Detection Design—The Research Perspective

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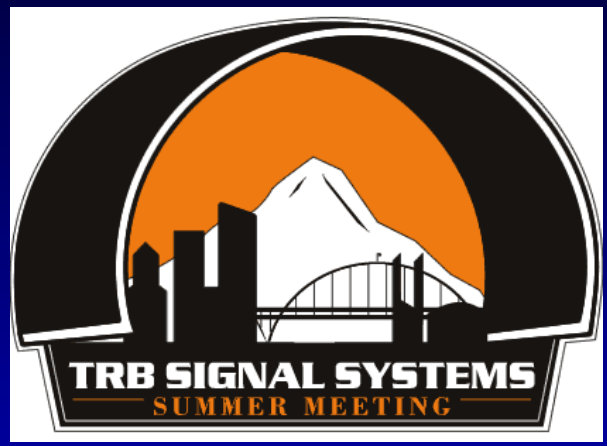

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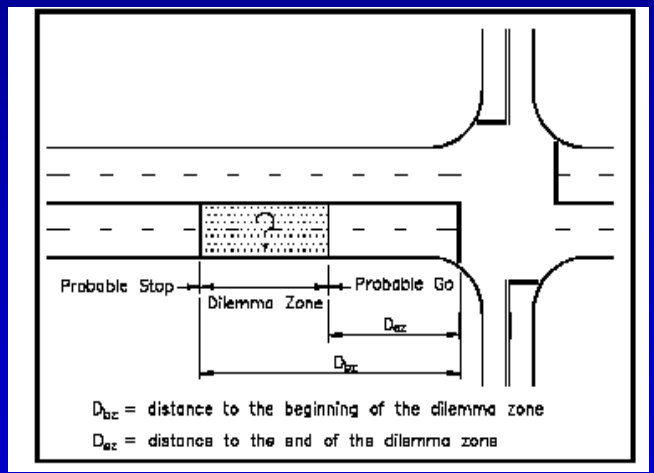
Presentation Outline

- Efficiency and safety considerations
- Stop-bar detection design procedure
- Advance detection design procedure
- Incorporating advantages of video detection
- TTI Detection-Control System

Efficiency and Safety Considerations

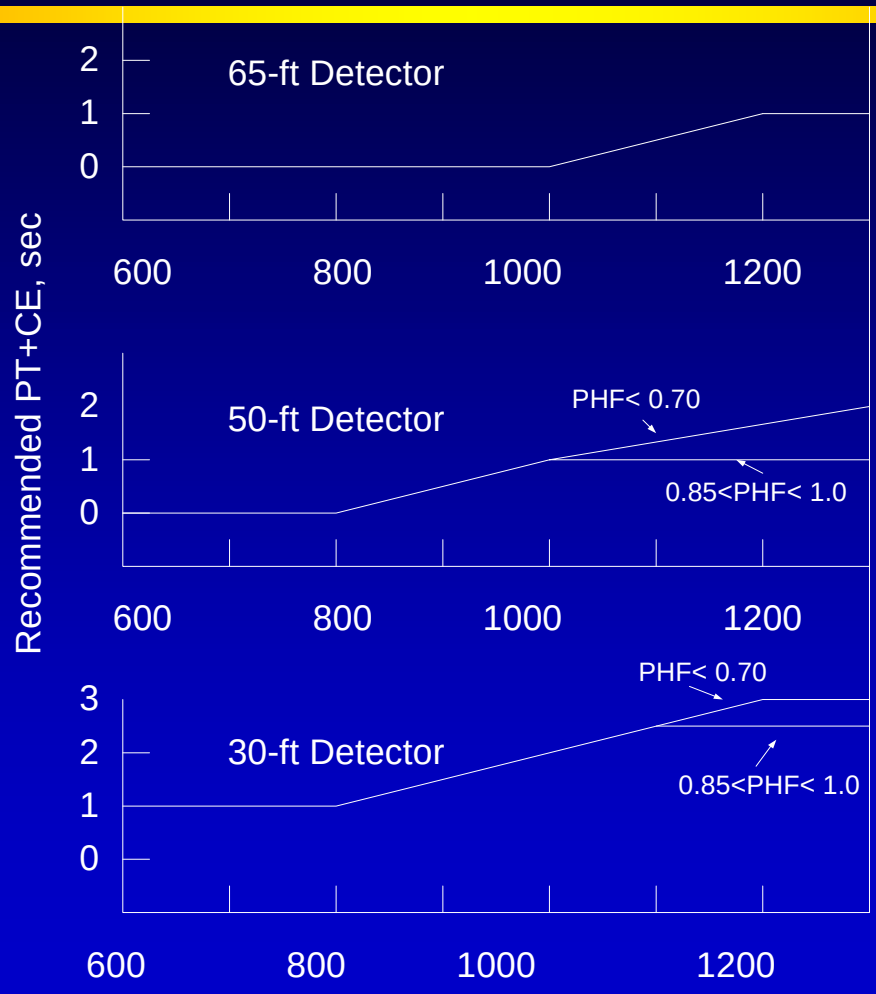
- **Efficiency: stop-bar detection to minimize delay**
  - *Sufficient green for queue clearance*
  - *Design MAH*
- **Safety: advance detection to provide dilemma zone protection**



