Commerce City
Crosswalk/RRFB Policy

Purpose

This policy establishes a uniform set of guidelines to determine when and where crosswalk treatments should be installed. It considers when marked crosswalks, Rectangular Rapid Flashing Beacons (RRFB's) and HAWK signals are appropriate engineering solutions. The character and setting of the perceived problem is a critical consideration to avoid unintended consequences and determine the best solution for all users of the transportation system. Commerce City has identified the following evaluation criteria for the installation of marked and/or enhanced crosswalks.

When evaluating crosswalk treatments, the City follows guidance from the Federal Highway Administration (FHWA), the Manual on Uniform Traffic Control Devices (MUTCD) – 2009 edition, and Colorado Department of Transportation's (CDOT's) Roadway Design Guide – 2018 edition; while also considering best practices. This policy outlines what standards the City follows and when they should be applied.

Procedure for Requesting a Marked or Enhanced Crosswalk

All pedestrian crossing issues, including the request for marked crosswalks, RRFB's and HAWK's shall be coordinated between Commerce City Police Department and the City's Engineering Division. When determined necessary, the appropriate fire district will be asked to provide input on requests. Requests can be initiated by a member of City Council, the City Manager, the Director of Public Works, the City Engineer, the Chief of Police, City residents, or City business owners. Requestors will be asked to provide the time and location of the perceived problem.

Design Standards

The Manual on Uniform Traffic Control Devices (MUTCD) – 2009 Edition

The Federal Highway Administration (FHWA) publishes the MUTCD, which contains all national design, application, and placement, standards, guidance, options, and support provisions for traffic control devices. The purpose of the MUTCD is to provide uniformity of these devices, which include signs, signals, and pavement markings, to promote highway safety and efficiency on the Nation's streets and highways. Title 23 of the Code of Federal Regulations, Part 655.603 states that the MUTCD is the national standard for all traffic control devices installed on any street, highway, or bicycle trail open to public travel. Failure to comply with the MUTCD could result in the withdrawal of Federal-aid funds or liability in lawsuits.

CDOT Roadway Design Guide

The CDOT Roadway Design Guide identifies recommendations for the type of crosswalk device provided based on the number of travel lanes, speed and volume. If a road is owned and maintained by CDOT, recommendations should follow the Roadway Design Guide.

Engineering Construction Standards and Specifications (ECSS)

The ECSS is provided pursuant to the Commerce City Land Development Code. The purpose is to provide minimum standards to safeguard the health, property and public welfare by regulating the design, construction, quality of materials, use, location and maintenance of all public improvements and common facilities including, but not limited to public and private streets and trails, open space, parking lots, storm drainage improvements, and appurtenances thereto.

Marked Crosswalks

Crosswalk markings provide guidance for vehicles and pedestrians by defining and delineating paths on approaches to and within signalized intersections and on approaches to non-signalized stop-controlled intersections. In conjunction with signs and other measures, crosswalk markings also help alert road users of a designated pedestrian crossing point across roadways at locations not controlled by traffic control signals or STOP or YIELD signs. Mid-block pedestrian crossings are generally not desirable on arterial roadways. Mid-block pedestrian crossings may be considered on arterial roadways in locations where a future signal could be located (based on Commerce City signal spacing standards) if installed in conjunction with an RRFB or a Pedestrian Hybrid Beacon.

Warrant Criteria

The MUTCD states that the installation of crosswalk lines should not be used indiscriminately and that an engineering study should be performed before a marked crosswalk is installed at a location away from a traffic-controlled intersection (i.e. STOP, YIELD or signal controlled). The engineering study should consider the number of lanes, the presence of a median, the distance from adjacent signalized intersections, the pedestrian volumes and delays, the average daily traffic, the posted or 85th percentile speed, the geometry of the location, the possible consolidation of multiple crossing points, the availability of street lighting and other appropriate factors.

Warrant 1 is based on standards outlined in the MUTCD/FHWA guidelines. **Warrant 2** is adopted from the City and County of Denver's (CCD's) Uncontrolled Pedestrian Crossing Guidelines. **Warrant 3** is taken from FHWA's guidelines but modified to give a higher weight to the young, elderly or disabled and modified to balance current standards with existing requests/concerns. **Warrant 4** is included in FHWA's and CCD's guidelines. **Warrant 5** is taken from the school crossing control criteria of the MUTCD. All warrants must be met to permit a marked crosswalk on a roadway within the City (with the exception of marked crosswalks near schools).

