Technical Feasibility Demonstration

Performance And Safety Certification Procedure

for the

Automated Highway System
System Definition Phase
Cooperative Agreement Number:
DTFH61-94-X-00001
Amendment 1

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Prepared by:

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Approvals:

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4/07/97

Preface

The purpose of this Performance and Safety Certification Procedure is to ensure that participant vehicles and scenarios meet certain minimum performance and safety requirements in order for them to participate in the live vehicle portion of the National Automated Highway System Consortium Technical Feasibility Demonstration.

The Safety and Certification Team will conduct a Preliminary Certification to determine the readiness of the Demonstration vehicles and scenario to enter formal certification activities. The Preliminary Certification process is intended to be conducted at the vehicle/system development site or on the I-15 Demonstration Lanes. Certain requirements of the Safety Certification Procedure may be satisfied during this preliminary certification phase. Wherever possible, performance and safety requirements will be verified during these preliminary certifications. This preliminary certification process will also serve to validate the established Safety Certification Procedure for each demonstration vehicle and scenario.

Following pre-certification, formal certification will be conducted on the I-15 Demonstration Lanes to verify the implementation of all functional, performance and safety requirements as specified in the Demonstration Specification and the prescribed scenario. Formal certification will be executed in a structured and controlled test environment, following specific certification procedures, administered and witnessed by the Safety and Certification Team. Validation results documented in a certification report will be submitted to the Safety Review Board.

The methods of validation to be used are: Inspection, Analysis, Demonstration, and Test defined as follows:

Inspection (I) - Certification or validation by visual examination of the item, reviewing descriptive documentation, and comparing the appropriate characteristics with a reference standard to determine conformance to requirements. This includes the mechanical inspection of equipment, verification of accuracy and completeness of documentation.

Analysis (A) - Certification or validation by evaluation or simulation using mathematical representation, charts, graphs, circuit diagrams, or data reduction. This includes analysis of algorithms independent of computer implementation, analytical conclusions drawn from test data, and extension of test produced data to untested conditions.

Demonstration (D)- Certification or validation by operation, movement, or adjustment of the item under a specific condition to perform the designed function. This includes the content of displays, comparison of vehicle/system products with independently derived test cases, and prompt vehicle/system recovery from induced failure conditions.

Test (T) - Certification or validation through systematic exercising of the applicable item under all appropriate conditions with instrumentation and collection, analysis, and evaluation of quantitative data.

Pass/Fail criteria specify results, including tolerances, that must be obtained to determine that a certification requirement has been satisfied, is defined in each step of Certification Procedure.

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Before proceeding with the Performance and Safety Certification Procedure, please provide the following information:

Scenario Name	
Lead Organization	
Date Certification Conducted	
Location Certification Conducted	
Certification Participants	
NAHSC Certification Team:	Scenario Certification Team:

Please provide the following information for every vehicle that will participate in the Technical Feasibility Demonstration (including spare vehicles):

Vehicle Number:	
Make, Model and MY	
Vehicle License No. and State	
Vehicle Registered to:	
Vehicle Identification No. (VIN)	
Check Below all that Apply:	
For Lateral Control	
Magnetic Markers	
Vision	
Laser	
Radar	
For Longitudinal Control	
Radar	
Laser	
Vision	
Not Automated	

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Please provide the following information for every driver that will participate in the Technical Feasibility Demonstration (including spare drivers):

	Name:	Company:	Driver License and State:	Is driver familiar with vehicle operation, safety features and procedures?	How many hours experience does driver have driving vehicle?	Has driver taken a formal, hands on vehicle handling course?	Where and when was course taken?
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
11.							
12.							

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
1	**GENERAL VEHICLE REQUIREMENTS**				
1.1	**Driver Qualifications** Examine the driver questionnaire in the front part of the Certification Procedure	(I)	Verify that all scenario vehicle drivers are: 1) minimum of 40 hours of familiarity/experience with the Demo vehicle operation, safety features, procedures and driving the vehicle, and, 2) have taken a formal, hands on vehicle handling course.	X_____	2526
1.2	**Vehicle Appearance**				
1.2.1	Inspect the exterior of all demonstration vehicles for a "production" appearance. Inspect for bulky, unsightly attachments mounted on the vehicle exterior.	(I)	No bulky or unsightly attachments shall be mounted on the vehicle exterior. Items such as antennas or radomes shall be pleasing integrated into the vehicle exterior.	X_____	2527
1.2.2	Inspect the interior of all vehicles that will carry passengers for a "production" appearance. Inspect for loose equipment, bulky or unsightly attachments mounted in the vehicle interior passenger compartment.	(I)	No bulky or unsightly instrumentation , computer keyboards, wiring harness, etc. shall be visible.	X_____	2527
1.2.3	Inspect vehicle controls and indicators added to the production vehicle for automated operation.	(I)	Control switches, buttons, indicators and displays shall be pleasingly integrated into the vehicle interior, and be easily accessible to the driver.	X_____	2527

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
1.2.4	Inspect vehicle passenger compartment for crash-worthiness hazards	(I)	For example, no equipment, controls or displays are mounted on the steering wheel or IP that might cause a head injury or interfere with SIR deployment.	X _____	2527
1.3	**Controls and Indicators.**				
1.3.1	Verify that the automation controls, for all vehicles that carry passengers, are not readily accessible to passengers.	(D)	Passengers shall not be able to easily reach any of the automation controls.	X_____	2525
1.3.2	Inspect the automated vehicles when the sun is shining on the lighted displays, indicators and controls to verify that they are still visible to the driver.	(I)	Displays, indicators and controls shall be visible to the driver under all ambient sun lighting conditions expected during the demonstration.	X_____	2541
1.4	**Vehicle Handling Provisions**				
1.4.1	Inspect all vehicles for prescribed OEM or high performance tires in good conditions.	(I)	All vehicles shall be equipped with prescribed OEM or high performance tires in good conditions.	X _____	2627
1.4.2	Inspect all vehicles for anti-lock brakes.	(I)	All vehicles shall be equipped with anti-lock brakes.	X _____	2627

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
1.5	**Seat Belts.**				
1.5.1	Inspect all demonstration passenger automobile for the presence of seat belts and shoulder restraints.	(I, D)	Seat belts and shoulder restraints are installed for driver, narrator and passengers, and buckles and retractors work properly. Record number of passengers allowed to be carried.	X_____ No._____	2531
1.5.2	Inspect all demonstration vans for the presence of seat belts and shoulder restraints.	(I, D)	Seat belts and shoulder restraints are installed for driver, narrator and passengers, and buckles and retractors work properly Record number of passengers allowed to be carried.	X_____ No._____	2616
1.5.3	Inspect trucks for seat belts.	(I, D)	Seat belts are installed for driver, narrator and passengers, and buckles and retractors work properly Record number of passengers allowed to be carried.	X_____ No._____	2617
1.5.4	Inspect transit busses for seat belts.	(I, D)	Seat belts are installed for driver and buckles and retractors work properly Record number of passengers allowed to be carried.	X_____ No._____	2618