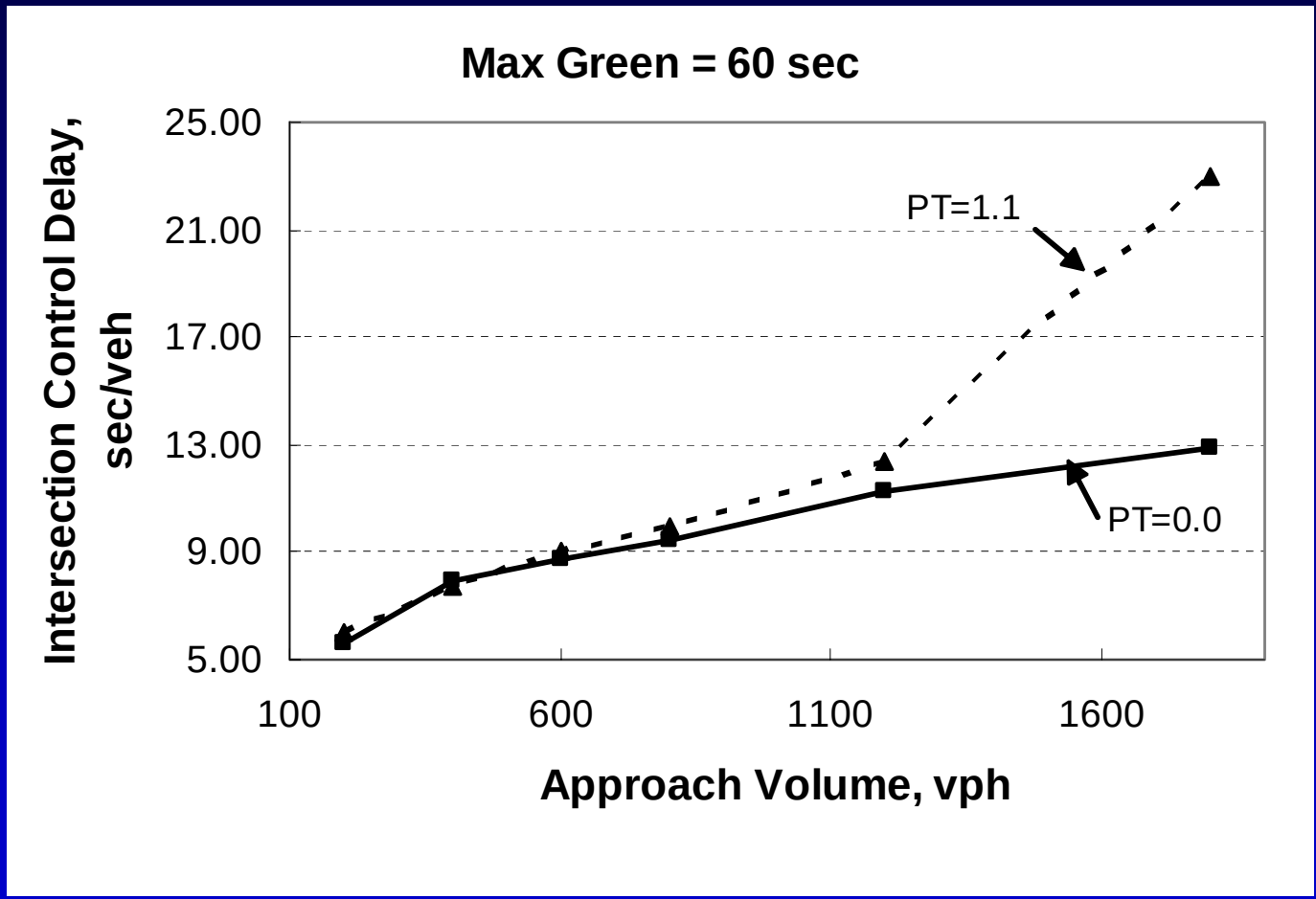
Stop-Bar Detection Design Procedure

- Determine Passage time based on sum of critical flows and detector length (F.B. Lin)
- Based on 3.6 second MAH