Warrant 1: Is the 85th percentile speed less than 45 mph? For speeds 30 mph or higher, additional treatments must be considered with the installation of marked crosswalks, such as: enhanced signage/striping, pedestrian warning devices, pedestrian refuge islands, and/or rumble strips. Marked crosswalks on roads with speeds 30 mph or higher must be approved by the City Engineer or his/her designee.

Warrant 2: Is the next signalized crossing more than 300 feet away?

Warrant 3: Does the pedestrian count exceed 20 pedestrians during any two hours of the day, where each child under 16, senior, or person with reduced mobility counts twice? In cases where the number of pedestrians is the only warrant that is not met and the location serves an

existing/future trail crossing or pedestrian underpass, a marked crosswalk and/or RRFB should be based on engineering judgement, as determined by the City Engineer.

Warrant 4: Does the location meet sight distance requirements (using appropriate stopping sight distance guidance from the American Association of State Highway and Transportation Officials (AASHTO))?

Warrant 5: Are adequate gaps in traffic provided to accommodate pedestrian crossings? A gap study of 15-60 minutes should be performed. An adequate number of gaps is equal to the number of minutes in the study. Gaps should be long enough for a pedestrian to travel from curb to curb at 3.5 feet per second. If adequate gaps are not provided some other device or alternative measure would be required.

The Engineering Division will collect the data necessary to determine the nature and severity of the issue. Vehicular/pedestrian counts and speed studies will be collected for a minimum period of 48 hours.

In the event a marked crosswalk is warranted, section 5.03.4 of the ECSS states that crosswalks shall be marked with two foot by eight foot (2' x 8') bars spread four feet apart (edge to edge). Markings shall consist of pre-formed thermoplastic material conforming to Section 713 of the CDOT Standard Specifications for Road and Bridge Construction.

Signage

The MUTCD states that warning signs should be installed for all marked crosswalks located at non-intersection locations because crossings at non-intersection locations are generally unexpected by the road user.

Signage/Striping for School Crossings

The MUTCD provides guidance for signing and striping of school crossings within school zones. CDOT has their "Typical School Zone Sign Order" based on the 2009 MUTCD which outlines their standard school zone sign sequence and preferred combination of signs. The City will follow the MUTCD standard for marked crosswalks within school zones and CDOT's preferred combination of signage for purposes of consistency.

In some cases, existing school signage is old, faded, or simply not consistent with current standards. In those cases, the signage should be replaced or modified to comply with the CDOT Typical School Zone Sign Order (Attachment 1), including the installation of flashing school beacons. Flashing beacons have been shown to get better compliance than static signs and the beacons can be updated more easily as schools change their hours to ensure compliance during the actual hours that students would be present.

RRFB's

RRFB's are pedestrian activated warning devices to enhance pedestrian crosswalks at uncontrolled intersection crossing locations. The RRFB uses rectangular-shaped high-intensity LED indicators that flash rapidly in a combination of wig-wag and simultaneous flash pattern. RRFB's may be mounted immediately adjacent to the crossing sign. The RRFB increases pedestrian visibility by attracting driver attention with flashing beacons and making them aware of the pedestrian's presence. Studies to date have shown higher driver yielding rates and yielding much further in advance of crosswalks where

RRFB's have been installed compared to standard circular yellow warning beacons. The RRFB allows for normal traffic flow when they are not actuated. When used, these devices should be installed on both the right and left sides of the roadway. They are not currently included in the MUTCD, but jurisdictions can use them under the terms and conditions of Interim Approval 21 (see section IA.10 of the MUTCD).

Interim Approval 21

The FHWA previously allowed the use of RRFB's through Interim Approval 11 (IA-11). IA-11 was terminated due to patent protection issues associated with the RRFB. Since the MUTCD does not allow patented traffic control devices, IA-11 was terminated. Since then, the patent was abandoned and the FHWA issued IA-21. IA-21 reflects more recent research and experience that agencies must comply to if they want to install RRFB's. Existing RRFB's will need to be reprogrammed to match the new flash pattern specified in IA-21 as part of a systematic upgrading process, such as when maintenance is performed or when signs are replaced.

