survey to document the limited access of deaf and hard of hearing people to hazardous weather information.

Our survey findings conclude that deaf and hard of hearing respondents have relatively limited ways of knowing that severe weather is imminent. Among the most important findings is that 81% of respondents reported that they have experienced a fear of being unprepared for weather emergencies. This fear was attributed to several factors, but mainly to poor information dissemination that included inadequate captioning of routine and emergency weather reports, in particular. Lack of education and assistive technologies further isolate deaf and hard of hearing citizens from weather alerts.

**TELEVISION ACCESS.** Television has become the primary source of daily weather information for the American public including deaf and hard of hearing viewers (Fig. 1). Most families have at least one television set, and have become entirely dependent upon local weather information for help in planning their daily activities. Nearly all deaf and hard of hearing viewers often receive visual weather alerts from television because stations display weather news crawls and maps highlighting counties under watches and warnings. Television is also the technology that is most widely available to survey participants. Our survey findings reveal that 80% of Oklahoma respondents have televisions with access to closed captioning,
whereas 18% have televisions without access to closed captioning. Only three respondents (2%) do not have their own televisions. In Minnesota, 87% of respondents have televisions with access to closed captioning, 6% have televisions without access to closed captioning, and only 10 respondents (7%) do not have their own televisions.

In both Minnesota and Oklahoma, 84% of the people surveyed reported that closed captioning overlapped the periodic crawls at the bottom of the television screen during severe weather coverage. The viewers sometimes turned the captions off in order to read the crawls along the bottom of the screen. Also, the problem created a dilemma for the viewers because they want to receive the severe weather information, but they also do not want to miss watching their favorite closed-captioned program dialogue.

The start of a weather crawl is accompanied by a tone ("beeping") that deaf and many hard of hearing viewers may not be able to hear. Because these viewers do not hear the warning signal, they may miss the entire crawl or a part of the crawl. Some deaf and hard of hearing individuals may be able to hear the beep in some circumstances. However, if their hearing aid is turned off, or if background noise is present, they may not hear the signal. According to our survey, 61% of Minnesota respondents and 69% of Oklahoma respondents missed all or part of the crawl when they were unable to hear the signal.

After the FCC’s emergency rules went into effect requiring broadcasters to disseminate emergency information accessible to deaf and hard of hearing viewers, most of the local television stations, including those in Oklahoma City and Minneapolis/Saint Paul, have recently taken steps to prevent the blocking of the crawls. Solutions have included moving the crawls to the top of the television screen (the method preferred by survey respondents), or by slightly shrinking the portion of the screen containing the regular programming and its associated closed captioning and running the unobstructed crawl below or above it.

A particularly noteworthy example of providing the required access to emergency information is the method used by The Weather Channel, which inaugurated real-time captioning on its cable network in December 1999 (while the survey questions were being compiled). The Weather Channel’s closed captioning allows local severe weather watch/warning crawls to be viewed unblocked along the bottom of the screen (Morgan 2000). These captions appear nicely on the viewers’ screens as two lines of text just above the updates from local weather sensors. A similar method has been used by Minneapolis/Saint Paul television stations to comply with the new FCC regulations. In addition, the frequent local segments provide routine and severe weather forecasts in a visual format. Unfortunately, The Weather Channel is almost useless to rural deaf and hard of hearing viewers who access this service through a satellite dish rather than from a local cable provider. In this instance, neither local severe weather warnings nor the local forecast segment appears during The Weather Channel’s broadcast. Cable access to The Weather Channel is available to 59% of Oklahoma respondents and 49% of Minnesota respondents, whereas 22% of Oklahoma participants and 37% of Minnesota participants live in rural areas where The Weather Channel probably could not provide full local weather coverage.

Besides the crawl problem, another television warning issue covered by the FCC ruling occurs during severe weather bulletins (where regular programming is interrupted for severe weather or other emergency information). These severe weather bulletins usually consist of an ad-libbing broadcast meteorologist showing a live radar display or video of the severe weather. Before the FCC ruling, most of these bulletins contained little text information about the warnings. As in the case of other live programs, there was no closed captioning provided. This latter problem usually was shared by the weather segment of regular news broadcasts; these segments were not scripted and no closed captioning was available. This problem prevented deaf and hard of hearing viewers from obtaining the needed information.

Our survey results indicate that the main reason deaf and hard of hearing viewers favor real-time closed captioning of local weather information is that it is an additional benefit in helping them understand the weather and therefore assisting them in planning their daily activities. Without captioning, deaf and hard of hearing viewers have to guess what is being said. Some of them speak-read a few words but not enough spoken words to grasp the true seriousness of emergency or nonemergency weather situations. Many viewers have difficulty in lip-reading an ad-libbing broadcast meteorologist and often have to ask hearing individuals (if they are present) to repeat the meteorologist’s message.

