

# Do Pedestrians/Rollers/Cyclists Deserve an Effective Red-Clearance Interval?

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**Abstract:** Believe it or not, over the last 70 years, the yellow change and red clearance intervals (CCI) at signalized intersections have been continually studied, researched, modified, improved, and vigorously debated. Still, we can see quite a variety of different CCI guidance applied from federal, state and local perspectives. The latest ITE journal article suggests that CCI “Research [is] Still Needed!” Within 11 areas of identified and related interests, “safety benefits of yellow change and red clearance intervals” is identified as the most important. In 2020, “ITE Releases Recommended Practice for Traffic Signal Change”; however, “this report is specifically focused on the timing of traffic signal change intervals and does not address pedestrian signal change intervals or enforcement of red light running”. If we seek to design surface transportation systems that promote the safety of all road users, we ask the question: do pedestrians and rollers/cyclists deserve all-red clearances that serve their needs in the way that the concurrent moving vehicles at signalized intersections receive. And, if so, what should the duration of the all-red indication be? To answer this question, the authors illustrate a thought experiment of five hypothetical signalization scenarios including dynamic traffic “simulation” by manually diagramming the three critical seconds of signal timing transition: yellow, red, green in one cycle with considerations of all approaches of passenger cars, pedestrians, cyclists and rollers. Through the scenarios, we can visually see the progressive safety improvements of reducing the frequency of “forced conflicts” as a surrogate for potential crashes. The authors randomly surveyed around 100 northwest urban signalized intersections among each of the states of Oregon and Washington, and Canadian British Columbia District (BC). The random survey findings are mostly supportive of the all-red-clearance signalization for all travelers, particularly the superior leading pedestrian intervals (LPI), which has also been incrementally implemented at major cities, such as Portland, Seattle and Vancouver.

**Key words:** pedestrian/roller intersection signalization, traffic safety, leading pedestrian interval, minimum distance to collision

## 1. Introduction

Since traffic engineers are still debating the subject question, let us start with a real example of no red-clearance interval for all vehicles and pedestrians/rollers/cyclists. As shown in Fig. 1 and Fig. 2, we can see the potential vehicle conflicts with the pedestrians at the transitional signal timing intervals from yellow to red because during the 1<sup>st</sup> second of the red-interval the red vehicle is still moving to clear the intersection while the pedestrians are concurrently given the “WALK” signal to walk. Suppose if these two pedestrians were walking from the other end of the crosswalk, or if one of them is riding an E-scooter, would the potential

vehicle-pedestrian or hypothetical vehicle-roller crash be more imminent and dangerous due to their proximity? Mr. Ren’s testimonial statements are that many years ago he was once at the other end of a crosswalk under the same traffic operation and was involved in a near miss that would have been a crash was it not for a fortunate last minute hard braking maneuver by the driver; and last New Year Eve in 2024, Mr. Ren observed a pedestrian immediately running back to the sidewalk after having taken a couple of steps into an intersection crosswalk as a rushing conflicting vehicle progressed through the intersection during the 1<sup>st</sup> second of red indication; and a couple of months later a woman on a

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**Fig. 1** During a yellow change interval, a pedestrian is waiting during the “Don’t Walk Interval” while a white Sports Utility Vehicle is exiting the intersection.



**Fig. 2** At No-All-Red, the red SUV is clearing the intersection during the first second of the red clearance interval while two pedestrians are crossing during the “Walk” interval concurrently.

bicycle was seriously injured while crossing a nearby intersection. All three of these intersections operate signal phasing absent all-red signalization.

The objective of this paper is also driven by a research proposal from Oregon DOT Traffic Safety Office as is stated: “Questions regarding safety have been a particular area of focus, as the rate of injuries sustained while riding an electric micromobility device that necessitated an ER visit or hospitalization has significantly increased between 2021 and 2024, rising from 414 potential injuries since 2021 to 1,229 in 2024, according to OHA (Oregon Health Administration) data.”

This displayed example is one signalized intersection scenario, but not the only scenario; therefore, we should evaluate other possible alternative signalization scenarios for this intersection to graphically illustrate and compare the potential traffic conflicts as surrogate safety measure (SSM). Listed below are five alternative signalization scenarios with respect to the red-clearance intervals for vehicles and pedestrians/rollers/bicyclists.