If the City installs an RRFB under IA-21 they must agree to:

- Comply with the Technical Conditions provided in Attachment 2,
- Maintain an inventory list of all locations where an RRFB is installed, and
- Comply with all the conditions listed in Paragraph 18 of Section 1A.10 of the 2009 MUTCD.

RRFB Warrant Criteria

The MUTCD states that the installation of an RRFB must be located at or immediately adjacent to an uncontrolled marked crosswalk. As such, the following must be evaluated and meet the warrants to consider installation of an RRFB.

1) If no crosswalk is currently marked the proposed location must answer yes to all 5 warrants for the installation of a marked crosswalk, *or*
2) If the proposed location has a marked crosswalk, data must be provided showing that warrants 3, 4 & 5 of the marked crosswalk warrant are met, *and*
3) The location must meet both of the warrants for installation of an RRFB.

Warrant 1 is based on standards outlined in CDOT's design guidelines. **Warrant 2** is adopted from a study used to support the FHWA interim approval of RRFB's.

Warrant 1: Does the pedestrian need to cross less than five lanes carrying through traffic? On roadways carrying 4 through lanes, pedestrian refuge islands are highly desirable.

Warrant 2: Is the average daily traffic (ADT) between 3,000 and 12,000 vehicles per day (vpd)? Or if the ADT is less than 3,000 vpd is this a school crossing where the peak hour traffic exceeds 10% of the ADT? On roadways with more than 10,000 ADT, pedestrian refuge islands are highly desirable. On roadways with more than 12,000 ADT, consideration of a PHB/HAWK is recommended.

The Engineering Division will collect the data necessary to determine the nature and severity of the issue. Vehicle/pedestrian counts and speed studies will be collected for a minimum period of 48 hours.

RRFB Installation and Design Standards

If the studied location meets warrants for a marked crosswalk (including adequate sight distance) and an RRFB, design and installation of the RRFB must follow the criteria outlined in FHWA's IA-21. The criteria are included as Attachment 2. If adequate sight distance is not provided, additional measures shall be taken to maximize sight distance before the installation of an RRFB occurs.

Consideration should be given to installing an additional RRFB in advance of the crosswalk if sight distance is limited or on higher speed (>35 mph) roadways.

On roadways with two-way left turn lanes, refuge islands should be installed at crossing locations for pedestrian refuge as well as a location to install an RRFB and warning signage in the middle of the roadway.

PHB's/HAWKS

Pedestrian hybrid beacons (PHB's) are a special type of beacon used to warn and control traffic at an unsignalized location to assist pedestrians in crossing a street or highway at a marked crosswalk. One type of commonly used PHB is the HAWK (High-Intensity Activated crossWalk beacon). Chapter 4F of the 2009 MUTCD outlines standards for considering PHB's.

If used, PHB's shall be used in conjunction with signs and pavement markings to warn and control traffic at locations where pedestrians enter or cross a street or highway. A PHB shall only be installed at a marked crosswalk.

The need for a PHB should be considered on the basis of an engineering study that considers major-street volumes, speeds, widths, and gaps in conjunction with pedestrian volumes, walking speeds, and delay.

PHB Warrant Criteria

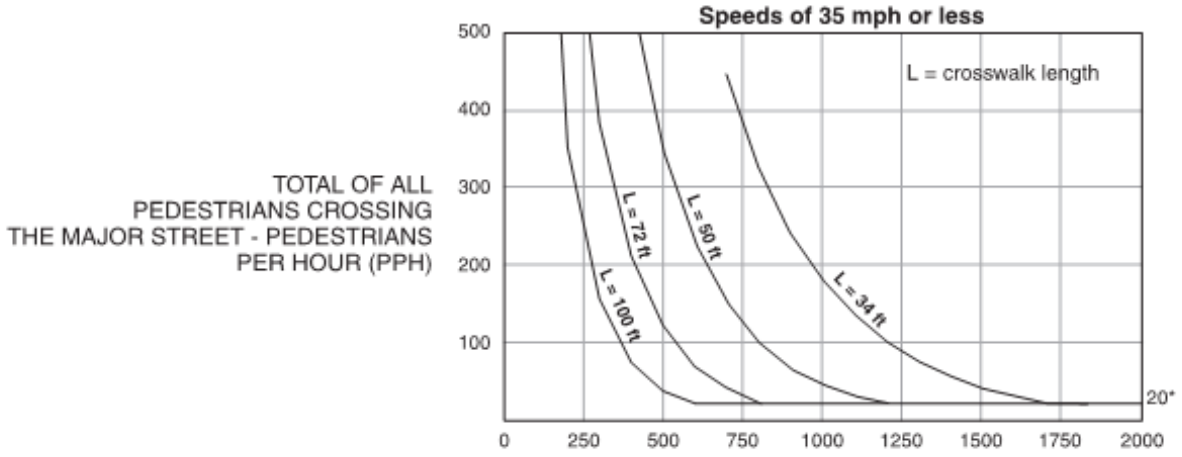
The 2009 MUTCD states that a PHB should be considered if gaps in traffic are not adequate to permit pedestrians to cross, or if the speed for vehicles approaching on the major street is too high to permit pedestrians to cross, or if delay is excessive. Consideration for a PHB should be based on an engineering study that considers major-street volumes, speeds, widths, and gaps in conjunction with pedestrian volumes, walking speeds and delay.

