U.S. Department of Transportation
National Highway Traffic Safety Administration

CRASH IMMINENT BRAKE SYSTEM PERFORMANCE EVALUTION

FOR THE

NEW CAR ASSESSMENT PROGRAM

October 2015

U. S. Department of Transportation
National Highway Traffic Safety Administration
1200 New Jersey Avenue SE
Washington, DC 20590

CRASH IMMINENT BRAKING SYSTEM PERFORMANCE EVALUTION

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LIST OF ACRONYMS

ACC	Adaptive Cruise Control
AEB	Automatic Emergency Brake
ASTM	American Society of Testing and Materials
CG	Center of Gravity
CIB	Crash Imminent Braking
CO	Contracting Officer (NHTSA)
COR	Contracting Officer's Technical Representative
DAS	Data Acquisition System
DTC	Diagnostic Trouble Code
FCW	Forward Collision Warning
GAWR	Gross Axle Weight Rating
GFE	Government Furnished Equipment
GPS	Global Positioning System
GVWR	Gross Vehicle Weight Rating
IBT	Initial Brake Temperature
IMU	Inertial Measurement Unit
LIDAR	Light Detection and Ranging
LRT	Lateral Restraint Track
NHTSA	National Highway Traffic Safety Administration
NIST	National Institute of Standards and Technology
PFC	Peak Friction Coefficient
POV	Principal Other Vehicle
RADAR	Radio Detection and Ranging
RCS	Radar Cross Section
SSV	Strikeable Surrogate Vehicle
SV	Subject Vehicle
STP	Steel Trench Plate
TTC	Time to Collision
UHMW	Ultra-high Molecular Weight Polyethylene
UVW	Unloaded Vehicle Weight

1.0 PURPOSE AND APPLICATION

This laboratory test procedure provides specifications for objectively quantifying the performance of a Crash Imminent Braking (CIB) system installed in a passenger vehicle with a gross vehicle weight rating (GVWR) of 10,000 pounds (4,536 kilograms) or less. Current CIB technology is dependent on RADAR, LIDAR, and/or vision-based sensors capable of detecting traffic. Although it is impossible to predict what sensing technologies could be used in future CIB systems, it is believed that with minor modifications to the test setup, systems with alternative sensing methods may also be evaluated.

The requirements of this indicant test procedure must be strictly adhered to. The Contractor's in-house test procedure must have NHTSA approval prior to conducting the first test of a particular fiscal year program. The Contractor's test procedure cannot deviate in any way from the NHTSA procedure without the prior approval of the NHTSA Contracting Officer's Representative (COR).

2.0 GENERAL REQUIREMENTS

This document describes the methods used by NHTSA to evaluate CIB performance on the test track. In the first three scenarios, a subject vehicle (SV) approaches a stopped, slower-moving, or decelerating principal other vehicle (POV) in the same lane of travel. For these tests, the POV is a strikeable object with the characteristics of a compact passenger car[1]. The fourth scenario is used to evaluate the propensity of a CIB system to inappropriately activate in a non-critical driving scenario that does not present a safety risk to the SV occupant(s).

3.0 SECURITY

The Contractor shall provide appropriate security measures to protect test vehicles and equipment during the entire test program, and shall be responsible for all equipment removed from test vehicles before and after the test. Vehicle equipment thefts or act of vandalism must be reported to NHTSA authorities immediately. Under no circumstances shall any vehicle components be removed during a visitor inspection unless authorized by NHTSA representative. All data collected during the test program shall be protected.

3.1 Rules for Contractors

1. No vehicle manufacturer's representative(s), or anyone other than the Contractor's personnel working on the Contracts and NHTSA personnel, shall be allowed to inspect NHTSA vehicles or witness vehicle preparations and/or testing without prior permission of NHTSA. Such permission can never be assumed.

[1] The specific attributes of the POV are described in S7.4.

2. All communications with vehicle manufacturers shall be referred to NHTSA, and at no time shall the Contractor release test data without permission from NHTSA.

3. Unless otherwise specified, the vehicle manufacturer's representatives shall only be authorized to visit the Contractor's test facility on the day that the test is scheduled, and the representatives must be escorted by NHTSA and/or Contractor personnel at all times.

4. Test vehicle inspection by the vehicle manufacturer's representative(s) shall be limited to 30 minutes prior to the start of vehicle test. Post-test inspection shall be limited to one (1) hour after Contractor personnel have completed their test tasks.

5. Photographs and videos of the test vehicle, associated test equipment and test event shall be allowed. However, test personnel shall not be included in any photographic coverage, and video data collection of vehicle preparation must be approved by NHTSA. The Contractor's personnel shall not respond to any questions from the manufacturer's representatives regarding this test program. All questions shall be referred to the COR, a NHTSA representative present at the test site, or to NHTSA.

6. The Contractor shall permit public access to and inspection of the test vehicles and related data during the times specified by the NHTSA COR. NHTSA shall advise interested parties that such access and inspection shall be limited to a specified day, specified hours, and require prior approval from NHTSA. The Contractor shall refer all visit requests from vehicle manufacturer's representatives and consumers to NHTSA. This service shall be included as an incidental part of the test program and will not result in any additional cost to NHTSA. The Contractor shall make their own arrangements with interested parties for expenses incurred beyond providing access and inspection services. All inquiries by manufacturers concerning the test program (vehicle, procedures, data, etc.) shall be directed to a NHTSA representative.

4.0 GOOD HOUSEKEEPING

The Contractor shall maintain the entire test area, vehicle pre-test preparation facility, instrumentation building, and equipment configuration and performance verification test laboratory in a clean, organized, and painted condition. All test instrumentation must be setup in an orderly manner consistent with good engineering practices.

5.0 TEST SCHEDULING AND MONITORING

The Contractor shall commence testing within four (4) weeks after receipt of the first test vehicle. Subsequent tests will be conducted, if requested, at a minimum of one (1) vehicle test per week. The NHTSA COR will make adjustments to the test schedule in cases of unusual circumstances such as inclement weather or difficulty experienced in the procurement of a

particular vehicle make and model. All testing shall be coordinated to allow monitoring by the COR.

6.0 TEST DATA DISPOSITION

The Contractor shall make all test data available within two hours after the test event if so requested by NHTSA personnel. Under no circumstances shall this preliminary data be furnished to non-NHTSA personnel. The Contractor shall analyze the preliminary test results as directed by the COR.

6.1 Test Data

The Contractor shall deliver to NHTSA the final data, digital printouts, and plots highlighting key data traces on a CD, DVD, or USB drive within one (1) week after the test.

6.2 Test Report

6.2.1 Report Content

The test report shall include all of the items shown in the Sample Test Report (see Section 14.3.4). The text and data sheet portion of the test report shall be in Microsoft Word format. Digital photographs shall be in JPEG format. The Contractor shall submit two (2) CDs or DVDs, or one (1) USB drive, and one (1) paper copy of the test report to the following address:

U. S. Department of Transportation
National Highway Traffic Safety Administration
1200 New Jersey Avenue SE
Washington, DC 20590

6.2.2 Report Submission

All final test reports shall be submitted to NHTSA within four (4) weeks from the date of the vehicle test.

6.3 Test Video

NHTSA shall receive one (1) copy of the color video for each test, and the copies shall be mailed directly to NHTSA within four (4) weeks of the vehicle test. The master recording for each of the test videos shall be retained by the Contractor, but will be made available to NHTSA upon request. See S9.1 for a description of the video to be taken during CIB test conduct.

6.4 Data Loss

6.4.1 Conditions for Retest

The test vehicle shall be instrumented in order to obtain data needed for the test program. An invalid test is one which does not conform precisely to all requirements/specifications of the laboratory test procedure and Statement of Work applicable to the test.

The NHTSA Contracting Officer (CO) is the only NHTSA official authorized to notify the Contractor that a retest is required.

No test report is required for any test which is determined to be invalid unless NHTSA specifically decides to require the Contractor to submit such a report. Invalidated test reports will not be publicly released.

RETEST CONDITIONS

Failure of the Contractor to obtain the specified data and to maintain acceptable test parameter tolerances in the manner outlined in this test procedure shall require a retest at the expense of the Contractor. The provisions of this paragraph apply to, but are not limited to, the Contractor maintaining proper speed tolerance, vehicle performance, and test data acquisition, reduction, and processing.

The Contractor shall also be responsible for obtaining usable data from all primary channels from instrumentation placed in each vehicle. Failure to produce such data shall also be at the expense of the Contractor and shall include vehicle repair or replacement and retest unless NHTSA determines that the data loss occurred through conditions beyond reasonable and foreseeable control of the Contractor. Should it become necessary for the Contractor to procure another test vehicle, it must have identical equipment and options as the original vehicle. The retested vehicle shall be retained without fee by the testing facility until its disposal is authorized by the COR.

6.4.2 Conditions for Partial Payment

The Contractor shall exercise reasonable and foreseeable control to ensure that no data is lost or rendered useless. If non-critical data (such as camera failure) and/or critical data (such as vehicle position data) are not obtained for the test and the test is accepted by the Agency, the Agency will not pay for the missing or lost data.

6.5 Data Retention by Contractor

The Contractor shall retain at no extra cost to NHTSA, reproducible copies of all test data, pictures, videos, and applicable electronic files for a period of one (1) year after test completion.

6.6 Data Availability to the Public

The Contractor shall provide interested parties with copies of test reports, test data on a CD or DVD, test videos, and/or test still photographs, at a reasonable cost to the purchaser, but only after NHTSA representative has advised the Contractor that the results of that particular test have been released to the public by NHTSA.

6.7 Indicant Failure Notification

Any indication of a "test failure" shall be communicated by telephone to the COR within 24 hours of the test.

Note: *In the event of a failure, a post-test calibration check of critically sensitive test equipment and instrumentation may be required for verification of accuracy. The necessity for the calibration shall be at the COR's discretion and shall be performed without additional cost.*

7.0 VEHICLES AND EQUIPMENT

7.1 Acceptance of Test Vehicles

The Contractor has the responsibility of accepting leased or NHTSA-provided test vehicles from new car dealers, leasing companies, or vehicle transporters. In all instances, the Contractor acts on NHTSA's behalf when signing an acceptance of test vehicles. The Contractor must check to verify the following:

1. The equipment necessary to support CIB functionally is present on the test vehicle.
2. All options listed on the "window sticker" are present on the test vehicle.
3. Tires and wheel rims are the same as listed.
4. There are no dents or other interior or exterior flaws.
5. The vehicle has been properly prepared and is in running condition.
6. The spare tire, jack, lug wrench, and tool kit are located in the vehicle cargo area (if applicable).

The Contractor shall check for damage that may have occurred during transit or prior use. The COR is to be notified of any damage prior to preparation of the vehicle for testing.

7.2 Notification of COR

The COR must be notified within 24 hours after a vehicle has been delivered.

7.3 Government Furnished Equipment (GFE)

No Government Furnished Equipment (GFE) will be available or provided for the tests described in this document.

