U.S. Department of Transportation

National Highway Traffic Safety Administration

NHTSA

Preliminary Regulatory Impact Analysis

Occupant Protection for Vehicles Equipped with Automated Driving Systems

Office of Regulatory Analysis and Evaluation
National Center for Statistics and Analysis

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EXECUTIVE SUMMARY

NHTSA has prepared this preliminary regulatory impact analysis to analyze the benefits and costs of enabling manufacturers of Automated Driving System-Dedicated Vehicles[1] (ADS-DVs) to satisfy the occupant protection Federal Motor Vehicle Safety Standards (FMVSSs) without including manual steering controls, as proposed in the Notice of Proposed Rulemaking (NPRM). ADS-DVs are represented in this analysis as vehicles that can only be controlled by an ADS; thus, in these vehicles, manual steering controls would be superfluous. NHTSA calculated the cost impacts of this proposed rule by analyzing the savings that would be realized by forgoing the installation of manual steering controls, along with the incremental costs of changing safety equipment requirements for left front vehicle occupants to be equivalent to requirements in the right front seating position.

The proposal would generate increased consumer and producer surplus from net production cost savings and increased opportunities for innovation. NHTSA was unable to quantify and monetize impact categories other than production cost impacts (e.g., incremental consumer surplus and innovation) due to data unavailability and uncertainty. The table below provides a summary of the various benefits and costs that may accrue from this rule, as well as

[1] An ADS-DV is defined as "[a] vehicle designed to be operated exclusively by a level 4 or level 5 ADS for all trips within its given operational design domain (ODD) limitations (if any)." High driving automation (Level 4) is defined as "[t]he sustained and ODD-specific performance by an ADS of the entire dynamic driving task (DDT) and DDT fallback without any expectation that a user will respond to a request to intervene." Full driving automation (Level 5) is defined as "[t]he sustained and unconditional (i.e., not ODD-specific) performance by an ADS of the entire DDT and DDT fallback without any expectation that a user will respond to a request to intervene." SAE J3016_201806 Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles.

the various factors that define the range of possible outcomes. This range illustrates the uncertainty inherent in predicting the outcome for a market that has yet to develop.

Table E-1: Ranges of Outcomes for Benefit and Cost Categories

Benefit Impacts

Element	**Low Case**	**High Case**
Incremental consumer and producer surplus	***Not estimated:*** Incremental consumer and producer surplus would be low if ADS-DV purchasers place a low value on the differences in the designs of vehicles without manual steering controls relative to vehicles with manual steering controls.	***Not estimated:*** Incremental consumer and producer surplus would be high if ADS-DV purchasers place a high value on the differences in the designs of vehicles without manual steering controls relative to vehicles with manual steering controls.
Innovation	***Not estimated:*** The proposed rule leads to manufacturers foregoing the installation of manual steering controls in ADS-DVs, and leads to little broader change in vehicle design and manufacturing processes.	***Not estimated:*** The proposed rule leads to broader change in vehicle design and manufacturing processes.

Table E-1 (Continued): Ranges of Outcomes for Benefit and Cost Categories

Cost Impacts

Element	Low Case	High Case
Mitigated production costs	***Estimated:*** Captures the cost impacts of forgoing the installation of manual steering controls, versus the incremental costs of adding safety equipment to the left front seating position. Differs from the high case by assuming a relatively low cost of manufacture and installation of manual steering controls relative to the costs of assembling a left front seating position without manual steering controls. Also differs from the high case by assuming relatively low sales impacts over time.	***Estimated:*** Captures the cost impacts of forgoing the installation of manual steering controls, versus the incremental costs of adding safety equipment to the left front seating position. Differs from the low case by assuming a relatively high cost of manufacture and installation of manual steering controls relative to the costs of assembling a left front seating position without manual steering controls. Also differs from the low case by assuming relatively high sales impacts over time.
Incremental fuel savings Safety improvements	***Not estimated:*** Reflects low vehicle mass impact and low sales impacts over time. ***Not estimated:*** The proposed rule has little to no effect on demand for ADS-DVs, with little to no corresponding (beneficial) effect on safety relative to travel in conventional vehicles.	***Not estimated:*** Reflects high vehicle mass impact and high sales impacts over time. ***Not estimated:*** The proposed rule has a strong effect on demand for ADS-DVs, yielding a beneficial effect on safety relative to travel in conventional vehicles.

NHTSA calculated ranges of preliminary estimates of cost impacts using a variety of logical assumptions. NHTSA calculated the impact of the proposed rule on costs by analyzing production cost savings arising from forgoing the installation of manual steering controls. These cost savings are partially offset by incremental costs associated with augmenting safety equipment in the left front seating position to make that position equivalent to the right front seating position.

Monetized estimated per-vehicle cost impacts are presented by vehicle type and discount rate in Table E-2 below based on a scenario presented by the Energy Information Administration[2] (EIA), in which ADS-DVs become a large share of new light-duty vehicle sales by the year 2050:

Table E-2: Summary of Net Per-Vehicle Cost Impact Estimates (ADS-DV Cost Impacts in 2050, 2018 Dollars)

Discount Rate	Mean Cost Impact	5th- to 95th-Percentile Cost Impacts
3%	-$398	-$255 to -$540
7%	-$122	-$78 to -$166

The ranges of estimates were identified within an uncertainty analysis addressing uncertainty in the average level of cost savings that would be achieved by ADS-DV manufacturers. The uncertainty analysis centered on identifying plausible ranges of per-vehicle cost savings, with corresponding assumptions regarding the distributions of values across each range (i.e., the likelihood of observing a particular value). The uncertainty analysis generated 50,000 simulated outcomes, across which the mean and percentile values reported in Table E-2 were identified.

We request comment on this approach to representing the range of estimated impacts under uncertainty.

For this analysis, NHTSA assumed that light-duty vehicle sales through 2032 (the last year specified in the baseline) would follow the identical baseline path projected in the Corporate

[2] Chase, N., Maples, J., and Schipper, M. (2018). *Autonomous Vehicles: Uncertainties and Energy Implications*. Issue in Focus from the *Annual Energy Outlook 2018*. Washington, DC: U.S. Energy Information Administration. Available at https://www.eia.gov/outlooks/aeo/av.php (last accessed October 22, 2019).

Average Fuel Economy (CAFE) Model used to develop the Safer Affordable Fuel-Efficient Vehicle[3] rule, and then would continue to grow at the average annual growth rate in the baseline from 2028-2032 (approximately 0.2 percent per year) for each year after 2032, growing to 18.7 million new light-duty vehicles sold in 2050. The projected sales growth rate across the final five years of the CAFE baseline was selected as a compromise in balancing proximity to the out-years in the analysis and covering sufficient years to preserve stability in projected (low) sales growth rates. Ultimately, because projected sales growth rates are low in the CAFE baseline, projected 2050 sales levels are relatively insensitive to the choice of interval used to select a growth rate.

NHTSA assumed that the share of new light-duty vehicle sales comprised of ADS-DVs would reach 31 percent in the year 2050, based on the EIA scenario described above[4]; thus, new ADS-DV sales in 2050 are assumed to be equal to 31 percent of 18.7 million, or 5.8 million. The EIA also presents a baseline with only a one-percent ADS-DV sales share among new light duty vehicles in 2050. For this analysis, estimates centering on an alternative baseline with one-percent ADS-DV sales shares would yield impacts in 2050 that are 1/31 as large as our central

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[3] https://www.nhtsa.gov/corporate-average-fuel-economy/safe (last accessed October 22, 2019).

[4] Chase, N., Maples, J., and Schipper, M. (2018). *Autonomous Vehicles: Uncertainties and Energy Implications*. Issue in Focus from the *Annual Energy Outlook 2018*. Washington, DC: U.S. Energy Information Administration. Available at https://www.eia.gov/outlooks/aeo/av.php (last accessed October 22, 2019). The 31-percent scenario was selected for this analysis rather than the reference case (with a one-percent ADS-DV share in 2050) provided by the EIA. The reference case is a conservative scenario that serves as a baseline against which to evaluate the incremental effects of alternative scenarios. A one-percent ADS-DV share for 2050 is low enough that it essentially assumes no meaningful development of full ADS vehicles over the next 30 years; we do not expect such a scenario to be representative, but present results under this alternative case for comparison. We have applied the 31-percent figure to all ADS-DVs, based on an assumption that nearly all Level 4 and Level 5 ADS-equipped vehicles will not have manual controls by the year 2050. This assumption centers on a projection that ADS-DVs will be predominantly fleet-owned and operating in a rideshare environment, rather than privately-owned. It is expected that such rideshare Level 4 and 5 vehicles would have little economic incentive to have manual driving control. Additionally, within their operational design domains (ODDs) Level 4 vehicles will have no need for driving controls and Level 5 vehicles can operate under full automation anywhere.

estimates. That is, under an assumption of a one-percent ADS-DV sales share, only approximately 187,000 vehicles would be affected in 2050, rather than 5.8 million.