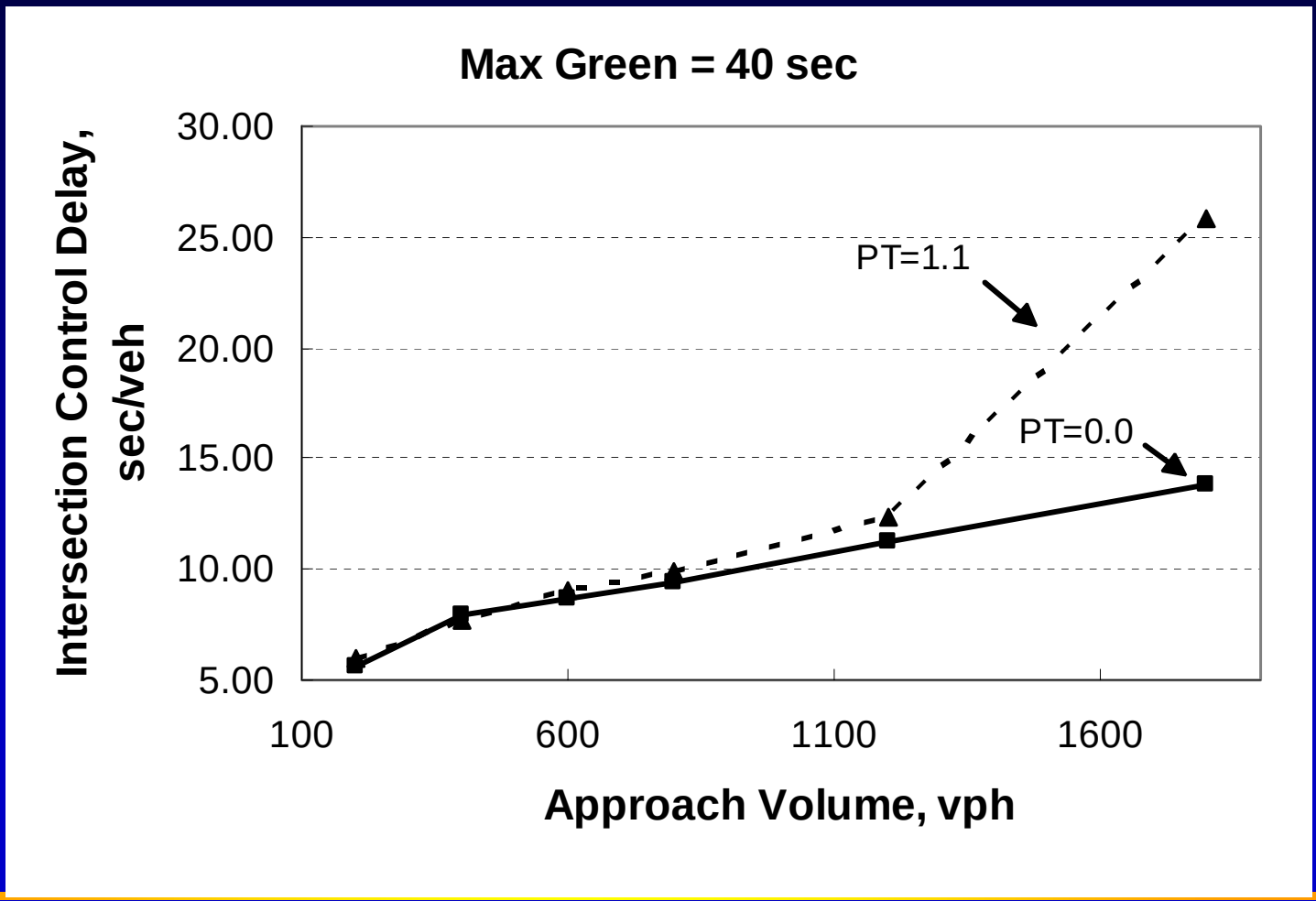
F.B. Lin Design



MAH: Passage Time Vs Real Vehicle Presence—60 sec Max Green



MAH: Passage Time Vs Real Vehicle Presence—40 sec Max Green



Advance Detection Design Procedure

- Several design philosophies and agency standards (Beirele, Winston-Salem, SSITE, etc.)
- Can generally be categorized as either constant speed reduction or constant passage time approaches

