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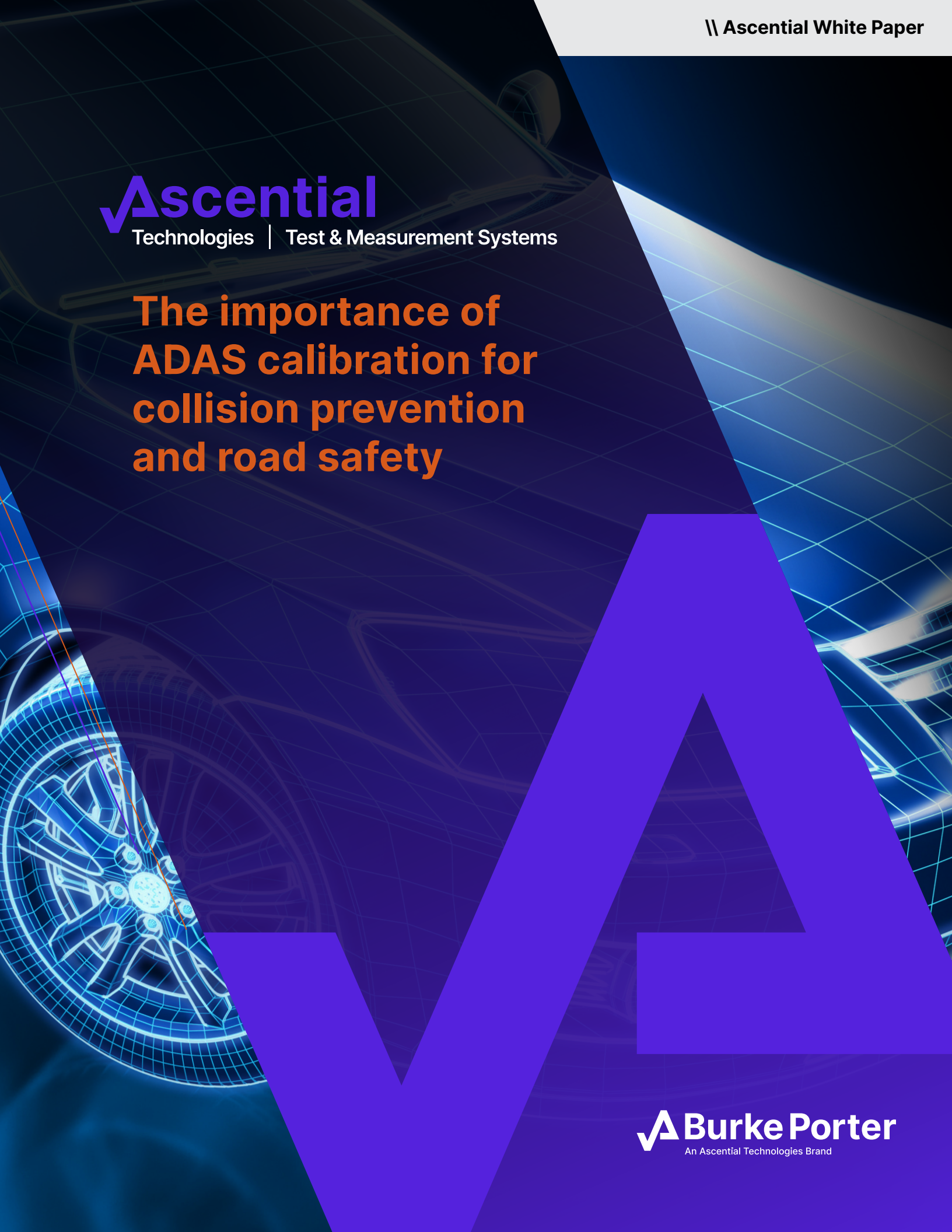
The importance of ADAS calibration for collision prevention and road safety



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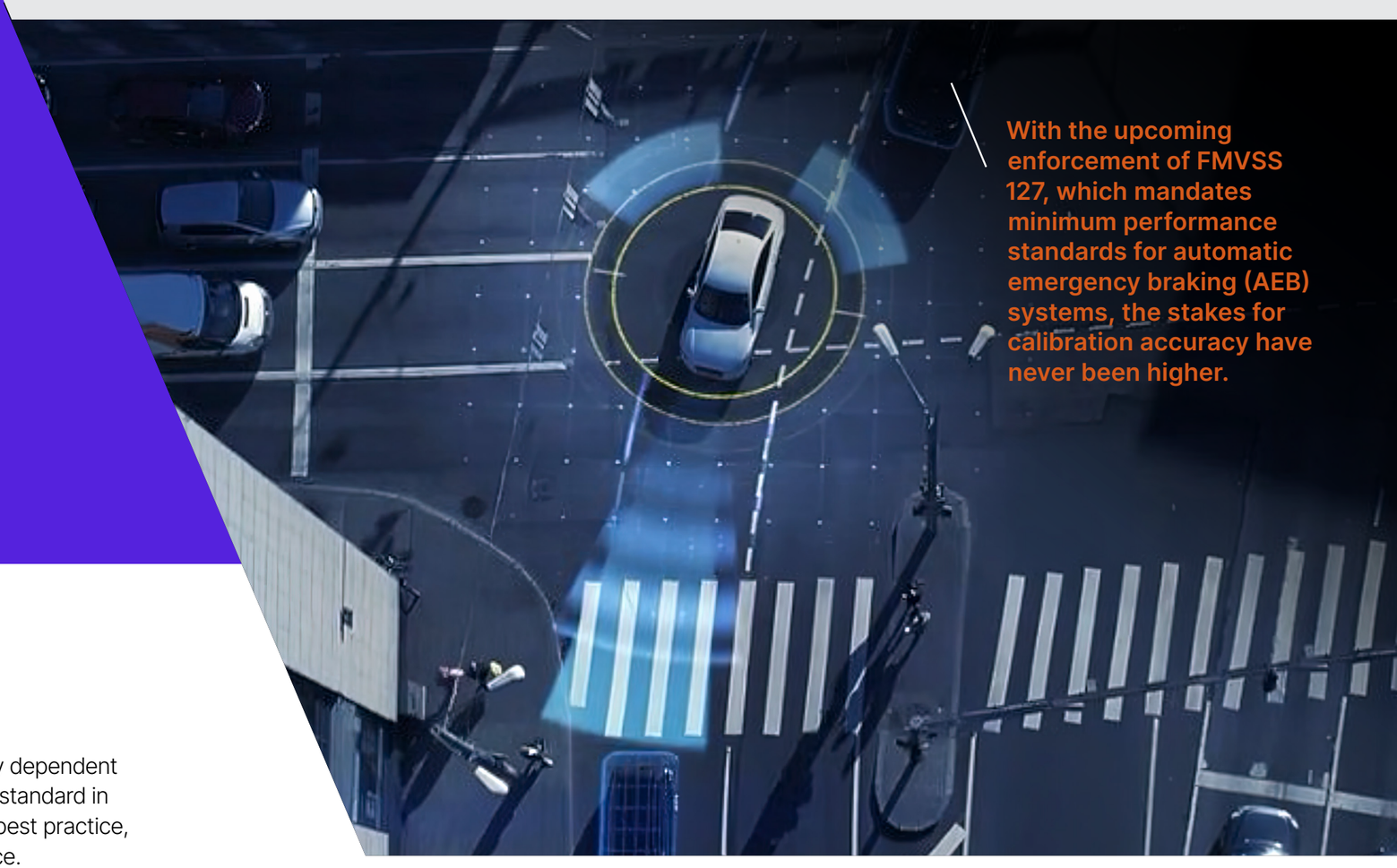
The importance of ADAS calibration for collision prevention and road safety

As ADAS technologies advance, proper calibration becomes essential for both safety and legal compliance



With the upcoming enforcement of FMVSS 127, which mandates minimum performance standards for automatic emergency braking (AEB) systems, the stakes for calibration accuracy have never been higher.

