Appendices

Appendix A. Instrumentation..... A-1

Appendix B. Shakedown Testing B-1

Appendix C. Database Information, Channel Descriptions, and Validation Information C-1

Appendix D. Quality Control Checklists (Including Final Checkout and Decommissioning).. D-1

Appendix E. Surveys E-1

Appendix F. Training Materials on Enabled Technologies F-1

APPENDIX A. INSTRUMENTATION

The pilot tractors and trailers were instrumented with modified versions of data acquisition systems (DAS) developed by the Aberdeen Test Center for use in a prior FOT. The two types of DAS utilized in this project are the "full DAS," which is installed on all tractors and all Template 2 trailers, and the "mini-DAS," which is installed on all Template 3 trailers.

The key differences between the full DAS and the mini-DAS are that the full DAS is capable of operating as a standalone device (meaning it does not need to be connected to another full DAS or mini-DAS) that contains a processor board and PCMCIA card for storing data collected from the vehicles. The mini-DAS is not a standalone device and must be connected to a full DAS since the mini-DAS does not have a processor board or storage media. The mini-DAS is used on Template 3 vehicles because the tractors and trailers are matched during the FOT, allowing a single tractor-based full DAS unit to collect data for both the tractor and trailer unit vehicles. The mini-DAS digitizes the data collected from analog sensors located on the Template 3 trailer and transmits the data to the tractor-based DAS unit for storage. The two types of DAS boxes are described in greater detail in the sections that follow.

Full DAS

The Full DAS hardware consists of a 486 PC/104 form factor computer with data acquisition and communications interfaces. The computer utilizes a real-time operating system and stores the application program and data in solid state media. The full DAS consists of the following key hardware components:

- Rugged aluminum enclosure suitable for operation on heavy commercial vehicles
- Electronically programmable ROM to store the data acquisition software/algorithms
- Processor card with Controller Area Network interface module (CAN, J1939, J1708, J1587) design to communicate between the PC/104 hardware and the vehicle
- 16 channel A/D card with integrated 2-axis accelerometer and analog to digital converter
- Gyro card
- Serial port communications card with Ethernet
- Removable solid-state storage device (PCMCIA card)
- 8-16 Mb of RAM for data storage buffers
- Power supply card
- Uninterruptible power supply card
- Battery unit
- Two RS232 I/O ports
- Video subsystem.
- Receptacles to accommodate input power, data bus inputs, analog sensor inputs, digital inputs, GPS inputs, as well as serial and Ethernet user diagnostic connections.

The full DAS receives data from standard vehicle data buses, technology-specific data, and other analog and digital sources:

- The SAE J1939 data bus is used for acquisition of ECBS fault codes and vehicle dynamic data from the Engine Control Unit (e.g., vehicle road speed, throttle and brake percentages)
- The SAE J1708 data bus provides vehicle and driver identification data (e.g., VIN) as well as fault codes
- The SAE J1587 data bus is a subset of J1708, which enables data interchange between the broadcast and diagnostic information between electronic devices
- The radar technology data bus transmits the relevant information pertaining to the braking system as collected by the ECBS subsystem
- The ABS data bus transmits the ABS parameters
- The GPS receiver provides vehicle location information as well as the corresponding time stamp for the data collected on-board the vehicle
- Analog sensors such as accelerometers, yaw rate sensors, wheel speed sensors, pressure transducers, and steering angle sensors provide vehicle dynamic information not available on data buses
- Digital signals can be provided from various truck components, including high beams, low beams, turn signals, and windshield wipers.

The data were acquired at a fixed sampling rate of 10 Hz. The data were stored in the form of multiple blob (binary large object[1]) files, each containing up to 10 minutes of onboard driving data.

Mini-DAS

The mini-DAS contains a PC/104 card stack which does not contain a processor board or means for storing data. The mini-DAS is comprised of the following key hardware components:

- Rugged aluminum enclosure suitable for operation on heavy commercial vehicles
- 16 channel A/D card with integrated 2-axis accelerometer
- Gyro card
- Serial port communications card
- Power supply card
- Receptacles to accommodate input power, analog sensor inputs, and digital signals that provide the trailer ID.

The mini-DAS receives data from analog sensors installed on the Template 3 trailers. Accelerometers, yaw rate sensors, pressure transducers, and wheel speed sensors provide vehicle dynamic information, which is digitized and transmitted to the tractor-mounted full DAS. The mini-DAS also provides the tractor-mounted full DAS with the trailer ID, which is hard-wired into a connector attached to one of the mini-DAS receptacles.

[1] Binary Large Object, used to refer to a variable or file in which a large block of data of non-universal/standard structure is stored. Usually only the system that creates the file knows the definition of the structure used to interpret the data contained.

APPENDIX B. SHAKEDOWN TESTING

Freightliner ECBS Pilot Vehicle Shakedown Test Outline

June 28, 2004

As described in the Freightliner ECBS FOT Test Plan, the FOT pilot tractors and trailers will be subjected to a series of basic driving tests to confirm that, when placed in operational environments, the Wal★Mart vehicles will perform safely and reliably. These tests will be conducted with instrumented vehicles to also demonstrate that the onboard DAS performs as required and that data collected will meet the needs of the IE for analysis.

FOT Shakedown Testing

To demonstrate the vehicle suitability for Wal★Mart operations and to ensure that valid data are collected for the FOT, Freightliner will conduct vehicle shakedown testing and data collections under representative service conditions. This testing will be performed on different combinations of tractors and trailers equipped with FOT technologies to verify functional compatibility. These tests will include general driving, and cross-country shakedown testing. In addition, Freightliner will verify braking functionality and compatibility through pneumatic timing, pressure balance, stopping distance, ABS activation and brake temperature balance tests.

Vendor Shakedown Testing

In addition, brake system suppliers plan to conduct additional functionality testing to demonstrate activation and performance of the FOT advanced systems such as RSS, TRSP and ESC. The vendors anticipate conducting this testing as part of their validation and due diligence in delivering these new technologies to Freightliner and the marketplace. Freightliner has requested the opportunity to participate in these tests as part of vendor support of the FOT and to allow selected vehicles to be instrumented. Data collected from FOT DAS during these tests will be used as a reference for the FOT. Data collected by the vendors will be shared to the extent possible with the US DOT and the IE, but are not part of the FOT.

Purpose and Types of Tests

Shakedown testing of FOT pilot tractors and trailers is needed for the following purposes:

1. Safety/fit-for-service: Ensure Wal★Mart FOT vehicles are fit-for-service in the operational environment. These are basic driving tests to confirm performance in normal driving maneuvers (also referred to as compatibility testing or Freightliner acceptance testing)
2. Safety/functionality: Ensure that the systems perform as designed and intended. These are tests designed to activate the safety systems and verify their functionality. The systems have been shown to function independently, but this testing is intended to ensure compatibility between “mixed” vehicles equipped with different systems.

3. FOT data verification: Ensure that the onboard DAS performs as needed, that is:
   a. DAS and Sensors are functioning properly and generating valid data
   b. Data collected will meet IE needs for analysis (data rates, data resolution, etc.)

Five types of shakedown tests are planned by the Freightliner Team. Test Type 1 supports the FOT by shakedown of the DAS and instrumentation systems. Test Type 2 represent normal Freightliner acceptance testing for new braking systems. Tests 3 through 5 are vendor functionality tests to demonstrate activation and performance of the FOT advanced systems. A more detailed overview of each test, describing the purpose, acceptance criteria, test configurations and vehicles to be tested is provided in Appendix A of this document.

1. Freightliner Team acceptance
   a. General driving (typical representative driving conditions)
   b. Cross-country shakedown (typical representative driving conditions)
2. Braking functionality:
   a. Pneumatic timing/pressure balance
   b. Stopping distance
   c. ABS activation tests
   d. Brake temperature balance
3. Roll stability functionality:
   a. Roll stability systems verification (ESC, RSC, RSS, TRSP)
4. Yaw stability functionality:
   a. Yaw stability system verification (ESC)
5. ACC functionality:
   a. Adaptive Cruise Control system verification (ACC)

Vehicle Combinations to be Tested

The Freightliner Team developed its test plan to demonstrate new technologies being introduced in this program and to verify their functional compatibility when paired with each other and when paired with existing systems.

APPENDIX C. DATABASE INFORMATION, CHANNEL DESCRIPTIONS, AND VALIDATION INFORMATION

Database Information

Battelle purchased a Dell PowerEdge 2650 – 2004 Server using the Microsoft Windows operating system for the ECBS project. The specifics for the server are

- Processors – Dual 3.06 GHz Xeon (80532)
- Memory – 2 GB of RAM
- Operating System Storage – 35 GB (two 35 GB disks in a RAID 1 array)
- Data Storage – 1.1 TB (nine 146 GB disks in a RAID 5 array)
- Backup – Autoloader removable media backup system.

This server proved to be adequate for the data that was collected during the FOT. A fast compression routine was also employed to minimize the blob storage requirements.

Channel Descriptions

There were many on board driving channels collect on the tractors and trailers. The Data Acquisition System (DAS) developed by the Aberdeen Test Center (ATC) collected and recorded the data on PCMCIA cards for later transfer and processing. Loaded on each DAS was a configuration file which acted as a set of commands for the DAS to record data. The same configuration files also gave instructions to the blob decoding algorithms when the data were processed. There were multiple configuration files installed on the tractors over the course of the FOT; however, they all had common elements. When the blob is decoded into CSV format, there are two parts to the file. The first part is header information or metadata, the second part is a list of the records. For a 10 minute blob, 6000 records are expected (10 min * 60 sec * 10 Hz), creating a table with 6000 rows. The columns of the table correspond to each recorded channel. Most channels are recorded in engineering units in the CSV file. However, some channels are not decoded and are left in hexadecimal format. These hexadecimal values, called words, can include multiple individual channels than can be deparsed at a later time.

Tables C-1, C-2, and C-3 give the channel information from those configuration files for T2 tractors, T3 tractors, and T2 trailers respectively. The following is a description of the columns in each table.

Column Header	The column heading listed in the decoded CSV format of the blob.
Column Header Unit	The engineering units for the values in the CSV format of the blob.

Source Unit	The engineering units according to the J1939-71 specification. The configuration file details the conversion from the Source Unit to the CSV unit.
Summary Statistics	An X indicates that summary statistics were generated by Battelle while processing the data. The summary statistics include the maximum, minimum, and average for value type channels (road speed) and a number and percentage of time of occurrences for even type channels (ACC activation).
Validation Performed	An X indicates that the values in the channel were range checked, or, if the channel was digital, that the digital code was checked for an error condition.
T2C1, T2C2, T2C4, T2C3	An X in these columns indicate that a particular channel was available on that template tractor or trailer. Table XX.2 does not contain these columns because it only describes T3 tractors.
Source Name	The J1939-71 or 73 name for the channel.
Source	The source of the channel.
Codes	The J1939-71, 73, or J1587 parameter group numbers (pgn) and suspect parameter numbers (spn).
Remarks	Gives amplifying information about a particular channel. For some analog channels, the decoding information. For analog signals, the signal is analog signal is converted to a digital signal before it is recorded. The digital signal is then decoded into engineering units using the conversion listed in the remarks.
Post Processing	This channel indicates the length of time used for the moving average applied to the channel before summary statistics were calculated.