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
1.6	**Maintenance of Vehicle Log Book**				
1.6.1	Inspect for the presence of a vehicle log book with each automated demonstration vehicle.	(I)	A vehicle log book is present in each automated vehicle, and the log book is marked so that it is uniquely associated with that vehicle.	X_____	2533
1.6.2	Examine vehicle log books for the recording of date of pre-certification.	(I)	Date of pre-certification evaluation is noted in vehicle log books.	date _____	2533
1.6.3	Examine vehicle log books for notations of all vehicle or component changes, after pre-certification, due to failure or modification that is performed on the vehicle after it has been pre-certified.	(I)	If/when a component is replaced due to failure or modification, vehicle log book is annotated with: – the reason for component replacement – old and new part and serial numbers, – date work was done, – name of who did the work, and – the vehicle odometer reading.	X_____	2534, 2535

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
1.6.4	Inspect vehicle log book for proper recording of vehicle anomalous operation, after pre-certification,.	(I)	If/when the vehicle is anomalous operation is observed, vehicle log book must be annotated with: - a description of the problem, - date observed, - name of who observed it, and - the vehicle odometer reading.	X_____	2536
1.6.5	Inspect vehicle log book for recording of vehicle maintenance after pre-certification.	(I)	If/when routine vehicle maintenance is performed, vehicle log book must be annotated with: - what was done, - date, - name of who did it, and - the vehicle odometer reading.	X_____	2537
1.7	**Logo Display**				
1.7.1	Inspect each live demonstration vehicle for NAHSC logo display.	(I)	Each vehicle shall display the NAHSC logo provided by the Demonstration Team.	X_____	2556
1.7.2	Inspect each live demonstration vehicle for any other logo display.	(I)	Each vehicle shall not display any other logo than the NAHSC logo provided by the Demonstration Team while operating on the I-15 demonstration lanes.	X_____	2556

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
1.8	**Vehicle Communications**				
1.8.1	Inspect all vehicles that will participate in the demonstration for the presence of an installed or portable in-vehicle voice radio.	(I)	An installed or portable in-vehicle radio is present in all demonstration vehicles. The voice radio shall meet the following minimal requirements.	X_____	2528
1.8.2	Inspect manufacturer's data plate or data sheet to verify the radio's: frequency range, number of channels, squelch, power output, user interface options.	(I)	**Frequency** Receive: 851-869 MHz - Repeater ops Transmit: 806-824 MHz - Repeater ops: 851-869 MHz (direct talk)	X_____	2528
		(I)	**Squelch** Switchable between carrier operated and decoder operated squelch. Use any of the standard EIA CTCSS tones on both transmit and receive.	X_____	2528
		(I)	**Power Output:** 15 watts nominal RF power output (preferred). 5 watts to 35 Watts acceptable.	X_____ _____Watts	2528

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
		(I)	**Frequency Switchable:** Frequency shall be switchable between operating frequencies. and repeater modes of operation.	X_____	2528
1.8.3	Demonstrate that it is possible to communicate with each scenario vehicle, the Demonstration Control Center and the Caltrans Radio Net using the applicable radio nets, frequencies and operating procedures in the Demonstration Communications Operating Guidelines. Repeat the demonstration of radio operation three more times uniformly spaced along the lanes.	(D)	The installed or portable in-vehicle radio communications operates in accordance with the following nets and frequencies:	X_____	2528
		(D)	**NAHSC Demonstration Radio Net Operating Frequencies** Receive: 868.0375 MHz Transmit: 823.0375 MHz (NAHSC Repeater) 868.0375 MHz direct (direct talk) Decoder operated squelch: 192.8 Hz - Both Transmit and Receive	X_____	2528

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
		(D)	**Caltrans Radio Net Operating Frequencies** Receive: 857.1000 MHz Transmit: 812.1000 MHz (SOLEDAD Repeater) Decoder operated squelch: 110.9 Hz - Both Transmit and Receive	X_____	2528
		(D)	**Radio Operation:** The vehicle narrator/radio operator is familiar with the operation of the radio equipment and operating procedures contained in the Demonstration Communications Operating Guidelines.	X_____	2528
1.8.4	Verify that installed vehicle voice radio can operate on battery power with engine off.	(D)	Installed vehicle voice radio shall be capable of operating for at least 20 min of vehicle battery power with engine off.	X _____	2528

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
1.8.5	Verify that the portable team radio is equipped with a headset and can operate using push-to-talk operations	(I)	**Team Radio:** Portable in-vehicle voice radio for team support/coordination shall be equipped with headset and have push-to-talk voice activated transmit capability.	X_____	2628
1.9	**Vehicle to DPC Telemetry**				
1.9.1	For each vehicle equipped to transmit data to the DPC, demonstrate the proper message content.	(D)	Message content shall contain the following information: a) Vehicle identification b) Location on the lane c) Lane being used d) Vehicle speed	X_____	2620
1.9.2	For each vehicle equipped to transmit data to the DPC, demonstrate the proper message data update rate	(T)	Data shall be updated at least one per sec averaged over 5 min	X_____ _____ sec	2620
2	**FAULT ANALYSIS**				
2.1	Submit a current vehicle block diagram showing, at the component level, all components added to the vehicle for automated operation.	(I)	Vehicle Block diagram shall be up to date.	X _____	
2.2	Submit a top level fault analysis, and show by means of a formal presentation that any single failure in the longitudinal control system will not induce a hazardous consequence.	(A)	The fault analysis shall be consistent with the block diagram, and include all elements of the longitudinal control system	X _____	2548, 2557, 2558, 2561,

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
			such as: the sensor, vehicle computer and software, actuators, actuator controllers and software, safety circuitry or software, power sources, driver alert provisions, and manual takeover provisions. The Certification Team shall be satisfied that reasonable effort has been invested in proving a safe system.		2562, 2563, 2564, 2565, 2566, 2567, 2568
2.3	Submit a top level fault analysis, and show by means of a formal presentation that any single failure in lateral control system will not induce a hazardous consequence.	(A)	The fault analysis shall be consistent with the block diagram, and include all elements of the lateral control system such as: the sensor, vehicle computer and software, actuator, actuator controller and software, safety circuitry or software, power sources, driver alert provisions, and manual takeover provisions. The Certification Team shall be satisfied that reasonable effort has been invested in proving a safe system.	X _____	2548, 2557, 2558, 2559, 2560, 2566, 2568
2.4	Review with the Certification Team, the Failure Effects Survey previously distributed. Attach the most current version to this Certification Procedure.	(A)	The Certification Team shall be satisfied that reasonable effort has been invested in proving a safe	X _____	2548, 2557

