Waymo LLC
1600 Amphitheatre Pkwy
Mountain View, CA

[redacted]

California Department of Motor Vehicles
Autonomous Vehicles Branch
505 Van Ness Ave.
San Francisco, CA 94102

Re: DMV Deployment Follow-Up

DMV Autonomous Vehicles Branch:

Enclosed please find Waymo's responses to your [redacted] follow-up questions regarding Waymo's pending Drivered Deployment Permit Application.

As noted on the document itself, the enclosed contains confidential business information. [redacted]

We are looking forward to next steps and very much appreciate your continued diligence in processing our application. Please do continue to reach out to [redacted] as your first point of contact on this application.

Thank you very much.

The Waymo Team

Waymo Deployment Application Follow-Up Questions

OPERATIONAL DESIGN DOMAIN (ODD)

1) ***The ODD described in the application provides a map of the entire City/County of San Francisco, CA.***

   a) ***On page 19, the application describes the Waymo Automated Driving System (Waymo ADS) has been designed to perform the entire dynamic driving task within a defined ODD. 'The system is further designed so a vehicle will not operate outside of its approved ODD.' 'For example, passengers cannot select a destination outside of our approved geography, and our software will not create a route that travels outside of a "geo-fenced" area, which has been mapped in detail." Can the Waymo ADS operate in tunnels, curvy block of Lombard, steep hills with limited visibility of cross streets, unprotected left turns?***

Response: Yes, the Waymo ADS can operate in drivered deployment on all of the roadway types listed above.

   i. ***Please describe these constraints, if applicable, and how the Waymo ADS is configured to account for these constraints.***

Response: [redacted]

   ii. ***Please demarcate any streets that are outside of the ODD on the map provided in the application, including the Law Enforcement Interaction Plans (LEIP) for both the Chrysler Pacifica and Jaguar I-PACE vehicle platforms.***

Response: [redacted]

   b) ***Please describe the driver interface (e.g. audio / visual signals)*** [redacted]

Response: [redacted]

[1] Waymo recently began using the term "autonomous specialist," which is synonymous with "trained driver."

c) ***Please define what Waymo considers to be the minimal risk condition(s) (MRC) for the Waymo ADS. Does this include stopping in an active traffic lane or does it require reaching a curb location?***

Response: [redacted]

[redacted]

d) How does Waymo account for San Francisco curb management policies within the defined ODD in instances where the Waymo ADS has to achieve a minimal risk condition?

Response: [redacted]

e) Please describe how the Waymo ADS recognizes where to pullover and park for vehicle passengers?

Response: When a rider requests a ride through the Waymo app, we provide pickup and dropoff locations that prioritize safety and convenience for our rider and other road users. [redacted] When the vehicle arrives at the rider's requested location [redacted] We also actively monitor relevant policy and legislative developments in San Francisco's evolving curb management strategy.

f) The San Francisco Slow Streets and Shared Spaces Program are designed to limit through traffic on certain residential streets and allow streets to be used as a shared space for pedestrians and bicyclists, as well as for outdoor eating establishments. Throughout the city, nearly thirty corridors have been implemented as a Slow Street. On these Slow Streets, signage and barricades have been placed to minimize through vehicle traffic and prioritize walking and biking. In some instances, the signage and markers can vary across neighborhoods.

i. Please describe how the Waymo ADS accounts for these dynamic programs within San Francisco, including potential variations across neighborhoods in San Francisco, while performing the dynamic driving task.

Response: The Waymo ADS is equipped with a powerful sensor suite that includes lidar, cameras, and radar. These sensors enable the Waymo ADS to safely navigate the world with a 360 degree view of the roadway, other road users, and roadway obstacles, including barricades. [redacted] The Waymo ADS further accounts for San Francisco's Slow Streets and Shared Spaces Program ("Program") specifically [redacted] In addition [redacted] Waymo actively monitors developments in the Program at a policy level to keep [redacted] apprised of potential or anticipated Program modifications directed by local leadership.

[redacted]

[redacted]

Response: [redacted]

b) Please describe examples of driving tasks or scenarios, if any, that the Waymo ADS can perform, but the Waymo trained driver would manually takeover to provide better riding experience for vehicle passengers [redacted]

Response: [redacted]

[3] [redacted]

[redacted]

[redacted]

3) [redacted]

[redacted]

Response: [redacted]

i. [redacted]

Response: [redacted]

ii. [redacted]

Response: [redacted]

[4] [redacted]

[redacted]

[redacted]

4) [redacted]

Response: [redacted]

[redacted]

5) The Law Enforcement Interaction Plan indicates that the ODD " will be expanded incrementally over time." Can Waymo provide any details on proposed or future expansion?