Also included in the blobs were metadata information. The metadata was plain text information which could be read to determine the tractor to which the blob belonged, the time and the odometer values that the blob covers, and the spatial location of the blob. The information contained in the metadata is detailed in Tables C-4 through C-6 for T2 tractors, T3 tractors, and T2 trailers respectively.

Table C-1. T2 Tractor Channel Description

For complete descriptions of each channel, see the applicable source entry specification (e.g. J1939-71). For a description of the validation ranges, see the applicable Validation Configuration File

Column Header	Column Header Unit	Source Unit	Calculated Summary Statistics	Validation Performed	ABS			EBS	Source Name	Source	Codes	Remarks	Post Processing Performed
					T2C1	T2C2	T2C4	T2C3					
Relative Time	Sec		X		X	X	X	X		DAS			
HH:MM:SS	HH:MM:SS		X		X	X	X	X		GPS (Analog)			
GPS Lat (long)	deg		X	X	X	X	X	X		GPS (Analog)			
GPS Long (long)	deg		X	X	X	X	X	X		GPS (Analog)			
GPSAlti (long)	ft	m	X	X	X	X	X	X		GPS (Analog)			
Road Speed	ft/s	km/h	X	X	X	X	X	X	Wheel-Based Vehicle Speed	J1939-71	pgn65265, spn84		0.5 sec moving average
% Throttle	%	%	X	X	X	X	X	X	Accelerator Pedal Position 1	J1939-71	pgn61443, spn91		
% Engine Torque	%	%	X	X	X	X	X	X	Actual Engine - Percent Torque	J1939-71	pgn61444, spn513		
Engine Speed	rpm	rpm	X	X	X	X	X	X	Engine Speed	J1939-71	pgn61444, spn190		0.5 sec moving average
CC_SW1			X		X	X	X	X		J1939-71	pgn65265		
									Cruise Control Active	J1939-71	spn595		
									Cruise Control Enable Switch	J1939-71	spn596		
									Brake Switch	J1939-71	spn597		
									Clutch Switch	J1939-71	spn598		
FrontRsRelWhlSpd	ft/s	km/hr	X		X	X	X	X	Relative Speed; Front Axle, Left Wheel	J1939-71	pgn65215, spn905		1.0 sec moving average
FrontCsRelWhlSpd	ft/s	km/hr	X		X	X	X	X	Relative Speed; Front Axle, Right Wheel	J1939-71	pgn65215, spn906		1.0 sec moving average
MidRsRelWhlSpd	ft/s	km/hr	X		X	X	X		Relative Speed; Rear Axle #1, Left Wheel	J1939-71	pgn65215, spn907		1.0 sec moving average
MidCsRelWhlSpd	ft/s	km/hr	X		X	X	X		Relative Speed; Rear Axle #1, Right Wheel	J1939-71	pgn65215, spn908		1.0 sec moving average
RearRsRelWhlSpd	ft/s	km/hr	X		X	X	X	X	Relative Speed; Rear Axle #2, Left Wheel	J1939-71	pgn65215, spn909		1.0 sec moving average
RearCsRelWhlSpd	ft/s	km/hr	X		X	X	X	X	Relative Speed; Rear Axle #2, Right Wheel	J1939-71	pgn65215, spn910		1.0 sec moving average
RsFrontPress	psi		X	X	X	X	X	X		Analog		-200.74 offset, 0.08895 multiplier	1.0 sec moving average
CsFrontPress	psi		X	X	X	X	X	X		Analog		-200.74 offset, 0.08895 multiplier	1.0 sec moving average
RsIntermPress	psi		X	X	X	X	X	X		Analog		-200.74 offset, 0.08895 multiplier	1.0 sec moving average
CsIntermPress	psi		X	X	X	X	X	X		Analog		-200.74 offset, 0.08895 multiplier	1.0 sec moving average
RsRearPress	psi		X	X	X	X	X	X		Analog		-200.74 offset, 0.08895 multiplier	1.0 sec moving average
CsRearPress	psi		X	X	X	X	X	X		Analog		-200.74 offset, 0.08895 multiplier	1.0 sec moving average

Table C-1. T2 Tractor Channel Description (continued)

Column Header	Column Header Unit	Source Unit	Calculated Summary Statistics	Validation Performed	ABS			EBS	Source Name	Source	Codes	Remarks	Post Processing Performed
					T2C1	T2C2	T2C4	T2C3					
AirCompressor	psi		X	X	X	X	X	X		Analog		-200.74 offset, 0.08895 multiplier	1.0 sec moving average
AirBag	psi		X	X	X	X	X	X		Analog		-200.74 offset, 0.08895 multiplier	1.0 sec moving average
TrlProtValve	psi		X	X	X	X	X	X		Analog		-200.74 offset, 0.08895 multiplier	1.0 sec moving average
Treadle Valve			X		X	X	X			Analog		-200.74 offset, 0.08895 multiplier	1.0 sec moving average
AnalogSteerAngle	deg				X	X	X			Analog			1.0 sec moving average
J1939SteerAngle	rad		X	X				X		J1939-71	pgn61449		-204.83 Offset
									Steering Wheel Angle	J1939-71	spn1807	1/1024 rad/bit, -28.2942 rad offset (J1939-71 spec calls for 1/1024 rad/bit and -31.374 rad offset)	
									Steering Wheel Turn Counter	J1939-71	spn1811	1 counts/bit x 2(3.1416) rad/turn = 6.283 rad/bit	
F/A DC	g's		X	X	X	X	X	X		DAS (Analog)		-0.00128 multiplier, 5.28 offset	1.0 sec moving average
Lat DC	g's		X	X	X	X	X	X		DAS (Analog)		0.00128 multiplier, -2.64 offset	1.0 sec moving average
YawRate	deg/s		X	X	X	X	X	X		DAS (Analog)		0.03861 multiplier, -80 offset	1.0 sec moving average
Wipers/Lights			X		X	X	X	X		DAS (Digital)			
									High Beams	DAS (Digital)		Bit 1, 1 bit, 0 = on, 1 = off	
									Low Beams	DAS (Digital)		Bit 2, 1bit, 0 = on, 1 = off	
									Left Turn Signal	DAS (Digital)		bit 3, 1 bit, 0 = on, 1 = off	
									Right Turn Signal	DAS (Digital)		Bit 4, 1 bit, 0 = on, 1 = off	
									Windshield Wipers	DAS (Digital)		Bit 5 - 8, 4 bits, 0000 = on, 1111 = off, all others invalid	
RSInterWheelSpeed	ft/s		X					X		DAS Counter		1.016 multiplier	1.0 sec moving average
CSInterWheelSpeed	ft/s		X					X		DAS Counter		1.016 multiplier	1.0 sec moving average
Tgt Range	ft	m	X	X	X	X	X	X	Distance to Forward Vehicle	J1939-71	pgn65135, spn1587	0 to 250m, 0xFF (255) - No Target, Validation Based On TgtDetect/Alerts	
Tgt RangeRate	ft/s	km/hr	X	X	X	X	X	X	Forward Vehicle Speed	J1939-71	pgn65135, spn1586	0 to 250 km/h, 0xFF (255) - No Target, Validation Based On TgtDetect/Alerts - Channel is Forward Vehicle Speed, not Target Range Rate as the Column Header suggests	
Tgt Azimuth	deg	deg	X	X	X	X	X	X	Target Azimuth	J1939-71	pgn65135	Byte 5 of the ACC1 word	

Table C-1. T2 Tractor Channel Description (continued)

Column Header	Column Header Unit	Source Unit	Calculated Summary Statistics	Validation Performed	ABS			EBS	Source Name	Source	Codes	Remarks	Post Processing Performed
					T2C1	T2C2	T2C4	T2C3					
TgtDetect/Alerts					X	X	X	X		J1939-71	pgn65135		
			X	X					ACC Target Detected	J1939-71	spn1798	00 No Target, 01 Target Detected, 10 Reserved, 11 Take No Action	
			X	X					ACC System Shutoff Warning	J1939-71	spn1797	00 ACC SSOW Not Active, 01 ACC SSOW Active, 10 Reserved, 11 Take no action	
			X	X					ACC Distance Alert Signal	J1939-71	spn1796	00 ACC DAS Not Active, 01 ACC DAS Active, 10 Reserved, 11 Take no action	
ACC System Error			X		X	X	X	X	ACC System Error	J1939-71	pgn65135	Byte 5 of the ACC1 word	
ESC_VDC1								X		J1939-71	pgn65103		
									VDC Information	J1939-71	spn1813		
			X	X					VDC fully operational	J1939-71	spn1814		
									VDC brake light request	J1939-71	spn1815		
									ROP engine control active	J1939-71	spn1816		
									ROP Brake control active	J1939-71	spn1818		
									YC engine control active	J1939-71	spn1817		
									YC brake control active	J1939-71	spn1819		
XBR								X		J1939-71	pgn1024		
			X	X					Requested deceleration (External acceleration demand)	J1939-71	spn2920		0.00048828125 Multipler
									EBI Mode	J1939-71	spn2914		
									Control priority	J1939-71	spn2915		
									Control Mode	J1939-71	spn2916		
ERC1_1 (long)					X	X	X	X		J1939-71	pgn61440		
									Retarder Torque Mode	J1939-71	spn900		
									Retarder Enable - Brake Assist Switch	J1939-71	spn571		
									Retarder Enable - Shift Assist Switch	J1939-71	spn572		
									Actual Retarder - % Torque	J1939-71	spn520		
									Intended Retarder Percent Torque	J1939-71	spn1085		
									Engine Coolant Load Increase	J1939-71	spn1082		
									Retarder Requesting Brake Light	J1939-71	spn1667		
									Source Address of Controlling Device for Retarder Control	J1939-71	spn1480		
									Drivers Demand Retarder - Percent Torque	J1939-71	spn1715		
									Retarder Selection, non-engine	J1939-71	spn1716		
									Actual Maximum Available Retarder - Percent Torque	J1939-71	spn1717		

Table C-1. T2 Tractor Channel Description (continued)

Column Header	Column Header Unit	Source Unit	Calculated Summary Statistics	Validation Performed	ABS			EBS	Source Name	Source	Codes	Remarks	Post Processing Performed
					T2C1	T2C2	T2C4	T2C3					
EBC1_1 (long_					X	X	X	X		J1939-71	pgn61441		
									ATC engine control active (ASR engine control active)	J1939-71	spn561		
									ATC brake control active (ASR brake control active)	J1939-71	spn562		
									ABS active	J1939-71	spn563		
									EBS Brake Switch	J1939-71	spn1121	Valid on T2C3 Only	
			X	X					Brake pedal position	J1939-71	spn521	Valid on T2C3 Only	0.4 Multiplier
									ABS Off road switch	J1939-71	spn575		
									ATC Off road switch (ASR offroad switch)	J1939-71	spn576		
									Accelerator Interlock Switch	J1939-71	spn972	Valid on T2C3 Only	
									Engine Derate Switch	J1939-71	spn971	Valid on T2C3 Only	
									Auxiliary Engine Shutdown Switch	J1939-71	spn970	Valid on T2C3 Only	
									Remote Accelerator Enable Switch	J1939-71	spn969	Valid on T2C3 Only	
									Engine Retarder Selection	J1939-71	spn973	Valid on T2C3 Only	
			X	X					ABS fully operational	J1939-71	spn1243		
									EBS red warning lamp status	J1939-71	spn1439	Valid on T2C3 Only	
									ABS/EBS amber warning lamp	J1939-71	spn1438		
									ATC/ABS lamp status	J1939-71	spn1793		
									Source Address of Controlling Device for Brake Control	J1939-71	spn1481	Valid on T2C3 Only	
			X	X					ABS trailer warning lamp state (Tractor-Mounted Trailer ABS Warning Signal)	J1939-71	spn1792		
Brake Pressures					X	X	X	X		J1939-71	pgn65197		
									Brake Application Pressure High Range, Front Axle, Left Wheel	J1939-71	spn1091		
									Brake Application Pressure High Range, Front Axle, Right Wheel	J1939-71	spn1092		
									Brake Application Pressure High Range, Rear Axle #1, Left Wheel	J1939-71	spn1093		
									Brake Application Pressure High Range, Rear Axle #1, Right Wheel	J1939-71	spn1094		
									Brake Application Pressure High Range, Rear Axle #2, Left Wheel	J1939-71	spn1095		
									Brake Application Pressure High Range, Rear Axle #2, Right Wheel	J1939-71	spn1096		
									Brake Application Pressure High Range, Rear Axle #3, Left Wheel	J1939-71	spn1097		
									Brake Application Pressure High Range, Rear Axle #3, Right Wheel	J1939-71	spn1098		