Based on these assumptions, NHTSA estimates that the present value of savings to ADS-DV manufacturers and consumers under the proposed rule would be up to approximately $2.3 billion in the year 2050 (fifth-percentile estimate of $1.5 billion and 95th-percentile estimate of $3.1 billion) discounted back to 2019 at a three-percent discount rate. At a seven-percent discount rate, the proposed rule's estimated year-2050 savings to ADS-DV manufacturers and consumers has a present value of up to approximately $0.7 billion (fifth-percentile estimate of $0.5 billion and 95th-percentile of $1.0 billion). These estimates represent an upper bound, in which all ADS-DV sales are comprised of single-mode vehicles with no manual steering controls (i.e., all 5.8 million ADS-DV sales in 2050 include a measure of production cost savings associated with forgoing manual steering controls). Under the conservative EIA scenario with a one-percent ADS-DV sales share in 2050, the corresponding ranges are approximately $50 million to $100 million (mean of approximately $70 million) at a three-percent discount rate, and approximately $10 million to $30 million (mean of approximately $20 million) at a seven-percent discount rate.

As a sensitivity analysis, NHTSA also considered an alternative case, in which 30 percent of ADS-DV sales in 2050 are comprised of dual-mode vehicles. This represents a case in which: (1) ADS-DV sales are split between 80 percent fleet sales and 20 percent private ownership; (2) 25 percent of fleet ADS-DV purchases are comprised of dual-mode vehicles; and (3) 50 percent of private ADS-DV purchases are comprised of dual-mode vehicles. Under this alternative scenario, savings to ADS-DV manufacturers and consumers under the proposed rule would be approximately $1.6 billion in the year 2050 (fifth-percentile estimate of $1.0 billion and 95th-

percentile estimate of $2.2 billion) discounted back to 2019 at a three-percent discount rate. At a seven-percent discount rate, under this alternative scenario the proposed rule's estimated year-2050 savings to ADS-DV manufacturers and consumers has a present value of approximately $0.5 billion (fifth-percentile estimate of $0.3 billion and 95th-percentile of $0.7 billion). The differences in results across the two scenarios are driven by a lack of cost savings for dual-mode vehicles, as those vehicles would preserve manual steering controls. Under the conservative EIA scenario with a one-percent ADS-DV sales share in 2050, the corresponding ranges are approximately $30 million to $70 million (mean of approximately $50 million) at a three-percent discount rate, and approximately $10 million to $20 million at a seven-percent discount rate.

Table E-3: Summary of Total Monetized Annual Net Cost Impact Estimates (ADS-DV Cost Impacts in 2050, Billions of 2018 Dollars, 31% ADS-DV Sales Share)

Dual-Mode Sales Share	Discount Rate	Mean Cost Impact	5th- to 95th-Percentile Cost Impacts
0%	3%	-$2.3	-$1.5 to -$3.1
0%	7%	-$0.7	-$0.5 to -$1.0
30%	3%	-$1.6	-$1.0 to -$2.2
30%	7%	-$0.5	-$0.3 to -$0.7

I. INTRODUCTION

A. Background

NHTSA has prepared this preliminary regulatory impact analysis to analyze the benefits and costs of enabling manufacturers of Automated Driving System-Dedicated Vehicles[5] (ADS-DVs) to satisfy the Federal Motor Vehicle Safety Standards (FMVSSs) without including manual steering controls, as proposed in the Notice of Proposed Rulemaking (NPRM).[6] ADS-DVs are represented in this analysis as vehicles that can only be controlled by an autonomous driving system (ADS); thus, in these vehicles, manual steering controls would be superfluous. NHTSA calculated the cost impacts of this proposed rule by analyzing the savings that would be realized by forgoing the installation of manual steering controls, along with the incremental costs of changing safety equipment requirements for left front vehicle occupants to be equivalent to requirements in the right front seating position.

The following (status quo) components of ADS-DVs are assumed to be affected by the proposed rule: steering controls, front left seating position air bags, and dashboard warning displays (i.e., telltales). Steering controls are considered in this analysis because they would not be necessary (or even useful) for the operation of an ADS-DV. Rather, vehicles equipped with high or full driving automation, as defined by J3016, would be assumed to be sufficiently

[5] An ADS-DV is defined as "[a] vehicle designed to be operated exclusively by a level 4 or level 5 ADS for all trips within its given operational design domain (ODD) limitations (if any)." High driving automation (Level 4) is defined as "[t]he sustained and ODD-specific performance by an ADS of the entire dynamic driving task (DDT) and DDT fallback without any expectation that a user will respond to a request to intervene." Full driving automation (Level 5) is defined as "[t]he sustained and unconditional (i.e., not ODD-specific) performance by an ADS of the entire DDT and DDT fallback without any expectation that a user will respond to a request to intervene." SAE J3016_201806 Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles.

capable of continually adjusting steering angles, brake pressure, and throttle without external components designed for human use. The proposed rule is expected to have no effect on steering control costs for dual-mode vehicles with full ADS because, by definition, manual steering controls would be required to enable dual mode operability. The proposed rule would increase production costs for dual-mode vehicles with full ADS, through the requirement for a sensor in the front left seat to identify child occupants, as clarified below.

Left front seat air bags are assumed to be affected by the proposed rule because, by eliminating driving controls, there is no steering wheel to mount the air bag. Thus, this analysis assumes the replacement air bags for the left front seat are essentially identical to the passenger air bag systems in the right front outboard seat. In addition, it is feasible that the front left seat of a vehicle with full ADS could be occupied by a child under the age of 12. In this analysis, we assume the left front air bag system will offer advanced air bag out-of-position (OOP) protection equal to the right front outboard seat. Such a system, in most cases, will require an occupant classification seat sensor. This would be necessary as a precaution against the potentially injurious deployments of air bags in left front seats occupied by children under the age of 12. We note that currently both driver's seat and right front outboard passenger seats must be equipped with advanced air bag protection for OOP adult occupants.

Dashboard warning displays of air bag suppression status are currently required for the right front outboard seat equipped with an air bag suppression system. The current display is required to be visible from both outboard front seats. In this analysis, we assume that manufacturers would be required to install an additional warning display (i.e., telltale), distinct from the existing one, if the driver's seat is converted to a passenger seat with an advanced air bag utilizing suppression technology.

FMVSS compliance testing costs are assumed to be unaffected, even though the proposed rule may affect the amount of testing to which a vehicle is subjected. The proposed changes could reduce testing costs by making some tests inapplicable to an ADS-DV with no manual controls, thereby reducing certification costs. For example, under the proposed rule, it would be unnecessary for the manufacturer of an ADS-DV to incur the costs associated with certifying compliance with FMVSS No. 204, "Steering control rearward displacement." Conversely, the proposed changes would permit additional compliance options that lead manufacturers of ADS-DVs to incur additional certification-related costs. For example, an ADS-DV with two front outboard passenger seats would be subject to more static tests under FMVSS No. 208 than would a traditional vehicle with a driver's seat, because it would have two seats that need to meet advanced air bag requirements. However, while upfront compliance testing costs may be affected, it is likely that these costs would be amortized over the production life of the make/model, which we project to reach millions of vehicles as the ADS-DV market matures. Accordingly, the net per-vehicle testing cost is assumed to be de minimis under a mature ADS-DV market. Components associated with crash avoidance (e.g., accelerator and brake controls) are outside of the scope of this analysis because the proposed rule is limited in scope to standards governing crashworthiness. We request comment on these assumptions.

B. Market Analysis

The primary quantifiable expected effect of the proposed rule is the reduction of production costs for ADS-DVs. For this analysis, we project annual production cost impacts for a future year (2050) in which it is plausible that ADS-DVs would represent a large proportion of total new light-duty vehicle sales (i.e., it is plausible that the ADS-DV market would reach

maturity by 2050). There is considerable uncertainty in the path of ADS-DV sales shares over time.

