APPENDIX C

THREAT PATH CALCULATIONS EXAMPLE

CHAPTER 1 INTRODUCTION

1 - 1 BACKGROUND.

In order to provide consistency and help facilitate the design of Access Control Points (ACPs) the USACE Center of Standardization for Access Control Points located in the Omaha District has developed a Design Guidance Manual. This Manual includes a report on laying out threat paths and the use of the University of Nebraska at Lincoln (UNL) Vehicle Threat Delay Calculator (VTDC) Spreadsheet. This report assumes that the ACP is located on an Army Installation and therefore UFC 4-022-01 Entry Control Faculties/Access Control Points, Army Standard for Access Control Points (ACPS) and the Army Standard Design for Access Control Points (ACPS) are required criteria.

1-2 PURPOSE AND SCOPE.

The purpose of this report is to provide an example of how to do threat path calculations for ACPs using a Computer Aided Drafting (CAD) program and the VTDC Spreadsheet to meet the requirements of the criteria. A copy of the VTDC Spreadsheet can be obtained by contacting the USACE - Protective Design Center.

1-3 INTENT.

The intent of this report is to provide consistency in how the threat paths are laid out and how the calculations are accomplished, as well as reduce the design time.

1-4 IMPLEMENTATION.

Threat Path Calculations must be done early in the development of the ACP roadway layout, usually in the concept level layout as the required response time will play a vital role in the geometry of the roadway. The Threat Path Calculations must be reevaluated anytime during the design process that the roadway geometry is changed and/or the Point of Detection (POD) or the locations of the Final Denial Active Vehicle Barriers (AVBs) is changed.

1-5 APPLICABILITY.

The use of this document is not required in the development of an ACP layout, but it will provide consistency between designs and reduce the design and review process.

1-6 THREAT SCENARIOS.

The following Threat Scenarios are identified in UFC 4-022-01 and the Army ACP Standard Design and are considered a minimum for the Threat Scenario to be evaluated. Each ACP layout is unique and may require additional Threat Scenarios that are not listed below. As the Threat Scenarios are very similar between these two criteria, and the small amount of influence that the differences have on the overall response time, the worst case of each of the Threat Scenarios was used in this example.

1-6.1 UFC 4-022-01.

The length of the response zone determines the placement of the final denial AVBs. AVBs must be installed on all inbound and outbound lanes in the response zone to defeat all threat scenarios.
Consider all scenarios when designing the Response Zone, determine which scenario governs, and verify the adequacy of the response time and AVB selected. ECFs/ACPs must be designed to defeat the following four threat scenarios as a minimum.

Vehicle Threat Scenario #1. Threat vehicle enters the ECF/ACP in the inbound or outbound lane(s) at the maximum speed attainable at the ECF/ACP entrance and then immediately accelerates at its maximum acceleration rate through the ECF/ACP. This scenario often includes either or both wrong way detection or over speed detection used to alert the ECF/ACP personnel of the threat and establishes the point within the ECF/ACP in which the threat is detected.

Vehicle Threat Scenario #2. Threat vehicle enters the ECF/ACP in the inbound or outbound lane(s) at or under the posted speed limit and then, later at some point farther in the approach zone, accelerates at its maximum acceleration rate through the rest of the ECF/ACP. This scenario often includes overspeed detection to establish the starting point and the initial velocity of the threat vehicle.

Note that 'some point' must be interpreted as being the worst-case threat delay time from point of detection to Active Vehicle Barrier (AVB) location(s) in the response zone. If multiple zones of overspeed detection are utilized the analysis will include the worst-case situations for each overspeed zone.

Vehicle Threat Scenario #3. Threat vehicle attempts to covertly enter the ECF/ACP but is detected and denied entry by guards at the ID Check Area. Vehicle driver then defies guards and accelerates at its maximum acceleration rate through the rest of the ECF/ACP. The initial velocity of this threat must be 25 mph.

Vehicle Threat Scenario #4. Similar to Threat Scenario 3 above, except the driver of the denied vehicle drives toward the turn-around/denial/exit point or search area at the ECF/ACP speed limit of 10mph as if complying with guard instructions, but then fails to turn and instead accelerates through the rest of the ECF/ACP. The initial velocity of this threat is no less than 10 mph.

Additional Threat Characteristics. Additional threat scenarios and initial velocity conditions may be considered and analyzed if supported by a local vulnerability or threat assessment and/or variations in facilities located in atypical ECF/ACP configurations. Consult service subject matter experts for more guidance.

1-6.2 ARMY ACP STANDARD DESIGN.

ACPs shall be designed to defeat the following four minimum vehicle threat scenarios. Additional vehicle threat scenarios shall be included if required by a local threat assessment.

Vehicle Threat Scenario #1. Threat vehicle enters the ACP in the inbound or outbound lane(s) at the maximum speed attainable at the ACP entrance and then immediately accelerates at its maximum acceleration rate through the ACP.

a. Threat vehicle characteristics shall be as defined below (includes, but is not limited to: top speed, acceleration, etc.)

Vehicle Threat Scenario #2. Threat vehicle enters the ACP in the inbound or outbound lane(s} at or under the posted ACP Speed Limit and then, later at some point further in the Approach Zone, accelerates at its maximum acceleration rate through the rest of the ACP.

a. Note that 'some point' shall be interpreted as being the worst-case threat delay time from point of detection to Active Vehicle Barrier (AVB) location(s) in the response zone. If multiple zones of overspeed detection are utilized the analysis will include the worst-case situations for each overspeed zone.

Vehicle Threat Scenario #3. Threat vehicle feigns compliance and stops in lane. The guard detects threat behavior or criminal status through observation or electronic means and moves to guard booth to initiate denial process. Threat vehicle occupant attempt to force entry (tactics include potential use of direct fire weapons and acceleration through the ACP).

a. Baseline protection for direct fire weapon shall be UL 752-Level 3. A higher level is required if direct fire weapons are identified in local threat assessment/policy that exceed the capabilities of UL 752-Level 3. The contents of local threat assessment/policy are not sufficient justification for the lowering of the baseline ballistic resistance (UL 752-Level 3). Use of ballistic standards other than UL 752 may be utilized anywhere where the barrier rating can be verified as clearly meeting or exceeding UL requirement designated.

Vehicle Threat Scenario #4. Similar to Threat Scenario 3 above, except the driver of the denied vehicle drives toward the Turn-around or Search Area at the ACP Speed Limit as if complying with guard instructions, but then fails to turn and instead accelerates at its maximum acceleration rate through the ACP while attempting to enter the Installation cantonment area.

1-7 THREAT VEHICLE CHARACTERISTICS.

The following Threat Vehicle Characteristics are identified in UFC 4-022-01 and the Army ACP Standard Design. Both of the criteria require that the base line vehicle be evaluated for all ACPs including Commercial Vehicle only ACPs. Additional Vehicles might need to be evaluated for determining the required barrier ratings, but the placement of the AVBs will be dictated by the base line vehicle due to it higher obtainable vehicle characteristics. Designer can use the Threat Vehicle Characteristics from one of the criteria and use it for the Threat Scenarios in the same criteria, but they are not interchangeable. Due to the small amount of influence that the Friction Factor has no the overall response time the 1.0 Friction Factor from UFC 4-022-01 was used for all threat paths in this example.

1-7.1 UFC 4-022-01.

Base Line Threat Vehicle: 4630 lb car
Maximum Velocity: 130 mph
Acceleration Rate: 11.3 ft/sec
Deceleration Rate: 24.1 ft/sec
Friction Factor: 1.0

1-7.2 ARMY ACP STANDARD DESIGN:

Base Line Threat Vehicle: 4630 lb car
Maximum Velocity: 130 mph
Acceleration Rate: 11.3 ft/sec
Deceleration Rate: 24.1 ft/sec
Friction Factor: 0.75

CHAPTER 2 THREAT PATH DESIGN PROCESS.

2-1 GENERAL.

The purpose of this chapter is to clarify the design process that is being used in this report. The process is divided into two major steps. Step one is to use a Computer-aided Design (CAD) software such as MicroStation or AutoCAD to layout the Threat paths. Step two is to enter the data into the VTDC spreadsheet. Several iterations of these two steps with modification of the location of the AVB and/or the roadway geometry might be necessary to obtain the response time required to the Safety Scheme being used for the AVBs.

2-2 ACP LAYOUT.

The fictional ACP used in this report consists of a Visitors Control Center, ID Check Area, POV Search Area, Gatehouse, Final Denial AVBs, Overwatch, One Zone Continuous Overspeed Detection, Point Overspeed Detection located prior to ID Check Canopy, and Wrongway Detection in three locations. Not all required equipment, signals and signs are included in the layout and the designer should refer to the appropriate manuals for the ACP criteria to ensure that all requirement are met.

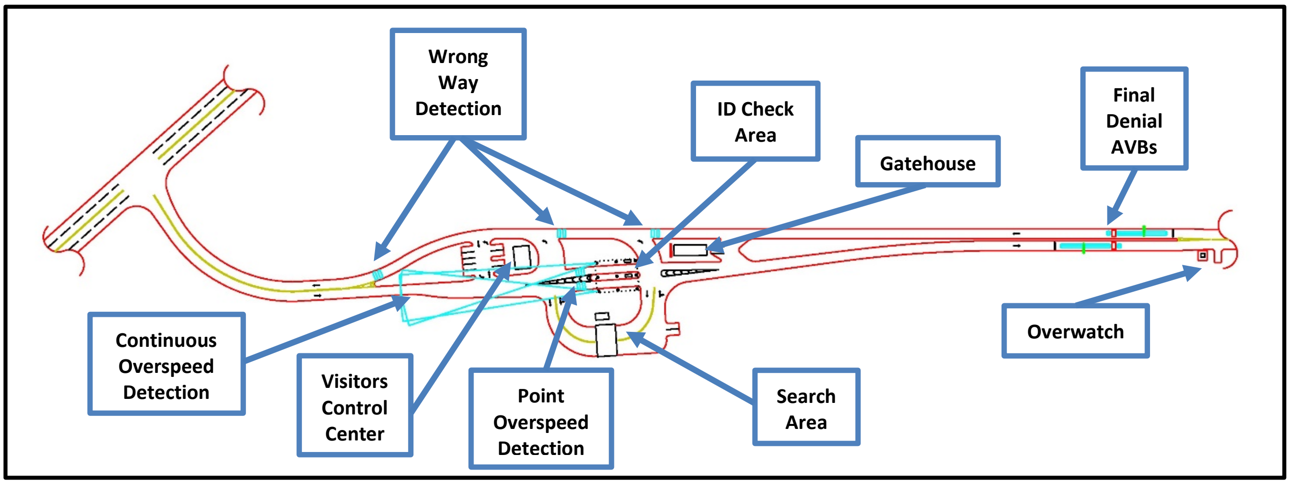


Figure 2-1: Fictional ACP Layout.

2-3 OVERSPEED DETECTIONAND WRONG WAY DETECTION.

2-3.1 OVERSPEED DETECTION.

The ACP layout includes Overspeed Detection in two locations. The first location of overspeed uses continuos overspeed detection with the radar heads located on the ID Check Canopy. The Length of the radar zone is 300 feet and the radar setting is 40 mph. The second location of Overspeed Detection uses Point Overspeed with induction loops. It is located with the beginning of the second loop 20 feet prior to the ID Check Canopy and is set at 25 mph.

2-3.2 WRONG WAY DETECTION.

The ACP layout includes Wrong Way Detection in three locations. Each location uses a set of two induction loops. The first location is in the outbound lanes right after the division of the inbound and outbound lanes in the Approach Zone. The second location is in the outbound lanes right after the rejection median cut prior to the ID Check Area. The third location is in the outbound lanes right after the rejection median cut after the ID Check Area.

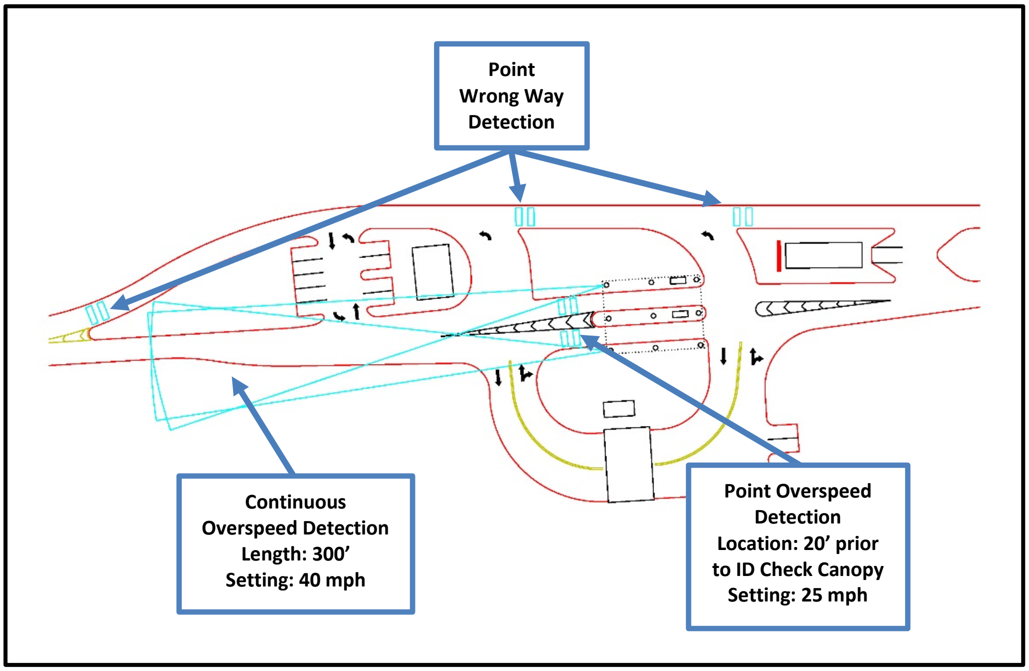


Figure 2-2: Overspeed and Wrong Way Detection Locations.

2-4 SAFETY SYSTEM.

The example layout includes the use of the Hybrid Beacon Safety System (One Lane) from the 2019 version of SDDC-TEA Pamphlet 55-15. This Safety System has a required response time of seven seconds for Threat Scenarios 1 through 3 and five seconds of required response time for Threat Scenario 4. Due to the longer safety loops incorporated into this Safety System the response time is calculated to the Safety Loops and not the Final Denial AVB itself.

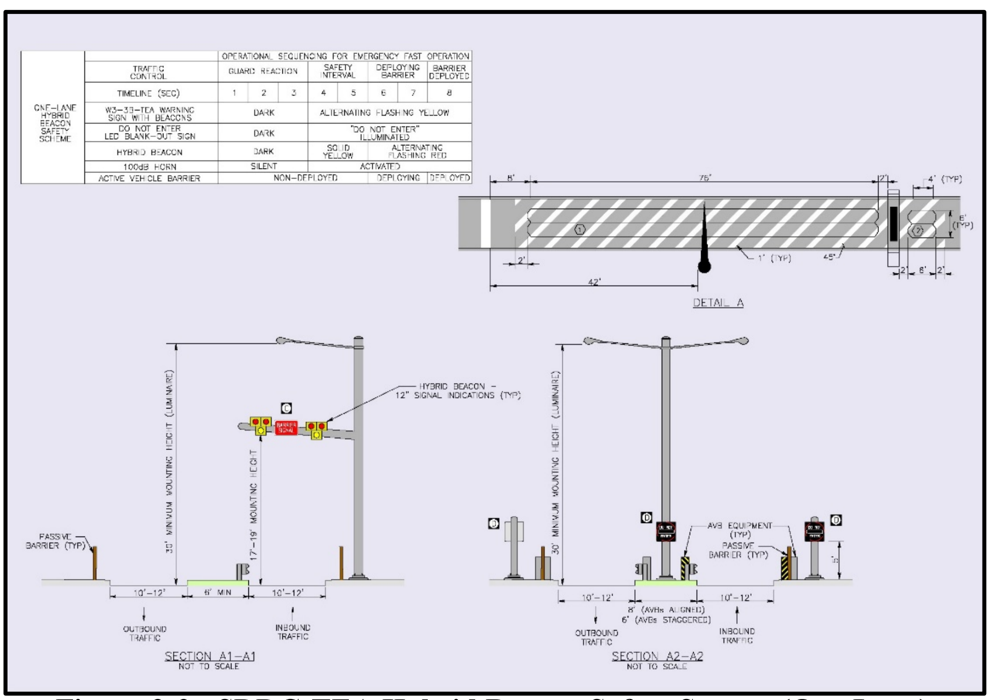


Figure 2-3: SDDC-TEA Hybrid Beacon Safety System (One Lane).

2-5 THREAT PATHS.

The intent of this example is to show all possible threat paths. A total of nine main threat paths were evaluated for this example with some divided into as many as four sub-paths for a total of thirteen paths. Threat Path A was used for Threat Scenarios #1, #2 and #3; Threat Path B was used for Threat Scenario #1; Threat Paths C and D were used for Threat Scenario #2; Threat Path E was used for Threat Scenarios # 2 and #3; Threat Paths F, G, H and I were used for Threat Scenario #4. Some of the threat paths that were used in this example can be eliminated by using engineering judgment. Examples of what threat paths can be eliminated are covered in section 5-3.

2-5.1 THREAT PATHS FOR THREAT SCENARIO #1.

Threat Scenario #1 is considered the high-speed attack threat scenario in both UFC 4-022-01 and Army ACP Standard Design, so neither is a worst-case scenario. The following paths were evaluated for Threat Scenario #1. Point of Detection (POD) is normally at the Vetting Areas, Overspeed Detectors or the Wrong Way Detectors for this threat scenario. For this layout there is only two possible paths for threat scenario #1, if there are median cuts in your layout prior to the ID Check that are not covered by Overspeed Detection, then a threat vehicle trying to cut over from the inbound to the outbound lanes and vice versa must be taken into consideration as well.

2-5.1.1 THREAT PATH A.

Designated by label 1A-1, in this threat path the threat vehicle attempts to access the Installation by accelerating at its highest obtainable velocity through the inbound lanes and the ID Check Area. POD is the Continuous Overspeed Detection.

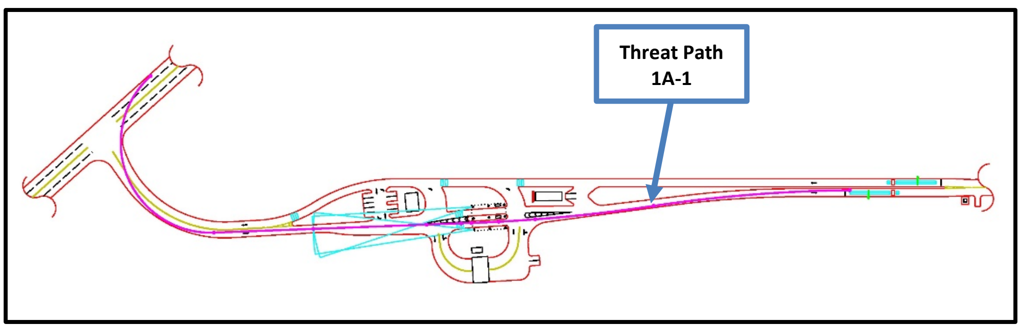


Figure 2-4: Threat Path A-1 for Threat Scenario 1

2-5.1.2 THREAT PATH B.

Designated by label 1B-1 in this threat path the threat vehicle attempts to access the Installation by accelerating at its highest obtainable velocity through the outbound lanes. POD is the outer set of Wrong Way Detectors.

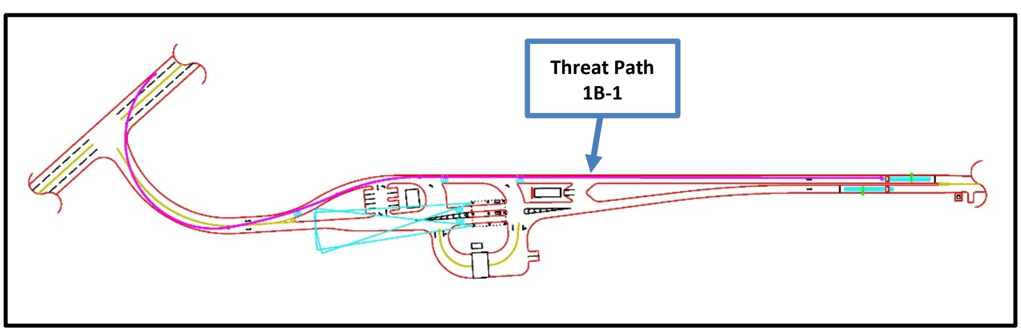


Figure 2-5: Threat Path B-1 for Threat Scenario 1

2-5.2 THREAT PATHS FOR THREAT SCENARIO #2.