Table C-1. T2 Tractor Channel Description (continued)

Column Header	Column Header Unit	Source Unit	Calculated Summary Statistics	Validation Performed	ABS			EBS	Source Name	Source	Codes	Remarks	Post Processing Performed
					T2C1	T2C2	T2C4	T2C3					
Brake_Lining					X	X	X	X		J1939-71	pgn65196		
									Brake Lining Remaining, Front Axle, Left Wheel	J1939-71	spn1099		
									Brake Lining Remaining, Front Axle, Right Wheel	J1939-71	spn1100		
									Brake Lining Remaining, Rear Axle #1, Left Wheel	J1939-71	spn1101		
									Brake Lining Remaining, Rear Axle #1, Right Wheel	J1939-71	spn1102		
									Brake Lining Remaining, Rear Axle #2, Left Wheel	J1939-71	spn1103		
									Brake Lining Remaining, Rear Axle #2, Right Wheel	J1939-71	spn1104		
									Brake Lining Remaining, Rear Axle #3, Left Wheel	J1939-71	spn1105		
									Brake Lining Remaining, Rear Axle #3, Right Wheel	J1939-71	spn1106		
Diagnostic					X	X	X			J1939-73			
			X	X					Malfunction Indicator Lamp Status	J1939-73	DM1, 5.7.1.1, spn1213		
									Red Stop Lamp Status	J1939-73	DM1, 5.7.1.2, spn623		
									Amber Warning Lamp Status	J1939-73	DM1, 5.7.1.3, spn624		
									Protect Lamp Status	J1939-73	DM1, 5.7.1.4, spn987		
									8 least significant bits of SPN (most significant at bit 8)	J1939-73	DM1, 5.7.1.5, spn1214		
									Second byte of SPN (most significant at bit 8)	J1939-73	DM1, 5.7.1.5, spn1214		
									SPN, 3 most significant bits (most significant at bit 8)	J1939-73	DM1, 5.7.1.5, spn1214		
			X	X					Failure Mode Identifier (most significant at bit 5)	J1939-73	DM1, 5.7.1.6, spn1215		
									SPN Conversion Method	J1939-73	DM1, 5.7.1.7, spn1706		
									Occurrence Count	J1939-73	DM1, 5.7.1.8, spn1216		
TSC1					X	X	X			J1939-71	pgn0		
									Override control mode	J1939-71	spn695		
									Requested Speed Control Conditions	J1939-71	spn696		
									Override control mode priority	J1939-71	spn897		
			X	X					Requested Speed/Speed Limit	J1939-71	spn898		0.125 Multiplier
			X	X					Requested torque/torque limit	J1939-71	spn518		-125 Offset
MD1 EBS								X		Wabco		Proprietary Channel	
MD2 EBS								X		Wabco		Proprietary Channel	
RSC/VDC					X	X				J1587			
									RSC/VDC engine control active	J1587	MID 88 PID 97		
									RSC/VDC brake control active	J1587	MID 88 PID 97		

Table C-1. T2 Tractor Channel Description (continued)

Column Header	Column Header Unit	Source Unit	Calculated Summary Statistics	Validation Performed	ABS			EBS	Source Name	Source	Codes	Remarks	Post Processing Performed
RSA					X	X				J1587			
									RSA level 1	J1587	MID 88 PID E2		
									RSA level 2	J1587	MID 88 PID E2		
									RSA level 3	J1587	MID 88 PID E2		
ACC_Mode - Adaptive Cruise Control Mode			X	X	X	X		X	Adaptive Cruise Control Mode	J1939-71	spn1590		
ACC_Mode -Set Distnace Mode			X	X	X	X		X	Adaptive Cruise Control Set Distance Mode	J1939-71	spn1589		

Table C-2. T3 Tractor Channel Description

For complete descriptions of each channel, see the applicable source entry specification (e.g. J1939-71). For a description of the validation ranges, see the applicable Validation Configuration File

Column Header	Column Header Unit	Source Unit	Calculated Summary Statistics	Validation Performed	Source Name	Source	Codes	Remarks	Post Processing Performed
Relative Time	Sec		X			DAS			
HH:MM:SS	HH:MM:SS		X			GPS (Analog)			
GPS Lat (long)	deg		X	X		GPS (Analog)			
GPS Long (long)	deg		X	X		GPS (Analog)			
GPSAlti (long)	ft	m	X	X		GPS (Analog)			
Road Speed	ft/s	km/h	X	X	Wheel-Based Vehicle Speed	J1939-71	pgn65265, spn84		0.5 sec moving average
% Throttle	%	%	X	X	Accelerator Pedal Position 1	J1939-71	pgn61443, spn91		
% Engine Torque	%	%	X	X	Actual Engine - Percent Torque	J1939-71	pgn61444, spn513		
Engine Speed	rpm	rpm	X	X	Engine Speed	J1939-71	pgn61444, spn190		0.5 sec moving average
CC_SW1			X			J1939-71	pgn65265		
					Cruise Control Active	J1939-71	spn595		
					Cruise Control Enable Switch	J1939-71	spn596		
					Brake Switch	J1939-71	spn597		
					Clutch Switch	J1939-71	spn598		
FrontRsRelWhlSpd	ft/s	km/hr	X		Relative Speed; Front Axle, Left Wheel	J1939-71	pgn65215, spn905		1.0 sec moving average
FrontCsRelWhlSpd	ft/s	km/hr	X		Relative Speed; Front Axle, Right Wheel	J1939-71	pgn65215, spn906		1.0 sec moving average
RearRsRelWhlSpd	ft/s	km/hr	X		Relative Speed; Rear Axle #2, Left Wheel	J1939-71	pgn65215, spn909		1.0 sec moving average
RearCsRelWhlSpd	ft/s	km/hr	X		Relative Speed; Rear Axle #2, Right Wheel	J1939-71	pgn65215, spn910		1.0 sec moving average
RsFrontPress	psi		X	X		Analog		-200.74 offset, 0.08895 multiplier	1.0 sec moving average
CsFrontPress	psi		X	X		Analog		-200.74 offset, 0.08895 multiplier	1.0 sec moving average
RsIntermPress	psi		X	X		Analog		-200.74 offset, 0.08895 multiplier	1.0 sec moving average
CsIntermPress	psi		X	X		Analog		-200.74 offset, 0.08895 multiplier	1.0 sec moving average
RsRearPress	psi		X	X		Analog		-200.74 offset, 0.08895 multiplier	1.0 sec moving average
CsRearPress	psi		X	X		Analog		-200.74 offset, 0.08895 multiplier	1.0 sec moving average
AirCompressor	psi		X	X		Analog		-200.74 offset, 0.08895 multiplier	1.0 sec moving average
AirBag	psi		X	X		Analog		-200.74 offset, 0.08895 multiplier	1.0 sec moving average
TrlProtValve	psi		X	X		Analog		-200.74 offset, 0.08895 multiplier	1.0 sec moving average
J1939SteerAngle	rad		X	X		J1939-71	pgn61449		10 Multiplier, -204.8 offset
					Steering Wheel Angle	J1939-71	spn1807	1/1024 rad/bit, -28.2942 rad offset (J1939-71 spec calls for 1/1024 rad/bit and -31.374 rad offset)	
					Steering Wheel Turn Counter	J1939-71	spn1811	1 counts/bit x 2(3.1416) rad/turn = 6.283 rad/bit	
F/A DC	g's		X	X		DAS (Analog)		-0.00128 multiplier, 5.28 offset	1.0 sec moving average
Lat DC	g's		X	X		DAS (Analog)		0.00128 multiplier, -2.64 offset	1.0 sec moving average
YawRate	deg/s		X	X		DAS (Analog)		0.03861 multiplier, -80 offset	1.0 sec moving average

Table C-2. T3 Tractor Channel Description (continued)

Column Header	Column Header Unit	Source Unit	Calculated Summary Statistics	Validation Performed	Source Name	Source	Codes	Remarks	Post Processing Performed
Wipers/Lights			X			DAS (Digital)			
					High Beams	DAS (Digital)		Bit 1, 1 bit, 0 = on, 1 = off	
					Low Beams	DAS (Digital)		Bit 2, 1bit, 0 = on, 1 = off	
					Left Turn Signal	DAS (Digital)		bit 3, 1 bit, 0 = on, 1 = off	
					Right Turn Signal	DAS (Digital)		Bit 4, 1 bit, 0 = on, 1 = off	
					Windshield Wipers	DAS (Digital)		Bit 5 - 8, 4 bits, 0000 = on, 1111 = off, all others invalid	
RSInterWheelSpeed	ft/s		X			DAS Counter		1.016 multiplier	1.0 sec moving average
CSInterWheelSpeed	ft/s		X			DAS Counter		1.016 multiplier	1.0 sec moving average
Tgt Range	ft	m	X	X	Distance to Forward Vehicle	J1939-71	pgn65135, spn1587	0 to 250m, 0xFF (255) - No Target, Validation Based On TgtDetect/Alerts	
Tgt RangeRate	ft/s	km/hr	X	X	Forward Vehicle Speed	J1939-71	pgn65135, spn1586	0 to 250 km/h, 0xFF (255) - No Target, Validation Based On TgtDetect/Alerts - Channel is Forward Vehicle Speed, not Target Range Rate as the Column Header suggests	
Tgt Azimuth	deg	deg	X	X	Target Azimuth	J1939-71	pgn65135	Byte 5 of the ACC1 word	
TgtDetect/Alerts						J1939-71	pgn65135		
			X	X	ACC Target Detected	J1939-71	spn1798	00 No Target, 01 Target Detected, 10 Reserved, 11 Take No Action	
			X	X	ACC System Shutoff Warning	J1939-71	spn1797	00 ACC SSOW Not Active, 01 ACC SSOW Active, 10 Reserved, 11 Take no action	
			X	X	ACC Distance Alert Signal	J1939-71	spn1796	00 ACC DAS Not Active, 01 ACC DAS Active, 10 Reserved, 11 Take no action	
ACC System Error			X		ACC System Error	J1939-71	pgn65135	Byte 5 of the ACC1 word	
ESC_VDC1						J1939-71	pgn65103		
					VDC Information	J1939-71	spn1813		
			X	X	VDC fully operational	J1939-71	spn1814		
					VDC brake light request	J1939-71	spn1815		
					ROP engine control active	J1939-71	spn1816		
					ROP Brake control active	J1939-71	spn1818		
					YC engine control active	J1939-71	spn1817		
					YC brake control active	J1939-71	spn1819		
XBR						J1939-71	pgn1024		
			X	X	Requested deceleration (External acceleration demand)	J1939-71	spn2920		0.00048828125 Multipler
					EBI Mode	J1939-71	spn2914		
					Control priority	J1939-71	spn2915		
					Control Mode	J1939-71	spn2916		