The year 2050 was selected as the representative future year with a high ADS-DV sales share based on a scenario presented by the Energy Information Administration (EIA)[7], in which the share of new light-duty vehicle sales comprised of (Level 4 or Level 5) ADS-DVs reaches 31 percent in the year 2050. The EIA scenario assumes that sales of ADS-DVs will grow steadily over time through increasing demand by fleets (e.g., ridesharing/carsharing providers) and households. In this analysis, we also provide results for an alternative EIA scenario in which ADS-DVs represent only one percent of new light duty vehicle sales in 2050.

Under the focal EIA scenario, vehicle miles traveled (VMT) increase relative to a baseline in which only fleets purchase ADS-DVs (by ten percent per privately-owned vehicle); in the baseline and alternative EIA scenarios, fleet-owned ADS-DVs are assumed to experience very high utilization (65,000 miles per year). This VMT growth is associated with an assumed higher average fuel economy (and thus lower average marginal operating cost) for ADS-DVs, due to a higher propensity to apply battery electric or hybrid electric drivetrains. Under the scenario, fleet-owned vehicles would be scrapped faster than conventional vehicles, due to the usage rate of 65,000 miles per year per vehicle. Conditional on a given level of travel demand, the increase in scrappage rates would be offset by a decrease in the number of vehicles required to meet travel demand, resulting in a neutral net effect on annual vehicle sales. The increase in privately-owned vehicle VMT in the EIA scenario could influence scrappage rates, as well; for

[7] Chase, N., Maples, J., and Schipper, M. (2018). *Autonomous Vehicles: Uncertainties and Energy Implications*. Issue in Focus from the *Annual Energy Outlook 2018*. Washington, DC: U.S. Energy Information Administration. Available at https://www.eia.gov/outlooks/aeo/av.php (last accessed October 22, 2019).

this analysis, we consider the ten-percent change in VMT for privately-owned vehicles to be low enough that it may reasonably be offset by other technological (e.g., lower wear rates for ADS-DVs relative to conventional vehicles) and behavioral (e.g., the types of trips taken) factors.

The EIA scenario does not reveal explicit specific sales shares for ADS-DVs in any years other than 2050. However, the reported decrease in conventional gasoline-powered vehicle sales in the EIA scenario relative to the corresponding EIA baseline in 2050 is also 31 percent (i.e., the change in sales shares represented by autonomous vehicles exactly offsets the change in conventional vehicle sales). Applying this relationship to other years reported in the EIA analysis (2020, 2030, and 2040) yields estimates of autonomous vehicle sales shares of approximately six percent in 2040 (and less than one percent in 2030). Based on these values, not only would total, undiscounted annual cost impacts associated with ADS-DVs be larger in 2050 than in 2040 (or 2030), but the corresponding discounted cost impacts (at 3% and 7% discount rates) would also be larger in 2050. Thus, based on the projected path of ADS sales growth in the EIA scenario, NHTSA has selected 2050 as the focal out-year in this analysis. NHTSA's position is that 2050 is sufficiently distant to enable the development of means to overcome current technological obstacles inhibiting the deployment of fully-autonomous vehicles, such as inclement weather and poor road markings and signage.

For the central analysis, we assume that dual-mode vehicles would represent an insignificant share of sales of vehicles with full ADS by the time the market for ADS-DVs reaches maturity. Rather, we assume that ADS-DVs in 2050 will be owned predominantly within vehicle fleets, and that the balance of ADS-DVs in 2050 will be single-mode, privately-owned vehicles. As a sensitivity analysis, NHTSA also considered an alternative case, in which 30 percent of ADS-DV sales in 2050 are comprised of dual-mode vehicles. This represents a case in

which: (1) ADS-DV sales are split between 80 percent fleet sales and 20 percent private ownership; (2) 25 percent of fleet ADS-DV purchases are comprised of dual-mode vehicles; and (3) 50 percent of private ADS-DV purchases are comprised of dual-mode vehicles. We request comment on the assumptions regarding ADS-DV sales.

NHTSA assumed that total new light-duty vehicle sales would follow the identical baseline path specified in the Safer Affordable Fuel-Efficient Vehicle rule through 2032 (the last year specified in the baseline), and then would continue to grow at the average annual growth rate in the baseline from 2028-2032 (approximately 0.2 percent per year) for each year after 2032. The projected sales growth rate across the final five years of the CAFE baseline was selected as a compromise in balancing proximity to the out-years in the analysis and covering sufficient years to preserve stability in projected (low) sales growth rates. Ultimately, because projected sales growth rates are low in the CAFE baseline, projected 2050 sales levels are relatively insensitive to the choice of interval used to select a growth rate.

Based on these assumptions, light-duty vehicle sales are projected to grow from 17.5 million in 2019 to 18.7 million in 2050. This estimate is close to the corresponding estimate of 18.2 million light-duty vehicles sold in 2050 in the EIA scenario.

Multiplying the projected light-duty vehicle sales shares for ADS-DVs in 2050 (31 percent) by the projected total annual sales for light-duty vehicles in 2050 (18.7 million) yields our central estimate of ADS-DV sales in 2050: 5.8 million (versus 5.6 million in the EIA scenario). For estimates centering on an alternative baseline with a one-percent ADS-DV sales share in 2050, the resulting estimated impacts in 2050 are 1/31 as large as our central estimates. Thus, under an assumption of a one-percent ADS-DV sales share, only approximately 187,000 vehicles would be affected in 2050, rather than 5.8 million.

II. COST IMPACTS

A. Overview of Methods

This section discusses the methods used to calculate quantifiable cost impacts associated with the proposed rule, which are limited to production cost impacts.

A.1. Affected Vehicles and Equipment

The unit of analysis is the component of future years' new light-duty vehicle sales that would be comprised of ADS-DVs. Dual-mode fully-autonomous vehicles are assumed to accrue no cost savings under the proposed rule because, by definition, manual steering controls would be required to enable dual mode operability.

The following (status quo) components of ADS-DVs are assumed to be affected by the proposed rule: steering controls, front left seating position air bags, and dashboard warning displays (i.e., telltales). Steering controls are considered in this analysis because they would not be necessary (or even useful) for the operation of a ADS-DV. Rather, vehicles equipped with high or full driving automation, as defined by J3016, would be assumed to be sufficiently capable of continually adjusting steering angles without external components designed for human use.

Left front seat air bags are assumed to be affected by the proposed rule because, by eliminating driving controls, there is no steering wheel to mount the air bag. Thus, this analysis assumes the replacement air bags for the left front seat are essentially identical to the passenger air bags systems in the right front seat. In addition, it is feasible that the front left seat of a ADS-DV could be occupied by a child under the age of 12. In this analysis, we assume the left front air bag system will offer advanced air bag out of position (OOP) protection equal to the right

front outboard seat. Such a system, in most cases, will require an occupant classification seat sensor. This would be necessary as a precaution against the potentially injurious deployments of air bags in left front seats occupied by children under the age of 12. We note that currently both driver's seat and right front outboard passenger seats must be equipped with advanced air bag protection for OOP adult occupants. However, right front outboard passenger seats, in most cases, include sensors to detect child occupants, while driver's seats do not.

Dashboard warning displays of air bag suppression status are currently required for the right front outboard seat equipped with an air bag suppression system. The current display is required to be visible from both outboard front seats. In this analysis, we assume that manufacturers would be required to install an additional warning display (i.e., telltale), distinct from the existing one, if the driver's seat is converted to a passenger seat with an advanced air bag utilizing suppression technology.

A.2. Cost Impact Estimation Technique

NHTSA identified per-vehicle cost impacts associated with the proposed rule by estimating manufacturers' average costs of including steering controls and air bag suppression telltales, along with the incremental cost of including passenger advanced air bags in the front left seat rather than driver advanced air bags. As detailed below, average costs of steering controls were estimated based on replacement parts costs (adjusted for marketing and retail costs associated with retail transactions). Costs of telltales and air bags were based on available cost teardown research. The net cost impact is estimated as the cost savings due to foregoing the installation of steering controls, less the cost of including an additional air bag telltale and the incremental cost of an advanced air bag in the front left seat (versus a standard air bag). For any

dual-mode vehicles, the net cost impact would be limited to the incremental cost associated with the left front seat sensor. For our central analysis, we assume that dual-mode vehicles would represent an insignificant share of vehicle sales by the time the ADS-DV market reaches maturity.