7.4 POV Characteristics

The Contractor shall use a strikeable object with the characteristics of a compact passenger car as the POV. This is intended to maximize the ability of the SV to detect the POV in the most realistic manner possible without compromising SV driver safety and minimizing the potential for SV damage. Specifically, the strikeable object must possess the following attributes:

1. Accurate physical characteristics (e.g., visual, dimensional, etc.) when the SV is traveling directly behind the POV and heading in the same direction within ±5 degrees.

    A. Body panels and rear bumper shall be white in color.

    B. Simulated body panel gaps shall be present.

    C. The simulated rear glass and tires shall be black.

    D. A rear-mounted United States-specification license plate, or reflective simulation thereof, shall be installed.

2. RADAR return characteristics, classified using the 24 GHz and 77 GHz bands, representative of a high-volume passenger car when approached from behind with a SV heading angle of ±5 degrees.

3. Remains consistently shaped (e.g., visually, dimensionally, internally, and from a RADAR sensing perspective) within each test series.

4. Resistant to damage resulting from repeated SV-to-POV impacts.

5. Inflicts minimal to no damage to the SV, even in the event of multiple impacts.

The Contractor shall present documentation that objectively qualifies how the POV used to perform the tests described in S12.2, S12.3, and S12.4 satisfies the requirements of S7.4.1 through S7.4.5.

Note: *From the face of the rear bumper to a plane defined by the center of the rear wheels, the POV used by NHTSA, the Strikeable Surrogate Vehicle (SSV), is dimensionally similar to a small*

high-volume hatchback. To reduce the potential of damage to the SV during an impact, the SSV is constructed from lightweight composite materials with favorable strength-to-weight characteristics, including carbon fiber, Kevlar, phenolic, and Nomex honeycomb. The SSV is wrapped with a commercially-available vinyl material to simulate paint on the body panels and rear bumper, and a tinted glass rear window. The taillights, rear bumper reflectors, and third brake light from a 2011 Ford Fiesta hatchback are installed. The contour of the SSV rear bumper has been designed to accommodate impacts from wide range of SVs (i.e., vehicles possessing a variety of front bumper heights), and features a RADAR cross section (RCS) representative of a real-world light vehicle. A 34 x 14 x 8 in (864 x 356 x 203 mm) foam bumper is attached to the rear of SSV to reduce the peak forces realized shortly after an SV impact occurs. This bumper features a 60-in convex radius and is made from lightweight foam with a neoprene cover.

7.5 Moving the POV

To perform the Slower-Moving and Decelerating POV tests described in S12.3 and S12.4, respectively, the Contractor's test equipment must:

1. Accurately control the nominal POV speed up to 35 mph (15.6 km/h).
2. Accurately control the lateral position of the POV within the travel lane.
3. Allow the POV to move away from the SV after an impact occurs.

One way to satisfy these requirements is by using a moving platform. Here, all POV movement is controlled by the platform; the POV is simply secured to it. However, if a moving platform is used, steps to avoid confounding test outcome and/or CIB system misclassification shall be made:

1. To reduce the potential of the POV moving platform confounding RADAR-based system operation, neither the platform nor its frame (if applicable) shall be fabricated from electrically conductive materials, unless the Contractor can demonstrate the equipment does not adversely affect the RCS realism of the surrogate vehicle secured to it.
2. To reduce the potential of the moving platform to confound LIDAR sensor or camera-based system operation, its surfaces shall be low-gloss or oriented in a position that eliminates glare when performing tests in direct sunlight. If applicable, the Contractor shall demonstrate provisions to reduce glare from the moving platform do not affect the RCS realism of the surrogate vehicle secured to it.

Note: *To facilitate POV movement, NHTSA secures its SSV to a two-piece energy-dissipating carbon fiber frame that moves longitudinally along two-rail metal track. Shortly after the SV impacts the rear bumper of the SSV, a sliding section of the frame (subsequently referred to as the "slider") collapses within a second structure (subsequently referred to as the "load frame"). As the slider moves, it engages with the load frame via four energy-absorbing nylon straps.*

NHTSA's two-rail track features nine modular sections designed to be quickly assembled in the field. Some basic specifications include:

1. *The total assembled length of the track is 72 ft (22 m).*

2. *The first section is 8 ft (2.4 m) long, fabricated from 2 x 2 x 0.25 in (51 x 51 x 6 mm) steel L-channels spaced 2 ft (0.6 m) apart using 1.5 x 1.5 x 0.19 in (38 x 38 x 5 mm) square steel tubing.*

    A. *The SSV is secured at the end of this track nearest to the SV before each test.*

    B. *The front-most horizontal edges of the L-channels (i.e., those facing the SV as it approaches the SSV) feature 45-degree tapers to attenuate their RCS.*

    C. *The RCS of the first two 1.5 x 1.5 x 0.19 in (38 x 38 x 5 mm) square tubes is attenuated by securing two shallow aluminum ramps covered with RADAR-absorbing material to the front vertical face of each tube.*

3. *Eight sections are 8 ft (2.4 m) long, fabricated from 2 x 2 x 0.25 in (51 x 51 x 6 mm) 6061-T6 aluminum L-channels spaced 2 ft (0.6 m) apart using 1.5 x 1.5 x 0.19 in (38 x 38 x 5 mm) square 6061-T6 aluminum tubing.*

    A. *A trailer hitch and steel support frame is attached to the end of the last section to allow the entire track to be towed.*

    B. *A 43 x 20 x 27 in (1092 x 508 x 686 mm) foam cushion attached to the front face of the trailer hitch support frame (i.e., the end opposite the impact point) dampens the impact of SSV reaching the end of the track after an SV impact, and prevents the SSV from making direct contact with the frame.*

4. *The track is supported by a series of 19 ultra-high molecular weight (UHMW) polyethylene skids designed to position the top face of the track 2.5 in (64 mm) from the ground. It is anticipated the track height will be low enough to evaluate any light vehicle without the track contacting underside components of the SV.*

5. *The bottom of each track section incorporates a "notch" to interface with the lateral restraint track (LRT) described in S7.6.*

The combination of the two-rail track and LRT allows the SSV to be accurately and repeatably positioned in the center of the travel lane during Stopped, Slower-Moving, and Decelerating POV tests. The interaction of the bumper cushion, slider, load frame, and two-rail track allow the forces acting on the SSV to be incrementally realized, letting the SSV move longitudinally away from the SV after an impact occurs. After impacting the SSV, the SV driver uses the steering wheel to maintain SV position in the center of the travel lane, thereby straddling the

two-rail track. As described in S12.2.7, S12.3.7, and S12.4.6, the SV driver must manually apply the SV brakes after a POV (i.e., SSV) impact. This avoids a situation where the SV is still applying force to the rear of the SSV when it stops at the end of the two-rail track.

7.6 POV Lateral Restraint Track (LRT) (Optional Equipment)

An LRT may be used to help the POV, and the apparatus the POV is attached to, maintain a straight path during conduct of the Slower-Moving and Decelerating POV tests described in S12.3 and S12.4. The LRT must be made from a low-gloss, non-conductive material such as UHMW polyethylene, and be black or dark gray in color.

Note: *The LRT used by NHTSA consists of 24.5 ft (7.5 m) long UHMW polyethylene strips, assembled in series, to produce a single 1000 ft (305 m) "monorail" in the center of the travel lane. Each LRT strip has a nominal rectangular cross section of 0.5 x 4 in (13 x 102 mm). To allow for thermal expansion and contraction, the fasteners used to secure the strips to the test surface reside in slotted grooves with a gap of 3 to 6 in (76 to 152 mm) between each strip.*

7.7 POV Tow Vehicle (Optional Equipment)

During conduct of the Slower-Moving and Decelerating POV tests described in S12.3 and S12.4, a tow vehicle may be used to bring the POV and POV Moving Platform assembly to the desired test speed. This avoids many of the logistical issues associated with a self-propelled POV. However, since a towed POV is not expected to contain any instrumentation itself, its kinematic data must be derived by translating known parameters of the POV tow vehicle back to the POV. The accuracy of this translation strongly depends on maintaining a known longitudinal and lateral proximity between the POV and POV tow vehicle. To promote safe test conduct, the distance between the POV and POV tow vehicle shall nominally be 74 ft (22.6 m); the actual distance shall be measured and recorded in S8.3.10.

7.8 Steel Trench Plate (STP)

Steel trench plates are often used in road construction to temporarily cover sections of pavement unsafe to drive over directly (typically during repair). The STP used in this test shall be made from ASTM A36 steel, and measure 8 ft x 12 ft x 1 in (2.4 m x 3.7 m x 25 mm).

8.0 INSTRUMENTATION AND CALIBRATION

8.1 Required Test Equipment

1. Portable tire pressure gauge with an operating pressure of at least 100 psi (700 kPa), graduated increments of 0.1 psi (1 kPa) and an accuracy of at least ±2.0% of the applied pressure.

2. Global Positioning System (GPS) equipment capable of providing position data (latitude and longitude) with at least 1.6 in (4.1 cm) static accuracy, 3.9 in (10 cm) dynamic accuracy, and update at a rate of at least 10 Hz. Use of a GPS system that provides real-time SV-to-POV headway data to the SV driver is recommended (e.g., via a windshield-mounted display).

    A. For the Stopped POV tests described in S12.2, one GPS receiver shall be installed in the SV. The rear-most location of the POV shall be surveyed and represented by a fixed point. For these tests, SV-to-POV headway is defined as the longitudinal distance from the front most location of the SV to the fixed point.

    B. For the Slower-Moving and Decelerating POV tests described in S12.3 and S12.4, one GPS rover shall be installed in the SV and one in the POV, POV moving platform, or POV tow vehicle. For these tests, SV-to-POV headway is defined as the longitudinal distance from the front most location of the SV to the rear of the POV.

3. A data acquisition system (DAS) shall be installed in the SV to record data from the sensors described in S11.4.2.

8.2 Calibration

Before the Contractor initiates the test program, a test instrumentation calibration system must be implemented and maintained in accordance with established calibration practices. Guidelines for setting up and maintaining such calibration systems are described in "*International Organization for Standards (ISO) 100 12- 1, "Quality Assurance Requirements for Measuring Equipment," Part 1 : "Meteorological Confirmation System for Measuring Equipment;" American National Standards Institute (ANSI)/National Conference of Standards Laboratories (NCSL) 2540-1, "General Requirements for Calibration Laboratories and Measuring and Test Equipment;"* or comparable alternative standards to MIL-C-45662A approved by the NHTSA COR.

The calibration system shall be set up and maintained as follows:

1. Standards (e.g., reference equipment) for calibrating the measuring instruments and test equipment will be stored and used under appropriate environmental conditions to assure their accuracy and stability.

2. All measuring instruments, test equipment, and test standards shall be calibrated by the Contractor, or a commercial facility, against a higher order standard at periodic intervals not exceeding twelve (12) months. Records showing the calibration traceability to the National Institute of Standards and Technology (NIST) standards, shall be maintained for all measuring and test equipment. The calibration frequency may be increased if deemed necessary by NHTSA.