The survey participants were asked to rate their preferred methods of receiving hazardous weather warnings. The preferred method of obtaining these warnings was real-time closed captioning during regular programming. Having weather crawls at the top of the television screen ranked second, while watching The Weather Channel ranked third.
Real-time closed captioning is used for live, unscripted programming and is expensive, time critical, and labor intensive. It involves the simultaneous transmission of all spoken words in a live presentation as captions by a court reporter who is highly skilled and specially trained as a “stenocaptioner” (Robson 1997). Most local television stations would have to rely on a stenocaptioner to type what a weather broadcaster is saying live. Some local stations appear reluctant to hire a stenocaptioner or to buy captioning equipment because of the additional cost. The four major networks (ABC, CBS, FOX, and NBC), as well as some cable news providers such as CNN, FOX News Channel, etc., routinely provide real-time captioning for news and weather, special reports, and sports events. Broadcasters, networks, and network affiliates in the top 25 television markets (as defined by the designated market areas of Nielsen Media Research, see online at www.nielsenmedia.com) are required to provide real-time captioning of unscripted material such as breaking news, live field reports, and weather updates.

Smaller market television stations experience difficulty finding stenocaptioners for real-time captioning. Such individuals may not be available for the short time period of a local newscast, and if available, reimbursement costs may become prohibitively high. There are two potential options that local television stations can use to provide emergency information in text form during live break-ins. One option is through a remote real-time live captioning service that provides closed captioning for local television stations during emergency situations. A television station, for example, would call a telephone number when an emergency forces the station to break into a regularly scheduled program. Via a telephone, a remote stenocaptioner would communicate with the station and provide live, closed-captioned emergency news coverage. A program called “REACT,” which stands for Real-time Emergency Announcement Captioning Team, is an example of a remote captioning service. It is offered by a company based near Pittsburgh called VITAC6 that captions many national programs in real time. Jeff Hutchins (2000, personal communication), executive vice president of Planning and Development for VITAC, says: “Subscribing to REACT is like getting an insurance policy. It is less costly for the station to subscribe to REACT than to hire a stenocaptioner to be available on call at all times.” There are many other real-time live captioning firms with which local television stations can have contracts to provide live emergency captioning on a standby basis. Unfortunately, many stations across the nation have chosen not to use such captioning services.

Another option is voice recognition technology, which may provide a new, inexpensive method for creating closed captions. The voice recognition system transcribes an ad-libbing broadcast meteorologist’s voice into a text stream (captions) that is then instantaneously transmitted with the television receiver and decoded by television sets equipped for closed captioning. A caption decoder or television extracts the closed-captioned information and converts it to visible subtitling within a few seconds.

OTHER METHODS AND TECHNOLOGY.

The focus of this article thus far has been on the television broadcast industry. It is important, however, to note from the survey results in the previous section that 20% of the Oklahoma respondents and 13% of the Minnesota respondents do not have access to television with closed-captioning capability. For the hearing community, there are other methods of access to severe weather information. However, most of these are inaccessible to deaf and hard of hearing people (though alternatives are being developed).

Personal Notification. Survey results indicate that, following television, the next preferred method of notification for deaf and hard of hearing people is personal contact (Fig. 1). The people remind their hearing families, neighbors, coworkers, and friends that they cannot completely hear or understand weather warnings or emergency instructions. They often ask hearing people to be their source of weather emergency information. Hearing people almost always obtain warnings more quickly and reliably than deaf and hard of hearing people through methods usually limited to hearing people, such as television and radio announcements or sirens. They notify a deaf or hard of hearing person of weather warnings by going to that person’s home or business or by using the TTY (text telephone or teletypewriter for the deaf used in conjunction with a telephone that allows two-way conversation via typing and reading text). The hearing individuals must be aware that deaf and hard of hearing persons often are not adequately informed of impending weather hazards.

Reliance on hearing persons sometimes delays the emergency weather response for those being warned and those relaying the warning. This method of warning is unreliable because the warning informa-

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6 Mention of this and other commercial companies or products in this article does not imply endorsement.
tion may not be relayed with all of the pertinent details. This system can easily break down; that is, the hearing person may not be able to contact the deaf or hard of hearing person in need because of other responsibilities, a downed telephone line, or other reasons.

Special-needs weather radio. After a tornado killed more than 20 people in a rural Alabama church on Palm Sunday in 1994, Vice President Al Gore set a goal to make weather radio receivers as common as smoke detectors in American homes and to extend the coverage provided by the National Oceanic and Atmospheric Administration (NOAA) Weather Radio (NWR) transmitter network to 95% of the United States (NOAA 1994). However, at that time, this technology did not serve the deaf and hard of hearing community. An exception is that a local National Weather Service (NWS) office in Salt Lake City, Utah, began in late 1993 to test specially designed NWR receivers by converting audio alert messages into text format (Campbell 1995; NOAA 1995). The usefulness of NWR to deaf and hard of hearing people has now changed with the introduction of “special needs” weather radio receivers.

