ATKINS

Georgia Department of Transportation

Automated Traffic Signal Performance Measures

Component Details

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List of Acronyms and Abbreviations

AoG/AOG ....Arrivals on Green

AoR/AOR ....Arrivals on Red

ATSPM ....Automated Traffic Signal Performance Measures

CPU.. Central Processing Unit

GDOT ....Georgia Department of Transportation

GOR .... Green Occupancy Ratio

fLU...Lane Utilization Adjustment Factor

FTP.. File Transfer Protocol

IP ....Internet Protocol

MPO...Metropolitan Planning Organization

PCD... Purdue Coordination Diagram

PHF .... Peak Hour Factor

ROR .... Red Occupancy Ratio

UDOT ....Utah Department of Transportation

Introduction

This is the second of three documents that comprise the full Georgia Department of Transportation (GDOT) Automated Traffic Signal Performance Measures (ATSPM) documentation package. Together, the three documents detail the installation and use of the Automated Traffic Signal Performance Measures website, including site navigation, reporting components, and report interpretation. This document is a detailed compilation of ATSPM website components and describes the steps necessary to configure charts and reports to display various features. The ATSPM website **About** tab, shown in Figure 1, displays a brief description of the version notes and provides a link to download the software.
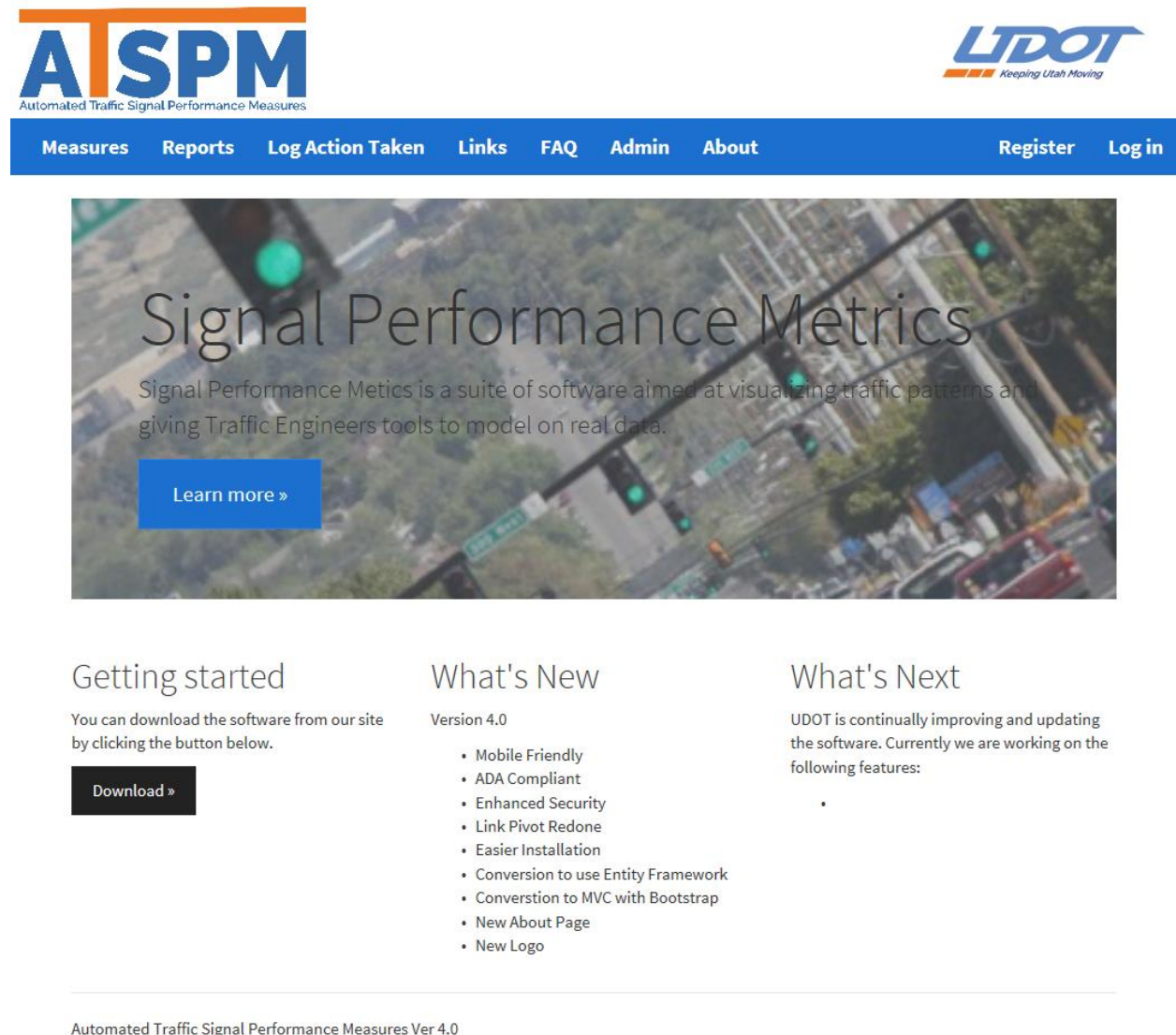

Figure 1: Automated Traffic Signal Performance Measures 4.0 About Tab

1.   Measures

This section details the charting features of the software's **Signal Measures**. These features are available from the menu by clicking **Measures>Signal**. Multiple charts can be generated from the Signal page. Selection and navigation instructions are provided in this document as well as descriptions of the ATSPM interface, the Signal Metric Types and associated charts.

1.1.   Signal

As shown in Figure 2, there are five panes in the interface: **Signal Selection**, **Signal List, Signal Map**, **Chart Selection**, and **Date Selection**. Initially, all fields are set blank except for the date and time, which defaults to the current date and spans from 12:00 AM to 11:59 PM. The following subsections provide a description of each pane.
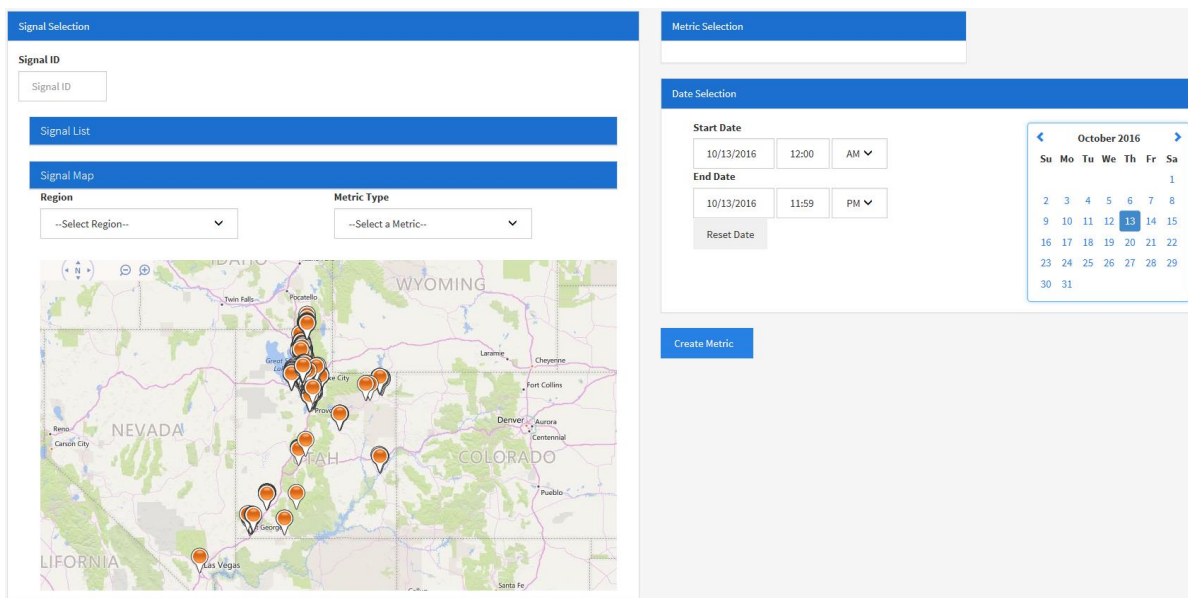
Figure 2: Default Signal Website

1.1.1.   Signal Selection

The first field in **Signal Selection** is **Signal ID**, which begins as a blank field. If the user knows the signal ID for which they wish to generate metrics, it may be typed followed by pressing "enter." The intersection details, main street and side street, will then display to the right of the field. These details will also display after selecting a signal by any other means (see Signal List and Signal Map). The selected signal is the signal targeted for analysis.

1.1.2.   Signal List

By default, the **Signal List** is hidden and can be expanded as shown in Figure 3. To utilize the **Signal List**, click on the **Signal List** banner. Click again to hide it. The Signal List includes a filter that can filter based on Signal ID, Primary Name, and Secondary Name. The first five signals are shown in the view. Filters are

inclusive to the search such that searching for a Signal ID of "60" will display Signal ID 1060 as well as 4602 or any other signal with "60" anywhere in the ID. Users can navigate to other signals by selecting the pages at the bottom of the list. After finding the desired signal, click "Select" in the corresponding row.

Figure 3: Signal List

1.1.3. Signal Map

By default, the **Signal Map**, see Figure 4, is expanded with a zoom level to the State of Utah. Zoom levels can be adjusted with the Minus and Plus icons in the top left corner of the map, the level selection that pops up while the mouse is hovering over the Minus and Plus, or by using the mouse scroll wheel while hovering over the map. The map depicts locations of traffic signals. Orange pushpin markers denote each traffic signal. A pointer appears when the mouse is navigating in the map. Click the left button of the mouse, then drag up, down, left, or right to move the map to the desired location. The map includes dropdown selectors for Region and Metric Type. Choosing a Region focuses the map view to that region. Selecting a Metric from the dropdown menu filters the map view so that it only displays signals supporting the selected Metric Type.
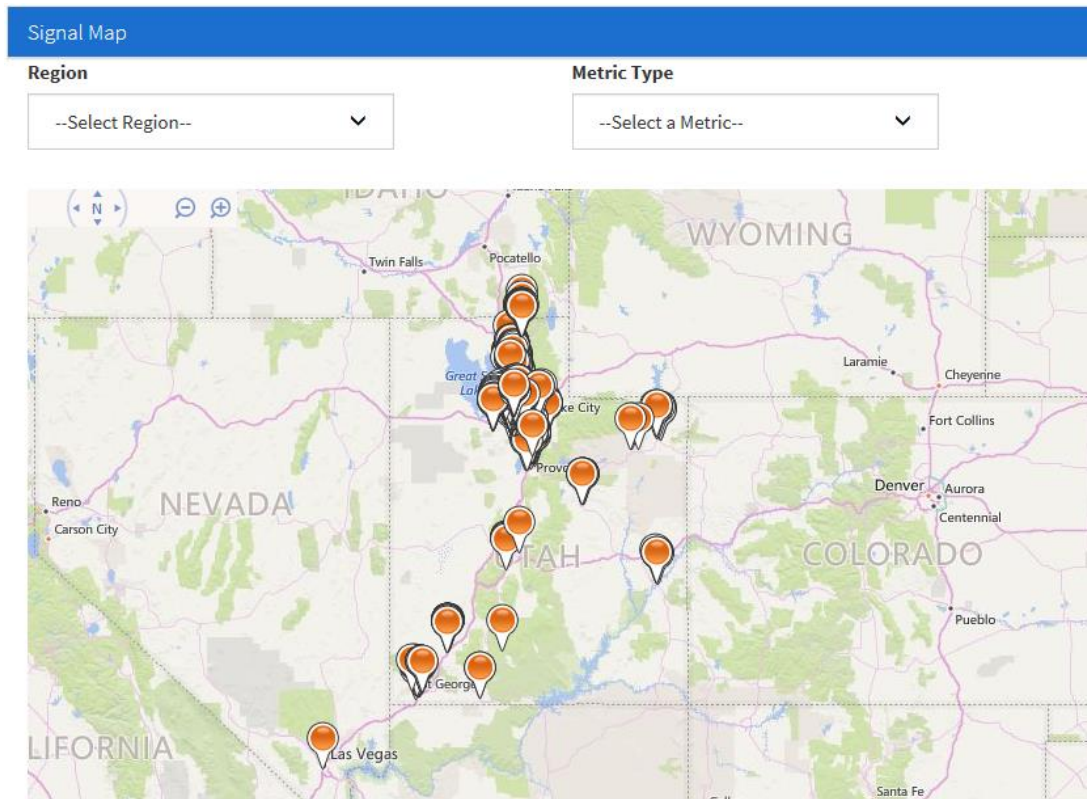
Figure 4: Signal Map

Clicking on a pushpin will zoom the map to that signal location, select the signal, and display the signal ID and Primary Name (see **Figure 5**).
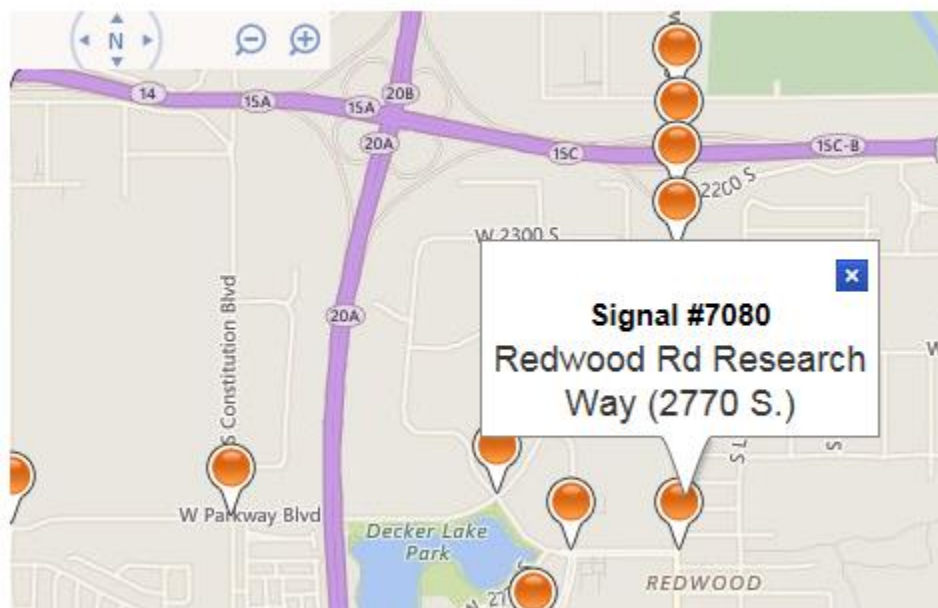
Figure 5: Signal Selected from Map

1.1.4. Chart Selection

This area is blank until a signal is selected. Once a signal is selected, the Purdue Phase Termination is displayed as the default chart and all other available metrics for the selected signal appear (see Figure 6 and Figure 7 below). The Phase Termination Options are shown by default to the right of Chart Selection. If the user selects another metric, the appropriate configuration parameters become available. Options may be different for each metric. Sections later in this document describe options available with each metric.

