

**A HISTORY OF PEDESTRIAN SIGNAL WALKING SPEED ASSUMPTIONS**

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**ABSTRACT**

The Manual of Uniform Traffic Control Devices (MUTCD) has long used 4.0 ft/sec as the recommended walking speed to be used in setting the time for the pedestrian clearance (Flashing Don't Walk) phase for pedestrian signal installations. Recently, the National Committee on Uniform Traffic Control Devices voted to change the recommended walking speed to 3.5 ft/sec for the pedestrian clearance phase, and 3.0-ft/sec for the entire Walk/Flashing Don't Walk interval. This paper will give the history of the 4.0 ft/sec walking speed, going back to the 1961 MUTCD, and then explain the rationale for the new MUTCD recommendations.

## **A HISTORY OF PEDESTRIAN SIGNAL WALKING SPEED ASSUMPTIONS** **by John LaPlante, PE, PTOE and Thomas Kaeser, PE, PTOE**

### **INTRODUCTION**

For motor vehicle travel, the use of the yellow signal indication to create a suitable clearance time between the green and red signal phases has been a well-understood traffic control tool for over 80 years. The history of the “Flashing Don’t Walk” pedestrian clearance goes back less than 40 years and is still not completely understood by a majority of pedestrians.

One of the reasons the “Flashing Don’t Walk” is so misunderstood is the counter-intuitive nature of the signal. While the primary purpose of the signal is to inform pedestrians who have already begun crossing the street on the steady “Walk” signal that they have enough time to complete their crossing and they should continue walking, the message actually says “Don’t Walk,” and it further emphasizes that message by flashing it. Recently, the advent of Count Down signals has begun to alleviate this condition, at least at those intersections where they are installed.

However, every city traffic engineer has received countless complaints regarding the inability of pedestrians to cross their city streets within the allotted pedestrian crossing time, and although many of these complaints can be answered by explaining that the “Walk” signal is just a preliminary indication of when to walk, and that the “Flashing Don’t Walk” signal really means it is all right to continue walking, there remains the lingering suspicion that the signals are only set for the young and the quick.

According to the 2003 MUTCD, the length of the pedestrian clearance phase, including the “Flashing Don’t Walk” segment, should be based on the “normal” pedestrian walking speed of 4.0 feet per second (fps). When slower pedestrians “routinely” use the crosswalk, slower walking speeds should be used. However, there are no guidelines as to what walking speed would be appropriate or when to use these lower speeds.

In 2002, the Public Rights-of-Way Access Advisory Committee (PROWAAC) released their draft guidelines for public comment. With respect to pedestrian walking speeds used for determining minimum pedestrian clearance times at signalized intersections, a universal maximum pedestrian walking speed of 3.0 fps was recommended. This recommendation raised a number of questions and concerns regarding the effect on traffic of universally requiring such a slow walking speed value. T.Y. Lin International was asked by the US Access Board to determine the history of the current walking speed values and to estimate the effect of the recommended changes on traffic operations.

### **CHANGING MUTCD LANGUAGE ON PEDESTRIAN WALKING SPEEDS**

#### **1948 MUTCD**

This edition of the MUTCD did not yet explicitly suggest a walking speed for which pedestrian crossing phases should be timed. However, there was general language about the need to provide sufficient time for pedestrians to cross a street.

“When the pedestrian crossing time runs concurrently with the vehicle Go period, which is the usual case, the total Go interval should be long

enough to allow not less than 5 seconds during which it is indicated that pedestrians may start to cross, and enough longer to permit pedestrians who have entered the roadway to reach a place of safety with the additional time provided by the vehicular clearance interval. Thus if it takes 14 seconds for *most* pedestrians to cross the roadway or reach a point of safety, and if the vehicle clearance (yellow) interval is 3 seconds, the total Go (green) interval should be at least  $5 + 14 - 3$ , or 16 seconds.” (Emphasis added.) The Manual goes on to say “Since the pedestrian, as well as the vehicle, requires a clearance interval, the period during which it is not possible to start and complete a crossing at the *normal* walking speed should always be recognized by an appropriate signal indication. Such indication should be given the pedestrian sufficiently in advance of the transfer of vehicle right-of-way to prevent pedestrians from being stranded in the middle of the street.” (Emphasis added.) (1)

The 1948 Manual did not get into specifics of either average (“normal”) walking speeds, or design speeds (for “most” pedestrians), analogous to a 15<sup>th</sup> percentile speed. Indeed, the concept of 85<sup>th</sup> percentile vehicular speeds was not mentioned in the Manual, with only the notion of arithmetical average vehicular speeds being used in some of the signal warrant provisions. Instead, the Manual offered broad guidance to signal engineers to consider the need to cross pedestrians safely at signalized locations.