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
			system.		
2.5	Review with the Certification Team, an analysis showing that the selected vehicle-to-vehicle spacing, during performance of your scenario, allows for safe avoidance of all other scenario vehicles in the event of a vehicle or longitudinal control failure. Attach the analysis to this Certification Procedure.	(A)	The Certification Team shall be satisfied that reasonable effort has been invested in proving a safe system.	X _____	2548, 2557
2.6	Review with the Certification Team, the answers to the Software Soundness Questionnaire previously distributed. Attach the most current version of the Software Soundness Questionnaire to this Certification Procedure.	(A)	The Certification Team shall be satisfied that reasonable effort has been invested in providing safe software.	X _____	2548, 2557
3	**VEHICLE PERFORMANCE DURING THE SCENARIO**				
3.1	**Safety Critical Maneuvers** Perform scenario as many times as required to demonstrate the following scenario performance requirements.	(D)	At no time, during performance of this Certification Procedure, shall any vehicle make any hazardous maneuver such as: hard over steering, full braking or approaching another vehicle, obstacle or part of the infrastructure too closely.	X _____ (mark at end of certification)	2594
3.2 3.2.1	**Scenario Execution Time and Maximum Speed** Measure the elapse time between when the lead vehicle in the scenario crosses the North End start line and when the last vehicle in the scenario	(T)	Record the time rounded off to the nearest tenth of a minute.	_____ min	2554

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
	crosses the South End finish line.				
3.2.2	Measure the time it takes for an obstacle placement/removal vehicle to put down or pickup the maximum number of obstacles used in the scenario.	(T)	Record the time rounded off to the nearest tenth of a minute.	_____ min	2554
3.2.3	Add the two times recorded above together.	(A)	The total shall not exceed 15.0 min.	_____ min	2554
3.2.4	During the above scenario run, record the top speed of every vehicle.	(D)	The maximum speed observed shall not exceed 65 mph.	_____ mph	2554
3.3	**Check-In** For every automated vehicle, demonstrate that the VRC Transponder causes the lane mounted changeable message sign to display the proper message as the vehicle passes the VRC reader.	(D)	The changeable message sign shall change from "TBD" to "Welcome to AHS"	X_____	2398
3.4	**Switching Between Manual and Automated Control.** Demonstrate transition from manual-to-automated control and from automated-to-manual control, and evaluate ride sensation for smoothness and stability	(D)	All vehicle shall transition, on a single attempt, between manual and automated control smoothly with no uncomfortable or unsafe weaving or jerking.	X_____	2544
3.5	**Acceleration.** Accelerate from minimum manual-to automated transition speed up to 65 mph, and evaluate ride sensation for smoothness and stability.	(D)	All vehicles shall accelerate to 65 mph (or their scenario top speed ≥ 45 mph and ≤ 65 mph) with no uncomfortable or unsafe weaving	X_____	2589

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
			or jerking.		
3.6	**Speed Variation.** While operating vehicle under automated control, vary vehicle speed and evaluate ride sensation for smoothness and stability.	(D)	All vehicle speed changes shall be performed smoothly with no uncomfortable or unsafe weaving or jerking.	X_____	2590
3.7	**Maneuvering.** While operating vehicle under automated control, evaluate ride sensation for smoothness and stability during normal (for your scenario) maneuvers such as lane changing, passing, starting, stopping and pulling up behind a slower vehicle.	(D)	All vehicle shall perform all maneuvers smoothly with no uncomfortable or unsafe weaving or jerking	X_____	2593, 2594
3.8 3.8.1	**Emergency Assumption of Manual Control.** While operating vehicle under automated control, insert faults and execute emergency driver assumption of manual control for each of the following conditions: 1) failure of any longitudinal control element 2) failure of any lateral control element 3) external notification to stop the scenario	(D)	Test vehicle, and all other vehicles in the scenario, shall remain under control without exposing anyone to harm or danger.	X _____	2526
3.8.2	When an emergency driver assumption of manual control occurs, show how the vehicle driver is notified.	(D)	The driver shall be provided with a visual or audible alert when ever a lateral or longitudinal control element fails and/or the driver assumes manual control.	X _____	2624

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
3.8.3	If possible, re-start the scenario after a vehicle executes an emergency driver assumption of manual control.	(D)	All vehicles shall be capable of clearing the lanes under either automated or manual control, but execution of the scenario as scripted may be discontinued.	X _____	2598
3.9	**Steering Control Safety**				
3.9.1	Verify by test that all automated vehicles with lateral control have a means to limit steering range.		Under automated lateral control, a range limiter shall prevent the steering control system from producing:		2538
		(T)	• a steering angle exceeding 2 degrees at the ground wheel when the vehicle is traveling at 65 mph (105 kph)	_____ deg	2538
3.9.2	Verify that the driver has the means of taking manual control of steering.	(D)	• Driver shall be able to easily take over steering any time vehicle is in automated control.	X _____	2578
3.9.3	Verify by inserting faults that if any of the conditions occur in 3.9.1 above, an alert is provided to the driver before the vehicle switches out of automated control, and the driver is capable of resuming manual control.	(D)	An audible or visual alert is provided to the driver	X_____	2624, 2625

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
		(D)	Drive can assume manual control of the vehicle.	X_____	2526
3.9.4	Verify by test that all automated vehicles with lateral control have a means to limit lateral acceleration, and the distance between the vehicle lane boundary or the yaw angle of the vehicle with respect to the lane center.		Under automated lateral control, a limiter shall prevent the steering control system from producing:		
		(T)	• a lateral acceleration exceeding 2.5 m/s^2	_____ m/s^2	2540
		(D)	• The vehicle does not cross the lane boundary except during a lane change.	X_____	2545
3.9.5	Verify by demonstration that if any of the conditions occur in 3.9.3 above, an alert is provided to the driver before the vehicle switches out of automated control, and the driver is capable of resuming manual control.	(D)	An audible or visual alert is provided to the driver	X_____	2624, 2625
		(D)	Driver can assume manual control of the vehicle.	X_____	2526 2578
3.10	**Speed Control Safety**				
3.10.1	Verify by test that all automated vehicles with longitudinal control have a means to limit acceleration.	(T)	Under longitudinal control, a limiter shall prevent the vehicle from producing an acceleration	+_____ m/s^2 -_____ m/s^2	2579, 2580

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
			exceeding ± 5 m/s^2.		
3.10.2	Verify by inserting faults into the longitudinal control system that an alert is provided to the driver before the vehicle switches out of automated control, and the driver is capable of resuming manual control.	(D)	An audible or visual alert is provided to the driver	X_____	2624, 2625
		(D)	Drive can assume manual control of the vehicle.	X_____	2526, 2578
3.11	**Kill Switch**				
3.11.1	Inspect all automated vehicles to verify that they have a "kill switch" within easy reach of the driver.	(I)	A "kill switch" is in easy reach of the driver.	X_____	2530
3.11.2	For all automated vehicles, demonstrate that the activation of the "kill switch" will safely return the vehicle to manual control and provide the driver with an indication that the vehicle is under manual control.	(D)	Activation of the "kill switch" disengages all automated controls, and provides the driver with full manual control, and an indication that control has been switched from automated to manual.	X_____	2524, 2530
		(D)	Feel of steering wheel and brakes shall not differ from drivers normal expectation.	X_____	2530