Figure 6: Chart Selection (unselected)

Figure 7: Chart Selection (selected)

1.1.5.   Date Selection

Figure 8 shows the pane in which a time and date range may be selected for the metric. The span can be minutes, hours, days, or years. Click a day in the calendar to generate metrics for that day, or enter the desired parameters in the **Start Date** and **End Date** fields to fine-tune start and end times.

To reset the date range to the current day, click **Reset Date**.

Figure 8: Date Selection

1.2. Signal Metric Types

The following is a list of Signal Metric Types.

- Purdue Phase Termination
- Split Monitor
- Pedestrian Delay
- Preemption Details
- Turning Movement Counts
- Purdue Coordination Diagram
- Approach Volume
- Approach Delay
- Arrivals on Red
- Approach Speed
- Yellow and Red Actuations
- Purdue Split Failure

1.2.1. Purdue Phase Termination

This metric plots the controller's phases and the reason the phase terminated. The metric plots phase terminations due to force off, gap out, or max out.

When **Purdue Phase Termination** is selected, the options shown in Figure 9 are available for generating the plot:

- **Y-axis Max:** This defaults to **Auto**, but can be changed to limit the number of phases displayed.
- **Consecutive Count:** Filters to include only points where this event type terminated the phase the specified consecutive number of times.
- **Show Plan Stripes:** Changes background color when the signal plan changes.
- **Show Ped Activity:** Displays orange dots depicting pedestrian phase actuations. (Note that this does not affect phase termination.)

Figure 9: Phase Termination Options

Click **Create Chart** to generate the plot.

Figure 10 is an example plot of the **Purdue Phase Termination**, including Ped Activity and Plan Stripes. Pedestrian activity is included for information purposes.
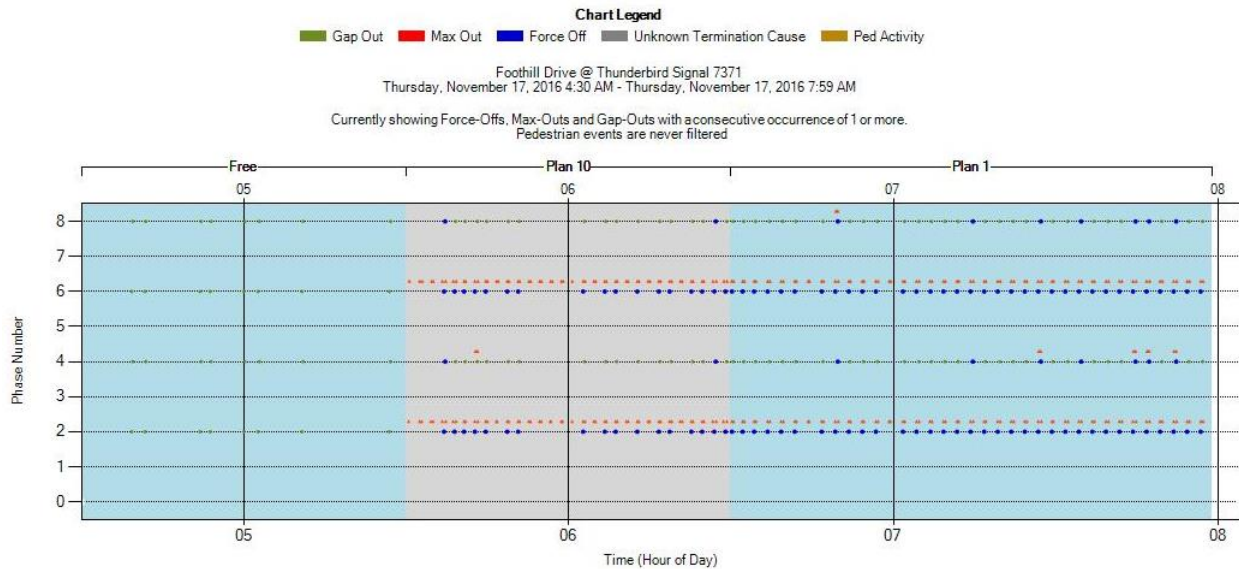
Figure 10: Purdue Phase Termination

1.2.2.   Split Monitor

This metric generates separate plots for each phase on the controller. Each plot depicts the length of the phase in seconds and the reason the phase terminated.

Figure 11 shows the options available for generating the plot when the **Split Monitor** is selected.

Figure 11: Split Monitor Options

- **Y-axis Max:** Constricts all plots to the same height in seconds. Otherwise, the plots will auto-expand to the maximum height. Default value is **Auto**.

- **Percentile Split**: Includes the length of the phase at this percentile during the duration of each signal plan. The available options in the dropdown list are No Percentile Split, 50, 75, 85, 90, and 95. The default value is **Auto**.
- **Show Plans:** Changes background color when the signal plan changes. This must be selected for the plan data to show.
- **Show Ped Activity:** Displays orange dots depicting pedestrian phase activations. (Note that this does not affect phase termination.)
- **Show Average Split:** Includes the average time of the phase during the duration of each signal plan.
- **Show % Max Out/Force Off:** Includes the percentage of phase terminations due to max out or force off during the duration of each signal plan.
- **Show Percent GapOuts:** Includes the percentage of phase terminations due to gap out during the duration of each signal plan.
- **Show Percent Skip:** Includes the percentage of times this phase was skipped outright due to lack of demand.

Click **Create Chart** to generate the plot.
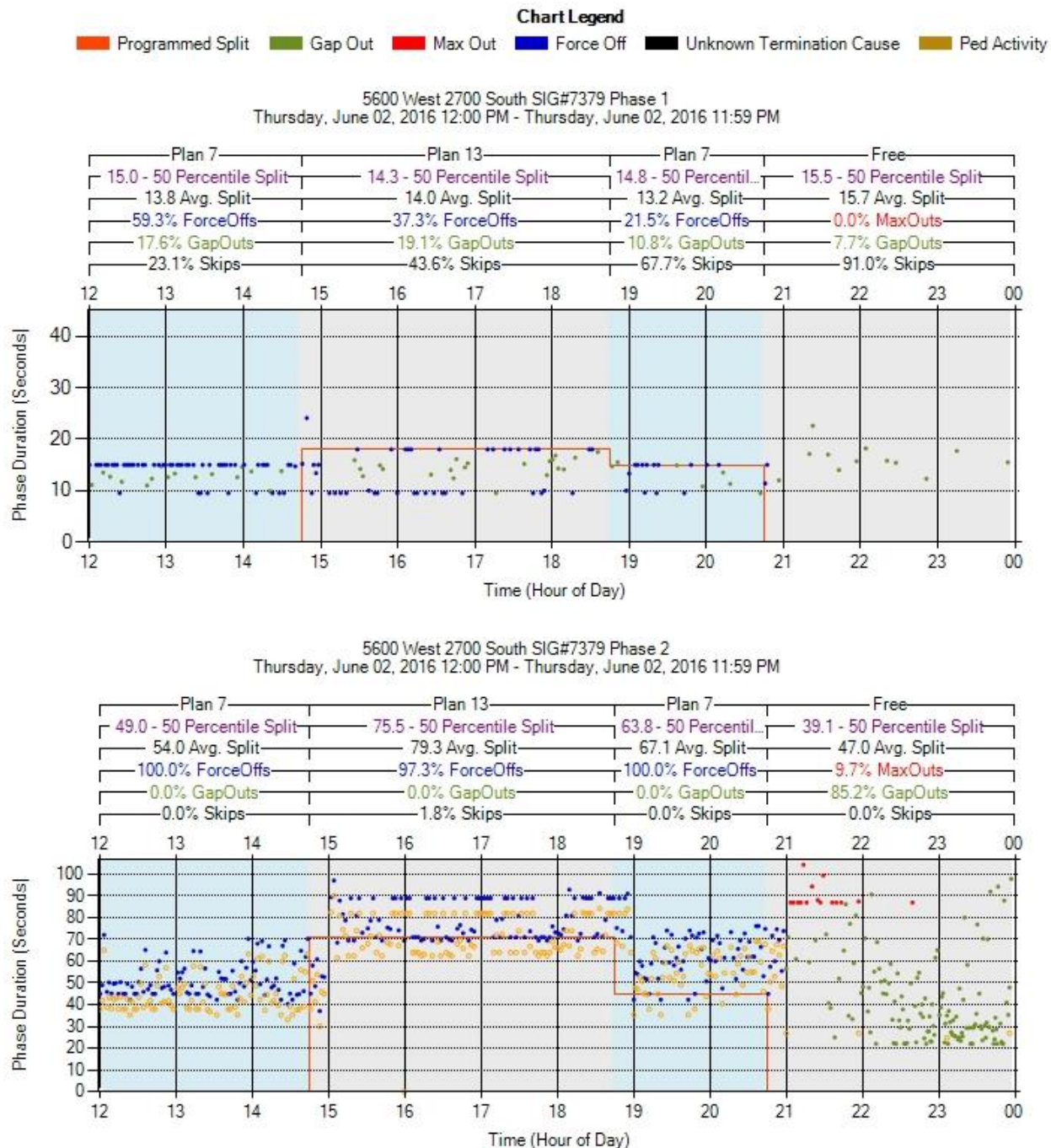
Figure 12: Split Monitor

Figure 12 shows an example Split Monitor plot with all options (except **Y-axis Max**) selected. The phase termination reasons are color-coded and include force off, gap out, max out, and unknown. Further, the split length programmed into the controller (if applicable) is included. Pedestrian activity is included for information purposes.

1.2.3.   Pedestrian Delay

This time-of-day plot depicts the delay, in minutes, associated with each pedestrian <u>actuation</u>.

Figure 13 shows the option available to generate a plot when **Pedestrian Delay** is selected.

Figure 13: Pedestrian Delay Options

- **Y-axis Max (Pedestrian Delay):** The maximum height in minutes of the vertical axis, Pedestrian Delay. The default is 3 minutes.

Click **Create Chart** to generate the plot.
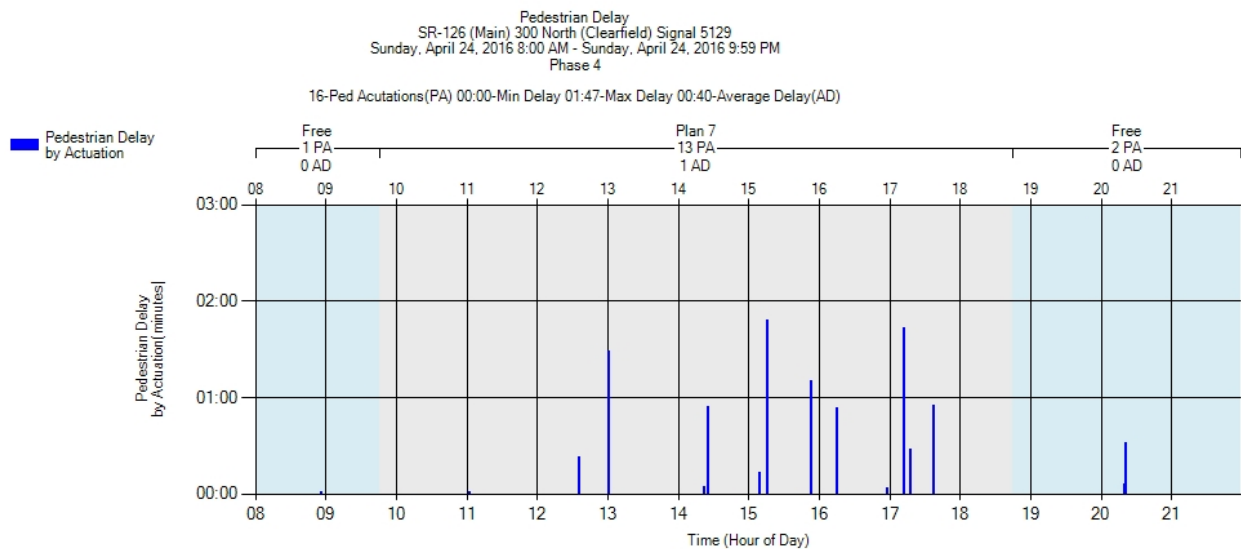
Figure 14: Pedestrian Delay

Figure 14 is an example of a Pedestrian Delay plot with a default delay axis of 3 minutes. Each blue bar represents the delay associated with each pedestrian <u>actuation</u>. The signal plans are color-coded and the total number of actuations and average delay (rounded to minutes) are tallied for the duration of each plan.

1.2.4.   Preemption Details

This metric details the <u>preemption</u> events at the signal. Either railroad crossings or emergency vehicles may preempt normal signal operation. This metric does not provide any options to configure the output. Click **Create Chart** to generate the plot.