Threat Scenario #2 is where a threat vehicle comes into the ACP Corridor at the speed limit and then sometime when driving along the roadway starts to accelerate. The most common use of Threat Scenario #2 is for a threat vehicle to come in at the Overspeed Detection setting and then start to accelerate right after it leaves the Overspeed Detection Area. Threat Scenario #2 in both UFC 4-022-01 and Army ACP Standard Design are the same so there is no worst-case scenario. The following threat paths were evaluated for Threat Scenario #2

2-5.2.1 THREAT PATH A.

In this threat path the threat vehicle tries to enter the Installation through the inbound lanes. The threat vehicle maintains a constant velocity just under the Overspeed Detector setting and then increases velocity at the maximum acceleration rate. There are two sub-paths to this threat path, designated 2A-1 and 2A-2. In threat path 2A-1 the threat vehicle comes in at the outer continuous Overspeed setting and then starts to accelerate once it leaves the radar cone. POD for threat path 2A-1 is the Point Overspeed Detection. In threat path 2A-2 the threat vehicle comes in at the point overspeed setting and then starts to accelerate once it passes over the second induction loop. POD for threat path 2A-2 will be at the Guard Booth were the Guard notices the vehicle as it drives by.

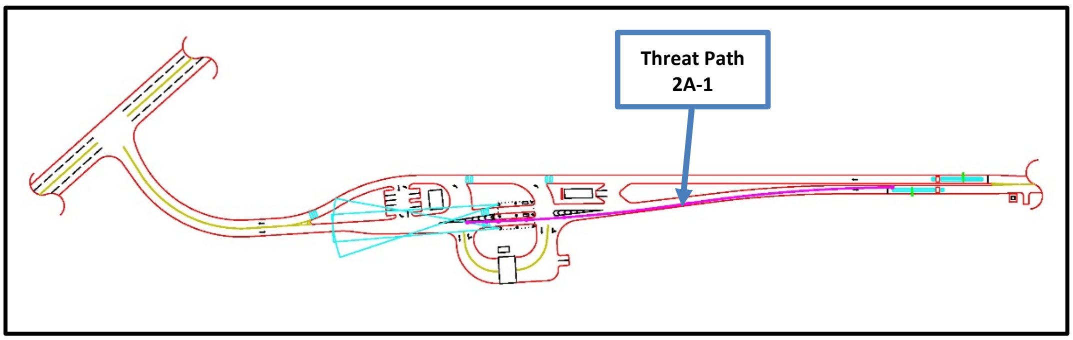


Figure 2-6: Threat Path A-1 for Threat Scenario 2

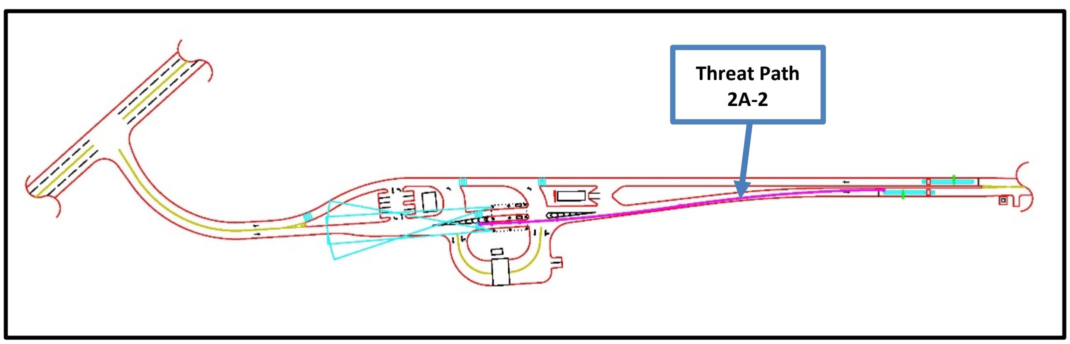


Figure 2-7: Threat Path A-2 for Threat Scenario 2

2-5.2.2 THREAT PATH C.

Designated by threat path label 2C-1 in this threat path the threat vehicle attempts to exploit the VCC parking lot by coming in at the outer Overspeed Detection setting and turning in to the VCC parking lot and then going down the outbound lanes in the wrong direction. POD for this threat path is the middle set of Wrong Way loops located just after the Median cut prior to the ID Check Area.

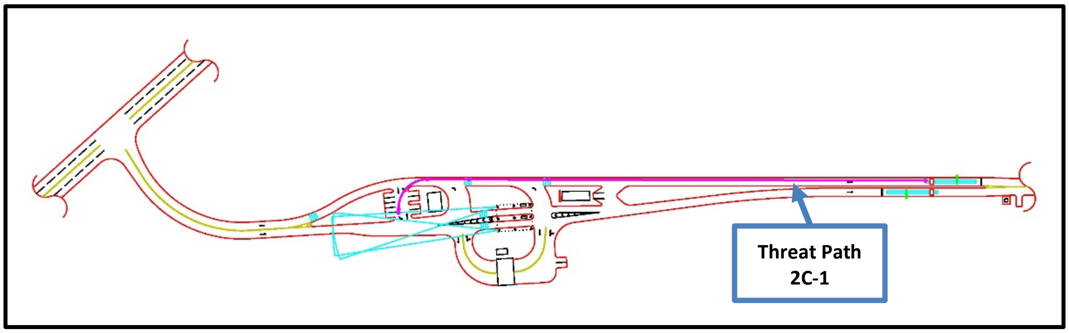


Figure 2-8: Threat Path C-1 for Threat Scenario 2

2-5.2.3 THREAT PATH D.

Threat Path 2D-1 is a lot like the previous threat path except that the threat vehicle attempts to exploit the self-rejection turn around just prior to the ID Check Area. POD for this threat path is the middle set of Wrong Way loops located just after the Median cut prior to the ID Check Area.

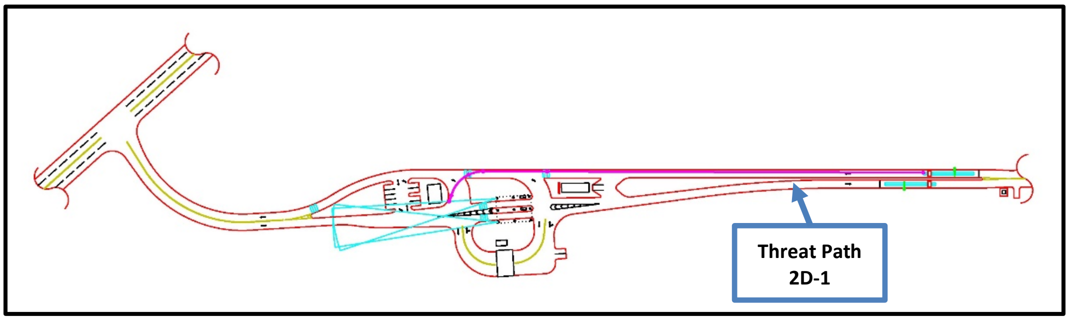


Figure 2-9: Threat Path D-1 for Threat Scenario 2

2-5.2.4 THREAT PATH E.

Designated by threat path label 2E-1 in this threat path the threat vehicle attempts to exploit the Search Area by coming in at the outer Overspeed Detection setting and turning in to the Search Area and then going down the inbound lanes. POD for this threat path is the middle set of the Search Area canopy as the Threat Vehicle drives past the Guards stationed there.

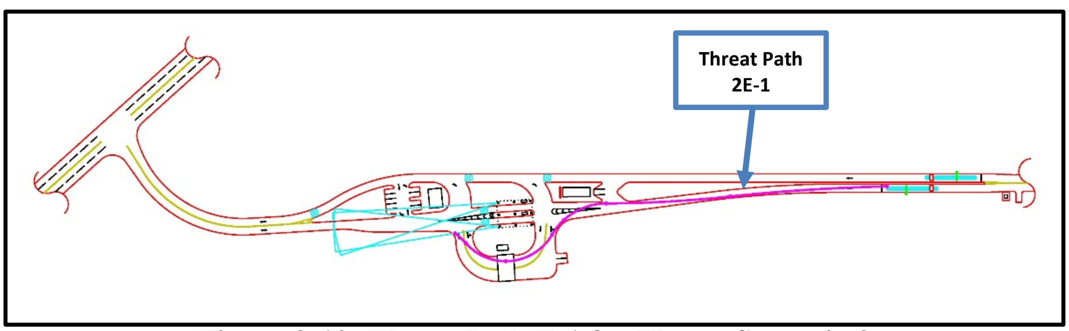


Figure 2-10: Threat Path E-1 for Threat Scenario 2

2-5.3 THREAT PATHS FOR THREAT SCENARIO #3.

Threat Scenario #3 is where a threat vehicle appears to be complaint and then drives by without stopping to be vetted. Army ACP Standard Design uses an initial velocity of 0 mph were UFC 4-022-01 uses an initial velocity of 25 mph therefore for this example the worst case of 25 mph identified in

UFC 4-022-01 will be used. PODs for this Threat Scenario is any point where credentials are checked including but not limited to ID Check Areas and Search Areas.

2.5.3.1 THREAT PATH A.

Designated by label 3A-1 in this threat path the threat vehicle attempts to enter the Installation by the inbound lanes. POD is where the Guard notices the vehicle driving past the ID Check Guard Booth.

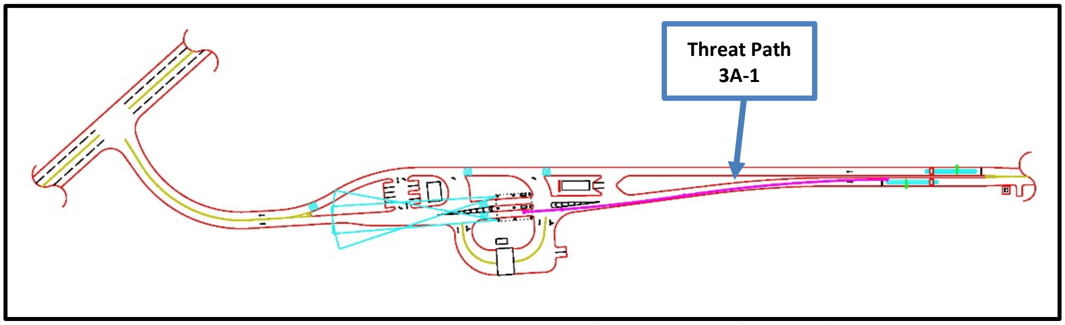


Figure 2-11: Threat Path A-1 for Threat Scenario 3

2.5.3.2 THREAT PATH E.

Like the previous threat path, in threat path 3E-1 the threat vehicle attempts to enter the Installation through the Search Area. POD for this threat path is the middle of the Search Area Canopy when the Guard notices that the vehicle is not stopping.

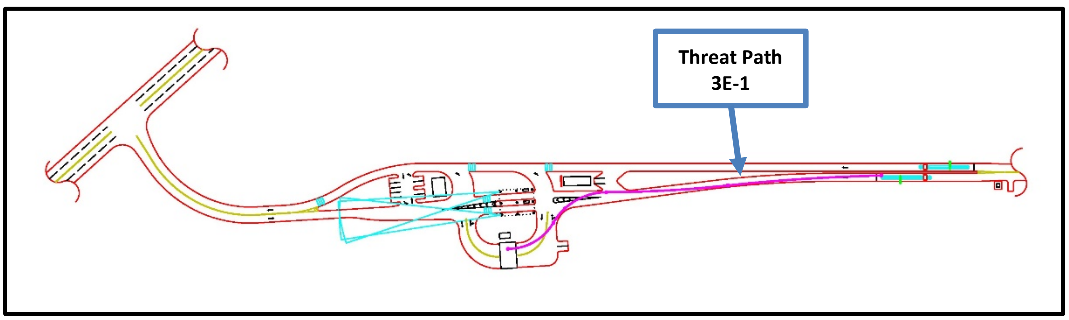


Figure 2-12: Threat Path E-1 for Threat Scenario 3

2.5.4 THREAT PATHS FOR THREAT SCENARIO #4.

This threat scenario can be considered the failure to reject threat scenario. The **A**rmy ACP Standard Design uses an initial velocity of the ACP Speed Limit (normally 25 mph) were UFC 4-022-01 uses an initial velocity of no less than 10 mph therefore the worst case of the 25 mph that is identified in the Army ACP Standard Design. As the use of 25 mph will meet the criteria of both documents it will be used in this example. As the Guard is already watching if the vehicle turns around, the Guard Reaction time is reduced from three seconds to one second.

2.5.4.1 THREAT PATH F.

Threat path 4F-1 is where the threat vehicle is rejected by the ID Check Guard, threat vehicle then tries to access the Installation through the inbound lanes. POD is 10 feet past the rejection turn, were it is obvious to the Guard that the vehicle is not rejecting.

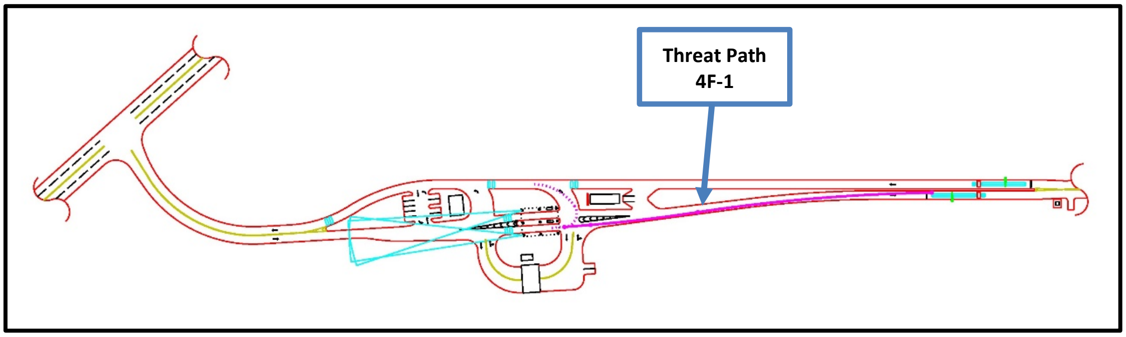


Figure 2-13: Threat Path F-1 for Threat Scenario 4

2.5.4.2 THREAT PATH G.

Like the previous threat path in threat path 4G-1 the vehicle is rejected by the Search Area Guard; threat vehicle then tries to access the Installation through the inbound lanes. POD is 10 feet past the rejection turn, were it is obvious to the Guard that the vehicle is not rejecting.

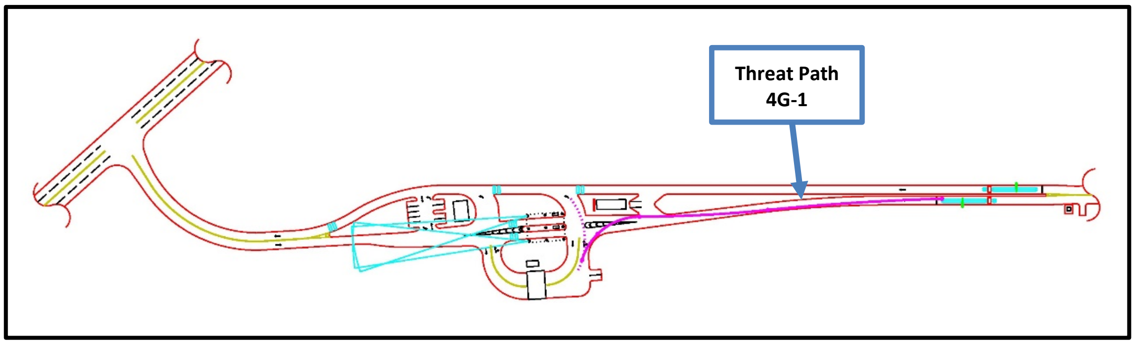


Figure 2-14: Threat Path G-1 for Threat Scenario 4

2.5.4.3 THREAT PATH H.

Threat path 4H-1 is where the threat vehicle is rejected by the ID Check Guard, threat vehicle then tries to access the Installation through the outbound lanes. POD is the Wrong Way Detector located in the outbound lanes after the rejection median cut after the ID Check Area.

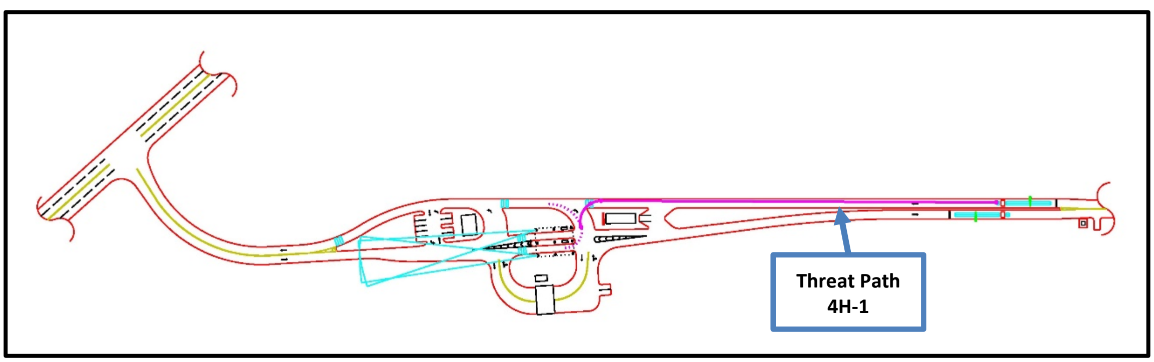


Figure 2-15: Threat Path H-1 for Threat Scenario 4

2.5.4.4 THREAT PATH I.

Like the previous threat path in threat path 4I-1 the vehicle is rejected by the Search Area Guard; threat vehicle then tries to access the Installation through the outbound lanes. POD is the Wrong Way Detector located in the outbound lanes after the rejection median cut after the ID Check Area.

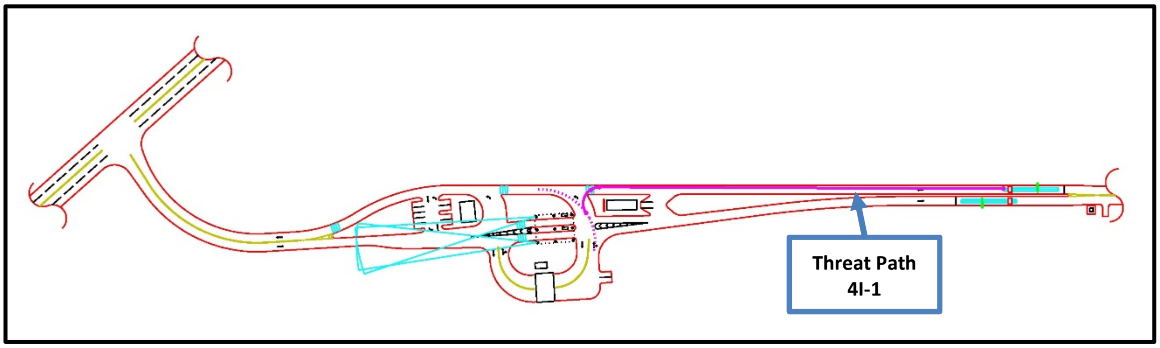


Figure 2-16: Threat Path I-1 for Threat Scenario 4

2.6 LAYING OUT THREAT PATHS.

For this example, the vehicle path for threat path A will be laid out. All other threat paths were done using the same basic process and can be seen in Section 5-2 of this report.

Step #1 - Import a raster image or drawing of the ACP into the CAD program that you will be using. If designing a new ACP this will be the project CAD drawings. If determining the threat paths for an existing ACP, then an aerial image will need to be imported and scaled in the CAD program.