- A) No all-red for vehicles/pedestrians/rollers
- B) No all-red for vehicles but for pedestrians/rollers
- C) All-red for vehicles but not for pedestrians/rollers
- D) All-red for concurrent vehicles/pedestrians/rollers
- E) All-red for vehicles but leading pedestrian interval

Can we deduce that the simple one cycle of yellow-red-green scenario would help to assess safety through an SSM with respect to potential traffic conflicts?

There are two verification approaches to the deduction: one is through the random surveys of what signalization scenarios are used in three different northwest regions in terms of their respective fatality or serious injury and fatality rates; and the other is through the incremental urban jurisdictional implementation of one signalization scenario versus the other scenarios.

This paper demonstrates both verification approaches in the Pacific Northwest to manifest the best signal phasing and timing approaches for the safety of all travelers.

## 2. Dynamic Diagramming of Scenarios A

Given the real-world observations presented in Fig. 1 and Fig. 2, we can extend this observation into a thought experiment. We can visually and dynamically illustrate the critical 1<sup>st</sup> second of the red change interval in four 0.25 second time periods while no red-clearance interval is provided to other conflicting traffic movements, such as vehicles/pedestrians/rollers/cyclists). Then we can comparatively count the potential “forced” conflicts among other scenarios under the same hypothetical traffic conditions.

As shown respectively in Fig. 3: A-1 (1<sup>st</sup> 0.25 seconds of red) through Fig. 6: A-4 (4<sup>th</sup> 0.25 seconds of

red), we can count the following potential conflicts (note that each picture is drawn to scale assuming vehicles traveling at 30 mph, pedestrians traveling at 3 mph and rollers traveling at 10 mph).

By counting 9 pairs of traffic conflicts in Figs. 3-6, we can individually isolate 12-vehicle, 2-pedestrian and 4-roller conflicts, which are considered “system forced conflicts” because vehicles/pedestrians/cyclists/rollers are assumed to follow the signal timing consistently!

### 3. Graphic Illustrations of Other Scenarios

Let each signalization scenario start from the same condition of traffic operation as shown in Fig. 7 A-1. Then we count the traffic conflicts from the 1<sup>st</sup> to the 2<sup>nd</sup> second of Eastbound red intervals as summarized in Table 1 below by each signalization scenario.

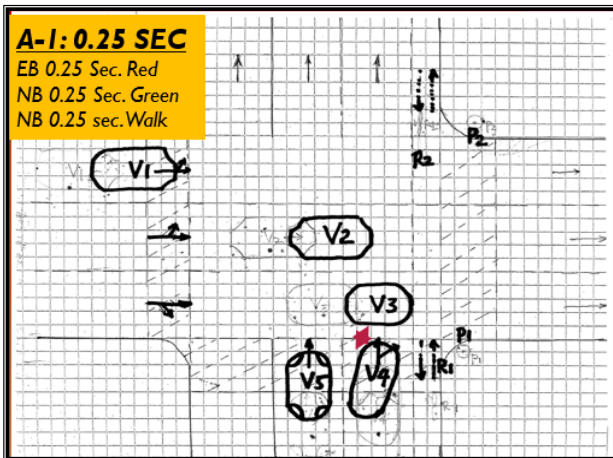


Fig. 3 A-1 shows V3-V4 conflict.

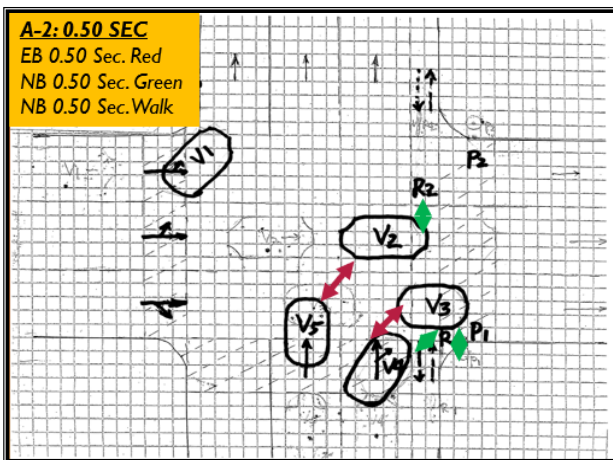


Fig. 4 A-2 shows additional V2-V5, V2-R2, V3-P1, V3-R1 conflicts.