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
4	**SCENARIO ROBUSTNESS**				
4.1	**Safety Questions** Before starting the scenario runs, answer the following questions. Answers will be used by the Demonstration Safety Officer to help decide if the Demonstration should be stopped.				
4.1.1	Have you experienced any problems with temperature during your previous testing on I-15 or other test locations?	(A)	Answer yes or no and explain if yes.	YES_____ NO_____	2622
4.1.2	Have you experienced any problems with shadows or other effects from the particular angle of the sun during your previous testing on I-15 or other test locations?	(A)	Answer yes or no and explain if yes.	YES_____ NO_____	2621
4.1.3	What is the maximum wind speed, from any angle, (both steady and gusts) that it is safe to operate your vehicles?	(A)	Record answer. a) Steady b) Gusts	 _____mph _____mph	2622
4.1.4	What is the maximum rain rate your vehicle can operate in?	(A)	Record answer.	____mm/hr	2622
4.1.5	What is the maximum amount of fog (in feet of visibility) your vehicle can operate in?	(A)	Record answer.	_____ ft	2622
4.1.6	Can your vehicles operate at night?	(A)	Answer yes or no.	YES_____ NO_____	2621

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
4.2	**Scenario Description** Submit the current version of your scenario description along with quantitative values for vehicle speeds versus distance, vehicle-to-vehicle gaps and detection ranges of obstacles to be avoided. Attach scenario description to this Certification Procedure.	(A)	Scenario shall contain the appropriate elements and exhibit the functionality described in the following Appendices for your particular scenario: (1) Platoon (2) Multi-Platform Free Agent (3) Maintenance (4) Evolutionary (5) Control Transition (6) Alternative Technology (7) Truck	X_____	
4.3	**Scenario Runs** Run your scenario ten times to demonstrate scenario is repeatable and robust. Scenario runs shall be conducted as follows: • Alternately make five full South-to-North runs and five full North-to- South runs. • Ensure that half the runs are performed before noon and the other half after noon. • Vary the number of people and their sitting positions among runs. • Record the results for each run.	(D)	a) All vehicles while under automated control shall stay in scenario scripted	X_____	2586

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
			lane(s)		
		(D)	b) All vehicles while automated control shall exhibit minimal weaving	X_____	2586
		(D)	c) All vehicles while under automated control shall exhibit minimal surging.	X_____	2586
		(D)	d) All vehicles while under automated control shall provide passenger ride comfort similar to that of 1996 model year manually controlled vehicles.	X_____	2587
		(D)	e) All vehicles while under automated control shall, once automated operation has commenced (in accordance with the scenario script), not be manually or automatically interrupted during the entire run.	X_____	2555, 2623
		(D)	f) All vehicles while under automated control shall: complete the scenario as	X_____	2554

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
			described in step 4.2 above.		
		(D)	g) Scenario shall pass pre-established way-point markers within acceptable timing as marked on velocity profile.	X _____	2554
4.4	**Run Results**		Record for each run:		
4.4.1	Run 1	(D)	North to South or South to North	_____	
		(D)	Time of day	_____	2621
		(D)	Temperature	_____	2622
		(D)	Wind Speed (note steady or gusts)	_____	2622
		(D)	Rain	____mm/hr	2622
		(D)	Fog Visibility	_____ft	2622
		(D)	Were any deviations from the success criteria in procedure 4.3 a thru g. above noted? If yes , record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
		(D)	Were any success criteria in procedure 4.3 a thru g. above not met. If yes, record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622
		(D)	Were any other anomalies in success criteria in procedure 4.3 a thru g. above observed? If yes, record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622
4.4.2	Run 2	(D)	North-to-South or South-to-North	_____	
		(D)	Time of day	_____	2621
		(D)	Temperature	_____	2622
		(D)	Wind Speed (note steady or gusts)	_____	2622
		(D)	Rain	____mm/hr	2622
		(D)	Fog Visibility	_____ft	2622
		(D)	Were any deviations from the	a. _____	2621,

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
			success criteria in procedure 4.3 a thru g. above noted? If yes , record the letter and attach an explanation.	b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2622
		(D)	Were any success criteria in procedure 4.3 a thru g. above not met. If yes, record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622
		(D)	Were any other anomalies in success criteria in procedure 4.3 a thru g. above observed? If yes, record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622
4.4.3	Run 3	(D)	North to South or South to North	_____	
		(D)	Time of day	_____	2621
		(D)	Temperature	_____	2622

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
		(D)	Wind Speed (note steady or gusts)	_____	2622
		(D)	Rain	____mm/hr	2622
		(D)	Fog Visibility	_____ft	2622
		(D)	Were any deviations from the success criteria in procedure 4.3 a thru g. above noted? If yes , record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ _____	2621, 2622
		(D)	Were any success criteria in procedure 4.3 a thru g. above not met. If yes, record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622
		(D)	Were any other anomalies in success criteria in procedure 4.3 a thru g. above observed? If yes, record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
4.4.4	Run 4	(D)	North to South or South to North	_____	
		(D)	Time of day	_____	2621
		(D)	Temperature	_____	2622
		(D)	Wind Speed (note steady or gusts)	_____	2622
		(D)	Rain	____mm/hr	2622
		(D)	Fog Visibility	_____ft	2622
		(D)	Were any deviations from the success criteria in procedure 4.3 a thru g. above noted? If yes , record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622
		(D)	Were any success criteria in procedure 4.3 a thru g. above not met. If yes, record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622
		(D)	Were any other anomalies in	a. _____	2621,

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
			success criteria in procedure 4.3 a thru g. above observed? If yes, record the letter and attach an explanation.	b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2622
4.4.5	Run 5	(D)	North to South or South to North	_____	
		(D)	Time of day	_____	2621
		(D)	Temperature	_____	2622
		(D)	Wind Speed (note steady or gusts)	_____	2622
		(D)	Rain	____mm/hr	2622
		(D)	Fog Visibility	_____ft	2622
		(D)	Were any deviations from the success criteria in procedure 4.3 a thru g. above noted? If yes , record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622
		(D)	Were any success criteria in procedure 4.3 a thru g. above not	a. _____ b. _____	2621, 2622

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
			met. If yes, record the letter and attach an explanation.	c. _____ d. _____ e. _____ f. _____ g. _____	
		(D)	Were any other anomalies in success criteria in procedure 4.3 a thru g. above observed? If yes, record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622
4.4.6	Run 6	(D)	North to South or South to North	_____	
		(D)	Time of day	_____	2621
		(D)	Temperature	_____	2622
		(D)	Wind Speed (note steady or gusts)	_____	2622
		(D)	Rain	____mm/hr	2622
		(D)	Fog Visibility	_____ft	2622
		(D)	Were any deviations from the success criteria in procedure 4.3 a thru g. above noted? If yes ,	a. _____ b. _____ c. _____	2621, 2622