Executive summary

The performance of Advanced Driver Assistance Systems (ADAS) is highly dependent on precise sensor calibration. As ADAS technology becomes increasingly standard in modern vehicles, maintaining system accuracy post-repair is no longer a best practice, it is a necessity for ensuring safety, functionality and regulatory compliance.

This report evaluates the effects of various calibration methods on the performance of a 2024 Nissan Altima equipped with forward-facing radar and camera-based ADAS features. Calibration scenarios ranged from original equipment manufacturer (OEM) standards to deliberately poor conditions, including misaligned sensor mounting and suboptimal calibration environments.

Key findings demonstrate that improper calibrations led to significant degradation in system performance, including failure to meet key criteria in lane departure warning (LDW), forward collision warning (FCW), crash imminent braking (CIB) and pedestrian automatic emergency braking (PAEB) scenarios. In contrast, calibrations performed under controlled and precise conditions consistently met or exceeded the performance benchmarks.

With the upcoming enforcement of FMVSS 127, which mandates minimum performance standards for automatic emergency braking (AEB) systems, the stakes for calibration accuracy have never been higher. Improper calibration not only jeopardizes road safety but also exposes service providers and vehicle owners to legal and regulatory risks.

This study underscores the critical role of accurate ADAS calibration in protecting human lives and ensuring future compliance. As the industry evolves, calibration integrity will be essential to advancing vehicle safety technologies and maintaining public trust.

Introduction

Advanced Driver Assistance Systems (ADAS) can dramatically improve vehicle safety but only if they are properly calibrated. Below, we explore how effective ADAS is at preventing crashes, what happens when ADAS sensors aren't calibrated correctly, why post-collision recalibration and routine checks are essential, and the broader industry implications. The evidence, including statistics, studies and real-world examples makes a compelling case that ADAS calibration must be a priority after repairs and as part of regular maintenance.

1. ADAS effectiveness in preventing collisions

Properly functioning ADAS have proven safety benefits including reducing crashes and saving lives. Key findings from safety research include:

- **Front crash prevention (Automatic emergency braking & forward collision warning):** Vehicles with forward collision warning (FCW) plus automatic emergency braking (AEB) experience about 50% fewer rear-end collisions compared to similar models without these systems.[4] Even FCW alone reduces rear-end crashes by ~27%. Crucially, AEB also greatly reduces rear-end crashes involving injuries by lowering impact speeds.[4] In practical terms, this technology is so effective that it was voluntarily made standard by most automakers by 2022, and studies show it significantly cuts insurance claims for vehicle damage and injuries.[4]

- **Lane departure warning (LDW) and Lane keeping assist:** LDW systems, which alert drivers drifting out of their lane, reduce the incidence of single-vehicle, sideswipe and head-on crashes by about 11%, and lower injury crashes of those types by 21%.[2] One Insurance Institute for Highway Safety (IIHS) study estimated that if all passenger vehicles had LDW, about 85,000 crashes and 55,000 injuries could have been prevented in a single year.[2]

  Even more striking, a simpler analysis (not controlling for driver factors) found fatal crashes fell 86% in vehicles with LDW,[2] highlighting the life-saving potential when this feature is widely used. (Real-world effectiveness depends on drivers leaving the system on; many U.S. drivers turn it off, which is one reason the measured 11% crash reduction isn't higher.[2])

- **Blind spot detection:** Blind spot monitoring, which alerts drivers of vehicles alongside them during lane changes, cuts lane-change crashes by roughly 14% and related injury crashes by 23% (the injury reduction trend was consistent across most studies, though the sample size made it slightly below full statistical significance).[2] IIHS researchers estimate that if every car had a quality blind spot detection system, about 50,000 crashes a year could be prevented.[2] Insurance data backs this up as well, as cars with blind spot monitors see fewer insurance claims for damage and injuries from lane-change collisions.[4]

- **Pedestrian detection and other features:** Systems that detect pedestrians and cyclists also help prevent collisions. One study found autobrake systems that recognize pedestrians cut pedestrian collisions by 27%.[4] Rear automatic braking (to prevent backing-up crashes) reduces backing collision claims more than any other rear safety technology (i.e. better than just parking sensors or cameras).[4] In short, each ADAS feature (rear cameras, cross-traffic alert, adaptive cruise with lane centering, etc.) targets a crash mode and can substantially reduce specific types of crashes when working properly.

- **Overall lives saved potential:** The broad adoption of ADAS could save thousands of lives. The National Safety Council (NSC) and others estimate that current ADAS technologies have the potential to prevent around 62% of traffic deaths and about 60% of crash injuries annually if widely implemented and used.[10] In numbers, that equates to roughly 20,000 lives saved per year in the U.S.[12]

Even when crashes aren't avoided outright, ADAS often reduces impact speeds (by warning/braking), mitigating severity. For example, in crash tests, a car with autobrake reduced impact speed by 13 mph, avoiding approximately $28,000 in damage compared to a full speed crash.[4] The bottom line: ADAS features (when properly functioning) significantly reduce the likelihood and severity of crashes, protecting drivers, passengers and vulnerable road users.

2. Failure rates and consequences of improper calibration

ADAS only delivers these safety benefits if its sensors and cameras are accurately calibrated. When calibration is poor or missing, the systems can malfunction or become entirely ineffective with serious safety consequences. Key points on the impact of improper calibration include:

- **ADAS sensors require precision:** ADAS sensors (cameras, radars, etc.) are finely tuned devices, and even a slight misalignment can throw them off. Industry experts note that if a sensor's aim is off by just one degree or a few millimeters, the error is magnified at a distance where the sensor could be looking several feet off target by the time it's 50+ feet down the road.[7,11] In practical terms, a one-degree misalignment can render an entire ADAS system ineffective and dangerous.[11] For example, a forward camera that's a hair off may "see" the road incorrectly, missing lane markings or vehicles that are actually in its path.

- **Common causes of miscalibration:** Collisions are a major cause of sensor misalignment. Even a minor fender-bender or bump can knock cameras or radar sensors out of position,[7] but normal maintenance and modifications can also affect calibration. Something as routine as a windshield replacement (for vehicles with cameras mounted at the windshield) or a suspension/wheel alignment (for vehicles with steering angle sensors and radars) will disturb ADAS sensor orientation.[7]

  In all these cases, manufacturers specify that the sensors must be recalibrated afterward or else the ADAS may not function properly.[10] Failing to do so means the car's "electronic eyes" could be looking in the wrong place.

- **What happens when calibration is off:** Improper calibration can lead to false inputs or no inputs to the ADAS computer, which in turn causes the system to behave unpredictably:

  - The vehicle may fail to warn the driver about a hazard or fail to intervene when it should. For instance, if a forward camera is aimed too high/low or rotated, it might not detect an obstacle in time for AEB to brake.

  - Conversely, it might trigger warnings or braking at the wrong time (false alarms) if it misreads the environment.

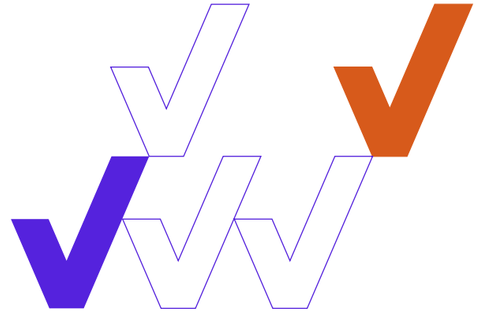
  - Sometimes, the first sign of a calibration problem is a dash warning light or error message after a repair.[7] The car might store a diagnostic trouble code or disable the ADAS feature until recalibrated.[7] But more worryingly, most vehicles will not activate a warning light, leaving the driver unaware of a system issue

  - Physical driving feel can be affected too when misaligned sensors have been linked to issues such as steering pull or increased steering effort if the car's systems are fighting bad data.[7]

- **Real-world data on calibration issues:** A recent IIHS survey underscores how common post-repair ADAS issues are if calibration isn't done correctly. Among car owners who had crash-avoidance features repaired, about half reported problems with the systems after the repair.6 Many even had to bring the vehicle back for additional fixes on the same feature.6 In particular, when repairs involved replacing a windshield or were due to crash damage, issues skyrocketed (more on that in Section 3). This shows that improper or incomplete calibration after service is a widespread problem, not a rare fluke.