3. All measuring instruments, test equipment, and test standards shall be labeled with the following information:

    A. Date of calibration

    B. Date of next scheduled calibration

    C. Name of the organization and the technician who calibrated the equipment

4. A written calibration procedure shall be provided to NHTSA by the Contractor which includes as a minimum the following information for all measurement and test equipment:

    A. Type of equipment, manufacturer model number, etc.

    B. Measurement range

    C. Accuracy

    D. Calibration interval

    E. Type of standard used to calibrate the equipment (calibration traceability of the standard must be evident)

    F. The actual procedures and forms used to perform the calibrations.

5. Records of calibration for all test instrumentation shall be kept by the Contractor in a manner that assures the maintenance of established calibration schedules. All such records shall be readily available for inspection when requested by the COR and shall be included in the final test report. The calibration system will need the acceptance of the COR before testing commences.

6. Test equipment shall receive pre- and post-test zero and calibration checks. These checks shall be recorded by the test technician(s) and submitted with the final report.

Note: *If review of the data provided in S6.1 reveals questionable or inconsistent results, additional calibration checks of some critically sensitive test equipment and instrumentation may be required for verification of accuracy. The necessity for the calibration will be at the COR's discretion and will be performed without additional cost to NHTSA.*

8.3 SV Measurement and Preparation

1. All sensors used by the SV CIB system, and any part of the vehicle immediately ahead of them (e.g., plastic trim, the windshield, etc.), shall be free of debris or obstructions.

2. The SV airbags shall be disabled using instructions provided by NHTSA if the contractor believes the airbags will affect the test setup. If this requires the airbag connector(s) be

physically separated, installation of resistors at the affected connector(s) may be necessary to ensure proper CIB functionality during test conduct. If the use of resistors is required, NHTSA shall provide the appropriate resistance values and installation instructions to the Contractor.

3. Use of adhesive-backed temporary paint protection applied to the front bumper, front fenders, hood, A-pillars, and the front face of the side mirrors of the SV is highly recommended. However, the protective material must not obstruct any sensor providing data to the CIB system.

4. The SV tires shall be inflated to the recommended cold inflation pressure as specified on the vehicle placard or optional tire inflation pressure label.

5. All non-consumable fluids must be at 100 percent capacity for the SV. SV fuel must not fall below 75 percent capacity during the testing.

6. Inclusion of an in-vehicle experimenter to assist the SV driver with test conduct (e.g., data acquisition, completion of logs, etc.) is permitted. Where possible, the in-vehicle experimenter shall be seated in the first seating position behind the front passenger's seat.

7. Vehicle load shall include the unloaded vehicle weight (UVW) plus a driver, experimenter (if required), and instrumentation without exceeding the lesser of either (1) a maximum of 610 lbs (277kg) or (2) Gross Vehicle Weight Rating (GVWR) and all Gross Axle Weight Ratings (GAWR).

8. The centerline of the SV, POV, and POV tow vehicle shall be measured and recorded.

9. The lateral, longitudinal, and vertical positions of the GPS antennas installed on the SV and POV or POV tow vehicle shall be measured and recorded.

10. For the SV, the longitudinal distance from the GPS antenna to the front-most position of the front bumper shall be measured and recorded.

11. If a POV tow vehicle is used,

    A. The POV shall first be set to the furthest distance from the rear POV tow vehicle as permitted by the test apparatus (i.e., the orientation used at the onset of the tests performed in S12.2, S12.3, and S12.4).

    B. The longitudinal distance from the GPS antenna of the POV tow vehicle to the rear-most position of the POV rear bumper shall then be measured and recorded.

9.0 PHOTOGRAPHIC DOCUMENTATION

Each vehicle shall be documented with color still pictures. Each test trial shall be documented using a color video camera. To facilitate visual analyses, light glare and shadows must be minimal.

9.1 Cameras Required

CAMERA 1: Real-time video inside of the SV.

CAMERA 2: Real-time video camera to one side of the most significant event area of the test.

CAMERA 3: A still camera to document the vehicle.

9.2 Informational Placards

Vehicle identification placards shall be positioned so that at least one placard will be visible in the field-of-view for at least one video camera. The following information will be shown:

1. Vehicle's NHTSA Number
2. The words “NHTSA CRASH IMMINENT BRAKE TEST”
3. Date of test
4. Name of contract laboratory
5. Vehicle year, make, and model

9.3 Test Video Title and Ending

Test video shall include the following title frames:

1. “The following Crash Imminent Brake test was conducted under contract with the National Highway Traffic Safety Administration by (name and location of test laboratory)”
2. NHTSA CRASH IMMINENT BRAKE TEST
3. TEST VEHICLE MODEL YEAR, MAKE, AND MODEL
4. NHTSA No. CXXXXX
5. DATE OF EVENT

6. CONTRACT NO.: DTNH22-XX-X-XXXXX
7. The ending frame shall state “THE END”

9.4 Test Video Editing

The test video shall be edited in the following sequence below. Any vehicle failures shall be completely documented.

1. Title
2. Pretest Coverage
3. Real Time Pan Coverage
4. Post-test Coverage
5. “The End”

9.5 Still Photographs

The following still photographs (8 x 10 or 8.5 x 11 inch color prints, or 2048 x 1080 pixel digital pictures), properly focused for clear images, are required for the test:

1. Pretest, uninstrumented pictures of the SV (front, rear, and four three-quarter view pictures)
2. Pretest, instrumented pictures of the SV, POV, and POV tow vehicle (front, rear, four three-quarter pictures, and pictures of the instrumentation)
3. SV tire placard
4. Window Sticker (i.e., Monroney label)

10.0 DEFINITIONS

Crash Imminent Brake (CIB) systems are intended to actively assist the driver by mitigating the impact of rear-end collisions (i.e., a vehicle striking the rear portion of another vehicle traveling in the same direction directly in front of it). These safety systems have forward-looking vehicle detection capability provided by sensing technologies such as RADAR, LIDAR, video cameras, etc. CIB systems mitigate crash severity by automatically applying the vehicle’s brakes shortly before the expected impact (i.e., without requiring the driver to apply force to the brake pedal).

10.1 System Purpose

CIB systems provide automatic braking in driving situations where a rear-end collision is expected to be unavoidable. Since CIB braking is designed to occur late in the pre-crash

timeline, CIB systems are not required to alert the driver of the immediacy of the collision or to prevent the crash, only to mitigate the severity of the impact.

10.2 System Attributes

The CIB systemAlthough CIB may be provided in combination with an adaptive cruise control (ACC) system, **use of any form of cruise control (i.e., conventional or ACC), to automatically control the SV speed is not permitted during test conduct**.

10.3 Suppressed Operation During Test Conduct

Some CIB systems include control algorithms capable of delaying and/or suppressing system activation under certain real-world operating conditions. These algorithms are intended to minimize the likelihood of "false activations" (i.e., CIB interventions that occur when not necessary) or "undesired activations" (i.e., during times where an individual is actively driving, but operating their vehicle in close proximity to another immediately in front of them). In either case, the intent of CIB suppression is to avoid activations that violate the expectation of an attentive driver.

With the exception of those used to directly evaluate false positive propensity (described in S12.5), the tests described in this document are performed using clear roadway lanes within the idealized confines of a test track. Careful and deliberate throttle and steering inputs are required from the SV driver during all tests. As such, CIB system suppression is not expected to occur during the conduct of valid test trials described in S12.2, S12.3 or S12.4 of this document.

11.0 PRETEST AND FACILITY REQUIREMENTS

11.1 Detailed Test and Quality Control Procedures Required

Prior to conducting any test, Contractors are required to submit a detailed in-house test procedure to the COR which includes:

1. A step-by-step description of the methodology to be used.

2. A written Quality Control (QC) Procedure which shall include calibrations, the data review process, report review, and the Contractor-assigned staff assigned to perform QC on each task.

3. A complete listing of test equipment, which shall include instrument accuracy and calibration dates.

4. Detailed check-off sheets used during the test and during data review. These sheets shall include lists of all test procedure requirements. Each separate check-off sheet shall identify the lab, test date, vehicle, and test technician(s), and shall be used to document

that all requirements and procedures have been completed for each test. The check sheets should be kept on file.

5. There shall be no contradiction between the laboratory test procedure and the Contractor's in-house test procedure. The procedures shall cover all aspects of testing from vehicle receipt to submission of the final report. Written approval of the procedures must be obtained from the COR before initiating the test program so that all parties are in agreement.

11.2 Road Test Surface

Unless specified otherwise, the road test surface shall be dry (without visible moisture on the surface), straight, and flat, with a consistent slope between level and one percent. The road surface shall be constructed from asphalt or concrete and shall be free of irregularities, undulations, and/or cracks that could cause the SV to pitch excessively.

The road test surface must produce a peak friction coefficient (PFC) of at least 0.9 when measured using an American Society for Testing and Materials (ASTM) E1136 standard reference test tire, in accordance with ASTM Method E 1337-90, at a speed of 64.4 km/h (40 mph), without water delivery. The test track PFC shall be documented.

Each trial shall be conducted with no other vehicles (except the POV and the POV tow vehicle, where applicable), obstructions, or stationary objects within one lane width of either side of the SV lane of travel.

The roadway used for the CIB tests may be delineated with up to two solid white lane lines. If a single lane line is used, the centerline of the SV and POV shall nominally be 6 ft (1.8 m) from the inside edge of the line for the duration of the test. Additionally, the orientation of the SV, POV, and POV tow vehicle centerlines to the single lane line shall remain constant for the duration of the test. See S12.2.3, S12.3.3, and S12.4.3 for lateral tolerances allowable during test conduct.

Example: If the single line is 6 ft (1.8 m) from left side of the SV centerline at the beginning of the test, the line shall also be 6 ft (1.8 m) from the left side of the POV centerline. If two lane lines are present, the distance between the inside edges shall be at least 12 ft (3.7 m), and the vehicles shall remain in the center of the lane for the duration of the trial.

11.3 Ambient Conditions

11.3.1 Ambient Temperature

The ambient temperature shall be between 45°F (7°C) and 104°F (40°C).

11.3.2 Wind Speed

The maximum wind speed shall be no greater than 22 mph (10 m/s).

11.3.3 Inclement Weather

Tests shall not be performed during periods of inclement weather. This includes, but is not limited to, rain, snow, hail, fog, smoke, and/or ash.

11.3.4 Visibility

The tests shall be conducted during daylight hours with good atmospheric visibility, defined as an absence of fog and the ability to see clearly for at least 3.1 mi (5.0 km). The tests shall not be conducted with the SV and POV oriented into the sun during very low sun angle conditions (where the sun is oriented 15 degrees or less from horizontal) as camera "washout" or system inoperability may result.