Table C-2. T3 Tractor Channel Description (continued)

Column Header	Column Header Unit	Source Unit	Calculated Summary Statistics	Validation Performed	Source Name	Source	Codes	Remarks	Post Processing Performed
ERC1_1 (long)						J1939-71	pgn61440		
					Retarder Torque Mode	J1939-71	spn900		
					Retarder Enable - Brake Assist Switch	J1939-71	spn571		
					Retarder Enable - Shift Assist Switch	J1939-71	spn572		
					Actual Retarder - % Torque	J1939-71	spn520		
					Intended Retarder Percent Torque	J1939-71	spn1085		
					Engine Coolant Load Increase	J1939-71	spn1082		
					Retarder Requesting Brake Light	J1939-71	spn1667		
					Source Address of Controlling Device for Retarder Control	J1939-71	spn1480		
					Drivers Demand Retarder - Percent Torque	J1939-71	spn1715		
					Retarder Selection, non-engine	J1939-71	spn1716		
					Actual Maximum Available Retarder - Percent Torque	J1939-71	spn1717		
EBC1_1 (long_						J1939-71	pgn61441		
					ATC engine control active (ASR engine control active)	J1939-71	spn561		
					ATC brake control active (ASR brake control active)	J1939-71	spn562		
					ABS active	J1939-71	spn563		
					EBS Brake Switch	J1939-71	spn1121		
			X	X	Brake pedal position	J1939-71	spn521		0.4 Multiplier
					ABS Off road switch	J1939-71	spn575		
					ATC Off road switch (ASR offroad switch)	J1939-71	spn576		
					Accelerator Interlock Switch	J1939-71	spn972		
					Engine Derate Switch	J1939-71	spn971		
					Auxiliary Engine Shutdown Switch	J1939-71	spn970		
					Remote Accelerator Enable Switch	J1939-71	spn969		
					Engine Retarder Selection	J1939-71	spn973		
			X	X	ABS fully operational	J1939-71	spn1243		
					EBS red warning lamp status	J1939-71	spn1439		
					ABS/EBS amber warning lamp	J1939-71	spn1438		
					ATC/ABS lamp status	J1939-71	spn1793		
					Source Address of Controlling Device for Brake Control	J1939-71	spn1481		
			X	X	ABS trailer warning lamp state (Tractor-Mounted Trailer ABS Warning Signal)	J1939-71	spn1792		

Table C-2. T3 Tractor Channel Description (continued)

Column Header	Column Header Unit	Source Unit	Calculated Summary Statistics	Validation Performed	Source Name	Source	Codes	Remarks	Post Processing Performed
Brake Pressures						J1939-71	pgn65197		
					Brake Application Pressure High Range, Front Axle, Left Wheel	J1939-71	spn1091		
					Brake Application Pressure High Range, Front Axle, Right Wheel	J1939-71	spn1092		
					Brake Application Pressure High Range, Rear Axle #1, Left Wheel	J1939-71	spn1093		
					Brake Application Pressure High Range, Rear Axle #1, Right Wheel	J1939-71	spn1094		
					Brake Application Pressure High Range, Rear Axle #2, Left Wheel	J1939-71	spn1095		
					Brake Application Pressure High Range, Rear Axle #2, Right Wheel	J1939-71	spn1096		
					Brake Application Pressure High Range, Rear Axle #3, Left Wheel	J1939-71	spn1097		
					Brake Application Pressure High Range, Rear Axle #3, Right Wheel	J1939-71	spn1098		
Brake_Lining						J1939-71	pgn65196		
					Brake Lining Remaining, Front Axle, Left Wheel	J1939-71	spn1099		
					Brake Lining Remaining, Front Axle, Right Wheel	J1939-71	spn1100		
					Brake Lining Remaining, Rear Axle #1, Left Wheel	J1939-71	spn1101		
					Brake Lining Remaining, Rear Axle #1, Right Wheel	J1939-71	spn1102		
					Brake Lining Remaining, Rear Axle #2, Left Wheel	J1939-71	spn1103		
					Brake Lining Remaining, Rear Axle #2, Right Wheel	J1939-71	spn1104		
					Brake Lining Remaining, Rear Axle #3, Left Wheel	J1939-71	spn1105		
					Brake Lining Remaining, Rear Axle #3, Right Wheel	J1939-71	spn1106		
TSC1						J1939-71	pgn0	This channel deblobs and is in the config file, but is not available on T3 tractors	
					Override control mode	J1939-71	spn695		
					Requested Speed Control Conditions	J1939-71	spn696		
					Override control mode priority	J1939-71	spn897		
			X	X	Requested Speed/Speed Limit	J1939-71	spn898		0.125 Multiplier
			X	X	Requested torque/torque limit	J1939-71	spn518		-125 Offset
MD1 EBS						Wabco		Proprietary Channel	

Table C-2. T3 Tractor Channel Description (continued)

Column Header	Column Header Unit	Source Unit	Calculated Summary Statistics	Validation Performed	Source Name	Source	Codes	Remarks	Post Processing Performed
MD2 EBS						Wabco		Proprietary Channel	
RSC/VDC						J1587		This channel deblobs and is in the config file, but is not available on T3 tractors	
					RSC/VDC engine control active	J1587	MID 88 PID 97		
					RSC/VDC brake control active	J1587	MID 88 PID 97		
RSA						J1587		This channel deblobs and is in the config file, but is not available on T3 tractors	
					RSA level 1	J1587	MID 88 PID E2		
					RSA level 2	J1587	MID 88 PID E2		
					RSA level 3	J1587	MID 88 PID E2		
TlrRoadFrontPsi	psi		X	X		Analog		-18.29 offset, 0.042733 multiplier	1.0 sec moving average
TlrCurbFrontPsi	psi		X	X		Analog		-18.29 offset, 0.042733 multiplier	1.0 sec moving average
TlrRoadRearPsi	psi		X	X		Analog		-18.29 offset, 0.042733 multiplier	1.0 sec moving average
TlrCurbRearPsi	psi		X	X		Analog		-18.29 offset, 0.042733 multiplier	1.0 sec moving average
TlrAirBag	psi		X	X		Analog		-18.29 offset, 0.042733 multiplier	1.0 sec moving average
TlrFrontLeftWhlSpd	ft/s		X			Analog		-2.316 offset, 0.0360864 multiplier	1.0 sec moving average
TlrFrontrightWhlSpd	ft/s		X			Analog		-2.316 offset, 0.0360864 multiplier	1.0 sec moving average
TlrRearLeftWhlSpd	ft/s		X			Analog		-2.316 offset, 0.0360864 multiplier	1.0 sec moving average
TlrRearRightWhlSpd	ft/s		X			Analog		-2.316 offset, 0.0360864 multiplier	1.0 sec moving average
Tlr_F/A	g's		X	X		Analog		2.64 offset, -0.00128 multiplier	5.0 sec moving average
Tlr_Lat	g's		X	X		Analog		2.64 offset, -0.00128 multiplier	5.0 sec moving average
TlrYawRate	deg/s		X	X		Analog		-80 offset, 0.03861	5.0 sec moving average
Tlr_ID									
ACC_Mode - Adaptive Cruise Control Mode			X	X	Adaptive Cruise Control Mode	J1939-71	spn1590		
ACC_Mode -Set Distnace Mode			X	X	Adaptive Cruise Control Set Distance Mode	J1939-71	spn1589		

Table C-3. T2 Trailer Channel Description

For complete descriptions of each channel, see the applicable source entry specification (e.g. J1939-71). For a description of the validation ranges, see the applicable Validation Configuration File

				ABS			EBS					
Column Header	Column Header Unit	Calculated Summary Statistics	Validation Performed	T2C1	T2C2	T2C4	T2C3	Source Name	Source	Codes	Remarks	Post Processing Performed
Relative Time	Sec	X		X	X	X	X		DAS			
HH:MM:SS	HH:MM:SS	X		X	X	X	X		GPS (Analog)			
GPS Lat (long)	deg	X	X	X	X	X	X		GPS (Analog)			
GPS Long (long)	deg	X	X	X	X	X	X		GPS (Analog)			
GPSAlti (long)	ft	X	X	X	X	X	X		GPS (Analog)			
TlrRoadFrontPsi	psi	X	X	X	X	X	X		Analog		-198.98 offset, 0.08816 multiplier	1.0 sec moving average
TlrCurbFrontPsi	psi	X	X	X	X	X	X		Analog		-198.98 offset, 0.08816 multiplier	1.0 sec moving average
TlrRoadRearPsi	psi	X	X	X	X	X	X		Analog		-198.98 offset, 0.08816 multiplier	1.0 sec moving average
TlrCurbRearPsi	psi	X	X	X	X	X	X		Analog		-198.98 offset, 0.08816 multiplier	1.0 sec moving average
TlrAirBag Psi	psi	X	X			X	X		Analog		-198.98 offset, 0.08816 multiplier	1.0 sec moving average
TlrFrontLeftWhlSpd	ft/s	X	X	X	X	X	X		Analog		-150.84 offset, 0.073401 multiplier	1.0 sec moving average
TlrFrontrightWhlSpd	ft/s	X	X	X	X	X	X		Analog		-150.84 offset, 0.073401 multiplier	1.0 sec moving average
TlrRearAxleLeftRear	ft/s	X		X	X	X	X		Analog		-150.84 offset, 0.073401 multiplier	1.0 sec moving average
TlrRearAxleRightRear	ft/s	X		X	X	X	X		Analog		-150.84 offset, 0.073401 multiplier	1.0 sec moving average
Lat DC	g's	X	X	X	X	X	X		Analog		-0.00128 multiplier, 2.64 offset	1.0 sec moving average
F/A DC	g's	X	X	X	X	X	X		Analog		-0.00128 multiplier, 5.28 offset	1.0 sec moving average
YawRate	deg/s	X	X	X	X	X	X		Analog		0.03861 multiplier, -80 offset	1.0 sec moving average

Table C-4. T2 Tractor Metadata

Column Header	Column Header Unit	Source Name	Source	Codes	Remarks
VIN		Vehicle Identification Number	J1587		
Start/Stop Time	YYYYMMDDHHMMSS		DAS		
Start/Stop Ambient Temperature	C	Ambient Air Temperature	J1939-71	pgn65269, spn171	
Start/Stop Odometer	mi	High Resolution Total Vehicle Distance	J1939-71	pgn65217, spn917	
Start/Stop GPS Latitude	DDMM.M		GPS (Analog)		
Start/Stop GPS Longitude	DDDMM.M		GPS (Analog)		
Start/Stop GPS Speed	knots		GPS (Analog)		
Start/Stop GPS Heading	DDD.D		GPS (Analog)		