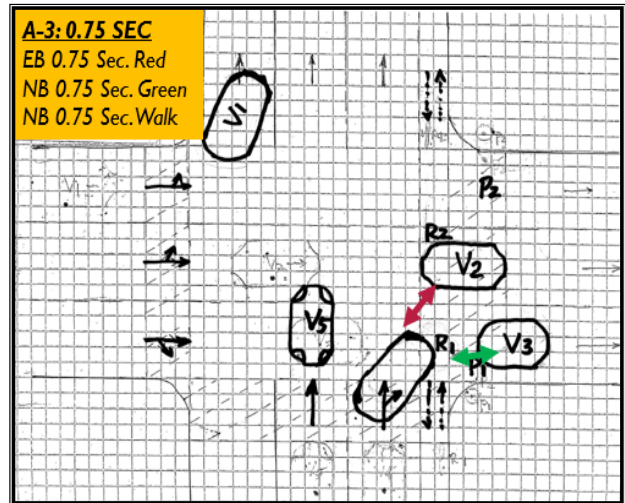


Fig. 5 A-3 additional V4-V2, V4-P1 & V4-R1 conflicts.

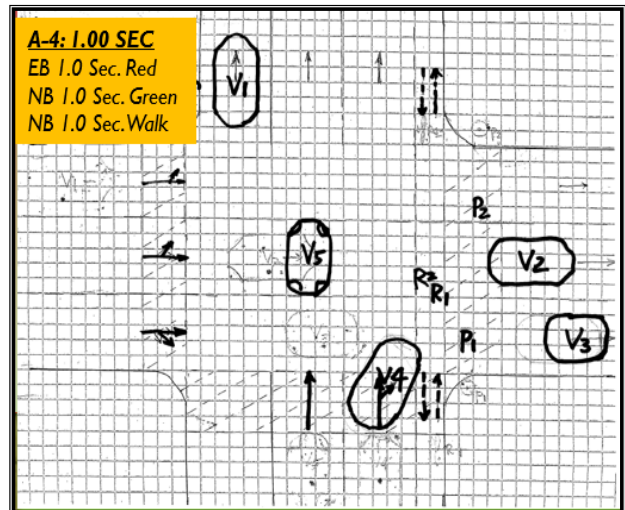


Fig. 6 A-4 shows additional V4-R2 conflict.

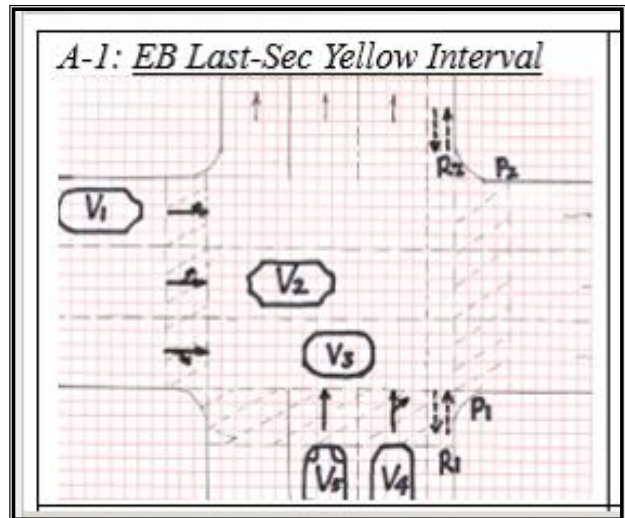


Fig. 7 A-1 shows no traffic conflict at EB yellow.

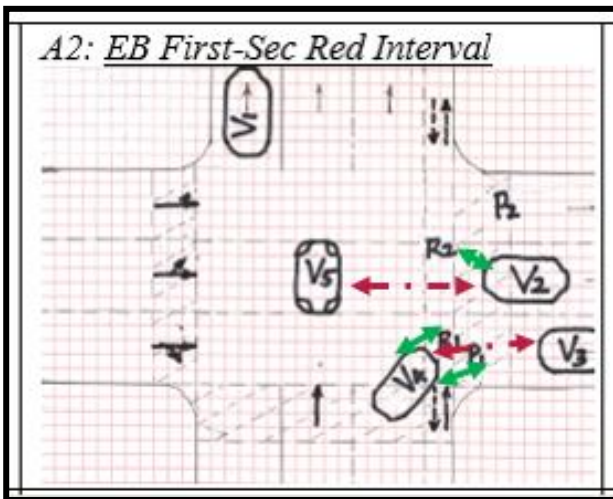


Fig. 8 A-2 shows V2-R2, V2-V5, V3-V4, V3-P1, V3-R1, V4-P1 and V4-R1 conflicts.