Advance Detection: Constant Speed Reduction Approach

- Use constant speed reduction for each detector (say 10 mph)
- Determine each detector location with the eqn.:

$$D_i = A * V_i + \frac{V_i^2}{2 * B}$$

- A & B depend on the method used as follows

Method	AASHTO	Fisher	Zegeer	ITE
A	2.5	1.5	5.0	3.0
B	9-12	10.0	Inf.	22.0

Advance Detection: Constant Speed Reduction Approach

- **Determine passage time+ call extension for each detector**

$$PT + CE_i = \frac{D_i - D_{i+1} - L_{d(i)} - L_v}{V_{i+1}}$$

- **For last detector $D_{(n)}$, use the deceleration eqn. where A & B depend on the method used:**

Method	FHWA	Carstens	Chang	Zegeer
A	1.0	1.32	2.0	0.8
B	22.1	14.7	Inf.	20.4

Advance Detection: Constant Passage Time Approach

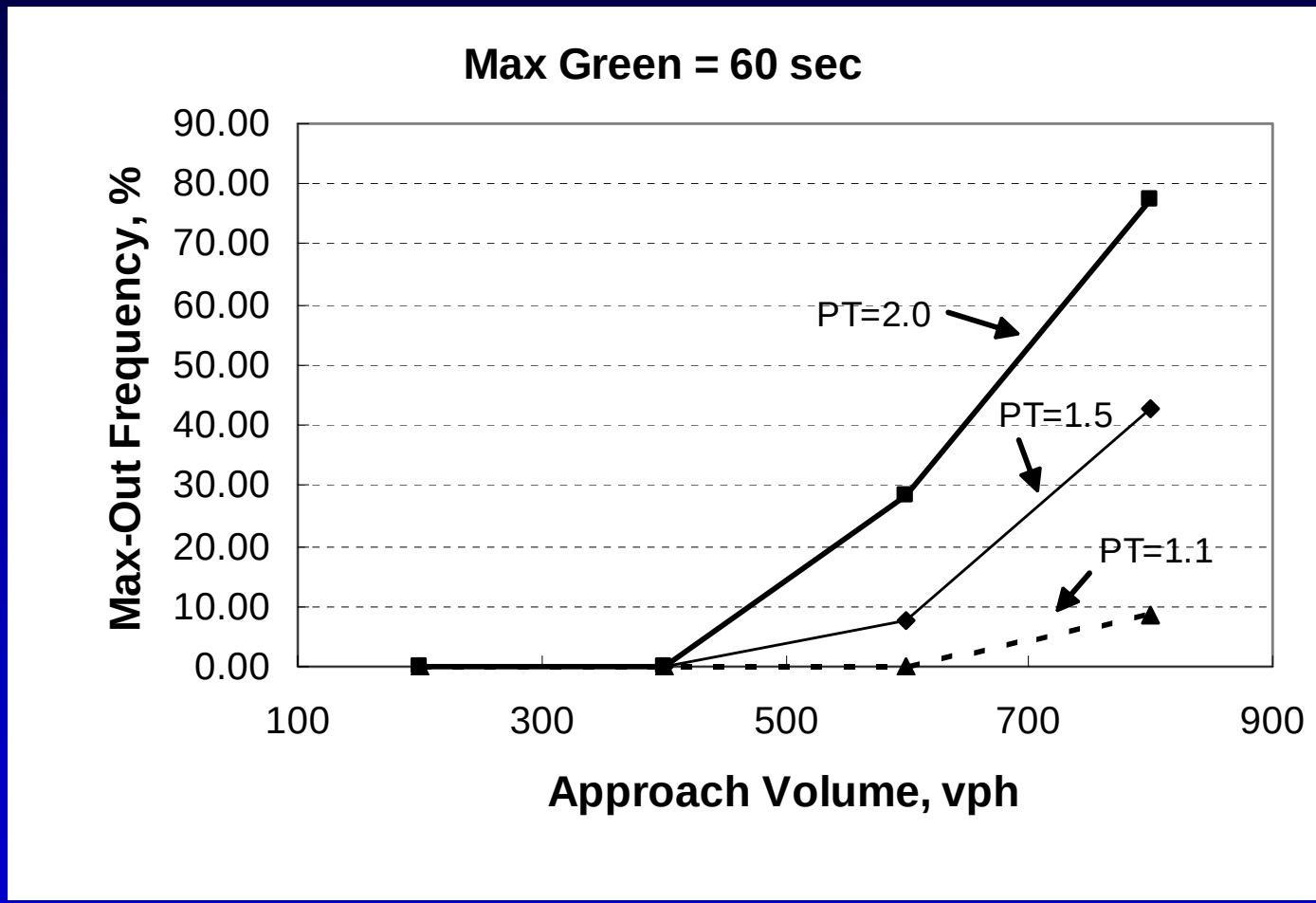
- Determine the passage time to be used (based on stop-bar detector setting)
- Solve the two following equations to determine location of each successive detector:

$$D_i = D_{i-1} - PT * V_i - L_{d(i-1)} - L_v$$

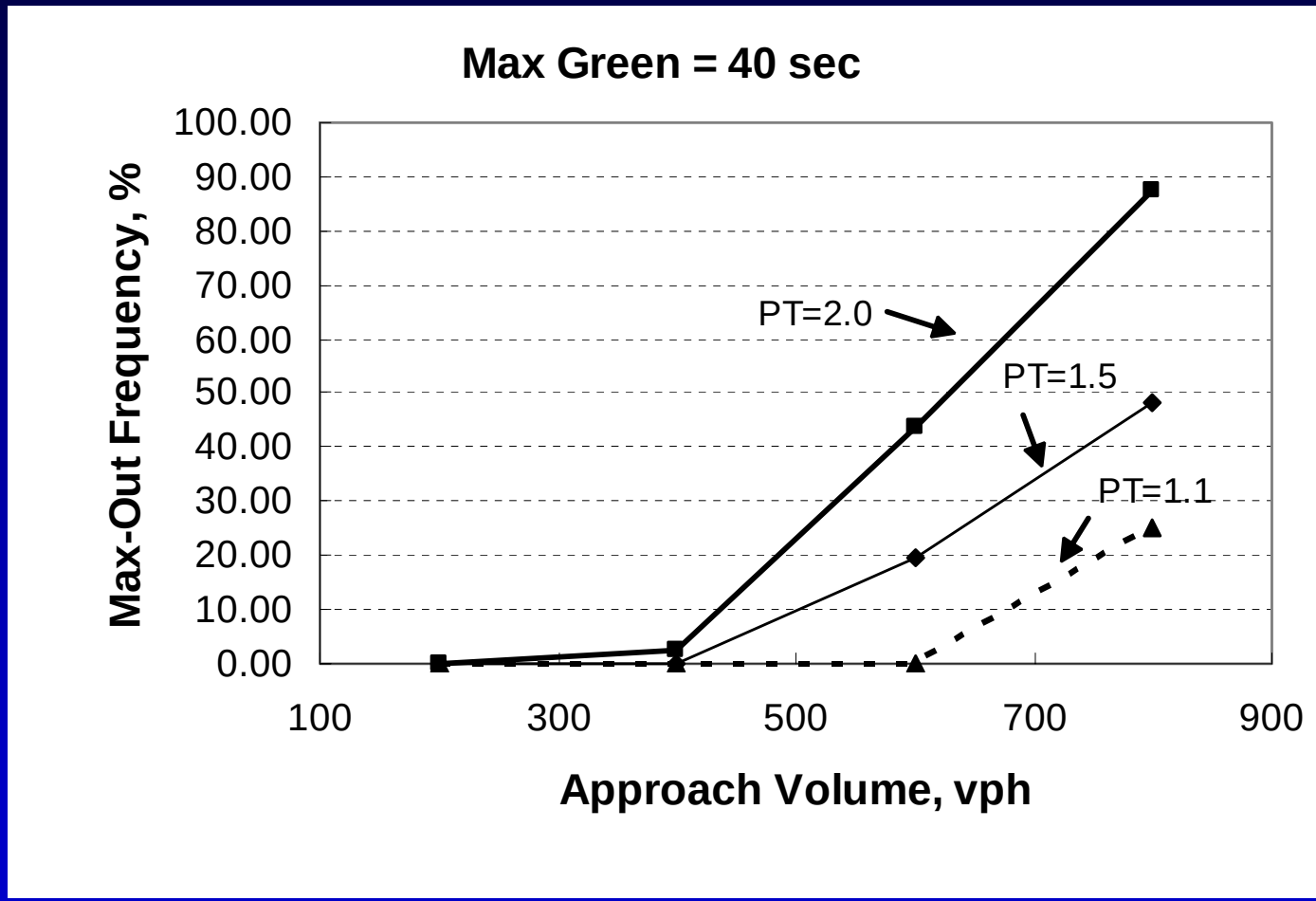
$$D_i = A * V_i + \frac{V_i^2}{2 * B}$$

- Continue until V_n is less than the lower design speed

Max-out %: Passage Time Vs Real Vehicle Presence—60 sec Max Green



Max-out %: Passage Time Vs Real Vehicle Presence—40 sec Max Green



Incorporating Advantages of Video Detection

- **Detection zone setting**
  - *Generous number of detection zones*
  - *Variable detection length*
- **Steps for "best" design**
  - *Provide desired MAH with detector length only*
  - *Apply PT to advance detection only by use of the controller's "inhibit" feature*

Stop-Line Zone Length

- **Based on 0.0-s passage time**
- **Yields minimal delays**

Stop-Line Detection Zone Length for VIVDS Applications.

Distance Between Camera and Stop Line[1], ft	Camera Height, ft				
	24	28	32	36	40
	Stop-Line Detection Zone Length[2], ft				
50	98	100	101	101	102
100	89	92	94	95	96
150	79	83	87	89	91

Advance Detection

- **Based on 1.0-s passage time**
- **Stop-line detector uses "inhibit" feature**

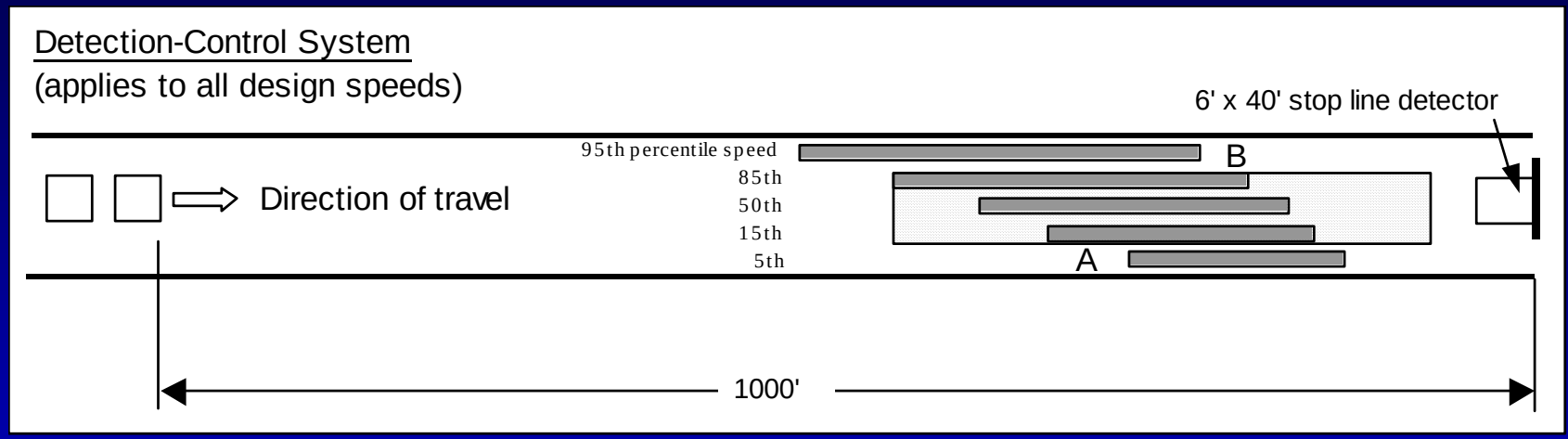
Advance Detection Zone Layout for VIVDS Applications.