The special-needs weather radio receiver has been designed to adapt to the weather alerting needs of the deaf and hard of hearing community. Released in 1999, the receiver includes a strobe light as well as an auditory signal that alerts a deaf or hard of hearing person, a liquid crystal display that shows what type of watch, warning, or advisory has been issued along with duration of watch or warning, and a pillow vibrator/bed shaker that awakens the person from sleep in case of a local weather warning. The portable receiver can be programmed to screen out warnings for other areas. The receiver now has a cigarette lighter adapter available for vehicle use, which also is useful for the hearing community. The receiver can also be equipped with special adaptations that convert weather alert messages into large print and/or Braille versions without depending on volunteer readers. Information on special-needs weather radio is available online at www.nssl.noaa.gov/NWR/.

While providing an improvement for severe weather access, use of special-needs NWR receivers by deaf and hard of hearing people has some limitations. The receiver does not display the full text of a local NWS warning, such as the source, or types of weather hazards expected, and basic safety measures to be taken. This limitation often causes many deaf and hard of hearing users to resort to viewing their televisions or to depend upon hearing people for up-to-the-minute weather information. Eventually, technology will enable NWR alert messages in text format (K. Putkovich 2001, personal communication), which is analogous to the Salt Lake City test system (Campbell 1995; NOAA 1995). Another limitation of NWR is that NWR does not yet cover 100% of the nation. Deaf and hard of hearing residents in areas where NWR is not available should work with local officials (e.g., civil emergency management officials) to establish some type of first-warning system.

Another problem that needs to be addressed is that the deaf and hard of hearing community does not usually consider using a product that is called a “radio.” All advocates for deaf and hard of hearing people must be made aware that these products exist and learn how to use them. Prior to the development of special-needs weather radio receivers, the conventional NWR receiver was used by less than 5% of those surveyed as a source of weather warnings (Fig. 1). A few respondents with mild hearing loss can hear the audio portion of a radio broadcast with their hearing aids. Thus, an education program is needed to inform deaf and hard of hearing people that special-needs NWR may work for them.

Internet. Some deaf and hard of hearing respondents use the Internet for up-to-the-minute weather information (Fig. 1). Although the Internet is good for some types of weather information, it may not be the most dependable way to receive severe weather warning information in an emergency. Deaf or hard of hearing people are not always near a personal computer, even if they have one. Sometime an Internet site is slow in coming up or is not reachable. Power failures also are a problem, often occurring during lightning activity accompanying severe weather. Also, the NWS safety rules suggest avoiding or turning off non-essential electrical appliances due to the small risk from a lightning strike (NOAA 1999).

Civil Defense sirens. Civil Defense sirens (or tornado-warning sirens), particularly those in tornado corridors, are primarily used to alert hearing people of an impending tornado. The sirens, however, are part of the “hole” in the weather warning system because they are inaccessible to many deaf and hard of hearing people who may not hear the blaring sirens. The deaf and hard of hearing taxpayers are supporting the siren system from which they cannot benefit. A few respondents to the survey suggested placing strobe lights atop the sirens or using tax revenue from deaf and hard of hearing taxpayers to fund an assistive technology that would benefit them. Strobe lights on
top of the siren towers, however, have limited utility, except for individuals who are awake and can gain an unrestricted view of the tower.

**Weather pagers.** Weather pagers play an increasingly important role in disseminating to deaf and hard of hearing people life-saving information (Wood 1998). NWS watches or warnings reach a pager user via a paging company. The pager vibrates and displays the full text of the local weather watches and warnings in real time. The pager is an ideal notification method for people who cannot afford to be tied down to a personal computer or other weather data source.

Whereas weather warnings are provided free to the hearing public over the radio or with sirens, deaf and hard of hearing people have to pay the cost of a pager and subscription to a weather paging service. Very few of the survey respondents receive warnings via pagers (Fig. 1).

Many weather providers offer paging services, typically for a monthly fee. There are, however, several areas in the country that offer a free or partially funded weather paging service to deaf and hard of hearing people. Private funding has allowed this type of service in Ann Arbor, Michigan, for example, that includes AccuWeather’s warning and forecasts (Rosenfeld 2000). Similar programs exist in Chicago, Illinois, and Fairbault, Minnesota. We highly recommend that both private and public groups everywhere in the country investigate providing such services either at no cost or at a very low cost. This service would be nearly equivalent to that provided for hearing people over public airwaves.