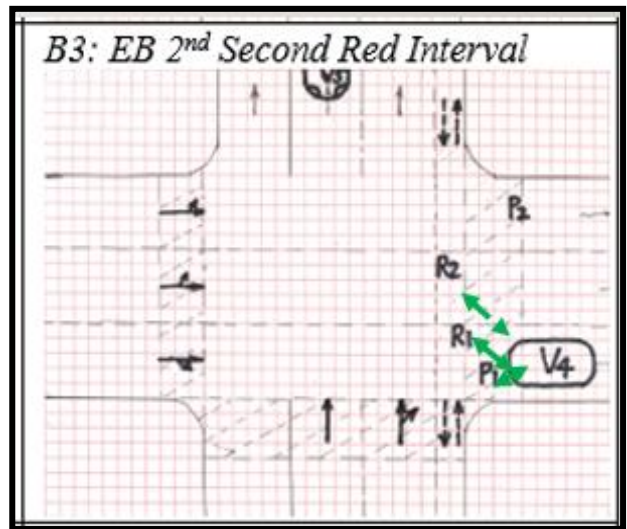


Fig. 11 B-3 shows V4-R2, V4-P1 & V4-R1 conflicts.

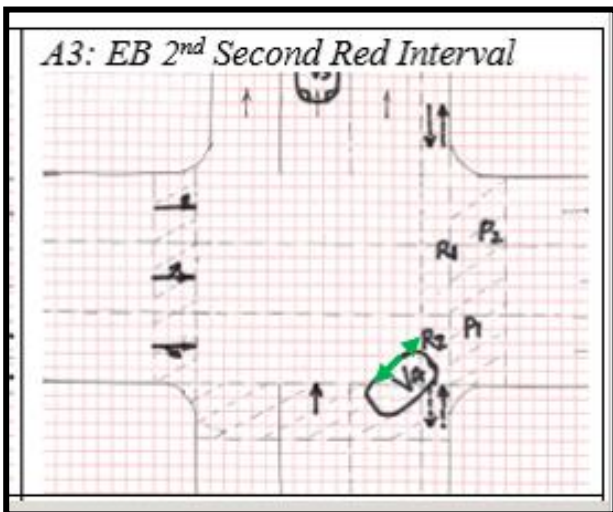


Fig. 9 A-3 shows additional V4-R2 conflict.

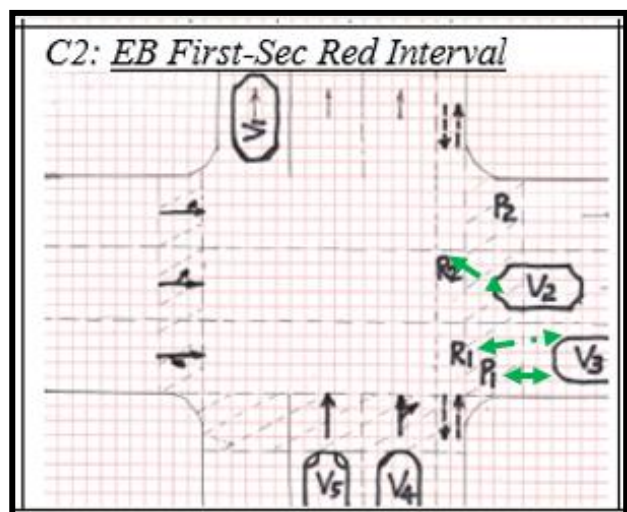


Fig. 12 C-2 shows V2-R2, V3-R1 & V3-P1 conflicts.