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
			record the letter and attach an explanation.	d. _____ e. _____ f. _____ g. _____	
		(D)	Were any success criteria in procedure 4.3 a thru g. above not met. If yes, record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622
		(D)	Were any other anomalies in success criteria in procedure 4.3 a thru g. above observed? If yes, record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622
4.4.7	Run 7	(D)	North to South or South to North	_____	
		(D)	Time of day	_____	2621
		(D)	Temperature	_____	2622
		(D)	Wind Speed (note steady or gusts)	_____	2622

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
		(D)	Rain	____mm/hr	2622
		(D)	Fog Visibility	_____ft	2622
		(D)	Were any deviations from the success criteria in procedure 4.3 a thru g. above noted? If yes , record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____	2621, 2622
		(D)	Were any success criteria in procedure 4.3 a thru g. above not met. If yes, record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622
		(D)	Were any other anomalies in success criteria in procedure 4.3 a thru g. above observed? If yes, record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622
4.4.8	Run 8	(D)	North to South or South to North	_____	

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
		(D)	Time of day	_____	2621
		(D)	Temperature	_____	2622
		(D)	Wind Speed (note steady or gusts)	_____	2622
		(D)	Rain	____mm/hr	2622
		(D)	Fog Visibility	_____ft	2622
		(D)	Were any deviations from the success criteria in procedure 4.3 a thru g. above noted? If yes , record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622
		(D)	Were any success criteria in procedure 4.3 a thru g. above not met. If yes, record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622
		(D)	Were any other anomalies in success criteria in procedure 4.3 a thru g. above observed? If yes,	a. _____ b. _____ c. _____	2621, 2622

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
			record the letter and attach an explanation.	d. _____ e. _____ f. _____ g. _____	
4.4.9	Run 9	(D)	North to South or South to North	_____	
		(D)	Time of day	_____	2621
		(D)	Temperature	_____	2622
		(D)	Wind Speed (note steady or gusts)	_____	2622
		(D)	Rain	____mm/hr	2622
		(D)	Fog Visibility	_____ft	2622
		(D)	Were any deviations from the success criteria in procedure 4.3 a thru g. above noted? If yes , record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622
		(D)	Were any success criteria in procedure 4.3 a thru g. above not met. If yes, record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____	2621, 2622

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
				e. _____ f. _____ g. _____	
		(D)	Were any other anomalies in success criteria in procedure 4.3 a thru g above observed? If yes, record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622
4.4.10	Run 10	(D)	North to South or South to North	_____	
		(D)	Time of day	_____	2621
		(D)	Temperature	_____	2622
		(D)	Wind Speed (note steady or gusts)	_____	2622
		(D)	Rain	____mm/hr	2622
		(D)	Fog Visibility	_____ft	2622
		(D)	Were any deviations from the success criteria in procedure 4.3 a thru g. above noted? If yes , record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____	2621, 2622

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
				f. _____ g. _____	
		(D)	Were any success criteria in procedure 4.3 a thru g. above not met. If yes, record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622
		(D)	Were any other anomalies in success criteria in procedure 4.3 a thru g. above observed? If yes, record the letter and attach an explanation.	a. _____ b. _____ c. _____ d. _____ e. _____ f. _____ g. _____	2621, 2622
4.5	**Electromagnetic Environment** During the performance of all certification procedures, demonstrate that all hardware and software is unaffected by the electromagnetic environment.	(D)	Vehicles shall not effect or be effected by any other demonstration vehicles or the infrastructure.	X _____	2529, 2543
4.6	**Safety Critical Maneuvers** After all 10 consecutive runs, return to step 3.1 and complete the results.				

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt #
4.7	**Comments, Discrepancies and Recommendations** Fill out attached Comments, Discrepancy and Safety Board Recommendation sheets and submit entire completed Certification Procedure to Safety Board for review.				

Record Comments Here

Record Observed Discrepancies Here

Record Recommendations to the Safety Board Here

APPENDIX 1 - PLATOON SCENARIO

4/07/97

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt#
1-1	Verify that while the platoon is moving at a constant speed, vehicle-to-vehicle spacing will be maintained at 4.5 ± 0.5m.	(D)	Spacing is maintained at 4.5 ± 0.5 m between vehicles for at least 3 m in each direction on 10 consecutive scenario runs.	X_____	2424
1-2	Verify that two vehicles, within the platoon, can increase spacing (split) to 30 ± 0.5 m.	(D)	Spacing increases from 4.5 ± 0.5 m to 30 ± 0.5 m, between two vehicles within the platoon on 10 consecutive scenario runs.	X_____	2423, 2592
1-3.	Verify that while the spacing between the above two vehicles is increased, the spacing between the other vehicles is maintained at 4.5 ± 0.5 m.	(D)	Spacing is maintained between the other vehicles in the platoon on 10 consecutive scenario runs.	X_____	2423
1-4	Verify that two vehicles can decrease spacing (join) from 30 meters ± 0.5 m to 4.5 ± 0.5 m.	(D)	Spacing decreases from 30 ± 0.5 m to 4.5 ± 0.5 m between two vehicles within the platoon on 10 consecutive scenario runs.	X_____	2425, 2591
1-5	Verify that as the spacing between the above two vehicles is reduced, spacing between the other vehicles is maintained at 4.5 ± 0.5 m.	(D)	Spacing is maintained between the other vehicles in the platoon on 10 consecutive scenario runs .	X_____	2425
1-6	Verify that vehicle data can be transmitted from the lead vehicle to all other vehicles in the platoon	(D)	Successful if, lead vehicle data is received by all other platoon vehicles on 10 consecutive scenario runs.	X_____	2427

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt#
1-7	Verify that vehicle data can be transmitted to the vehicle behind it and received.	(D)	Successful if transmitted vehicle data is received by the vehicle behind it (except last platoon vehicle) on 10 consecutive scenario runs.	X_____	2427
1- 8	Remove any arbitrary vehicle from the platoon. Repeat a total of three times with the lead vehicle being removed on one trial.	(D)	If any vehicle in the platoon is removed, the remaining nine vehicles shall still operate as a platoon and execute the scenario.	X _____	2592
1-9	Verify that all vehicles display vehicle/scenario information on the Human Machine Interface (HMI).	(D)	Information is displayed on the HMI (HUD and front flat panel display) that is consistent with vehicle actions.	X _____	2631

