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March 28, 2023
Page 1 of 7

SUBJECT: eGen Flex™ Geofencing User Guidelines

Introduction:

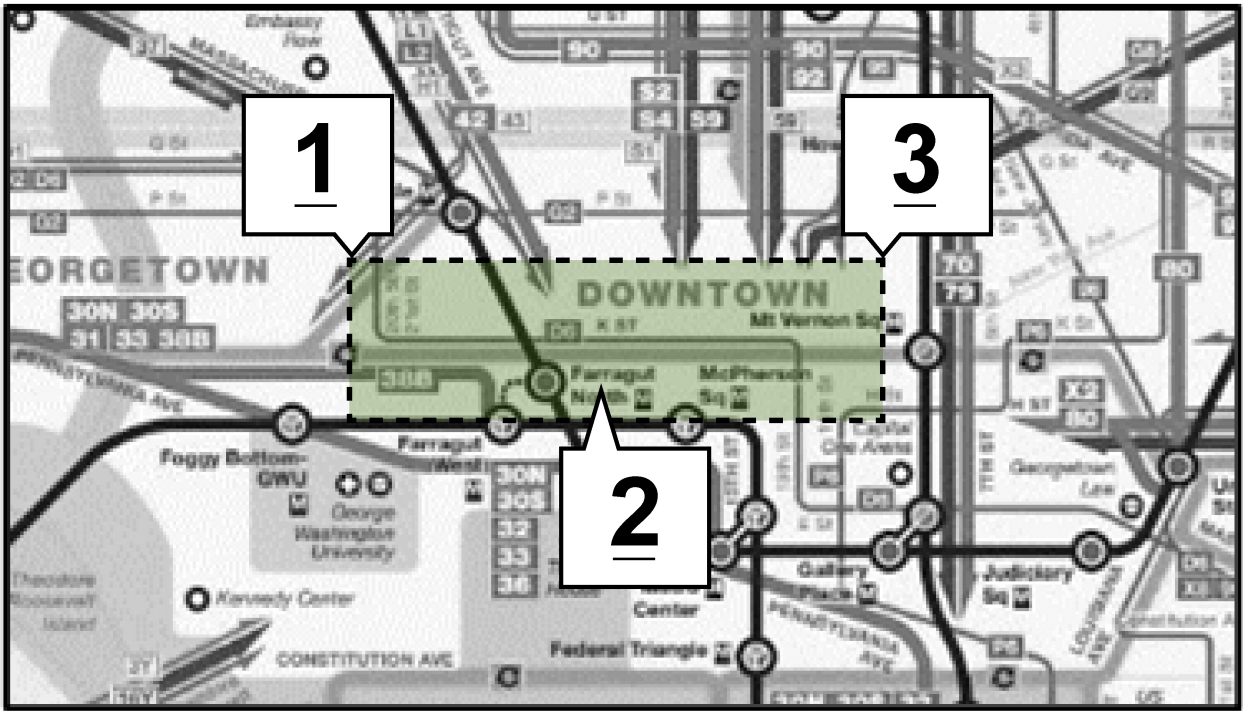
The Allison eGen Flex™ Max system can operate Emission Free up to 50% of the time during daily in-route operation (duty cycle dependent). This is accomplished through geofencing within a Telematics Service Provider (TSP) User Interface (UI). Fleets will specify and change geofencing zones through the TSP UI. Geofencing is ideal for places of high population along a bus route, such as near hospitals, schools, bus stops, downtown courts or bus depots.

How It Works:

Geofencing zones can be created for different routes and assigned to specific buses as needed. Upon setting up the geofencing zones within the TSP UI, the mode of operation being requested is engaged automatically and no additional action from the bus operator is required. All signals are transferred through the OEM body controller. The Allison eGen Flex Max system relies on commanded messages to change the modes of operation. Geofencing messages will be received by Allison controls through the body controller once a switch or TSP command is requested and vehicle conditions are met. The TSP will use GPS to determine the location of the bus. Once the bus crosses a geofenced area, a J1939 message is sent to the Allison eGen Flex Max system, requesting a certain mode of operation (e.g. EV Mode or EV Charge Mode). If the conditions are met, the bus will enter the mode being requested. When a bus is not operating in a geofenced area, the bus returns to its default operating mode (e.g. Engine Stop-Start Mode or Hybrid Mode).