All tests shall be conducted in an area void of overhead signs, bridges, or other significant structures over or near the testing site. Each trial shall be conducted with no vehicles (as indicted in S11.2), obstructions, or stationary objects within one lane width of either side of the SV path. Shadows cast by objects other than the SV, POV, POV test apparatus, POV tow vehicle (where applicable), or steel trench plate (described in S12.5) shall not be present in the SV lane of travel, or within one lane width of either side of the SV path.

11.4 Instrumentation Required

Each test vehicle shall be equipped with instrumentation and a data acquisition system. Nominal equipment location and weight specifications are presented in Table 1.

11.4.1 Data Collection

All analog data shall be sampled at 100 Hz. Signal conditioning shall consist of amplification and digitizing. Amplifier gains shall be selected to maximize the signal-to-noise ratio of the digitized data. Filtering of the data as it is collected is not necessary. However, if a filter is applied to incoming data (during the trial or immediately following), it shall be of a low-pass, 6^{th} order Butterworth with cutoff corner frequency of 3Hz to prevent aliasing. Data collection shall be initiated at least one second before the onset the validity periods defined in S12.2.6, S12.3.6,and S12.4.7.

Table 1 – Test Equipment Location and Weights

Equipment Description	Typical Location	Nominal Weight
Data Acquisition System	SV rear cargo area (e.g., trunk)	≈58 lbs (26 kg)
Integrated Inertial Measurement Unit (IMU) and GPS (SV)	Antenna(s)[1] mounted to the roof of the SV. IMU/GPS securely positioned near the center of the vehicle, just behind the front seats. GPS acquisition and ancillary equipment installed/secured in the SV rear cargo area.	≈15 lbs (7 kg)
Vehicle-to-Vehicle Range Receiver (SV) *(wireless communication between the SV and POV or POV tow vehicle)*	Antenna mounted to the roof of the SV. Ancillary equipment secured in the SV rear cargo area..	≈10 lbs (5 kg)
Integrated Inertial Measurement Unit and GPS (POV or POV tow vehicle)	Antenna(s)[1] mounted to the POV or to the roof of the POV tow vehicle. IMU/GPS securely positioned within the POV, or just behind the front seats of the POV tow vehicle, near the center of either unit. GPS acquisition and ancillary equipment securely positioned within the POV or on the rear driver-side seat of the POV tow vehicle.	≈15 lbs (7 kg)
Vehicle-to-Vehicle Range Transmitter (POV or POV tow vehicle) *(wireless communication between the SV and POV or POV tow vehicle)*	Antenna mounted to the POV or to the roof of the POV tow vehicle. Ancillary equipment secured within the POV or on the rear driver-side seat of the POV tow vehicle.	≈8 lbs (4 kg)
Programmable Brake Controller (POV)	Brake actuator is connected to the POV brake pedal, floor, and seat. The brake controller electronics box is typically secured in the footwell behind the driver seat.	Actuator ≈8 lbs (4 kg) Electronics Box ≈15 lbs (7 kg)

[1]Two antennas are necessary if communication with a local base station is used (i.e., to provide real time kinematic correction of GPS position data).

11.4.2 Sensors and Sensor Locations

An overview of the sensors used for the tests described in this document is provided in Table 2.

Table 2 – Recommended Sensor Specifications

Type	Output	Range	Resolution	Accuracy
Longitudinal Speed Sensor[1]	SV and POV longitudinal speed	0.1 – 62 mph (0.1 -100 km/h)	0.1 mph (0.2 km/h)	+/- 0.25% of full scale range
Rate Sensor[1]	SV yaw rate	+/- 100 deg/s	0.01 deg/s	+/- 0.25% of full scale range
Accelerometer	SV and POV longitudinal deceleration	+/- 2g	0.001g	+/- 0.01% of full scale range
Position Sensor	SV throttle position	0 - 100 percent (normalized)	0.1 percent	0.1 percent
Various	Longitudinal position of SV and POV	650 ft (200 m)	2 in (5 cm)	At least 3.9 in (10 cm) absolute
Various	Lateral position of SV and POV	650 ft (200 m)	2 in (5 cm)	At least 3.9 in (10 cm) absolute
Data Flag (FCW Alert)	Signal from SV forward collision warning (FCW) system indicating whether the alert is in operation.	0 – 10V	N/A	Output response better than 10 ms
Vehicle Dimensional Measurements	Location of SV and POV or POV tow vehicle GPS antennas; SV, POV, and POV tow vehicle centerlines (where applicable); front-most SV bumper position; and rear-most POV bumper position.	N/A	0.04 in (1 mm)	0.04 in (1 mm)
SV-to-POV Static Range	Distance between POV or POV tow vehicle reference point (typically the longitudinal center of gravity (CG)) and rear-most POV bumper position.	N/A	2 in (5 cm)	At least 3.9 in (10 cm) absolute

[1]Differentially corrected GPS may be used to provide data to calculate vehicle speed and yaw rate in lieu of direct measurement provided the resulting accuracy is comparable.

11.4.2.1 Vehicle Speed

SV and POV longitudinal vehicle speed shall be measured. Use of contact or non-contact based speed sensors is acceptable. Alternatively, GPS-based sensors that have an update rate of at least 100 Hz are acceptable. Sensor outputs are to be transmitted not only to the data

acquisition system, but also to a dashboard display unit in the SV. This allows the driver to accurately monitor vehicle speed.

11.4.2.2 Yaw Rate

SV yaw rate shall be measured. Alternatively, differentially-corrected GPS data may be used to calculate yaw rate in lieu of direct measurement, provided the resulting accuracy is comparable.

11.4.2.3 SV Brake Pedal Force

A single axis load cell shall be securely attached to the SV brake pedal. SV brake pedal inputs shall be measured to ensure that the driver did not apply force to the pedal during the validity periods defined in S12.2.6, S12.3.6, S12.4.7, and S12.5.6. If the driver does apply force to the brake pedal within the validity period, the test trial is not valid and shall be repeated.

11.4.2.4 SV Throttle Pedal Position

SV throttle pedal position shall be expressed as a percentage of the wide open throttle (WOT) pedal position.

11.4.2.5 Longitudinal and Lateral Position

Longitudinal and lateral position of the SV and POV can be measured by several different sensors and/or measurement techniques provided they meet the range, resolution, and accuracy specifications provided in Table 2. The longitudinal and lateral positions of the SV and POV shall be reported in the same coordinate system. The longitudinal distance between the front of the SV and the rearmost location of the POV shall be transmitted to a dashboard display unit in the SV. This allows the driver to accurately monitor SV-to-POV headway (which is particularly important for the Decelerating POV tests described in S12.4).

11.4.2.6 Forward Collision Warning (FCW) Activation Flag

The Forward Collision Warning (FCW) activation flag shall indicate when the system has issued an alert to the SV driver. The FCW modality shall be either the auditory alert, or the alert indicated to the test conductor by a NHTSA representative. The FCW activation flag shall be recorded from a discrete signal and/or other methods that clearly indicate when the alert has been issued provided there is no damage to the SV.

12.0 TEST EXECUTION AND TEST REQUIREMENTS

If the SV is equipped with an automatic transmission, all trials shall be performed in ‘‘Drive.’’ If equipped with a manual transmission, the highest gear capable of sustaining the desired test speed shall be used. Manual transmission clutches are to remain engaged during all test trials

throughout the validity periods described in S12.2.6, S12.3.6, S12.4.7, and S12.5.6.

CIB system performance shall be evaluated in accordance with the following test procedures described in S12.2 through S12.5.

12.1 General Vehicle Preparation and Pre-Test Conditioning

12.1.1 SV Brake Burnish

To achieve full brake system capability, and to ensure consistent performance, the procedure defined in S14.1.2 and S14.1.3 of FMVSS No. 135 TP-135-01 shall be used to burnish new SV brake components:

1. Load the SV to its Gross Vehicle Weight Rating (GVWR).

2. From a speed of 49.7 mph (80 km/h), perform 200 stops with an average deceleration of 0.31g (3.0 m/s²) during each stop.

    A. Each stop shall be performed with the transmission in gear.

    B. The Initial Brake Temperature (IBT), defined as the average brake pad or lining friction material temperature on the highest-temperature axle of the SV at the onset of a test trial, shall be ≤ 100°C (212°F) at the onset of each stop.

    C. The interval from the onset of one stop to the onset of the next is either the time necessary to reduce the IBT to ≤ 100°C (212°F), or the distance of 2 km (1.24 miles), whichever occurs first.

    D. Accelerate to 49.7 mph (80 km/h) after each stop and maintain that speed until initiating the next.

12.1.2 SV Brake Warm-up and Temperature Maintenance

The IBT shall be between 149°F (65°C) and 212°F (100°C) at the onset of each test described in S12.2 through S12.5.

1. If the IBT is <149°F (65°C), the brakes are heated to the IBT by making one or more brake applications from a speed of 31.1 mph (50 km/h), at a deceleration rate not greater than 0.31g (3 m/s²).

2. If the IBT > 212°F (100°C), the SV shall be driven at speeds up to 62.1 mph (100 km/h) until the IBT specified in 12.1.2 is reached.

12.1.3 Instrumentation Initialization

All instrumentation shall be secure and properly configured. With all instrumentation off, the SV and POV, POV moving platform, or POV tow vehicle shall be driven to an outdoor location unobstructed by buildings, overpasses, or other structures capable of interfering with the ability of the GPS equipment to acquire satellite-based position information and real-time base station corrections (where applicable). At this location, the instrumentation shall be turned on, and static and dynamic GPS initializations be performed.

1. Static initialization

    A. Where applicable, the transmissions of the SV and POV, POV moving platform, or POV tow vehicle shall be placed in park (automatic transmission) or neutral with the emergency brake enabled (manual transmission).

    B. The SV and POV, POV moving platform, or POV tow vehicle shall remain at rest until transmissions from least six (6) GPS satellites have been obtained and indicated by the vehicle's respective instrumentation.

2. Dynamic initialization

    A. The SV and POV, POV moving platform, or POV tow vehicle shall be driven in a straight line, at a speed of at least 35 mph (56.3 km/h) for at least 350 ft (107 m).

    B. The SV and POV, POV moving platform, or POV tow vehicle shall be driven in three (3) figure eight patterns. The radii of the turns shall be approximately 20 ft (6 m).

    C. Steps 12.1.3.2.A and 12.1.3.2.B shall be repeated until the respective instrumentation indicates that the required accuracies for position and heading have been achieved.

12.1.4 CIB System Initialization

Before CIB system performance can be properly assessed, some vehicles require a brief period of initialization. During this time, diagnostics to verify functionality and sensor calibrations are performed. If system initialization is required by a particular CIB system, NHTSA will obtain the appropriate procedure from the vehicle manufacturer, and provide it to the Contactor. The Contractor shall perform any NHTSA-provided initialization schedule prior to performing the tests specified in S12.2 through S12.5.

12.2 SV Encounters a Stopped POV on a Straight Road

This test evaluates the ability of the CIB system to detect and respond to a stopped lead vehicle

in the immediate forward path of the SV.