Response: We don't have any details on future expansion to share at this time. However, prior to deploying in geographic areas different than and/or in addition to those that the DMV may approve in connection with Waymo's pending application for drivered deployment, we plan to be in close communication with the DMV.

[5] [redacted].

6) ***Please describe Waymo ADS failure mitigation strategies if the Waymo ADS is rendered incapable of performing fallback to achieve a minimal risk condition.***

Response: [redacted]

7) [redacted] ***Are there situations where the Waymo ADS may delay a handoff to the trained driver?***

Response: [redacted]

ROLES & RESPONSIBILITIES OF THE TRAINED DRIVER

8) ***On page 20, the application states the Waymo ADS will hand over control to the safety driver in specified situations. In addition…"trained drivers monitor the autonomous vehicle and ADS… Waymo configures the SDS to handover control to the trained driver for a specific set of low-level autonomous technology faults where the ADS would otherwise command a high-deceleration immediate stop."***

   a) ***Trained Drivers can:***
      i. ***Take over at any time***
      ii. ***Take over when the Waymo ADS signals the need to achieve a Minimal Risk Condition***
      iii. ***Take control for specific situations involving low level autonomous technology faults.***

   Please describe how the role and qualifications of the trained driver differs from those of the safety driver under Waymo's existing Autonomous Vehicle Testing permit.

Response: The terms "trained drivers" and "safety drivers" are synonymous. While qualifications and training for trained drivers will almost certainly evolve over time based on high safety standards, drivers will receive the same robust training under Waymo's existing Autonomous Vehicle Testing permit and under the proposed Deployment permit for drivered operation. That training is described in Appendix A of the Application.

If there are no differences, does Waymo plan to use safety drivers on the deployment permit?

Response: Yes.

How is drivered deployment operation different from Waymo's testing operations?

Response: As indicated in the Application, once granted a Deployment permit for drivered operation, Waymo may operate a commercial ride-hailing service to transport members of the public (after having also secured the requisite authority from the CPUC) or a goods delivery service. This expansion of purpose - from exclusively testing to also include commercial activities for which fares and/or fees may be charged - will, of course, launch certain consumer-facing operational activities (e.g., customer account administration), for which we have real world experience that is second-to-none in the AV ride-hailing industry. However, vehicle operations themselves will fundamentally remain the same between Waymo's testing operations and drivered deployment operations.

b) Under the Waymo Autonomous Vehicles Testing permit, we have seen Waymo utilize two safety drivers [redacted]. Please specify how many trained driver(s) will be in the drivered deployed vehicle at any given time?

Response: [redacted] two trained drivers are not necessary for the safe operation of the Waymo autonomous vehicle [redacted] a second individual sometimes accompanies the trained driver for data collection purposes. [redacted]

c) Please describe how the trained driver "monitors" the Waymo ADS. Does the trained driver monitor ADS system performance, vehicle performance, the driving environment, or all the above?

Response: [redacted]

d) On page 3, the application describes one of the roles of the test driver is to "interact with the public and Waymo riders...in addition to supervising the ADS and vehicle." What will this interaction with passengers involve? How will this be combined with the monitoring functions when the vehicle is in motion?

Response: A trained driver's primary responsibility is to monitor the safe operation of the Waymo autonomous vehicle. Accordingly, drivers are trained to not proactively engage with or initiate conversation with riders, except under limited circumstances (e.g., a rider medical emergency). For reinforcement, we educate our public riders about the role of the trained driver vis-a-vis their user experience; namely, that a trained driver is present in drivered operations to focus on AV performance and that the customer service role is performed by Waymo's Rider Support team. However, trained drivers are prepared to interact with members of the public, including Waymo riders. Such preparation generally includes training on responding to questions from riders and other road users, executing collision procedures, and interfacing with law enforcement personnel.

e) [redacted]

Response: [redacted]

ROLES & RESPONSIBILITIES OF FLEET SUPPORT

9) What types of "specific situations require attention" from Fleet Response Specialists? (page 5) Will Fleet Support be dispatched to the vehicle in the case of an emergency? How soon can the team be deployed?