- **"One degree off" can be deadly:** Experts often say calibration is a game of inches (or millimeters). If not done to exact specifications, the consequences can be dire. A collision industry specialist put it this way: "Properly calibrating ADAS systems is a matter not of inches but of millimeters."[11] Even being slightly off can mean a sensor misses a target by several feet or triggers at the wrong time.[7]

  To illustrate, IIHS research found that a forward camera misaligned by only 0.6° reduced an AEB system's effective reaction time by 60% (from 1.5 seconds down to just 0.6–0.9 seconds).[12] That kind of degradation can be the difference between a near-miss and a serious crash. In short, ADAS calibration is unforgiving, there is little margin for error, and "close enough" is not enough for these safety-critical systems.



3. Post-Collision ADAS calibration – A must for safe repairs

After a vehicle is involved in a collision (even a minor one), recalibrating ADAS components is not just recommended, it is essential. The vehicle has absorbed forces that almost certainly shifted sensor positions or damaged their mounts, and repairs themselves (panel replacements, new windshields, etc.) often disturb the sensors. Failing to recalibrate after an accident repair can leave the driver with a false sense of security or a system that doesn't work when it's needed most. Consider the following:

- **Survey of drivers post-repair:** The IIHS conducted a survey of drivers with ADAS-equipped cars that had been repaired. The findings are alarming: nearly three out of four drivers (75%) who had repairs due to crash damage reported problems with their ADAS afterward.[13] Similarly, about 66% of drivers who had a windshield replaced (and the camera reinstalled) experienced post-repair issues.[13]

These issues ranged from persistent error warnings to the features simply not working as intended. By contrast, among those who had ADAS serviced for other reasons (like a recall or software update), less than half had any issues.[13] This stark difference underscores that post-crash and post-glass replacement calibrations are frequently not done properly in the field, leaving many drivers with malfunctioning safety systems.

- **Recurring problems and repairs:** Not only did many drivers experience ADAS glitches after the initial repair, but some had to return multiple times to get the systems fixed.[6] In other words, an improper calibration can turn into a frustrating cycle of repeat visits, and worse, the car is on the road in the meantime, potentially without effective crash avoidance. Despite these headaches, the IIHS notes most drivers still value the technology and want it in their next car,[6] they just want it to work correctly. This highlights a critical responsibility on repair shops: once a vehicle is repaired from collision damage, the ADAS must be recalibrated to factory specs (using proper tools and procedures) to restore its safety function. Skipping this step or doing it wrong isn't just an inconvenience, it directly puts lives at risk.

- **Case study – miscalibration leading to missed warnings:** Imagine a car that's been repaired but its forward-facing camera wasn't calibrated. In testing scenarios, the outcomes have been dire. In a controlled study conducted at the Transportation Research Center (TRC) and commissioned by Burke Porter, an Ascential Technologies brand, a vehicle was intentionally put in an "improperly calibrated" state (camera slightly mis-aimed and radar mis-mounted, simulating common post-repair mistakes). The miscalibrated car completely failed to issue any lane departure warnings during tests and it never alerted when drifting out of its lane. Even more concerning, the automatic emergency braking did not activate at all, resulting in the car striking the obstacle in the test scenario.[1] Essentially, the ADAS might as well have been turned off. This is exactly what could happen in the real world if, for example, a windshield camera is off-center after replacement. In this case the car might not "see" the lane lines or a stopped car ahead, and the driver would get no help avoiding a crash. (More in-depth results and analysis in Section 5.)

- **Real-world tragedies to avoid:** While specific crash investigations are still catching up to this new technology, safety experts widely acknowledge the risk. A poorly calibrated AEB system, for example, "may fail to engage or engage too late, resulting in a collision."[9] There have been anecdotes of drivers assuming their ADAS would save them, only to find out (too late) that a sensor was misaligned from a previous minor crash. This creates a false sense of security in which the driver might follow too closely or not brake in time, expecting the car to intervene, but the car's "eyes" are effectively blinded.[9]

Manufacturers and insurers fear a scenario where someone is injured in a crash that could have been avoided had the ADAS been properly recalibrated after an earlier repair. It's worth noting that modern cars will often self-diagnose major miscalibrations and flash a dashboard warning, but not always. Subtle misalignments can go undetected by

onboard diagnostics and still dramatically impair performance.[12]

- **The John Eagle collision case:** This case serves as a cautionary tale for the ADAS industry: a body shop deviated from OEM repair procedures bonding a roof instead of welding it, which lead to catastrophic structural failure in a crash and a $31.5 million jury verdict.[16] The same principle applies to ADAS: when repairers skip or improperly perform calibrations, they compromise the vehicle's safety systems, potentially exposing themselves to similar liability. This underscores the legal and ethical obligations to follow OEM calibration requirements precisely.

- **The cost of skipping calibration:** Besides the safety risk, failing to calibrate ADAS after a collision repair can have legal and financial repercussions (explored more in Section 6). The important point for drivers is this: whenever your vehicle undergoes body work or repairs that involve ADAS components (cameras, radars, suspension, etc.), insist on a calibration.

  It often requires specialized equipment and expertise, but it is not an "extra", it is part of returning your car to safe operating condition. As one automotive glass expert put it, even a quick windshield swap now takes hours because the cameras must be calibrated; skipping that step is simply not an option.[10] Safety systems that aren't calibrated are safety systems in name only.

4. ADAS calibration as a routine maintenance requirement

Beyond post-accident repairs, there is a growing recognition that ADAS calibration may need to be performed periodically as part of regular maintenance, due to sensor drift, wear-and-tear, or other environmental factors over the duration of a vehicle's life. Traditional car maintenance focuses on mechanical components, but as cars become "smarter," maintaining their electronic eyes and ears is just as important for safety. Here's why regular calibration checks might be necessary:

- **Sensors can drift or wear over time:** ADAS components are subject to vibrations, thermal expansion and aging just like any other part. Over years of use (or exposure to potholes, curbs and harsh weather), cameras and radar brackets can slowly shift or loosen from their original factory alignment. Moreover, age-related wear and tear, or something like a windshield developing a minor distortion where the camera looks through, can degrade sensor performance.[5]

  A study by TÜV Rheinland (TÜV) and the UK's Transport Research Laboratory (TRL) projected that by 2029, as ADAS equipped cars age, there could be up to 790,000 "risk events" per year in the EU due solely to reduced performance of lane-keeping systems from wear, damage or calibration neglect.[5] In worst-case scenarios (many cars with unaddressed issues), they estimated up to 2.3 million such incidents annually in the EU could occur.[5] Each "risk event" means the ADAS didn't perform as intended when it should have – for example, the lane keeping assist might fail to correct an unintentional drift, or give no warning, potentially leading to a crash.

- **Tested impact of aging and misalignment:** In the TÜV/TRL research, engineers artificially aged components, misaligned cameras and even simulated slight windshield damage to see how a lane-keep assist (LKA) system would react. The results confirmed fears, the LKA's function deteriorated under these conditions.[5] In some trials, the car drove over lane markings without any warning or correction from the system.[5] In a few cases, the LKA would abruptly shut off ("fail silent") without alerting the driver, presumably because the system detected an inconsistency it couldn't reconcile.[5]

  These kinds of outcomes were observed without any fresh accident, just simulated wear or small miscalibrations that could easily happen over a vehicle's life. It demonstrates that ADAS performance can change over time, a system that worked fine when the car was new might not work properly a few years and many bumps later, unless checked. (See more data from our testing in Section 5 demonstrating performance concerns on a vehicle with only 12,900 miles.)