Figure 15 is an example of a Preemption Details plot. Plots are generated for each preempt configured in the controller.
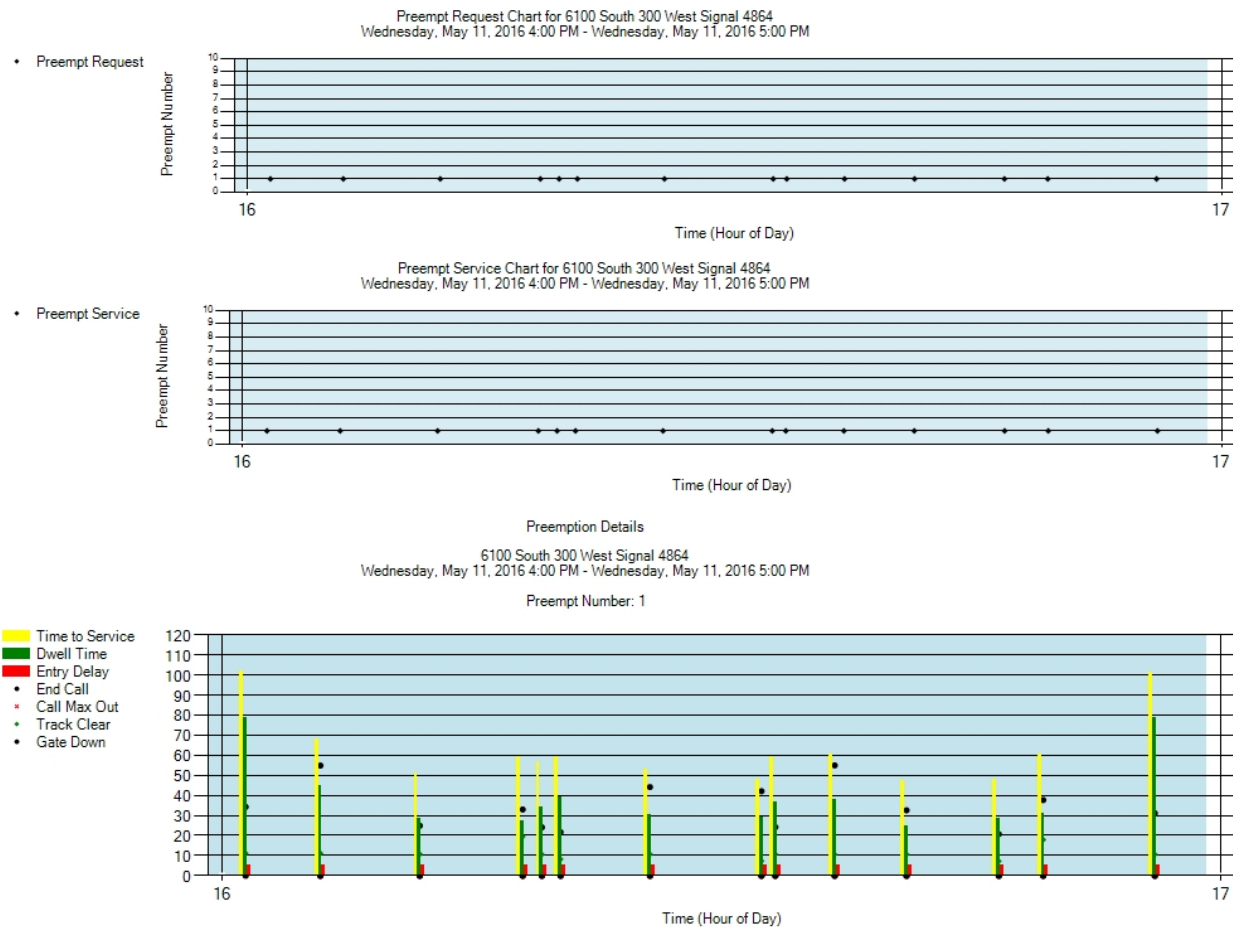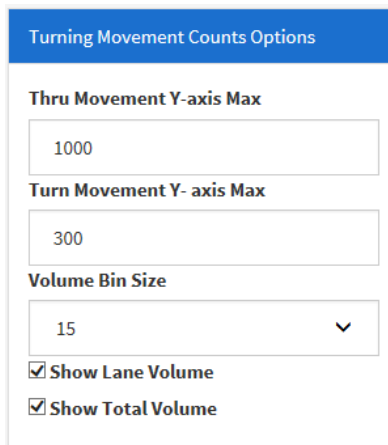
Figure 15: Preemption Details

The first plot shows the times of preempt requests received. The second plot depicts when preempts were serviced. The third plot shows details from the preempt events with minutes on the vertical axis. Entry delay, dwell time, time to service, and max out (if applicable) are plotted for each event. The time that the preempt call end is also shown.

In the case of railroad preemption, the plot tracks the times when the gate is down and when the track is clear.

1.2.5. Turning Movement Counts

This time-of-day plot shows volume for the lanes in a turning movement. Available turning movements also include the through movement.

Figure 16: Turning Movement Counts Options

- **Thru Movement Y-axis Max:** This is the maximum hourly volume that can be displayed on the Y-axis of through lane charts.
- **Turn Movement Y-axis Max**: This is the maximum hourly volume that can be displayed on the Y-axis of turn lane charts.
- **Volume Bin Size**: This is the resolution of the hourly volume measurement. Sizes of 5 and 15 minutes are available with 15 as the default value.
- **Show Lane Volume:** When selected, this displays volumes by individual lane in the chart.
- **Show Total Volume**: When selected, this displays the total volume for the movement (all lanes) in the chart.

Click **Create Chart** to generate the plot.

Figure 17 is a Turning Movement Count plot. Note that ATSPM generates plots for all available movements, including through movements.
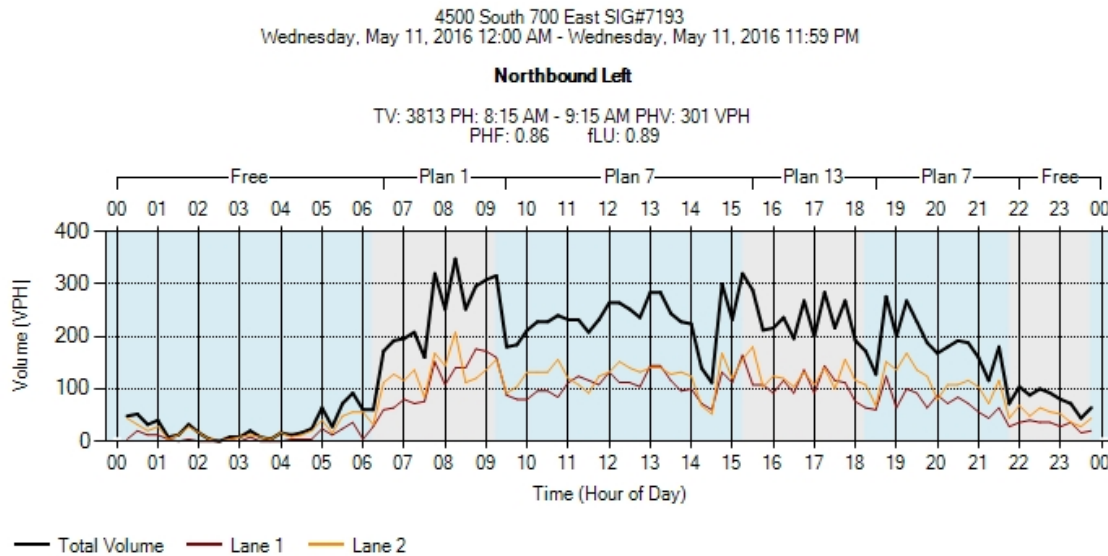
Figure 17: Turning Movement Counts

The plot depicts the vehicle flow rate in vehicles per hour. Labels and shading denote different signal plans. The following information is included at the top of the plot:

- Total volume (TV), for all lanes within the selected time period.
- Peak hour (PH) within the selected time period.
- Peak Hour Factor within the selected time period.
- Lane utilization adjustment factor (f_{LU}), within the selected time period.

1.2.6. Purdue Coordination Diagram

The **Purdue Coordinate Diagram** is a powerful spatial metric. It plots vehicle arrivals against the current movement (green, yellow, red) and traffic flow in vehicles / hour.

Figure 18 shows the options available to generate a plot when the **Purdue Coordination Diagram** is selected.

Figure 18: Purdue Coordination Diagram Options

- **Y-axis Max (Cycle Time):** The maximum extent of the cycle time in seconds depicted on the left-hand Y-axis.
- **Secondary Y-axis Max (Volume):** The maximum extent of vehicle flow in vehicles/hour depicted on the right-hand Y-axis.
- **Volume Bin Size**: The resolution of the hourly volume measurement. Sizes of 5 and 15 minutes are available and 15 is the default value.
- **Dot Size:** The size of black dots depicting vehicle arrivals (detector activations). The options are Small and Large with Small being the default value.
- **Show Plan Statistics:** Delineates signal plans on the horizontal axis above the plot. Includes measurements for percentage of vehicles arriving on green, percentage green time, and platoon ratio.
- **Show Volumes:** Displays vehicle flow rate (vehicles per hour) on the plot.

Click **Create Chart** to generate the plot.
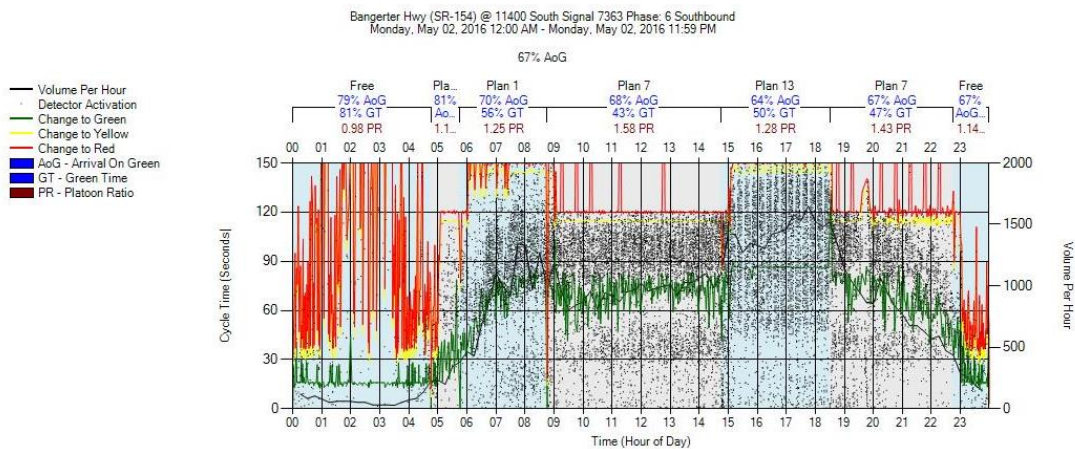
Figure 19: Purdue Coordination Diagram

Figure 19 is what a typical Purdue Coordination Diagram for an entire day will look like. Figure 20 is zoomed in to show details of the PCD. Each slanted stripe of black dots represents vehicle arrivals during one signal cycle. Starting at the X-axis, the cycle is in red, then switches to green (shown by the green plotline). After the yellow and red intervals, the next cycle restarts at the X-axis. By these means, the degree of vehicle platooning is visualized.
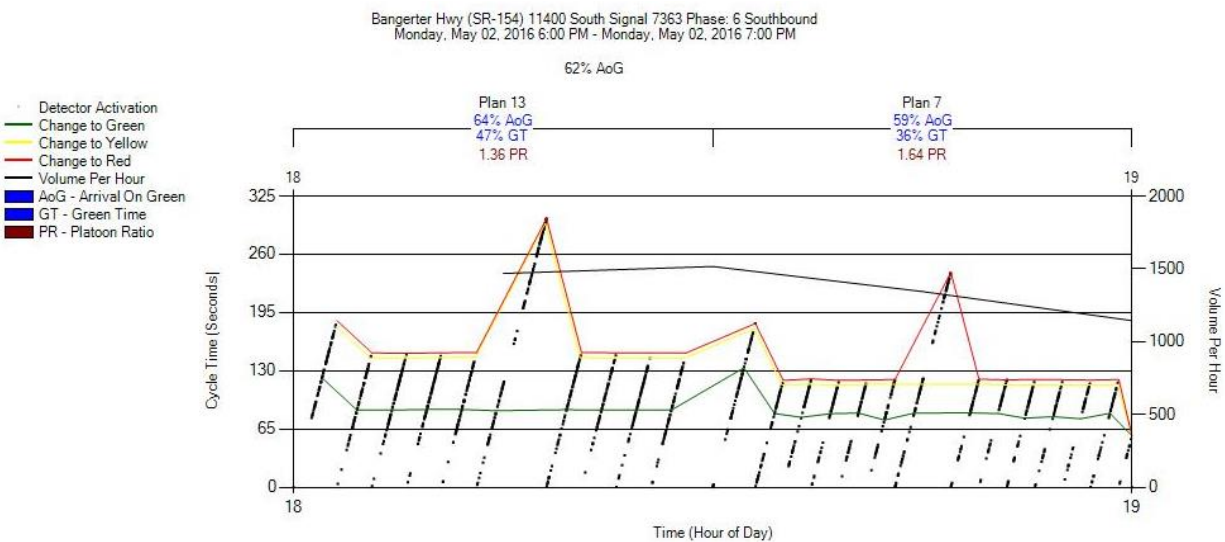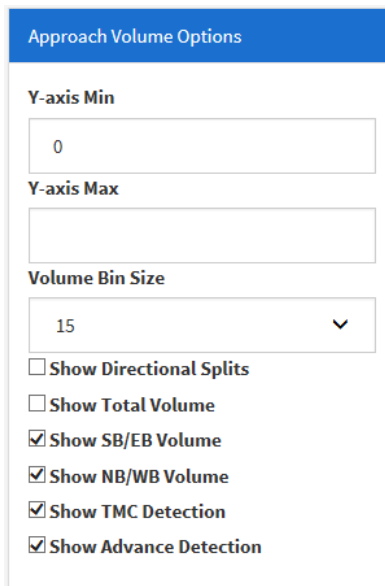
Figure 20: PCD Zoomed for Detail

The percentage of vehicles arriving on green and the percentage of green time in the cycle is displayed for each signal plan. The platoon ratio is also calculated.

1.2.7. Approach Volume

This metric plots traffic approaching an intersection with advanced analysis comparing opposing directions, detector sites, and more.

Figure 21 shows the options available for generating a plot when the Approach Volume is selected.

Figure 21: Approach Volume Options

- **Y-axis Min:** Constrains the minimum extent of the Y-axis to this value.
- **Y-axis Max:** Constrains the maximum extent of the Y-axis to this value.
- **Volume Bin Size**: Shows the resolution of the hourly volume measurement. Sizes of 5 and 15 minutes are available and 15 is the default value.
- **Show Directional Splits:** Displays dotted lines of D factors comparing each direction of traffic to the total. Default is not selected.
- **Show Total Volume:** Displays an additional line showing the sum of both directions. Default is not selected.
- **Show SB/EB Volume:** Displays the southbound and eastbound volumes.
- **Show NB/WB Volume:** Displays the northbound and westbound volumes.
- **Show TMC Detection:** Displays the data for Turning Movement Count detection at the stop bar.
- **Show Advance Detection:** Displays the plots for advance detectors, placed approximately 400 feet ahead of the stop bar.