Response: [redacted]

Fleet Response may dispatch on-scene support for events that render the vehicle unable to continue operating (e.g., a flat tire). Additionally, if the ADS detects a collision, it will notify the Fleet Response team, who will verify whether a collision has occurred. Once verified, Fleet Response may call 911 if the circumstances warrant (e.g., where there is a significant collision in which police and/or EMS may be needed because of injuries or vehicles blocking traffic). Fleet Response then assigns the handling of the event to the appropriate Waymo support team, who will assist with dispatching on-scene support for passengers and first responders. In the event of a passenger emergency that does not involve a collision, a passenger or the trained driver can notify Rider Support, who will assist and call first responders, as appropriate.

10) Under what types of driving situations or conditions will Rider Support Agents be notified to initiate communication and assist the passenger? On pages 4 and 5, the application mentions "in certain situations", "irregular trip situations," or "if something seems out of the ordinary."

Response: [redacted]

Riders can also reach out to Rider Support at any time using the in-vehicle touch screens or through the Waymo app.

11) On pages 4 and 5, the application describes passengers may contact Rider Support Agents via in-vehicle display screens. Where are the in-vehicle display screens located, and will this be easily accessible to passengers?

Response: Passengers may contact Rider Support through the in-vehicle display screens or through the Waymo app on their mobile devices. [redacted] There are two passenger screens in the second row, located behind the headrests of the front two seats. In addition, a physical "help" button is located on a panel attached to the ceiling between the two front seats, which, when pressed, automatically calls Rider Support.

In the Jaguar I-PACE platform [redacted] a touch screen is attached to the back of the center console between the two front passenger seats. [redacted]

Waymo has conducted human factors testing to ensure the touch screens are reachable and accessible for a wide range of users. Waymo has also conducted user experience testing to ensure that the Waymo app is fully accessible. [redacted]

12) On page 5, the application states Fleet Support receives "a live three-dimensional rendering of the vehicle and its surroundings, a camera feed, and information regarding the state of the vehicle."

a) Please describe any prioritization of messages utilized when transmitting sensor data from the Waymo ADS to Fleet Support, especially during periods of higher latency or in situations where the communication channel is lost?

Response: [redacted]

[redacted]

[redacted]

VEHICLE PLATFORM

13) Both the hybrid Chrysler Pacifica and electric Jaguar I-PACE are listed on the application as vehicles to be deployed for drivered operations.

> ***a) Please explain the operational limitations and core capability differences between the two vehicle ADS platforms, if any are present.***

Response: Both platforms have comparable core capabilities and are strong bases for safe, driverless operation. In Arizona, we have deployed Chrysler Pacificas in our fully driverless ride-hailing service. The Jaguar I-PACE platform was introduced more recently [redacted]. We have conducted extensive testing on the I-PACE platform [redacted]. We will continue to test and operate both platforms.

[redacted]

- Vehicle size: The smaller footprint of the Jaguar I-PACE makes it more nimble for use in a dense urban environment like San Francisco. The Chrysler Pacifica is larger, which offers passengers more space in the vehicle cabin.
- Powertrain: The Jaguar I-PACE is a battery electric vehicle, while the Chrysler Pacifica is a plug-in hybrid. The powertrain differences do not affect the operational capabilities of the

vehicles, but Waymo did make changes to tailor the ADS in the I-PACE platform to a battery electric powertrain.

b) Will both vehicles be deployed simultaneously, or will each vehicle be gradually deployed?

Response: [redacted]

DISENGAGEMENT REPORTING

14) In the 2020 Report of Autonomous Vehicle Disengagements (OL 311R), Waymo reported 21 disengagements occurred during testing operations from December 2019 to November 2020. Of those 21 disengagements the following descriptions were provided:

a) Disengage for a perception discrepancy for which a component of the vehicle's perception system failed to detect an object correctly.

b) Disengage for incorrect behavior prediction of other traffic participants.

c) Disengage for unwanted maneuver of the vehicle that was undesirable under the circumstances.

d) Disengage for a recklessly behaving road user.

e) Disengage for adverse weather conditions experienced during testing.

Please describe how Waymo has addressed the problems that led to these disengagements during on road public testing to minimize the likelihood of their recurrence during the operational deployment.

Response: Waymo prioritizes operating safely - whether in testing or deployment - over minimizing disengagements. Although the annual rate of disengagement reported by AV permit holders to DMV is a source of regulatory and public scrutiny, Waymo does not consider the rate to be a useful proxy for safety. In fact, disengagements are in and of themselves an effective safety mitigation and a layer of redundancy for the ADS in drivered operations. Additionally, Waymo does not discourage drivers from disengaging the ADS at their discretion while operating on public roads. Instead, Waymo's dynamic ADS development program is focused on continuously improving ADS performance, including to minimize or moderate conditions that may trigger disengagements.