- **The need for periodic checks:** Traditionally, safety systems like airbags or ABS don't require "recalibration" in routine service but ADAS is different. Some experts argue that when you go for an annual service or inspection, ADAS calibration should be on the checklist, especially for vehicles a few years old. TÜV Rheinland's VP of Mobility emphasized that assistance systems "must function reliably for many years" and advocated for more studies on long-term reliability and potential inspection requirements as cars age.[5]

  In Europe, there is movement toward including ADAS checks in periodic roadworthiness inspections, precisely to catch any deterioration before it causes harm. In the U.S., this concept is newer but forward-thinking repair centers and ADAS service specialists already advise owners to get their systems checked periodically. One ADAS calibration provider notes that calibration is not a one-time set-and-forget task; it "requires periodic checks and adjustments" and ongoing maintenance to ensure performance doesn't degrade.[9]

- **Evidence of long-term resilience and caveats:** On a positive note, if a car hasn't been in a crash or had components disturbed, the calibration can hold for quite a long time. The Highway Loss Data Institute found that Subarus and Hondas with ADAS continued to show the same lower crash claim rates even when the

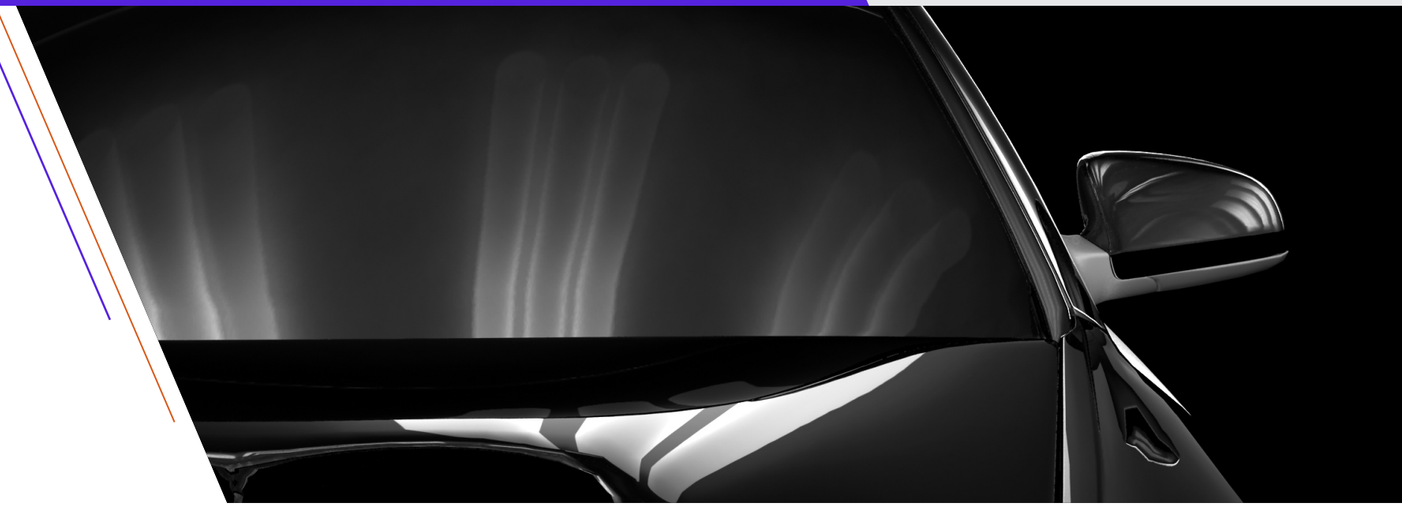
vehicles were 5+ years old, implying their systems were still functioning well.[6] This suggests that catastrophic drift is not inevitable in the short term.

However, not all degradation is immediate or obvious to the driver, and a car that's been through rough use may tell a different story than one gently driven on smooth roads. Given the stakes, many in the industry err on the side of caution, if there's any doubt, it's wise to verify sensor calibration periodically. This might be especially true if you notice the ADAS behaving oddly (i.e. false alarms or missed detections), or after harsh events like off-roading, bodywork (even unrelated to ADAS) or once the car hits certain mileage/time milestones.

- **Environmental factors:** Everyday environmental factors can also necessitate recalibration. Extreme temperature swings, for instance, might affect camera housings. Dirt, snow or ice can temporarily block sensors (vehicles usually warn you when sensors are obscured), but if debris or water consistently infiltrates a sensor mounting, it might shift its position.

  Many ADAS sensors are positioned behind bumpers or windshields, which are areas that are frequently flexed or stressed. UV exposure can even warp plastic calibration targets or camera mounts over many years. While manufacturers design these systems to be robust, keeping them in perfect tune may occasionally require a proactive calibration tune-up much like wheel alignment or suspension tuning in a traditional service.

In summary, as ADAS become older and more common, regular calibration checks could become as routine as an oil change in ensuring safety. The goal is to catch any drift or damage before an ADAS failure contributes to a collision. Given that these systems are increasingly mandated (the EU now requires features like LKA and AEB on new models[5]), maintaining them is part of responsible vehicle ownership. It's far better to spend a little time on a calibration verification than to discover an error at the moment a crash is looming.



5. Performance evaluation of ADAS calibration quality

This section presents a structured analysis of how calibration quality affects ADAS performance, based on controlled testing conducted at the TRC commissioned by Burke Porter using a 2024 Nissan Altima. The goal was to simulate real-world calibration scenarios and quantify their impact on safety-critical ADAS functions.

5.1 Calibration conditions and methodology

Four calibration states were evaluated:

Calibration Type	Description
Factory Baseline	OEM calibration with 12,900 miles of use.
No Calibration	Sensors disturbed post-repair, no recalibration performed.
Poor Calibration	Calibration performed under worst-case conditions (e.g., sun glare, slope, not following OEM requirements).
Good Calibration	OEM-compliant calibration at Burke Porter facility using proper tools & environment.

Table 1

Each configuration was tested across multiple National Highway Traffic Safety Administration (NHTSA) and IIHS protocols, including LDW, FCW, Crash Imminent Braking (CIB), Adaptive Cruise Control (ACC) and Pedestrian Automatic Emergency Braking (PAEB).

5.2 Instrumentation and test setup

Instrumentation included:

- OXTS RT3003 GPS/IMU for velocity and yaw rate
- SEA camera/microphone for alert capture
- Dewesoft DAQ system
- AB Dynamics robotic targets (Soft Car 360, PTM)
- Faro Quantum E arm for mm-level sensor alignment verification

All tests were conducted under controlled conditions at TRC's SMARTCenter.

Image 1

Image 2

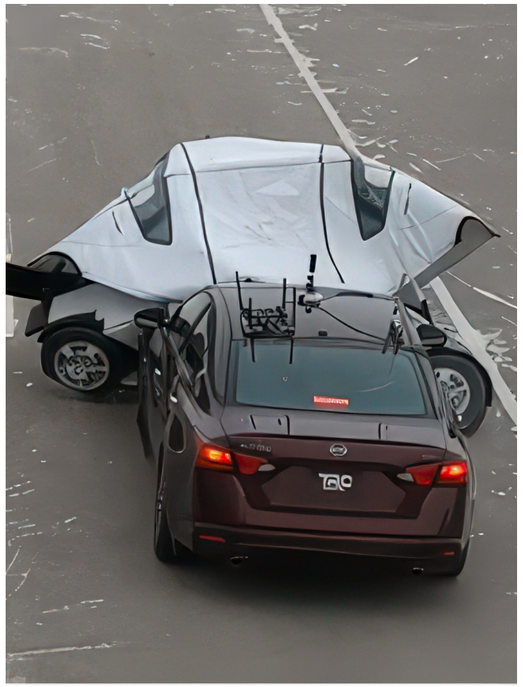


Image 3: Non calibrated vehicle crashing into target vehicle.