APPENDIX 2 - MUTI-PLATFORM FREE AGENT SCENARIO

4/07/97

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt#
2-1	Verify that Free Agent vehicles can demonstrate roadway departure warning and alert the driver.	(D)	Successful if on 10 consecutive scenario runs, as the vehicle is leaving the lane, the driver is alerted.	X _____	2403
2-2.	Verify that Free Agent vehicles can maintain a constant speed of 50 mph ± 7 mph.	(D)	Successful if speed is maintained over a distance of 3 miles for 10 consecutive scenario runs.	X_____	2400
2-3	Verify that Free Agent vehicles can maintain accurate lane keeping while maintaining a spacing of 20 ± 0.5 m.	(D)	Successful if all vehicles stay within their lanes while maintaining of a spacing of 20 ± 0.5 m for a distance of 3 mi for 10 consecutive scenario runs.	X_____	2406
2-4	Verify that Free Agent vehicles can maintain accurate lane keeping while maintaining a spacing of 25 ± 0.5 m.	(D)	Successful if all vehicles stay within their lanes while maintaining of a spacing of 25 ± 0.5 m over a distance of 3 mi on 10 scenario runs.	X_____	2402
2-5	Verify that Free Agent vehicles can maintain accurate lane keeping while maintaining a spacing of 40 ± 0.5 m.	(D)	Successful if all vehicles stay within their lanes while maintaining a spacing of 40 ± .5 meters. over a distance of 3 miles on 10 consecutive scenario runs.	X_____	2401, 2405

APPENDIX 2 - MUTI-PLATFORM FREE AGENT SCENARIO

4/07/97

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt#
2-6	Verify that Free Agent vehicles can transfer from manual operation on entrance ramp to automated operation on the driving lane.	(D)	Successful if transfer occurs on 10 consecutive scenario runs.	X_____	2416, 2399
2-7	Verify that Free Agent vehicles can transfer from automated control on the driving lane to manual operation onto the exit ramp.	(D)	Successful if control is transferred on 10 consecutive scenario runs.	X_____	2399
2-8	Verify that Free Agent vehicles can automatically maneuver the vehicle between lanes for entry/exit, lane change, and obstacle avoidance.	(D)	Successful if all vehicles accomplish maneuvers on 10 consecutive scenario runs.	X_____	2404
2-9	Verify that Free Agent vehicles can detect automated and non-automated vehicles that merge in front of the FA vehicles.	(D)	Successful if the merged vehicle is detected on 10 consecutive scenario runs	X _____	2407
2-10	Verify that Free Agent vehicles can maintain spacing in the presence of merging automated and non-automated vehicles.	(D)	Successful if spacing is maintained for 10 consecutive scenario runs.	X_____	2407
2-11	Verify that Free Agent vehicles can detect an obstacle at a minimum distance of 100 meters.	(D)	Successful if obstacle is detected on 10 consecutive scenario runs.	X_____	2408
2-12	Attach a description of the obstacle(s) used.		Record for information.	X_____	2408

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt#
2-13	Free Agent vehicles shall avoid the obstacle by stopping.	(D)	Successful if vehicles stop, before hitting the obstacle, on 10 consecutive scenario runs.	X_____	2411
2-14	Verify that Free Agent vehicles can avoid the obstacle by executing a lane transition maneuver.	(D)	Successful if lane change maneuver executed, without hitting the obstacle, 10 consecutive times.	X_____	2412
2-15	Verify that Free Agent vehicles can transmit information on obstacle location to other automated vehicles.	(D)	Successful if vehicle transmits accurate obstacle information on 10 consecutive scenario runs.	X_____	2413
2-16	Verify that Free Agent vehicles can receive information on obstacle location from other automated vehicles.	(D)	Successful if vehicle receives accurate obstacle information on 10 consecutive scenario runs.	X _____	2413
2-17	Verify that Free Agent vehicles can avoid an obstacle based on information from other automated vehicles.	(D)	Successful if vehicle avoids obstacle based on received information on 10 consecutive scenario runs.	X _____	2413
2-18	Verify that Free Agent vehicles can detect that it is closing on a slower vehicle.	(D)	Successful if slower vehicle detected and driver alerted on 10 consecutive scenario runs.	X_____	2414

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt#
2-19	Verify that once slower vehicles are detected, the driver is alerted.	(D)	Successful if driver is alerted on 10 consecutive scenario runs.	X_____	2414
2-20	Verify that Free Agent vehicles can determine if it is safe to change lanes prior to executing a lane change maneuver.	(D)	Check shall be made 20 times with vehicles in various location around the automated vehicle. Successful if vehicle locations are accurately identified 19 times.	X_____	2415
2-21	Verify that Free Agent vehicles can verify vehicle readiness to transfer from manual to automated.	(D)	Successful if vehicle readiness is verified on 10 consecutive scenario runs.		2399
2-22	Verify that Free Agent vehicles can accurately display vehicle status to the driver.	(D)	Successful if status is accurately displayed on 10 consecutive scenario runs.	X_____	2626
2-23	Verify that Free Agent Demonstration sedans display vehicle/scenario information on the Human Machine Interface (HMI).	(D)	Information is displayed on the HMI (HUD and front flat panel display) that is consistent with vehicle actions.	X _____	2626

APPENDIX 3 - MAINTENANCE SCENARIO

4/07/97

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt#
3-1	Verify that the IDV can drive "hands free" at 60 mph the length of the express lanes in both directions.	(D)	Successful if the IDV stays within it's lane over the entire length of the demonstration lanes on 10 consecutive scenario runs.	X_____	2428
3-2	Verify that the IDV is equipped with a conventional cruise control in good working order.	(D)	Successful if, when set at 60 mph, speed is maintained between 58 and 62 mph over the entire length of the demonstration lanes on 10 consecutive scenario runs.	X_____	2429
3-3	Verify that the IDV can accurately measure the field strength and polarity of magnetic markers	(D)	Successful if the diagnostic package can successfully measure the field strength and polarity of 98% of the magnetic nails during one round trip.	X_____	2465
3-4	Verify that the IDV can transmit the following maintenance data to the DPC: a. VRC Operational Status b. Periodic Transmittal of Magnet Status	(T)	Successful if the data can be accurately transmitted in less than 5 seconds after collection on 10 consecutive scenario runs, and the DPC accurately receives the status data.	X_____	2431
3-5	Verify that the IDV can verify that the check-in system is working properly.	(D)	Successful if the CMS is triggered on 10 consecutive scenario runs.	X_____	2467

APPENDIX 3 - MAINTENANCE SCENARIO

4/07/97

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt#
3-6	Verify that the speed of the IDV is read by the vehicle controller and sent to the DPC.	(T,D)	Successful if the controller correctly reads the vehicle speed, when compared to the vehicle speed profile sent to the DPC, on 10 consecutive scenario runs.	X_____	2469
3-7	Verify that the IDV can determine its location on the lanes, at any given time.	(T,D)	Successful if location is accurately determined on 10 consecutive scenario runs, based on a speed profile.	X _____	2470
3-8	Verify that the IDV transmits position data to the DPC.	(T,D)	Successful if data is accurately transmitted to the DPC on 10 consecutive scenario runs.	X_____	2470
3-9	Verify that the position date is received by the DPC.	(T,D)	Successful if data is accurately received by the DPC on 10 consecutive scenario runs.	X _____	2470
3-10	Verify that the IDV can determine vehicle subsystem status. Failures will be induced to provide variation in status.	(T,D)	Successful if data is collected on 10 consecutive scenario runs.	X_____	2472
3-11	Verify that the ALTS can receive problem inputs, assign a location to each problem and communicate data on problem and locations to the DPC.	(D)	Successful if data is collected on 10 consecutive scenario runs.	X_____	2432