12.2.1 POV Placement

The SV shall approach the rear of the POV. From the start of each trial to the end of the validity period described in S12.2.6:

1. The POV (and POV moving platform, where applicable) shall be positioned in the center of the SV travel lane (laterally) with its longitudinal axis oriented parallel to the roadway edge.

2. The POV shall be secured to the ground such that its position relative to the roadway remains constant.

12.2.2 Static Instrumentation Calibration

Calibration data shall be collected prior to the tests specified in S12.2.3 to assist in resolving uncertain test data.

1. The SV and POV (and POV moving platform and/or tow vehicle, if used) shall be centered in the same travel lane with the same orientation (i.e., each must face the same direction).

2. The front-most location of the SV shall be positioned such that it just makes contact with a vertical plane that defines the rearmost location of the POV This is the "zero position." For the NHTSA SSV, the rearmost surface is defined by the rearmost face of the foam bumper cover if one exists.

3. The zero position shall be documented prior to, and immediately after, conduct of a test series.

    A. If the zero position reported by the data acquisition system differs by more than ±2 in (±5 cm) from that measured during collection of the pre-test static calibration data file, the pre-test longitudinal offset shall be adjusted to output zero and another pre-test static calibration data file collected.

    B. **If the zero position reported by the data acquisition system differs by more than ±2 in (±5 cm) from that measured during collection of the post-test static calibration data file, the Stopped POV tests performed between collection of that post-test static calibration data file and the last valid pre-test static calibration data file shall be repeated.**

4. Static data files shall be collected prior to, and immediately after, conduct of the test series described in S12.2.3 through S12.2.7. The pre-test static files shall be reviewed

prior to test conduct to confirm that all data channels are operational and have been properly configured.

12.2.3 SV Approach to the Stopped POV

For an individual trial to be valid, the following must hold true throughout the test:

1. The SV driver seatbelt must be latched.

2. If any load has been placed on the SV front passenger seat (e.g., for instrumentation), the vehicle's front passenger seatbelt must be latched.

3. The SV shall be driven at the nominal speed specified in S12.2.4, in the center of the travel lane, toward the stationary POV.

4. The driver shall use the least amount of steering input necessary to maintain SV position in the center of the travel lane during the validity period specified in S12.2.6. Use of abrupt steering inputs or corrections shall be avoided.

5. The yaw rate of the SV must not exceed ±1.0 deg/s from the onset of the validity period specified in S12.2.6 to the instant SV deceleration exceeds 0.25g.

6. The lateral distance between the centerline of the SV and the centerline of the POV shall not deviate more than ±1 ft (0.3 m) during the validity period specified in S12.2.6.

7. The SV driver shall not apply any force to the brake pedal during the validity period specified in S12.2.6.

12.2.4 Nominal SV Speed

1. All Stopped POV test trials are performed with an SV speed of 25 mph (40.2 km/h).

2. The SV speed shall not deviate more than ±1.0 mph (±1.6 km/h) during an interval defined by a Time to Collision (TTC) = 5.1 seconds to t_{FCW}

    A. TTC = 5.1 seconds is taken to occur at an SV-to-POV distance of 187 ft (57 m).

    B. t_{FCW} is defined as the instant the SV FCW alert described in S11.4.2.6 is presented.

12.2.5 Throttle Pedal Inputs

1. The SV driver shall modulate the throttle, using smooth inputs, to maintain a constant SV speed from a TTC = 5.1 seconds to t_{FCW}. Abrupt throttle inputs shall be avoided.

2. Within 500 ms after t_{FCW} the SV throttle pedal shall be fully released. The throttle pedal release rate is not restricted.

12.2.6 Validity Period

1. The valid test interval begins when the SV-to-POV TTC = 5.1 seconds, as defined in S12.2.4.2.

2. The valid test interval ends when either of the following occurs:

    A. The SV comes in contact with the POV (SV-to-POV contact may be assessed by using GPS-based range data or by measurement of direct contact sensor output); or

    B. The SV comes to a stop before making contact with the POV.

12.2.7 End-of-Test Instructions

1. After the validity period specified in S12.2.6.2 is complete, the SV driver shall manually apply force to the brake pedal, bring the vehicle to a stop (if necessary), and place the transmission in park (automatic transmission) or neutral (manual transmission).

2. The Stopped POV test trial is complete.

12.2.8 Number of Test Trials

A total of seven (7) valid trials shall be performed for the Stopped POV scenario, as shown in Table 3. If the test conductor performs more than seven trials within this scenario, the first seven trials satisfying all test tolerances shall be used to assess the SV performance.

12.2.9 CIB Speed Reduction

The magnitude of the SV speed reduction attributable to CIB intervention is calculated in one of two ways, depending on whether a test trial concludes with the SV colliding with the POV.

1. If SV-to-POV contact occurs during a test trial, the CIB speed reduction is calculated by subtracting the SV speed at the time of SV-to-POV contact (i.e., when longitudinal range becomes zero) from the average SV speed calculated from t_{FCW} - 100 ms to t_{FCW}.

2. If SV-to-POV contact does not occur during a test trial (i.e., CIB intervention prevents the crash), the SV speed at a time of SV-to-POV contact is taken to be zero. The speed reduction is therefore equal to the SV speed at t_{FCW}.

12.3 SV Encounters a Slower-Moving POV on a Straight Road

This test evaluates the ability of the CIB system to detect and respond to a slower-moving lead vehicle traveling at a constant speed in the immediate forward path of the SV.

12.3.1 POV Placement

The SV shall approach the rear of the POV. From the start of each trial to the end of the validity period described in S12.3.6:

1. The POV (and POV moving platform, where applicable) shall remain in the center of the travel lane (laterally) with its longitudinal axis oriented parallel to the roadway edge.

2. If a POV moving platform is used to facilitate POV movement, the POV shall be secured to the POV moving platform such that its position relative to the platform remains constant

3. If towed, the POV moving platform shall remain at the end of the towing mechanism furthest from the tow vehicle.

12.3.2 Static Instrumentation Calibration

Calibration data shall be collected prior to tests specified in S12.3.3 to assist in resolving uncertain test data.

1. The SV and POV (and POV moving platform and/or tow vehicle, if used) shall be centered in the same travel lane with the same orientation (i.e., each must face the same direction).

2. The front-most location of the SV shall be positioned such that it just makes contact with a vertical plane that defines the rearmost location of the POV. This is the zero position. For the NHTSA SSV, the rearmost surface is defined by the rearmost face of the foam bumper cover.

3. The zero position shall also be documented prior to, and immediately after, conduct of the test series described in S12.3.3.

A. If the "zero position" reported by the data acquisition system differs by more than ±2 in (±5 cm) from that actually measured during collection of the pre-test static calibration data file, the pre-test longitudinal offset shall be adjusted to output zero and another pre-test static calibration data file collected.

B. If the "zero position" reported by the data acquisition system differs by more than ±2 in (±5 cm) from that actually measured during collection of the post-test static calibration data file, the Slower POV tests performed between collection of that post-test static calibration data file and the last valid pre-test static calibration data file shall be repeated.

4. Static data files shall be collected prior to, and immediately after, conduct of the test series described in S12.3.3 through S12.3.7. The pre-test static files shall be reviewed prior to test conduct to confirm that all data channels are operational and have been properly configured.

12.3.3 SV Approach to the Slower-Moving POV

For an individual trial to be valid, the following must hold true throughout the test:

1. The SV driver seatbelt must be latched.

2. If any load has been placed on the SV front passenger seat (e.g., for instrumentation), the vehicle's front passenger seatbelt must be latched.

3. The SV shall be driven at one of the two nominal speeds specified in S12.3.4, in the center of the lane of travel, toward the POV.

4. The driver shall use the least amount of steering input necessary to maintain SV position in the center of the travel lane during the validity period specified in S12.3.6. Use of abrupt steering inputs or corrections shall be avoided.

5. The yaw rate of the SV must not exceed ±1.0 deg/s from the onset of the validity period specified in S12.3.6 to the instant SV deceleration exceeds 0.25g.

6. The lateral distance between the centerline of the POV and the center of the travel lane shall not deviate more than ±1 ft (0.3 m) during the validity period specified in S12.3.6.

7. The lateral distance between the centerline of the SV and the center of the travel lane shall not deviate more than ±1 ft (0.3 m) during the validity period specified in S12.3.6.

8. The lateral distance between the centerline of the SV and the centerline of the POV shall not deviate more than ±1 ft (0.3 m) during the validity period specified in S12.3.6.

9. The SV driver shall not apply any force to the brake pedal during the validity period specified in S12.3.6.

12.3.4 Nominal SV and POV Speeds

1. Tests are performed using two combinations of SV and POV speeds:

    A. SV: 25 mph (40.2 km/h), POV: 10 mph (16.1 km/h).

    B. SV: 45 mph (72.4 km/h), POV: 20 mph (32.2 km/h).

2. SV and POV speed tolerances

    A. The SV speed shall not deviate more than ±1.0 mph (±1.6 km/h) during an interval defined by TTC = 5.0 seconds t_{FCW}, where t_{FCW} is defined as the instant the SV FCW alert described in S11.4.2.6 is presented.

        i. When the SV test speed is 25 mph (40.2 km/h) and the POV speed is 10 mph (16.1 km/h), TTC = 5.0 seconds occurs at a SV-to-POV distance of 110 ft (34 m).

        ii. When the SV test speed is 45 mph (72.4 km/h) and the POV speed is 20 mph (32.2 km/h), TTC = 5.0 seconds occurs at a SV-to-POV distance of 183 ft (56 m).

    B. The POV speed shall not deviate more than ±1.0 mph (±1.6 km/h) during the validity period specified in S12.3.6.

12.3.5 SV Throttle Pedal Inputs

1. The SV driver shall modulate the throttle, using smooth inputs, to maintain a constant SV speed from the onset of the validity period defined in S12.3.6 to t_{FCW}. Abrupt throttle inputs shall be avoided.

2. Within 500 ms after t_{FCW} the SV throttle pedal shall be fully released. The throttle pedal release rate is not restricted.

12.3.6 Validity Period

1. The valid test interval begins when the SV-to-POV TTC = 5.0 seconds, as defined in S12.3.4.2.A.

2. The valid test interval ends when either of the following occurs:

    A. The SV comes in contact with the POV; or

    B. 1 second after the velocity of the SV becomes less than or equal to that of the POV.

12.3.7 End-of-Test Instructions

1. After the validity period specified in S12.3.6 is complete, the SV driver shall manually apply force to the brake pedal, bring the vehicle to a stop (if necessary), and place the transmission in park (automatic transmission) or neutral (manual transmission).

2. The Slower-Moving POV test trial is complete.

12.3.8 Number of Test Trials

A total of seven (7) valid trials per test speed combination shall be performed for each Slower-Moving POV scenario, as shown in Table 3. If the test conductor performs more than seven trials per scenario, the first seven trials satisfying all test tolerances shall be used to assess the SV performance.

12.3.9 CIB Speed Reduction

The magnitude of the SV speed reduction attributable to CIB intervention is calculated in one of two ways, depending on whether a test trial concludes with the SV colliding with the POV.