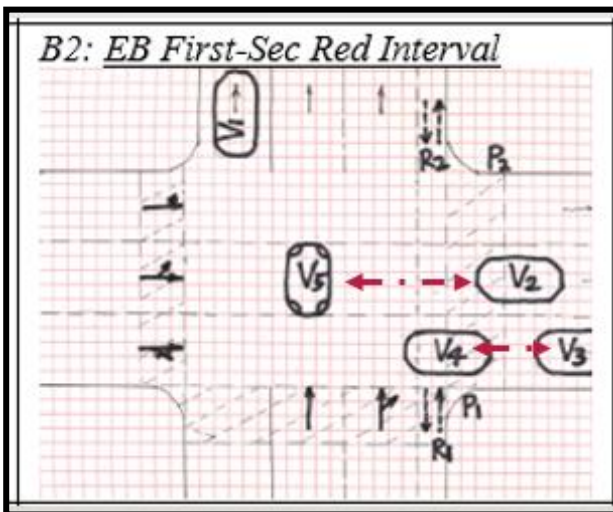


Fig. 10 B-2 shows V2-V5 and V4-V3 conflicts.

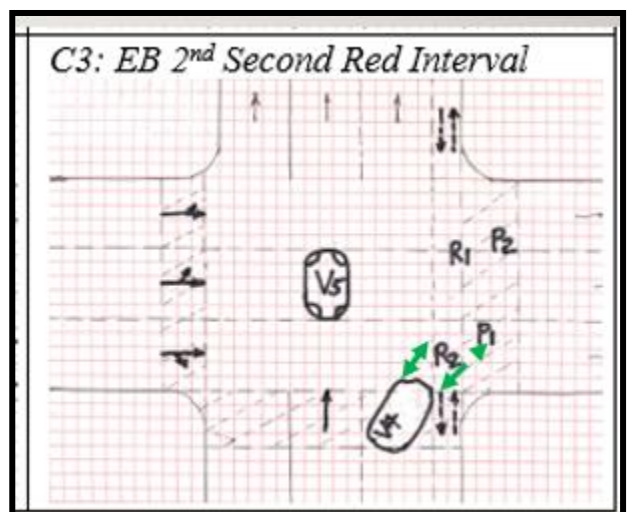


Fig. 13 C-3 shows additional V4-P1 & V4-R1 conflicts.

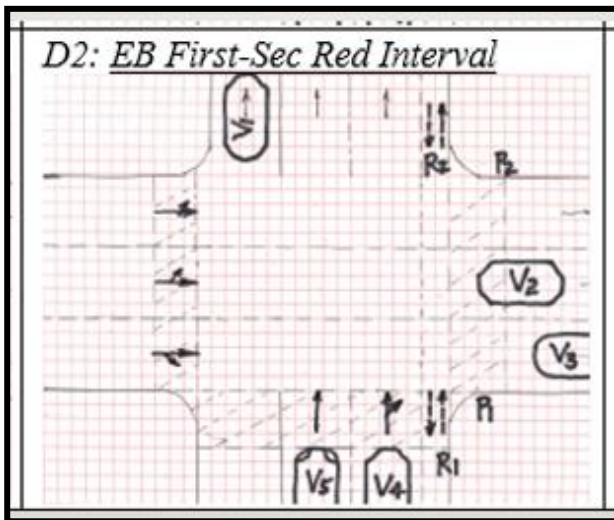


Fig. 14 D-2 shows NO conflicts.

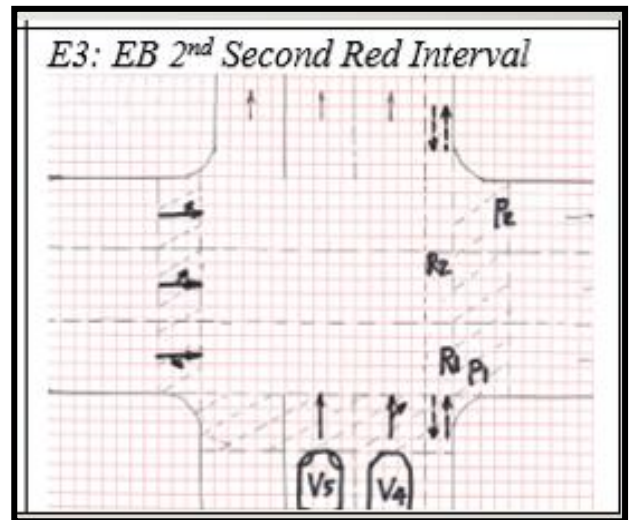


Fig. 17 E-3 shows NO conflict (V4-R1 & V4-P1 conflicts may come next, but LPI prioritizes peds/rols.).