We believe this is a reasonable assumption based on several factors. It is public information that many large vehicle manufacturers and other firms working on automated vehicle development are focused on a ridesharing business model. In this model, there is no need to have driving controls in the vehicle, as long as the vehicles are fully autonomous either universally, or within operational design domains that the vehicles are restricted to. In fact, there is incentive to remove the controls as cost savings and interior space savings. Additionally, the expected increased cost of ADS vehicles would provide resistance to the private ownership model. Furthermore, although the private ownership model may be more incentivized to maintain driving controls, at least initially, to satisfy consumer desires to drive, with time and proliferation of ADS vehicles, fewer people would be trained in the driving task. Thus, private ownership of ADS-equipped vehicles with manual controls might become more of a niche business. Nonetheless, we have provided alternative estimates that account for an outcome in which 30 percent of ADS-DV sales are comprised of dual-mode vehicles. We request comment on these assumptions.

The primary sources of costs for the relevant steering components were online providers of original equipment for vehicles manufactured by Ford (parts.ford.com), General Motors (gmpartsgiant.com), and Fiat Chrysler (dodgeparts.com). Where feasible, a core brand and luxury brand version of a common sport utility vehicle was selected for analysis for each

manufacturer; due to the lack of a corresponding luxury vehicle for Chrysler, a minivan with the same engine size and drive type was selected. The vehicles selected for the analysis are:

- 2018 Ford Explorer, 3.7L, all-wheel drive
- 2018 Lincoln MKT, 3.7L, all-wheel drive
- 2017 Chevrolet Equinox
- 2016 Cadillac SRX (final model year)
- 2017 Dodge Journey, 3.6L, all-wheel drive
- 2017 Chrysler Pacifica, 3.6L, all-wheel drive

The prices identified online are assumed to be higher than the costs of manufacturing the components by a factor of 1.51, due to retail markups. The factor of 1.51 was identified in a NHTSA technical report for FMVSS No. 201[8]; the factor incorporates an estimated manufacturer markup of 36 percent and a dealer markup of 11 percent (1.36 x 1.11 = 1.51). For this analysis, cost impacts are assumed to include both manufacturing costs (equal to the estimated price divided by 1.51) and marketing costs (equal to the difference between the estimated price and manufacturing cost). Thus, for every dollar manufacturing costs are reduced, more than one dollar ($1.51) is estimated to accrue among consumers (via consumer surplus), manufacturers and dealers (via producer surplus).

For each of the six vehicles, prices were collected for individual components associated with steering controls that are specific to human input (i.e., not also expected to be required for manipulation by the ADS). The estimated OEM (i.e., non-deflated) price for each component is the simple average of the highest and lowest quoted price. Individual components in the analysis include (not all components are on all vehicles, and some components require duplicate parts):

[8] NHTSA (2004). *Perform Cost and Weight Analysis*. National Highway Traffic Safety Administration, Report No. DOT HS 809 842, Washington, DC. (December).

- Steering wheel
- Steering housing assembly
- Steering shroud assembly
- Steering column assembly
- Shaft assembly
- Steering motor
- Steering boot
- Steering wheel cover
- Horn contact
- Wheel pad harness
- Cruise control switch
- Radio switch
- Steering column seal
- Multifunction switch
- Switch speed control
- Control switch
- Spring tilt assist
- Column assembly fastener
- Steering level
- Steering seal
- Steering wheel bezel
- Steering wheel trim
- Cover boot

We request comment on the applicability of the above components to the analysis, along with comment on any additional components to include in the analysis.

The mitigated costs (or cost savings) are assumed to yield benefits that accrue fully to manufacturers (via producer surplus, as the difference between sales price and cost of production grows) and vehicle purchasers (via incremental consumer surplus, as the difference between willingness-to-pay and sales price grows), consistent with economic theory. The estimated cost savings represent an incomplete share of the total incremental consumer and producer surplus under the proposed rule. That is, it is feasible that changes to vehicle cabin configurations would

utilize the lack of manual steering controls to yield vehicle designs that are more desirable to consumers, and thus in higher demand (i.e., higher willingness-to-pay). Under higher demand, the number of vehicles sold would yield increased producer surplus (if there is any increase in price), increased consumer surplus (unless an increase in price fully matches the increase in willingness-to-pay), or both.

However, NHTSA does not have sufficient information on demand and supply for fully-autonomous vehicles and their substitutes to estimate incremental consumer and producer surplus beyond the cost savings estimated in this section. Thus, the cost savings identified in this section serve as a partial measure of incremental consumer and producer surplus. The unquantifiable component of incremental consumer and producer surplus is recognized in Section III. We make no further assumptions on how the cost savings are allocated among producers and consumers; rather, we assume that each dollar saved in the production process yields a benefit of one dollar across producers and consumers. NHTSA assumes no cost savings associated with the installation of forgone steering components; rather, NHTSA assumes that labor would be transferred from installing the steering components to installing whatever amenities or equipment are installed in their place. As noted above, the estimated cost savings are assumed to represent two components: (1) a core cost input cost savings to manufacturers (i.e., equal to the market price of the equipment multiplied by 1/1.51); and (2) a measure of consumer and producer surplus equal to the share of market price associated with all costs other than production costs (i.e., equal to the market price of the equipment multiplied by 0.51/1.51).

Cost impact estimates for individual vehicles are multiplied by the number of vehicles assumed to be produced in a year to generate estimates of total annual cost impacts. The estimated cost impacts are assumed to occur at the time of vehicle manufacture (i.e., cost savings

are realized when the vehicle is built). Discounted cost impacts incorporate discount factors equal to $1/(1+r)^{t-2019}$, where *r* equals the discount rate and *t* equals the year of manufacture.

The ranges of estimates were identified within an uncertainty analysis addressing uncertainty in the average level of cost savings that would be achieved by ADS-DV manufacturers. The uncertainty analysis centered on identifying plausible ranges of the key analytical inputs, with corresponding assumptions regarding the distributions of values across each range (i.e., the likelihood of observing a particular value). The uncertainty analysis generated 50,000 simulated outcomes, across which mean and percentile values reported in the analysis were identified.

FMVSS compliance testing costs are assumed to be unaffected. For example, although the proposed rule would make it feasible to manufacture a fully-autonomous vehicle that has no steering controls, and thus eliminate the need to certify compliance with FMVSS No. 204, "Steering control rearward displacement." Conversely, under FMVSS No. 208, there are potentially more static tests to certify a driver's seat that has been converted to a passenger seat in a vehicle with full ADS, than there would have been for the original driver's seat. However, while upfront compliance testing costs may be affected, it is likely that these costs would be amortized over the production life of the make/model, which we project to reach millions of vehicles as the ADS-DV market matures. Accordingly, the per-vehicle testing cost is assumed to be de minimis under a mature ADS-DV market. Components associated with crash avoidance (e.g., accelerator and brake controls) are outside of the scope of this analysis because the proposed rule is limited in scope to standards governing crashworthiness. We request comment on these assumptions.

B. Total Cost Impacts

B.1. Total Monetized Per-Vehicle Cost Impacts

The estimated costs of providing steering controls for the vehicles in the analysis are summarized in Table 1:

Table 1: Estimated Steering Control Costs per Vehicle (2018 Dollars)

Model	Minimum	Maximum	Average
Ford Explorer	$618.24	$1,974.45	$1,296.35
Lincoln MKT	$1,485.90	$2,559.92	$2,022.91
Chevrolet Equinox	$571.54	$673.27	$622.41
Cadillac SRX	$982.81	$1,143.55	$1,063.18
Dodge Journey	$1,474.80	$1,537.86	$1,506.33
Chrysler Pacifica	$1,143.00	$1,716.86	$1,429.93
Average Consumer Cost	***$1,046.05***	***$1,600.99***	***$1,323.52***

The estimated mean online cost of steering controls across the six vehicle models in the analysis is $1,324 (ranging from a low of $618 for the least expensive Chevrolet Equinox components to a high of $2,560 for the most expensive Lincoln MKT components).