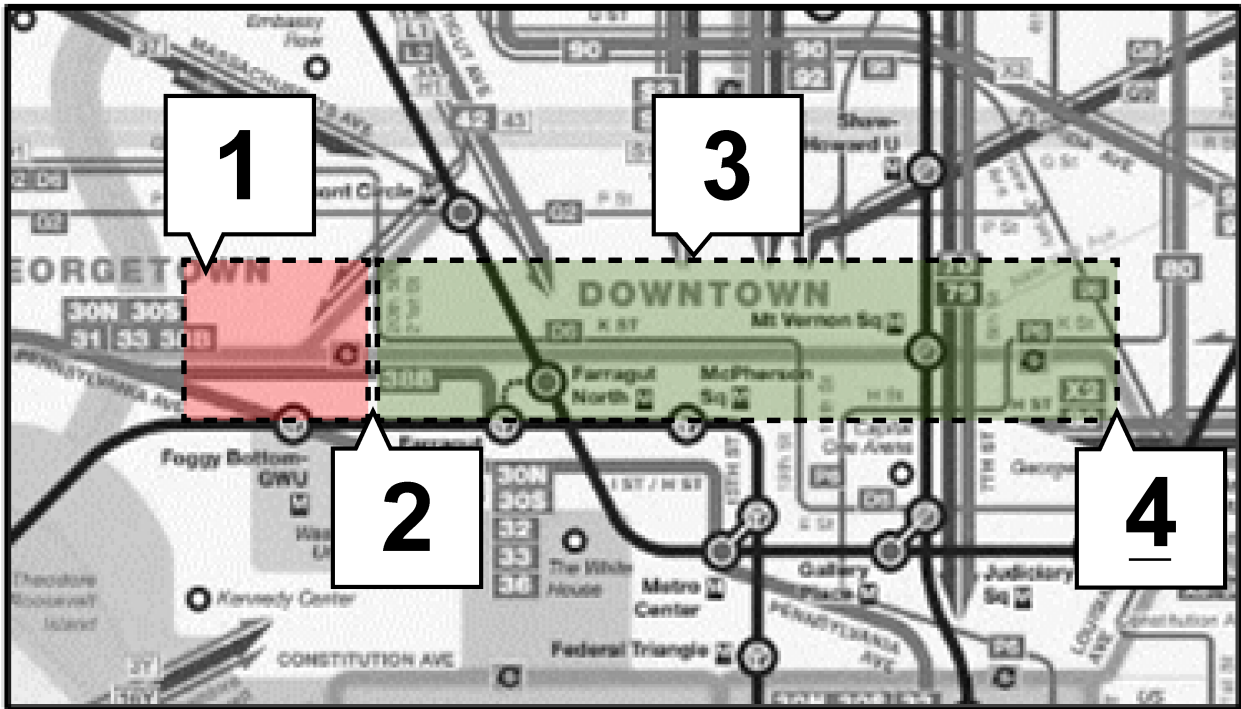
NOTE: EV Mode is the mode of operation in which a bus operates with zero-emissions propulsion and accessories throughout a geofenced zone. EV Charge Mode is the mode of operation in which a bus temporarily increases the engine's RPMs to increase the battery's State of Charge (SOC) before an oncoming EV Zone that is greater than 15 minutes in length. EV Charge Zones are recommended to be $\frac{1}{4}$ of the distance of the oncoming EV Zone.



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- (1) – The engine automatically turns off after the bus enters a designated EV Zone.
- (2) – The bus operates with zero-emissions propulsion and accessories throughout the EV Zone.
- (3) – The engine automatically restarts after the bus exits the designated EV Zone.