1. If SV-to-POV contact occurs during a test trial, the CIB speed reduction is calculated by subtracting the SV speed at the time of SV-to-POV contact (i.e., when longitudinal range becomes zero) from the average SV speed calculated from t_{FCW} - 100 ms to t_{FCW}.

2. If SV-to-POV contact does <u>not</u> occur during a test trial (i.e., CIB intervention prevents the crash), the CIB speed reduction is calculated by subtracting the SV speed at the minimum longitudinal SV-to-POV range during the validity period specified in S12.3.6 from the SV speed at t_{FCW}.

12.4 SV Encounters a Decelerating POV on a Straight Road

This test evaluates the ability of the CIB system to detect and respond to a lead vehicle slowing with a constant deceleration in the immediate forward path of the SV.

12.4.1 POV Placement

The SV shall approach the rear of the POV. From the start of each trial to the end of the applicable validity period:

1. The POV (and POV moving platform, where applicable) shall remain in the center of the travel lane with its longitudinal axis oriented parallel to the roadway edge.

2. If a POV moving platform is used to facilitate POV movement, the POV shall be secured to the POV moving platform such that its position relative to the platform remains constant

3. If towed, the POV moving platform shall remain at the end of the towing mechanism furthest from the tow vehicle.

12.4.2 Static Instrumentation Calibration

Calibration data shall be collected prior to tests specified in S12.4.4 and S12.4.5 to assist in resolving uncertain test data.

1. The SV and POV (and POV moving platform and/or tow vehicle, if used) shall be centered in the same travel lane with the same orientation (i.e., each must face the same direction).

2. The front-most location of the SV shall be positioned such that it just makes contact with a vertical plane that defines the rearmost location of the POV. This is the zero position. For the NHTSA SSV, the rearmost surface is defined by the rearmost face of the foam bumper cover.

3. The zero position shall also be documented prior to, and immediately after, conduct of the test series described in S12.4.3.

    A. If the "zero position" reported by the data acquisition system differs by more than ±2 in (±5 cm) from that actually measured during collection of the pre-test static calibration data file, the pre-test longitudinal offset shall be adjusted to output zero and another pre-test static calibration data file collected.

    B. If the "zero position" reported by the data acquisition system differs by more than ±2 in (±5 cm) from that actually measured during collection of the post-test static calibration data file, the Decelerating POV tests performed between collection of that post-test static calibration data file and the last valid pre-test static calibration data file shall be repeated.

4. Static data files shall be collected prior to, and immediately after, conduct of the test series described in S12.4.3 through S12.4.6. The pre-test static files shall be reviewed prior to test conduct to confirm that all data channels are operational and have been properly configured.

12.4.3 SV Approach to the Decelerating POV

For an individual trial to be valid, the following must hold true throughout the test:

1. The SV driver seatbelt must be latched.

2. If any load has been placed on the SV front passenger seat (e.g., for instrumentation, etc.), the vehicle's front passenger seatbelt must be latched.

3. The SV shall be driven in the center of the lane of travel, behind the POV.

4. The headway between the SV and POV shall be constant from the onset of the applicable validity period to the onset of POV braking.

5. The driver shall use the least amount of steering input necessary to maintain SV position in the center of the travel lane during the applicable validity period. Use of abrupt steering inputs or corrections shall be avoided.

6. The yaw rate of the SV must not exceed ±1.0 deg/s from the onset of the applicable validity period to the instant SV deceleration exceeds 0.25g.

7. The lateral distance between the centerline of the POV and the center of the travel lane shall not deviate more than ±1 ft (0.3 m) during the applicable validity period.

8. The lateral distance between the centerline of the SV and the center of the travel lane shall not deviate more than ±1 ft (0.3 m) during the applicable validity period.

9. The lateral distance between the centerline of the SV and the centerline of the POV shall not deviate more than ±1 ft (0.3 m) during the applicable validity period.

10. The SV driver shall not apply any force to the brake pedal during the during the applicable validity period.

12.4.4 Nominal SV and POV Speeds and Headway

1. From the onset of the validity period defined in S12.4.7 to the onset of POV braking defined in S12.4.6, the following conditions shall be met:

A. The POV speed shall be 35 mph (56.3 km/h) ±1.0 mph (1.6 km/h)

B. The SV-to-POV headway shall be 45.3 ft (13.8 m) ±8 ft (2.4 m)

2. The SV speed shall be 35 mph (56.3 km/h) ±1.0 mph (1.6 km/h) from the onset of the validity period defined in S12.4.7 to $t_{FCW,}$ where t_{FCW} is defined as the instant the SV FCW alert described in S11.4.2.6 is presented.

12.4.5 SV Throttle Pedal Inputs

1. The SV driver shall modulate the throttle, using smooth inputs, to maintain the nominal SV speed and headway defined in S12.4.4 from the onset of the validity period defined in S12.4.7 to t_{FCW}. Abrupt throttle inputs shall be avoided.

2. Within 500 ms after t_{FCW} the SV throttle pedal shall be fully released. The throttle pedal release rate is not restricted.

12.4.6 POV Brake Applications

1. The onset of POV braking is taken to be the instant the POV achieves a deceleration of 0.05g.

2. The POV deceleration shall nominally be a constant 0.3g.

    A. The timing tolerance for achieving the specified POV deceleration is 1.5 ±0.1s

    B. The average POV deceleration shall not deviate from 0.3g by more than ±0.03g from 1.5 seconds after the onset of POV braking to the time one of the following two conditions is satisfied:

        i. 250 ms prior to the POV coming to a stop.

        ii. The SV comes in contact with the POV.

12.4.7 Validity Period

1. The valid test interval begins 3 seconds before the onset of POV braking, as defined in S12.4.6.1.

2. The valid test interval ends when either:

    A. The SV comes in contact with the POV; or

    B. 1 second after minimum longitudinal SV-to-POV range occurs.

12.4.8 CIB Speed Reduction

The magnitude of the SV speed reduction attributable to CIB intervention is calculated in one of two ways, depending on whether a test trial concludes with the SV colliding with the POV.

1. If SV-to-POV contact occurs during a test trial, the CIB speed reduction is calculated by subtracting the SV speed at the time of SV-to-POV contact (i.e., when longitudinal range becomes zero) from the average SV speed calculated from t_{FCW} - 100 ms to t_{FCW}.

2. If SV-to-POV contact does not occur during a test trial (i.e., CIB intervention prevents the crash), the CIB speed reduction is calculated by subtracting the SV speed at the minimum longitudinal SV-to-POV range during the validity period specified in S12.4.7 from the SV speed at t_{FCW}.

12.4.9 End-of-Test Instructions

1. After the applicable validity period is complete, the SV driver shall manually apply force to the brake pedal, bring the vehicle to a stop (if necessary), and place the transmission in park (automatic transmission) or neutral (manual transmission).

2. The Decelerating POV test trial is complete.

12.4.10 Number of Test Trials

A total of seven (7) valid trials per test speed combination shall be performed for the Decelerating POV scenario, as shown in Table 3. If the test conductor performs more than seven trials within this scenario, the first seven trials satisfying all test tolerances shall be used to assess the SV performance.

12.5 SV CIB False Positive Suppression Evaluation

The False Positive Suppression test series evaluates the ability of a CIB system to differentiate a steel trench plate (STP) from an object presenting a genuine safety risk to the SV. Although the STP is large and metallic, it is designed to be driven over without risk of injury to the driver or damage to the SV. Therefore, in this scenario, the automatic braking available from CIB is not necessary and should be suppressed. The test condition is nearly equivalent to that previously defined in S12.2 for the Stopped POV condition, but with an STP in the SV forward path in lieu of a POV.

12.5.1 STP Placement

1. The STP shall be positioned in the center of a travel lane, oriented with its longest sides parallel to the roadway edge.

2. The STP position relative to the roadway shall remain constant for the duration of each test (i.e., up to the instant when the SV is driven over the plate). Any fasteners deemed necessary to secure the STP to the ground shall be nonmetallic or flush with the top surface of the STP.

12.5.2 Static Instrumentation Calibration

Calibration data shall be collected prior to the tests specified in S12.5.3.

1. The SV and STP shall be centered in the same travel lane.

2. The front-most location of the SV shall be positioned such that it just reaches a vertical plane defined by the leading edge of the STP first encountered by the SV (i.e., just before it is driven onto the STP). This is the "zero position." For the NHTSA SSV, the rearmost surface is defined by the rearmost face of the foam bumper cover.

3. The zero position shall be documented prior to, and immediately after, conduct of a test series.

    A. If the zero position reported by the data acquisition system differs by more than ±2 in (±5 cm) from that measured during collection of the pre-test static calibration data file, the pre-test longitudinal offset shall be adjusted to output zero and another pre-test static calibration data file collected.

    B. **If the zero position reported by the data acquisition system differs by more than ±2 in (±5 cm) from that measured during collection of the post-test static calibration data file, the False Positive Suppression tests performed between collection of that post-test static calibration data file and the last valid pre-test static calibration data file shall be repeated.**

4. Static data files shall be collected prior to, and immediately after, conduct of the test series described in S12.5.3 through S12.5.7. The pre-test static files shall be reviewed prior to test conduct to confirm that all data channels are operational and have been properly configured.

12.5.3 SV Approach to the STP

For an individual trial to be valid, the following must hold true throughout the test:

1. The SV driver seatbelt must be latched.

2. If any load has been placed on the SV front passenger seat (e.g., for instrumentation), the vehicle's front passenger seatbelt must be latched.

3. The SV shall be driven at one of the two nominal speeds specified in S12.5.4, in the center of the lane of travel, toward the STP.

4. The driver shall use the least amount of steering input necessary to maintain SV position in the center of the travel lane during the validity period specified in S12.5.6. Use of abrupt steering inputs or corrections shall be avoided.

5. The SV driver shall not manually apply force to the brake pedal during the validity period specified in S12.5.6.

12.5.4 Nominal Speed

1. In this scenario, the SV is driven directly towards, and over, the STP at one of two nominal speeds:

    A. SV: 25 mph (40.2 km/h)

    B. SV: 45 mph (72.4 km/h)

2. The SV speed shall not deviate more than ±1.0 mph (±1.6 km/h) during an interval defined by TTC = 5.1 seconds to t_{FCW}.

    A. When the SV test speed is 25 mph (40.2 km/h), TTC = 5.1 seconds is taken to occur at an SV-to-STP distance of 187 ft (57 m).

    B. When the SV test speed is 45 mph (72.4 km/h), TTC = 5.1 seconds is taken to occur at an SV-to-STP distance of 337 ft (106 m).

    C. t_{FCW} is defined as the instant the SV FCW alert described in S11.4.2.6 is presented. If the SV does not present an FCW alert before the end of the validity period defined in S12.5.6, the SV driver shall not let the SV speed deviate more than ±1.0 mph (±1.6 km/h) from TTC = 5.1 s to the end of the validity period.