Waymo evaluates each disengagement and determines whether and how it may be appropriate to address each, taking a holistic view of how a change could impact other aspects of the system or operations. In general, however, a course of action may include [redacted]

[redacted]

TRAFFIC COLLISION REPORTING

15) On April 8, 2021, Waymo reported two collision events occurred on March 19, 2021 and March 30, 2021, each involving the 2021 Jaguar I-Pace. [redacted]

a) [redacted]

Response: [redacted]

b) [redacted]

Response: [redacted].

c) [redacted]

Response: [redacted]

d) [redacted]

Response: [redacted]

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DMV Autonomous Vehicles Branch:

Enclosed please find Waymo's responses to your [redacted] follow-up questions regarding Waymo's pending Drivered Deployment Permit Application.

As noted on the document itself, the enclosed contains confidential business information. Waymo has also provided DMV with a redacted version of our responses, as well as a redaction of the questions propounded to Waymo on [redacted]

We are looking forward to next steps and very much appreciate your continued diligence in processing our application. Please do continue to reach out to [redacted] as your first point of contact on this application.

Thank you very much.

The Waymo Team

Waymo Deployment Application Additional Follow-Up Questions

In response to the following questions, please provide full detail, specificity, and clarity.

1) Waymo indicates that the Waymo ADS can perform the entire dynamic driving task within the ODD. Please clarify if the primary role of the Waymo trained driver is to provide a more desirable quality of service and less disruptive riding experience for vehicle passengers, and better driving interactions with other road users, based on societal driving norms and expectations within the ODD.

Response: The trained driver's primary role is to monitor the performance of the ADS and to assume control of the vehicle as appropriate to support safety, traffic law compliance, and community values. In other words, the trained driver provides redundancy for our system in drivered operations. Trained drivers have discretion to assume control to facilitate a smoother, more efficient ride for passengers.

2) Please describe the priority (i.e. sequence) and hierarchy (i.e. who has the higher level of decision authority when there is a potential conflict) when the Waymo ADS seeks assistance from Fleet Response, including the communication link used to transmit responses to the multiple-choice questions, and if these posed questions are standardized or vary by each unique situation. What is the trained driver's role within this sequence and hierarchy compared to the role of the Fleet Response staff?

Response: Fleet Response provides information and assistance to the ADS, but at no point performs the dynamic driving task. When the vehicle is in autonomous mode, the ADS performs the entire dynamic driving task.

[redacted]

3) Please describe in detail the Waymo ADS Fleet Response procedure(s) for responding to adverse event(s), including all communication links with any redundant communication systems, what visual/audio information will Fleet Response personnel have access to, and how many deployed vehicles will each Fleet Response personnel be assigned to monitor and/or respond to?

Response: [redacted]

4) [redacted] Please describe how Waymo will distinguish testing operations from deployment operations and determine which specific trips (or portions of trips) will be classified in each category for reporting purposes.

Response: [redacted]

5) Please describe how Waymo intends to use the drivered testing operations to inform and/or update the drivered deployment operations.

Response: We learn from all of our driving experience, whether in testing or deployment. We use the data we gather from all of our operations, including drivered testing, to inform the continual process of updating our ADS software. Our continual process of learning from experience and using that learning to iteratively update our ADS is described in the Application (see section 9, "Summary of Testing in ODD - 13 CCR § 228.06(c)(7)") as well as

our published white paper, *Waymo's Methodologies and Safety Readiness Determinations* (October 2020).[1]

6) Will failures, instances of poor performance, crashes or traffic law violations occurring during deployment operations be used to inform software development?

Response: Yes. For a detailed description of Waymo's layered safety methodologies and continuous development process, see section 9 of the Application ("Summary of Testing in ODD - 13 CCR § 228.06(c)(7)") and our published white paper, *Waymo's Methodologies and Safety Readiness Determinations* (October 2020).[2]

[1] This white paper was enclosed in the original application and is also available at waymo.com/safety.
[2] This white paper was enclosed in the original application and is also available at waymo.com/safety.

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Re: DMV Deployment Follow-Up

DMV Autonomous Vehicles Branch:

Below please find Waymo's follow-up responses supplementing [redacted] Waymo's pending Drivered Deployment Permit Application.

As noted below, these responses contain confidential business information. [redacted]

Thank you for the opportunity to provide you with this further information. We look forward to next steps towards approval. Please reach out to [redacted]

Thank you very much.

The Waymo Team

Waymo Deployment Application Discussion Follow-Up

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]