Step #2 – Set up a level in the program titled edge of roadway and define the driving limits of the threat vehicle with lines and curves in this layer. For an ACP that has a curbed roadway this will normally be the curb line. For a non-curbed roadway, it will normally be outer edge of the shoulder of the roadway, but it can also be any permanently installed item such as medians, building and passive barrier. Swing gates, removable bollards, concrete or plastic road barriers are not to be taken into consideration as there is no way of knowing if they will be in place when the threat vehicle makes its attempt to penetrate the ACP. The assumption in laying out the threat path is that the threat vehicle will stay on the roadway to maintain maximum velocity instead of trying to cut across curve sections by curb hopping or driving in ditches to shorten their path. Caution must be used when using this assumption so that it is not applied to any major curves where in the Engineer's judgment it is believed to be a benefit to the threat vehicle to cut across a curve. For the example it was assumed that the ACP had eight-inch-high curbs that set the driving limits. These are identified by the red lines as shown in the image below.

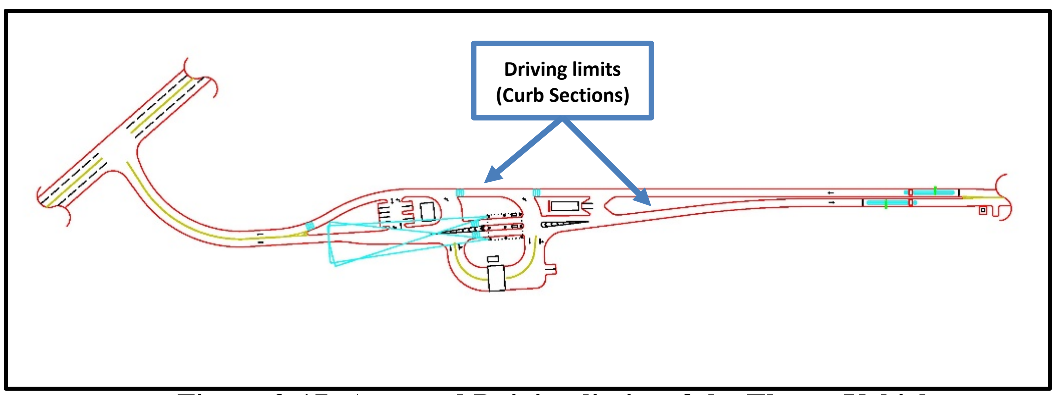


Figure 2-17: Assumed Driving limits of the Threat Vehicle

Step #3 – The velocity of the threat vehicle through the ACP corridor will be limited by the spin out velocity of the curves on the threat path. In order to obtain the most conservative response time, the starting point when establishing the threat path should be the tightest curve so that the largest obtainable radius for that curve can be established. If there is a curve in the Response Zone of the ACP, then this curve should take priority over curves in the Approach Zone as the Response Zone curve will include segments between the POD and the AVBs where the response time is calculated. For the example there is no limiting curves in the Response Zone so the curve where the threat vehicle turns off the local public roadway and into the ACP corridor will be the starting section of the threat path. If we assume that the threat vehicle will use as much of the roadway as possible then it should be just brushing the driving limits lines in the CAD drawing as it does around the curve. If a 4630 lb threat vehicle is six feet wide, we can establish the center of the threat vehicle by copy parallel function in the CAD program offsetting the driving limits by three feet. For the example we copied parallel the outer edge of the public roadway as well as the inner curb line at the intersection and the right-hand curb line of the inbound lanes in the Approach Zone.

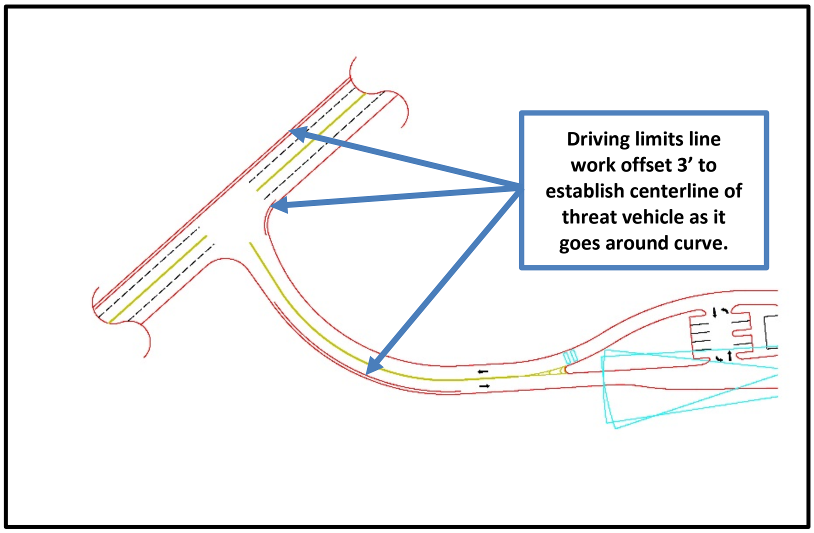


Figure 2-18: Offset of driving limits

Step #4 – Using the snap tangent and place arc functions in the CAD program to establish a curve that is tangent to each of the offset lines. In order to facilitate placing the next section extend this curve using the extend line function in the CAD program past its initial stopping point.

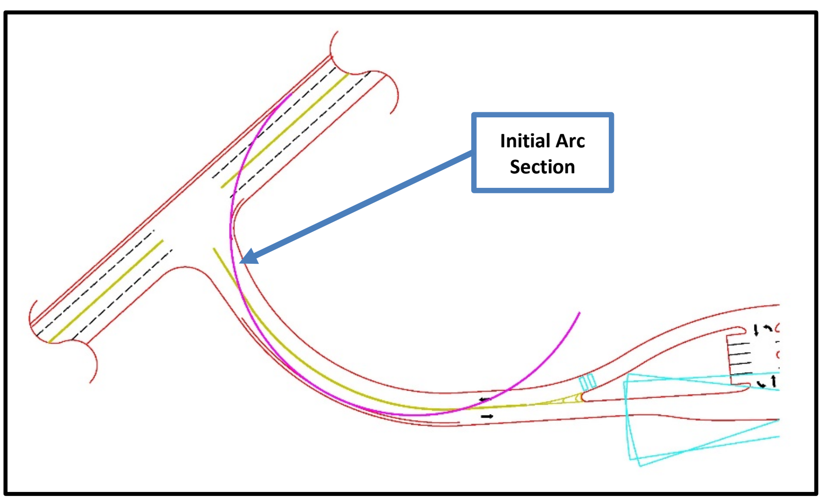


Figure 2-19: Initial Curved section of the threat path

Step #5 – The Next segment happens to be a straight line (referred to as a tangent in this report and in the spreadsheet). This tangent goes through the right-hand ID Check Lane next to the ID Check Median. So, the ID Check Median curb line which defines the driving limits was offset three feet using the copy parallel function in the CAD program and a tangent line was drawing using the Line and Snap Tangent functions in the CAD Program. The Tangent was then extended, and the initial curve was trimmed so that it did not extend past the new tangent line.

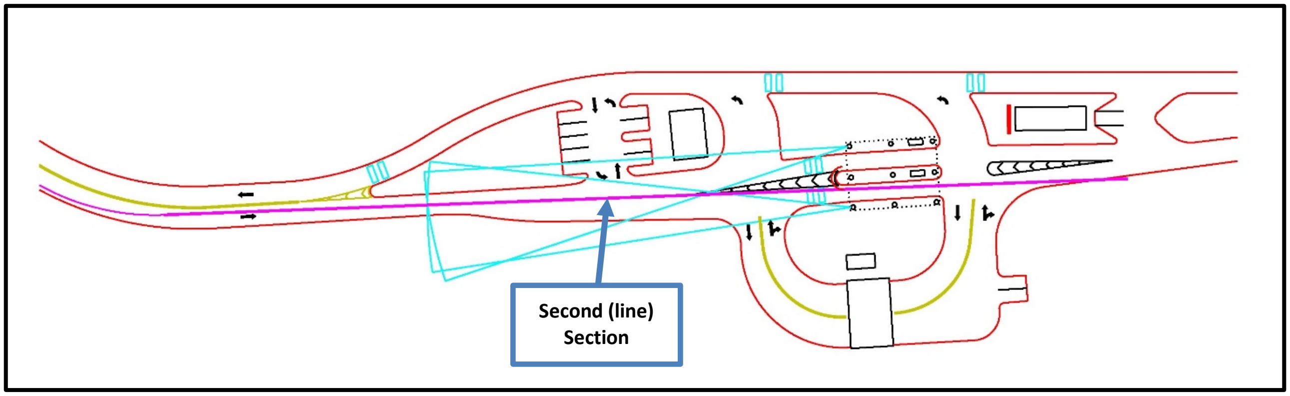


Figure 2-20: Placement of second section of the threat path

Step #4 – Using the same CAD functions already mentioned were continued through the ACP Corridor establishing each section of the threat path and the final section was trimmed at the induction loops before the AVB. For the example we ended up with four initial sections consisting of three curves and one tangent in the initial threat path layout.

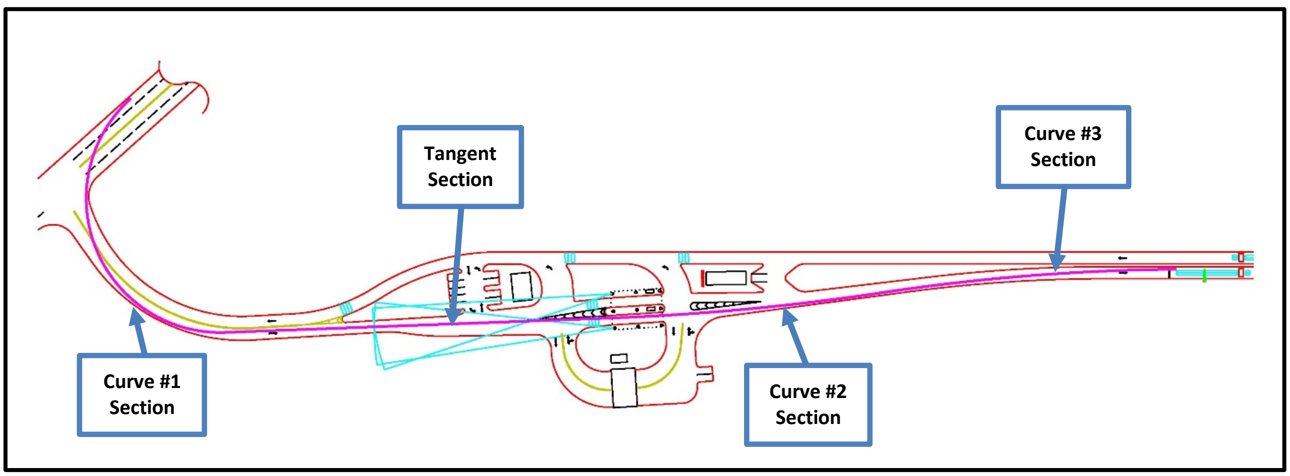


Figure 2-21: Initial placement of all the sections of the threat path

Step #5 – In order to facilitate the use of this path for multiple threat scenarios the initial sections should be broken down into segments. These brakes should be at the PODs for each Threat Scenario as well as were the threat vehicle enters into or comes out of Overspeed Detection and crosses Wrong Way Detectors. For the example there should be five breaks placed in the initial sections; Outer edge of the Continuous Overspeed Detection - POD for Threat Scenario #1, Inner edge of the Continuous Overspeed Detector - point of acceleration for a Threat Scenario #2 path, Beginning of second loop on the Point Overspeed Detector - POD for one path in Threat Scenario #2 and point of acceleration for another, ID Check Guard Booths - POD for a path in Threat Scenario #2 and #3 in this example and the primary POD for ACPs that do not have overspeed detectors, and ten feet after the outer edge of the rejection lane after the ID Check Area - POD for threat Scenario #4.

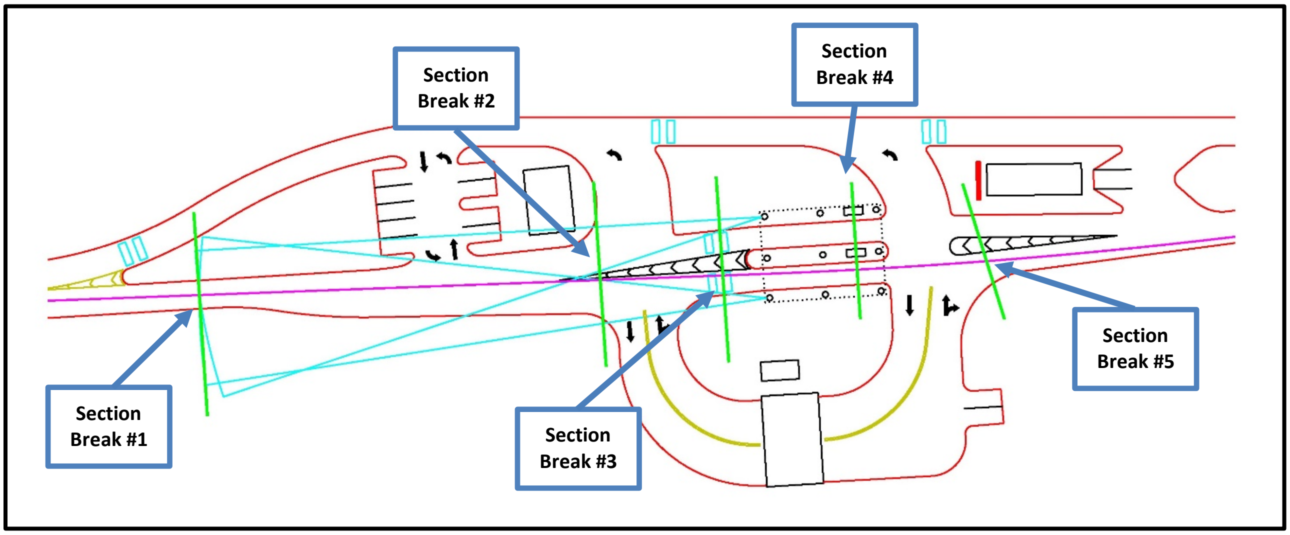


Figure 2-22: Location of Section Breaks

Step #6 – Breaking the sections down into segments resulted in a total of nine segments. To ensure that no segment is missed when placing the information into the VTDC spreadsheet solid circles were placed at the beginning and end of each segment to help distinguish them.

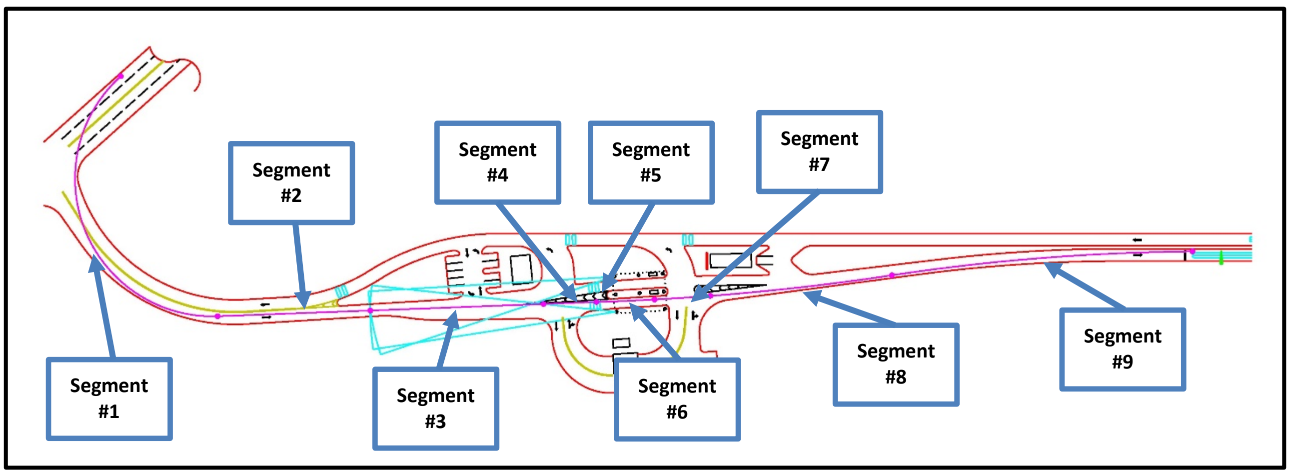


Figure 2-23: Final Segments

CHAPTER 3 VEHICLE THREAT DELAY CALCULATOR SPREADSHEET.

3-1 GENERAL.

The Vehicle Threat Delay Calculator (VTDC) was constructed for the US Army Corps of Engineers – Protective Design Center (USACDE – PDC) in March of 2016 by the University of Nebraska Lincoln, Nebraska Transportation Center. It was done to help standardize how the Threat Scenarios were evaluated and expedite the design and review process. This spreadsheet is considered open distribution and a copy can be obtained by contacting the USACE – PDC. The Spreadsheet was done without the use of macros so it is not considered a program and can be used on Government Computers without having to go through the IT personnel.

3-2 VTDC SPREADSHEET LAYOUT.

There are fourteen tabs in the VTDC Spreadsheet they are as follows:

- Table of Contents
- Input Worksheet
- General Information Worksheet
- Nomenclature Worksheet
- Pre-calculation Worksheet
- TD Calculator Worksheet
- Route – Distance vs Time Graph
- Route – Speed vs Distance Graph
- Route – Speed vs Time Graph
- Segment Calculator Worksheet
- Segment – Distance vs Time Graph
- Segment – Speed vs Distance Graph
- Segment – Speed vs Time Graph
- Acknowledgments

Of these the Input Worksheet, the General Information, and the TD Calculator tabs are the most commonly used. The Input Worksheet tab is where the basic information including the segment information is input. The General Information Tab is where the constants in the formulas are located and can be modified. And the TD Calculator is where the output from the spreadsheet can be found. The Segment Calculator is also very helpful when determining the final location of the AVB as it breaks down each segment into Time and Distance starting on line 104.

3-3 ENTERING DATA INTO VTDC SPREADSHEET LAYOUT.

This Chapter is to identify the important input sections on the spreadsheet and how to input the information from the CAD program into the VTDC Spreadsheet, The spreadsheet for threat path 1A-1 for Threat Scenario #1 was used in this chapter, and a more complete example threat path for each Threat Scenario can be seen in Chapter 4.

3-3.1 GENERAL INFORMATION TAB.

Go to the General Information Tab, the information in the greenish colored cells can be changed as needed. Updating a greenish cell under US Standards will automatically updated the corresponding cell under Metric except for Acceleration due to gravity constant. Ensure that the following are set in accordance with the criteria that is being used; Side friction (cell C9), Maximum speed on a segment (cell F15), Maximum Deceleration Rate (cell F21) and Maximum Acceleration Rate (cell F23). The Superelevation (cell C10) should remain at Zero. Most ACP roadways do not have superelevation and are only sloped to drain the road surface. If superelevation is taken into consideration then both positive and negative superelevation needs to be considered and might mean having to run each segment one at a time in the spreadsheet, including having to break the segments down into smaller segments with different superelevation, and so it is frankly not worth the time for the minimal impact that it has on the overall response time.

The Threat Scenario 1 Entry Speed (cell F30) will automatically update when the Maximum speed on a segment (cell F15) is changed. The Threat Scenario 2, 3, and 4 Entry Speeds (cells F33, F36 and F39) can be changed to meet the criteria and the information obtained from the roadway geometry, as shown in Chapter 4.

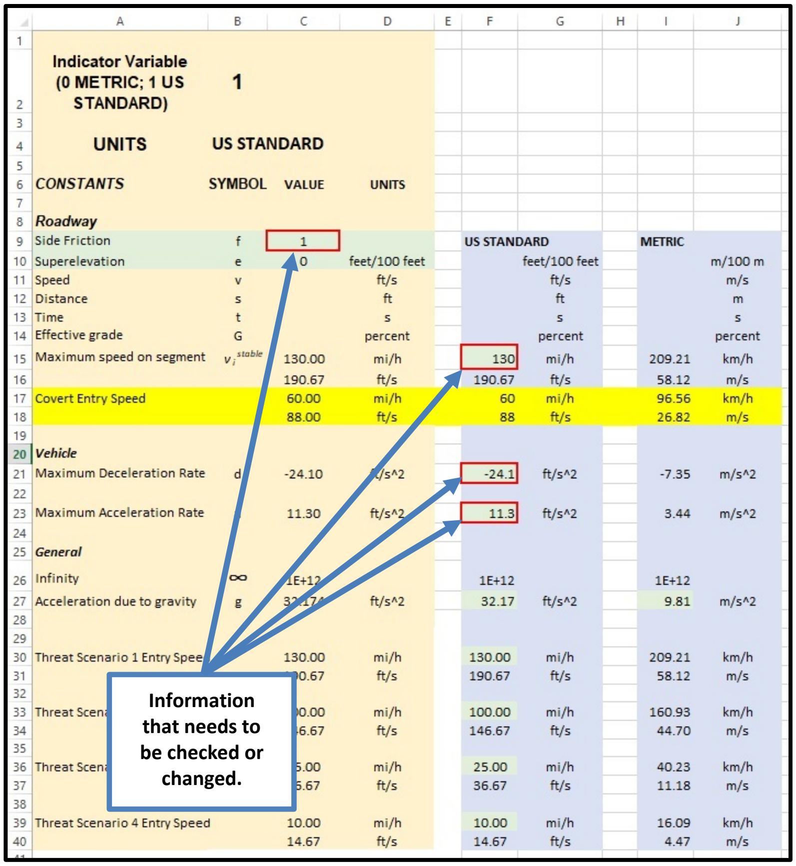


Figure 3-1: General Information Tab

3-3.2 INPUT TAB.