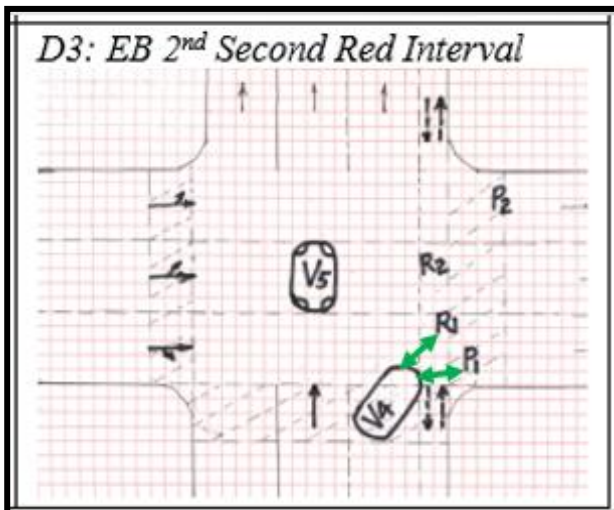


Fig. 15 D-3 shows V4-P1 and V4-R1 conflicts.

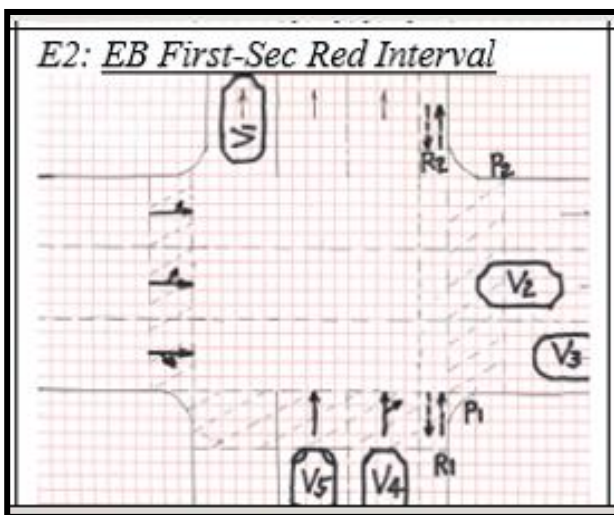


Fig. 16 E-2 shows NO conflicts.

Table 1 Potential Traffic Conflicts by Scenario.

Scenario	Veh.	Ped.	Rol.	Total
A	12	2	4	18
B	7	1	2	10
C	5	2	2	9
D	2	1	1	4
E	0	0	0	0

Fig. 8 through Fig. 17 respectively through Signalization Scenario A to E, via the three seconds of transitional signal cycle timing comparatively demonstrates the progressive traffic conflict reductions of 18-10-9-4-0 as shown in Table 1 above, and thus significant safety improvements.

#### 4. Random Surveys and Findings of NW Urban Intersection Signalizations

Random surveys were strategically conducted to demonstrate how the five signalization scenarios are distributed in the northwest urban areas.

In Oregon, we randomly surveyed the following cities: Portland, Salem, Keizer, Corvallis, Wilsonville, Tigard, Beaverton, Lake Oswego, Woodburn and Tualatin.

In Washington, we randomly surveyed the following cities: Seattle, Bellevue, Redmond, Olympia, Lacey, Shoreline, Lynnwood, Everett, Tacoma and Bellingham.

In BC, we randomly surveyed the following cities: Vancouver, White Rock, Surrey, Richmond, Burnaby,



**Table 5 Red clearance interval calculation for through movement (wider width) ) in Colorado DOT.**

Approach speed	Red clearance interval (rounded up to nearest tenth of a second) for Through Movements (125 ft to 200 ft)															
	Intersection Width (ft)															
	125	130	135	140	145	150	155	160	165	170	175	180	185	190	195	200
25	3.0	3.1	3.3	3.4	3.5	3.7	3.8	3.9	4.1	4.2	4.4	4.5	4.6	4.8	4.9	5.0
30	2.3	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.4	3.5	3.6	3.7	3.8	3.9	4.0
35	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3
40	1.5	1.6	1.7	1.8	1.9	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.5	2.6	2.7	2.8
45	1.2	1.3	1.4	1.5	1.5	1.6	1.7	1.8	1.8	1.9	2.0	2.1	2.1	2.2	2.3	2.4
50	1.0	1.1	1.2	1.2	1.3	1.4	1.4	1.5	1.6	1.6	1.7	1.8	1.8	1.9	2.0	2.0
55	1.0	1.0	1.0	1.0	1.1	1.2	1.2	1.3	1.3	1.4	1.5	1.5	1.6	1.6	1.7	1.8
60	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.2	1.3	1.3	1.4	1.4	1.5	1.5
65	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.4
70	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.2