Figure 1. EV Mode Operation



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- | | | |
|--|---|---|
| (1) – The bus temporarily increases the engine’s RPMs to increase the battery’s SOC. <i>An EV Charge Zone is recommended when the oncoming EV Zone is greater than 15 minutes in length.</i> | (2) – The engine automatically turns off after the bus enters a designated EV Zone. | (4) – The engine automatically restarts after the bus exits the designated EV Zone. |
| (3) – The bus operates with zero-emissions propulsion and accessories throughout the EV Zone. | | |

Figure 2. EV Charge and EV Mode Operation

Questions to Ask Before Geofencing:

Before implementing the Geofencing Guidelines outlined below, users need to identify what their transit property’s goals are. For example, the transit property’s goal may be one of the following:

- Maximize EV Mode operation.*
- Geofence Zero Emission Zones based on location, such as in Reduced Noise Designated Areas or near hospitals, schools, downtown courts, etc.
- Geofence only bus stops along a route, so the bus operates Emission Free when approaching a bus stop, loading/unloading passengers and departing a bus stop.
- Geofence only at the bus depot.
- Balance EV Mode operation and fuel economy.**

** How to Maximize EV Mode Operation*

1. Locate the areas where you want to place EV Zones.
2. Reasonably extend each EV Zone around points of interest (within Allison’s guidelines).

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3. Adjust EV Charge Zones as needed per Allison's guidelines.
4. Balance EV Mode operation with default operating mode (e.g. Engine Stop-Start Mode or Hybrid Mode) to avoid large, constant SOC swings.



NOTE: It is recommended to keep EV Mode operation up to 40% of the route distance.

**** How to Balance EV Mode Operation and Fuel Economy**

1. Locate the areas where EV Zones are necessary.
2. Focus on small EV Zones (less than 15 minutes in length), so they do not require EV Charge Zones.
3. Provide adequate time between the EV Zones to allow the battery's SOC to return to its nominal level through default operating mode (e.g. Engine Stop-Start Mode or Hybrid Mode). Refer to item 8 in [Frequently Asked Questions](#): for additional guidance.

Geofencing Guidelines:

The following guidelines aid in configuring EV and EV Charge Zones within a TSP's UI for an Allison eGen Flex Max-equipped vehicle. By following these guidelines, fleets will optimize Zero Emission Zones, increase the probability of the control system achieving EV Mode while operating in Zero Emission Zones and maintain battery life expectations.

- Activation points must not be underneath structures that will interfere with GPS, such as bridges, tunnels, walkways, etc. GPS interference may result in the system's inability to activate the mode being requested.
- EV Zones are not recommended for speed limits over 35 mph (56 kph).
 - EV Mode is road speed limited at 35 mph (56 kph).
 - EV Mode will not activate until vehicle speed is under 35 mph (56 kph).
 - Road speed limit will not deactivate until the vehicle exits EV Mode.
- EV or EV Charge Mode activation may occur regardless of direction of travel into geofenced zones depending on the TSP geofencing implementation.
 - EV or EV Charge Mode may unintentionally activate on buses passing through an assigned geofenced zone from the opposite direction.
- Excessive EV Mode use can decrease battery life — use EV Zones where necessary.
 - Keep EV Zones up to 40% of the route distance.
 - EV Zone operation is capable of greater than 5 miles in length. Allison recommends keeping each EV Zone no longer than 5 miles in length to increase the probability of the control system honoring the full length of the EV Zone and to prevent excessive battery use.
 - Avoid EV operation on grades that are greater than 10%.
 - There must be at least some default operating mode (e.g. Engine Stop-Start Mode or Hybrid Mode) used within the route.
- For 40 foot (12 m) buses, the maximum targeted operating time for any single EV Zone should be less than 50 minutes. EV operation will cease when active for more than 50 minutes.
- For 60 foot (18 m) buses, the maximum targeted operating time for any single EV Zone should be less than 40 minutes. EV operation will cease when active for more than 40 minutes.

- Consideration should be given to the impact of traffic pattern changes on EV and EV Charge Mode activation and duration.
- Add EV Charge Zones before EV Zones that are expected to be greater than 15 minutes in length.
 - The suggested length of an EV Charge Zone is ¼ of the oncoming EV Zone distance.
- Small EV Zones can be defined around bus stops as desired.

Frequently Asked Questions:

Please contact your Allison Transit Sales Manager for questions regarding Allison’s Geofencing Guidelines.