The Input Tab is where most of the information is input this includes type of units, number of segments, threat scenario that is being evaluated, entry speed for segment #1, and the type, length and radius of each segment. An effective grade can also be input in a percentage but the use of it will require either the calculation of the average grade over the whole segment or to break the initial segment into smaller segments at major grade changes. For the grade to have a dramatic effect on the segment it must be a very steep grade. Due to the requirement for line of sight through the ACP corridor normally the grades are not steep enough to influence the overall response time, so it is not normally taken into consideration. The POD cell and the Response Time Calculation Column (Column L) were input by the author of this document and might not be on your copy of the spreadsheet. The POD is used by the author to indicate the last segment that is not used in the response time calculation and the Response Time Calculations cells are just copied from the TD Calculator Tab.

For the example a 1 is input into cell B3 this corresponds to US Standard Units. As there are nine segments in Threat Path 1A-1 so a 9 is input into cell B7. As the threat path being evaluated in this example is for Threat Scenario #1, a 1 is placed into cell B9. Input 130 mph into cell D12 initially, it is assumed that the threat vehicle will be doing the maximum acceleration rate of 130 mph. The spreadsheet itself will calculate and adjust the entry speed accordingly, or it can be manually changed to the entry speed calculated by the spreadsheet as shown below.

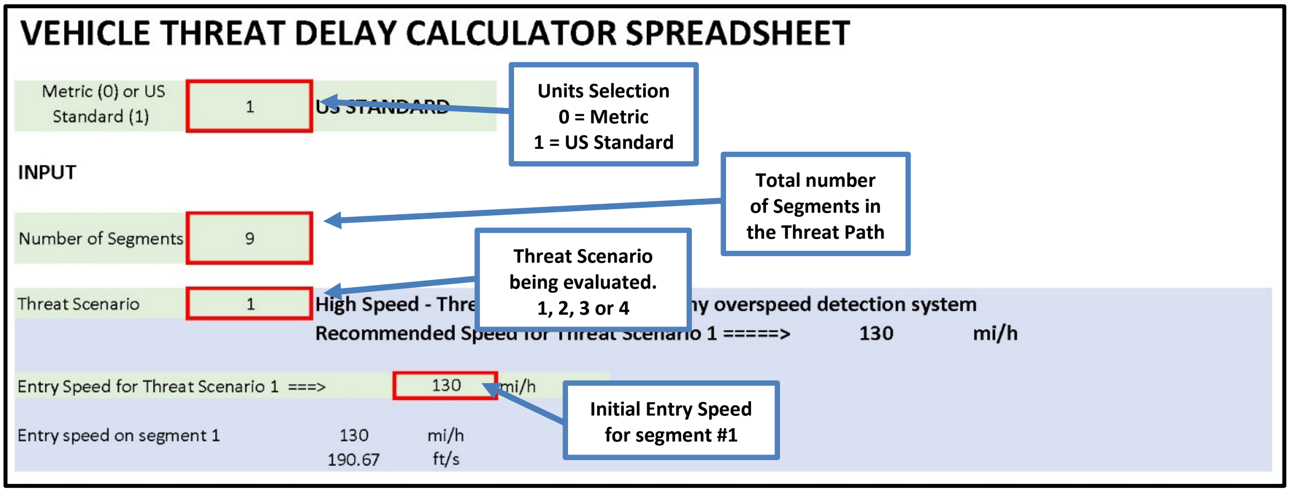


Figure 3-3: Inputs for Threat Path being evaluated

Cells B20 to B39 designate the type of segment, use either a 0 for a tangent (straight line) or a 1 for a curve (arc). Cells C20 to C39 and D20 to D39 is where the length and radius for each segment is input. If the segment is a tangent (straight line) than enter 0' for the radius. Cells E20 to E39 are where an effective grade can be input in either a positive (downhill) or a negative (uphill) percentage. As most ACPs are relatively flat and it must be a steep grade to greatly influence the overall response time these cells are not normally used. Column L (Response Time Calculation) and Cell K21 (POD) were input by the author to help keep track of response time and might not be on your copy of the spreadsheet.

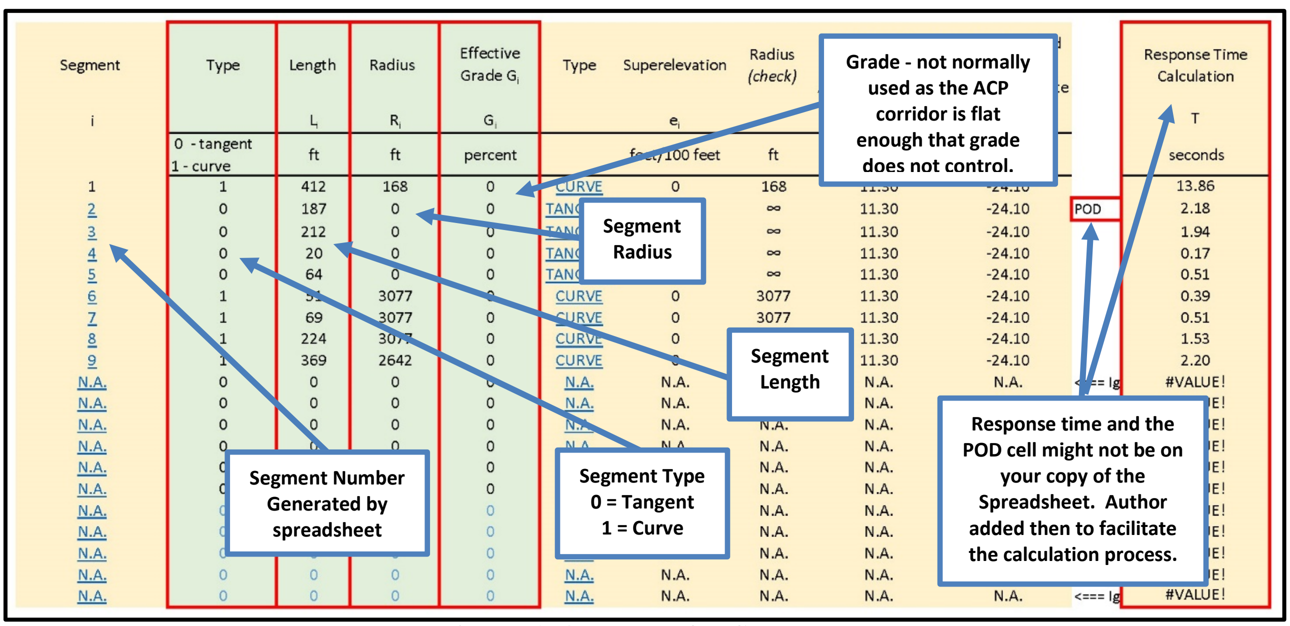


Figure 3-4: Inputs for Segments

The segment length and radius information that needs to be entered into the Input Tab for each segment can be found by selecting the segment in the CAD program and then using the information function in the program as shown for a MircoStation drawing in Figure 3-2. For MicroStation click on the Element Information Tool button identified with an i in a circle and then select the appropriate segment.

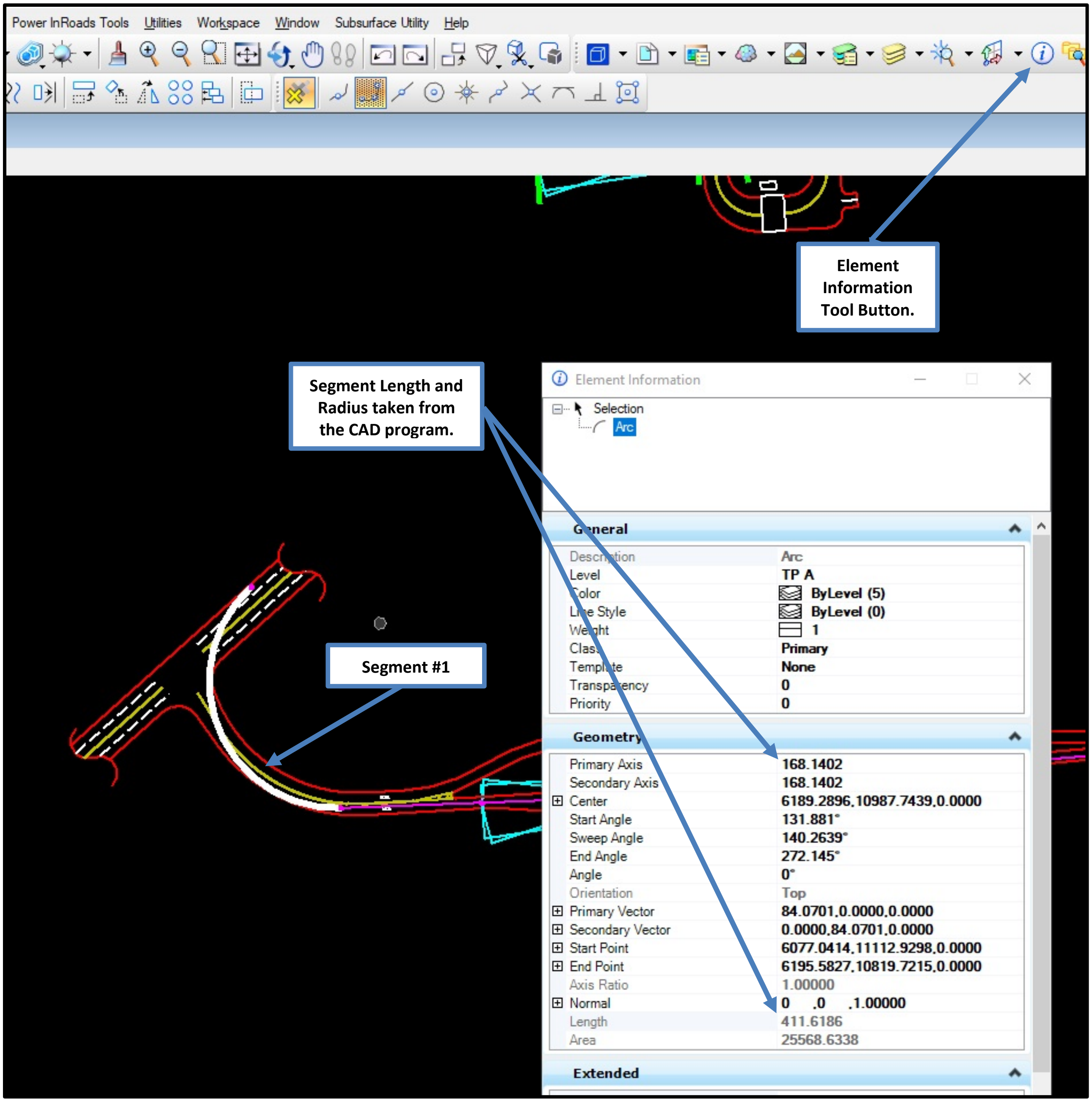


Figure 3-5: Length and Radius from MircoStation

This process is repeated for each segment, and the corresponding type of segment, length of segment and radius of segment was entered into tap Input of the spreadsheet.

CHAPTER 4 VEHICLE THREAT PATH EXAMPLES.

4-1 GENERAL.

An example threat path for each Threat Scenario is included in this chapter to show how the spreadsheet needs to be changed for each Threat Scenario. A completed threat path and spreadsheet for all the threat paths identified in section 2.5 can be seen in section 5-2.

4-2 THREAT SCEANRIO #1

For Threat Scenario #1 threat path 1A-1 was chosen to be used as an example. Threat path 1A-1 had a total of nine segments with the POD for the start of the response time being at the start of the Continuous Overspeed Detection which is also the end of segment #2. The required response time for the Hybrid Beacon Safety System for this Threat Scenario is seven seconds.

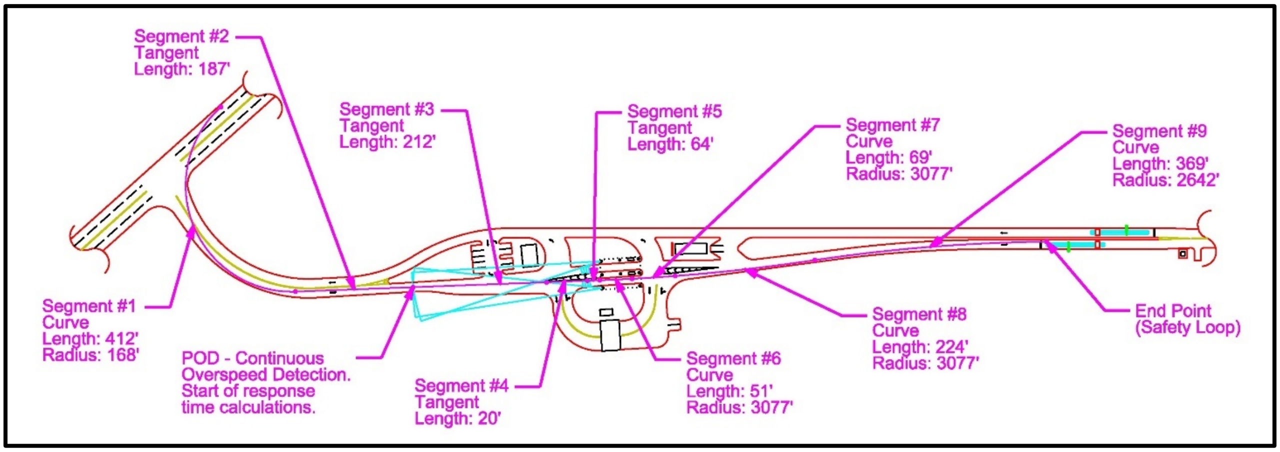


Figure 4-1: Threat Path 1A-1

On the INPUT tab of the Spread sheet the total number of segments (9) was entered into cell B7, the Threat Scenario number that is being evaluated (1) was entered into cell B9 and an initial entry velocity of 130 mph was entered into cell D12, as this is the highest obtainable velocity as set by the criteria.

INPUT				
Number of Segments	9			
Threat Scenario	1	High Speed - Threat vehicle disregards any overspeed detection system		
		Recommended Speed for Threat Scenario 1 =====>	130	mi/h
Entry Speed for Threat Scenario 1 ===>		130	mi/h	
Entry speed on segment 1	130	mi/h		
	190.67	ft/s		

Figure 4-2: Threat Path Inputs for Threat Path 1A-1

Still on the INPUT tab for each segment in the threat path enter in the Type of Segment (0 = tangent, 1 = curve) into cells B20-28, Length of the segment into cells C20-28, and Radius of each segment into cells C20-28 (using 0 for each tangent segment).

Segment	Type	Length	Radius	Effective Grade G_i
i		L_i	R_i	G_i
	0 - tangent 1 - curve	ft	ft	percent
1	1	412	168	0
2	0	187	0	0
3	0	212	0	0
4	0	20	0	0
5	0	64	0	0
6	1	51	3077	0
7	1	69	3077	0
8	1	224	3077	0
9	1	369	2642	0

Figure 4-3: Segment Inputs for Threat Path 1A-1

Go to the TD CALCULATOR tab on the spreadsheet and note the spin-out speed for segment number 1 in cell C24 is 73.52 ft/s. This is how fast the threat vehicle can navigate a 168' radius curve with a friction factor of 1. Because the INPUT tab on the spreadsheet is in mph this will have to be converted, 73.53 ft/s is 50.13 mph. Go to the INPUT tab and enter 50.13 mph into the cell D12 for the Entry Speed. Because the overall response time does not include segment #1 it will not affect the results, but it is a good habit to get into incase this segment is ever included in the overall response time calculation.

The overall Response Time is determined by the sum of the Travel Time of each segment from the POD to the AVB Safety Loop (segments 3 to 9) designated by the symbol (s) in line 29 of the spreadsheet. This gives an overall response time of 7.25 seconds for this threat path.

Units	Segment==>	1	2	3	4	5	6	7	8	9
		OK	OK	OK	OK	OK	OK	OK	OK	OK
	Type	CURVE	TANGENT	TANGENT	TANGENT	TANGENT	CURVE	CURVE	CURVE	CURVE
ft	Length	412	187	212	20	64	51	69	224	369
ft	Radius	168	0	0	0	0	3077	3077	3077	2642
	Superelevation	0	0	0	0	0	0	0	0	0
	Effective Grade	0	0	[illegible]	0	0	0	0	0	0
ft/s^2	Modified Maximum Acceleration Rate	11.30	11.30	11.30	11.30	11.30	[illegible]	[illegible]	11.30	11.30
ft/s^2	Modified Maximum Deceleration Rate	-24.10	-24.10	-24.10	-24.10	-24.10	[illegible]	[illegible]	-24.10	-24.10
ft/s	v_i^{spin}	73.52	190.67	190.67	190.67	190.67	[illegible]	[illegible]	314.64	291.55
ft/s	v_i^{stable}	190.67	190.67	190.67	190.67	190.67	[illegible]	[illegible]	190.67	190.67
ft/s	$v_i^{maximum}$	73.52	190.67	190.67	190.67	190.67	[illegible]	[illegible]	190.67	190.67
ft/s	$v_i^{max\_exit}$	73.52	190.67	190.67	190.67	190.67	190.67	190.67	190.67	190.67
ft/s	$v_i^{max\_entry}$	73.52	190.67	190.67	190.67	190.67	190.67	190.67	190.67	190.67
ft/s	v_i^{entry}	73.52	73.52	98.14	120.09	121.96	127.75	132.19	137.96	155.23
ft/s	v_i^{exit}	73.52	98.14	120.09	121.96	127.75	132.19	137.96	155.23	180.10
s	t_i	5.60	2.18	1.94	0.17	0.51	0.39	0.51	1.53	2.20

Spin-out Speed for Segment #1

Total Response time is the time for each segment between POD and AVB Safety Loop.

Total Response time is 7.25 Seconds

Figure 4-4: TD CALCULATOR TAB outputs for Threat Path 1A-1

4-3 THREAT SCEANRIO #2

For Threat Scenario #2 threat path 2A-1 was chosen to be used as an example. For this Threat Path the threat vehicle is coming in at just under the Continuous Overspeed Radar setting of 40 mph and starts to accelerate just as soon as it leaves the radar cone. POD for this Threat Path is when the threat vehicle passes over the second loop in the Point Overspeed Detection just prior to the ID Check Canopy. Between the POD and the AVB Safety Loop there are a total of five segments whose sum will make up the total response time. The required response time for the Hybrid Beacon Safety System for this Threat Scenario is seven seconds.