**Table 6 Minimum Phase Intervals in Vancouver B.C. [15].**

Signal Type	Phase	Min Green	Amber	Red/All-Red	Walk
Full Signal	Protected-Permissive Turn	5.0	4.0	0.0	N/A
	Protected Only Turn	8.0	3.5	1.5	N/A
	Major Street Through (Fixed Time, Fully Actuated, and Semi- Actuated Signal)	16.0	3.5	1.5	7.0*
	Minor Street — Actuated Through (With and Without Cyclists Actuation)	10.0	3.5	1.5	7.0"
	Minor Street - Fixed Time	16.0	3.5	1.5	7.0
Pedestrian/Bicycle	Major Street Through (Pedestrian/Bicycle Signal)	16.0	3.5	2.5	7.0

\*At fully actuated intersections (i.e., phases are actuated along both major and minor streets), the minimum and maximum Walk durations are equal to one another.

Victoria, New Westminster, and Coquitlam.

The survey findings of the northwest urban signalized intersections are summarized in Table 2, which shows that majority of Scenario D and E are in the State of Washington and B.C. though only 40% in the State of Oregon. Fortunately, the City of Portland has a plan to implement 10 LPIs a year to improve its pedestrian/ bicyclist safety at signalized intersections.

**5. Discussion**

Although annual traffic fatality rates change year by year among different states of USA and British Columbia district, it is consistently shown in Table 2 of the 5-year traffic fatality rates that Oregon is ranked above Washington, while BC is lowest of the three. Is it a coincidence that implementing the less “forced conflict” signalization scenario shows less fatality rates as Table 2 indicates?

Cities usually follow the traffic operation guidance in their respective State DOT (USA) or Ministry of Transportation (BC), particularly if they do not develop the traffic guidance themselves; for instance, Oregon Association of Counties require its associated counties follow the Oregon DOT’s traffic standard guidance all the time. As such, the authors investigated each of the respective state/district red-clearance signalization guidance to draw comparisons and inferences as to why the cities run their intersection signalization the way they do now.

Tables 3 to 6 summarize the minimum phase intervals at signalized intersections that will be discussed in the following sections.

First listed in Table 3 is Oregon DOT’s “Traffic Signal Policy Guidelines” [13], July 2024.

Since Washington DOT designates to use Colorado

DOT's guidance, above Table 4 and Table 5 show the detailed CDOT Guidelines for Traffic Signal Vehicle Change and Clearance Intervals in 2024 [14].

Listed in Table 6 is the City of Vancouver Traffic Signal Timing Guidelines, Oct. 2023 [15].

By comparison, the City of Vancouver Guidelines requires 1.5 seconds of All-Red for vehicles at protected signal phases for vehicle movements, and 2.5 seconds for Pedestrian/Bicycle, while Oregon DOT takes a very simple approach by just setting the Minimum Red Clearance (sec), which however reverses what CDOT does according to various approach speeds. Theoretically, the slower the vehicle approach speed the more red-clearance intervals should be given to conflicting travelers (vehicles/pedestrians/cyclists/rollers) because it takes more time for the exiting vehicles to clear the intersection (especially the larger intersections) at slower speeds, counterintuitively.

The "Oregon Transportation Safety Action Plan 2026 Update" [16] indicates "Lane or roadway departures (39%) and intersections (38%) are the most common contributing factors in fatal and serious injury crashes"; "Fatal and serious injury crashes rose 44% from 2014–2018 to 2019–2023, with notable increases involving speeding, impairment distraction, unrestrained occupants, aging drivers, trucks, and intersections"; and particularly, intersection crashes increase by 52% from 3413 to 5201. Further investigation into these aspects may be needed for improving all travelers' safety of signalized intersections in the Oregon DOT's "Traffic Signal Policy Guidelines". Fortunately, the DOT is committed to that safety aspect in the new Transportation Safety Implementation Plan by focusing more on intersections!

## 6. Conclusions

Signal timing does make significant differences to the traffic conflict potentials at signalized intersections, the best LPI signalization scenario should be considered the top priority if resources allow.

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