### 1961 MUTCD

This edition of the Manual introduced a specific walking speed that could be used to determine timing for crossing a street, and also described the crossing distance to be considered when calculating this crossing time.

“A pedestrian clearance interval shall always be provided. The duration shall be sufficient to allow a pedestrian crossing in the crosswalk to leave the curb and travel to the center of the farthest traveled lane before opposing vehicles receive a green indication. (*Normal* walking speed is assumed to be 4 feet per second.)” (Emphasis added.) (2)

In discussing this language with some longtime members of the National Committee on Uniform Traffic Control Devices (NCUTCD), it was found that the 4 feet per second speed was introduced following research done in 1952 by James Exnicios while a graduate student at Yale University.(3) His unpublished research on pedestrians crossing streets in downtown New Haven, Connecticut indicated that a walking speed of 4 fps could be considered an average speed for all crossing pedestrians, including men and women and all age groups. However, the research did note that the speed frequency distribution curves indicated a break point in the curves that generally corresponded to a 15<sup>th</sup> percentile walking speed. For all pedestrians, this value was 3.5 fps, which was considered a critical slow walking speed of particular interest to traffic engineers. The research also noted variations in speeds for other classes of pedestrians, such as elderly pedestrians, and noted the need to consider these classes of pedestrians in designing signal timing. For elderly pedestrians, the research indicated a 50<sup>th</sup> percentile speed of about 3.5 fps, and a 15<sup>th</sup> percentile speed of about 3.0 fps. It is worth noting that the 1948 Manual used this data by stating that 4 fps is the “normal” speed, and not necessarily a design or critical speed, to consider in setting signal timing.

### 1978 and 1988 MUTCD

These editions of the Manual are quite similar to the 1961 version, with only minor differences with respect to the definition of pedestrian clearance interval.

“A pedestrian clearance interval shall always be provided where pedestrian signal indications are used. It shall consist of a flashing DONT WALK indication. The duration should be sufficient to allow a pedestrian crossing in the crosswalk to leave the curb and travel to the center of the farthest traveled lane before opposing vehicles receive a green indication (*normal* walking speed is assumed to be 4 feet per second).” (Emphasis added.) (4,5)

It may be worth noting that these editions of the Manual, use the wording “duration *should* be” compared to the 1961 version that stated the “duration *shall* be”, suggesting a recommended rather than required condition. (Emphasis added.)

### Millennium Edition MUTCD

The Millennium edition of the Manual further elaborated on the concept of the pedestrian clearance interval, and also explicitly noted the need to consider pedestrians who may move at a speed slower than the “normal” 4 feet per second. As a Standard, this Manual stated:

“The first portion of the pedestrian clearance time shall consist of a pedestrian change interval during which a flashing UPRAISED HAND (symbolizing DONT WALK) signal indication shall be displayed. The remaining portions shall consist of the yellow change interval and any red clearance interval (prior to a conflicting green being displayed), during which a flashing or steady UPRAISED HAND (symbolizing DONT WALK) signal indication shall be displayed.” (6)

It went on to offer the following Guidance:

“The pedestrian clearance time should be sufficient to allow a pedestrian crossing in the crosswalk who left the curb or shoulder during the WALKING PERSON (symbolizing WALK) signal indication to travel at a *normal* walking speed of 1.2 m (4 ft) per second, to at least the center of the farthest traveled lane or to a median of sufficient width for pedestrians to wait. Where pedestrians who walk slower than normal, or pedestrians who use wheelchairs, routinely use the crosswalk, a walking speed of less than 1.2 m (4 ft) per second should be considered in determining the pedestrian clearance time.” (Emphasis added.) (6)

### 2003 MUTCD

The most recently adopted 2003 edition of the MUTCD included a change that altered the crossing distance to be considered when determining pedestrian crossing time. Rather than providing a pedestrian clearance to the center of the furthest traveled lane, it recommends providing that clearance to the far side of the traveled way. Under Guidance, the current language now reads:

“The pedestrian clearance time should be sufficient to allow a pedestrian crossing in the crosswalk who left the curb or shoulder during the

WALKING PERSON (symbolizing WALK) signal indication to travel at a normal walking speed of 1.2 m (4 ft) per second, to at least the far side of the traveled way or to a median of sufficient width for pedestrians to wait....” (7)

This had already been the practice for some time in some jurisdictions, and provides a more conservative approach to safety by trying to get pedestrians completely out of the roadway before the start of a conflicting green, rather than crossing pedestrians only to the center of the farthest through lane, which can be problematic on multilane approaches where a vehicle in a left hand lane can obscure the visibility of motorists approaching in the farthest lane when trying to see a crossing pedestrian.

### **SUMMARY OF RESEARCH ON PEDESTRIAN WALKING SPEED**

As noted above, James Exnicios’ research in the early 1950’s was used to provide guidance for traffic engineers in setting pedestrian signal crossing timing, beginning with the 1961 edition of the MUTCD. This unpublished research indicated that a walking speed of 4 fps could be considered an average speed for all crossing pedestrians, including men and women and all age groups, and that 3.5 fps was the 15<sup>th</sup> percentile. For elderly pedestrians, 3.5 fps was the average and 3.0 was the 15<sup>th</sup> percentile. (3)

The 1982 Traffic Engineering Handbook cites research by Robert Sleight that indicates 50<sup>th</sup> percentile walking speeds of about 4.5 fps, and 15<sup>th</sup> percentile speeds of about 3.3 fps for elderly pedestrians, and about 3.7 fps for other adults. The Handbook suggests that “for the relatively slow walkers, speeds of 3.0 to 3.25 fps would be more appropriate” than 4.0 fps. (8)

The 1983 Traffic Control Devices Handbook notes that the “MUTCD cites an assumed normal walking speed of 4 feet per second”, but goes on to say that “...research verifies that one-third of all pedestrians cross streets at a rate slower than 4 fps and 15 percent walk at or below 3.5 fps.” (9) The specific research is not cited in the Handbook.

In 1995, Coffin and Morrall published a study of elderly pedestrians at crosswalks, which recommended as a design (15<sup>th</sup> percentile) speed for elderly pedestrians, values of 4.0 fps (1.2m/s) at intersections, and 3.3 fps (1.0m/s) at midblock crosswalks and intersections near senior housing and nursing homes. (10)

In 1996, Knoblauch, Pietrucha, and Nitzburg, published “Field Studies of Pedestrian Walking Speed and Start-Up Time” in Transportation Research Record 1538, that studied walking speeds of younger (ages 13 to 64) and older pedestrians (65 and over). While the report did not provide an aggregate walking speed for all pedestrians, young and old, it did provide data on mean and 15<sup>th</sup> percentile walking speeds for those two groups. For younger pedestrians, the mean speed was 4.95 feet per second, while the 15<sup>th</sup> percentile speed was 4.11 feet per second. For older pedestrians, the mean speed was 4.11 fps, while the 15<sup>th</sup> percentile speed was 3.19 feet per second. The authors suggest for traffic signal design purposes a value of 4 feet per second for younger pedestrians, and 3 feet per second for older pedestrians. With respect to startup times, Knoblauch et al found that pedestrian reaction times varied between 1 and 3 seconds, depending on the age and number of pedestrians in the group waiting to cross. (11)

In 1998, Guerrier and Jolibois published a study of pedestrian crossing speeds in Miami, and found an average crossing speed of 4.42 fps for younger and 3.19 fps for

older pedestrians, and 15<sup>th</sup> percentile speeds of 3.09 fps overall, 3.31 fps for younger, and 2.20 fps for older pedestrians. (12)

In 1999, Milazzo, Roupail, Hummer, and Allen reviewed some of the past research and guidelines for pedestrian crossing speeds in Transportation Research Record #1678. They noted that the 1994 Highway Capacity Manual cited a value of 4.5 fps as a typical walking speed in a crosswalk, but a value of 4.0 fps as the assumed 15<sup>th</sup> percentile crosswalk walking speed when pedestrian timing requirements are computed. They cited research by Griffiths et al. that found average walking speeds at unsignalized crossings of 5.7 fps for young pedestrians, 4.9 fps for middle-aged, and 3.8 for elderly, and also cited the Knoblauch et al. and Coffin and Morrall studies. Milazzo et al recommend a “crosswalk walking speed value of 1.2 m/s (3.9 fps) for most conditions”, but a walking speed of 1.0 m/s (3.3 fps) for areas “with large amounts of older pedestrians”, which they suggest is locations where the percentage of older pedestrians exceeds 20 percent of the users of the facilities. (13)