Simons (2017)[9] offers estimates of the costs of air bag telltales and incremental components distinguishing advanced air bags from standard air bags:

Table 2: Costs of Incremental Advanced Air Bag Components (2012 Dollars)

Component	Driver Advanced Air Bag Cost	Passenger Advanced Air Bag Cost	Incremental Cost
Air Bag	$78.40	$117.88	$39.48
Seat Sensor	$0.85	$9.76	$8.91

[9] Simons, J.F. (2017, November). *Cost and weight added by the Federal Motor Vehicle Safety Standards for MY 1968-2012 passenger cars and LTVs*. Report No. DOT HS 812 354. Washington, DC: National Highway Traffic Safety Administration.

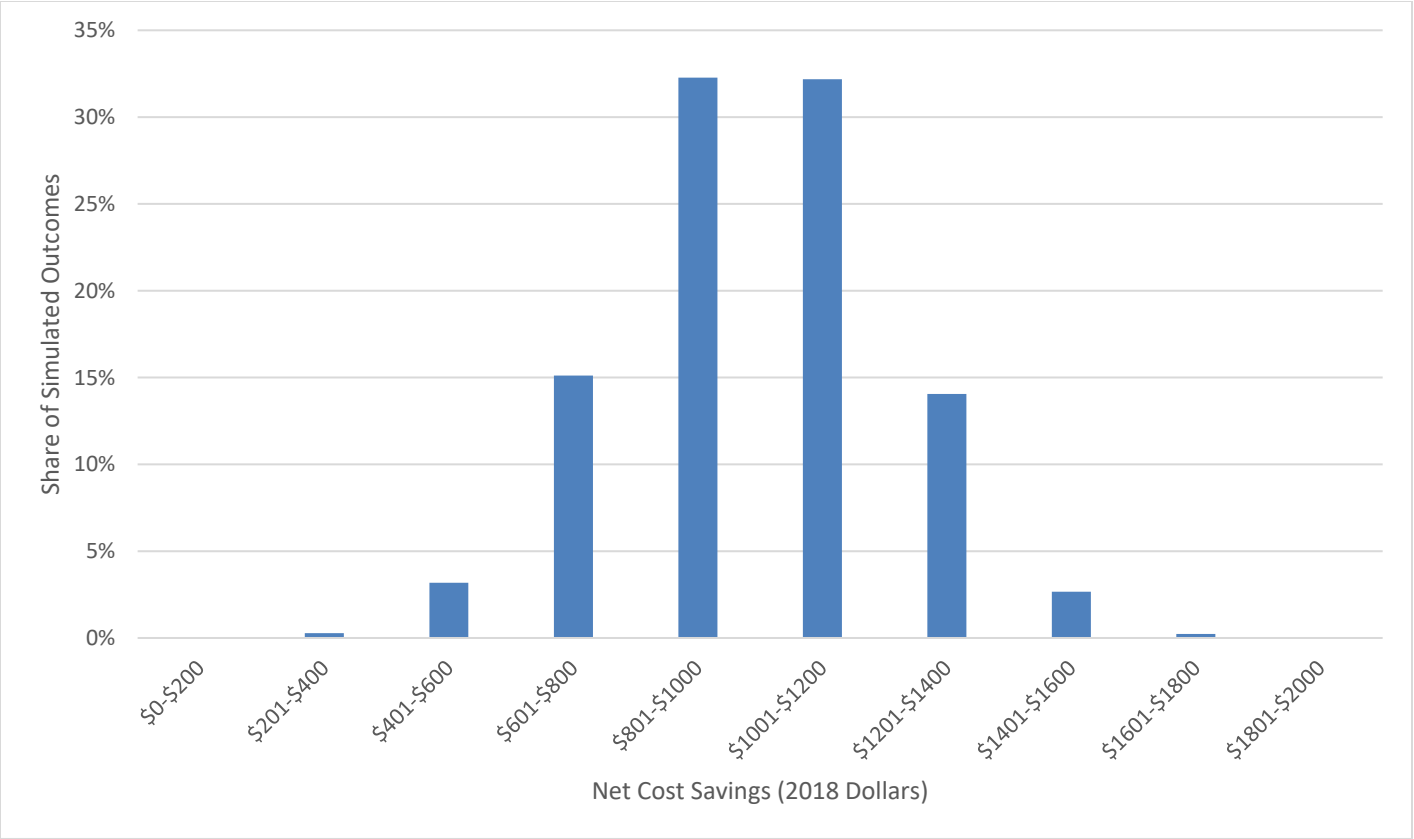
Strain/Occupant Sensor	$0.00	$12.51	$12.51
Telltale	$0.32	$0.64	$0.32
Belt Use Sensor	$0.82	$2.35	$1.53
Total Incremental Cost (2012$)			*$62.75*
Total Incremental Cost (2018$)			***$69.23***

The total estimated incremental cost of: (1) providing an advanced passenger air bag in the front left seat; and (2) adding another air bag telltale is $63 in 2012 dollars. This estimate was converted to 2017 dollars using annual values for the Implicit GDP Deflator[10] (the most recent year available for the annual series), and then converted to 2018 dollars by multiplying the 2017-dollar value by the ratio of the fourth-quarter values for the quarterly series of the Implicit GDP Deflator[11] for 2018 to the corresponding value for 2017, yielding an estimate of $69 per vehicle. NHTSA has no basis to assume any change in the type of advanced air bag system (fully low risk deployment (LRD) for all child dummy sizes or a suppression type system requiring a seat sensor for some child dummy sizes) manufacturers will install in the right front passenger position in ADS-equipped vehicles compared to non-ADS vehicles. Similarly, we would expect that ADS vehicle manufacturers would mirror the air bag type in the left front seating position when installing the air bag for the right front seating position. Although fully LRD air bags are approximately ten percent less expensive than other advanced air bags because no seat sensor is required (or an incremental cost lower by approximately four dollars), our cost estimates will assume all left front passenger air bag systems will have the higher cost system requiring a seat sensor. This results in a higher overall cost estimate. We request comment on this assumption.

[10] https://fred.stlouisfed.org/series/USAGDPDEFAISMEI
[11] https://fred.stlouisfed.org/series/GDPDEF

NHTSA's estimate of per-vehicle cost savings for ADS-DVs is specified as the per-vehicle cost savings associated with foregoing the installation of manual steering controls, less the costs of incremental advanced air bag components ($69 per vehicle, from Table 2). To account for uncertainty in per-vehicle steering control costs, NHTSA conducted an uncertainty analysis. The uncertainty analysis involved 50,000 trials, across which 90 percent of per-vehicle steering control costs were assumed to range between 50 percent of the minimum value in Table 1 (50 percent of $1,046, or $523) and the maximum value in Table 1 ($1,601). The 50-percent scaling factor for the lower bound of the assumed range was selected to: (1) account for unobserved costs for constructing the left front seating position in the absence of steering controls; and (2) reflect potential economies of scale in current manufacturing processes that were not identified in the search for equipment costs. The difference between per-vehicle steering control costs and incremental advanced air bag component costs was assumed to be distributed normally, with a standard deviation equal to 20 percent of the range. The assumption regarding the spread of the normal distribution was selected to ensure that: (1) at least 90 percent of the generated values were within the assumed range; and (2) no generated values were negative. The distribution of simulated outcomes for net cost impacts is presented in Figure 2:

Figure 2: Distribution of Net Cost Impacts in the Uncertainty Analysis (Share of Simulated Outcomes, by 2018 Dollars)



Summary statistics from the sensitivity analysis are presented in Table 3:

Table 3: Net Undiscounted Per-Vehicle Cost Impacts (2018 Dollars)

Statistic	Value
Mean	$995
Median	$995
Standard Deviation	$216
5th Percentile	$636
95th Percentile	$1,350

This estimate does not take into account the timing of the cost impacts, however. Applying discount factors to mean undiscounted per-vehicle benefits (which are assumed to accrue during the year of vehicle manufacture) yields the following estimates of total discounted benefits as a function of the year of manufacture, discounted from 2050 back to 2019:

Table 4: Summary of Discounted Net Per-Vehicle Cost Impact Estimates (ADS-DV Cost Impacts in 2050, 2018 Dollars)

Discount Rate	Mean Cost Impact	5th- to 95th-Percentile Cost Impacts
3%	-$398	-$255 to -$540
7%	-$122	-$78 to -$166

Estimated per-vehicle cost impacts of the proposed rule in 2050 are $398 at a three-percent discount rate, and $122 at a seven-percent discount rate.