Click **Create Chart** to generate the plot.
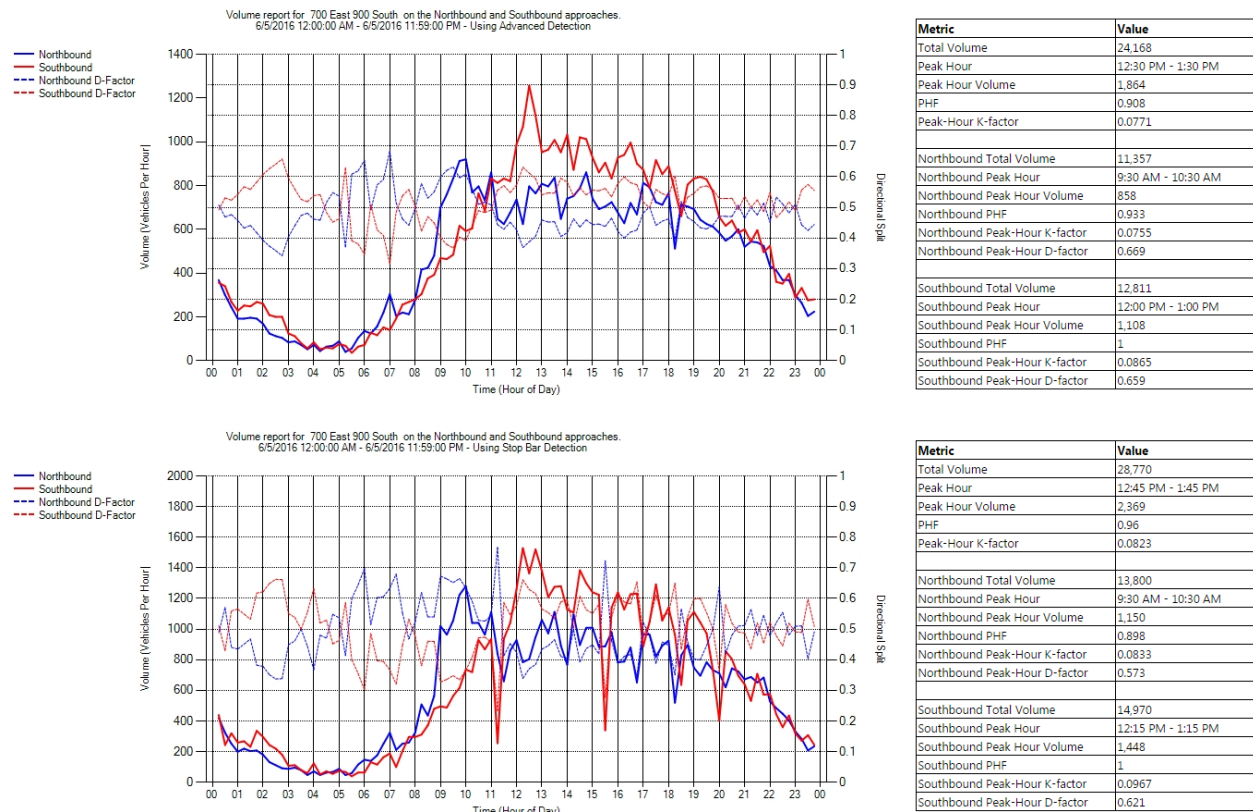
Figure 22: Approach Volume

Figure 22 is an example Approach Volume plot of northbound (blue) and southbound (red) movements. Both Advanced and Stop Bar detections are plotted in volume per hour (VPH) as referenced on the primary Y-axis. Directional Splits (D Factors) are depicted with a dotted line in percent as referenced on the secondary Y-axis.

The tables to the right of each plot display total volume, peak hour, peak hour volume, peak hour factor, and peak hour K factor for the analysis period. These metrics are also available for the northbound and southbound movements along with the D Factor for the peak hour.

1.2.8.   Approach Delay

This metric plots a simplified approach delay experienced by vehicles approaching and entering the intersection. The delay per vehicle and total delay are both available.

Figure 23 shows options available for generating a plot when the **Approach Delay** is selected.

Figure 23: Approach Delay Options

- **Y-axis Max (Delay Per Vehicle):** The maximum Y-axis extent for Delay Per Vehicle, depicted with a blue plotline. This is the left Y-axis.
- **Secondary Y-axis Max (Total Delay Per Hour):** The maximum Y-axis extent for Delay Per Hour, depicted with a red plotline. This is the right Y-axis.
- **Volume Bin Size**: The resolution of the hourly volume measurement. Sizes of 5 and 15 minutes are available and 15 is the default value.
- **Show Plan Statistics:** Located above the plot; displays average delay and total delay for each signal plan.
- **Show Total Delay Per Hour:** Toggles the Total Delay per Hour plotline (red).
- **Show Delay Per Vehicle:** Toggles the Delay per Vehicle plotline (blue).

Click **Create Chart** to generate the plot.
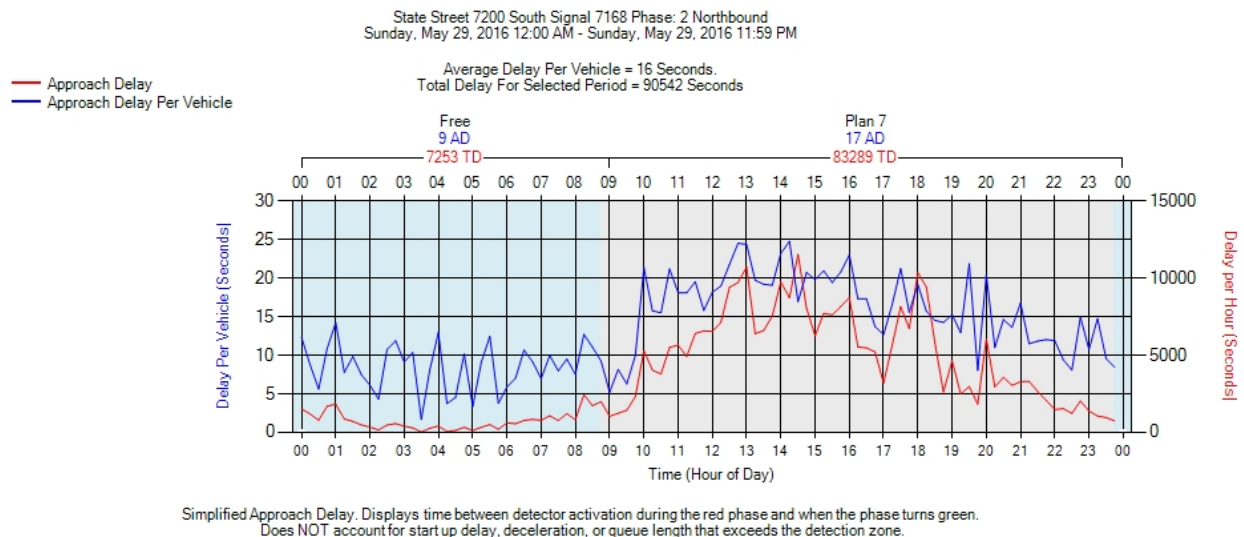
Figure 24: Approach Delay
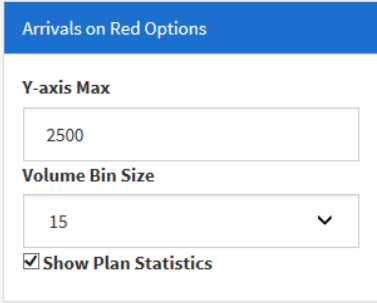
Figure 24 is a sample Approach Delay plot. The **Y-axis Max (Delay Per Vehicle)** is set to 30 and the **Secondary Y-axis Max (Total Delay Per Hour)** is set to 15,000. Both delay metrics are displayed along with **Show Plan Statistics**.

Note: **This metric has not been thoroughly quality-checked.**

1.2.9. Arrivals on Red

This metric plots both the volume and percentage of vehicles arriving on red. Phases where data is available will be plotted.

Figure 25 shows options available for generating the plot when the **Arrivals on Red** is selected.

Figure 25: Arrivals on Red Options

- **Y-axis Max:** The maximum extent of the Y-axis in vehicles per hour. This defaults to Auto.
- **Volume Bin Size**: The resolution of the hourly volume measurement. Sizes of 5 and 15 minutes are available and 15 is the default value.
- **Show Plan Statistics:** For each signal plan, displays the overall percentage of vehicles arriving on red, and the percentage of signal cycle in red.

Click **Create Chart** to generate the plot.

State Street 7200 South Signal 7168 Phase: 2 Northbound
Sunday, May 29, 2016 12:00 AM - Sunday, May 29, 2016 11:59 PM

Total Detector Hits = 5189 Total AoR = 2838
Percent AoR for the select period = 55
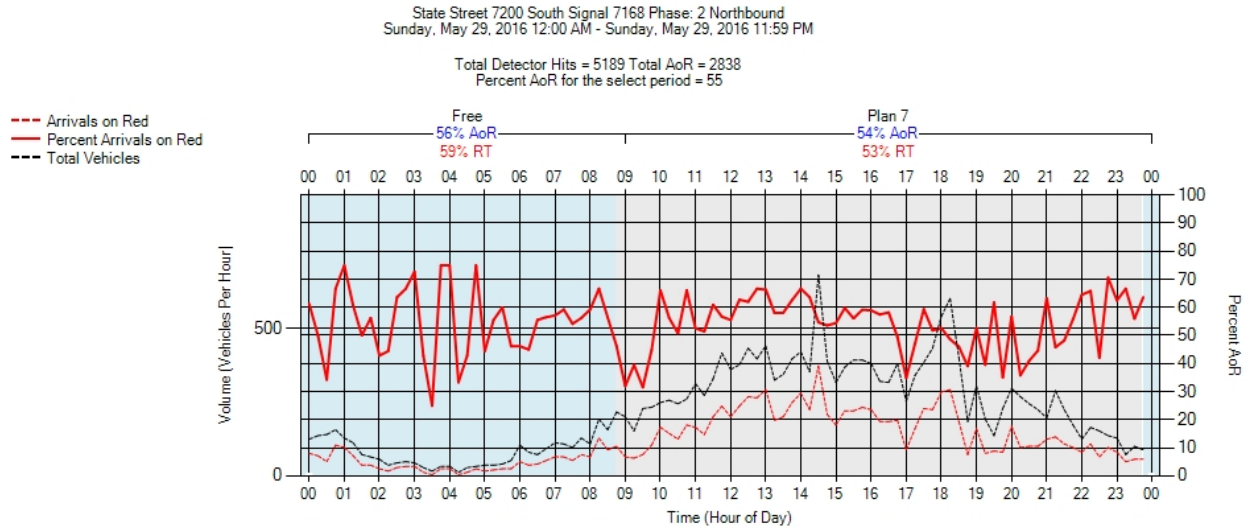
Figure 26: Arrivals on Red

Figure 26 is a sample **Arrivals on Red** plot. **Show Plan Statistics** are checked, and the bin size is 15 minutes. The dotted red line depicts arrivals on red and the dotted black line depicts total arrivals (both vehicles/hour). The solid red line depicts overall percentage of vehicles arriving on red.

At the top of the plot, the **Total Detector Hits**, **Total AoR** (arrivals on red), and **Percent AoR** for the analysis period are shown.

1.2.10. Approach Speed

This metric tracks the speed of vehicles approaching a signalized intersection. Phases where this data are available will be plotted. This metric requires detection set back from the stop bar that can detect speed; currently the only supported product is the Wavetronix SmartSensor™ Advance.

Figure 27 shows the options available for generating the plot when the **Approach Speed** is selected.

Figure 27: Approach Speed Options

- **Y-axis Min:** Defines a minimum speed extent on the Y-axis.
- **Y-axis Max:** Defines a maximum speed extent on the Y-axis.
- **Volume Bin Size**: Displays the resolution of the hourly volume measurement. Sizes of 5 and 15 minutes are available and 15 is the default value.
- **Show Plan Statistics:** Displays header information above the plot detailing the signal plan, average 85% speed, average overall speed, and the standard deviation within the speed measurement. This option toggles background shading that denotes different signal plans.
- **Show Average Speed:** Displays the plot for average speed of approaching vehicles.
- **Show Posted Speed:** Displays a horizontal line for the posted speed limit.
- **Show 85% Speed:** Displays the plot for the 85th percentile speed of approaching vehicles.

Click **Create Chart** to generate the plot.
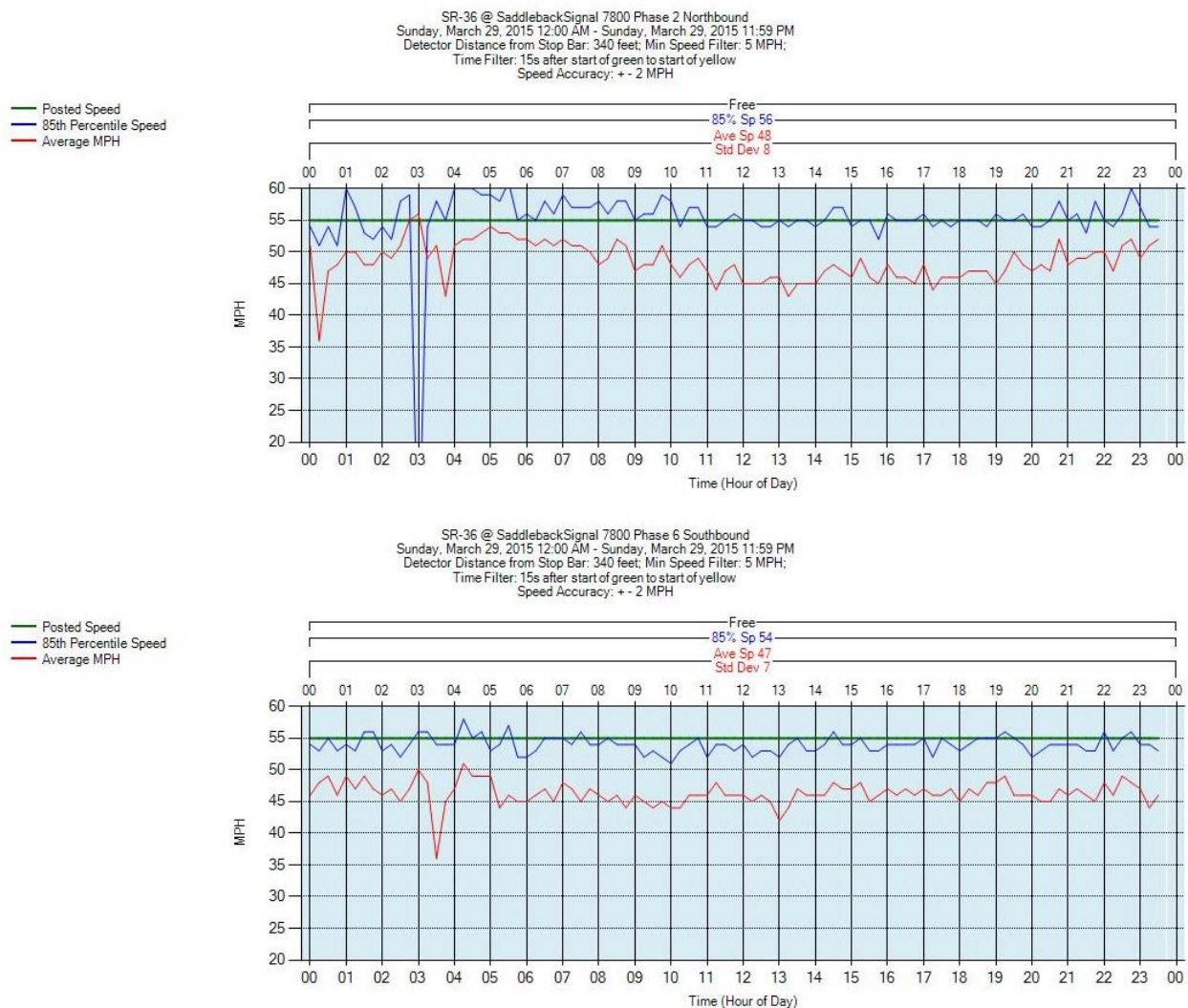
Figure 28: Approach Speed

Figure 28 is an example of Approach Speed plots. The average speed (red) and 85th percentile speeds (blue) are plotted against the posted 40 miles per hour speed limit (green). Plan statistic headers are

included above the plot showing the 85th percentile speed, average speed, and standard deviation of speed for the single signal plan within the analysis period.