12.5.5 Throttle Pedal Inputs

1. The SV driver shall modulate the throttle, using smooth inputs, to maintain a constant SV speed from a TTC = 5.1 seconds to t_{FCW}, where t_{FCW} is defined as the instant the SV FCW alert described in S11.4.2.6 is presented. Abrupt throttle inputs shall be avoided. If the SV does not present an FCW alert before the end of the validity period defined in S12.5.6, the SV driver shall not release the throttle pedal until the end of the validity period.

2. Within 500 ms after t_{FCW} the SV throttle pedal shall be fully released. The throttle pedal release rate is not restricted.

12.5.6 Validity Period

1. The valid test interval begins when the SV-to-STP TTC = 5.1 seconds, as defined in S12.5.4.2.

2. The valid test interval ends at the instant the front most part of SV reaches a vertical plane defined by the leading edge of the STP first encountered by the SV (i.e., just before it is driven onto the STP).

12.5.7 End-of-Test Instructions

1. After the validity period specified in S12.5.6 is complete, the SV driver shall manually apply force to the brake pedal to bring the vehicle to a stop (if necessary), and place the transmission in park (automatic transmission) or neutral (manual transmission).

2. The SV Approaches a Steel Trench Plate trial is complete.

12.5.8 Number of Test Trials

As shown in Table 4, a total of seven (7) valid trials per SV speed shall be performed for the STP test scenario. If the test conductor performs more than seven trials per scenario, the first seven trials satisfying all test tolerances shall be used to assess the SV performance.

12.6 CIB Performance Requirements

The SV speed reductions (calculated using the methods described in S12.2.9, S12.3.9, and S12.4.8) shall be documented for each Stopped, Slower-Moving, and Decelerating POV test trial, respectively. SV decelerations within the validity period described in S12.5.6 shall be documented for each test trial performed over the steel trench plate. Tables 3 and 4 provide a summary of acceptable SV performance for each test scenario. Five (5) of seven (7) valid test runs must meet the performance requirements for each test scenario. However, once five (5) trials have satisfied the performance requirements for a given scenario, performing additional trials within that scenario is not required.

Table 3. CIB Performance Requirements.

Pre-Crash Scenario	SV Speed Reduction or SV-to-POV Crash Avoidance				
	SV: 25 mph POV: 0 mph	**SV: 45 mph POV: 0 mph**	**SV: 25 mph POV: 10 mph**	**SV: 45 mph POV: 20 mph**	**SV: 35 mph POV: 35 mph**
Stopped POV	≥ 9.8 mph (15.8 km/h) for at least 5 of 7 valid test trials	--	--	--	--
Slower POV	--	--	No SV-to-POV impact for at least 5 of 7 valid test trials	≥ 9.8 mph (15.8 km/h) for at least 5 of 7 valid test trials	--
Decelerating POV	--	--	--	--	≥ 10.5 mph (16.9 km/h) for at least 5 of 7 valid test trials

Table 4. CIB Non-Activation Requirements.

Pre-Crash Scenario	SV Deceleration				
	SV: 25 mph POV: 0 mph	**SV: 45 mph POV: 0 mph**	**SV: 25 mph POV: 10 mph**	**SV: 45 mph POV: 20 mph**	**SV: 35 mph POV: 35 mph**
False Positive Check (STP in lieu of POV)	≤ 0.50g for 5 of 7 valid test trials	≤ 0.50g for 5 of 7 valid test trials	--	--	--

Note: *The values shown in Table 3 can be achieved using an effective SV deceleration of 0.6g (5.9 m/s^2) achieved at a pre-CIB activation TTC of 0.6 seconds.*

1. *When the SV test speed is 25 mph (40.2 km/h) and the POV speed is 0 mph, TTC = 0.6 seconds occurs at a SV-to-POV distance of 22.0 ft (6.7 m).*

2. *When the SV test speed is 25 mph (40.2 km/h) and the POV speed is 10 mph (16.1 km/h), TTC = 0.6 seconds occurs at a SV-to-POV distance of 13.2 ft (4.0 m).*

3. *When the SV test speed is 45 mph (72.4 km/h) and the POV speed is 20 mph (32.2 km/h), TTC = 0.6 seconds occurs at a SV-to-POV distance of 22.0 ft (6.7 m).*

4. *No CIB activation shall occur for any valid STP test trial described in S12.5. CIB activation is said to occur if SV deceleration ≥ 0. 5g within the validity period defined in S12.5.6.*

12.7 Diagnostic Trouble Codes (DTC)

Repeatedly impacting the POV may result in a diagnostic trouble code (DTC) being set by the SV's CIB system. Activation of a DTC, typically reported via illumination of a telltale within the SV instrument cluster, indicates that a plausibility check has failed or that a system malfunction has been detected. In the event a DTC is presented, the Contractor must suspend the test series and determine which error the DTC has identified. If no damage has actually occurred to any CIB component, the DTC shall be cleared to bring the SV CIB system back online and initialized using the methods described in S12.1.4 (if applicable).

NHTSA will obtain the appropriate procedures for interpreting and/or clearing DTCs from the SV from the respective vehicle manufacturer, and will provide it to the Contactor in the event a DTC occurs. If this process requires specialized equipment from the SV manufacturer, NHTSA will provide it to the Contactor as Government Furnished Equipment (GFE) or make arrangements for technical support to be present during SV test conduct.

13.0 POST TEST REQUIREMENTS

13.1 Vehicle Data and Test Documentation

The Contractor shall collect all data necessary to complete the final test report data sheets and provide details of any problem areas.

13.2 Post Test Vehicle Inspection

The Contractor shall inspect the test vehicle after all testing is completed. Any vehicle modifications or damage shall be restored to the as-delivered condition or the vehicle shall be declared "totaled" and shall be disposed of as a totally destroyed vehicle. The vehicle shall be returned to either the leasing company, if leased, or the Government if purchased or totaled. Disposal of a totaled vehicle shall be determined by the Government, at the direction of the NHTSA COR. Any damage to the vehicle sustained during the actual tests, except damage caused by negligence of the Contractor, shall be the responsibility of the Government.

14.0 REPORTS

14.1 Monthly Status Reports

The Contractor shall submit a monthly Test Status Report and a Vehicle or Equipment Status Report to the COR (both reports shown in this section). The Vehicle Status Report shall be submitted monthly until all vehicles or items of equipment are disposed of.

14.2 Test Anomalies

In the event of an apparent test failure, a post-test calibration check of critically-sensitive test equipment and instrumentation may be required for verification of accuracy. The necessity for the calibration shall be at the COR's discretion and shall be performed without additional costs to NHTSA.

14.3 Final Test Report

The Contractor shall provide NHTSA with the test data and test report in accordance with the deliverable schedule indicated in S6.0.

Contractors are required to submit one color copy of each Final Test Report in draft form. The report should not be stamped as "*preliminary"* or *"draft."* The COR will review the draft report and notify the laboratory of any corrections that are required. If the COR agrees to make changes to the test report, the Contractor shall send the modified pages to the COR. The new pages will be inserted into the preliminary test report. The preliminary test report will be accepted with the inserted pages as the final test report.

14.3.1 Requirements

The Final Test Report and associated documentation (including photographs) are relied upon as a complete record of the testing performed. The Final Test Report will be released to the public domain after review and acceptance by the COR. For these reasons, each final report must be a complete document capable of standing by itself.

The Contractor should use detailed descriptions of all test events. Any events that are not directly associated with the test program but are of technical interest should also be included. Instructions for the preparation of the first three pages of the final test report are provided below for the purpose of standardization.

14.3.2 First Three Pages

Front Cover – A heavy paperback cover (or transparency) shall be provided for the protection of the final report. The information required on the cover is as follows:

A. Final Report Number such as NHTSA-ABC-0X-001

Where:
NHTSA is the National Highway Traffic Safety Administration,
ABC are the initials for the laboratory,
0X is the Fiscal Year of the test program,
001 is the Group Number (00 1 for the 1st test, 002 for the 2nd test, 003 for the 3rd test, etc.)

B. Final Report Title and Subtitle such as

Final Report of Crash Imminent Brake System Tests
****
World Motors Corporation
201X XYZ 4-door sedan
NHTSA No. CX0401

C. Contractor's Name and Address such as

XYZ TESTING LABORATORIES, INC.
4335 West Dearborn Street
Detroit, Michigan 48090

***Note**: DOT SYMBOL WILL BE PLACED BETWEEN ITEMS (C) AND (D)*

D. Date of Final Report completion

E. The words “FINAL REPORT”

F. The sponsoring agency's name and address as follows

U. S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
1200 New Jersey Avenue SE
Washington, DC 20590

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Prepared By: _____

Approved By: _____

Approval Date: _____

FINAL REPORT ACCEPTANCE BY NHTSA:

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Manager, NHTSA

Date: _____

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COR, NHTSA

Date: _____

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NHTSA-ABC-0X-001

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Block No. 4 – TITLE AND SUBTITLE

Final Report of Crash Imminent Brake System Tests
of a 201X World XYZ Deluxe 4-door sedan
NHTSA No. CX0401

Block No. 5 – REPORT DATE

March 1, 201X

Block No. 6 – PERFORMING ORGANIZATION CODE

ABC

Block No. 7 – AUTHOR(S)

John Smith, Project Manager
Bill Doe, Project Engineer

Block No. 8 – PERFORMING ORGANIZATION REPORT NUMBER

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Final Test Report
XXX to XXX, 201X

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NVS-120

Block No. 15 – SUPPLEMENTARY NOTES

Leave blank

Block No. 16 – ABSTRACT

These tests were conducted on the subject 201X World XYZ 4-door sedan in accordance with the specifications of NHTSA Test Procedure No. TP-NHTSA-XX for the evaluation of a Crash Imminent Brake (CIB) system.

Block No. 17 – KEY WORDS

Crash Imminent Brake system, CIB

Block No. 18 – DISTRIBUTION STATEMENT

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Leave blank

14.3.3 TABLE OF CONTENTS .....PAGE NO.

Sample Test Report Table of Contents:

14.3.4 SAMPLE TEST REPORT INFORMATION

PURPOSE AND SUMMARY OF TEST

PURPOSE

This test is part of the Crash Avoidance program to assess Crash Imminent Brake (CIB) system performance, sponsored by the National Highway Traffic Safety Administration (NHTSA) under Contract No._____. The purpose of this test was to obtain vehicle crash avoidance performance data for _____.

