*Paper No. 00-1700*

# Locator Tones for Pedestrian Signals

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**The two primary problems experienced by visually impaired persons at pedestrian-actuated intersections are determining whether there is a push-button and locating the push button. Many countries use accessible pedestrian signals much more widely than has been done in the United States, and a number of these—including Australia, Hong Kong, Sweden, Denmark, Germany, Belgium, and Austria—routinely require the use of a locator tone. Typically emanating from the push-button housing, a push-button locator tone indicates to pedestrians that they are expected to push a button to request a pedestrian phase. It enables visually impaired pedestrians to locate the push button quickly and efficiently. Research was undertaken to determine the effect of locator tone repetition rate on efficiency of pedestrians' location of the push-button pole. Repetition rates of 1.0 and 1.5 Hz resulted in equal pole location speed, faster than that for the 0.5 Hz repetition rate, and were preferred over the 0.5 Hz repetition rate. Locator tones 2 dB above ambient sound resulted in faster pole location than did tones 5 dB and 10 dB above ambient sound. Push-button locator tones should have a standardized repetition rate between 1.0 Hz and 1.2 Hz so that it may be ensured that visually impaired pedestrians can efficiently locate push buttons. Locator tones need be no more than 5 dB louder than ambient traffic sound.**

A survey of orientation and mobility specialists (conducted by the Association for Education and Rehabilitation of the Blind and Visually Impaired) and a survey of pedestrians who are blind (conducted by the American Council of the Blind) both indicate that the two primary problems experienced by visually impaired persons at pedestrian-actuated intersections are determining whether there is a push button and locating the push button. These surveys confirm the findings of previous research in San Diego and Japan (*1–4*).

## BACKGROUND

Many countries use accessible pedestrian signals much more widely than has been done in the United States, and a number of these—including Australia, Hong Kong, Sweden, Denmark, Germany, Belgium, and Austria—routinely require the use of a locator tone. A push-button locator tone typically emanates from the push-button housing, although it sometimes comes from a unit located higher up on the pole that has the push button. The tone indicates to pedestrians that they are expected to push a button to request a pedestrian phase. It also enables pedestrians who are visually impaired to locate the push button quickly and efficiently. The locator tone is most commonly repeated at a rate of approximately 0.5 to 1.25 Hz (30 to 75 cycles) per minute. The International Standards Organization (ISO) draft standard on acoustic and tactile signals for traffic lights (Committee Draft ISO/CD 1159.2, 5.2.1, November, 1997) requires that for locator tones, "an intermittent sound shall be used with a maximum repetition rate of 1.2 Hz" (72 cycles per minute). An international literature search revealed no research on the repetition rate for the locator tone. However, stakeholders in various countries strongly advocate for various repetition rates.

This research was undertaken to determine whether repetition rate of locator tones was related to efficiency in location of push buttons. The research was conducted in conjunction with the mid-year meeting of the American Council of the Blind (Los Angeles, February 13–14, 1999). Participants who were blind were tested individually, on a sidewalk along a busy street, in order that objective and subjective data on efficiency of push-button location could be obtained for push buttons having three different locator tone repetition rates.

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## METHOD

### Subjects

All participants were attendees at the mid-year meeting of the American Council of the Blind, and their participation was solicited by meeting organizers. Participants were required to be totally blind or have insufficient vision to enable them to visually locate poles. Forty-two persons volunteered to participate. Thirty-five participants used long canes and seven used dog guides. Participants represented a range of ages and varying degrees of hearing (see Table 1).

### Materials

An 880-Hz square wave tone, having multiple harmonics at onset, an attack time of 3 ms, a 15-ms sustain, and 82-ms release, was recorded at the three different repetition rates (0.5 Hz, 1.0 Hz, and 1.5 Hz) on two accessible pedestrian signal push buttons supplied by NOVAX Industries Corporation of New Westminster, British Columbia. An 880-Hz tone has been found to be highly localizable by most pedestrians, including those with age-related hearing loss (*3*, *5*). Each of the push buttons was mounted on a lightweight movable pole. So that each pole could be repositioned as silently as possible, it was given a rubber-covered bottom.