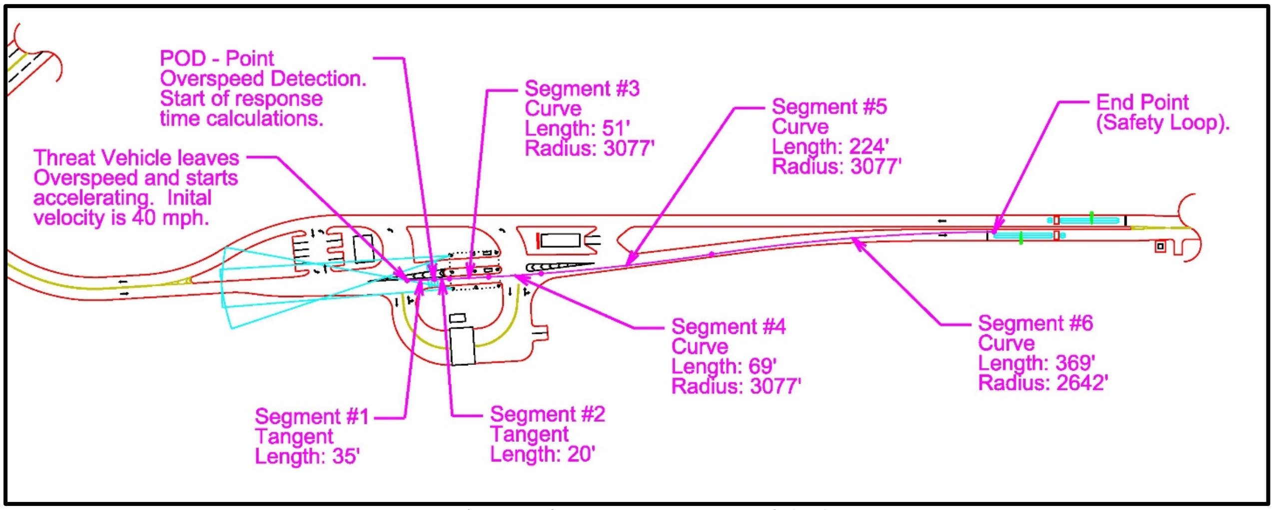


Figure 4-5: Threat Path 2A-1

On the INPUT tab of the Spread sheet the total number of segments (6) was entered into cell B7, the Threat Scenario number that is being evaluated (2) was entered into cell B9 and an initial entry velocity of 40 mph was entered into cell D12, as this is the setting of the Continuous Overspeed Setting.

INPUT

Number of Segments	6			
Threat Scenario	2	**High speed - Threat vehicle does not trigger overspeed detection system**		
		Recommended speed for Threat Scenario 2 =====>	**100**	**mi/h**
Entry Speed for Threat Scenario 2 ===>		40	mi/h	
Entry speed on segment 1	40	mi/h		
	58.67	ft/s		

Figure 4-6: Threat Path Inputs for Threat Path 2A-1

Still on the INPUT tab for each segment in the threat path enter in the Type of Segment (0 = tangent, 1 = curve) into cells B20-25, Length of the segment into cells C20-25, and Radius of each segment into cells C20-25 (using 0 for each tangent segment).

Segment	Type	Length	Radius	Effective Grade G_i
i		L_i	R_i	G_i
	0 - tangent 1 - curve	ft	ft	percent
1	0	35	0	0
2	0	20	0	0
3	1	51	3077	0
4	1	69	3077	0
5	1	224	3077	0
6	1	369	2642	0

Figure 4-7: Segment Inputs for Threat Path 2A-1

Go to the TD CALCULATOR tab on the spreadsheet and the overall Response Time is determined by the sum of the Travel Time of each segment from the POD to the AVB Safety Loop (segments 2 to 6) designated by the symbol (s) in line 29 of the spreadsheet. This gives an overall response time of 7.01 seconds for this threat path.

Units	Segment==>	1	2	3	4	5	6
		OK	OK	OK	OK	OK	OK
	Type	TANGENT	TANGENT	CURVE	CURVE	CURVE	CURVE
ft	Length	35	20	51	69	224	369
ft	Radius	0	0	3077	3077	3077	2642
	Superelevation	0	0	0	0	0	0
	Effective Grade	0	0	0	0	0	0
ft/s^2	Modified Maximum Acceleration Rate	11.30	11.30	11.30	11.30	11.30	11.30
ft/s^2	Modified Maximum Deceleration Rate	-24.10	-24.10	-24.10	[illegible]	[illegible]	-24.10
ft/s	v_i^{spin}	190.67	190.67	314.64	[illegible]	[illegible]	291.55
ft/s	v_i^{stable}	190.67	190.67	190.67	[illegible]	[illegible]	190.67
ft/s	$v_i^{maximum}$	190.67	190.67	190.67	190.67	190.67	190.67
ft/s	$v_i^{max\_exit}$	190.67	190.67	190.67	190.67	190.67	190.67
ft/s	$v_i^{max\_entry}$	190.67	190.67	190.67	190.67	190.67	190.67
ft/s	v_i^{entry}	58.67	65.06	68.45	76.40	86.00	111.62
ft/s	v_i^{exit}	65.06	68.45	76.40	86.00	111.62	144.22
s	t_i	0.57	0.30	0.70	0.85	2.27	2.88

Total Response time is the time for each segment between POD and AVB Safety Loop.

Total Response time is 7.01 Seconds

Figure 4-8: TD CALCULATOR TAB outputs for Threat Path 2A-1

4-4 THREAT SCEANRIO #3

For Threat Scenario #3 threat path 3A-1 was chosen to be used as an example. For this Threat Path the threat vehicle acts like it is going to comply but instead just drives past the Guard at 25 mph without showing ID. POD for this Threat Path is the Guard Booth as the vehicle drives past. Between the POD and the AVB Safety Loop there are a total of three segments whose sum will make up the total response time. The required response time for the Hybrid Beacon Safety System for this Threat Scenario is seven seconds.

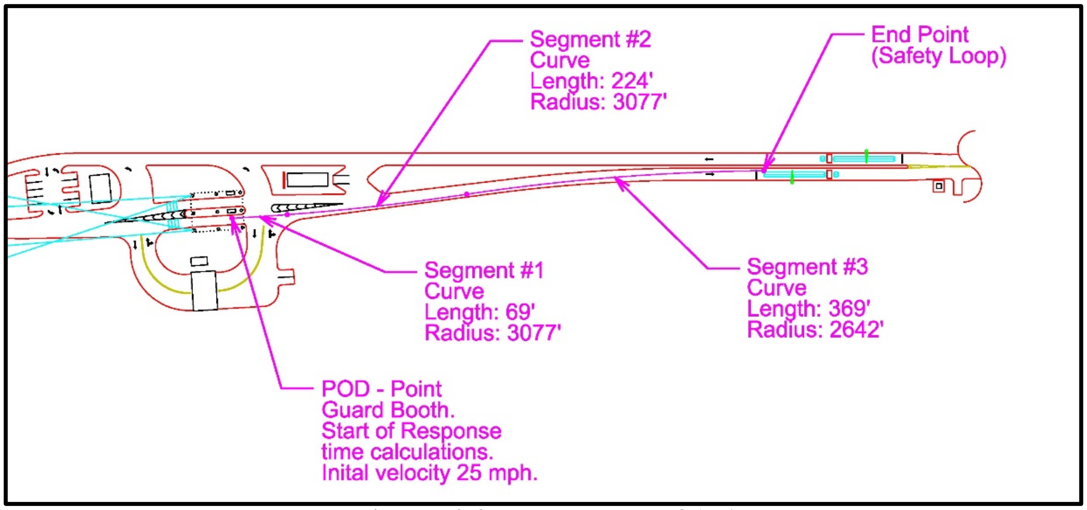


Figure 4-9: Threat Path 3A-1

On the INPUT tab of the Spread sheet the total number of segments (3) was entered into cell B7 and the Threat Scenario number that is being evaluated (3) was entered into cell B9. The initial entry velocity should automatically be uploaded to 25 mph. If it is not 25 mph DO NOT change it on this tab but instead change it in cell F36 in the GENERAL INFORMATION tab of the spreadsheet.

INPUT

Number of Segments	3		
Threat Scenario	3	**Covert Entry at the ID Check Point**	
		Threat vehicle is assumed to start for stationary positio	
Do not need to enter entry speed		25	Threat Scenario 3 and 4: User does not need to enter entry speed
Entry speed on segment 1	25	mi/h	
	36.67	ft/s	

Figure 4-10: Threat Path Inputs for Threat Path 3A-1

Still on the INPUT tab for each segment in the threat path enter in the Type of Segment (0 = tangent, 1 = curve) into cells B20-22, Length of the segment into cells C20-22, and Radius of each segment into cells C20-22 (using 0 for each tangent segment).

Segment	Type	Length	Radius	Effective Grade G_i
i		L_i	R_i	G_i
	0 - tangent 1 - curve	ft	ft	percent
1	1	69	3077	0
2	1	224	3077	0
3	1	369	2643	0

Figure 4-11: Segment Inputs for Threat Path 3A-1

Go to the TD CALCULATOR tab on the spreadsheet and the overall Response Time is determined by the sum of the Travel Time of each segment from the POD to the AVB Safety Loop (all three segments on this threat path) designated by the symbol (s) in line 29 of the spreadsheet. This gives an overall response time of 8.06 seconds for this threat path.

Units	**Segment==>**	**1**	**2**	**3**
		OK	**OK**	**OK**
	Type	CURVE	CURVE	CURVE
ft	Length	69	224	369
ft	Radius	3077	3077	2643
	Superelevation	0	0	0
	Effective Grade	0	0	0
ft/s^2	Modified Maximum Acceleration Rate	11.30	11.30	11.30
ft/s^2	Modified Maximum Deceleration Rate	-24.1	[illegible]	-24.10
ft/s	v_i^{spin}	314.6	[illegible]	291.61
ft/s	v_i^{stable}	190.67	190.67	190.67
ft/s	$v_i^{maximum}$	190.67	190.67	190.67
ft/s	$v_i^{max\_exit}$	190.67	190.67	190.67
ft/s	$v_i^{max\_entry}$	190.67	190.67	190.67
ft/s	v_i^{entry}	36.67	53.89	89.25
ft/s	v_i^{exit}	53.89	89.25	127.69
s	t_i	1.52	3.13	3.40

Total Response time is the time for each segment between POD and AVB Safety Loop.

Total Response time is 8.06 Seconds

Figure 4-12: TD CALCULATOR TAB outputs for Threat Path 3A-1

4-5 THREAT SCEANRIO #4

For Threat Scenario #4 threat path 4F-1 was chosen to be used as an example. For this Threat Path the threat vehicle is stopped at the ID Check Area and directed to reject from the Installation. Vehicle then acts like it is going to comply but instead it drives past the rejection turn-around and accelerates towards the AVBs. Segment #1 starts at the point where the threat vehicle deviates from the rejection path and it is assumed that the vehicle is going 25 mph at this point. POD for this Threat Path is ten feet past the turn into the rejection turn-around as this is the point where the Guard would be sure that the vehicle is not rejecting. Between the POD and the AVB Safety Loop there are a total of two segments whose sum will make up the total response time. As the Guard is already on alert for this vehicle the required response time for the Hybrid Beacon Safety System for this Threat Scenario is five seconds.

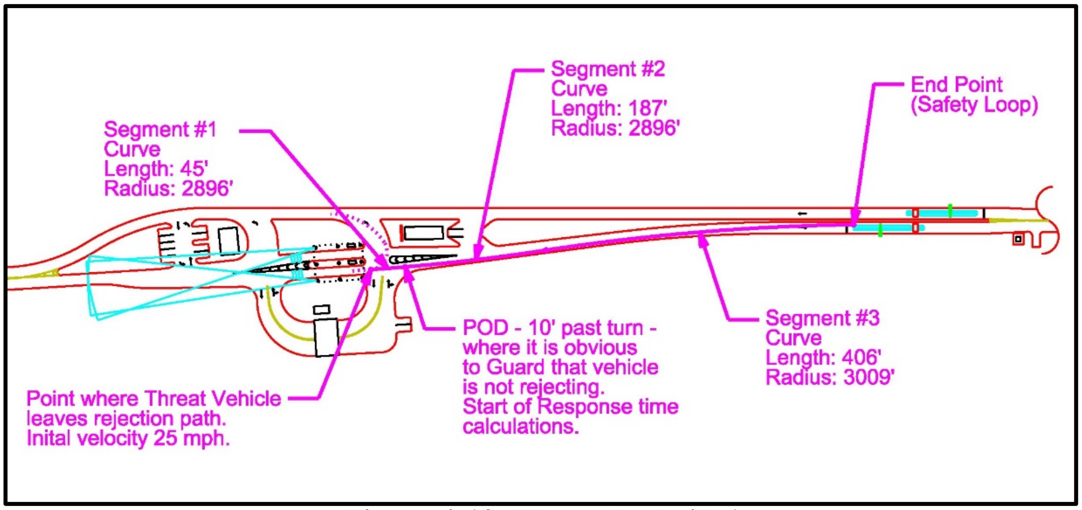


Figure 4-13: Threat Path 4F-1

On the INPUT tab of the Spread sheet the total number of segments (3) was entered into cell B7 and the Threat Scenario number that is being evaluated (4) was entered into cell B9. The initial entry velocity should automatically be uploaded to 25 mph. If it is not 25 mph DO NOT change it on this tab but instead change it in cell F36 in the GENERAL INFORMATION tab of the spreadsheet.

INPUT			
Number of Segments	3		
Threat Scenario	4	**Covert Entry at the end of the last turnaround**	
		Threat vehicle is assumed to start for stationary positio	
Do not need to enter entry speed		25	Threat Scenario 3 and 4: User does not need to enter entry speed
Entry speed on segment 1	25	mi/h	
	36.67	ft/s	

Figure 4-14: Threat Path Inputs for Threat Path 4F-1

Still on the INPUT tab for each segment in the threat path enter in the Type of Segment (0 = tangent, 1 = curve) into cells B20-22, Length of the segment into cells C20-22, and Radius of each segment into cells C20-22 (using 0 for each tangent segment).

Segment	Type	Length	Radius	Effective Grade G_i
i		L_i	R_i	G_i
	0 - tangent 1 - curve	ft	ft	percent
1	1	45	2896	0
2	1	187	2896	0
3	1	406	3009	0

Figure 4-15: Segment Inputs for Threat Path 4F-1

Go to the TD CALCULATOR tab on the spreadsheet and the overall Response Time is determined by the sum of the Travel Time of each segment from the POD to the AVB Safety Loop (all three segments on this threat path) designated by the symbol (s) in line 29 of the spreadsheet. This gives an overall response time of 7.87 seconds for this threat path.

Units	**Segment==>**	**1**	**2**	**3**
		OK	**OK**	**OK**
	Type	CURVE	CURVE	CURVE
ft	Length	45	187	406
ft	Radius	2896	2896	3009
	Superelevation	0	0	0
	Effective Grade	0	0	0
ft/s^2	Modified Maximum Acceleration Rate	11.30	11.30	11.30
ft/s^2	Modified Maximum Deceleration Rate	-24.1	[illegible]	-24.10
ft/s	v_i^{spin}	305.2	[illegible]	311.15
ft/s	v_i^{stable}	190.67	190.67	190.67
ft/s	$v_i^{maximum}$	190.67	190.67	190.67
ft/s	$v_i^{max\_exit}$	190.67	190.67	190.67
ft/s	$v_i^{max\_entry}$	190.67	190.67	190.67
ft/s	v_i^{entry}	36.67	48.59	81.16
ft/s	v_i^{exit}	48.59	81.16	125.55
s	t_i	1.06	2.88	3.93

Total Response time is the time for each segment between POD and AVB Safety Loop.

Total Response time is 7.87 Seconds

Figure 4-16: TD CALCULATOR TAB outputs for Threat Path 4F-1

CHAPTER 5 VEHICLE THREAT EXAMPLES.

5-1 GENERAL.

The Figures 5-1 to 5-26 in section 5-2 show the path layouts and the INPUT tab Spreadsheets for each of the Threat Paths Identified in Chapter 2. Below is a table of summary for all these Threat Paths. Each Threat path met the required response time for the Hybrid Safety System for each Threat Scenario. For this ACP the location of the AVBs is controlled by the response time for Threat Path 2A-1 of 7.01 seconds.

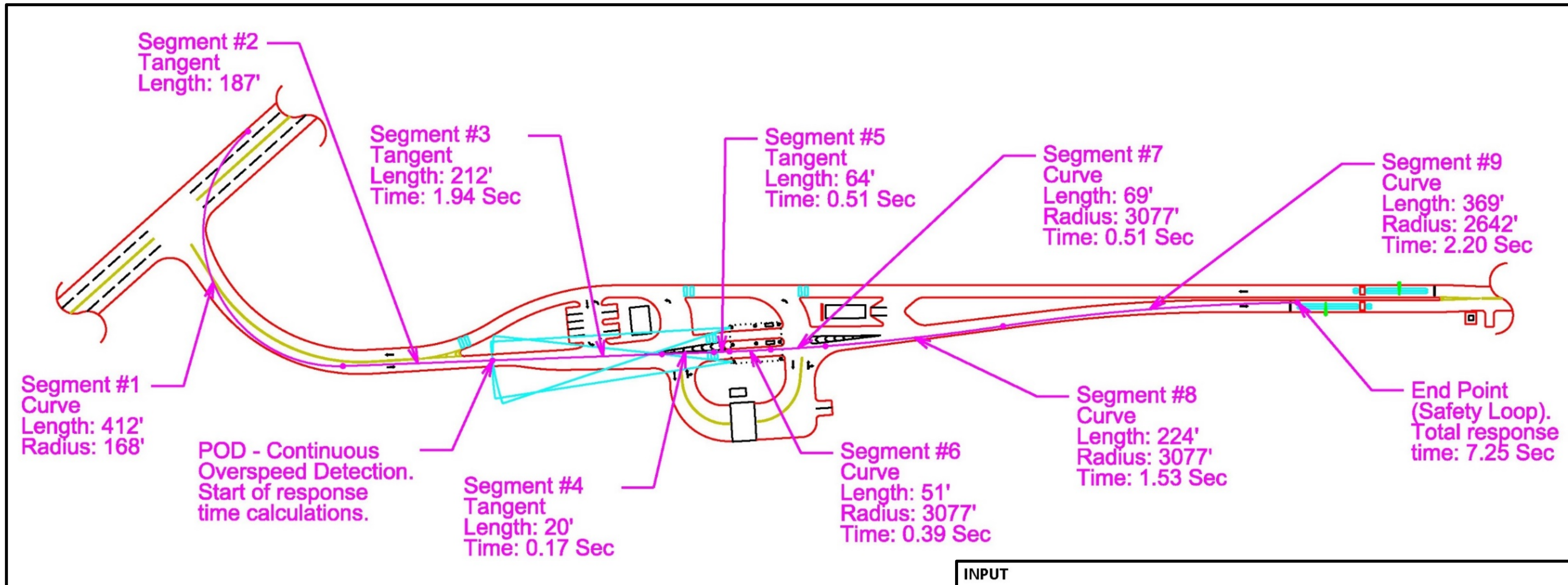
Threat Path	Point of Detection (POD)	Number of Segments in Path	Required Response Time	Calculated Response Time
Threat Scenario #1				
1A-1	Continuous Overspeed Detector	7	7	7.25
1B-1	Outer Wrong Way Detector	5	7	8.40
Threat Scenario #2				
2A-1	Point Overspeed Detector	5	7	7.01
2A-2	ID Check Guard	4	7	7.04
2C-1	Middle Wrong Way Detector	2	7	8.01
2D-1	Middle Wrong Way Detector	3	7	9.27
2E-1	Search Area Guard	5	7	9.34
Threat Scenario #3				
3A-1	ID Check Guard	3	7	8.06
3E-1	Search Area Guard	5	7	9.63
Threat Scenario #4				
4F-1	10 Feet Past Rejection Turn	2	5	6.81
4G-1	10 Feet Past Rejection Turn	3	5	7.68
4H-1	Inner Wrong Way Detector	2	5	8.87
4I-1	Inner Wrong Way Detection	2	5	9.11

Table 5-1: Summary of Response time for threat paths

5-2 THREAT PATHS

The following Threat Paths were done to show all possible threat paths. Engineering judgment can be used to eliminate some of the threat paths in Threat Scenarios #2, #3 and #4. The basis of the elimination of possible threat paths should be based on threat paths that were already completed.

5-2.1 THREAT PATH 1A-1



For Threat Scenario #1 Threat Path A-1 the threat vehicle comes in at maximum acceleration using the inbound lanes. POD is the outer Continuous Overspeed Detector. It takes the threat vehicle a total 7.25 seconds to traverse the ACP Corridor from the POD to the AVB Safety loop. Response time for the Hybrid Beacon Safety System for Threat Scenario #1 is 7 seconds.