Table C-5. T3 Tractor Metadata

Column Header	Column Header Unit	Source Name	Source	Codes	Remarks
VIN		Vehicle Identification Number	J1587	pgn65260, spn237	
Start/Stop Time	YYYYMMDDHHMMSS		DAS		
Start/Stop Ambient Temperature	C	Ambient Air Temperature	J1939-71	pgn65269, spn171	
Start/Stop Odometer	mi	High Resolution Total Vehicle Distance	J1939-71	pgn65217, spn917	
Start/Stop GPS Latitude	DDMM.M		GPS (Analog)		
Start/Stop GPS Longitude	DDDMM.M		GPS (Analog)		
Start/Stop GPS Speed	knots		GPS (Analog)		
Start/Stop GPS Heading	DDD.D		GPS (Analog)		

Table C-6. T2 Trailer Metadata

Column Header	Column Header Unit	Source Name	Source	Remarks
Trailer ID			DAS	
Start/Stop Time	YYYYMMDDHHMMSS		DAS	
Start/Stop Ambient Temperature	C	Ambient Air Temperature		Temperature is not recorded
Start/Stop Odometer	mi	High Resolution Total Vehicle Distance		Odometer Values are not recorded
Start/Stop GPS Latitude	DDMM.M		GPS (Analog)	
Start/Stop GPS Longitude	DDDMM.M		GPS (Analog)	
Start/Stop GPS Speed	knots		GPS (Analog)	
Start/Stop GPS Heading	DDD.D		GPS (Analog)	

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Validation Information

Battelle created validation routines to check the data as it was being processed. There were two types of validation performed. First, for value type channels such as road speed, the data was checked to fall within an acceptable range. Second, for digital data or event type data, error codes or invalid codes were screened. There are also some channels which are checked against others. For example, in the target range channel, a check is performed on the target detect alert channel to ensure that a target is present. In each event, a flag is produced for that channel and blob combination that indicates that channel's data is invalid during that period of time. These validation flags could then be used by the IE to quickly remove data which was unacceptable.

Tables C-7 though C-9 give information about the specific validation parameters used for each channel for T2 Tractors, T3 Tractors, and T2 Trailers respectively. The following is a description of the fields in the table:

ID	The channel ID number for this configuration.
Column #	The column number of this channel in the decoded CSV file.
ChannelUUID	A unique identifier present in the blob which identifies the channel.
Message Desc	The description of the channel that is present in the configuration file.
Channel Desc	The decoded CSV column header for the channel.
Type	the data of data contained in the channel. Value type channels are those in engineering units. Bits types are normally event channels such as a target detect alert. Ignore types are decoded CSV channels upon which no validation is performed.
Bit Index	For Bits type channels, the starting index of the bits of interest in the binary encoded digital channel signal.
Bit Length	The number of bits to be compared from the binary encoded digital signal.
Data Type	The SQL data type of the data being validated.
Multiplier	A multiplier indicates that the channel value must be multiplied by a value before it can be compared to the validation range
Offset	An offset indicates that the channel value must be summed with the offset (after multiplication if necessary) before it can be compared to the validation range.
Range Min	The minimum valid value for the channel
Range Max	The maximum valid value for the channel.
Ignore Vehicle Configurations	The vehicle configurations tow which this channel does not apply. For example, the T2 configurations do not apply to T3 tractors.

	For some Channels, values are ignored based their default condition. For example, the target range channel defaults to 836.61 ft if not target is present.
Ignore Type	The type of value to compared to determine if the value in a channel should be ignored when calculating summary statistics and validating the data.
Column #	The column number of the value to be compared
Bit Start Index	Identifying the bit start index for Bits type comparisons
Bit Length	The length of bits to be used for comparison
Compare Type	The type of comparison to be made, equality for example.
Compare Value	The value to be compared

For bits type channels, information about the meaning of the bits are provided.

Value	The values of the bits that are possible.
Type	The condition of the corresponding values (Off, On, Error).
Description	The meaning of the bit sequence.
Error	If the Type is an Error condition, then the meaning of the Error condition.

These are the most recent validation routines in place at the end of the FOT. Because of various configuration changes throughout the project, earlier configuration files were different. The most significant change was that the configuration files in place in the first half of the FOT, before the technologies were activated, did not have an ACC Mode channel or an ACC Set Distance Mode channel.

Table C-7. T2 Tractor Validation Information

Columns: *52*

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1539	1	FLTRC00000000020420040001031E1AE7	Relative Time	Relative Time	Value		
		Data Type: Short ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min:	Range Max:	
1540	2	FLTRC00000010204200400010 31E1AE7	HH:MM:SS	HH:MM:SS	Value		
		Data Type: Time ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min:	Range Max:	
1589	3	E82ACA4AB86A4824844BCDF8B1184A24	TT:GPS Lat (long)	GPS Lat (long)	Value		
		Data Type: Long ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: 30	Range Max: 49	
1588	4	0C346CD9EEE645F88A7B176103BDFB40	TT:GPS Long(long)	GPS Long (long)	Value		
		Data Type: Long ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: -125	Range Max: -90	
1587	5	E3B285952F4941D68F25E7DFE0F3E497	TT:GPS Alti(long)	GPSAlti (long)	Value		
		Data Type: Long ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: 0	Range Max: 10000	
1586	6	9F39C5FB5007474E89BBB4B1D5397BA1	TT:RoadSpeed	Road Speed	Value		
		Data Type: Short ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: 0	Range Max: 110	
1585	7	BD3BE011417A4071B4DDFC20468C9055	TT:% Throttle	% Throttle	Value		
		Data Type: Short ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: 0	Range Max: 101	
1584	8	C1338B49FF0A4901997012A4CD542A5C	TT:% Engine Torque	% Engine Torque	Value		
		Data Type: Short ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: 0	Range Max: 101	
1583	9	9DB8A35759994AB79575614E6831EB45	TT:Engine Speed	Engine Speed	Value		
		Data Type: Short ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: 0	Range Max: 3500	

Table C-7. T2 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1582		10A4BB4520FEF144CB91ABCC8DA453342F	TT:CC_SW1	CC_SW1 - Cruise Control	Bits	1	4

Data Type: Short
Occurrence Error Count:
Occurrence Error:

Value	Type	Description	Error
0000	Off	Disabled and Inactive	
0001	Off	Enabled and Inactive	
0100	Error	Disabled and Active	2011 - Error Condition: Bits indicate an error condition
0101	On	Enabled and Active	

Ignore Vehicle Configuration(s)
T3

1581	11	82C4722D83864EE0B71894FE83B62D12	TT:FrontLefttWhlSpd	FrontRsRelWhlSpd	Value		

Data Type: Short
Multiplier:
Offset:
Range Min:
Range Max:
Ignore Vehicle Configuration(s)
T3

1580	12	8C7DF60D616740F7B819A47E8A5A9A7D	TT:FrontrightWhlSpd	FrontCsRelWhlSpd	Value		

Data Type: Short
Multiplier:
Offset:
Range Min:
Range Max:
Ignore Vehicle Configuration(s)
T3

1579	13	A3C87EF431F34EADBAEA47302DA38D5A	TT:MidLefttWhlSpd	MidRsRelWhlSpd	Value		

Data Type: Short
Multiplier:
Offset:
Range Min:
Range Max:
Ignore Vehicle Configuration(s)
T2C3
T3

1578	14	B72F9173CB774A1B8BAAB18B92D948E2	TT:MidRightWhlSpd	MidCsRelWhlSpd	Value		

Data Type: Short
Multiplier:
Offset:
Range Min:
Range Max:
Ignore Vehicle Configuration(s)
T2C3
T3

1577	15	23EEC31C27A2462EBF04179F3B28EB41	TT:RearAxleLeftRear	RearRsRelWhlSpd	Value		

Data Type: Short
Multiplier:
Offset:
Range Min:
Range Max:
Ignore Vehicle Configuration(s)
T3

1576	16	6753758463434B409F3AA0A764830F87	TT:RearAxleRightrear	RearCsRelWhlSpd	Value		

Data Type: Short
Multiplier:
Offset:
Range Min:
Range Max:
Ignore Vehicle Configuration(s)
T3

1575	17	AC5F2885642747F59B01E78791EBFC73	TT:Pressure 1	RsFrontPress	Value		

Data Type: Short
Multiplier:
Offset:
Range Min: -5
Range Max: 100
Ignore Vehicle Configuration(s)
T3

Table C-7. T2 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1574	18	62E23439CD18476A9E56698A3EF50596	TT:Pressure 2	CsFrontPress	Value		
		Data Type: Short ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: -5	Range Max: 100	
1573	19	86657F01E9FF4DE5BC2268DB922FA0D9	TT:Pressure 3	RsIntermPress	Value		
		Data Type: Short ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: -5	Range Max: 100	
1572	20	1E5359F4D9E942B7AFEAB2DD4313241D	TT:Pressure 4	CsIntermPress	Value		
		Data Type: Short ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: -5	Range Max: 100	
1571	21	E8CB8FD5CEEA44038AAA5B86939D25DB	TT:Pressure 5	RsRearPress	Value		
		Data Type: Short ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: -5	Range Max: 100	
1570	22	7AF342FE9E4C4474A7CED2BE1AA4D632	TT:Pressure 6	CsRearPress	Value		
		Data Type: Short ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: -5	Range Max: 100	
1569	23	7BB1618782CD455FB4F57810359E7784	TT:Pressure 7	AirCompressor	Value		
		Data Type: Short ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: -5	Range Max: 150	
1568	24	7349C386111B416F8827A4208ADD63E8	TT:Pressure 8	AirBag	Value		
		Data Type: Short ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: -5	Range Max: 100	
1567	25	F23B95F08F324C4BA757E82B6BEC9320	TT:Pressure 9	TrlrProtValve	Value		
		Data Type: Short ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: -5	Range Max: 150	
1566	26	268019F247C54EF2A2F6E786B687603F	TT:Pressure 10	Treadle Valve	Value		
		Data Type: Short ***Ignore Vehicle Configuration(s)*** T2C3 T3	Multiplier:	Offset:	Range Min:	Range Max:	

Table C-7. T2 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1565	27	786061724C0E489CBFBA5AB3ADF9007B	TT:Steer Angle	AnalogSteerAngle	Ignore		
		Ignore Vehicle Configuration(s) T2C3 T3					
1564	28	D384E0AADEDA4C73A80C1F671C70434A	TT:J1939SteerAngle	J1939SteerAngle	Value		
		Data Type: Short	Multiplier:	Offset: -204.83	Range Min: -13	Range Max: 13	
		Ignore Vehicle Configuration(s) T2C1 T2C2 T2C4 T3					
1563	29	07AC18BB5F4B4D6BBEE1FF572C03A222	TT:F/A DC	F/A DC	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -2	Range Max: 1	
		Ignore Vehicle Configuration(s) T3					
1562	30	29CB2CF3A7454C56A3ED76E46993380A	TT:Lat DC	Lat DC	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -1	Range Max: 1	
		Ignore Vehicle Configuration(s) T3					
1561	31	DE1527BBDC894504972917DD47B01446	TT:YawRate	YawRate	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -20	Range Max: 20	
		Ignore Vehicle Configuration(s) T3					
1560	32	CDB0B86EF11E4BE0BA8384F1ED00DDC9	TT:DigIO	Wipers/lights	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min:	Range Max:	
		Ignore Vehicle Configuration(s) T3					
1559	33	F434BAAC293A4AD9AE1CD2DFCF7BD73F	TT:RearAxleInitLeft	RSInterWheelSpeed	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min:	Range Max:	
		Ignore Vehicle Configuration(s) T2C1 T2C2 T2C4 T3					
1558	34	0CF4DA36583A4BA0A8780CC43D9BC877	TT:RearAxleInitRight	CSInterWheelSpeed	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min:	Range Max:	
		Ignore Vehicle Configuration(s) T2C1 T2C2 T2C4 T3					