PHB's may be considered at locations to facilitate pedestrians where signal warrants are not met or where signal warrants are met but the decision is made not to install a traditional traffic signal system.

Based on the CDOT Roadway Design Guide, roadways with six or more lanes require PHB's at unsignalized designated crossings. Furthermore, PHB's should not be installed where the crossing volume is less than 20 pedestrians per hour.

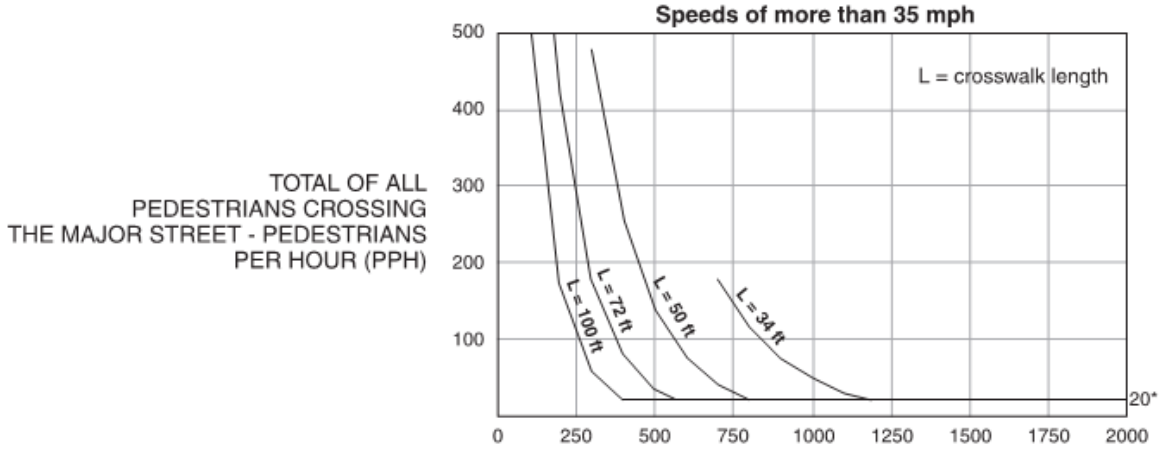
The following charts, taken from the 2009 MUTCD, should be used to determine if pedestrian and vehicle volumes are high enough to warrant the installation of a PHB.

Figure 4F-1. Guidelines for the Installation of Pedestrian Hybrid Beacons on Low-Speed Roadways



* Note: 20 pph applies as the lower threshold volume

Figure 4F-2. Guidelines for the Installation of Pedestrian Hybrid Beacons on High-Speed Roadways



* Note: 20 pph applies as the lower threshold volume

PHB Installation and Design Standards

If the studied location meets warrants for a PHB, design and installation must follow the criteria outlined in Chapters 4D, 4E, and 4F of the 2009 MUTCD.

City Engineer Date

Brent Soderlin, P.E.

Attachment 1

CDOT Typical School Zone Sign Order

MUTCD 2009 EDITION – CDOT Typical School Zone Sign Order – Double Fines School Zone with Reduced Speed Limit

School Advance Crossing Assembly **

S1-1

W16-9P **

W16-2aP **

W16-5P ** (L/R)

W16-6P ** (L/R)

** choose one above

R52-5

* Proper placement in advance of S5-1 – See MUTCD Table 2C-4, column 4.

School Speed Limit Assembly with Higher Fines

S5-1(XX)

Placement at least 200 feet (or more if ≥ 30mph) before the school grounds.