Milazzo et al also noted that the 1994 Highway Capacity Manual uses a value of 4.5 fps as a typical walking speed, but 4.0 fps as the “assumed 15<sup>th</sup>-percentile crosswalk walking speed when pedestrian timing requirements are computed.” Their paper is in turn cited in the 2000 Highway Capacity Manual references to average walking speed of 4.0 fps, where there are 0 to 20 percent elderly pedestrians, and 3.3 fps where there are greater than 20 percent elderly.

Finally, the 2001 Traffic Control Devices Handbook suggests that where walking speeds slower than a normal rate of 4.0 fps are known to occur frequently and resources do not exist to undertake studies to establish the 15<sup>th</sup>-percentile speed, a rate of 3.5 fps may be applied. (14) The City of Los Angeles Department of Transportation in January 2004 cited a number of pedestrian speed studies undertaken at locations where there were complaints of insufficient pedestrian clearance time, often in locations near senior centers. Their findings indicate that the average 15<sup>th</sup>-percentile walking speed for reported problem intersections is 3.82 fps, and their staff has noted that the 2001 Traffic Control Devices Handbook value of 3.5 fps in the absence of specific studies appears to be appropriately conservative as an assumed walking speed. (15)

## **UPCOMING MUTCD WALKING SPEEDS**

The brief history of walking speed values and standards summarized above shows how a 4 fps “normal” or average walking speed gradually morphed into a 4 fps minimum design speed for the Pedestrian Clearance interval, with slower speeds suggested only for special situations where some unspecified number of elderly pedestrians are expected to cross. This application of the MUTCD has resulted in the vast majority of traffic signals being timed so that up to half of the pedestrians beginning their crossing at the start of the Pedestrian Clearance interval will potentially still be in the street when the conflicting traffic is free to proceed. Although many of the slower pedestrians will begin their crossing at the onset of the WALK signal, at intersections where the street to be crossed is wide (80 feet or greater) and traffic movements are heavy, only a minimum 4 to 5 seconds of WALK will precede the FDW signal, and they will still not be able to complete their crossing before opposing traffic is released.

Based on these findings, we recommended that both the Draft Accessible Guidelines and the MUTCD use a 3.5 fps (1.1 m/s) minimum walking speed across the

street itself (curb-to-curb) for determining the Pedestrian Clearance interval, and a 3.0 fps (0.9 m/s) walking speed across the total crossing distance (top of ramp to far curb) for the entire WALK plus Pedestrian Clearance signal phasing. In any case, the minimum WALK signal indication should still be 4 seconds. (16)

Since that recommendation was submitted, one additional important study on walking speeds was completed. The Texas Transportation Institute, as part of a joint TCRP and NCHRP Project on Improving Pedestrian Safety at Unsignalized Roadway Crossings, collected data on the time it took a pedestrian to cross to the middle of the street and then to the other side of the street. The resulting walking speeds showed a 15<sup>th</sup> percentile walking speed for young pedestrians of 3.77 fps and for old pedestrians a walking speed of 3.03 fps. It was their recommendation to use a 3.5 fps walking speed for timing of traffic signals, and where older pedestrians are a concern to use 3.0 fps. (17)

With this new data in hand, the National Committee on Uniform Traffic Control devices voted to adopt the 3.5 fps ped clearance and 3.0 fps total walking speeds for inclusion in the next revision of the MUTCD, which is now expected to be approved for publication sometime toward the end of this year or the beginning of 2008. Similarly, PROWAG has taken similar action for inclusion in the current draft of the new Accessibility Guidelines for Public Rights-of-Way (PROWAG), expected out sometime in 2008 or 2009. In January 2006, FHWA issued a memorandum advising all public agencies using Federal highway funds to follow these draft accessibility guidelines until the final PROWAG document is formally approved and adopted. This means that for all practical purposes, these new walking speeds should be in use for any major highway or urban arterial pedestrian traffic signal installation or upgrade since 2006.

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