INPUT

Number of Segments 9

Total Response Time 7.25 Seconds

Threat Scenario 1 **High Speed - Threat vehicle disregards any overspeed detection system**

Recommended Speed for Threat Scenario 1 =====> 130 mi/h

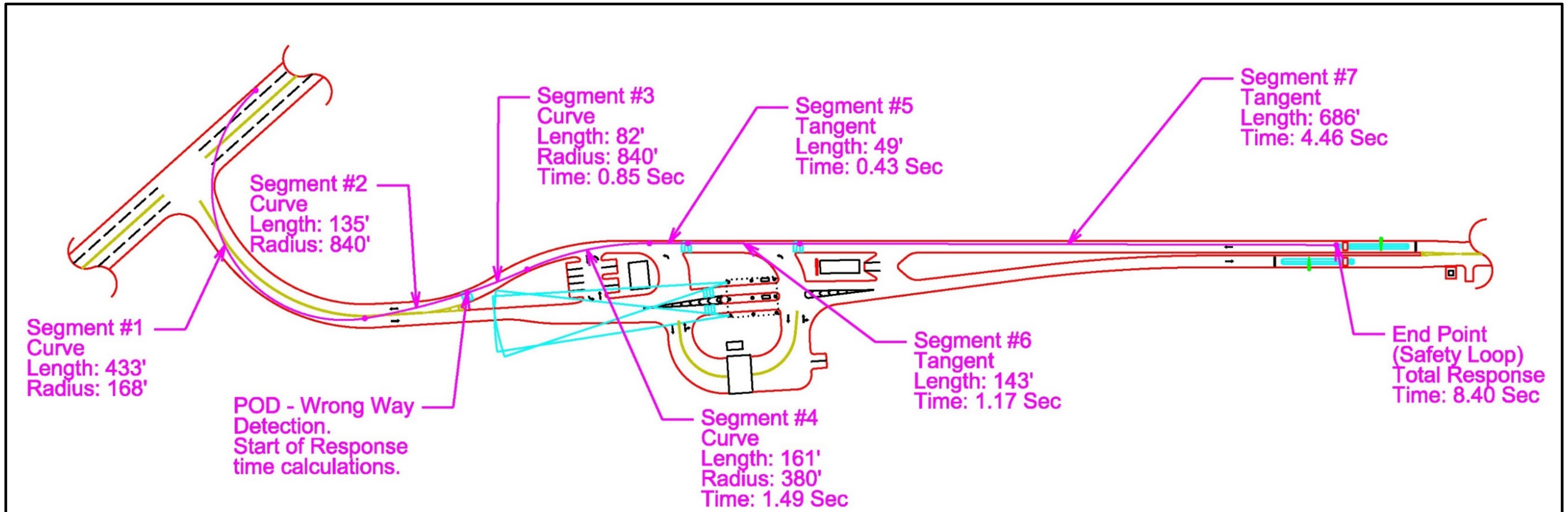
Entry Speed for Threat Scenario 1 ===> 130 mi/h

Entry speed on segment 1 130 mi/h
190.67 ft/s

Segment	Type	Length	Radius	Effective Grade G_i	Type	Superelevation	Radius *(check)*	Grade Modified Maximum Acceleration Rate	Grade Modified Maximum Deceleration Rate		Response Time Calculation	Distance Calculation
i		L_i	R_i	G_i		e_i		d_i	a_i		T	d_i
	0 - tangent 1 - curve	ft	ft	percent		feet/100 feet	ft	ft/s^2	ft/s^2		seconds	ft
1	1	412	168	0	CURVE	0	168	11.30	-24.10		13.86	412
2	0	187	0	0	TANGENT	0	∞	11.30	-24.10	POD	2.18	187
3	0	212	0	0	TANGENT	0	∞	11.30	-24.10		1.94	212
4	0	20	0	0	TANGENT	0	∞	11.30	-24.10		0.17	20
5	0	64	0	0	TANGENT	0	∞	11.30	-24.10		0.51	64
6	1	51	3077	0	CURVE	0	3077	11.30	-24.10		0.39	51
7	1	69	3077	0	CURVE	0	3077	11.30	-24.10		0.51	69
8	1	224	3077	0	CURVE	0	3077	11.30	-24.10		1.53	224
9	1	369	2642	0	CURVE	0	2642	11.30	-24.10		2.20	369

Figures: 5-1 and 5-2 Layout and INPUT Spreadsheet for Threat Path 1A-1

5-2.2 THREAT PATH 1B-1



For Threat Scenario #1 Threat Path B-1 the threat vehicle comes in at maximum acceleration using the outbound lanes. POD is the outer Wrong Way Detector where the Inbound lanes separate from the Outbound lanes. It takes the threat vehicle a total 8.40 seconds to traverse the ACP Corridor from the POD to the AVB Safety loop. Response time for the Hybrid Beacon Safety System for Threat Scenario #1 is 7 seconds.

INPUT

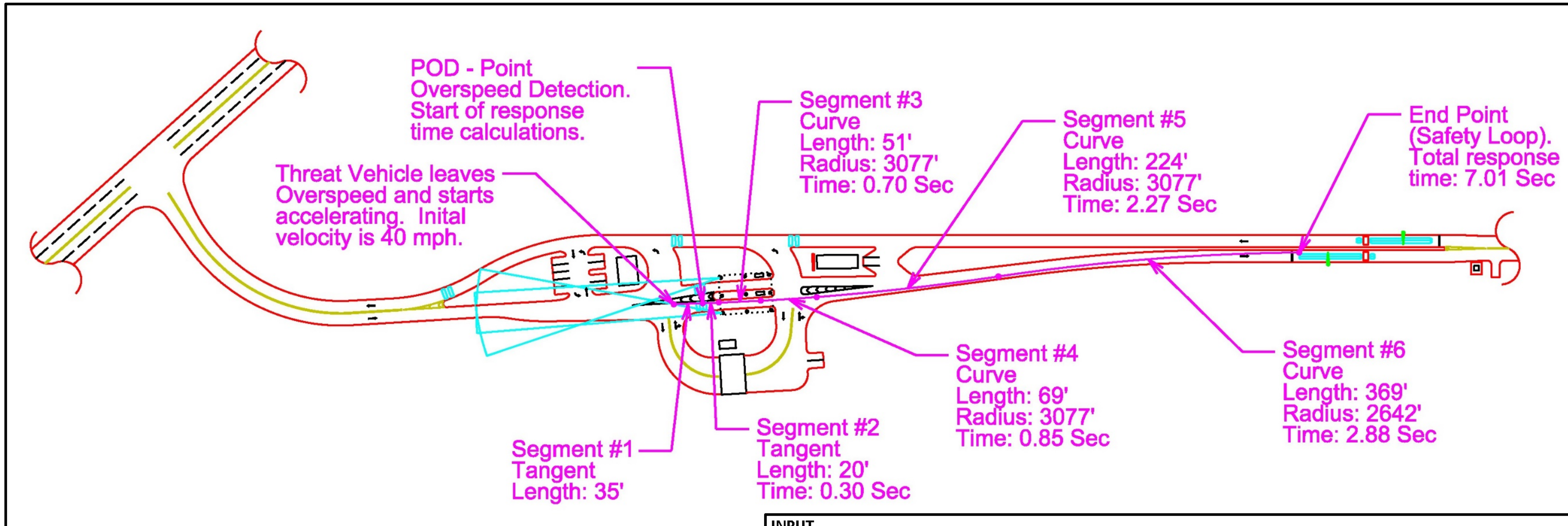
Number of Segments	7	Total Response Time	8.40	Seconds

Threat Scenario	1	**High Speed - Threat vehicle disregards any overspeed detection system**		
		Recommended Speed for Threat Scenario 1 =====>	**130**	**mi/h**
Entry Speed for Threat Scenario 1 ===>	130	mi/h		
Entry speed on segment 1	130	mi/h		
	190.67	ft/s		

Segment	Type	Length	Radius	Effective Grade G_i	Type	Superelevation	Radius *(check)*	Grade Modified Maximum Acceleration Rate	Grade Modified Maximum Deceleration Rate		Response Time Calculation	Distance Calculation
i		L_i	R_i	G_i		e_i		d_i	a_i		T	d_i
	0 - tangent 1 - curve	ft	ft	percent		feet/100 feet	ft	ft/s^2	ft/s^2		seconds	ft
1	1	433	168	0	CURVE	0	168	11.30	-24.10		14.15	433
2	1	135	840	0	CURVE	0	840	11.30	-24.10	POD	1.63	135
3	1	82	840	0	CURVE	0	840	11.30	-24.10		0.85	82
4	1	161	380	0	CURVE	0	380	11.30	-24.10		1.49	161
5	0	49	0	0	TANGENT	0	∞	11.30	-24.10		0.43	49
6	0	143	0	0	TANGENT	0	∞	11.30	-24.10		1.17	143
7	0	686	0	0	TANGENT	0	∞	11.30	-24.10		4.46	686

Figures: 5-3 and 5-4 Layout and INPUT Spreadsheet for Threat Path 1B-1

5-2.3 THREAT PATH 2A-1



For Threat Scenario #2 Threat Path A-1 the threat vehicle comes in at the Overspeed Setting for the continuous Overspeed. As soon as it leaves the radar cone the threat vehicle starts to accelerate at maximum acceleration rate. POD is the second induction loop of the Point Overspeed Detector located just prior to the ID Check Canopy. It takes the threat vehicle a total 7.01 seconds to traverse the ACP Corridor from the POD to the AVB Safety loop. Response time for the Hybrid Beacon Safety System for Threat Scenario #2 is 7 seconds.

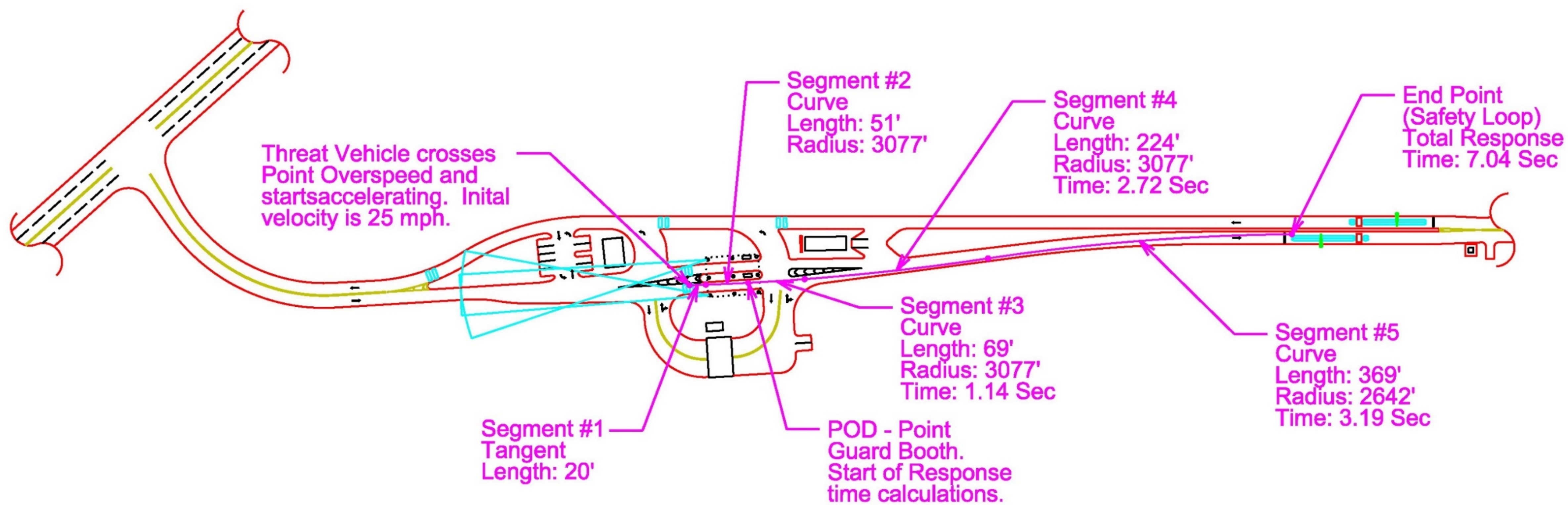
INPUT

Number of Segments	6	Total Response Time	7.01	Seconds	
Threat Scenario	2	**High speed - Threat vehicle does not trigger overspeed detection system**			
		Recommended speed for Threat Scenario 2 =====>	**100**	**mi/h**	
Entry Speed for Threat Scenario 2 ===>		40	mi/h		
Entry speed on segment 1		40	mi/h		
		58.67	ft/s		

Segment	Type	Length	Radius	Effective Grade G_i	Type	Superelevation	Radius *(check)*	Grade Modified Maximum Acceleration Rate	Grade Modified Maximum Deceleration Rate		Response Time Calculation	Distance Calculation
i		L_i	R_i	G_i		e_i		d_i	a_i		T	d_i
	0 - tangent 1 - curve	ft	ft	percent		feet/100 feet	ft	ft/s^2	ft/s^2		seconds	ft
1	0	35	0	0	TANGENT	0	∞	11.30	-24.10	POD	0.57	35
2	0	20	0	0	TANGENT	0	∞	11.30	-24.10		0.30	20
3	1	51	3077	0	CURVE	0	3077	11.30	-24.10		0.70	51
4	1	69	3077	0	CURVE	0	3077	11.30	-24.10		0.85	69
5	1	224	3077	0	CURVE	0	3077	11.30	-24.10		2.27	224
6	1	369	2642	0	CURVE	0	2642	11.30	-24.10		2.88	369

Figures: 5-5 and 5-6 Layout and INPUT Spreadsheet for Threat Path 2A-1

5-2.4 THREAT PATH 2A-2



INPUT

Number of Segments	5	Total Response Time	7.04	Seconds

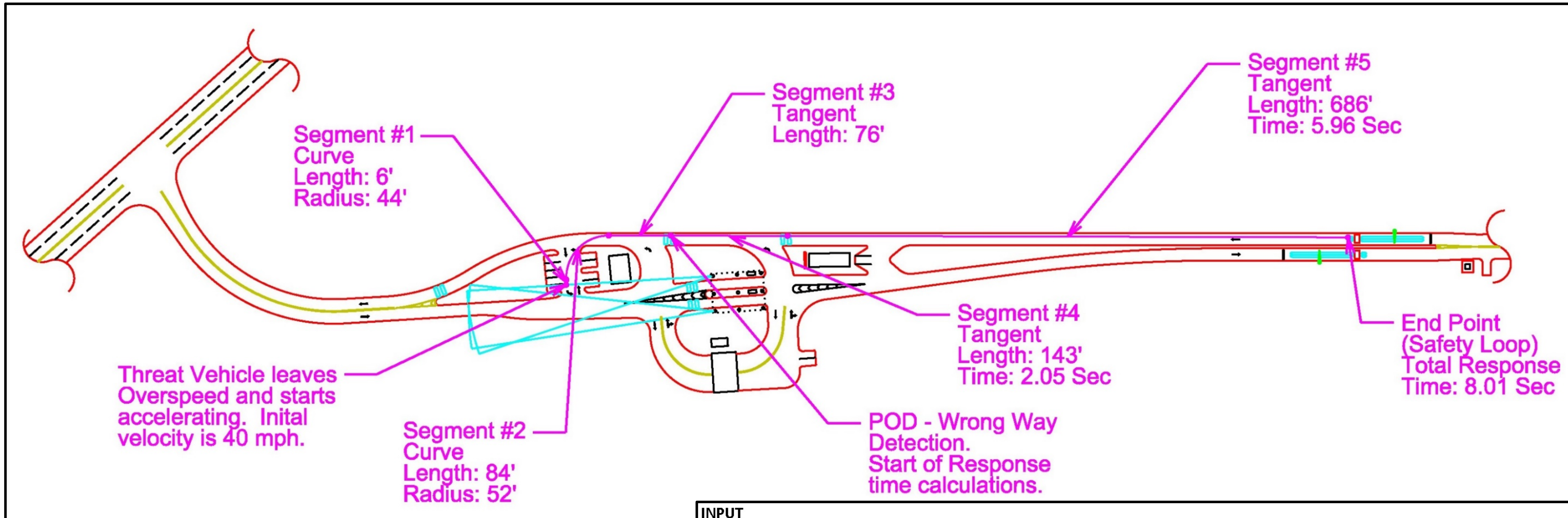
Threat Scenario	2	**High speed - Threat vehicle does not trigger overspeed detection system**		
		Recommended speed for Threat Scenario 2 =====>	**100**	**mi/h**
Entry Speed for Threat Scenario 2 ===>		25	mi/h	
Entry speed on segment 1		25	mi/h	
		36.67	ft/s	

Segment	Type	Length	Radius	Effective Grade G_i	Type	Superelevation	Radius *(check)*	Grade Modified Maximum Acceleration Rate	Grade Modified Maximum Deceleration Rate		Response Time Calculation	Distance Calculation
i		L_i	R_i	G_i		e_i		d_i	a_i		T	d_i
	0 - tangent 1 - curve	ft	ft	percent		feet/100 feet	ft	ft/s^2	ft/s^2		seconds	ft
1	0	20	0	0	TANGENT	0	∞	11.30	-24.10		0.51	20
2	1	51	3077	0	CURVE	0	3077	11.30	-24.10	POD	1.05	51
3	1	69	3077	0	CURVE	0	3077	11.30	-24.10		1.14	69
4	1	224	3077	0	CURVE	0	3077	11.30	-24.10		2.72	224
5	1	369	2642	0	CURVE	0	2642	11.30	-24.10		3.19	369

For Threat Scenario #2 Threat Path A-2 the threat vehicle crosses the Point Overspeed Detection just below its setting so that the vehicle does not set off the alarm. Threat Vehicle then starts to accelerate at maximum acceleration rate. POD is the Guard Booth were the Guard notices the vehicle drive by. It takes the threat vehicle a total 7.04 seconds to traverse the ACP Corridor from the POD to the AVB Safety loop. Response time for the Hybrid Beacon Safety System for Threat Scenario #2 is 7 seconds.

Figures: 5-7 and 5-8 Layout and INPUT Spreadsheet for Threat Path 2A-2

5-2.5 THREAT PATH 2C-1



For Threat Scenario #2 Threat Path C-1 the threat vehicle tries to use the VCC parking lot to sneak onto the base. Threat Vehicle come into the parking lot at the setting for the outer Continuous Overspeed Detection setting, then starts to accelerate down the outbound lanes at maximum acceleration rate. POD is the second Wrong Way detection located near the ID Check center median. It takes the threat vehicle a total 8.01 seconds to traverse the ACP Corridor from the POD to the AVB Safety loop. Response time for the Hybrid Beacon Safety System for Threat Scenario #2 is 7 seconds.