R2-6aP

"Optional" Advance School Crossing Assembly

S1-1

W16-9P *

W16-5P * (L/R)

W16-6P * (L/R)

* choose one above

"Optional" School Advance Crossing Assembly may be omitted where a School Zone (S1-1) sign is installed to identify the beginning of a school zone in advance of the School Crossing Assembly.

Give adequate advance warning when using the "Optional" Advance School Crossing Assembly before the School Crossing Assembly.

CDOT policy is to only use this "Optional" School Advance Crossing Assembly when something is obstructing the sight of the crossing.

School Crossing Assembly

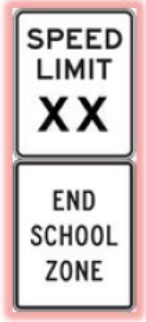
S1-1

W16-7PL **

W16-7PR **

** choose one above

End School Speed Limit and School Zone



R2-1(XX)

S5-2

Red Highlighted Preferred Combinations

Version: 03/20/2014

Attachment 2

FHWA Conditions of Interim Approval 21

1. General Conditions:
    a. Each RRFB unit shall consist of two rapidly flashed rectangular-shaped yellow indications with an LED-array-based light source, and shall be designed, located, and operated in accordance with the detailed requirements specified below.
2. Allowable Uses:
    a. An RRFB shall only be installed to function as a pedestrian-actuated conspicuity enhancement.
    b. An RRFB shall only be used to supplement a post-mounted W11-2 (Pedestrian), S1-1 (School), or W11-15 (Trail) crossing warning sign with a diagonal downward arrow (W16-7P) plaque, or an overhead-mounted W11-2, S1-1, or W11-15 crossing warning sign, located at or immediately adjacent to an uncontrolled marked crosswalk.
    c. Except for crosswalks across the approach to or egress from a roundabout, an RRFB shall not be used for crosswalks across approaches controlled by YIELD signs, STOP signs, traffic control signals, or pedestrian hybrid beacons.
    d. In the event sight distance approaching the crosswalk at which RRFBs are used is less than deemed necessary by the engineer, an additional RRFB may be installed on that approach in advance of the crosswalk, as a pedestrian-actuated conspicuity enhancement to supplement a W11-2 (Pedestrian), S1-1 (School), or W11-15 (Trail) crossing warning sign with an AHEAD (W16-9P) or distance (W16-2P or W16-2aP) plaque. If an additional RRFB is installed on the approach in advance of the crosswalk, it shall be supplemental to and not a replacement for the RRFBs at the crosswalk itself.
3. Sign/Beacon Assembly Locations:
    a. For any approach on which RRFBs are used to supplement post-mounted signs, at least two W11-2, S1-1, or W11-15 crossing warning signs (each with an RRFB unit and a W16-7P plaque) shall be installed at the crosswalk, one on the right-hand side of the roadway and one on the left-hand side of the roadway. On a divided highway, the left-hand side assembly should be installed on the median, if practical, rather than on the far left-hand side of the highway.
    b. An RRFB unit shall not be installed independent of the crossing warning signs for the approach that the RRFB faces. If the RRFB unit is supplementing a post-mounted sign, the RRFB unit shall be installed on the same support as the associated W11-2, S1-1, or W11-15 crossing warning sign and plaque. If the RRFB unit is supplementing an overhead-mounted sign, the RRFB unit shall be mounted directly below the bottom of the sign.

4. Beacon Dimensions and Placement in the Sign Assembly:
    a. Each RRFB shall consist of two rectangular-shaped yellow indications, each with an LED-array-based light source. The size of each RRFB indication shall be at least 5 inches wide by at least 2 inches high.
    b. The two RRFB indications for each RRFB unit shall be aligned horizontally, with the longer dimension horizontal and with a minimum space between the two indications of at least 7 inches, measured from the nearest edge of one indication to the nearest edge of the other indication.
    c. The outside edges of the RRFB indications, including any housings, shall not project beyond the outside edges of the W11-2, S1-1, or W11-15 sign that it supplements.
    d. As a specific exception to Paragraph 5 of Section 4L.01 of the 2009 MUTCD, the RRFB unit associated with a post-mounted sign and plaque may be located between and immediately adjacent to the bottom of the crossing warning sign and the top of the supplemental downward diagonal arrow plaque (or, in the case of a supplemental advance sign, the AHEAD or distance plaque) or within 12 inches above the crossing warning sign, rather than the recommended minimum of 12 inches above or below the sign assembly.
5. Beacon Flashing Requirements:
    a. When actuated, the two yellow indications in each RRFB unit shall flash in a rapidly flashing sequence.
    b. As a specific exception to the requirements for the flash rate of beacons provided in Paragraph 3 of Section 4L.01, RRFBs shall use a much faster flash rate and shall provide 75 flashing sequences per minute. Except as provided in Condition 5f below, during each 800-millisecond flashing sequence, the left and right RRFB indications shall operate using the following sequence:

        The RRFB indication on the left-hand side shall be illuminated for approximately 50 milliseconds.
        Both RRFB indications shall be dark for approximately 50 milliseconds.

        The RRFB indication on the right-hand side shall be illuminated for approximately 50 milliseconds.
        Both RRFB indications shall be dark for approximately 50 milliseconds.

        The RRFB indication on the left-hand side shall be illuminated for approximately 50 milliseconds.
        Both RRFB indications shall be dark for approximately 50 milliseconds.

        The RRFB indication on the right-hand side shall be illuminated for approximately 50 milliseconds.
        Both RRFB indications shall be dark for approximately 50 milliseconds.

Both RRFB indications shall be illuminated for approximately 50 milliseconds. Both RRFB indications shall be dark for approximately 50 milliseconds.

Both RRFB indications shall be illuminated for approximately 50 milliseconds. Both RRFB indications shall be dark for approximately 250 milliseconds.

c. The flash rate of each individual RRFB indication, as applied over the full flashing sequence, shall not be between 5 and 30 flashes per second to avoid frequencies that might cause seizures.
d. The light intensity of the yellow indications during daytime conditions shall meet the minimum specifications for Class 1 yellow peak luminous intensity in the Society of Automotive Engineers (SAE) Standard J595 (Directional Flashing Optical Warning Devices for Authorized Emergency, Maintenance, and Service Vehicles) dated January 2005.
e. To minimize excessive glare during nighttime conditions, an automatic signal dimming device should be used to reduce the brilliance of the RRFB indications during nighttime conditions.
f. Existing RRFB units that use the flashing sequence that was specified in the Interim Approval 11 memorandum and a subsequent interpretation (the RRFB indication on the left-hand side emits two slow pulses of light after which the RRFB indication on the right-hand side emits four rapid pulses of light followed by one long pulse of light) should be reprogrammed to the flash pattern specified above in Condition 5b as part of a systematic upgrading process, such as when the units are serviced or when the existing signs are replaced.

6. Beacon Operation:
    a. The RRFB shall be normally dark, shall initiate operation only upon pedestrian actuation, and shall cease operation at a predetermined time after the pedestrian actuation or, with passive detection, after the pedestrian clears the crosswalk.
    b. All RRFB units associated with a given crosswalk (including those with an advance crossing sign, if used) shall, when actuated, simultaneously commence operation of their rapid-flashing indications and shall cease operation simultaneously.
    c. If pedestrian pushbutton detectors (rather than passive detection) are used to actuate the RRFB indications, a Push Button To Turn On Warning Lights (R10-25) sign shall be installed explaining the purpose and use of the pedestrian pushbutton detector.
    d. The duration of a predetermined period of operation of the RRFBs following each actuation should be based on the procedures provided in Section 4E.06 of the 2009 MUTCD for the timing of pedestrian clearance times for pedestrian signals.
    e. The predetermined flash period shall be immediately initiated each and every time that a pedestrian is detected either through passive detection or as a result of a pedestrian pressing a pushbutton detector, including when pedestrians are

detected while the RRFBs are already flashing and when pedestrians are detected immediately after the RRFBs have ceased flashing.

f. A small pilot light may be installed integral to the RRFB or pedestrian pushbutton detector to give confirmation that the RRFB is in operation.

7. Accessible Pedestrian Features:
    a. If a speech pushbutton information message is used in conjunction with an RRFB, a locator tone shall be provided.
    b. If a speech pushbutton information message is used in conjunction with an RRFB, the audible information device shall not use vibrotactile indications or percussive indications.
    c. If a speech pushbutton information message is used in conjunction with an RRFB, the message should say, "Yellow lights are flashing." The message should be spoken twice.