APPENDIX 3 - MAINTENANCE SCENARIO

4/07/97

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt#
3-12	Verify that the DPC receives data on problems and locations.	(D)	Successful if data is received on 10 consecutive scenario runs.	X_____	2432
3-13	Verify that the ORV can pick up the obstacle and place it in the ORV in less than 2 minutes.	(D)	Successful if obstacle is picked up in less than two minutes on 10 consecutive scenario runs.	X_____	2433
3-14	Verify that the ORV can communicate via voice with the DPC.	(D)	Successfully transmit and receive between the ORV and the DPC.	X_____	2474, 2473, 2468
3-15	Verify that there exists a reference system by which the DPC can direct the ORV to the Debris.	(D)	Successful if the reference system exists and is documented.	X_____	2474
3-16	Verify that both the DPC personnel and the ORV driver understand the reference system.	(D)	Successful if the DPC can accurately direct the ORV driver to the obstacle.	X_____	2474

APPENDIX 4 - EVOLUTIONARY SCENARIO

4/07/97

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt#
4-1	Verify that the vehicle can determine when it is about to cross the lane boundary, warn the driver, and automatically return to within the lane boundary before the vehicle enters a hazardous condition.	(D)	Successful if the vehicle can determine that the lane boundary is about to be crossed, warn the driver, and return to the lane on 10 consecutive boundary violations.	X_____	2446, 2451
4-2	Verify that the vehicle can detect another vehicle, that enters its path at a distance of less than 50 ± m and at a speed of 85 kph ± 5 kph.	(D)	Vehicle successfully detected on 10 consecutive scenario runs.	X_____	2447
4-3	Verify that the automated vehicles can detect that the vehicle is moving at a different rate of speed and alter it's speed to match the other vehicle.	(D)	Differential in vehicle speed successfully detected on 10 consecutive scenario runs.	X_____	2447, 2449
4-4	Verify that the automated vehicles can alter speed to match the other vehicle.	(D)	Speed successfully altered on 10 consecutive scenario runs.	X_____	2447
4-5	Verify that the automated vehicles can maintain a spacing of 50 ± 0.5 m with the other vehicle.	(D)	Successful if spacing is maintained for a distance of 3 mi on 10 consecutive scenario runs.	X_____	2447
4-6	Verify that the automated vehicle can detect another vehicle traveling in it's blind spot.	(D)	Successful if the vehicle is detected on 10 consecutive scenario runs. Unsuccessful if there are any false alarms.	X_____	2448
4-7	Verify that upon detection of a vehicle in the blind spot, the driver is warned.	(D)	Successful if driver is warned on 10 consecutive scenario runs.	X_____	2448

APPENDIX 4 - EVOLUTIONARY SCENARIO

4/07/97

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt#
4-8	Verify that the automated vehicles can maintain a spacing of 50 ± 0.5 m with the other vehicle.	(D)	Successful if spacing is maintained for a distance of 3 mi on 10 consecutive scenario runs.	X_____	2449
4-9	Verify that vehicles maintain a spacing of a minimum of 10 meters behind another vehicle whose speed varies between 0 and 25 mph.	(D)	Successful if spacing is maintained for 10 consecutive scenario runs.	X_____	2450
4-10	Verify that a vehicle can detect an obstacle in the roadway.	(D)	Successful if one vehicle detects the obstacle at a distance not less than 100 meters on 10 consecutive scenario runs.	X_____	2452
4.11	Attach a description of the obstacle(s) used.		Record for information.	X _____	2452
4-12	Verify that vehicle can communicate the detection of an obstacle in the roadway to adjacent vehicles.	(D)	Successful if detection information transmitted on 10 consecutive scenario runs.	X_____	2453
4-13	Verify that vehicle can receive information about an obstacle in the roadway from other vehicles.	(D)	Successful if detection information received on 10 consecutive scenario runs.	X_____	2454
4-14	Verify that vehicles can automatically change lanes to avoid an obstacle.	(D)	Successful if lane change maneuver is executed in less than 100 meters on 10 consecutive scenario runs.	X_____	2455, 2445

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt#
4-15	Verify that vehicles can check for the presence and location of adjacent vehicles prior to executing a lane change maneuver.	(D)	Check shall be attempted 20 times with vehicles in various location around the automated vehicle. Successful if vehicle locations are accurately identified 19 times.	X_____	2456
4-16	Verify that vehicles can detect an vehicle in the driver's blind spot.	(D)	Check shall be attempted 20 times, 10 times with vehicles in the blind spots and 10 times without. Successful if obstacles are correctly detected, or not, 19 times.	X_____	2460
4-17	Verify that once a vehicle is detected in the blind spot, the lane change maneuver is delayed until the blind spot is clear.	(D)	Successful if on 10 consecutive scenario runs, the lane change is delayed until the blind spot is clear.	X_____	2461
4-18	Verify that a vehicle can maintain a constant spacing of 20 ± 0.5 m behind another vehicle.	(D)	Successful if one vehicle maintains the spacing for a distance of 3 mi on 10 consecutive scenario runs.	X_____	2457
4-19	Verify that a vehicle can automatically follow another vehicle that is executing a lane change maneuver.	(D)	Successful if both vehicles complete the lane change maneuver on 10 consecutive scenario runs.	X_____	2462
4-20	Verify that during the lane change maneuver, the following vehicle can maintain a spacing of 20 meters ± 0.5 meters.	(D)	.Successful if lane change maneuver is complete while maintaining the appropriate spacing on 10 consecutive scenario runs.	X_____	2462

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt#
4-21	Verify that a vehicle can detect obstacles in two adjoining lanes.	(D)	Successful if one vehicle detects obstacles on two adjoining lanes on 10 consecutive scenario runs.	X_____	2458
4-22	Verify that both vehicles can come to a complete stop to avoid an obstacle when both lanes are obstructed.	(D)	Successful if both vehicles come to an emergency stop on 10 consecutive scenario runs.	X_____	2459

APPENDIX 5 - CONTROL TRANSITION SCENARIO

4/07/97

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt#
5-1	Verify that vehicles can stay in their lane using a vision based lateral control system.	(D)	Successful if both vehicles stay within their lanes on 10 consecutive scenario runs.	X_____	2629
5-2	Verify that vehicles can stay in their lane using a magnetic marker based lateral control system	(D)	Successful if both vehicles stay within their lanes on 10 consecutive scenario runs.	X _____	2630
5-3	Verify that the obstacle can be detected.	(D)	Obstacle successfully detected at a distance not less than 100 meters on 10 consecutive scenario runs.	X_____	2435
5-4	Attach a description of the obstacle(s) used.		Record for information.	X _____	2435
5-5	Verify that the vehicles can execute an automated lane change maneuver.	(D)	Automated lane change maneuver successfully completed on 10 consecutive scenario runs.	X_____	2436
5-6	Verify that the vehicle can detect another vehicle in its path.	(D)	Vehicle successfully detected on 10 consecutive scenario runs.	X_____	2437
5-7	Verify that the vehicles can detect that the vehicle is moving at a slower rate of speed.	(D)	Differential in vehicle speed successfully detected on 10 consecutive scenario runs.	X_____	2437
5-8	Verify that the vehicles can reduce speed to match the slower vehicle.	(D)	Speed successfully reduced on 10 consecutive scenario runs.	X_____	2437