The estimated undiscounted cost impact for dual-mode vehicles is equal to the incremental seat senor costs, $10 per vehicle in 2018 dollars. Thus, overall undiscounted cost impacts would increase (i.e., become less negative) by approximately $1 million per 100,000 dual-mode vehicles produced. Discounting production in 2050 back to 2019, the per-vehicle cost impacts for dual-mode vehicles are $4 at a three-percent discount rate and $1 at a seven-percent discount rate. Thus, overall discounted cost impacts in 2050 would increase (i.e., become less negative) by approximately $1 million per 250,000 dual-mode vehicles produced at a three-

percent discount rate (approximately $1 million per 830,000 dual-mode vehicles produced at a seven-percent discount rate).

B.2. Total Monetized Annual Cost Impact

The total discounted annual cost impact of the proposed rule is identified by multiplying the total monetized discounted cost impact per vehicle (as projected in the uncertainty analysis above) by the number of vehicles that would be affected by the rulemaking in a focal year (in this case, 5.8 million vehicles in 2050 for the primary scenario with no dual-mode ADS-DV sales, 4.0 million vehicles in 2050 for the alternative scenario with 30% of ADS-DV sales comprised of dual-mode vehicles; under alternatives with one-percent ADS-DV sales shares, 0.18 million vehicles in 2050 with no dual-mode sales, and 0.13 million vehicles in 2050 with 30% dual-mode sales).

NHTSA's resulting estimates of total annual discounted cost impacts are the means of the values across the 50,000 simulated outcomes:

Table 5: Summary of Total Monetized Annual Cost Impact Estimates (ADS-DV Cost Impacts in 2050, Billions of 2018 Dollars, 31% ADS-DV Sales Share)

Dual-Mode Sales Share	Discount Rate	Mean Cost Impact	5th to 95th Percentile Cost Impacts
0%	3%	-$2.3	-$1.5 to -$3.1
0%	7%	-$0.7	-$0.5 to -$1.0
30%	3%	-$1.6	-$1.0 to -$2.2
30%	7%	-$0.5	-$0.3 to -$0.7

The proposed rule is estimated to generate up to a $2.3 billion cost savings in 2050 at a three-percent discount rate (fifth-percentile cost savings of $1.5 billion and 95th-percentile cost savings of $3.1 billion should all ADS-DV sales be comprised of single-mode vehicles). At a

seven-percent discount rate, the proposed rule is estimated to generate up to a $0.7 billion cost savings in 2050 at a three-percent discount rate (fifth-percentile cost savings of $0.5 billion and 95th-percentile cost savings of $1.0 billion). Under the conservative EIA scenario with a one-percent ADS-DV sales share in 2050, the corresponding ranges are approximately $50 million to $100 million (mean of approximately $70 million) at a three-percent discount rate, and approximately $10 million to $30 million (mean of approximately $20 million) at a seven-percent discount rate.

Under the alternative scenario in which 30 percent of ADS-DV sales in 2050 would be comprised of dual-mode vehicles, the proposed rule is estimated to generate a $1.6 billion cost savings in 2050 at a three-percent discount rate (fifth-percentile cost savings of $1.0 billion and 95th-percentile cost savings of $2.2 billion should all ADS-DV sales be comprised of single-mode vehicles). At a seven-percent discount rate under the alternative scenario, the proposed rule is estimated to generate a $0.5 billion cost savings in 2050 at a three-percent discount rate (fifth-percentile cost savings of $0.3 billion and 95th-percentile cost savings of $0.7 billion). The differences in results across the two scenarios are driven by a lack of cost savings for dual-mode vehicles, as those vehicles would preserve manual steering controls. Under the conservative EIA scenario with a one-percent ADS-DV sales share in 2050, the corresponding ranges are approximately $30 million to $70 million (mean of approximately $50 million) at a three-percent discount rate, and approximately $10 million to $20 million at a seven-percent discount rate.

C. Unquantified Cost Impacts

The estimated cost impacts above represent the subset of potential impacts that are quantifiable (albeit with considerable uncertainty) under the available information. NHTSA

identified two additional, but unquantified, cost impacts associated with the proposed rule: impacts on fuel consumption, and impacts on safety.

C.1. Incremental Fuel Consumption

The proposed rule could affect per-vehicle fuel consumption by changing the mass of ADS-DVs. NHTSA expects ADS-DV mass to either decrease (due to the removal of currently-required equipment) slightly or remain essentially unchanged (due to the addition of automated steering components that offset the mass savings of the removed equipment) under the proposed rule. NHTSA acknowledges that, in principle, ADS-DV mass could increase (if vehicle seating configurations and amenities are changed sufficiently when exploiting the reduction in design constraints when removing manual steering controls) under the proposed rule. However, as stated in the NPRM, NHTSA has not attempted to address the revisions that may be necessary to provide regulatory certainty for manufacturers that wish to self-certify ADS-equipped vehicles with unconventional seating arrangements.

There are multiple factors restricting the ability to estimate fuel consumption impacts under the proposed rule, the most important of which are: baseline per-mile fuel costs, travel demand, baseline vehicle mass, and average changes in vehicle mass. Per-mile energy consumption of ADS-DVs, unit costs of energy used by ADS-DVs, and total miles travelled by ADS-DVs are unknown, but could be combined within an uncertainty analysis to yield estimates of baseline ADS-DV energy costs. However, without information on the average mass of ADS-DVs with and without manual steering controls, it is difficult to project how energy costs would change under the proposed rule.

C.2. Safety

The proposed rule is assumed to have no effect on the per-mile risk of travel in ADS-DVs. That is, the removal of manual steering controls is not assumed to offer any direct safety benefit or detriment for travel in ADS-DVs. However, it is feasible that changes in ADS-DV demand associated with the proposed rule (e.g., due to changes in vehicle design or decreases in cost) could increase demand in ADS-DVs. In turn, safety outcomes associated with the proposed rule would be equal to the net effects of: (1) changes in per-mile fatality and injury risk for travel that is shifted from conventional vehicles to ADS-DVs; and (2) incremental fatalities and injuries for travel in ADS-DVs that would not have taken place in any vehicle otherwise. It is difficult to project net safety impacts associated with the proposed rule without information on: (1) per-mile fatality and injury risk for ADS-DVs and conventional vehicles over time; and (2) demand for travel in ADS-DVs and conventional vehicles as a function of ADS-DV price and design attributes.

III. BENEFIT IMPACTS

This section discusses the two benefit categories associated with the proposed rule: incremental consumer and producer surplus, and innovation.

A. Unquantified Benefit Impacts

A.1. Incremental Consumer and Producer Surplus

NHTSA recognizes that incremental consumer and producer surplus under the proposed rule would likely exceed the magnitude of the production cost savings estimated in the preceding section. That is, by reconfiguring seating configurations and amenities to exploit the lack of

manual steering controls, ADS-DV manufacturers would generate incremental consumer and producer surplus as consumers' willingness-to-pay increases.

However, NHTSA does not have sufficient information available on the demand and supply of ADS-DVs and their substitutes to estimate the components of incremental consumer and producer surplus that are not captured within the estimates of production cost savings. Thus, the share of incremental consumer and producer surplus not comprised of the cost savings identified in the preceding section is an unquantified benefit. We request comment and information on the potential demand and supply of ADS-DVs and their substitutes.

A.2. Innovation

The proposed rule removes a regulatory constraint for ADS-DV manufacturers. By eliminating an equipment requirement for a class of vehicles, the proposed rule would enable new opportunities for innovation. The monetized impacts in this preliminary analysis are limited to production cost savings. Potentially, ADS-DV manufacturers may find innovative ways to change vehicle designs. Primarily, without any manual steering controls, the interior of an ADS-DV could be dramatically different to the interior of a current vehicle. To the extent that innovation modifies the design and price of ADS-DVs, this will influence the consumer and producer surplus associated with ADS-DV sales, which, as noted above, we are currently unable to measure. However, it is also possible that innovation among ADS-DV manufacturers could stimulate improvements in other markets.

Prior studies have concluded that deregulation can stimulate innovation[12]. Removing regulatory constraints would allow manufacturers the opportunity to develop innovative vehicle

[12] See, for example, https://www.oecd.org/sti/inno/2102514.pdf

design changes. Additional innovations might include systems of manufacture, vehicle performance, or materials used in certain aspects of manufacture.