1. What is the difference between the Allison eGen Flex Base and eGen Flex Max systems?

The Allison eGen Flex Base and eGen Flex Max systems share the same physical components and many of the same feature set. However, the Allison eGen Flex Max system can operate Emission Free up to 50% of the time during daily in-route operation (duty cycle dependent) through geofencing within a TSP UI. Properties can choose to utilize the Allison eGen Flex Max system’s geofencing capabilities or they can choose to operate the system in default operating mode (e.g. Engine Stop-Start Mode or Hybrid Mode). Please consult your OEM for which Allison eGen Flex system(s) they offer.

eGen Flex Base System	eGen Flex Max System
<p>Feature Set</p> <ul style="list-style-type: none"> • Hybrid Mode • Engine Stop-Start (ES-S) Mode • Regenerative Braking • Acceleration Rate Management (ARM) • Vanner Hybrid Beltless Alternator (HBA) <ul style="list-style-type: none"> – (For Accessory Electrification) <p>Additional Requirements</p> <ul style="list-style-type: none"> • Vanner IAP II™ System Required 	<p>Feature Set</p> <ul style="list-style-type: none"> • Hybrid Mode • Engine Stop-Start (ES-S) Mode • Regenerative Braking • Acceleration Rate Management (ARM) • Vanner Hybrid Beltless Alternator (HBA) <ul style="list-style-type: none"> – (For Accessory Electrification) • EV Operation (Emission Free up to 50% of the time during daily in-route operation – Duty Cycle Dependent) <ul style="list-style-type: none"> – EV Charge Mode – EV Mode – Depot Mode – Geofencing <p>Additional Requirements</p> <ul style="list-style-type: none"> • Vanner IAP II System Required

2. Does Engine Stop-Start Mode or Hybrid Mode need to be geofenced?

No. Default operating mode (e.g. Engine Stop-Start Mode or Hybrid Mode) does not need to be geofenced. Only EV and EV Charge Zones need to be geofenced according to Allison’s guidelines described above.

3. How can I monitor if a bus is achieving the EV Mode operation that I geofenced?

To maximize EV Zone operation, users may need to utilize the TSP’s reporting tools to analyze if the full length of each EV Zone is achieved. This can be accomplished multiple ways, including:

- Monitoring the number of EV Request(s) within the TSP’s reporting tool and comparing it to the number of EV Zone(s) set up in the TSP UI.

- *Example:* A bus completes a single route 10 times daily. Within the route, there are five bus stops, where an EV Zone is set up at each bus stop. If the TSP's reporting tool shows there were 50 EV Requests within a 24-hour period, a user can determine that the bus is operating in EV Mode as expected.
- Monitoring the percentage of EV Mode distance and total route distance by utilizing the TSP's reporting tools.
- *Example:* A bus completes a 10-mile route 20 times daily, making for a 200-mile route. Within the route, four miles of EV Zones are set up within the TSP UI. The mileage of EV Mode operation is expected to be 80 miles daily. If the TSP's reporting tool shows the bus only operates 50 miles in EV Mode daily, this indicates a user may need to adjust the EV Zones per Allison's guidelines within the TSP UI to maximize EV Mode operation.

4. What is the target life of the Allison eGen Flex Max system battery?

The target life of the Allison eGen Flex Max system battery is eight years. This battery life expectation assumes the bus is operating Emission Free up to 50% of the time during daily in-route operation (duty cycle dependent).

5. What is the purpose of EV Charge Mode? Is it necessary to geofence an EV Charge Zone before every oncoming EV Zone?

EV Charge Mode is the mode of operation in which a bus temporarily increases the engine's RPMs to increase the battery's SOC before an oncoming EV Zone that is greater than 15 minutes in length. EV Charge Zones are recommended to be $\frac{1}{4}$ of the distance of the oncoming EV Zone. EV Charge Zones are only necessary for zones greater than 15 minutes in length.

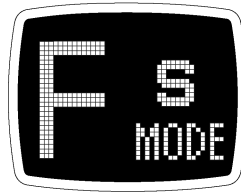
6. I geofenced an EV Zone where a section of the route's speed limit is greater than 35 mph (56 kph). What will happen?

EV Zones are not recommended for speed limits over 35 mph (56 kph). EV Mode is road speed limited at 35 mph (56 kph). EV Mode will not activate until vehicle speed is under 35 mph (56 kph). For sections of a route that have speed limits over 35 mph (56 kph), Allison recommends to trim existing or create multiple EV Zones to not include those sections of the route.