APPENDIX 5 - CONTROL TRANSITION SCENARIO

4/07/97

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt#
5-9	Verify that the vehicles can maintain the spacing with the slower vehicle.	(D)	Spacing successfully maintained 20 ± 0.5 meters over a distance of 3 mi.	X_____	2437
5-10	Verify that vehicles can automatically transition from a vision based lateral control system to a magnetic marker based lateral control system while traveling at a speed of at least 30 mph.	(D)	Control will be successfully transitioned on both vehicles on 10 consecutive scenario runs.	X_____	2438
5-11	Verify that speed can be maintained after transition from a vision based lateral control system to a magnetic marker based lateral control system.	(D)	Successful if speed of 65 ± 2 mph can be maintained for at least 1.5 miles on both vehicles on 10 consecutive scenario runs.	X_____	2439
5-12	Verify that vehicles can reduce spacing to 10 meters ± 0.5 meters.	(D)	Successful if one vehicle can reduce spacing to 10 ± .5 m on 10 consecutive scenario runs.	X_____	2440
5-13	Verify that vehicles can transfer from manual to automated control while in motion.	(D)	Control will be successfully transitioned on both vehicles on 10 consecutive scenario runs.	X_____	2434

APPENDIX 6 - ALTERNATIVE TECHNOLOGY SCENARIO

4/07/97

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt#
6-1	Verify that the vehicle can detect another vehicle in its path.	(D)	Vehicle successfully detected on 10 consecutive scenario runs.	X_____	2443
6-2	Verify that the vehicles can detect that the vehicle is moving at a slower rate of speed.	(D)	Differential in vehicle speed successfully detected on 10 consecutive scenario runs.	X_____	2443
6-3	Verify that the vehicles can reduce speed to match the slower vehicle.	(D)	Speed successfully reduced on 10 consecutive scenario runs.	X_____	2443
6-4	Verify that the vehicles can maintain the spacing with the slower vehicle.	(D)	Spacing successfully maintained at 20 ± 0.5 m over a distance of 3 mi.	X_____	2443
6-5	Verify that vehicles can transition from a radar reflective tape to a vision based lateral control	(D)	Successful of control is transitioned on all vehicles on 10 consecutive scenario runs.	X_____	2441
6-6	Verify that vehicles can transition from vision based to radar reflective lateral control.	(D)	Successful of control is transitioned on all vehicles on 10 consecutive scenario runs.	X_____	2442
6-7	Verify that the vehicles and execute a lane change maneuver.	(D)	Successful if vehicle can automatically execute a lane change maneuver on 10 consecutive scenario runs.	X_____	2444

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt#
6-8	Verify that vehicles can determine when it is safe to execute a second lane change maneuver.	(D)	Successful if vehicle can determine that it is safe to change lanes again on 10 consecutive scenario runs.	X_____	2444
6-9	Verify that the vehicles can execute a lane change maneuver in the opposite direction.	(D)	Successful if vehicle can automatically execute a lane change maneuver on 10 consecutive scenario runs.	X_____	2444

APPENDIX 7 - TRUCK SCENARIO

4/07/97

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt#
7-1	Verify that the truck can detect a vehicle which cuts in front of the truck at approximately 50 meters.	(D)	Successful if vehicle detected on 10 consecutive scenario runs.	X_____	2599
7-2	Verify that once a vehicle is detected, the truck can maintain a spacing behind the vehicle of 2 or more seconds.	(D)	Successful if after truck to vehicle spacing is adjusted and maintained 2 or more seconds on 10 consecutive scenario runs.	X_____	2600
7-3	Verify that the truck can determine the closing speed and distance, between itself and a vehicle which cuts in front of it is too rapid.	(D)	Successful if driver is alerted on 10 consecutive scenario runs. scenario runs.	X_____	2601
7-4	Verify when the closing speed and distance are gradual, the truck can determine of the closing speed is safe.	(D)	Successful if the driver receives the correct alert on 10 consecutive scenario runs.	X_____	2601
7-5	Verify that if the closing speed is unsafe, the driver is warned of an unsafe condition.	(D)	Successful if warning is accurately activated on 10 consecutive scenario runs.	X_____	2601
7-6	Verify that the truck can detect slower moving vehicles in the same lane at a range of 200 feet.	(D)	Successful if slower vehicle is detected at a range of 200 feet on 10 consecutive scenario runs. Truck speed will be 50 mph. Slow vehicle will drive at 40 mph.	X_____	2602

APPENDIX 7 - TRUCK SCENARIO

4/07/97

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt#
7-7	Verify that the truck alerts the driver that the closing speed and distance, between itself and another vehicle in front of it is too rapid	(D)	Successful if driver is alerted on 10 consecutive scenario runs with speed differential of 10 mph	X_____	2603
7-8	Verify that once the speed and distance are determined, the truck can determine of the closing speed is safe.	(D)	Successful if driver receives correct alert on 10 consecutive scenario runs.	X _____	2603
7-9	Verify that if the closing speed is unsafe, the driver is warned of an unsafe condition.	(D)	Successful if warning is accurately activated on 10 consecutive scenario runs.	X _____	2603
7-10	Verify that the truck can detect a stopped vehicle in the same lane of travel at approximately 200 feet.	(D)	Successful if stopped vehicle is detected on 10 consecutive scenario runs.	X_____	2604
7-11	Verify that once the stopped vehicle is detected, the truck can provide a warning to the driver.	(D)	Successful if driver is warned of stopped vehicle at a distance approximately 200 feet on 10 consecutive scenario runs.	X_____	2605
7-12	Verify that the truck can set a spacing 2 or more seconds behind a slower moving vehicle.	(D)	Successful if spacing is set spacing 2 or more seconds on 10 consecutive scenario runs.	X_____	2606

Step	Procedure	Method	Pass/Fail Criteria	Results	Rqmt#
7-13	Verify that the truck can maintain a set spacing behind another vehicle.	(D)	Successful if truck maintains spacing on 10 consecutive scenario runs.	X_____	2606
7-14	Verify that the truck can disengage from "following mode" operation when the lead vehicle accelerate to speed beyond truck's cruise control set speed.	(D)	Successful if truck switches from "following mode" operations to cruise control on 10 consecutive scenario runs.	X_____	2607
7-15	Verify that the truck can maintain a constant speed of approximately 50 mph.	(D)	Successful if speed is maintained for a distance of 6 miles.	X_____	2612
7-16	Verify that the truck can maintain a spacing of spacing 2 or more seconds behind another vehicle.	(D)	Successful if headway is maintained for a distance of 6 miles.	X_____	2613