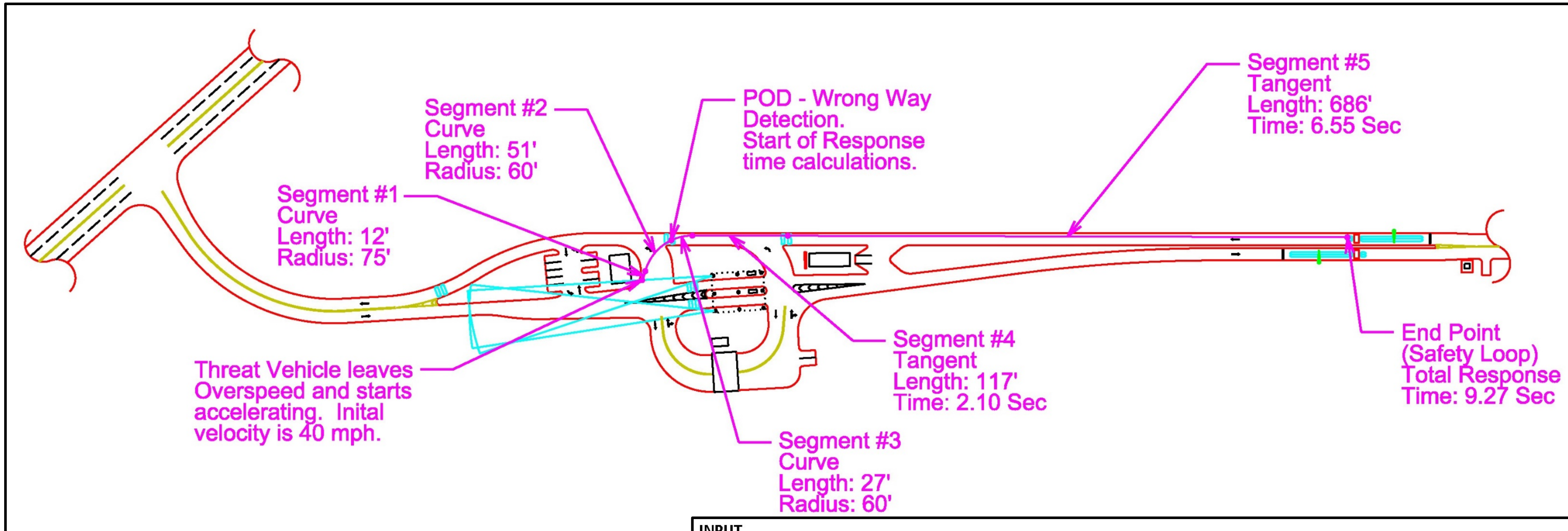
INPUT

Number of Segments	5	Total Response Time	8.01	Seconds
Threat Scenario	2	**High speed - Threat vehicle does not trigger overspeed detection system**		
		Recommended speed for Threat Scenario 2 =====>	**100**	**mi/h**
Entry Speed for Threat Scenario 2 ===>		40	mi/h	
Entry speed on segment 1		40	mi/h	
		58.67	ft/s	

Segment	Type	Length	Radius	Effective Grade G_i	Type	Superelevation	Radius *(check)*	Grade Modified Maximum Acceleration Rate	Grade Modified Maximum Deceleration Rate		Response Time Calculation	Distance Calculation
i		L_i	R_i	G_i		e_i		d_i	a_i		T	d_i
	0 - tangent 1 - curve	ft	ft	percent		feet/100 feet	ft	ft/s^2	ft/s^2		seconds	ft
1	1	6	44	0	CURVE	0	44	11.30	-24.10		0.68	6
2	1	84	52	0	CURVE	0	52	11.30	-24.10		2.07	84
3	0	76	0	0	TANGENT	0	∞	11.30	-24.10	POD	1.53	76
4	0	143	0	0	TANGENT	0	∞	11.30	-24.10		2.05	143
5	0	686	0	0	TANGENT	0	∞	11.30	-24.10		5.96	686

Figures: 5-9 and 5-10 Layout and INPUT Spreadsheet for Threat Path 2C-1

5-2.6 THREAT PATH 2D-1



For Threat Scenario #2 Threat Path D-1 the threat vehicle tries to use the Self Rejection prior to the ID Check Area to sneak onto the base. Threat Vehicle come into the rejection area at the setting for the outer Continuous Overspeed Detection setting, then starts to accelerate down the outbound lanes at maximum acceleration rate. POD is the second Wrong Way detection located near the ID Check center median. It takes the threat vehicle a total 9.27 seconds to traverse the ACP Corridor from the POD to the AVB Safety loop. Response time for the Hybrid Beacon Safety System for Threat Scenario #2 is 7 seconds.

INPUT

Number of Segments 5

Total Response Time 9.27 Seconds

Threat Scenario 2 **High speed - Threat vehicle does not trigger overspeed detection system**

Recommended speed for Threat Scenario 2 =====> 100 mi/h

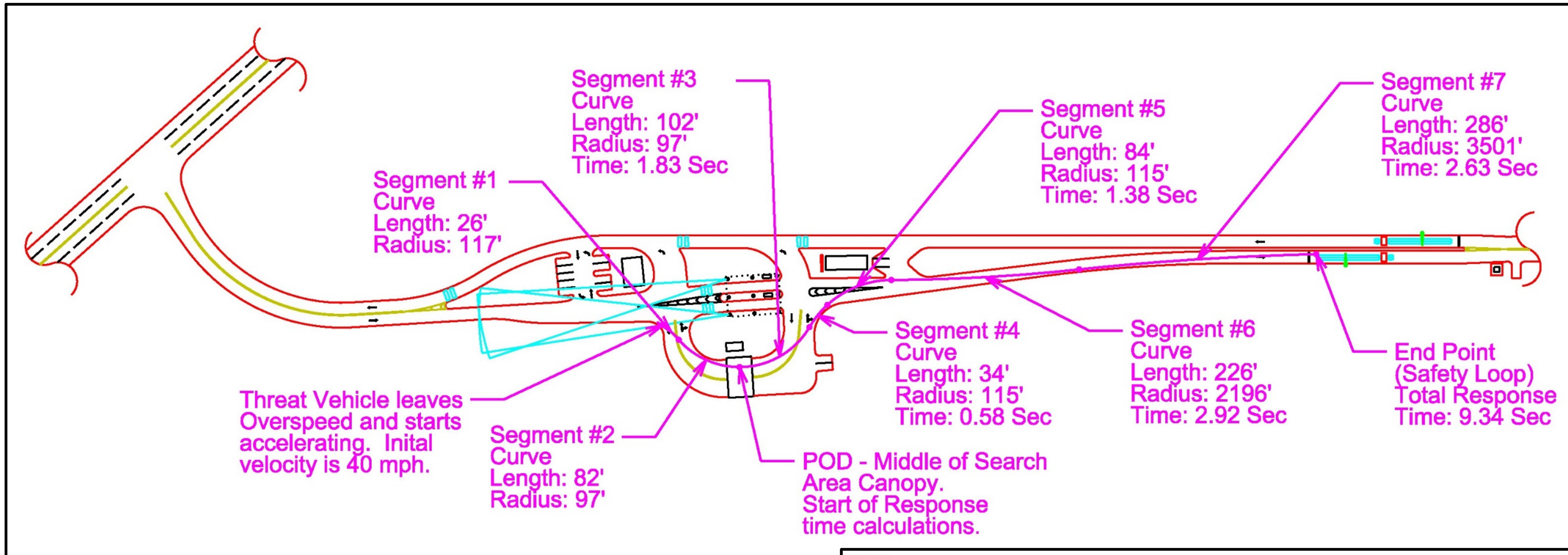
Entry Speed for Threat Scenario 2 ===> 40 mi/h

Entry speed on segment 1 40 mi/h
58.67 ft/s

Segment	Type	Length	Radius	Effective Grade G_i	Type	Superelevation	Radius *(check)*	Grade Modified Maximum Acceleration Rate	Grade Modified Maximum Deceleration Rate		Response Time Calculation	Distance Calculation
i		L_i	R_i	G_i		e_i		d_i	a_i		T	d_i
	0 - tangent 1 - curve	ft	ft	percent		feet/100 feet	ft	ft/s^2	ft/s^2		seconds	ft
1	1	12	75	0	CURVE	0	75	11.30	-24.10		0.34	12
2	1	51	60	0	CURVE	0	60	11.30	-24.10	POD	1.16	51
3	1	27	60	0	CURVE	0	60	11.30	-24.10		0.61	27
4	0	117	0	0	TANGENT	0	∞	11.30	-24.10		2.10	117
5	0	686	0	0	TANGENT	0	∞	11.30	-24.10		6.55	686

Figures: 5-11 and 5-12 Layout and INPUT Spreadsheet for Threat Path 2D-1

5-2.7 THREAT PATH 2E-1



For Threat Scenario #2 Threat Path E-1 the threat vehicle tries to use the Search Area to sneak onto the base. Threat Vehicle come into the Search Area at the setting for the outer Continuous Overspeed Detection setting, then starts to accelerate through the Search Area at the maximum acceleration rate. POD is the Guard in the Search Area. It takes the threat vehicle a total 9.34 seconds to traverse the ACP Corridor from the POD to the AVB Safety loop. Response time for the Hybrid Beacon Safety System for Threat Scenario #2 is 7 seconds.

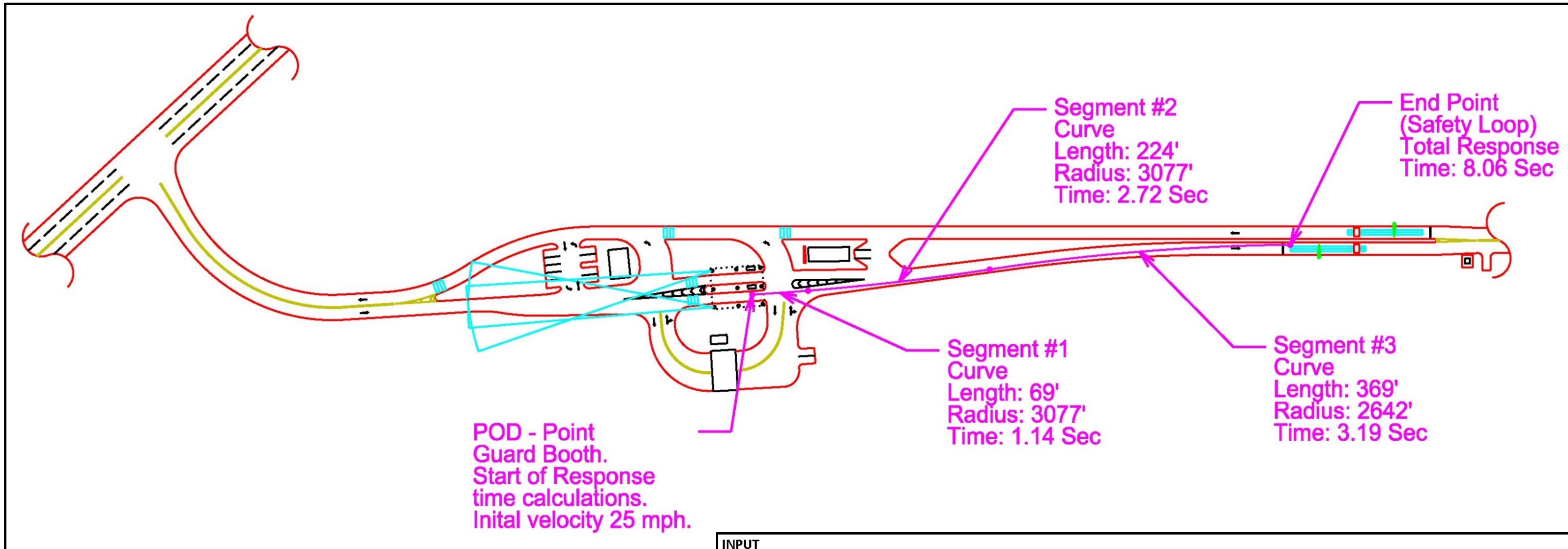
INPUT

Number of Segments	7		Total Response Time	9.34	Seconds
Threat Scenario	2	**High speed - Threat vehicle does not trigger overspeed detection system**			
		Recommended speed for Threat Scenario 2 =====>	**100**	**mi/h**	
Entry Speed for Threat Scenario 2 ===>	40	mi/h			
Entry speed on segment 1	40	mi/h			
	58.67	ft/s			

Segment	Type	Length	Radius	Effective Grade G_i	Type	Superelevation	Radius *(check)*	Grade Modified Maximum Acceleration Rate	Grade Modified Maximum Deceleration Rate		Response Time Calculation	Distance Calculation
i		L_i	R_i	G_i		e_i		d_i	a_i		T	d_i
	0 - tangent 1 - curve	ft	ft	percent		feet/100 feet	ft	ft/s^2	ft/s^2		seconds	ft
1	1	26	117	0	CURVE	0	117	11.30	-24.10		0.44	26
2	1	82	97	0	CURVE	0	97	11.30	-24.10	POD	1.47	82
3	1	102	97	0	CURVE	0	97	11.30	-24.10		1.83	102
4	1	34	115	0	CURVE	0	115	11.30	-24.10		0.58	34
5	1	84	115	0	CURVE	0	115	11.30	-24.10		1.38	84
6	1	226	2196	0	CURVE	0	2196	11.30	-24.10		2.92	226
7	1	286	3501	0	CURVE	0	3501	11.30	-24.10		2.63	286

Figures: 5-13 and 5-14 Layout and INPUT Spreadsheet for Threat Path 2E-1

5-2.8 THREAT PATH 3A-1



For Threat Scenario #3 Threat Path A-1 the threat vehicle appears to be complaint up to the ID Check Guard position but then just drives by at 25 mph. It takes the threat vehicle a total 8.06 seconds to traverse the ACP Corridor from the POD to the AVB Safety loop. Response time for the Hybrid Beacon Safety System for Threat Scenario #3 is 7 seconds.

INPUT

Number of Segments 3

Total Response Time 8.06 Seconds

Threat Scenario 3 **Covert Entry at the ID Check Point**
Threat vehicle is assumed to start for stationary positio

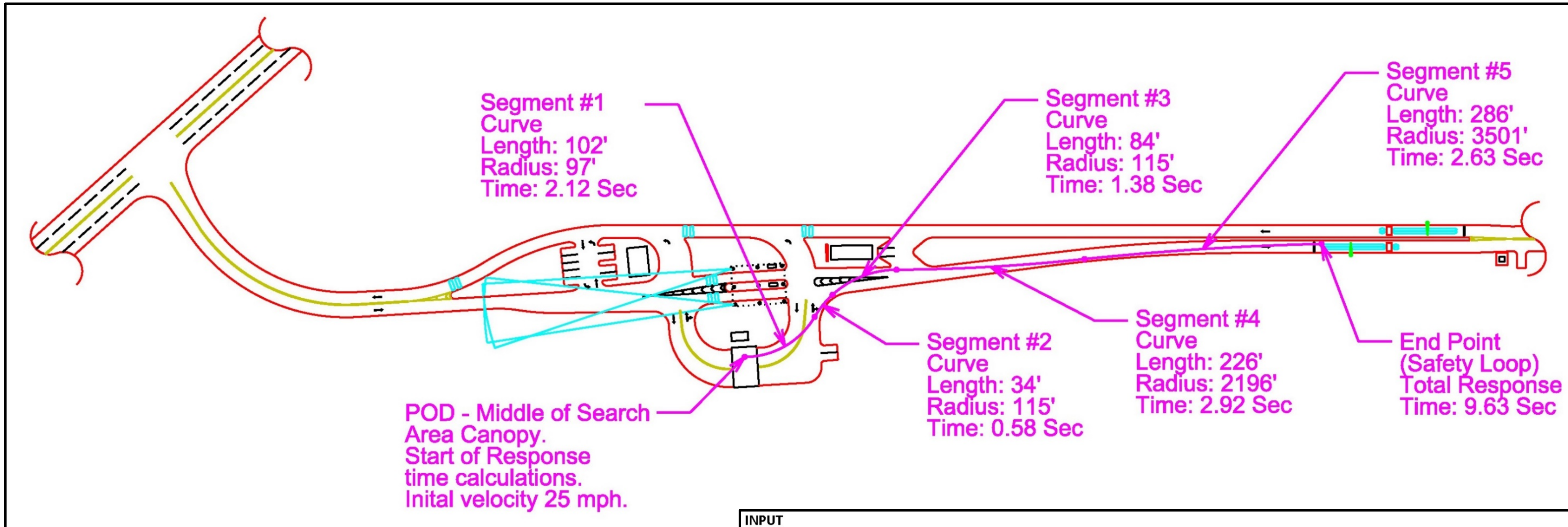
Do not need to enter entry speed 25 Threat Scenario 3 and 4: User does not need to enter entry speed

Entry speed on segment 1 25 mi/h
36.67 ft/s

Segment	Type	Length	Radius	Effective Grade G_i	Type	Superelevation	Radius *(check)*	Grade Modified Maximum Acceleration Rate	Grade Modified Maximum Deceleration Rate	Response Time Calculation	Distance Calculation
i		L_i	R_i	G_i		e_i		d_i	a_i	T	d_i
	0 - tangent 1 - curve	ft	ft	percent		feet/100 feet	ft	ft/s^2	ft/s^2	seconds	ft
1	1	69	3077	0	CURVE	0	3077	11.30	-24.10	1.52	69
2	1	224	3077	0	CURVE	0	3077	11.30	-24.10	3.13	224
3	1	369	2643	0	CURVE	0	2643	11.30	-24.10	3.40	369

Figures: 5-15 and 5-16 Layout and INPUT Spreadsheet for Threat Path 3A-1

5-2.9 THREAT PATH 3E-1



For Threat Scenario #3 Threat Path E-1 the threat vehicle appears to be complaint up to the Search Guard position but then just drives by at 25 mph. It takes the threat vehicle a total 9.36 seconds to traverse the ACP Corridor from the POD to the AVB Safety loop. Response time for the Hybrid Beacon Safety System for Threat Scenario #3 is 7 seconds.

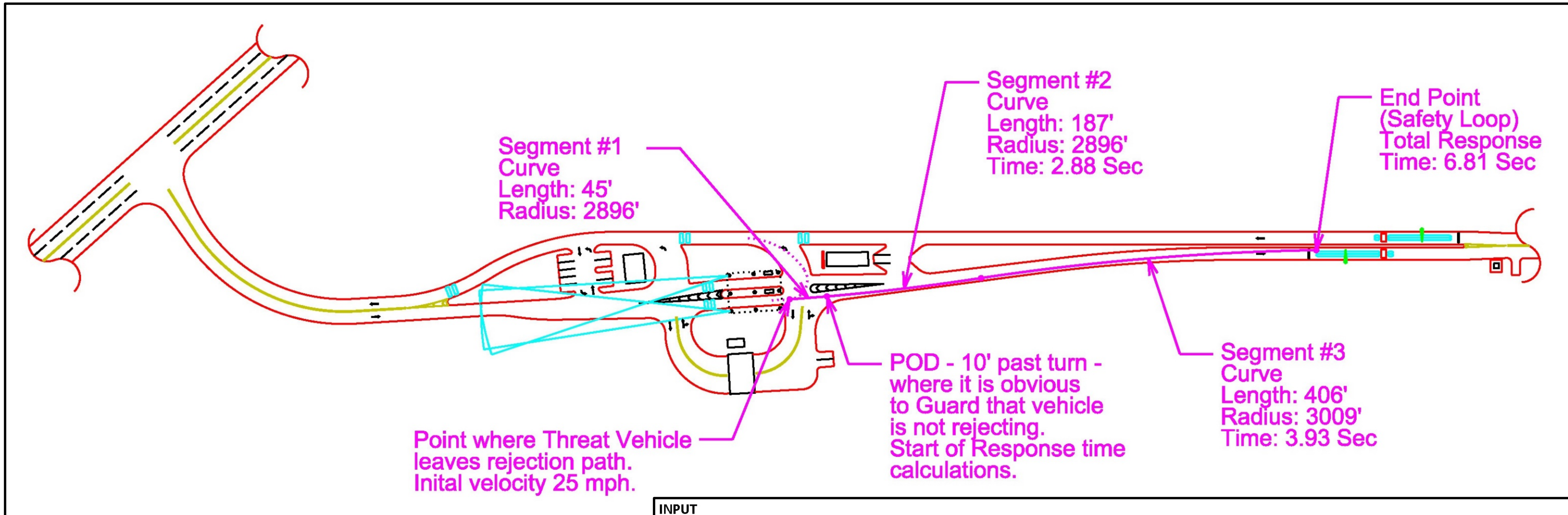
INPUT

Number of Segments	5	Total Response Time	9.63	Seconds
Threat Scenario	3	**Covert Entry at the ID Check Point**		
		Threat vehicle is assumed to start for stationary positio		
Do not need to enter entry speed	25	Threat Scenario 3 and 4: User does not need to enter entry speed		
Entry speed on segment 1	25	mi/h		
	36.67	ft/s		

Segment	Type	Length	Radius	Effective Grade G_i	Type	Superelevation	Radius *(check)*	Grade Modified Maximum Acceleration Rate	Grade Modified Maximum Deceleration Rate	Response Time Calculation	Distance Calculation
i		L_i	R_i	G_i		e_i		d_i	a_i	T	d_i
	0 - tangent 1 - curve	ft	ft	percent		feet/100 feet	ft	ft/s^2	ft/s^2	seconds	ft
1	1	102	97	0	CURVE	0	97	11.30	-24.10	2.12	102
2	1	34	115	0	CURVE	0	115	11.30	-24.10	0.58	34
3	1	84	115	0	CURVE	0	115	11.30	-24.10	1.38	84
4	1	226	2196	0	CURVE	0	2196	11.30	-24.10	2.92	226
5	1	286	3501	0	CURVE	0	3501	11.30	-24.10	2.63	286

Figures: 5-17 and 5-18 Layout and INPUT Spreadsheet for Threat Path 3E-1

5-2.10 THREAT PATH 4F-1



For Threat Scenario #4 Threat Path F-1 the threat vehicle is rejected from the ID Check Area. Vehicle appears to be compliant, but then accelerates down the Inbound lanes. POD is 10 feet past the rejection lane where there is no doubt to the Guard that the vehicle is not rejecting. It takes the threat vehicle a total 6.81 seconds to traverse the ACP Corridor from the POD to the AVB Safety loop. Response time for the Hybrid Beacon Safety System for Threat Scenario #4 is 5 seconds.