5.3 Key findings by scenario

Lane departure warning

Calibration type	Avg. alert distance (Right)	Notes
Good Calibration	7.53 in	Consistent, symmetric alerts
Poor Calibration	3.60 in	Late alert due to yaw misalignment
Baseline	8.04 in	Acceptable
No Calibration	0.00 in	No alerts triggered

Table 2

No calibration resulted in complete system failure. Poor calibration introduced asymmetry. Good calibration restored factory-level performance.

FCW & CIB

Calibration Type	Min distance to target	Avoidance rate	Notes
Good Calibration	46.76 ft*	100%*	Consistent alerts
Poor Calibration	40.91 ft	100%	Higher variability
Baseline	40.10 ft	100%	Acceptable, but less aggressive
No Calibration	13.71 ft	0%	No braking, full impact

**Removal of outlier due to inclement weather*

Table 3

The good calibration scenario delivered the most consistent and timely alerts, with the longest average stopping margin and highest reliability.

The no calibration vehicle did not engage the brakes at all and had full impact to the target vehicle in all tests performed.

Pedestrian AEB

Calibration type	Min distance to pedestrian	TTC alert(s)	Avoidance outcome	Notes
Good Calibration	4.19 ft	1.24	✔ 100% avoided	Earliest alert, most consistent
Poor Calibration	4.89 ft	1.16	✔ 100% avoided	Slightly delayed, highly variable
Baseline	1.51 ft	1.09	⚠ Mixed	Inconsistent, impacts observed
No Calibration	0.00 ft	0.01–0.02	✘ No avoidance	System failed to detect pedestrian

Table 4

Good calibration more than doubled the stopping margin vs. baseline and was the only configuration with both early alerts and consistent avoidance.

5.4 Variability and predictability (–) PAEB

Scenario	Metric	Baseline CV (%)	Good calibration CV (%)	Poor calibration CV (%)	No calibration
PAEB Alert Timing	Coefficient of Variation	13.72	4.74	6.59	—

Table 5

Pedestrian fatalities in the U.S. have surged by over 77% since 2010, reaching an estimated 7,508 deaths in 2022, the highest number in four decades.[1] The Governors Highway Safety Association (GHSA) attributes this rise to factors like increased vehicle size, nighttime visibility challenges and distracted driving. Alarmingly, 77% of these deaths occurred at night, and 84% happened in locations without intersections, exactly the kinds of scenarios where properly calibrated PAEB systems can make a lifesaving difference.[1]

Image 4: Baseline vehicle hitting pedestrian dummy.

5.5 Summary of improvements over baseline

Metric	Good calibration	% Improvement vs. baseline
Pedestrian Stopping Distance	4.19 ft	+177%
FCW Alert Time (TTC)	1.87 s	+2.2%
LDW Alert Distance (Right)	7.53 in	−6% (more centered)

Table 6

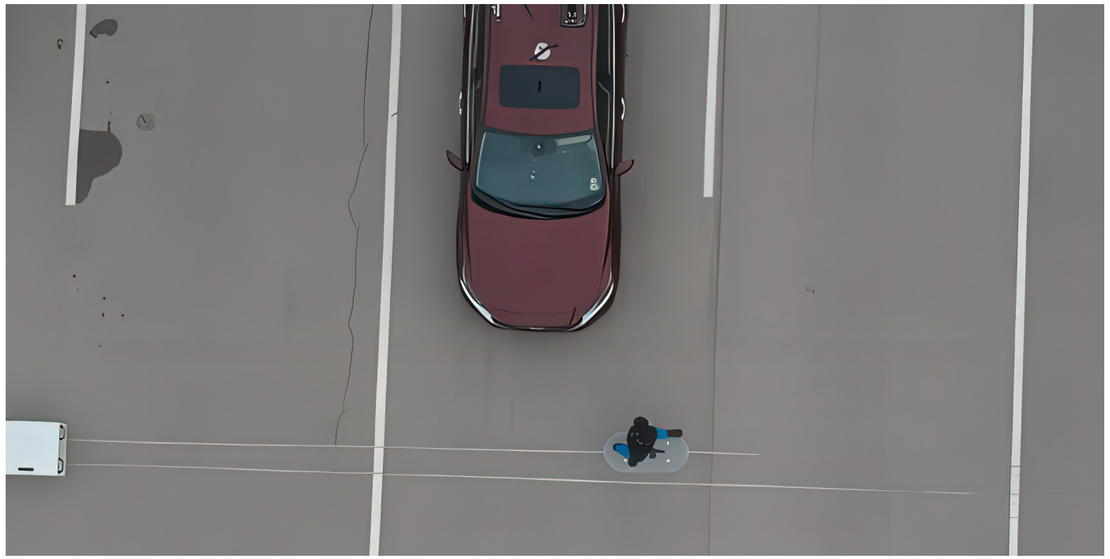


Image 5: Good calibration enabling vehicle to safely avoid collision with pedestrian.

5.6 Conclusion: Why good calibration matters

The data clearly shows:

- Good calibration restores and enhances ADAS performance.
- Poor calibration introduces dangerous unpredictability, even when systems appear functional.
- No calibration results in silent failure, with systems failing to activate at all.
- Baseline systems degrade over time, reinforcing the need for calibration as a maintenance item.

Proper calibration is not optional. It is the difference between a system that saves lives and one that fails silently.

6. Regulatory and industry implications

Because ADAS calibration is so vital to vehicle safety, it has caught the attention of regulators, insurers, automakers and repair professionals. Ensuring these systems are calibrated properly, and holding parties accountable if they aren't, is a developing area of policy and practice. Here are the key implications and actions from various stakeholders:

- **FMVSS 127 implications:** The recently finalized FMVSS 127 establishes minimum performance requirements for AEB systems on new vehicles starting in 2029. This regulation mandates that vehicles must be capable of automatically applying brakes to avoid or mitigate collisions with both vehicles and pedestrians. The

findings in this study have direct relevance to FMVSS 127, as the performance degradation observed with improper ADAS sensor calibration, particularly in CIB and PAEB scenarios where it could result in non-compliance with the standard's thresholds for braking effectiveness and reaction timing.

The testing demonstrated that poorly executed calibrations can lead to system failures (no alert, no braking) or reduced performance (longer stopping distances), which would fail FMVSS 127 criteria. Conversely, calibrations executed under controlled and recommended conditions maintained or improved AEB system consistency, aligning with FMVSS 127's compliance expectations. This underscores the critical need for rigorous post-repair calibrations to meet future federal safety mandates.

- **Regulatory oversight and potential rules:** In the U.S., there isn't yet a specific federal law requiring ADAS recalibration after repairs. However, the NHTSA has signaled that it is monitoring the issue. In formal guidance, NHTSA warned automakers that "unreasonable risks [due] to... impractical recalibration requirements" could be considered a safety defect in the vehicle.[8] In other words, if a car's design is such that it frequently requires complex recalibration that consumers won't or can't do, the onus is on the manufacturer to fix that, otherwise NHTSA might step in.[8]

  This stance essentially acknowledges the real-world "care and feeding" of ADAS: regulators expect automakers to design ADAS to be maintainable and to provide guidance so that cars remain safe over their lifespan (not just in pristine lab conditions). We may see future regulations or new car assessment program (NCAP) requirements to make calibration procedures more user-friendly, or even built-in self-calibration capabilities, so that these systems don't become a safety liability as they age.

  In Europe, as mentioned, there's movement toward including ADAS in periodic inspections and the EU has mandated many ADAS features on new cars with the expectation that they remain functional. Some jurisdictions are considering rules for body shops and glass installers to document that calibration was performed after any repair that could affect ADAS. In short, the regulatory trend is that calibration is not optional: if a safety system isn't verified after a repair, that could one day violate vehicle safety standards or consumer protection laws.