Table C-7. T2 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1557	35	55592EABACD14085A30766CCE5BE0CA6	TT:Tgt Range	Tgt Range	Value		

Data Type: Short Multiplier: Offset: Range Min: 0 Range Max: 450

Ignore Type	Col #	Bit Start Index	Bit Length	Compare Type	Compare Value	Error on Ignore
Value	35			Equal (==)	836.61	
Value	35			Equal (==)	0	
Bits	38	1	2	Not Equal (!=)	1	

Ignore Vehicle Configuration(s)
T3

1556	36	D7BE63F25F004FB9BBB8BF0DA013B2AA	TT:Tgt RangeRate	Tgt RangeRate	Value		

Data Type: Short Multiplier: Offset: Range Min: 0 Range Max: 120

Ignore Type	Col #	Bit Start Index	Bit Length	Compare Type	Compare Value	Error on Ignore
Value	36			Equal (==)	836.61	
Bits	38	1	2	Not Equal (!=)	1	

Ignore Vehicle Configuration(s)
T3

1555	37	F7F6AF8F47FA4F6281B2A673FA7F8400	TT:Tgt Azimuth	Tgt Azimuth	Value		

Data Type: Short Multiplier: Offset: Range Min: -4.1 Range Max: 4.1

Ignore Type	Col #	Bit Start Index	Bit Length	Compare Type	Compare Value	Error on Ignore
Value	37			Equal (==)	4.06	
Bits	38	1	2	Not Equal (!=)	1	

Ignore Vehicle Configuration(s)
T3

1554	38	2DABB49AA6A64C7DA2AF81E60A326DDB	TT:TgtDetect/Alerts	TgtDetect/Alerts - Target Detect	Bits	1	2

Data Type: Short Occurrence Error Count: Occurrence Error:

Value	Type	Description	Error
00	Off	No Target	
01	On	Target Detected	
10	Error	Reserved	2021 - Not Available: Bits indicate a value that should not happen
11	Error	Take No Action	2021 - Not Available: Bits indicate a value that should not happen

Ignore Vehicle Configuration(s)
T3

1590	38	2DABB49AA6A64C7DA2AF81E60A326DDB	TT:TgtDetect/Alerts	TgtDetect/Alerts - ACC Shutoff Warning	Bits	3	2

Data Type: Short Occurrence Error Count: Occurrence Error:

Value	Type	Description	Error
00	Off	ACC SSOW Not Active	
01	On	ACC SSOW Active	
10	Error	Reserved	2021 - Not Available: Bits indicate a value that should not happen
11	Error	Take No Action	2021 - Not Available: Bits indicate a value that should not happen

Ignore Vehicle Configuration(s)
T3

Table C-7. T2 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1591	38	2DABB49AA6A64C7DA2AF81E60A326DDB	TT:TgtDetect/Alerts	TgtDetect/Alerts - ACC Distance Alert Signal	Bits	5	2

Data Type: Short Occurrence Error Count: Occurrence Error:

Value	Type	Description	Error
00	Off	ACC DAS Not Active	
01	On	ACC DAS Active	
10	Error	Reserved	2021 - Not Available: Bits indicate a value that should not happen
11	Error	Take No Action	2021 - Not Available: Bits indicate a value that should not happen

Ignore Vehicle Configuration(s)

T3

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1553	39	7C50A82DA36F42038EC6D0DAC1A234AC	TT:ACC System Error	ACC System Error	Value		

Data Type: Short Multiplier: Offset: Range Min: Range Max:

Ignore Type	Col #	Bit Start Index	Bit Length	Compare Type	Compare Value	Error on Ignore
Value	39			Equal (==)	24584	
Value	39			Equal (==)	25088	
Value	39			Equal (==)	25089	
Value	39			Equal (==)	25090	
Value	39			Equal (==)	25091	
Value	39			Equal (==)	25093	
Value	39			Equal (==)	25094	
Value	39			Equal (==)	25098	
Value	39			Equal (==)	25099	
Value	39			Equal (==)	25100	
Value	39			Equal (==)	25095	
Value	39			Equal (==)	25106	
Value	39			Equal (==)	25108	
Value	39			Equal (==)	25111	
Value	39			Equal (==)	25120	
Value	39			Equal (==)	25121	
Value	39			Equal (==)	25122	
Value	39			Equal (==)	25123	
Value	39			Equal (==)	25124	
Value	39			Equal (==)	25125	
Value	39			Equal (==)	25126	
Value	39			Equal (==)	25127	
Value	39			Equal (==)	25128	
Value	39			Equal (==)	25129	
Value	39			Equal (==)	25092	
Value	39			Equal (==)	25141	
Value	39			Equal (==)	25142	
Value	39			Equal (==)	25144	
Value	39			Equal (==)	25145	
Value	39			Equal (==)	25152	
Value	39			Equal (==)	25153	
Value	39			Equal (==)	25155	

Table C-7. T2 Tractor Validation Information (continued)

ID	Col #	Channel UUID		Message Desc	Channel Desc		Type	Bit Index	Bit Length
		Value	39		Equal (==)	25160			
		Value	39		Equal (==)	25162			
		Value	39		Equal (==)	4101			
		Value	39		Equal (==)	4102			
		Value	39		Equal (==)	4103			
		Value	39		Equal (==)	4104			
		Value	39		Equal (==)	4105			
		Value	39		Equal (==)	4106			
		Value	39		Equal (==)	4107			
		Value	39		Equal (==)	4352			
		Value	39		Equal (==)	4353			
		Value	39		Equal (==)	4354			
		Value	39		Equal (==)	4355			
		Value	39		Equal (==)	4356			
		Value	39		Equal (==)	4357			
		Value	39		Equal (==)	4358			
		Value	39		Equal (==)	4359			
		Value	39		Equal (==)	4360			
		Value	39		Equal (==)	4361			
		Value	39		Equal (==)	5901			
		Value	39		Equal (==)	24583			
		Value	39		Equal (==)	4096			
		Value	39		Equal (==)	4097			
		Value	39		Equal (==)	4098			
		Value	39		Equal (==)	4099			
		Value	39		Equal (==)	4100			
		Value	39		Equal (==)	4108			
		Value	39		Equal (==)	4362			
		Value	39		Equal (==)	4363			
		Value	39		Equal (==)	4364			
		Value	39		Equal (==)	4365			
		Value	39		Equal (==)	4366			
		Value	39		Equal (==)	4367			
		Value	39		Equal (==)	4368			
		Value	39		Equal (==)	4369			
		Value	39		Equal (==)	4370			
		Value	39		Equal (==)	4372			
		Value	39		Equal (==)	4373			
		Value	39		Equal (==)	4374			
		Value	39		Equal (==)	4608			
		Value	39		Equal (==)	4609			
		Value	39		Equal (==)	4610			
		Value	39		Equal (==)	4611			
		Value	39		Equal (==)	4613			
		Value	39		Equal (==)	4864			
		Value	39		Equal (==)	4865			
		Value	39		Equal (==)	4866			

Table C-7. T2 Tractor Validation Information (continued)

ID	Col #	Channel UUID		Message Desc	Channel Desc		Type	Bit Index	Bit Length
		Value	39		Equal (==)	5120			
		Value	39		Equal (==)	5121			
		Value	39		Equal (==)	5122			
		Value	39		Equal (==)	5123			
		Value	39		Equal (==)	5124			
		Value	39		Equal (==)	5125			
		Value	39		Equal (==)	5126			
		Value	39		Equal (==)	5127			
		Value	39		Equal (==)	5128			
		Value	39		Equal (==)	5376			
		Value	39		Equal (==)	5888			
		Value	39		Equal (==)	5889			
		Value	39		Equal (==)	5890			
		Value	39		Equal (==)	5891			
		Value	39		Equal (==)	5892			
		Value	39		Equal (==)	5893			
		Value	39		Equal (==)	5894			
		Value	39		Equal (==)	5897			
		Value	39		Equal (==)	5898			
		Value	39		Equal (==)	5899			
		Value	39		Equal (==)	5900			
		Value	39		Equal (==)	5902			
		Value	39		Equal (==)	5903			
		Value	39		Equal (==)	5904			
		Value	39		Equal (==)	5905			
		Value	39		Equal (==)	5907			
		Value	39		Equal (==)	6144			
		Value	39		Equal (==)	6145			
		Value	39		Equal (==)	24577			
		Value	39		Equal (==)	24578			
		Value	39		Equal (==)	4612			
		Value	39		Equal (==)	5632			
		Value	39		Equal (==)	5896			
		Value	39		Equal (==)	5906			
		Value	39		Equal (==)	24576			
		Value	39		Equal (==)	24579			
		Value	39		Equal (==)	24580			
		Value	39		Equal (==)	24581			
		Value	39		Equal (==)	24582			
		Value	39		Equal (==)	25414			
		Value	39		Equal (==)	25163			
		Value	39		Equal (==)	25164			
		Value	39		Equal (==)	25165			
		Ignore Vehicle Configuration(s)							
		T3							

Table C-7. T2 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1552	40	ACC1AAAAAAAAAAAAAAAAAAAAAA	TT:ESC_VDC1	ESC_VDC1 - VDC Fully Operational	Bits	3	2

Data Type: Raw Occurrence Error Count: Occurrence Error:

Value	Type	Description	Error
00	Off	Not Fully Operational	
01	On	Fully Operational	
10	Off	Reserved	
11	Off	Don't Care/Take No Action	

Ignore Vehicle Configuration(s)
T2C1
T2C2
T2C4
T3

1551	41	FD12965C77764A5BA1F869AB95EA0540	TT:XBR	XBR - Requested Deceleration	Value	1	16

Data Type: Raw Multiplier: 0.00048828125 Offset: Range Min: -15.687 Range Max: 15.687

Ignore Vehicle Configuration(s)
T2C1
T2C2
T2C4
T3

1550	42	4F4DC90B49A04C3193341CC345AE2216	TT:ERC1_1 (Long)	ERC1_1 (Long)	Ignore		

Ignore Vehicle Configuration(s)
T3

1594	43	8AEDF18CB022422EB9DAA2FF98ED9D6F	TT:EBC1_1 (Long)	EBC1_1 (Long) - Brake Pedal Position	Value	17	8

Data Type: Raw Multiplier: 0.4 Offset: Range Min: 0 Range Max: 101

Ignore Vehicle Configuration(s)
T3

1593	43	8AEDF18CB022422EB9DAA2FF98ED9D6F	TT:EBC1_1 (Long)	EBC1_1 (Long) - Engine Retarder Selection	Ignore	33	8

Ignore Vehicle Configuration(s)
T3

1549	43	8AEDF18CB022422EB9DAA2FF98ED9D6F	TT:EBC1_1 (Long)	EBC1_1 (Long) - ABS Fully Operational	Bits	41	2

Data Type: Raw Occurrence Error Count: Occurrence Error:

Value	Type	Description	Error
00	Off	Not Fully Operational	
01	On	Fully Operational	
10	Ignore	Ignore	
11	Ignore	Ignore	