Some studies have concluded that regulatory flexibility helps to promote innovation, and that less prescriptive economic regulations allowed market innovation to increase markedly[13]. The reduction of economic regulatory constraints among airlines in the 1970s is associated with subsequent price decreases and expanded services[14]. In the healthcare sector, the relationship between regulation and innovation is recognized in the development of medical devices[15]. Removal of tax and other restrictions on home and small brewers at both the federal and state levels is widely recognized as a necessary precursor to the dramatic expansion of the craft brew industry in the United States[16].

While it is difficult to predict what specific innovations in the design, manufacture or performance of ADS-DVs might result from a lessening of constraints as outlined in the proposed rule, it is reasonable to anticipate qualitatively that some innovation may be a benefit resulting from the final rule. We request comments on the impact on innovation that could result from enabling the production of ADS-DVs without manual steering controls.

IV. NET BENEFITS

Net benefits represent the difference between total benefits and total costs. In regulatory analysis, net benefits are used as an absolute measure of how much better off society would be

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[13] See, for examples from multiple industries, https://www.itif.org/files/2011-impact-regulation-innovation.pdf

[14] https://www.mercatus.org/publication/unleashing-innovation-deregulation-air-cargo-transportation
[15] https://www.nejm.org/doi/full/10.1056/NEJMp1109094
[16] https://www.theatlantic.com/business/archive/2018/01/craft-beer-industry/550850/

(in dollar terms) if a policy alternative were enacted; a positive value for net benefits indicates that society would be better off under the policy alternative, and a negative value indicates that society would be worse off.

There is only one quantifiable impact category in this analysis (cost impacts). Thus, estimated discounted monetized net benefits of the proposed rule are equal to the estimated discounted monetized cost impacts multiplied by -1 (i.e., zero benefit impact minus a negative cost impact)[17]:

Table 1: Total Annual Monetized Discounted Net Benefits, ADS-DV Production in 2050 (Billions of 2018 Dollars, 31% ADS-DV Sales Share)

Dual-Mode Sales Share	Discount Rate	Mean Net Benefits	5th Percentile to 95th Percentile
0%	3%	$2.3	$1.5 to $3.1
0%	7%	$0.7	$0.5 to $1.0
30%	3%	$1.6	$1.0 to $2.2
30%	7%	$0.5	$0.3 to $0.7

Under the conservative EIA scenario with a one-percent ADS-DV sales share in 2050 with no dual-mode vehicle sales, the corresponding ranges of net benefits are approximately $50 million to $100 million (mean of approximately $70 million) at a three-percent discount rate, and approximately $10 million to $30 million (mean of approximately $20 million) at a seven-percent discount rate. With a 30% dual-mode vehicle sales share, the corresponding ranges of net benefits are approximately $30 million to $70 million (mean of approximately $50 million) at a

[17] Benefit impacts and net benefits do not include unquantified incremental consumer and producer surplus, unquantified fuel consumption impacts, or unquantified innovation impacts.

three-percent discount rate, and approximately $10 million to $20 million at a seven-percent discount rate.

V. EXECUTIVE ORDER 13771

This proposed rule is expected to be an Executive Order 13771 deregulatory action. Details on the estimated cost savings of this proposed rule can be found above in Section II.B. of this document.

VI. UNFUNDED MANDATES REFORM ACT

The Unfunded Mandates Reform Act of 1995 (Public Law 104-4) requires agencies to prepare a written assessment of the costs, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditures by States, local or tribal governments, in the aggregate, or by the private sector, of more than $100 million annually (adjusted annually for inflation with base year of 1995).

The proposed rule is not likely to result in expenditures by State, local or tribal governments of more than $100 million annually. The estimated monetized annual change in costs is between -$1.5 billion and -$3.1 billion at a three-percent discount rate (between -$0.5 billion and -$1.0 billion at a seven-percent discount rate).

VII. REGULATORY FLEXIBLITY ACT

The Regulatory Flexibility Act of 1980 (5 U.S.C §601 et seq.) requires agencies to evaluate the potential effects of their proposed and final rules on small business, small organizations and small Government jurisdictions.

5 U.S.C §603 requires agencies to prepare and make available for public comments an initial and final regulatory flexibility analysis (RFA) describing the impact of proposed and final rules, respectively, on small entities. An RFA is not required if the head of the agency certifies that the proposed or final rule will not have a significant impact on a substantial number of small entities. The head of NHTSA has made such a certification with regard to this NPRM.

The factual basis for the certification (5 U.S.C. 605(b)) is set forth below. While NHTSA is not required to issue an initial RFA (IRFA) by certifying as it did above, the agency discusses below the issues that would be addressed by an IRFA. By discussing these issues, NHTSA explains its analyses of the potential effects of this NPRM on small entities.

Section 603(b) of the Act specifies the content of a RFA. Each RFA must contain:

1. A description of the reasons why action by the agency is being considered;

2. A succinct statement of the objectives of, and legal basis for a proposed rule;

3. A description of and, where feasible, an estimate of the number of small entities to which the proposed rule will apply;

4. A description of the projected reporting, recording keeping and other compliance requirements of a proposed rule including an estimate of the classes of small entities which will be subject to the requirement and the type of professional skills necessary for preparation of the report or record;

5. An identification, to the extent practicable, of all relevant Federal rules which may duplicate, overlap or conflict with the proposed rule;

6. Each initial regulatory flexibility analysis shall also contain a description of any significant alternatives to the proposed rule which accomplish the stated objectives of

applicable statutes and which minimize any significant economic impact of the rule on small entities.

1. Description of the reason why action by the agency is being considered

This action is being considered by the agency to safely remove unnecessary regulatory barriers to ADS-DVs without manual controls that currently exist in the occupant protection standards. Removing regulatory barriers to the subject vehicles will encourage innovation in motor vehicle design and manufacture.

2. Objectives of, and legal basis for, the proposed rule

NHTSA believes that removing regulatory barriers to ADS-DVs without manual controls in the occupant protection standards will encourage innovation by eliminating design restrictions on these vehicles while maintaining safety. Moreover, until NHTSA fully revises the FMVSS to permit the removal of manual controls, removing barriers in the occupant protection standards will reduce the number of standards from which manufacturers of ADS-DVs will have to seek exemptions, which will lessen the administrative burden on both manufacturers and NHTSA.

The legal basis for this proposed rule is NHTSA's authority to promulgate FMVSS under the Vehicle Safety Act (49 U.S.C. 30111 and 30115, 49 U.S.C. 7103; delegation of authority at 49 CFR 1.95).

3. Description and estimate of the number of small entities to which the proposed rule will apply

The proposed rule would apply to small entities that are motor vehicle manufacturers who wish to produce ADS-DVs without manual controls and with conventional seating arrangements (i.e., forward-facing, front row seats). To determine if there is a significant impact

on small vehicle manufacturers, we have attempted to identify if there are any such firms that exist currently and if there might be such firms in the future, within the projected time period of the economic analysis, i.e., 2050.

Business entities are defined as small businesses using the North American Industry Classification System (NAICS) code, for the purpose of receiving Small Business Administration assistance. One of the criteria for determining size, as stated in 13 CFR 121.201, is the number of employees in the firm. For establishments primarily engaged in manufacturing or assembling automobiles, light and heavy duty trucks, buses, motor homes, new tires, or motor vehicle body manufacturing, the firm must have fewer than 1,500 employees to be classified as a small business.

Current Small Manufacturers

Currently, there are at least 14 small light vehicle manufacturers in the United States. Table 1 provides information about the 14 small volume domestic manufacturers in MY 2020. All are small manufacturers, having fewer than 1,500 employees. We do not believe the small manufacturers listed in Table 1 are developing ADS systems for installation on the vehicles they manufacture. Further, we note that, in today's motor vehicle market, small vehicle manufacturers, who are less able than large manufacturers to take advantage of economies of scale to lower production costs, typically produce specialized, expensive vehicles.

Table 1
Small Volume Vehicle Manufacturers (MY 2020)[18]

Manufacturer	Type of Vehicles	Number of Employees (Appx.)	MSRP for Vehicles (Appx.)
Anteros Coachworks	Specialty Sports Cars	2	$110,000
Callaway Cars	Specialty Sports Cars	50	~$17,000 above base (GM) vehicle price
Carroll Shelby International	Specialty Sports Cars	170	$86,085-$180,995+
Equus Automotive	Specialty Sports Cars	25	$250,000+
Falcon Motorsports	Specialty Sports Cars	2	$300,000-$400,000
Faraday Future	Electric	350	$225,000
Fisker Inc.	Electric	<200	$37,499+
Karma Automotive	Electric	750	$135,000
Lucid Motors	Electric	1,100	$60,000+
Panoz	Specialty Sports Cars	<50	$159,900+

[18] Provided to illustrate the current population of small vehicle manufacturers. These manufacturers are not developing ADS systems for installation on their vehicles.