- **Insurance industry perspective:** Insurers have a big interest in ADAS because it reduces claim frequency. Fewer crashes mean fewer payouts. Studies by IIHS and the Highway Loss Data Institute (HLDI) have shown vehicles with ADAS have lower claim rates and slightly lower claim severity, leading to benefits for insurers.[14] One analysis found an 8% reduction in overall collision claim costs for ADAS equipped vehicles, largely because of reduced crash frequency.[14]

  Because of this, insurance companies want these systems working correctly. Many insurers now fully cover the cost of ADAS calibration as part of a claim if you've had an accident or windshield claim where they recognize it's necessary. In fact, in a recent "Who Pays for What?" survey, 87% of repair shops reported that insurers reimbursed them for ADAS calibration charges (which can range from $250 to $600+ depending on the vehicle).[11] However, insurers also scrutinize repair bills, and there have been disputes over calibration charges.

  Repair experts advise shops to remind insurers of the liability if a calibration is skipped to save money; no insurer wants to be on the hook if a safety system fails and causes a subsequent crash.[15] Indeed, from a liability standpoint, if an accident is traced back to a malfunctioning ADAS that wasn't calibrated after prior repairs, the insurance company (and the repairer) could face serious claims. Some insurers are even developing protocols to ensure that when a claim involves ADAS parts, the calibration step is verified. On the flip side, if owners neglect a needed calibration (say, choosing not to fix an ADAS sensor to avoid paying out-of-pocket), an insurer might dispute liability for a later crash. All told, insurance companies have come to see proper ADAS calibration as fundamental to restoring a vehicle to safe condition, just like fixing the airbags or brakes.

- **Automaker and OEM stance:** Every automaker with ADAS publishes repair procedures in their service manuals, and these almost universally require recalibration of ADAS sensors after specific events. For example, Honda, Toyota, Ford, etc., have position statements that if you replace a windshield, remove and reinstall a camera, change a radar sensor, or straighten a bent bumper mounting, you must perform a calibration using the specified target systems or scan tools.

  OEMs design proprietary calibration routines (often using OEM scan tools and calibration targets) to ensure the car's systems meet factory specs. They also often insist on using OEM replacement parts for sensor mounting components – an off-brand windshield or bumper cover might have slight dimensional differences that throw off calibration. The reason is simple, the OEM tested the vehicle's ADAS with their exact parts and procedures and any deviation introduces uncertainty. Some OEM representatives have expressed concern about aftermarket calibration tools or "unofficial" methods, though many of those tools can do the job well if used correctly.

  One important caveat is that the OEM calibrating procedures for service of ADAS systems is extremely outdated, where plumb bobs and tape measurers are the "tools" being called out, introducing high variance and lack of repeatability. The key from the automaker's view is adhering to the proper process. Skipping calibration is considered a serious no-no. Failure to follow OEM calibration requirements can even void warranties or lead to liability for a repair shop. Manufacturers rely on

dealerships and certified collision centers to uphold these standards. To support shops, automakers provide training and sometimes build calibration facilities (for example, special alignment bays).

As ADAS becomes ubiquitous, OEMs are also exploring more automated self-calibration (for example, some new systems can self-check alignment via software routines), but these are still in early stages. Until then, the OEM message is: "If you disturb it, you must calibrate it." They want their safety systems saving lives, not malfunctioning due to neglected calibration.

- **Collision repair and body shop practices:** The repair industry has rapidly been adjusting to the calibration challenge. Proper ADAS repair often requires new equipment (special calibration target boards, lasers, leveling devices) and training for technicians. Many body shops have started to bring ADAS calibration in-house rather than sending cars to dealerships, to better control quality and cycle time.[11] This is because outsourcing can introduce delays and confusion, and if something goes wrong, the original shop is still liable.

Speaking of liability, repairers are very aware of the legal risk: delivering a car with uncalibrated ADAS that later crashes could expose the shop to lawsuits. The repair industry literature is full of warnings like "Even one degree off and you're liable if that system fails." Shops are responding by following OEM procedures meticulously and documenting the calibration results (many scan tools can print out a report showing a successful calibration). Trade groups and insurers often audit heavy repairs now to ensure ADAS was addressed. There's also an increasing push for pre- and post-repair scans of vehicle computer systems to catch any ADAS fault codes that might indicate a calibration issue.

All of this is a major change in collision repair workflows. It adds time and cost, but the consensus is that it's absolutely necessary. Modern cars simply cannot be considered fully repaired until all ADAS sensors are verified. One way to put it: neglecting ADAS calibration is equivalent to leaving the lug nuts loose on a wheel — it's a critical safety step.

- **Liability and legal considerations:** If ADAS calibration is skipped or done improperly, who is responsible when something goes wrong? This is a hot question. If a driver ignores a calibration requirement (perhaps not realizing it's needed) and then crashes, fault may lie with the driver, but their insurance might subrogate against a shop if a recent repair was involved. If a shop signs off on a repair without calibrating, they can be deemed negligent.

Attorneys have already begun using repair records in crash cases to see if all manufacturer procedures were followed. There's also an element of consumer education needed where drivers should know to return to the shop if they see an ADAS warning light, and not to rely on a system that's indicating a fault. But ultimately, professionals bear the burden to hand over a safe vehicle. We're likely to see precedent-setting cases in the near future that further cement the duty of repairers (and perhaps manufacturers, if their systems are too hard to keep calibrated) to ensure ADAS is operational. On the flip side, if an owner intentionally deactivates or ignores ADAS maintenance, that could complicate their liability in a crash as well.

- **Insurance claims and calibration costs:** A practical implication for vehicle owners is that ADAS calibration often incurs additional costs in a repair, but this cost is necessary and usually covered. For example, replacing a windshield used to cost approximately $300. Now, with ADAS cameras, the bill might be $600 including calibration. Most comprehensive insurance policies will cover that calibration cost as part of a glass claim. In collision claims, calibration charges are included in the estimate.

The important thing is owners should not be tempted to decline calibration to save money, it's playing with fire. In fact, some insurers have begun requiring proof of calibration (invoices or scan tool printouts) for reimbursement, precisely to ensure it gets done. From an insurance industry perspective, paying a few hundred dollars for a proper calibration is trivial compared to the cost of a potential severe accident claim if the system fails. Thus, insurers are becoming key allies in pushing for proper ADAS service.

- **Future directions (Industry):** We may see standardization in calibration methods to make it easier for independent shops to perform them accurately. As the technology evolves, some ADAS might become more self-calibrating (for instance, using GPS and maps to recalibrate a cameras understanding of alignment). But until that day, the industry as a whole is aligning on one message: calibration is integral to the repair and maintenance of ADAS vehicles. It's not just an add-on service, it's part of keeping the car safe. Publications and training programs emphasize that technicians need to treat ADAS calibration with the same rigor as they would engine or brake work. The phrase "safety system" now includes software and sensors, not just bolts and hydraulics.

Conclusion:

Advanced Driver Assistance Systems are game changers for road safety, significantly cutting crash rates, injuries and fatalities. However, the assistance these systems provide is entirely dependent on accurate calibration. We've seen that even slight miscalibrations can negate the benefits of ADAS, turning a potentially life-saving feature into a non-functioning ornament (or worse, a source of misinformation). The research and cases above unequivocally show that ADAS calibration must be prioritized:

- After any collision or relevant repair, to ensure the system is restored to proper working order, and

- Periodically as maintenance, to catch any drift or degradation before an accident happens.

This is backed by statistics (i.e. huge reductions in crashes when ADAS works, versus dangerous failure modes when it doesn't), by studies (IIHS, TÜV, etc. all demonstrating the consequences of poor calibration) and by expert opinions from

across the industry. Regulators and insurers are also recognizing calibration as a linchpin of vehicle safety in the ADAS era.