SUMMARY

DATA SHEET NO. DESCRIPTION

1. Test Summary
2. General Test and Vehicle Parameter Data
3. Post test Data
4. Test Vehicle Information
5. Vehicle Measurements

15.0 DATA SHEETS

DATA SHEET NO. 1

TEST SUMMARY

General Vehicle Information	
NHTSA Vehicle No.	Test Date
Vehicle Make/Model/Body Style	
In-Vehicle CIB Setting (If applicable; provided by the Manufacturer to the COR)	

General Test Facility Information	
Facility Designation (e.g., "Skid Pad Lane #4")	Test Surface (e.g., asphalt, concrete)
Surface Condition	

Pretest Conditions			
Time	Ambient Temperature (°C)	Wind Speed (km/h)	Wind Direction
Test Vehicle-to-POV Distance During Static Cal, Measured (mm)		Test Vehicle-to-POV Distance During Static Cal, Displayed (mm)	

Post-test Conditions			
Time	Ambient Temperature (°C)	Wind Speed (km/h)	Wind Direction
Test Vehicle-to-POV Distance During Static Cal, Measured (mm)		Test Vehicle-to-POV Distance During Static Cal, Displayed (mm)	

DATA SHEET NO. 2

TEST SUMMARY

CIB Speed Reduction Summary (mph; km/h). If no SV-to-POV contact occurred, enter "NC".				
Trial #	**Test Condition**			
	Stopped POV	**Slower-Moving POV**		**Decelerating POV**
	SV: 25 mph POV: 0 mph	**SV: 25 mph POV: 10 mph**	**SV: 45 mph POV: 20 mph**	**SV: 35 mph POV: 35 mph**
1				
2				
3				
4				
5				
6				
7				
# of Trials Satisfying the CIB Speed Reductions Criteria[1]				

[1]Defined in Table 3 of S12.6

DATA SHEET NO. 3

SV RESPONSE TO STP TEST SUMMARY

Trial #	Peak Deceleration (g)	
	SV: 25 mph	SV: 45 mph
1		
2		
3		
4		
5		
6		
7		
# of Trials ≤ 0. 5 g		

DATA SHEET NO. 4

VEHICLE DATA

NHTSA Vehicle No.		VIN	
Vehicle Make/Model/Body Style		Vehicle Test Weight (kg)	Exterior Color
Date of Manufacture		Date Received	
Pretest Odometer Reading	Post-test Odometer Reading	Fuel System Capacity (l) (from manual)	Allowable Fuel Level Range (l) (75 to 100% of fuel system capacity)

GVWR (kg)	Front GAWR (kg)	Rear GAWR (kg)

Engine Data			Drivetrain Data		
Cylinder Count	Displacement (l)	Fuel type	Configuration (Rear, Front, or Four Wheel Drive)	Transmission: (Manual, Automatic, CVT, etc.)	Final Drive Ratio

Advanced Technology References From Owner's Manual (provide page number)			
Forward Collision Warning	Crash Imminent Braking	Adaptive Cruise Control	Advanced Braking

Placard Information					
Cold Pressure*		With Max Capacity		Speed Rating	Load Index
Front (kPa)	Rear (kPa)	Front (kPa)	Rear (kPa)		

*Tire pressure used for NHTSA CIB tests.

Tire Information			
Recommended Size (front)	Recommended Size (rear)	Size As Installed (front)	Size As Installed (rear)

Manufacturer	Load Index	Speed Rating

Treadwear Grade	Temperature Grade	Traction Grade

DATA SHEET NO. 5

TEST VEHICLE PREPARATION

Driver Seatbelt Buckled?	Front Passenger Seatbelt Buckled?
Airbags Disabled?	
Method To Disable Airbag(s)?	
Airbag Squibs Installed?	Airbag Squib Resistance (ohms)

PRINCIPAL OTHER VEHICLE (POV) INFORMATION

POV Description	POV Construction Type / Materials (e.g., carbon fiber shell)
POV Moving Platform Description (if applicable)	POV Moving Platform Material (if applicable)
POV Tow Vehicle Make/Model/Body Style (if applicable)	POV Towing Method (if applicable)
Distance From Rearmost Location of POV Tow Vehicle to Rear Most Location of POV (if applicable)	

Elevation (degrees)[1]	Aspect (degrees)[1]	POV Radar Cross Section at 131 ft (40 m)	
		24 GHz	77 GHz
0[2]	180[2]		
	185[4]		
1.5[3]	180[2]		
	185[4]		

[1]Radar aimed horizontally, 45 cm from the ground.

[2]Measurement is perpendicular to a vertical plane defined by the center of the POV rear bumper.

[3]Measurement destination is offset vertically (i.e., angled towards the POV roof). At a range of 40 m, the center of the measurement is approximately 1.95 m above the ground.

[4]Measurement source is laterally offset, but the line of sight is directed to the POV horizontal centerline.

DATA SHEET NO. 6

TEST VEHICLE INSTRUMENTATION LOCATION MEASURMENTS[1]

Description	Mnemonic	Longitudinal Orientation (m) (x-axis)	Lateral Orientation (m) (y-axis)	Vertical Orientation (m) (z-axis)
IMU centroid	C_RT_TRUE_CENTER	0	0	0
GPS antenna location on roof	M_ANTENNA_CENTER			
Front Bumper	M_FRONT_MOST_POINT			
Rear Bumper	M_REAR_MOST_POINT			
Rear Axle Midpoint	C_REAR_AXLE_MID_POINT PROJECTED TO SURFACE			

[1]All Measurements Are Relative to the Subject Vehicle Inertial Measurement Unit (IMU)

POV TOW VEHICLE INSTRUMENTATION LOCATION MEASURMENTS (if applicable)[1]

Description	Mnemonic	Longitudinal Orientation (m) (x-axis)	Lateral Orientation (m) (y-axis)	Vertical Orientation (m) (z-axis)
IMU centroid	C_RT_TRUE_CENTER	0	0	0
GPS antenna location on roof	M_ANTENNA_CENTER			
Front Bumper	M_FRONT_MOST_POINT			
Rear Bumper	M_REAR_MOST_POINT			
Rear Axle Midpoint	C_REAR_AXLE_MID_POINT PROJECTED TO SURFACE			

[1]All Measurements Are Relative to the Subject Vehicle Inertial Measurement Unit (IMU)

DATA SHEET NO. 7

PHOTOGRAPHS

16.0 TIME-TO-COLLISION CALCULATIONS

For each test, the position of POV over time is defined as:

$$s_{pov} = s_{pov,initial} + (v_{pov,initial} * t) + (0.5 * a_{pov} * (t^2))$$

where,

$s_{pov,initial}$ = initial position condition for the POV at the time of the FCW alert
$v_{pov,initial}$ = initial speed condition for the POV at the time of the FCW alert
a_{pov} = longitudinal acceleration of the POV at the time of the FCW alert

Similarly, for each test the position of SV over time is defined as:

$$s_{sv} = s_{sv,initial} + (v_{sv,initial} * t) + (0.5 * a_{sv} * (t^2))$$

where,

$s_{sv,initial}$ = initial position condition for the SV at the time of the FCW alert
$v_{sv,initial}$ = initial speed condition for the SV at the time of the FCW alert
a_{sv} = longitudinal acceleration of the SV at the time of the FCW alert

Subject Vehicle (SV) Encounters A Stopped Principle Other Vehicle (POV)

At the time the FCW alert occurs,

$s_{pov,initial}$ = 0 (simplifies the equation of motion)
$v_{pov,initial}$ = 0 (POV is at rest)
$s_{sv,initial}$ = distance between SV and POV at the time of the FCW alert (Note: this is a negative value)
a_{pov} = a_{sv} = 0 (test conditions state vehicles should be moving at a constant speed)

therefore,

$$s_{pov} = 0$$
$$s_{sv} = s_{sv,initial} + (v_{sv,initial} * t)$$

At the time of collision, $s_{pov} = s_{sv}$

therefore,

0 = $s_{sv,initial} + (v_{sv,initial} * t)$

Solving for time *t*, we find the TTC:

$$TTC = t = \frac{-s_{sv,initial}}{v_{sv,initial}}$$

Subject Vehicle (SV) Encounters A Slower Moving Principle Other Vehicle (POV)

At the time the FCW alert occurs,

$s_{pov,initial}$ = 0 (simplifies the equation of motion)
$s_{sv,initial}$ = distance between SV and POV at the time of the FCW alert (Note: this is a negative value)
a_{pov} = a_{sv} = 0 (test conditions state vehicles should be moving at a constant speed)

therefore,

$$s_{pov} = v_{pov,initial} * t$$
$$s_{sv} = s_{sv,initial} + (v_{sv,initial} * t)$$

At the time of collision, $s_{pov} = s_{sv}$

therefore,

$$v_{pov,initial} * t = s_{sv,initial} + (v_{sv,initial} * t)$$

Solving for time *t*, we find the TTC:

$$TTC = t = -\frac{(s_{sv,initial})}{(v_{sv,initial} - v_{pov,initial})}$$

Subject Vehicle (SV) Encounters A Decelerating Principle Other Vehicle (POV)

At the time the FCW alert occurs,

$s_{pov,initial}$ = 0 (simplifies the equation of motion)
$s_{sv,initial}$ = distance between SV and POV at the time of the FCW alert (Note: this is a negative value)
a_{pov}= deceleration, negative value if POV is decelerating
a_{sv} = 0 if possible, positive if accelerating, negative if SV is decelerating. therefore,

$$s_{pov} = s_{pov,initial} + (v_{pov,initial} * t) + (0.5 * a_{pov} * (t^2))$$

$$s_{sv} = s_{sv,initial} + (v_{sv,initial} * t) + (0.5 * a_{sv} * (t^2)$$

At the time of collision, $s_{pov} = s_{sv}$

therefore,

$$s_{pov,initial} + (v_{pov,initial} * t) + (0.5 * a_{pov} * (t^2)) = s_{sv,initial} + (v_{sv,initial} * t) + (0.5 * a_{pov} * (t^2))$$

simplifying we find,

$$(0.5 * (a_{pov} - a_{sv}) * (t^2)) + (v_{pov,initial} - v_{sv,initial}) * (t) + (s_{pov,initial} - s_{sv,initial}) = 0$$

With $s_{pov,initial} = 0$

$$(0.5 * (a_{pov} - a_{sv}) * (t^2)) + (v_{pov,initial} - v_{sv,initial}) * (t) + (0 - s_{sv,initial}) = 0$$

Solving for time *t*, we find:

$$t = \frac{-(v_{pov,initial} - v_{sv,initial}) \pm \sqrt{(v_{pov,initial} - v_{sv,initial})^2 - 4 * (0.5 * (a_{pov} - a_{sv})) * (-s_{sv,initial})}}{2 * 0.5 * (a_{pov} - a_{sv})}$$

simplifying we find,

$$t = \frac{-(v_{pov,initial} - v_{sv,initial}) \pm \sqrt{(v_{pov,initial} - v_{sv,initial})^2 + 2 * (a_{pov} - a_{sv}) * s_{sv,initial}}}{(a_{pov} - a_{sv})}$$

Solving for time *t* produces two solutions; one positive and one negative. The positive value provides the correct Test #2 TTC calculation. Therefore,

$$TTC = t = \frac{-(v_{pov,initial} - v_{sv,initial}) - \sqrt{(v_{pov,initial} - v_{sv,initial})^2 + 2 * (a_{pov} - a_{sv}) * s_{sv,initial}}}{(a_{pov} - a_{sv})}$$