1.2.11. Yellow and Red Actuations

This metric plots vehicle arrivals during the yellow and red portions of an intersection's movements where the speed of the vehicle is interpreted to be too fast to stop before entering the intersection. It provides users with a visual indication of <u>occurrences</u>, <u>violations</u>, and several related statistics. The purpose of this chart is to identify engineering countermeasures to deal with red light running.

Figure 29 shows the options available for generating the plot when the **Yellow and Red Actuations** is selected.

Figure 29: Yellow and Red Actuations Options

- **Y-axis Max:** Maximum vertical extent of the Y-axis in seconds. The default is 15 seconds, which would extend about 10 seconds into the Red time.
- **Severe Red Light Violations (entry field):** Records the number of seconds for a vehicle to pass through the intersection relative to the start of the red clearance. The default value is 4 (estimated from the average summation of red clearance time plus start-up loss time).
- **Red Light Violations:** For the duration of each signal plan, displays the total number of red light violations (vehicles passing through red clearance or red). Abbreviated "RLV" in the plot.
- **Severe Red Light Violations (checkbox):** Displays the total of severe red light violations for the duration of each signal plan as configured using the Severe Red Light Violations entry field. Abbreviated "SRLV" in the plot.
- **Percent Red Light Violations:** Displays the percentage of RLVs for the duration of each signal plan relative to total flow. Abbreviated "%RLV" in the plot.
- **Percent Severe Red Light Violations:** Displays the percentage of red light violations for the duration of each signal plan relative to total flow. Abbreviated "%SRLV" in the plot.

- **Average Time Red Light Violations:** Displays the average time in seconds that a violation occurs (relative to the start the cycle) for the duration of each signal plan. Abbreviated "TRLV" in the plot
- **Yellow Light Occurrences:** Display the total number of vehicles passing through the yellow light for the duration of each signal plan. Abbreviated "#YLO" in the plot.
- **Percent Yellow Light Occurrences:** Displays the percentage of yellow light vehicles relative to total flow for the duration of each signal plan. Abbreviated "%YLO" in the plot.
- **Average Time Yellow Occurrences:** Displays the average time in seconds that a vehicle passes through yellow (relative to the start of the yellow) for the duration of each signal plan. Abbreviated "TYLO" in the plot.

Click **Create Chart** to generate the plot.
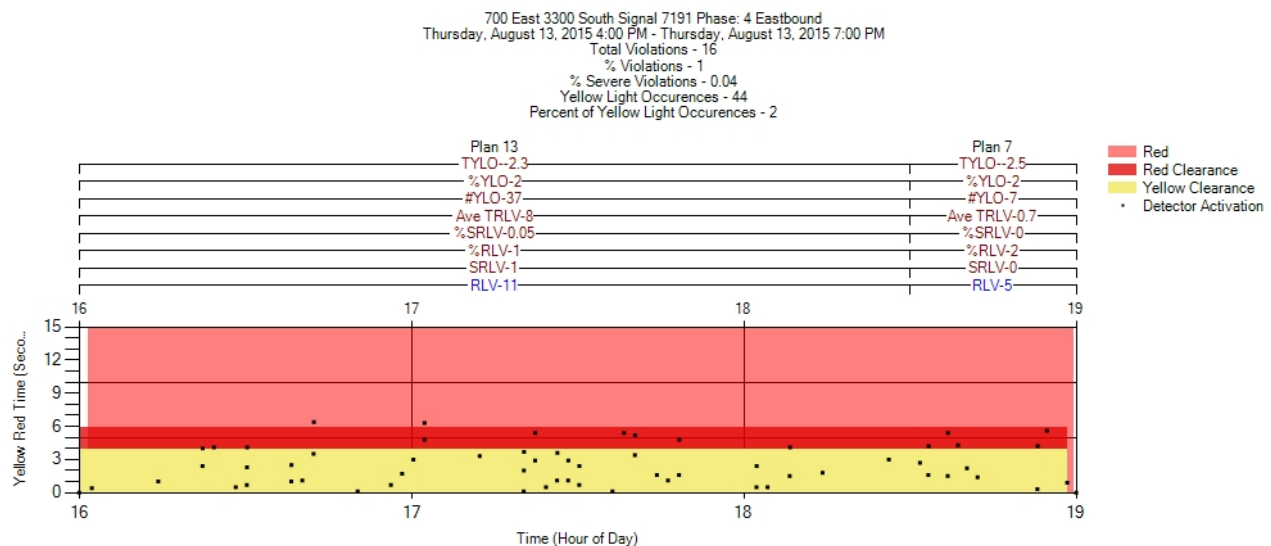
Figure 30: Yellow and Red Actuations

Figure 30 is a sample Yellow and Red Actuations plot. The **Y-axis Max** is set to 15 seconds and the **Severe Red Light Violations** cutoff is set to 4.0 seconds. All the checkboxes described above are selected and populate information for each signal plan.

For the entire analysis period (in this sample, 4:00 PM to 7:00 PM), the following additional statistics are available at the top of the chart:

- **Total Violations:** Red Light Violations (vehicles passing through red clearance or red) over the entire analysis period.
- **% Violations:** Over the entire analysis period, the percentage of red light violations relative to total flow.
- **% Severe Violations:** Over the entire analysis period, the percentage of red light violations relative to total flow.
- **Yellow Light Occurrences:** Over the entire analysis period, the total number of vehicles passing through the yellow light.

- **Percent of Yellow Light Occurrences:** Over the entire analysis period, the percentage of yellow light vehicles relative to total flow.

1.2.12.   Purdue Split Failure

Purdue Split Failure relies on stop bar presence detection, either by lane group or lane-by-lane. This metric calculates the percent of time that stop bar detectors are occupied during the green phase and then during the first five seconds of red. These values are the green occupancy ratio (GOR) and red occupancy ratio (ROR).

Plots will be generated for each phase supporting the metric. The GOR and ROR are calculated and plotted when both gap out and force off occur. When the occupancy ratios both exceed 80 percent, that phase is considered a split failure in the cycle.

Figure 31 shows the options available for generating the plot when the **Purdue Split Failure** is selected.

Figure 31: Purdue Split Fail Options

- **First Seconds of Red:** The number of seconds into red for calculating the ROR. Default is 5 (from Purdue research).
- **Show Fail Lines:** Displays yellow vertical lines to indicate split failure.
- **Show Average Lines:** Displays the mean GOR and ROR over 15-minute increments.
- **Show Percent Fail Lines:** Displays the percentage of cycles experiencing split failure, averaged over 15 minute increments. By default, this is not selected.

Click **Create Chart** to generate the plot.
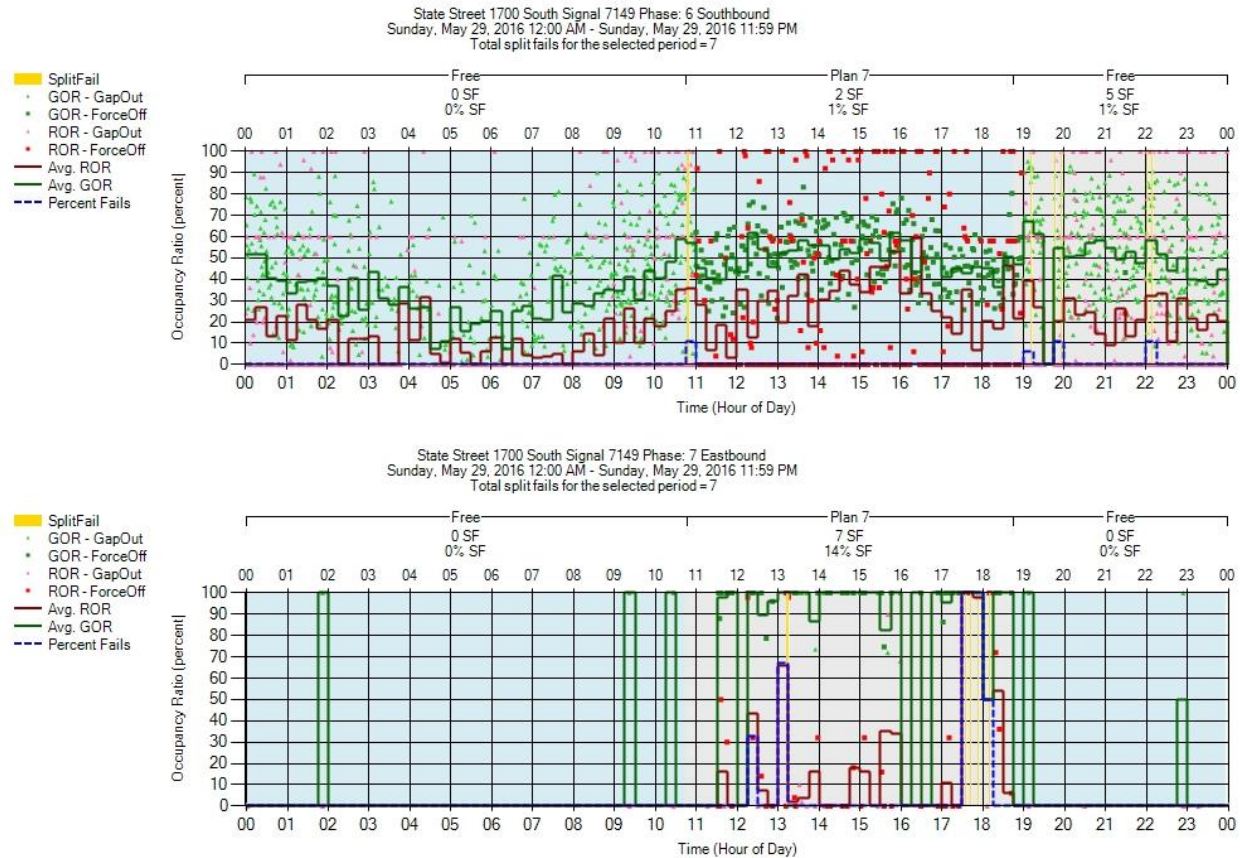
Figure 32: Purdue Split Failure

Figure 32 is an example Purdue Split Failure diagram, shown for both southbound through and eastbound turn phases. The **First Seconds of Red** is the default 5 seconds. **Show Fail Lines**, **Show Average Lines**, and **Show Percent Fail Lines** are all toggled On.

Gap outs and force offs are both depicted. Further, for the duration of each signal plan the total number and percentage of cycles with split failures are both calculated. Finally, the total number of split fails for the analysis period is reported in the top header.

1.3.   Purdue Link Pivot

The Purdue Link Pivot tool generates recommended offsets for coordinated operation along a pre-defined route of consecutive signals with Purdue Coordination Diagrams configured along the route.

Selecting **Measures > Purdue Link Pivot** displays the **Link Pivot Analysis** page, which includes a selectable drop down list to choose the **Route**. After selecting the desired route, clicking **Signals** expands the list to display the signals within the route (see Figure 34) after which the desired metric options (see Figure 33) can be selected. These metric options are:

- **Cycle Length** (default is 90 – this needs to be verified and adjusted to the intersection's timing)
    - ○ Cycle length limits the recommended delta.

- **Start Date** selects the beginning of the metric date.
- **End Date** selects the ending of the metric date.
- **Start Time** selects the beginning of the metric time.
- **End Time** selects the ending of the metric time.

Additional options are available by clicking on **Advanced**. These options are:

- **Days to Include** (via checkbox): Default is weekdays selected and weekends not selected.
- **Starting Point** (end signal): Choices are Upstream and Downstream; default is Downstream.
- **Bias** (in percentage): Adding bias will add a multiplier to the **Bias Direction** in the **Max Arrivals On Green By Second** chart, thereby adding weight to that direction for calculating the recommended delta.
- **Bias Direction:** Chooses the selected (Upstream or Downstream) direction to add the multiplier to.

Figure 33: Link Pivot Analysis Options

Figure 34: Signals along Route

After configuring the desired **Link Pivot** options, click **Run Report** to view the details of the **Adjustments** and **Approach Link Comparison**. Offset Adjustments include:

- The **Link**, a sequential numerical value for the signal within the selected route based on the Upstream/Downstream choice.
- Each **Signal** number.
- The **Location** of the signal depicted by the main street and cross street names. Link 1 in the example below (Figure 35) is Foothill Drive at Thunderbird.
- The recommended **Link Delta** for each signal. Delta is the recommended relative timing offset change for an approach on a link to optimize combined arrivals on green.
- **Edit Link Delta** allows editing to view what effect the change would have on the **Offset**.
- The recommended **Offset (+ to offset)** for each signal. The adjustment is the cumulative recommended offset change versus the cycle length. It is determined as each link's delta is applied to the upstream approach.
- **Existing Offset** allows editing to enter existing programmed field offsets to calculate actual offsets to program into field controllers.
- **New Offset** is a calculation of the **Offset** added to the **Existing Offset**.

Adjustments

Link	Signal	Location	Link Delta	Edit Link Delta	Offset(+ to Offset)	Existing Offset	New Offset
1	7371	Foothill Drive Thunderbird	0	0	45	0	45
2	7223	Foothill Drive 2100 South	6	6	45	0	45
3	7222	Foothill Drive 1700 South	69	69	39	0	39
4	7221	Foothill Drive 2300 East	2	2	60	0	60
5	7220	Foothill Drive 1300 South	1	1	58	0	58
6	7503	Foothill Drive 2100 East	90	90	57	0	57
7	7219	Foothill Drive Sunnyside	57	57	57	0	57
8	7218	Foothill Drive Wakara Way (660 S.)	0	0	0	0	0
9	7217	Foothill Drive Mario Capecchi Dr (1950 E.)	0	0	0	0	0

Figure 35: Link Pivot Adjustments

The **Approach Link Comparison** table (an example is shown in Figure 36) details upstream and downstream signals, upstream and downstream direction, information regarding percentages, and

number of vehicles for arrival on green (AOG), and includes a link to the respective Max Arrivals On Green By Second (**AOG Chart**) graph (see Figure 37).

Figure 36: Approach Link Comparison
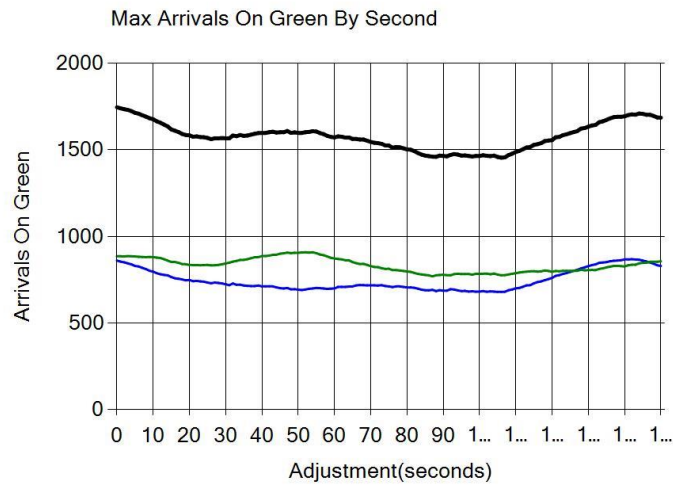
Figure 37: Max Arrivals On Green By Second

Within each link of the **Approach Link Comparison** table, a **PCD Options** button is displayed in the **AOG Chart** column. Clicking this button will add PCD Options (Figure 38) on the left pane below the Link Pivot **Run Report** button. The choices are:

- **Dates:** displays all dates within the range as determined in the **Link Pivot Analysis** options.
- **Y-Axis:** sets the Y-axis range limit. Default is 150.
- **Delta:** sets the **Link Delta** between the **Existing** and **Predicted** metrics for the **PCD Chart** to display. Defaults to the **Link Delta** from the **Adjustments** table, but can be modified to predict various outcomes.