On 2 July 2001, a small group of deaf and hard of hearing Oklahomans began receiving emergency weather alerts via alphanumeric pagers, as part of a new pilot program launched by two NOAA employees in Norman, Oklahoma (NOAA 2001). This system uses the Oklahoma Department of Civil Emergency Management’s Paging Alert System (EMPAS) to send NWS alerts to the deaf community. EMPAS developer Weather Affirmation, LLC, of Oklahoma City, agreed to adapt the system with the understanding that its use would be limited to individuals who are deaf and hard of hearing.

The Oklahoma School for the Deaf in Sulphur, Oklahoma, has agreed to oversee, finance, and implement the pilot project. Alerts from local NWS offices are transmitted via satellite to EMPAS software, which condenses and sends it to local paging companies for distribution to deaf and hard of hearing pager users in the pilot program.

It is anticipated that the program will be expanded statewide. The pilot program is believed to be the only state-supported program that directly relays NWS alerts via pagers to individuals who are deaf and hard of hearing.

**Weather Alert 2000.** A newly released product, the Weather Alert 2000, accommodates the needs of the deaf and hard of hearing community. It was created from a modified caller ID box and sends weather updates in text form to wireless phones and pagers (Norman Transcript, 9 April 2001). The device can activate a strobe light and an alarm tone when it receives warnings via a satellite signal, and can be programmed to receive weather alert information for up to 16 counties anywhere in the United States.

Weather Alert 2000 has advantages over NWR. It is not subject to interference during storms, and enables the messages to be received even when NWR is unable to receive the FM signals. However, Weather Alert 2000 is more expensive than the NWR receiver and it involves a monthly fee for satellite feeds.

**A NEED FOR INFORMATION.** Severe weather education is vital for all deaf and hard of hearing people, including an understanding of severe weather terminology. Under the Americans with Disabilities Act, meteorologists or other appropriately trained individuals conducting hazardous weather seminars or workshops with deaf and hard of hearing persons in attendance are responsible for reserving and paying for qualified interpreters for these sessions (see Part III, Section 36.303, available online at www.usdoj.gov/crt/ada/adahtm.htm). Closed-captioned videos describing weather hazards can be helpful for deaf and hard of hearing people. Also, there are many excellent weather education sources containing detailed information on safety rules, preparedness plans, and various types of weather hazards on the Internet.

Substantial progress has been made to “close this hole” in the nation’s weather warning system during the past two years in increasing the amount of weather emergency information available to the deaf and hard of hearing. Television stations continue to come into compliance with the FCC’s new emergency regulations. The use of new technology such as pager systems, weather radios adapted for use by those with special needs, and other warning systems have allowed deaf and hard of hearing people to have more access to the information.

Community outreach is needed to educate deaf and hard of hearing people about new alternatives in receiving weather warning information. Those in-
involved in educational outreach should be aware of updated information and research results, which might lead to new systems or enhanced communication techniques related to awareness and warning dissemination for people with hearing loss.

An estimated 28 million Americans, or roughly 10% of the nation’s population, have hearing loss that may vary from slight to a total loss of hearing. Hearing loss affects more American families than any other chronic health condition (Finn 2001). Traditionally, seniors with hearing loss have been shown to be the most vulnerable age group. However, in the last three decades, there has been a sharp increase in the number of younger people with hearing difficulties owing to increased environmental noise and other risk factors (Ries 1994; Wallhagen et al. 1997). Without sealing the hole in the nation’s weather warning system that today does not address reaching people with hearing loss, the safety of the deaf and hard of hearing population remains in jeopardy.

ACKNOWLEDGMENTS. We thank the following people for helping to make the survey a success: Mike Eilts of NSSL; Dee Porter, Patsy Hollingsworth, and Ray Willingham of the Oklahoma Department of Rehabilitation Services; Pati Burns of the Oklahoma City Chapter of Self Help for Hard of Hearing People, Inc.; Alice Labarre of the Minnesota Department of Human Services; Claudia Lee of Detroit’s Deaf Community Advocacy Network; and others. The authors acknowledge the assistance of Rodger Brown of NSSL, Jim Schmaelzle of Oklahoma State Department of Health, and Diane Leonard of the Minnesota Department of Human Services for helping improve the survey. The authors gratefully acknowledge the invaluable assistance of Don Senger of the FCC’s Emergency Alert System National Advisory Committee, Jim Purpura at NWS in Norman, Oklahoma; Van Schallenberg of the FCC’s Emergency Alert System National Advisory Committee; and Paul Spencer of the Oklahoma Department of Civil Emergency Management for giving helpful comments. The authors thank all of those who participated in the survey. The lead author is also indebted to the survey participants who shared their valuable experiences and frustrating problems with him in his personal and e-mail interviews with them. We appreciate the efforts of John Cortinas and Carl Hane of NSSL, Jim Schmaelzle, and Peggy Doviak for providing helpful suggestions on an earlier version of the manuscript. Finally, we appreciate the constructive comments and critiques of the anonymous reviewers.

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