Ignore Vehicle Configuration(s)
T3

Table C-7. T2 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1592	43	8AEDF18CB022422EB9DAA2FF98ED9D6F	TT:EBC1_1 (Long)	EBC1_1 (Long) - ABS Trailer Warning Lamp State	Bits		63

Data Type: Raw Occurrence Error Count: Occurrence Error:

Value	Type	Description	Error
00	Off	Available Not Active	
01	On	Active	
10	Ignore	Reserved	2021 - Not Available: Bits indicate a value that should not happen
11	Ignore	Not Available or Not Supported	2021 - Not Available: Bits indicate a value that should not happen

Ignore Vehicle Configuration(s)
T3

1548	44	C1E1BEF9462843D39352DBB7A9C0F771	TT:EBC3 Brake Press	Brake_Pressures	Ignore		

Ignore Vehicle Configuration(s)
T3

1547	45	C1E1BEF9462843D39352DBB7A9C0F761	TT:Brake Lining Wear	Brake_Lining	Ignore		

Ignore Vehicle Configuration(s)
T3

1546	46	4F63B1C530E1448AA00591A69CB8B564	TT:Diagnostic	Diagnostic - Lamp Status	Bits	1	8

Data Type: Raw Occurrence Error Count: Occurrence Error:

Value	Type	Description	Error
00000000	Off	Lamp Off	
00000001	On	Lamp On - Protect	
00000100	On	Lamp On - Amber	
00000101	On	Lamp On - Amber, Protect	
00010000	On	Lamp On - Red	
00010001	On	Lamp On - Red, Protect	
00010100	On	Lamp On - Red, Amber	
00010101	On	Lamp On - Red, Amber, Protect	
01000000	On	Lamp On - Malfunction	
01000001	On	Lamp On - Malfunction, Protect	
01000100	On	Lamp On - Malfunction, Amber	
01000101	On	Lamp On - Malfunction, Amber, Protect	
01010000	On	Lamp On - Malfunction, Red	
01010001	On	Lamp On - Malfunction, Red, Protect	
01010100	On	Lamp On - Malfunction, Red, Amber	
01010101	On	Lamp On - Malfunction, Red, Amber, Protect	

Ignore Vehicle Configuration(s)
T2C3
T3

Table C-7. T2 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1595	46	4F63B1C530E1448AA00591A69CB8B564	TT:Diagnostic	Diagnostic - Failure Mode Identifier	Bits	33	5

Data Type: Raw Occurrence Error Count: Occurrence Error:

Value	Type	Description	Error
00000	Ignore	No Failure	
00001	Error	Failure	2011 - Error Condition: Bits indicate an error condition
00010	Error	Failure	2011 - Error Condition: Bits indicate an error condition
00011	Error	Failure	2011 - Error Condition: Bits indicate an error condition
00100	Error	Failure	2011 - Error Condition: Bits indicate an error condition
00101	Error	Failure	2011 - Error Condition: Bits indicate an error condition
00110	Error	Failure	2011 - Error Condition: Bits indicate an error condition
00111	Error	Failure	2011 - Error Condition: Bits indicate an error condition
01000	Error	Failure	2011 - Error Condition: Bits indicate an error condition
01001	Error	Failure	2011 - Error Condition: Bits indicate an error condition
01010	Error	Failure	2011 - Error Condition: Bits indicate an error condition
01011	Error	Failure	2011 - Error Condition: Bits indicate an error condition
01100	Error	Failure	2011 - Error Condition: Bits indicate an error condition
01101	Error	Failure	2011 - Error Condition: Bits indicate an error condition
01110	Error	Failure	2011 - Error Condition: Bits indicate an error condition
01111	Error	Failure	2011 - Error Condition: Bits indicate an error condition
10000	Error	Failure	2011 - Error Condition: Bits indicate an error condition
10001	Error	Failure	2011 - Error Condition: Bits indicate an error condition
10010	Error	Failure	2011 - Error Condition: Bits indicate an error condition
10011	Error	Failure	2011 - Error Condition: Bits indicate an error condition
10100	Error	Failure	2011 - Error Condition: Bits indicate an error condition
10101	Error	Failure	2011 - Error Condition: Bits indicate an error condition
10110	Error	Failure	2011 - Error Condition: Bits indicate an error condition
10111	Error	Failure	2011 - Error Condition: Bits indicate an error condition
11000	Error	Failure	2011 - Error Condition: Bits indicate an error condition
11001	Error	Failure	2011 - Error Condition: Bits indicate an error condition
11010	Error	Failure	2011 - Error Condition: Bits indicate an error condition
11011	Error	Failure	2011 - Error Condition: Bits indicate an error condition
11100	Error	Failure	2011 - Error Condition: Bits indicate an error condition
11101	Error	Failure	2011 - Error Condition: Bits indicate an error condition
11110	Error	Failure	2011 - Error Condition: Bits indicate an error condition
11111	Error	Failure	2011 - Error Condition: Bits indicate an error condition

Ignore Vehicle Configuration(s)
T2C3
T3

1596	47	4F63B1C530E1448AA00591A69CB8B566	TT:TSC1	TSC1 - Requested Speed/Speed Limit	Value	9	16

Data Type: Raw Multiplier: 0.125 Offset: Range Min: 0 Range Max: 8031.875

Ignore Vehicle Configuration(s)
T2C3
T3

Table C-7. T2 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1545	47	4F63B1C530E1448AA00591A69CB8B566	TT:TSC1	TSC1 - Requested Torque/Torque Limit	Value	25	8
		Data Type: Raw	Multiplier:	Offset: -125	Range Min: -125	Range Max: 125	
		Ignore Vehicle Configuration(s)					
		T2C3					
		T3					
1544	48	4F63B1C530E1448AA00591A69CB8B567	TT:MD1 EBS	MD1 EBS	Ignore		
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T3					
1543	49	4F63B1C530E1448AA00591A69CB8B568	TT:MD2 EBS	MD2 EBS	Ignore		
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T3					
1542	50	4F63B1C530E1448AA00591A69CB8B569	TT:RSC/VDC	RSC/VDC	Ignore		
		Ignore Vehicle Configuration(s)					
		T2C4					
		T2C3					
		T3					
1541	51	4F63B1C530E1448AA00591A69CB8B56A	TT:RSA	RSA	Ignore		
		Ignore Vehicle Configuration(s)					
		T2C4					
		T2C3					
		T3					
1597	52	D7BE63F25F004FB9BCD8BF0DA013B2BD	TT:ACC_Mode	ACC_Mode - Adaptive Cruise Control Mode	Bits	1	3

Data Type: Short Occurrence Error Count: Occurrence Error:

Value	Type	Description	Error
000	Off	Off (Standby, enabled, ready for activation)	
001	On	Speed control active	
010	On	Distance control active	
011	On	Overtake mode	
100	On	Hold mode	
101	On	Finish mode	
110	Error	Disabled or Error Condition	2011 - Error Condition: Bits indicate an error condition
111	Error	Not Available/Not Valid	2021 - Not Available: Bits indicate a value that should not happen

Table C-7. T2 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1598	52	D7BE63F25F004FB9BCD8BF0DA013B2BD	TT:ACC_Mode	ACC_Mode - Set Distance Mode	Bits	4	3

Data Type: Short Occurrence Error Count: Occurrence Error:

Value	Type	Description	Error
000	Ignore	ACC Distance mode #1 (largest distance)	
001	Ignore	ACC Distance mode #2	
010	Ignore	ACC Distance mode #3	
011	Ignore	ACC Distance mode #4	
100	Ignore	ACC Distance mode #5 (shortest distance)	
101	Ignore	Conventional Cruise Control Mode	
110	Error	Error Condition	2011 - Error Condition: Bits indicate an error condition
111	Error	Not Available/Not Valid	2021 - Not Available: Bits indicate a value that should not happen

Table C-8. T3 Tractor Validation Information

Columns: *60*

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1274	1	FLTRC00000000020420040001031E1AE7	Relative Time	Relative Time	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min:	Range Max:	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1275	2	FLTRC00000010204200400001031E1AE7	HH:MM:SS	HH:MM:SS	Value		
		Data Type: Time	Multiplier:	Offset:	Range Min:	Range Max:	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1276	3	E82ACA4AB86A4824844BCDF8B1184A24	TT:GPS Lat (long)	GPS Lat (long)	Value		
		Data Type: Long	Multiplier:	Offset:	Range Min: 30	Range Max: 49	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1277	4	0C346CD9EEE645F88A7B176103BDFB40	TT:GPS Long(long)	GPS Long (long)	Value		
		Data Type: Long	Multiplier:	Offset:	Range Min: -125	Range Max: -90	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1278	5	E3B285952F4941D68F25E7DFE0F3E497	TT:GPS Alti(long)	GPSAlti (long)	Value		
		Data Type: Long	Multiplier:	Offset:	Range Min: 0	Range Max: 10000	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					

Table C-8. T3 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1279	6	9F39C5FB5007474E89BBB4B1D5397BA1	TT:RoadSpeed	Road Speed	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: 0	Range Max: 110	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1280	7	BD3BE011417A4071B4DDFC20468C9055	TT:% Throttle	% Throttle	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: 0	Range Max: 101	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1281	8	C1338B49FF0A4901997012A4CD542A5C	TT:% Engine Torque	% Engine Torque	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: 0	Range Max: 101	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1282	9	9DB8A35759994AB79575614E6831EB45	TT:Engine Speed	Engine Speed	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: 0	Range Max: 3500	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1283	10	A4BB4520FEF144CB91ABCC8DA453342F	TT:CC_SW1	CC_SW1 - Cruise Control	Bits	1	4
		Data Type: Short	Occurrence Error Count:	Occurrence Error:			

Value	*Type*	*Description*	*Error*
0000	Off	Disabled and Inactive	
0001	Off	Enabled and Inactive	
0100	Error	Disabled and Active	2011 - Error Condition: Bits indicate an error condition
0101	On	Enabled and Active	

Ignore Vehicle Configuration(s)

T2C1
T2C2
T2C4
T2C3

Table C-8. T3 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1284	11	82C4722D83864EE0B71894FE83B62D12	TT:FrontLefttWhlSpd	FrontRsRelWhlSpd	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min:	Range Max:	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1285	12	8C7DF60D616740F7B819A47E8A5A9A7D	TT:FrontrightWhlSpd	FrontCsRelWhlSpd	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min:	Range Max:	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1286	13	A3C87EF431F34EADBAEA47302DA38D5A	TT:MidLefttWhlSpd	RearRsRelWhlSpd	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min:	Range Max:	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1287	14	B72F9173CB774A1B8BAAB18B92D948E2	TT:MidRightWhlSpd	RearCsRelWhlSpd	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min:	Range Max:	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1288	15	62E23439CD18476A9E56698A3EF50596	TT:Pressure 1	RsFrontPress	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -5	Range Max: 100	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1289	16	86657F01E9FF4DE5BC2268DB922FA0D9	TT:Pressure 2	CsFrontPress	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -5	Range Max: 100	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					

Table C-8. T3 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1290	17	1E5359F4D9E942B7AFEAB2DD4313241D	TT:Pressure 3	RsIntermPress	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -5	Range Max: 100	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1291	18	E8CB8FD5CEEA44038AAA5B86939D25DB	TT:Pressure 4	CsIntermPress	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -5	Range Max: 100	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1292	19	7AF342FE9E4C4474A7CED2BE1AA4D632	TT:Pressure 5	RsRearPress	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -5	Range Max: 100	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1293	20	7BB1618782CD455FB4F57810359E7784	TT:Pressure 6	CsRearPress	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -5	Range Max: 100	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1294	21	7349C386111B416F8827A4208ADD63E8	TT:Pressure 7	AirCompressor	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -5	Range Max: 150	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1295	22	F23B95F08F324C4BA757E82B6BEC9320	TT:Pressure 8	AirBag	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -5	Range Max: 100	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					