After choosing the desired criteria, click the "View PCDs" button. The PCD charts for both the **Existing** and **Predicted** AoG will display.

Figure 38: Link Pivot PCD Options
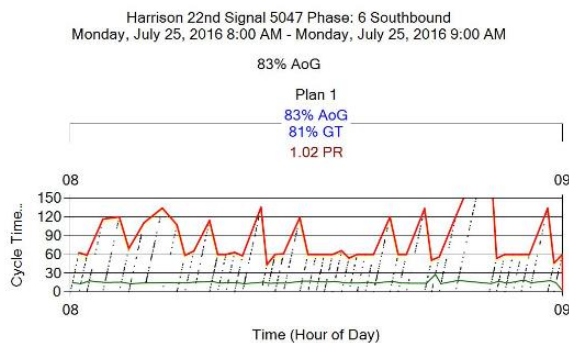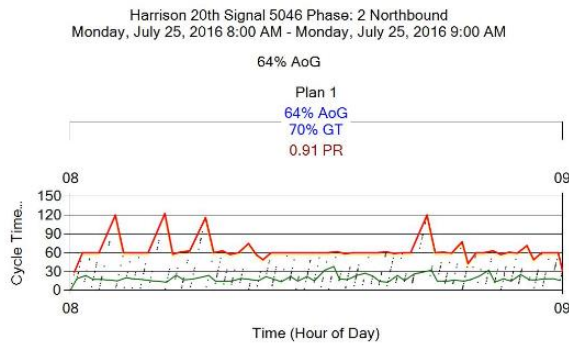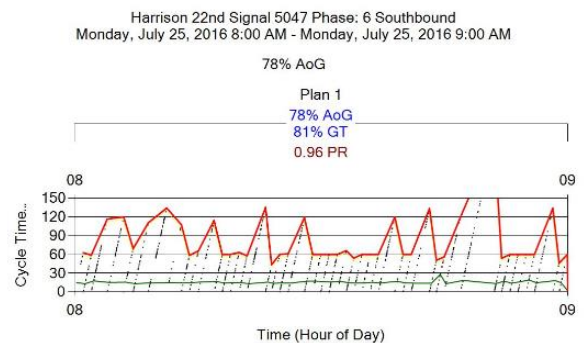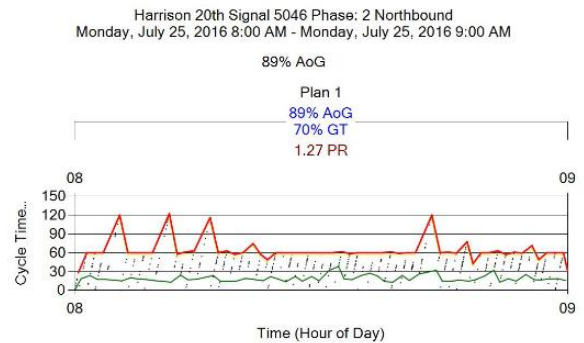
Figure 39 - Purdue Coordination Diagrams for Purdue Link Pivot

For the selected intersection and time period, the number and percentage of AOG are shown – for both existing and optimized conditions (see Figure 39).

See the Purdue Coordination Diagram for additional information on this metric.

1.4.   Signal Configuration

To access Signal Configuration, the user account logged into the system must have Admin Privileges. Click **Admin** and then **Signal Configuration**. A login screen will appear if you are not logged in. Once logged in as an administrator, you will see the website SPM Configuration Tool.
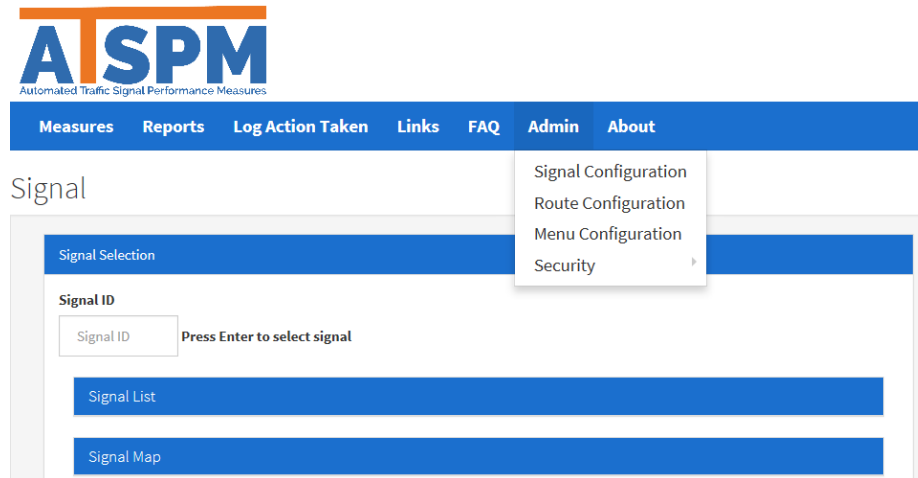
Figure 40: Admin Selection Options and SPM Configuration site

The SPM Configuration Tool, shown in Figure 40, offers options to create a new signal or edit existing ones. To begin the process of creating a new signal, click **Create New Signal**. This will open a pop-up window, shown in Figure 41, asking for the signal ID number.
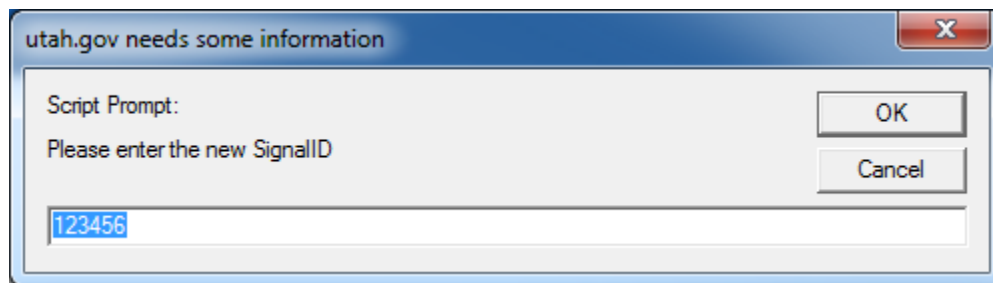
Figure 41: New Signal ID Prompt

Below the **Create New Signal** link is the Signal Selection pane for signal configuration editing. Use this area to edit an existing signal or a recently created one. This is like the signal selection area for choosing metrics to display. The options are to enter the **Signal ID**, navigate the **Signal List**, or choose it from the **Signal Map**.

After selecting the signal to configure, whether existing or new, the signal details will display below the map pane. The signal configuration pane confirms the selected signal; provides the command options of **Save** and **Copy**; and it provides configuration fields for **Primary Name**, **Secondary Name**, **IP Address**, **Latitude**, **Longitude**, **Region**, **Controller Type**, **Show on Map**, **Comments**, and the **Configuration Table**.

Command functions are:

- **Save:** commits any edits made in the configuration fields.
- **Copy:** replicates the data in the fields and presents the **Create New Signal** prompt.

Configuration fields are:

- **Primary Name:** the name of the main road at the intersection.
- **Secondary Name:** the name of the secondary road at the intersection.
- **IP Address:** the Internet Protocol (IP) address for communication to the controller.
- **Latitude:** the geographical latitude location for mapping purposes.
- **Longitude:** the geographical longitude location for mapping purposes.
- **Region:** the regional name for mapping purposes.
- **Controller Type:** the controller type.
- **Show on Map:** a checkbox to choose whether the signal is displayed on the map.
- **Comments:** the notes relative to the intersection. These will show up at the top of the metric page. Only the newest comment will show. A space can be saved to effectively erase the note.
- **Configuration Table:** an expandable link (see Figure 42) that once clicked displays all detector information including the Detector ID, Detector Channel, Phase, and other detector settings.

Configuration Table

Detector ID	Det. Channel	Phase	Perm. Phase	Overlap	Direction	Enabled	PCD Enabled	Dist. From StopBar	MPH	Decision Point	Speed Enabled	Move. Delay	Min Speed Filter	TMC Enabled	YRA Enabled	Split Fail Enabled	Lane Type	Comment
722014	14	2		False	Northbound	True	True	350	40		True	15	5	False	False	False		was 6 dt 4-5-13
722018	18	2		False	Northbound	True	False		40		False			False	False	True		
722019	19	2		False	Northbound	True	False		40		False			False	False	True		
722020	20	2		False	Northbound	True	False		40		False			False	False	True		

Figure 42: Detector Configuration Table expanded

Below the **Configuration Table** is a list of all approaches (Phase/Direction). Clicking on an approach expands the detectors for that approach. Each **Detector** can also be expanded (see Figure 43) to display the configuration for a **Detector**. The **Phase/Direction** and **Detector** configuration options are:

- **Phase/Direction**
  - **Direction:** a dropdown list of the directions **NB**, **SB**, **EB**, **WB**, **NE**, **NW**, **SE,** and **SW**.
  - **Description:** the header bar text for the approach. The recommendation is direction and phase, for example, "NBT Ph2."
  - **Protected Phase:** the number associated with the phase.
  - **Permissive Phase:** if applicable, the number of any permissible phase.
  - **Overlap:** a checkbox to select if the phase is an overlap.
- **Detectors (expand):**
  - **Det (Detector) Channel:** the number associated with the detector.
  - **Detector Types:** a group of selectable boxes for types of detection, including:
    - **Advanced Count Sensor**
    - **Advanced Speed**
    - **Lane-by-lane Count**
    - **Lane-by-lane with Speed Restriction**
    - **Stop Bar Presence**
  - **Date Added:** a calendar field for date time selection.
  - **Detector Comment:** a field that displays existing comments with the ability to add a new comment.

- **New Comment:** to enter a new comment, press the blue circle with a white plus; this opens a new **Comment Text** field and a **Create** button.
  - **MPH (Advanced Count, Advanced Speed):** to enter the speed limit for the approach.
  - **Lane Number (Lane-by-lane Count):** the lane number, if detector(s) are assigned to individual lanes. This is available for all detection types but only required for Lane-by-lane Counts.
  - **Distance To Stop Bar (Advanced Count):** enters the distance to the stop bar for Purdue Coordination.
  - **Decision Point (Advanced Count):** blank for the Utah ATSPM, but incorporated if other agencies wish to move the timestamp earlier (in seconds) e.g. 3 seconds before the stop bar.
  - **Movement Delay (Advanced Speed):** the approximate time in seconds needed to clear the queue to the sensor. (Usually 15 seconds)
  - **Min Speed Filter (Advanced Speed):** any speeds below this value will not be included in the calculation of average or percentile speeds. (Usually 5 mph)
  - **Movement Type (Lane-by-lane Count):** a dropdown list for the type of direction of travel for the lane. The choices are **Thru**, **Right**, **Left**, **Thru-Right,** and **Thru-Left**. This is available for all detection types but only required for Lane-by-lane Counts.
  - **Lane Type (Lane-by-lane Count):** a dropdown list for the type of direction of travel for the lane. The choices are **Vehicle**, **Bike**, **Pedestrian**, **Exit**, **Light Rail Transit**, **Bus**, and **High Occupancy Vehicle**. This is available for all detection types but only required for Lane-by-lane Counts.

Figure 43: Approach with One Detector Options Expanded

1.5. Route Configuration

To access the Route Configuration, the user account logged into the system must have Admin Privileges. Click **Admin** and then **Route Configuration**.

Index

Create New

RouteName	
R1: Riverdale Rd	Edit | Details | Delete
R2: Foothill Blvd	Edit | Details | Delete
R3: Pioneer Crossing	Edit | Details | Delete
R2: SR-36 South	Edit | Details | Delete

Figure 44: Route Configuration page

The route configuration page, shown in Figure 44, displays all existing **RouteName** and links to edit, view details on, or delete. There is also a link to **Create New** in the upper left corner.

- **Edit:** Selecting **Edit** next to a **RouteName** opens a webpage that allows a user to edit the name of the route.
- **Details:** Selecting **Details** opens a webpage (Figure 45) that displays all signals within the route, including the main and side road names, the direction of travel, and the phase. Within the **Details** page, there are also links to edit, view details, and delete for each intersection.
  - o **Edit** – Selecting **Edit** next to an **Intersection** opens a webpage that allows a user to edit the **ApproachRouteID**, **ApproachOrder**, and **ApproachID**. After making changes, click **Save** to commit them.
    - ▪ **ApproachRouteID** is a dropdown list of all existing routes.
    - ▪ **ApproachOrder** is a number for sequencing the signals.
    - ▪ **ApproachID** is a dropdown list of all existing intersections and phases.
  - o **Details** – Selecting **Details** opens a webpage that displays the signal's ID, the RouteName, and the ApproachOrder. This page also includes an edit link that brings the user to the **Details Edit** screen.
  - o **Delete** – Selecting **Delete** opens a website asking "are sure you want to delete this?" Clicking OK deletes the intersection from the route and removes the selected route from the table.
- **Delete:** Selecting **Delete** opens a website asking "are sure you want to delete this?" Clicking OK deletes the route from the list of routes returns the user to the Index.

Index

Create New

ApproachRouteDescription	RouteName	ApproachOrder	
5004 - Riverdale Road 1500 West Eastbound Phase 6	R1: Riverdale Rd	1	Edit | Details | Delete
5003 - Riverdale Road I-84 SPUI Eastbound Phase 6	R1: Riverdale Rd	2	Edit | Details | Delete
5002 - Riverdale Road 1050 West Eastbound Phase 6	R1: Riverdale Rd	3	Edit | Details | Delete

Figure 45: Route Details page

2. Reports

ATSPM incorporates **Reports** as a method to review data logs of which agency is accessing and entering information using the **Log Action Taken** command on the top menu.

Selecting **Reports > Chart Usage** navigates to the **Chart Usage Report** date selection page where there are two blank fields, one for the StartDate and one for the EndDate. StartDate auto populates with the first calendar date of the year and EndDate auto populates to the current date. These can be modified to the desired date range. After entering the desired range, click **Run Report** to load the usage reports for the prescribed period.