- If a bus enters an EV Zone traveling at or under 35 mph (56 kph), the bus will be limited to 35 mph (56 kph) throughout the EV Zone. The bus will not exit EV Mode, thus limiting road speed to 35 mph (56 kph) throughout the EV Zone.
- If a bus enters an EV Zone traveling over 35 mph (56 kph) and continues at that speed throughout the EV Zone, the bus will *not* enter EV Mode and will operate in default operating mode (e.g. Engine Stop-Start Mode or Hybrid Mode) regardless of the EV Zone.
- If a bus enters an EV Zone traveling over 35 mph (56 kph) and later reduces its speed to under 35 mph (56 kph), the bus will then enter EV Mode and will be limited to 35 mph (56 kph) throughout the rest of the EV Zone. The bus will not exit EV Mode if the driver attempts to exceed 35 mph, thus limiting road speed to 35 mph (56 kph) throughout the EV Zone

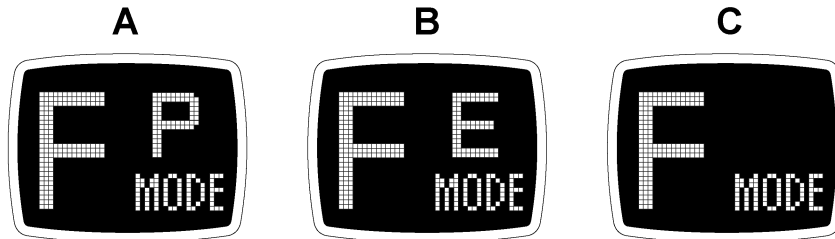
7. How is the operator notified of the bus's mode of operation?

An operator is notified of the bus's mode of operation through the Push Button Shift Selector (PBSS) display. Refer to [Figure 3](#) and [Figure 4](#). These figures and additional information can be found in the Allison eGen Flex Operator's Manual, which is available for download on [Allison HUB™](#).



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Figure 3. PBSS Display for Engine Stop-Start Mode



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Figure 4. PBSS Displays for EV Mode

(A) — EV Charge Mode Active

(B) — EV Mode Active

(C) — EV Mode Exited, Still being requested by GPS*

* When the vehicle is in a Zero Emission Zone and operating in EV Mode, the eGen Flex may exit to Hybrid Mode even though the vehicle has not exited the Zero Emission Zone. This typically occurs in heavy traffic when and the RESS SOC becomes too low to support EV Operation.

8. **What electric accessory load is allowed for EV Mode to be activated?**

EV Mode will support electric accessory loads up to 35 kW if battery conditions (SOC, temperature, voltage) are also met.

9. **In default operating mode (e.g. Engine Stop-Start Mode or Hybrid Mode), how long does it take for the battery to recharge itself to its nominal SOC? In EV Charge Mode, how long does it take for the battery to recharge itself to its nominal SOC?**

The time it takes to go certain distances varies greatly from city to city due to bus duty cycle. Per Allison's Geofencing Guidelines, we recommend EV Charge Zones to be $\frac{1}{4}$ of the distance of the oncoming EV Zone. Based on data collected in Indianapolis, the system will typically charge from its minimum SOC to its maximum SOC in 12-15 minutes if the vehicle is in EV Charge Mode. If the vehicle is operating in the default mode (Engine Stop-Start or Hybrid Mode), the system will typically charge from its minimum SOC to its nominal SOC in 20-25 minutes. These times are based on data collected on test buses in Indianapolis and may not reflect other vehicles.

10. **During non-EV and non-EV Charge Mode operation, the Allison eGen Flex Max system operates in a default mode. What is the difference between Engine Stop-Start Mode and Hybrid Mode?**

When in Hybrid Mode, the TCM controls the blending of mechanical torque and electrical motor torque in the Drive Unit. The torque blending algorithms in the TCM combine possible torque-speed points for the engine with the specific points of operation for each Drive Unit motor. The algorithms continuously establish the most efficient means of attaining the desired vehicle performance. When in Engine Stop-Start (ES-S) Mode, the same blending of mechanical torque and electrical motor torque in the Drive Unit occurs while the vehicle is moving, but if conditions are met while at a complete stop, the engine will shut down until the vehicle begins to propel forward again. The vehicle will utilize battery power and allow all accessories to remain operating during an Engine Stop-Start event.