For drivers and shops alike, the takeaway is clear: calibrating ADAS is not optional. It is a critical step to keeping the vehicle safe to drive. Skipping it can literally be an accident waiting to happen. On the positive side, when ADAS is calibrated and functioning, it can be a true guardian angel on the road preventing that fender-bender or saving a pedestrian's life in a split second. To ensure these high-tech safety systems deliver on their promise, we must treat calibration with the importance it deserves, every time, without fail.

References

1. GHSA. (2022). Pedestrian Traffic Fatalities by State
2. IIHS. (2017). *Lane departure warning, blind spot detection help drivers avoid trouble*
3. NHTSA. (2015). *Crash Imminent Braking System Confirmation Test Procedures for NCAP Evaluation.*
4. IIHS & Highway Loss Data Institute (HLDI). (2022). *Crash Avoidance Technologies Reduce Real-World Crashes.*
5. TÜV Rheinland & TRL. (2021). *Advanced driver assistance systems not always reliable in long-term operation*
6. Autobody News. (2023). IIHS Survey: *Many ADAS Systems Malfunction After Repairs.*
7. AAA Automotive. (2021). *ADAS Sensor Calibration Increases Repair Complexity and Costs.*
8. Repairer Driven News. (2023). *NHTSA agrees 'impractical recalibration requirements' could be car safety defect.*
9. Midwest ADAS. (2023). *Poor Calibration: An Accident Waiting to Happen.*
10. The Cooper Firm (Legal). (2022). *Product Liability and ADAS: When Calibration is Missed.*
11. Tweddle Group. (2023). *Bring ADAS Calibration In-house to Increase Efficiency and Cashflow*
12. Collision Repair Mag. (2025). *Calibration Considerations: Recent Forbes article voices concerns over ADAS calibrations*
13. IIHS & Highway Loss Data Institute (HLDI). (2023). *Crash avoidance features improve safety but complicate repairs*
14. Claims Journal. (2021). *ADAS Reduces Loss Costs For Auto Insurers Despite Increased Repair Costs, LexisNexis Says*
15. ADAS Depot. (2024). *Navigating the Minefield: How to Handle Insurance Disputes Over ADAS Calibration Pricing*
16. ADAS Certified Alliance. (2025). *When the "John Eagle" of the ADAS World Happens, It's Going to Be Huge*

Appendix A - Images

Image 6: 2024 Nissan Altima with 12,900 miles.

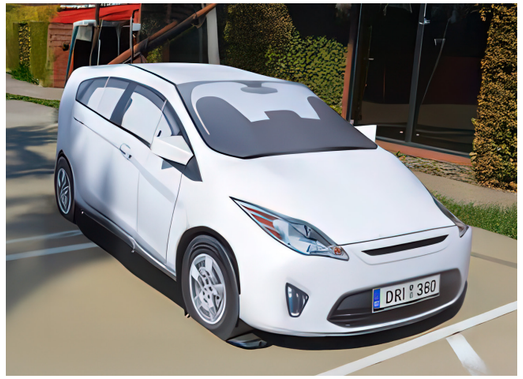


Image 7: Target dummy vehicle.

ADAS Technology	Test Procedure	Test Scenario	SV Speed (mph)	Departure Direction	# of Test Runs
Lane Departure Warning/ Lane Keep Assist	NHTSA Lane Departure Warning Confirmation Test Feb 2013	Dashed Line	45	Left	7
				Right	7
ADAS Technology	**Test Procedure**	**Test Scenario**	**SV Speed (mph)**	**POV Speed (mph)**	**# of Test Runs**
Forward Collision Warning/ Automatic Emergency Braking	NHTSA Crash Imminent Braking Confirmation Test Oct 2015	Slower Moving Lead Vehicle	25	10	7
Adaptive Cruise Control/ Automatic Emergency Braking	NHTSA Traffic Jam Assist Confirmation Test Jul 2019	Lead Vehicle Decel, Accel, and Decel	25	25	7
ADAS Technology	**Test Procedure**	**Test Scenario**	**SV Speed (mph)**	**Impact Position**	**# of Test Runs**
Pedestrian Automatic Emergency Braking	IIHS PAEB Test Protocol Version II Feb 2019	Crossing Adult	25	25%	7

Image 8: Test matrix of all tests.

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SHOP: 6107 Progress Drive Unit B,
Sterling Heights 48312
BILLING: 730 Plymouth Ave NE, Grand
Rapids, MI 49505
(586) 388-0557
sterlingheightsadas@bpgr.com
MI Repair Facility # F171221

Repair Order #62707
Created: 1/11/2025 10:04 AM EST
Completed: 1/11/2025 02:14 PM EST
Payment Term: On Receipt
Service Writer: David Cole #M216090
PO #: TRC TEST

(7) CALIBRATION DOCUMENTATIONS

Inspected: 01/11/2025
Completed: 01/11/2025

	Item	Green	Yellow	Red	N/A
2	CALIBRATION (WINDSHIELD CAMERA STATIC)	✓			

Note/Recommendation: *PIC DOC: TMM Reading, Target/Mat Placement (if applicable)*
PIC DOC: Successful or Failed Calibration
****
SCAN TOOL USED: CONSULT 3
TECH COMMENTS: STATIC FRONT WINDSHIELD CALIBRATION
The windshield camera static calibration process has been completed, ensuring accurate performance of the camera system. The camera target was positioned per OEM specification, distance, vertical height, and horizontal angle. The camera was adjusted with OEM scan tool, lens distortion corrected, and sensor calibrated for consistent readings per OEM specifications. Image processing was optimized, and extensive testing was conducted to validate the camera's accuracy. The calibrated camera is now ready to support various ADAS functionalities for enhanced safety and driving assistance.

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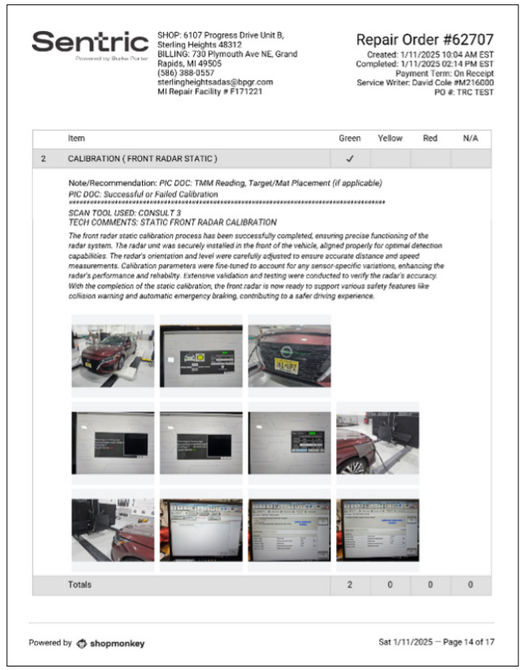
Sat 1/11/2025 – Page 13 of 17



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PO #: TRC TEST

	Item	Green	Yellow	Red	N/A
2	CALIBRATION (FRONT RADAR STATIC)	✓			

Note/Recommendation: *PIC DOC: TMM Reading, Target/Mat Placement (if applicable)*
PIC DOC: Successful or Failed Calibration
****
SCAN TOOL USED: CONSULT 3
TECH COMMENTS: STATIC FRONT RADAR CALIBRATION
The front radar static calibration process has been successfully completed, ensuring precise functioning of the radar system. The radar unit was securely installed in the front of the vehicle, aligned properly for optimal detection capabilities. The radar's orientation and level were carefully adjusted to ensure accurate distance and speed measurements. Calibration parameters were fine-tuned to account for any sensor-specific variations, enhancing the radar's performance and reliability. Extensive validation and testing were conducted to verify the radar's accuracy. With the completion of the static calibration, the front radar is now ready to support various safety features like collision warning and automatic emergency braking, contributing to a safer driving experience.