- **Chart Usage** – This is a pie chart displaying the usage or changes (in percent) of the ATSPM data for Purdue Phase Termination, Split Monitor, Pedestrian Delay, Preemption Details, Turning Movement Counts, Purdue Coordination Diagram, Approach Volume, Approach Delay, Arrivals on Red, Approach Speed, Yellow and Red Actuations, Purdue Split Failure, Purdue Link Pivot, Preempt Service Request, and Preempt Service. The chart is aggregated from user-input data through **Log Action Taken**.
- **Agency Usage** – This is a pie chart (see Figure 46) displaying the users or the agencies logging information. The users are Academics, City Government, Consultant, County Government, Federal Government, MPO (metropolitan planning organization), State Government, and Other. This is based on user-input data through **Log Action Taken**.
- **Reports Run** – This is a bar graph (see Figure 47) displaying the number of times each measure was run, based on self-reporting through **Log Action Taken**.
- **Actions By Metric** – This is a bar graph displaying the number of times actions based on each measure were taken. This is based off of user-input data through **Log Action Taken**.

The remaining charts are bar charts where the data represents the number of times and the type of actions taken regarding the metrics.

- **Purdue Phase Termination**
- **Split Monitor**
- **Pedestrian Delay**
- **Preemption Details**
- **Turning Movement Counts**
- **Purdue Coordination Diagram**
- **Approach Volume**
- **Approach Delay**
- **Arrivals On Red**
- **Approach Speed**
- **Yellow and Red Actuations**
- **Purdue Split Failure**
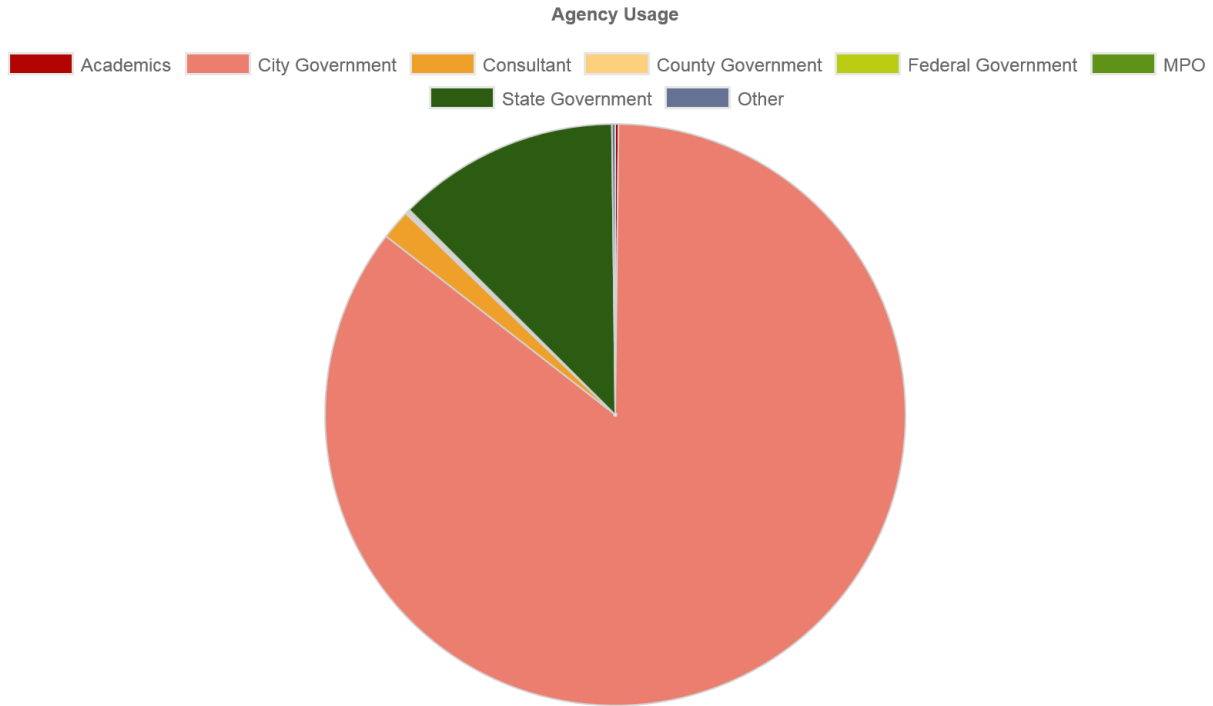
Figure 46: Agency Usage chart (pie example)
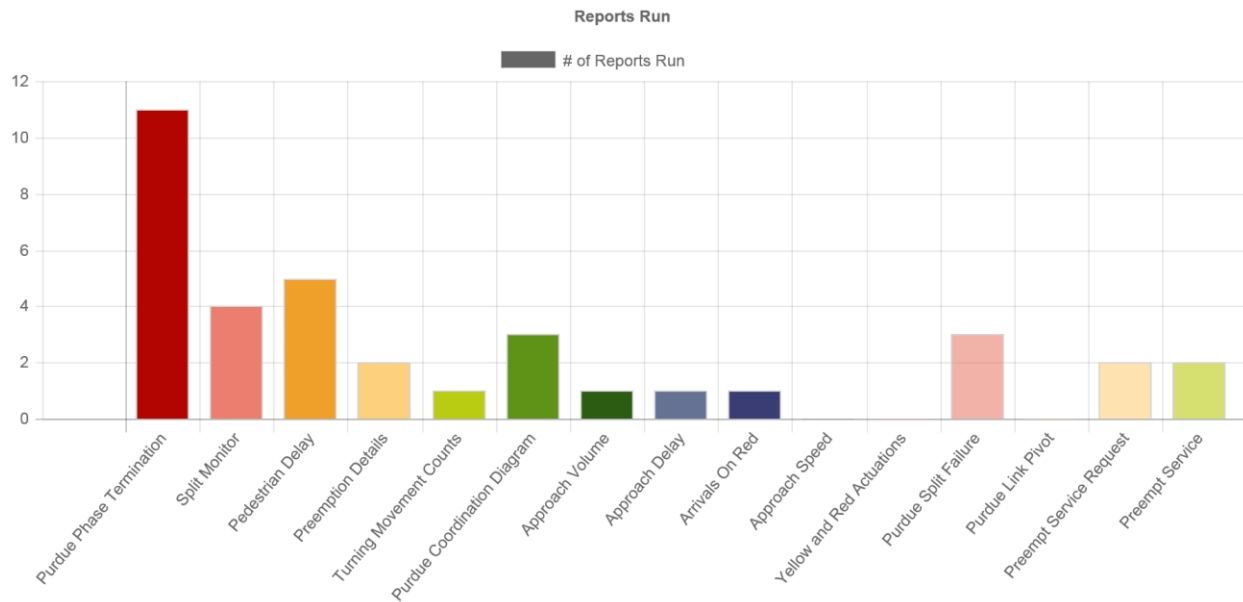
Figure 47: Reports Run chart (bar example)

3.   Log Action Taken

Selecting **Log Action Taken** displays a data entry form for the Create Action Log as shown in Figure 48.

Figure 48: Create Action Log Form

This entry only form allows a user – for example, an agency employee – to record activities performed in response to ATSPM information. Actions can include signal retiming, a traffic study, and more. These actions will then be used to populate a Usage report. There are seven areas to complete during the process of logging actions. All fields except Comment are required. These fields are:

- **Name:** The name of the person entering the action.
- **Date:** Auto-populated with the current date, which can be modified if the action is not being logged on the date it was taken.
- **Signal:** A dropdown list with all signal IDs and location. Select the corresponding signal ID and location for the logged action.
- **Agency:** A dropdown list for the type of entity that performed the action. The choices are:
  - Academics
  - City Government
  - Consultant
  - County Government
  - Federal Government
  - MPO

- o State Government
- o Other
- **MetricTypes:** A group of Check Boxes for each metric. Select the applicable metric or metrics that motivated the action.
- **Comment:** A text box to enter comments about the action.

After all appropriate fields are completed, click the **Create** button to complete the log of the action taken.

4. Links

The **Links** tab on the ATSPM menu bar provides hyperlink access to various documents, presentations, and ATSPM sites from other states. These links can be used for implementation possibilities and information related to ATSPM. Each state's ATSPM links will vary. Links available at the UDOT ATSPM site are described herein.

4.1. ATSPM Documents

4.1.1. GDOT ATSPM documentation

4.1.1.1. Installation Manual

The GDOT ATSPM Installation Manual is an Atkins publication developed in collaboration with Utah DOT for Georgia. It is a detailed manual depicting step-by-step instructions on how to install and configure the ATSPM.

4.1.1.2. Component Details

The GDOT ATSPM Component Details is an Atkins publication developed in collaboration with Utah DOT for Georgia. It is a detailed description on navigating the ATSPM site and configuring reports to ensure they include the desired results.

4.1.1.3. Reporting Details

The GDOT ATSPM Reporting Details is an Atkins publication developed in collaboration with Utah DOT for Georgia. It includes detailed guidance on the components necessary to provide each metric as well as how the data is gathered, displayed, and interpreted.

4.2. ATSPM Presentations

The **ATSPM Presentations** link provides users access to four separate presentations Utah has given. They are:

- ATSPM UDOT Conference 11-2-16
- ATSPM CO WY ITE & Rocky Mtn 10-20-16

- ATSPM ITS California 9-21-16
- ATSPM EDC4 Minnesota 10-25-16

4.3.   UDOT Traffic Signal Documents

The **UDOT Traffic Signal Documents** link provides access to three Utah documents for information regarding the UDOT **Traffic Signal Management Plan (TSMP)**, the UDOT **Emergency Response Plan for UDOT's Traffic Signals**, and **Signal Ops QIT Final Report** for providing "world class traffic signal maintenance and operations" in Utah.

4.4.   Indiana Hi Resolution Data Logger Enumerations

The **Indiana Hi Resolution Data Logger Enumerations** link accesses the Purdue University document of the same title in the Purdue e-Pubs library. "This document [created by industry representatives and Purdue staff] defines the enumerations used to encode events that occur on traffic signal controllers with high resolution data loggers."

4.5.   Seminole County, Florida

The **Seminole County** link accesses another ATSPM site for Seminole County Florida. This is currently the 3.0 version of the ATSPM software.

4.6.   FAST (Southern Nevada)

The **FAST** link accesses another ATSPM site for Seminole County Florida. This is currently an older version of the UDOT ATSPM software, but has some enhancements added by FAST.

5.   FAQ

The **FAQ** tab on the ATSPM menu bar, shown in Figure 49, includes questions that, when selected, expand to show the answer to each question. These include questions and answers for the public, such as navigation tips and a description of what SPMs are, as well as detailed information regarding server, data storage, and system requirements. A question regarding whom to contact for additional information is also provided. Questions and answers can be modified for each agency as needed.

Who uses the Signal Performance Metrics data?

The data has been useful for some of the following users in Utah:

- Signal engineers in optimize and fine-tuning signal timing.
- Maintenance signal technicians in identifying broken detector problems and investigating trouble calls.
- Traffic engineers in conducting various traffic studies, such as speed studies, turning movement studies, modeling studies, and optimizing the intersection operations.
- Consultants in improving traffic signal operations, as UDOT outsources some of the signal operations, design and planning to consultants.
- UDOT Traffic & Safety, UDOT Traffic Engineers, UDOT Resident Construction Engineers in conducting various traffic studies and/or in determining the time-of-day where construction or maintenance activities would be least disruptive to the traveling motorists.
- Metropolitan Planning Organizations (MPO's) in calibrating the regional traffic models.
- Academia in conducting various research studies, such as evaluating the effectiveness of operations during adverse weather, evaluating the optimum signal timing for innovative intersections such as DDI's, CFI's and Thru-Turns, etc.
- City and County Government in using the data in similar manner to UDOT.

What are the detection requirements for each metric?

Figure 49: FAQ site with a question expanded

6. Additional Website Components

6.1. Generate Add Data Script

This is an application tool supporting the website. It generates JavaScript code based on the traffic controllers currently configured in the database. The output JavaScript file, in turn, places controller location pins on navigation map (as shown in Figure 50).
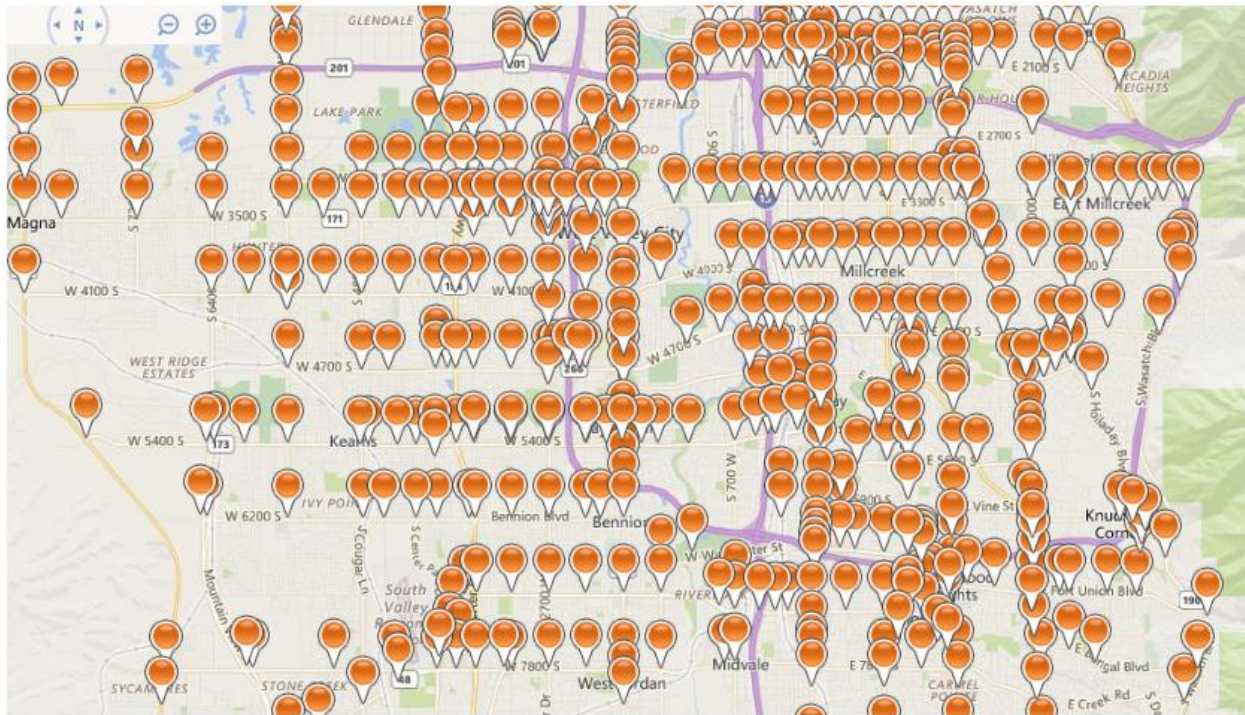
Figure 50: Map pins generated by JavaScript

The **GenerateAddDataScript** executable is invoked by the Windows scheduler on a timer. Typically, the timer is scheduled hourly, so it can pick up new traffic signals that have been added to the system. A copy of the *MOE.Common.DLL.Config* file should be placed in the same folder as the script generator, so the application can pick up the database location and connection strings.