The intensity of the tones automatically varied in response to ambient sound. Initially, the intensity was set at 10 dB above ambient sound. Several of the first twelve participants volunteered that they thought the locator tone was louder than necessary and perhaps objectionably loud. Researchers then set the intensity of the locator tone at 5 dB above ambient sound for the next nineteen participants. When participants continued to volunteer that the locator tone was louder than necessary, researchers reduced it to 2 dB above ambient sound for the last eleven participants. Maximum locator tone intensity was always set at 90 dB.

TABLE 1 Participant Age and Hearing Status

| Age | | Hearing status | |
|---|---|---|---|
| Range | No. of subjects | Status | No. of subjects |
| 20-35 | 5 | good | 34 |
| 36-50 | 21 | mild loss | 6 |
| 51-65 | 11 | moderate loss | 2 |
| >65 | 5 | severe loss | 0 |

The experiment was conducted on the sidewalk along the east and west sides of Century Boulevard, an eight-lane artery in front of the Airport Westin Hotel in Los Angeles, near the T-shaped semi-actuated intersection with Concourse Street. A 3.7-m (12-ft) length of each sidewalk was marked with positions for pole placement and for participant starting position.

### Procedure

Participants were tested individually between 7:30 a.m. and 9:00 p.m. Twenty-one participants were tested on each side of the street.

Each participant located the push button three times for each of three locator tone repetition rates, from starting distances and directions counterbalanced across trials and participants and varying from 1.8 to 3.6 m (6 to 12 ft) from the pole. Participants were randomly headed approximately 45 degrees to the right or left of the pole. The pole was positioned from 0.3 to 1.8 m (1 to 6 ft) from the outer edge of the sidewalk, which was at the curb line.

Participants were instructed that as soon as they heard a locator tone, they should face the direction of the tone and then move as quickly as possible to touch the pole on which the push button (source of the tone) was located. As soon as they located the pole, one experimenter guided them to the next starting position while another experimenter moved the pole.

Experimenters used a digital stopwatch to measure the time from the onset of the first tone in each trial until the participant touched the pole.

Following this procedure, each signal repetition rate was demonstrated and participants were asked to rate the use of each of the three signals as a locator tone, according to a five-point scale in which 1 was equal to "not good at all" and 5 was equal to "very good."

## RESULTS

### Repetition Rate

To assess the effect of locator tone repetition rate on efficiency of pole location as indicated by rate of travel toward the pole, the researchers performed a two-way mixed analysis of variance (ANOVA) [east versus west side of street—between; repetition rate (0.5, 1.0, 1.5)—within]. (The east-versus-west-street-side factor was a control measure and is not considered in the results presented). Analysis revealed a significant effect of repetition rate for rate of travel, $F(2, 80) = 20.5$, $p < .001$. Mean rate of travel for the 0.5, 1.0, and 1.5 repetition rates were 0.43, 0.49, and 0.49 m/s (1.4, 1.6, and 1.6 ft/s), respectively. Planned contrasts revealed that the 0.5 repetition rate resulted in significantly slower rates of travel than did the 1.0 or 1.5 repetition rate ($ps < .001$), the latter two not differing.

### Loudness

To assess the effect of loudness (dB) of the locator tones relative to ambient sound on the rate of travel toward the pole, a two-way mixed ANOVA (2, 5, 10 dB—between; 0.5, 1.0, 1.5 repetition rate—within) was used. Analysis revealed a significant effect of loudness $F(2, 39) = 3.0$, $p < .06$, as well as repetition rate, $F(2, 78) = 17.2$, $p < .001$. For the tones with loudness of 2, 5, and 10 dB above ambient sound, the average rates of travel were 0.52, 0.45, and 0.44 m/s (1.7, 1.48, and 1.43 ft/s), respectively. Planned contrasts revealed that the 2 dB signal resulted in faster rates of travel than did either the 5 or 10 dB tones ($ps < .01$), the latter two not differing from one another. For repetition rates of 0.5, 1.0, and 1.5, the average speeds were 0.43, 0.49, and 0.49 m/s (1.4, 1.6, and 1.6 ft/s), respectively, as reported above.