Speed Limit, mph	Distance to 1st Det. Zone, ft	Distance Between Camera and Stop Line, ft	Camera Height, ft									
			24	28	32	36	40	24	28	32	36	40
			Distance to 2nd Det. Zone, ft					Extension on 2nd Det. Zone, s				
55	430	50	260	271	278	284	289	0.0	0.1	0.3	0.5	0.6
		100	250	264	272	279	284	0.0	0.0	0.1	0.3	0.3
		150	245	255	267	274	280	0.0	0.0	0.0	0.1	0.3
50	390	50	234	243	250	256	260	0.0	0.1	0.3	0.5	0.6
		100	226	236	244	251	255	0.0	0.0	0.1	3.0	0.4
		150	218	230	239	245	251	0.0	0.0	0.0	0.1	0.3
45	350	50	207	216	222	227	231	0.0	0.1	0.3	0.5	0.6
		100	199	209	216	222	226	0.0	0.0	0.0	0.3	0.4
		150	192	202	210	217	222	0.0	0.0	0.0	0.0	0.2

TTI Detection-Control System

- Uses one advance detector about 1000 ft upstream of intersection
- Estimates vehicle speeds, calculates arrival time, and determines dilemma zone for each vehicle
- Holds the green until no vehicle is in its dilemma zone