The **GenerateAddDataScript.config** file sets configuration keys for this executable. The most relevant key is:

- **Path*N***: The physical or network path where the javascript will be saved. Multiple output paths may be specified, where *N* is numeric starting at 1. The path must end with the javascript filename, typically *AddData.js*.

6.2. Speed Listener

This component, **WavetronicsSpeedListener.exe**, receives data packets from Wavetronix Advance Detectors via a Digi PortServer®. The Digi PortServer must be configured to send to the IP address and port of the speed listener service. Other serial to Ethernet converters will likely function, but the instructions provided are specifically for the PortServer. When the speed listener receives a new packet, it creates a timestamp, pairs it with the data, and inserts the detector ID, miles per hour, kilometers per hour, and timestamp into the Speed Events table in the database.

The database connection information is contained in the speed listener configuration file, **WavetronicsSpeedListener.exe.config**.

7. Data Collection Components

7.1. FTP from All Controllers

ATSPM uses the **FTPfromAllControllers** executable as a background task managed by Windows Scheduler. This component fetches logs via file transfer protocol (FTP). Once the logs are retrieved, Decode and Import processes (described in the following section) will decode the files and ingest them to the system database.

The **FTPfromAllControllers.exe.config** file sets configuration keys for this executable. The most relevant keys are:

- **HostDir:** Denotes the path where the downloaded signal logs (.DAT) will be stored. The path can be any network path or local disk. Downloaded files are written to a subdirectory corresponding to the signal controller. These subdirectories are keyed according to the website's internal, 4-digit signal ID.
- **DeleteFiles:** This true/false flag controls whether logs are deleted on the signal controller after being retrieved.

7.2. Decode and Import

ATSPM invokes several different processes to decode signal controller logs and ingest the data into the system database. The process used depends on the signal controller vendor. These processes are background tasks managed by the Windows scheduler, and are described in the following subsections.

7.2.1. ASC/3

The **NewDecodeAndImportASC3Logs** executable decodes and imports logs from the Econolite ASC/3 signal controller.

The **NewDecodeAndImportASC3Logs.exe.config** file sets configuration keys for this executable. The most relevant keys are:

- **ASC3LogsPath:** Denotes the path of the downloaded signal logs (.DAT) from the controller. Normally this is the same path as **FTPfromAllControllers.exe.config (HostDir)**.
- **CSVOutPath:** Denotes the output folder where decoded CSV files are placed.
- **DeleteFiles:** Specifies whether the importer deletes the .DAT files after ingesting them into the database.

7.2.2. Siemens

The **DecodeSiemensLogs** executable decodes and imports logs from Siemens signal controllers.

The **DecodeSiemensLogs.exe.config** sets configuration keys for this executable. The most relevant keys are:

- **LogPath:** Denotes the path of the downloaded signal logs (.DAT) from the controller. Normally this is the same path as **FTPfromAllControllers.exe.config <HostDir>**.
- **DeleteFile:** Specifies whether the importer deletes the .DAT files after ingesting them into the database.
- **CSVOutPath:** Denotes the output folder where decoded CSV files are placed.
- **DecoderPath**: Specifies the full path to the SiemensDecoder.exe, a proprietary Siemens component required for the Siemens decoder to run.

7.2.3.   TrafficWare

 The **DecodeTrafficwareLogs** executable decodes and imports logs from Siemens signal controllers.

The **DecodeTrafficwareLogs.exe.config** sets configuration keys for this executable. The most relevant keys are:

- **TWLogsPath:** Denotes the path of the downloaded signal logs (.DAT) from the controller. Normally this is the same path as **FTPfromAllControllers.exe.config (HostDir)**.
- **DeleteFile:** Specifies whether the importer deletes the .DAT files after ingesting them into the database.
- **CSVOutPath:** Denotes the output folder where decoded CSV files are placed.
- **DecoderPath:** Specifies the full path to the SiemensDecoder.exe, a proprietary Siemens component required for the Siemens decoder to run.

7.2.4.   Peek

Retrieval and ingestion of information from Peek is configured on a case-by-case deployment. The Peek representative should be consulted during ATSPM deployment with this hardware.

7.2.5.   Intelight MaxTime

Retrieval and ingestion of information from Intelight MaxTime is handled differently from all other signal vendors. Since the MaxTime interface is entirely web based, ATSPM employs a web service to communicate with this hardware.

The **GetMaxTimeRecords** executable handles retrieval of controller events and ingestion into the database. Windows scheduler runs this at regular intervals as a scheduled task (typically every five minutes). Events are retrieved in XML format and ingested directly into the database. No FTP is necessary.

7.3.   Archive Metric Data

This tool pre-processes traffic signal data. Data for every intersection in the system is processed. It supports the creation of Executive Reports when requested by the user, and allows them to be generated in a timely manner. It saves off data in configurable bins (time chunks).

The executable is **ArchiveMetricData.exe** and is typically scheduled to run each evening (as a background task via Windows Scheduler). Its settings are configured in **ArchiveMetricData.exe.config**. Relevant keys in this configuration file include:

- **<BinSize>:** The size of time chunk, in minutes, in which data are grouped. Default is 15 minutes.
- **<ErrorRecipients>:** A comma-separated list of email addresses that are notified, should an archiving error occur.
- **<MaxThreads>:** The maximum number of central processing unit (CPU) threads the executable process will use.
- **<ConnectionStrings>:** Connection string(s) for the target database(s).

The processed information and statistics are stored in the *Archived_Metrics* table in the system database. For each time bin, the volume, speed, cumulate delay, cumulative AoR, and cumulative green time are tabulated.

7.4.   ATSPM Watchdog

The ATSPM Watchdog is a scheduled executable. It sends out email alerts when it detects one or more of the following conditions (based on defaults in the configuration file):

- **No data:** report phases with less than 500 records in the database between midnight and midnight the previous day.
- **Force offs:** report phases with more than 90% force offs in at least 50 activations between 1 a.m. and 5 a.m. the same day.
- **Max outs:** report signals with more than 90% max outs in at least 50 activations between 1 a.m. and 5 a.m. the same day.
- **Low advanced detector counts:** report phases with PCD detectors that have less than 100 vehicles counted between 5 p.m. and 6 p.m. the previous day.
- **Stuck ped:** report phases with more than 200 pedestrian activations between 1 a.m. and 5 a.m. the same day.

Watchdog is intended to run daily. Normally, only the first occurrence of each error will be reported. But if a day or more is skipped, previous occurrences will be reported as new errors the next time watchdog runs. For example, if watchdog is not run Monday but resumes Tuesday, then the Tuesday run will report new errors from both the Monday and Tuesday periods. This should be rare, but does provide a means to catch problems that may have been missed.

The "AspNetUsers" database table contains the list of email recipients. If the "ReceiveAlerts" column value is set to one, the user will receive emails generated by the SPM Watchdog. If the value is set to zero, the user will not receive any emails.

The executable is **ATSPMWatchDogNew.exe** and is typically scheduled to run early each morning (as a background task via Windows Scheduler). Its settings are configured in **ATSPMWatchDogNew.exe.config**. Relevant keys in this configuration file include:

- **ConnectionStrings:** Connection string(s) for the target database(s). The key for the default string is "ATSPM."
- **ConsecutiveCount:** The minimum number of consecutive phase termination events for the watchdog criteria to apply.
- **StartHour** and **EndHour:** The hours of the day between which the watchdog criteria will apply. These are on a 24-hour scale; 8 corresponds to 8:00 in the morning, while 18 is 6:00 in the evening.
- **EmailServer:** The mail server that will send the Watchdog emails. If the mail server is hosted on the same machine running Watchdog, use the machine's network name.
- **ToAddress**: This field will append an email address on the outbound email to the corresponding address(s) in the database.
- **PercentThreshold:** This is the threshold percentage for max-out or force-off phases, for these data to be included in the Watchdog criteria. The percentage is expressed as a decimal; 0.9 corresponds to 90 percent.
- **MinPhaseTerminations:** The minimum number of phase termination events (max-out or force-off) for these data to be included in the Watchdog criteria. Applied in conjunction with **PercentThreshold**.
- **LowHitTheshold:** The volume threshold, tallied between **StartHour** and **EndHour**, below which the low hit count Watchdog criteria will apply.
- **MaxThreads:** The maximum number of CPU threads the executable process will use.

8. Architectural Components

8.1. MOE WCF Library

The MOE WCF Library (MOEWcfServiceLibrary in the source code) contains Windows Communication Foundation (WCF) services. Currently, ATSPM uses the Metric Generator and Link Pivot services.

The Metric Generator service is hosted on the web server, and handles requests triggered when the user clicks "Create Chart." The service, in turn, instantiates a "MetricOptions" object corresponding to the chart type and returns it to MOE.Common (see below). Similarly, when the user runs a Link Pivot Report, the Link Pivot Service will create a LinkPivot object and return its parameters to MOE.Common.

8.2. MOE.Common

MOE.Common represents the core, business logic of the ATSPM website. As part of the Model-View-Controller architecture, it includes the "Model" logic which scans the database and generates all charts. The "MetricOptions" object described above (and in the Reporting Details document) is housed here and contains sub-types corresponding to each chart (such as Turning Movement Counts, Arrivals on Red, Split Monitor, etc.).

9.   Configuration Tools

9.1.   ATSPM Configuration Tool

The ATSPM Configuration Tool is used to set up and configure traffic signals, approaches for each signal, and detectors attached to the respective signals. This component is built into the website, accessible from the top menu (**Admin > Signal Configuration**). When accessing this item, the user may be asked to log in with an administrative account if necessary.

For additional information on this tool, please see: Signal Configuration.

Appendix A: Glossary

This Appendix lists and defines the technical terms used throughout the document.

A.1. Activation (pedestrian)

Activation of a pedestrian phase indicates the phase was served. This includes actuation by the push button or if the phase was called by a ped recall or coordination.

A.2. Actuation (pedestrian)

Actuation is another term for a pedestrian pressing the button at the crosswalk to request the crossing signal.

A.3. Approach Delay

Approach delay is defined as the time starting when the vehicle begins to decelerate at an intersection and ending when it crosses the stop bar.

On the ATSPM website, this figure is simplified as the time starting when the advance detector is actuated and ending when the phase turns green.

A.4. D (Directional) Factor

D Factor indicates the directionality of flow when comparing opposing directions (east versus west, north versus south). It can be the ratio of one direction to the other or of one direction to their sum (directional split).

A.5. Dwell Time

On signal controllers supporting preemption, dwell time is the time elapsed while the preemption is activated and servicing the emergency movement. For example, dwell time applies when the railroad gates are down and the train is present.

A.6. Entry Delay

On signal controllers supporting preemption, entry delay is a timing delaying the onset of preemption.

A.7. Force Off

Force Off occurs when the controller's split timer expires, terminating the phase. This only occurs under coordinated operation. A force-off indicates that a phase is over-capacity.

A.8.   Gap Out

Gap Out occurs when the signal controller terminates the phase because its minimum time has been served, and the vehicle extension timer has expired. A gap-out can indicate that a phase has excess capacity.

A.9.   Green Occupancy Ratio

GOR is the proportion of green time that a detector is occupied. On the ATSPM website, the detector is at the stop bar.

A.10.   Green Time

The time, in seconds, that a phase (or overlap) has the green light.

A.11.   K Factor

On the ATSPM website, the K Factor denotes the ratio of the peak hour volume to the total traffic for the day. It is non-applicable when the analysis period is shorter or longer than 24 hours.

A.12.   Lane Utilization Adjustment Factor

The f_{LU} reflects the degree of variation of traffic flow between lanes in a lane group. According to the *Highway Capacity Manual 2000*, it is calculated as:

$$f_{LU} = v_g/(v_{g1}N)$$

V_g is the unadjusted demand flow rate for the lane group in vehicles/hour. V_{g1} is the unadjusted demand flow rate on the single lane in the lane group with the highest volume. A f_{LU} of 1.0 indicates that all lanes in the group have the exact same flow rate.

A.13.   Max Out (phase)

Max Out occurs when, under high traffic demand, a phase has been extended to its maximum length. This only occurs under non-coordinated operation. A max-out indicates that a phase is over-capacity.

A.14.   Max Out (preemption)

On signal controllers supporting preemption, max out refers to a timer that expires after initiation of the preempt call. The max out timer covers cases where the emergency movement was never actually serviced (a false alarm).

A.15.   Occurrence

In Yellow and Red Actuation, Occurrence is defined as a vehicle proceeding beyond the stop bar and entering the intersection during the yellow indication.

A.16.   Peak Hour

Peak Hour is the hour within a time period (typically a day) with the maximum volume. The hour is measured with a 15-minute resolution. Thus, the peak hour might be 4:15-5:15 PM.

A.17.   Peak Hour Volume

Peak Hour Volume is the vehicle count recorded during the peak hour.

A.18.   Peak Hour Factor

Peak Hour Factor (PHF) measures the relationship between the peak hour volume and the maximum rate of flow within that hour.

PHF for the standard 15-minute volume resolution is described as:

$$PHF = \frac{V_h}{4 \cdot V_{15\,max}}$$

V_h is the peak hour volume, and V_{15max} is the highest 15-minute volume recorded during that hour. A PHF of 1.0 indicates perfectly uniform traffic flow within the peak hour.

A.19.   Preemption

Preemption is a function in most signal controllers, whereby an external source sends the controller command to change operating conditions for a special event. Preemption is often used for emergency vehicles and railroad crossings.

A.20.   Platoon Ratio

Platoon ratio is a metric describing the quality of vehicle progression through an intersection. Higher ratios denote higher degrees of platooning, or AoG.

Platoon ratio R_p is calculated as:

$$R_p = \frac{P}{g/C} = \frac{CP}{g}$$

P is the proportion of vehicles arriving on green, *g* is the length of green in the cycle, and *C* is the overall cycle length.

A.21.   Red Occupancy Ratio

ROR is the proportion of time that a detector is occupied during the beginning of red (default, five seconds). On the ATSPM website, the detector is at the stop bar.

A.22.   Split

Split is the fraction of the overall cycle time the signal controller assigns to a particular phase. It includes the green, yellow, and red intervals.

A.23.   Split Failure

Split failure occurs when a signal controller is unable to serve all the demand on a phase within a cycle. Split failure imposes delay on vehicles passing through the intersection.

A.24.   Time-to-Service

On signal controllers supporting preemption, time-to-service elapses between the initiation of the preempt call and the actual servicing of the emergency movement.

A.25.   Violation

In Yellow and Red Actuation, Violation is defined as a vehicle proceeding beyond the stop bar and entering the intersection during the red indication.