	Totals	2	0	0	0

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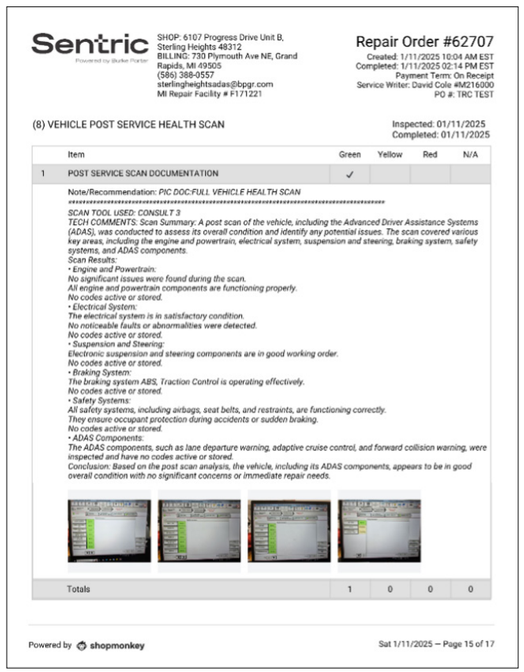
Sat 1/11/2025 – Page 14 of 17

Images 9 & 10: "Good Calibration" documentation of calibration equipment, targets, vehicle positioning and proof of successful calibration.



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Payment Term: On Receipt
Service Writer: David Cole #M216090
PO #: TRC TEST

(8) VEHICLE POST SERVICE HEALTH SCAN

Inspected: 01/11/2025
Completed: 01/11/2025

	Item	Green	Yellow	Red	N/A
1	POST SERVICE SCAN DOCUMENTATION	✓			

Note/Recommendation: *PIC DOC:FULL VEHICLE HEALTH SCAN*
****
SCAN TOOL USED: CONSULT 3
TECH COMMENTS: Scan Summary: A post scan of the vehicle, including the Advanced Driver Assistance Systems (ADAS), was conducted to assess its overall condition and identify any potential issues. The scan covered various key areas, including the engine and powertrain, electrical system, suspension and steering, braking system, safety systems, and ADAS components.
Scan Results:
• Engine and Powertrain:
No significant issues were found during the scan.
All engine and powertrain components are functioning properly.
No codes active or stored.
• Electrical System:
The electrical system is in satisfactory condition.
No noticeable faults or abnormalities were detected.
No codes active or stored.
• Suspension and Steering:
Electronic suspension and steering components are in good working order.
No codes active or stored.
• Braking System:
The braking system ABS, Traction Control is operating effectively.
No codes active or stored.
• Safety Systems:
All safety systems, including airbags, seat belts, and restraints, are functioning correctly.
They ensure occupant protection during accidents or sudden braking.
No codes active or stored.
• ADAS Components:
The ADAS components, such as lane departure warning, adaptive cruise control, and forward collision warning, were inspected and have no codes active or stored.
Conclusion: Based on the post scan analysis, the vehicle, including its ADAS components, appears to be in good overall condition with no significant concerns or immediate repair needs.

	Totals	1	0	0	0

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Sat 1/11/2025 – Page 15 of 17

Image 11: "Good Calibration" documentation of post-calibration vehicle health scan.

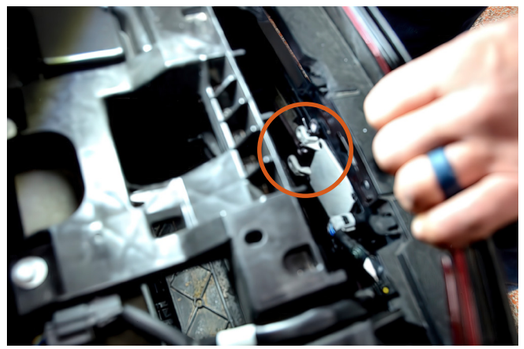


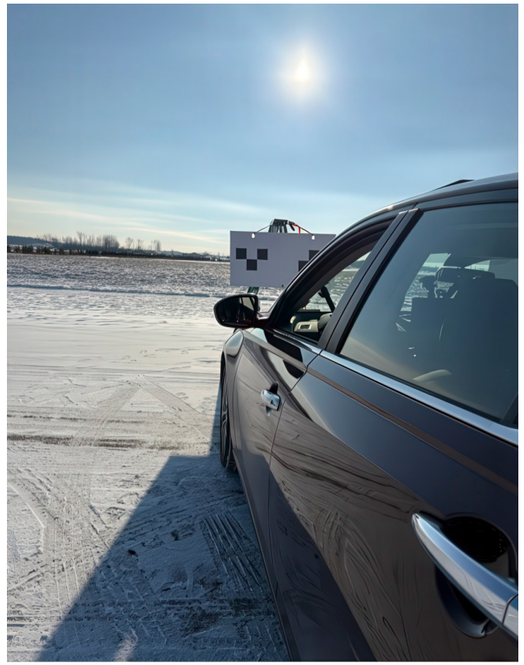
Image 12: "No Radar Calibration" scenario with radar sensor disturbed. Radar installed with two bolts missing so that it's mounted on an improper angle, outside of OEM specification.

Image 13: Windshield camera installed correctly prior to disturbance in "No Windshield Camera Calibration" scenario.

Image 14: "No Windshield Camera Calibration" scenario with windshield camera disturbed. Camera not properly seated into front saddle mount of camera retaining bracket, outside of OEM specification.

Image 15: "Poor Windshield Camera Calibration" scenario with fuel tank not full, outside of OEM specification.

Image 16: "Poor Windshield Camera Calibration" scenario with steering wheel off center during calibration to emulate improper alignment outside of OEM specification.



Images 17 & 18: "Poor Windshield Camera Calibration" environment outdoors with vehicle facing direct sunlight on uneven ground. Target positioned off center, favoring driver's side of vehicle, outside of OEM specifications.

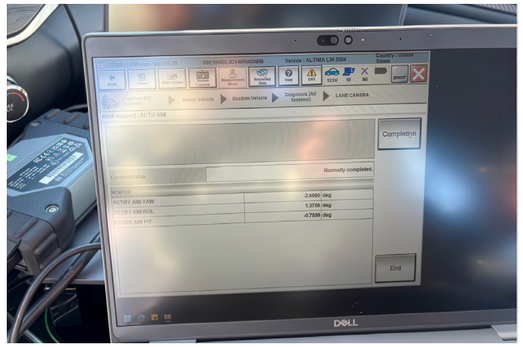


Image 19: "Poor Windshield Camera Calibration" scenario with successfully completed calibration.

Image 20: "Poor Radar Calibration" environment with garage door used for calibration target, outside of OEM specification.

Image 21: "Poor Radar Calibration" environment with technician in the vehicle with driver's side door open while calibration is performed, outside of OEM specification.

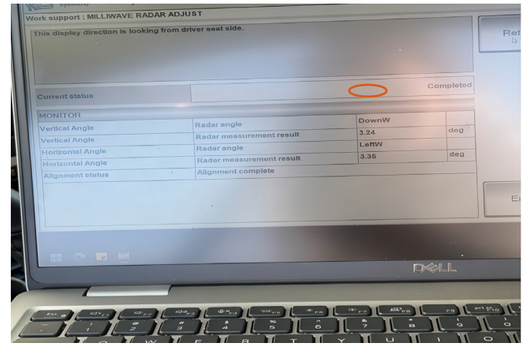


Image 22: "Poor Radar Calibration" scenario with successfully completed calibration while vertical angle reading 0.24 degrees outside of OEM specification.

Images 23 – 26: "Poor Radar Calibration" with no diagnostic trouble codes after successful calibration performed.

Appendix B – Contributors

The following individuals/companies contributed to the development, execution and analysis of the ADAS calibration study and this white paper:

- Brunno Moretti – Strategic direction & white paper author
- Leah Nakfoor – Data analysis & video documentation
- Dave Cole – Calibration & vehicle setup
- Dealer Tire – Study co-sponsor

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