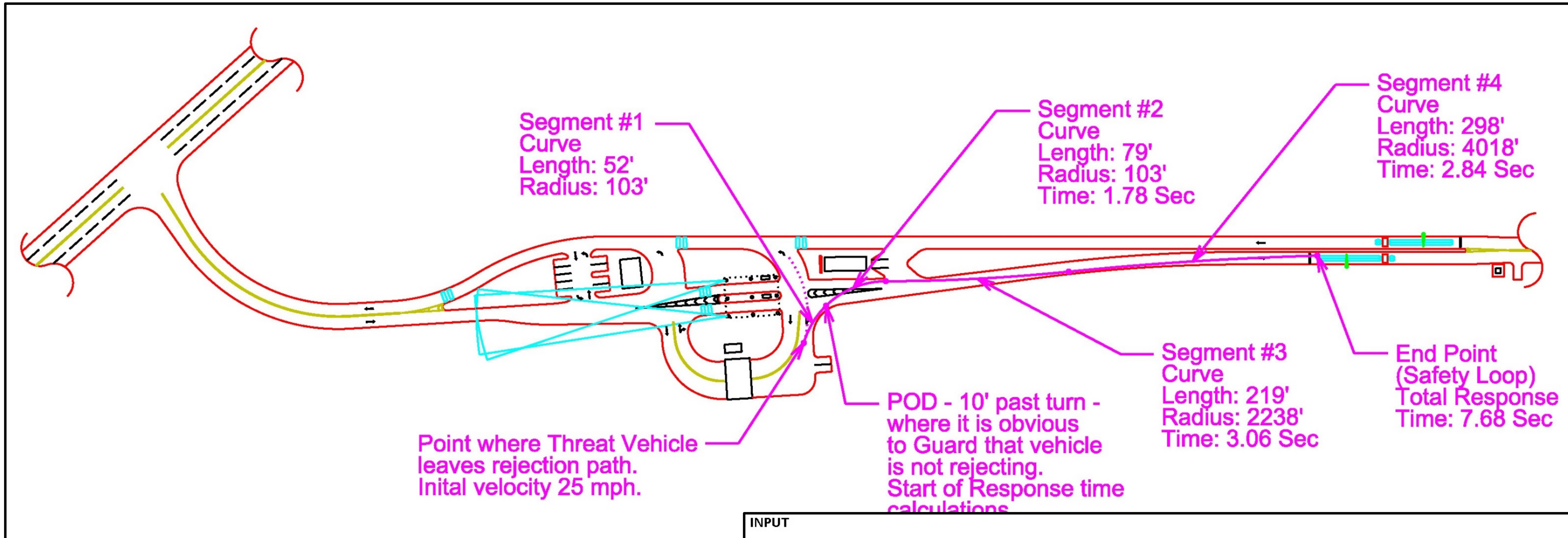
INPUT

Number of Segments	3		Total Response Time	6.81	Seconds
Threat Scenario	4	**Covert Entry at the end of the last turnaround**			
		Threat vehicle is assumed to start for stationary positio			
Do not need to enter entry speed	25	Threat Scenario 3 and 4: User does not need to enter entry speed			
Entry speed on segment 1	25	mi/h			
	36.67	ft/s			

Segment	Type	Length	Radius	Effective Grade G_i	Type	Superelevation	Radius *(check)*	Grade Modified Maximum Acceleration Rate	Grade Modified Maximum Deceleration Rate		Response Time Calculation	Distance Calculation
i		L_i	R_i	G_i		e_i		d_i	a_i		T	d_i
	0 - tangent 1 - curve	ft	ft	percent		feet/100 feet	ft	ft/s^2	ft/s^2		seconds	ft
1	1	45	2896	0	CURVE	0	2896	11.30	-24.10	POD	1.06	45
2	1	187	2896	0	CURVE	0	2896	11.30	-24.10		2.88	187
3	1	406	3009	0	CURVE	0	3009	11.30	-24.10		3.93	406

Figures: 5-19 and 5-20 Layout and INPUT Spreadsheet for Threat Path 4F-1

5-2.11 THREAT PATH 4G-1



For Threat Scenario #4 Threat Path G-1 the threat vehicle is rejected from the Search Area. Vehicle appears to be compliant, but then accelerates down the Inbound lanes. POD is 10 feet past the rejection lane where there is no doubt to the Guard that the vehicle is not rejecting. It takes the threat vehicle a total 6.81 seconds to traverse the ACP Corridor from the POD to the AVB Safety loop. Response time for the Hybrid Beacon Safety System for Threat Scenario #4 is 5 seconds.

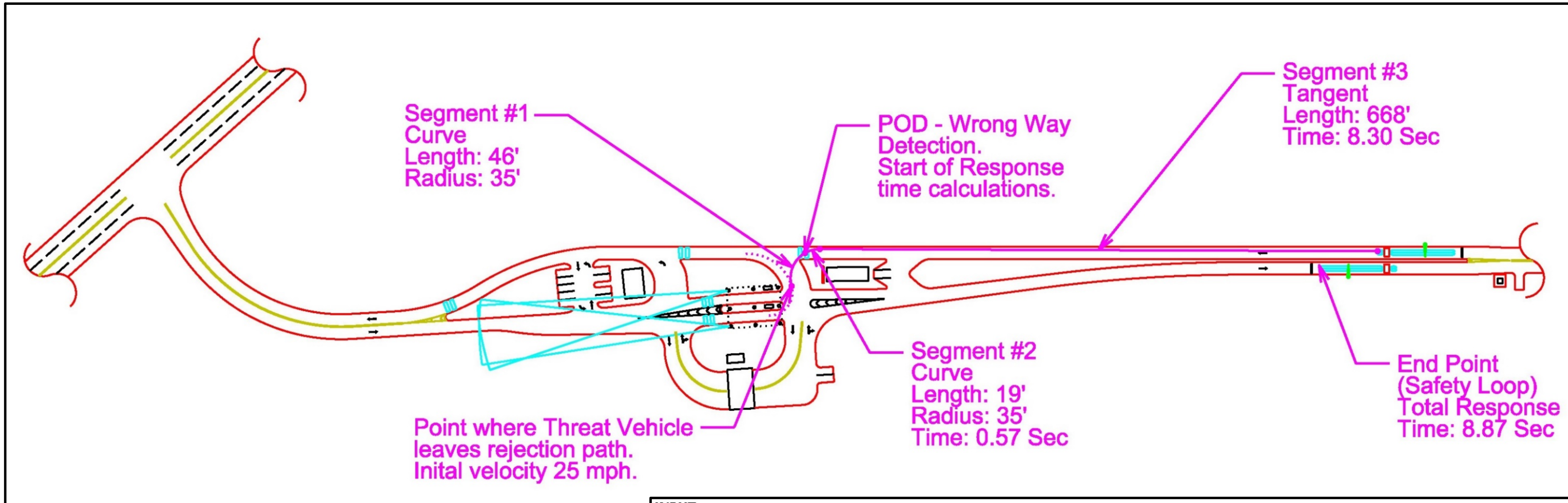
INPUT

Number of Segments	4	Total Response Time	7.68 Seconds
Threat Scenario	4	**Covert Entry at the end of the last turnaround** **Threat vehicle is assumed to start for stationary positio**	
Do not need to enter entry speed	0	Threat Scenario 3 and 4: User does not need to enter entry speed	
Entry speed on segment 1	0 0.00	mi/h ft/s	

Segment	Type	Length	Radius	Effective Grade G_i	Type	Superelevation	Radius (check)	Grade Modified Maximum Acceleration Rate	Grade Modified Maximum Deceleration Rate		Response Time Calculation	Distance Calculation
i		L_i	R_i	G_i		e_i		d_i	a_i		T	d_i
	0 - tangent 1 - curve	ft	ft	percent		feet/100 feet	ft	ft/s^2	ft/s^2		seconds	ft
1	1	52	103	0	CURVE	0	103	11.30	-24.10	POD	3.03	52
2	1	79	103	0	CURVE	0	103	11.30	-24.10		1.78	79
3	1	219	2238	0	CURVE	0	2238	11.30	-24.10		3.06	219
4	1	298	4018	0	CURVE	0	4018	11.30	-24.10		2.84	298

Figures: 5-21 and 5-22 Layout and INPUT Spreadsheet for Threat Path 4G-1

5-2.12 THREAT PATH 4H-1



For Threat Scenario #4 Threat Path H-1 the threat vehicle is rejected from the ID Check Area. Vehicle appears to be compliant, but then accelerates down the Outbound lanes. POD is the Wrong Way Detection next to the Gatehouse. It takes the threat vehicle a total 8.87 seconds to traverse the ACP Corridor from the POD to the AVB Safety loop. Response time for the Hybrid Beacon Safety System for Threat Scenario #4 is 5 seconds.

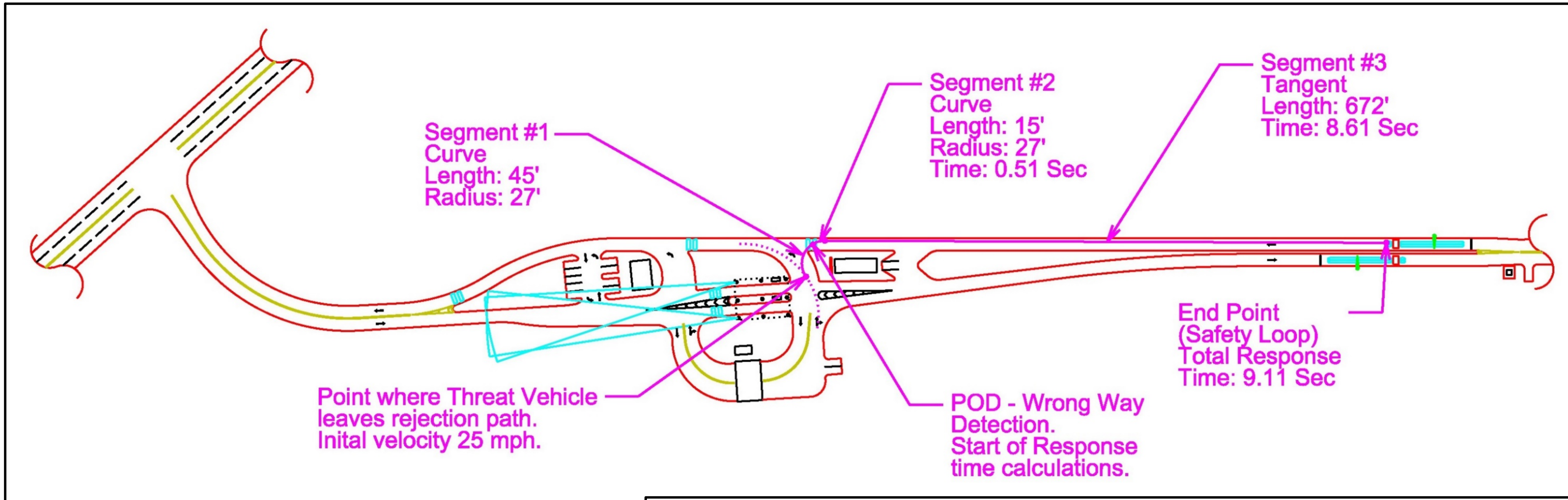
INPUT

Number of Segments	3		Total Response Time	8.87	Seconds
Threat Scenario	4	**Covert Entry at the end of the last turnaround**			
		Threat vehicle is assumed to start for stationary positio			
Do not need to enter entry speed		0	Threat Scenario 3 and 4: User does not need to enter entry speed		
Entry speed on segment 1	0	mi/h			
	0.00	ft/s			

Segment	Type	Length	Radius	Effective Grade G_i	Type	Superelevation	Radius *(check)*	Grade Modified Maximum Acceleration Rate	Grade Modified Maximum Deceleration Rate		Response Time Calculation	Distance Calculation
i		L_i	R_i	G_i		e_i		d_i	a_i		T	d_i
	0 - tangent 1 - curve	ft	ft	percent		feet/100 feet	ft	ft/s^2	ft/s^2		seconds	ft
1	1	46	35	0	CURVE	0	35	11.30	-24.10	POD	2.85	46
2	1	19	35	0	CURVE	0	35	11.30	-24.10		0.57	19
3	0	668	0	0	TANGENT	0	∞	11.30	-24.10		8.30	668

Figures: 5-23 and 5-24 Layout and INPUT Spreadsheet for Threat Path 4H-1

5-2.13 THREAT PATH 4I-1



For Threat Scenario #4 Threat Path I-1 the threat vehicle is rejected from the Search Area. Vehicle appears to be compliant, but then accelerates down the Outbound lanes. POD is the Wrong Way Detection next to the Gatehouse. It takes the threat vehicle a total 9.11 seconds to traverse the ACP Corridor from the POD to the AVB Safety loop. Response time for the Hybrid Beacon Safety System for Threat Scenario #4 is 5 seconds.

INPUT

Number of Segments 3

Total Response Time 9.11 Seconds

Threat Scenario 4 **Covert Entry at the end of the last turnaround**

Threat vehicle is assumed to start for stationary positio

Do not need to enter entry speed 25 Threat Scenario 3 and 4: User does not need to enter entry speed

Entry speed on segment 1 25 mi/h
36.67 ft/s

Segment	Type	Length	Radius	Effective Grade G_i	Type	Superelevation	Radius *(check)*	Grade Modified Maximum Acceleration Rate	Grade Modified Maximum Deceleration Rate		Response Time Calculation	Distance Calculation
i		L_i	R_i	G_i		e_i		d_i	a_i		T	d_i
	0 - tangent 1 - curve	ft	ft	percent		feet/100 feet	ft	ft/s^2	ft/s^2		seconds	ft
1	1	45	27	0	CURVE	0	27	11.30	-24.10	POD	1.60	45
2	1	15	27	0	CURVE	0	27	11.30	-24.10		0.51	15
3	0	672	0	0	TANGENT	0	∞	11.30	-24.10		8.61	672

Figures: 5-25 and 5-26 Layout and INPUT Spreadsheet for Threat Path 4H-1

5.3 THREAT PATH EVALUATION

Threat paths 1A-1 and 1B-1, high speed attack from outside the Installation using both the Inbound and Outbound lanes will need to be evaluated. Threat path 1A-1 will determine the placement and the setting of the Outer Continuous Overspeed Detection, and threat path 1B-1 will determine the location of the Outer Wrongway Detection. As threat Path 1B-1 ended up with a total time of 8.40 seconds we could move the Outer Wrongway Detection back more, but if we move it back to where there is 7 seconds of Response Time it will place it in the entrance/exit to the VCC parking lot from the outbound lane which could cause false alarms.

Threat paths 2A-1 and 2A-2, the Overspeed Detection threat paths need to be evaluated as they determine the location and settings for the Point Overspeed detection.

Engineering judgment tells us that because threat path 2C-1 is going through the VCC parking lot and the threat vehicle will have to make the curve into the outbound lanes it will be going at a slower at this location than it was for threat path 1B-1. The PODs for both threat paths are different so we need to look at the times given for threat path 1B-1 from the POD for threat path 2C-1 (middle Wrongway Detector) to the AVB Safety loop. This distance is covered by Segments #6 (1.17 seconds) and #7 (4.46 seconds) of threat path 1B-1 which gives us a total time of 5.63 seconds. Because this time is lower than the required 7 seconds response time this threat path will need to be evaluated to ensure that it does not control the placement of the AVB. If this time had been over the 7 second required response time this path would not have to be evaluated.

Threat Path 2D-1 has the same POD as threat path 2C-1, as threat path has a longer run up to the POD than Threat path 2D-1 Engineering Judgment tells us that the Threat Vehicle will be going slower at the POD for threat path 2D-1 than 2C-1. This can be confirmed by looking at Cell F29 of the TD CALCULATOR Tab in the spreadsheet for threat path 2C-1. This cell tells us at the POD (beginning of segment #4) the Threat Vehicle was going 58.23 ft/sec in threat path 2C-1. The velocity at the POD for threat path 2D-1 can be determined by using the spinout speed for segments #2 and #3. The radius for both segments is 60 ft, by using the equation (6) on page 17 of UFC 4-022-02 we can determine that the spin out speed of a 60-foot radius curve is 43.95 ft/sec. Because both threat paths used the same POD and threat path 2C-1 has a higher velocity at the POD than threat path 2D-1 does, it is clear that threat path 2C-1 will control over threat path 2D-1 and threat path 2D-1 does not need to be evaluated.

Threat path 2E-1 is where the threat vehicle leaves the Outer Overspeed Detector at the Overspeed setting than goes through the Search Area. Engineering judgment tells us that this threat path will not control but as the threat path is completely different than any of the other it will need to be evaluated to confirm.

Threat path 3A-1 has the same POD as threat path 2A-2. As the beginning velocity for Threat Scenario #3 is set by UFC 4-022-01 at 25 mph we just need to insure that the POD velocity for threat path 2A-2 is equal to or greater than 25 mph to determine if threat path 3A-1 needs to be evaluated. Referring to cell E29 on the TD CALCULATOR tab of the spreadsheet for threat path 2A-2 it is determined that the POD velocity is 54.31 ft/sec (37.03 mph) as this is greater than the 25 mph set by UFC 4-022-01 for Threat Scenario #3 it is obvious that threat path 3A-1 will not have to be evaluated.

Threat path 3E-1 has the same POD as threat path 2E-1. As the beginning velocity for Threat Scenario #3 is set by UFC 4-022-01 at 25 mph we just need to insure that the POD velocity for threat path 2E-1 is equal to or greater than 25 mph to determine if threat path 3E-1 needs to be evaluated. Referring to cell E29 on the TD CALCULATOR tab of the spreadsheet for threat path 2E-1 it is determined that the

POD velocity is 55.86 ft/sec (38.09 mph) as this is greater than the 25 mph set by UFC 4-022-01 for Threat Scenario #3 it is obvious that threat path 3E-1 will not have to be evaluated.

Threat Path 4F-1 can be evaluated to see if it will control the AVB location by referring to segments #4 and #5 in threat path 2A-2, as these are the two segments that are used to determine the response time for threat path 4F-1. Segment #4 has a travel time of 2.72 seconds, and segment #5 has a travel time of 3.19 seconds, for a total time of 5.91 seconds. As the required response time for the Hybrid Safety System for Threat Scenario #4 is 5 seconds it is obvious that threat path 4F-1 will not control for the placement of the AVBs so it will not have to be evaluated.

Threat Path 4G-1 can be evaluated to see if it will control the AVB location by referring to segments #3, #4, and #5 in threat path 3E-1, as these are the three segments that are used to determine the response time for threat path 4G-1. Segment #3 has a travel time of 1.38 seconds, segment #4 has a travel time of 2.92 seconds, and segment #5 has a travel time of 2.63 seconds, for a total time of 6.83 seconds. As the required response time for the Hybrid Safety System for Threat Scenario #4 is 5 seconds it is obvious that threat path 4G-1 will not control for the placement of the AVBs so it will not have to be evaluated.

Threat paths 4H-1 and 4I-1 have the same POD and can be evaluated to see if they might control the location of the AVB by referring to segment #5 in threat path 2C-1, as this is the segment that is used to determine the response time for threat paths 4H-1 and 4I-1. Segment #5 for threat path 2C-1 has a travel time of 5.96 seconds. As the required response time for the Hybrid Safety System for Threat Scenario #4 is 5 seconds it is obvious that threat paths 4H-1 and 4I-1 will not control for the placement of the AVBs therefore will not have to be evaluated.

Of the 13 original possible threat paths 7 where eliminated by using Engineering Judgment and the data from the other threat paths as being able to control the final placement of the AVBs, leaving only 6 possible threat paths that need to be evaluated.

5.4 THREAT PATH REPORT

The Threat Report that is to be included in the Design Analysis must include a layout of each threat path that was evaluated which includes: type of segment, length of segment, segment radius (if the segment is a curve), and the travel time if the segment is used in the response time summation. The report must also include a pdf of the INPUT tab of the spreadsheet for each threat path that was evaluated. The best way to do this is to use a layout like is shown in section 5-2.