### Subjective Ratings

The repetition rate was judged from 1 to 5 for preference as a locator tone, according to a 5-point scale in which 1 was equal to "not good at all" and 5 was equal to "very good."

A one-way within-subjects ANOVA (repetition rate—0.5, 1.0, 1.5) revealed significant effects for repetition rate, $F(1, 38) = 89.4$, $p < 0.000$. The mean ratings for the 0.5, 1.0, and 1.5 repetition rates were 1.9, 3.4, and 4.1, respectively. Planned contrasts revealed that all pair-wise comparisons were significant ($ps < 0.00$).

## CONCLUSIONS

1. The 1.0 and 1.5 repetition rates resulted in equal and faster pole location than did the 0.5 repetition rate.
2. The 1.5 repetition rate was preferred over the 1.0 rate, and the 1.0 rate was preferred over the 0.5 rate.
3. Tones 2 dB above ambient traffic sound resulted in faster pole location than did tones 5 and 10 dB above ambient sound.

## DISCUSSION OF RESULTS

The fastest locator tone repetition rate permitted by ISO draft standards on acoustic and tactile signals for traffic lights is 1.2 Hz. There is no proposed minimum repetition rate. This limitation was set in light of many years' positive experience with push-button locator tones in other countries, in the knowledge of strong preferences for different repetition rates at or below 1.2 Hz in different countries, and to permit the use of a pedestrian Walk tone whose repetition rate is reliably perceived as being different than the locator tone, but is readily achieved by existing accessible pedestrian signal technologies. The draft ISO standard requires a Walk tone with a repetition rate of equal to or greater than 2 Hz.

The 1.2 Hz repetition rate limit falls between the two faster repetition rates tested in this research, 1.0 Hz and 1.5 Hz. While only three repetition rates were tested, and they did not include the 1.2 Hz ISO (draft) limit, the greatest difference in efficiency of pole location observed in this research occurred between 0.5 Hz and 1.0 Hz; the trajectory flattened somewhat above 1.0 Hz, and there also was no significant difference in preference between the 1.0 and 1.5 repetition rates. A 1.2 Hz repetition rate seems to be an appropriate upper limit for locator tones, given the factors—in addition to objective efficiency of pole location—that informed the ISO draft standard.

However, a lower limit of 1.0 Hz is also necessary to assure good localizability of push buttons.

That pole location is faster at 2 dB above ambient sound than it is at 5 or 10 dB above ambient sound is puzzling. One possible explanation is that low sound frequencies heard when the locator tone is louder may mask the frequencies in the tone that are better for localizability. The ear is less sensitive to lower frequencies at low sound levels, and low frequency components may not have masked the more localizable frequencies at lower sound levels. The ISO draft standard says that the signal/noise level shall be +5 dB to the ambient noise level. This level may be higher than necessary for locator tones.

## RECOMMENDATIONS

To ensure that pedestrians who are visually impaired can efficiently locate push buttons, push-button locator tones should have a standardized repetition rate of between 1.0 Hz and 1.2 Hz. A signal level between 2 and 5 dB greater than ambient noise level appears to be adequate for efficient localization of poles equipped with locator tones.

Additional research should be conducted on locator tones so that tonal qualities such as frequency and harmonics, which result in optimal detection and efficient push-button location, may be identified. Additional research is also needed in order that researchers may clarify the relationship between ambient sound compensation factors and location of push buttons having locator tones.

## ACKNOWLEDGMENTS

This research was supported in part by The Seeing Eye, Inc., the American Council of the Blind, and the Blinded Veterans Association. The authors thank the American Council of the Blind for making subjects available, along with Lukas Franck and Linda Myers for their assistance in data collection, and Randolph Easton, Daniel Ashmead, and Chantal Laroche, for their assistance in research design and interpretation of results.

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*Publication of this paper sponsored by Committee on Pedestrians.*