Rivian	Electric	1,300	$69,000-$72,500+
Rossion Automotive	Specialty Sports Cars	70	$80,000
Saleen Automotive	Specialty Sports Cars	170	$48,000-$100,000+
SSC North America	Specialty Sports Cars	9	$2,000,000

Current Small Developers

As there appear to be no current small vehicle manufacturers that will be affected by this rulemaking, the question remains if there are likely to be any in the future that might be affected by this proposal. Through publicly available sources, the agency has determined that 9 small entities are known to be developing ADS systems and integrating them with light vehicle platforms (see table below). The types of vehicles these firms plan to or have produced have at least one of the following three characteristics: (1) the vehicle has an unconventional seating arrangement; (2) the vehicle was not subject to the standards being modified by this proposal because it is a low-speed vehicle subject only to FMVSS No. 500; or (3) the vehicle was compliant with the occupant protection standards being modified by this proposal prior to being modified into an ADS-DV.

As discussed below, this proposal would not impact small entities working with vehicles with the above characteristics, respectively, for the following reasons: (1) this rulemaking is not intended to remove barriers to ADS-DVs with unconventional seating arrangements, as this would require additional research that NHTSA has not yet done; (2) the occupant protection standards that would be impacted by this proposal are not barriers to the removal of manual controls from LSVs; and (3) the cost savings associated with this proposal

would not accrue to fully compliant non-LSV light vehicles, because they would still be equipped with manual steering controls (i.e., the vehicles would not be affected by this proposed rule). All of the small entities engaged in ADS development listed below meet one or more of these characteristics, and thus, this proposal would not impact them.

Currently, there are 9 known small firms engaged in ADS development in the United States (see Table 2). All are small entities, having much fewer than 1,500 employees. It is noted that these small firms, which are less able than large manufacturers to take advantage of economies of scale to lower production costs, produce specialized, expensive vehicles.

Table 2
Small Firms Engaged in ADS Development[19]

Manufacturer	Employees
Apex AI	34
Argo AI	700
Local Motors	200
May Mobility	45
Next Future Transportation	14
Optimus Ride	140
Perrone Robotics	32
Voyage Auto	27
Zoox	470

[19] Provided to illustrate the current population of small firms engaged in this area. Note that these entities are not producing vehicles that would be affected by this NPRM.

NHTSA cannot predict how many of these companies, if any, would be producing ADS-DVs in 2050, nor can NHTSA predict how the number of manufacturers producing such vehicles will change. However, we believe it is unlikely that small vehicle manufacturers would comprise a significant share of the ADS-DV market affected by the proposed rule, due to the inherent advantages that large motor vehicle manufacturers would have in taking advantage of economies of scale associated with resource-intensive ADS technologies.

4. A description of the projected reporting, recording keeping and other compliance requirements of the proposed rule including an estimate of the classes of small entities which will be subject to the requirement and the type of professional skills necessary for preparation of the report or record.

Reporting & Recording Impacts:

This proposal does not create any new reporting or recording requirements, nor does it affect any existing reporting or recording requirements.

Compliance Impacts:

This proposal does not impose any new requirements on vehicle manufacturers, including those that are small businesses. Rather, it would enable manufacturers of the subject vehicles (ADS-DVs without manual controls) to comply with relevant occupant protection standards by adding a new compliance option that essentially replicates the existing passenger-side requirements in all front outboard seating positions.[20] Manufacturers would still be permitted to

[20] We note that all new light vehicles (other than LSVs and trailers) are statutorily required to have air bags in all front outboard passenger seating positions, regardless of the presence of manual steering controls (see section 2508 of the "Intermodal Surface Transportation Efficiency Act of 1991," PL 102-240), and that these air bags are statutorily required to minimize risk to infants, children, and other occupants by means that include advanced air bags (see section 7103 of the "Transportation Equity Act for the 21st Century," PL 105-178).

certify to the requirements of the affected standards under the compliance options available today.

For those small manufacturers of ADS-DV that opt to remove manual steering controls from their vehicles, this proposal would represent a slight reduction in regulatory burden.[21] To the extent an IRFA takes into account a cost savings, the proposed rule would have a slight positive effect on ADS-DV manufacturers that opt to remove manual steering controls from ADS-DVs, as they would no longer have to address standards referencing steering controls. However, we believe that the rule would not have a significant economic impact on small manufacturers of such vehicles.

This is because in the modern motor vehicle market, small vehicle manufacturers, who are less able than large manufacturers to take advantage of economies of scale to lower production costs, typically produce specialized, expensive vehicles. Moreover, NHTSA expects that ADS-DVs will generally be far more expensive than traditional vehicles, given their relative level of sophistication and high development cost. Given these two points, we expect that any ADS-DVs that are produced by small manufacturers would be very expensive relative to the average price of a vehicle. In turn, any cost savings accruing to small manufacturers are expected to represent an insignificant share of the sales price of affected ADS-DVs. Thus, while the removal of manual steering controls represents a cost savings affecting all ADS-DV manufacturers, including small ones, NHTSA does not believe the impact would be significant.

[21] We assume for purposes of our analysis here that there are no other regulatory barriers to removing manual controls, such as those that exist in the crash avoidance (100-level) FMVSS. Until NHTSA removes such other barriers, manufacturers of ADS-DVs without manual controls that would be impacted by today's proposed rule would need to seek an exemption from these other requirements to deploy their vehicles.

Given that the proposed rule would add a new compliance option for the occupant protection standards without affecting existing compliance options, and that the potential benefit of this new compliance option would likely be relatively small relative to the overall cost of manufacturing an ADS-DVs, NHTSA believes this proposal would not result in a significant impact on a substantial number of small entities.

5. An identification, to the extent practicable, of all relevant Federal rules which may duplicate, overlap, or conflict with the proposed rule

We know of no Federal rules which duplicate, overlap, or conflict with the proposed rule.

6. A description of any significant alternatives to the proposed rule which accomplish the stated objectives of applicable statutes and which minimize any significant economic impact of the proposed rule on small entities.

The proposed rule represents a deregulatory action that would affect small manufacturers that would opt to remove manual steering controls from covered ADS-DVs, since it would create an optional compliance pathway that does not currently exist. NHTSA notes that the new compliance option would remove one of the barriers now facing manufacturers of the subject vehicles, thus helping them develop designs for ADS-DVs that are not currently permitted. It would relieve a minor regulatory paperwork for any manufacturer who opts to take advantage of the new compliance option, by enabling them to petition for exemption for one fewer standard.

Also, the anticipated economic impact on small manufacturers would not be significant, because the cost of a manual control is not large compared to the cost of the subject vehicle. No meaningful alternative is known that could achieve the stated objective of the Vehicle Safety Act with less of an economic impact.

The proposed rule would permit the removal of manual controls from the former "driver's seat" but proposes that the seating position affected by the removal must provide passenger-side occupant protection (air bag technology) to that "new" passenger-side seat. NHTSA does not believe an alternative is available that would permit the new passenger-side seat not to have an advanced air bag. Advanced air bags are required by statute for the front outboard seating positions (see § 2508 of the "Intermodal Surface Transportation Efficiency Act of 1991," PL 102-240 and §7103 of the Transportation Equity Act for 21st Century (PL 102-240 105-178). ADS-DVs without manual controls could operate with a child in either (or both) front outboard seats, because there is no driver's seating position. Thus, all the occupant protection requirements that are uniquely applicable to the passenger seat in a vehicle with manual steering controls (including advanced air bags) would need to apply to both front outboard seats in an ADS-DV without manual controls to ensure there is not a negative impact on vehicle safety due to the removal of the steering control.

We note, however, that all manufacturers, including small entities, are currently subject to the advanced air bag requirements for the passenger seating position. Thus, all manufacturers, including small entities, already have the skills and abilities to certify their vehicles to the advanced air bag requirements. Because they are already installing air bags on the driver-side and are installing advanced air bags on the passenger-side in their vehicles, the agency believes that the proposed rule would not have a significant impact on vehicle manufacturers, including small manufacturers.