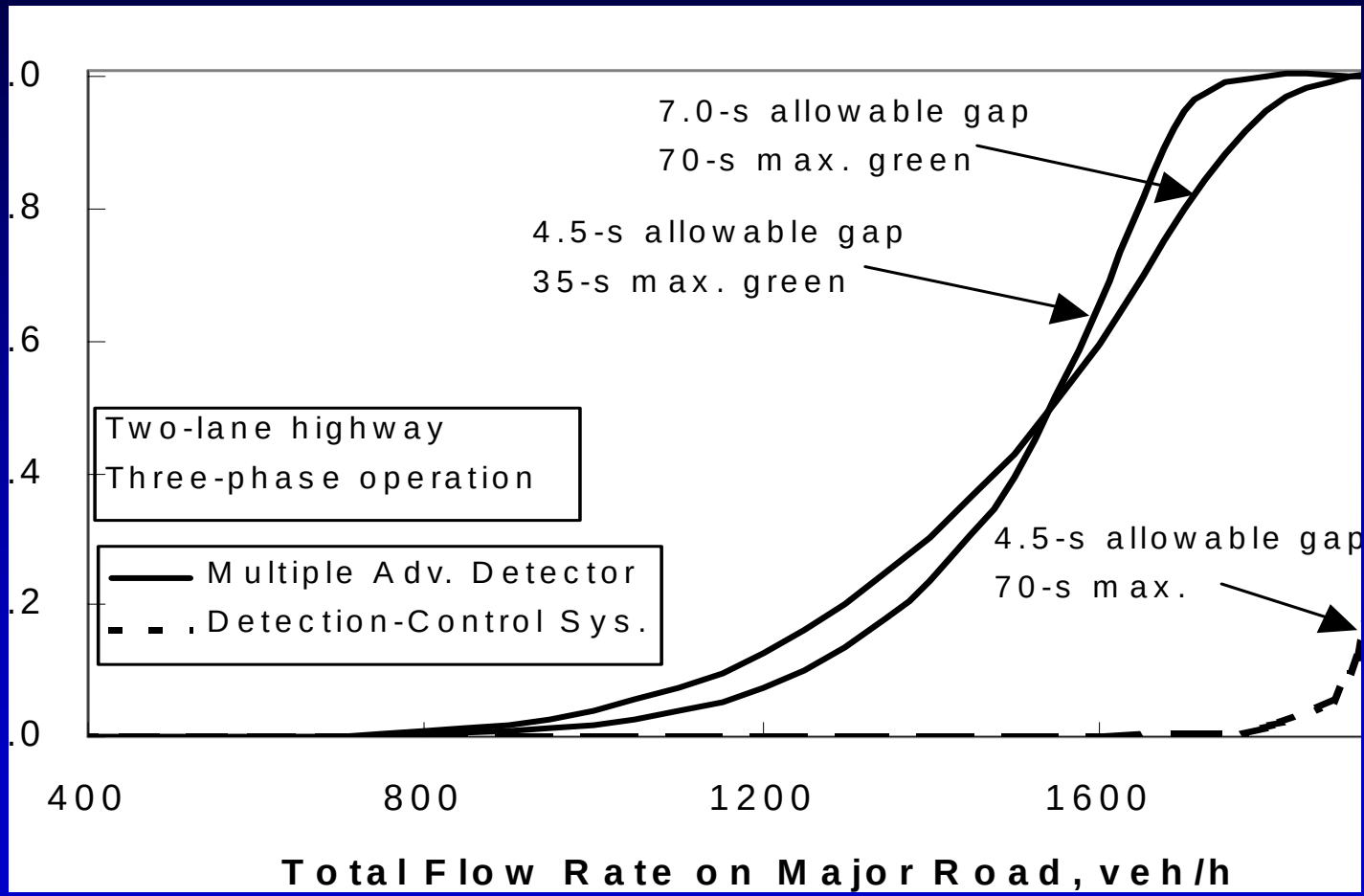
Dynamic Dilemma Zone Protection



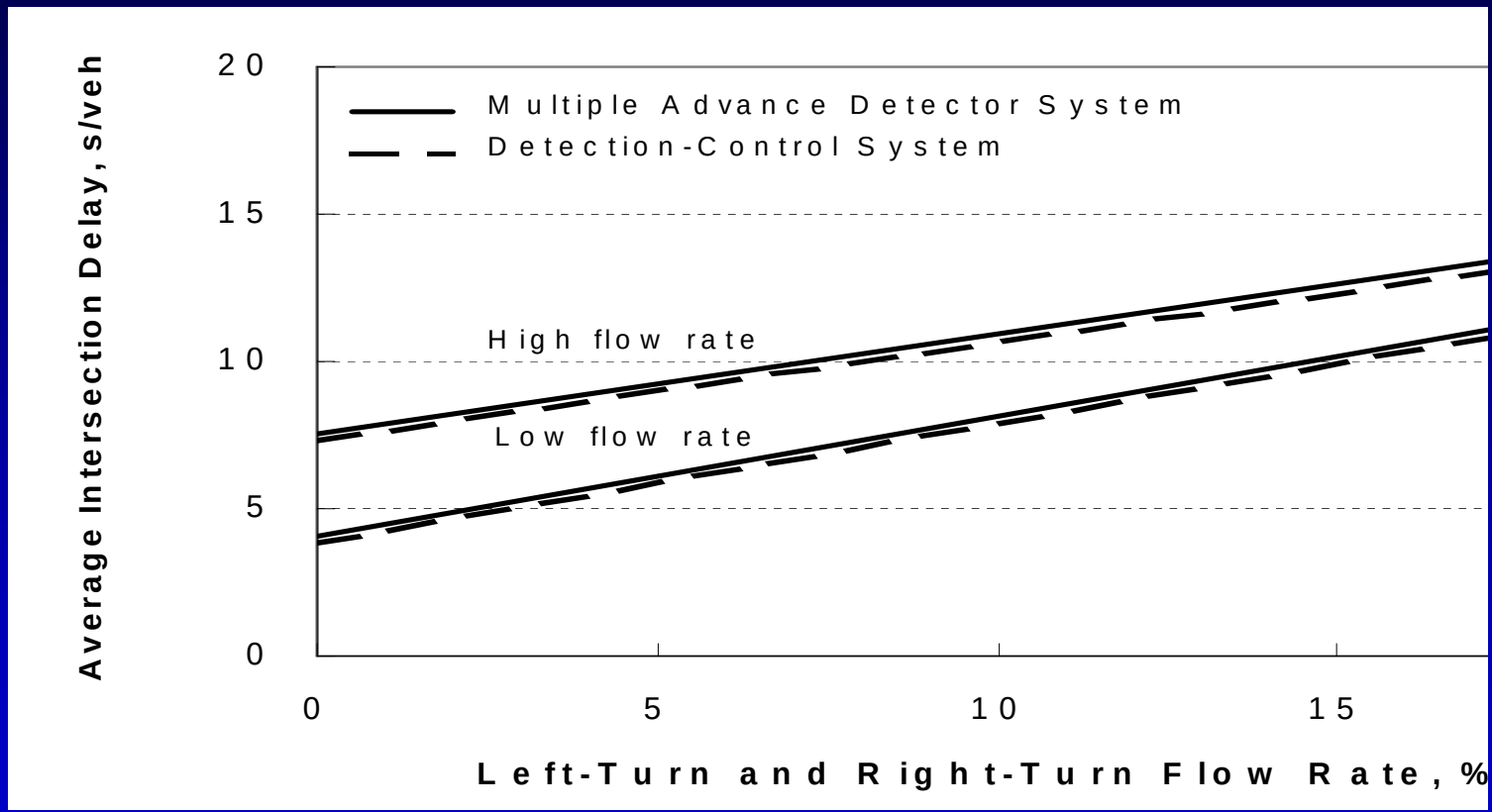
Dilemma zone, starts at 5.5 s and ends at 2.5 s travel time from the stop line.

Zone protected by traditional multiple advance detector system

Standard Design Vs D-CS MAH



Comparison of Intersection Delay with Each System



Questions?