Table C-8. T3 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1296	23	268019F247C54EF2A2F6E786B687603F	TT:Pressure 9	TrlrProtValve	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -5	Range Max: 150	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1332	24	07AC18BB5F4B4D6BBEE1FF572C03A222	TT:J1939SteerAngle	J1939SteerAngle	Value		
		Data Type: Short	Multiplier: 10	Offset: -204.8	Range Min: -13	Range Max: 13	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1331	25	29CB2CF3A7454C56A3ED76E46993380A	TT:Lat Acc	Lat Acc	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -1	Range Max: 1	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1330	26	DE1527BBDC894504972917DD47B01446	TT:F/A Acc	F/A Acc	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -2	Range Max: 1	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1329	27	CDB0B86EF11E4BE0BA8384F1ED00DDC9	TT:YawRate	YawRate	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -20	Range Max: 20	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1328	28	F434BAAC293A4AD9AE1CD2DFCF7BD73F	TT:DigIO	Wipers/lights	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min:	Range Max:	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					

Table C-8. T3 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1327	29	0CF4DA36583A4BA0A8780CC43D9BC877	TT:RearAxleInitLeft	RSInterWheelSpeed	Value		

Data Type: Short Multiplier: Offset: Range Min: Range Max:

Ignore Vehicle Configuration(s)
T2C1
T2C2
T2C4
T2C3

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1326	30	55592EABACD14085A30766CCE5BE0CA6	TT:RearAxleInitRight	CSInterWheelSpeed	Value		

Data Type: Short Multiplier: Offset: Range Min: Range Max:

Ignore Vehicle Configuration(s)
T2C1
T2C2
T2C4
T2C3

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1325	31	D7BE63F25F004FB9BBB8BF0DA013B2AA	TT:Tgt Range	Tgt Range	Value		

Data Type: Short Multiplier: Offset: Range Min: 0 Range Max: 450

Ignore Type	Col #	Bit Start Index	Bit Length	Compare Type	Compare Value	Error on Ignore
Value	31			Equal (==)	836.61	
Bits	34	1	2	Not Equal (!=)	1	

Ignore Vehicle Configuration(s)
T2C1
T2C2
T2C4
T2C3

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1324	32	F7F6AF8F47FA4F6281B2A673FA7F8400	TT:Tgt RangeRate	Tgt RangeRate	Value		

Data Type: Short Multiplier: Offset: Range Min: 0 Range Max: 120

Ignore Type	Col #	Bit Start Index	Bit Length	Compare Type	Compare Value	Error on Ignore
Value	32			Equal (==)	836.61	
Bits	34	1	2	Not Equal (!=)	1	

Ignore Vehicle Configuration(s)
T2C1
T2C2
T2C4
T2C3

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1323	33	2DABB49AA6A64C7DA2AF81E60A326DDB	TT:Tgt Azimuth	Tgt Azimuth	Value		

Data Type: Short Multiplier: Offset: Range Min: -4.1 Range Max: 4.1

Ignore Type	Col #	Bit Start Index	Bit Length	Compare Type	Compare Value	Error on Ignore
Value	33			Equal (==)	4.06	
Bits	34	1	2	Not Equal (!=)	1	

Ignore Vehicle Configuration(s)
T2C1
T2C2
T2C4
T2C3

Table C-8. T3 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1322	34	7C50A82DA36F42038EC6D0DAC1A234AC	TT:TgtDetect/Alerts	TgtDetect/Alerts - Target Detect	Bits	1	2

Data Type: Short Occurrence Error Count: Occurrence Error:

Value	Type	Description	Error
00	Off	No Target	
01	On	Target Detected	
10	Error	Reserved	2021 - Not Available: Bits indicate a value that should not happen
11	Error	Take No Action	2021 - Not Available: Bits indicate a value that should not happen

Ignore Vehicle Configuration(s)
T2C1
T2C2
T2C4
T2C3

1333	34	7C50A82DA36F42038EC6D0DAC1A234AC	TT:TgtDetect/Alerts	TgtDetect/Alerts - ACC Shutoff Warning	Bits	3	2

Data Type: Short Occurrence Error Count: Occurrence Error:

Value	Type	Description	Error
00	Off	ACC SSOW Not Active	
01	On	ACC SSOW Active	
10	Error	Reserved	2021 - Not Available: Bits indicate a value that should not happen
11	Error	Take No Action	2021 - Not Available: Bits indicate a value that should not happen

Ignore Vehicle Configuration(s)
T2C1
T2C2
T2C4
T2C3

1334	34	7C50A82DA36F42038EC6D0DAC1A234AC	TT:TgtDetect/Alerts	TgtDetect/Alerts - ACC Distance Alert Signal	Bits	5	2

Data Type: Short Occurrence Error Count: Occurrence Error:

Value	Type	Description	Error
00	Off	ACC DAS Not Active	
01	On	ACC DAS Active	
10	Error	Reserved	2021 - Not Available: Bits indicate a value that should not happen
11	Error	Take No Action	2021 - Not Available: Bits indicate a value that should not happen

Ignore Vehicle Configuration(s)
T2C1
T2C2
T2C4
T2C3

1321	35	ACC1AAAAAAAAAAAAAAAAAAAAAAAA	TT:ACC System Error	ACC System Error	Value		

Data Type: Short Multiplier: Offset: Range Min: Range Max:

Ignore Type	Col #	Bit Start Index	Bit Length	Compare Type	Compare Value	Error on Ignore
Value	35			Equal (==)	24584	
Value	35			Equal (==)	25088	
Value	35			Equal (==)	25089	

Table C-8. T3 Tractor Validation Information (continued)

ID	Col #	Channel UUID		Message Desc	Channel Desc		Type	Bit Index	Bit Length
		Value	35		Equal (==)	25090			
		Value	35		Equal (==)	25091			
		Value	35		Equal (==)	25093			
		Value	35		Equal (==)	25094			
		Value	35		Equal (==)	25098			
		Value	35		Equal (==)	25099			
		Value	35		Equal (==)	25100			
		Value	35		Equal (==)	25095			
		Value	35		Equal (==)	25106			
		Value	35		Equal (==)	25108			
		Value	35		Equal (==)	25111			
		Value	35		Equal (==)	25120			
		Value	35		Equal (==)	25121			
		Value	35		Equal (==)	25122			
		Value	35		Equal (==)	25123			
		Value	35		Equal (==)	25124			
		Value	35		Equal (==)	25125			
		Value	35		Equal (==)	25126			
		Value	35		Equal (==)	25127			
		Value	35		Equal (==)	25128			
		Value	35		Equal (==)	25129			
		Value	35		Equal (==)	25092			
		Value	35		Equal (==)	25141			
		Value	35		Equal (==)	25142			
		Value	35		Equal (==)	25144			
		Value	35		Equal (==)	25145			
		Value	35		Equal (==)	25152			
		Value	35		Equal (==)	25153			
		Value	35		Equal (==)	25155			
		Value	35		Equal (==)	25160			
		Value	35		Equal (==)	25162			
		Value	35		Equal (==)	4101			
		Value	35		Equal (==)	4102			
		Value	35		Equal (==)	4103			
		Value	35		Equal (==)	4104			
		Value	35		Equal (==)	4105			
		Value	35		Equal (==)	4106			
		Value	35		Equal (==)	4107			
		Value	35		Equal (==)	4352			
		Value	35		Equal (==)	4353			
		Value	35		Equal (==)	4354			
		Value	35		Equal (==)	4355			
		Value	35		Equal (==)	4356			
		Value	35		Equal (==)	4357			
		Value	35		Equal (==)	4358			
		Value	35		Equal (==)	4359			
		Value	35		Equal (==)	4360			

Table C-8. T3 Tractor Validation Information (continued)

ID	Col #	Channel UUID		Message Desc	Channel Desc		Type	Bit Index	Bit Length
		Value	35		Equal (==)	4361			
		Value	35		Equal (==)	5901			
		Value	35		Equal (==)	24583			
		Value	35		Equal (==)	4096			
		Value	35		Equal (==)	4097			
		Value	35		Equal (==)	4098			
		Value	35		Equal (==)	4099			
		Value	35		Equal (==)	4100			
		Value	35		Equal (==)	4108			
		Value	35		Equal (==)	4362			
		Value	35		Equal (==)	4363			
		Value	35		Equal (==)	4364			
		Value	35		Equal (==)	4365			
		Value	35		Equal (==)	4366			
		Value	35		Equal (==)	4367			
		Value	35		Equal (==)	4368			
		Value	35		Equal (==)	4369			
		Value	35		Equal (==)	4370			
		Value	35		Equal (==)	4372			
		Value	35		Equal (==)	4373			
		Value	35		Equal (==)	4374			
		Value	35		Equal (==)	4608			
		Value	35		Equal (==)	4609			
		Value	35		Equal (==)	4610			
		Value	35		Equal (==)	4611			
		Value	35		Equal (==)	4613			
		Value	35		Equal (==)	4864			
		Value	35		Equal (==)	4865			
		Value	35		Equal (==)	4866			
		Value	35		Equal (==)	5120			
		Value	35		Equal (==)	5121			
		Value	35		Equal (==)	5122			
		Value	35		Equal (==)	5123			
		Value	35		Equal (==)	5124			
		Value	35		Equal (==)	5125			
		Value	35		Equal (==)	5126			
		Value	35		Equal (==)	5127			
		Value	35		Equal (==)	5128			
		Value	35		Equal (==)	5376			
		Value	35		Equal (==)	5888			
		Value	35		Equal (==)	5889			
		Value	35		Equal (==)	5890			
		Value	35		Equal (==)	5891			
		Value	35		Equal (==)	5892			
		Value	35		Equal (==)	5893			
		Value	35		Equal (==)	5894			
		Value	35		Equal (==)	5897			

Table C-8. T3 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
		Value 35		Equal (==) 5898			
		Value 35		Equal (==) 5899			
		Value 35		Equal (==) 5900			
		Value 35		Equal (==) 5902			
		Value 35		Equal (==) 5903			
		Value 35		Equal (==) 5904			
		Value 35		Equal (==) 5905			
		Value 35		Equal (==) 5907			
		Value 35		Equal (==) 6144			
		Value 35		Equal (==) 6145			
		Value 35		Equal (==) 24577			
		Value 35		Equal (==) 24578			
		Value 35		Equal (==) 4612			
		Value 35		Equal (==) 5632			
		Value 35		Equal (==) 5896			
		Value 35		Equal (==) 5906			
		Value 35		Equal (==) 24576			
		Value 35		Equal (==) 24579			
		Value 35		Equal (==) 24580			
		Value 35		Equal (==) 24581			
		Value 35		Equal (==) 24582			
		Value 35		Equal (==) 25414			
		Value 35		Equal (==) 25163			
		Value 35		Equal (==) 25164			
		Value 35		Equal (==) 25165			
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1320	36	FD12965C77764A5BA1F869AB95EA0540	TT:ESC_VDC1	ESC_VDC1 - VDC Fully Operational	Bits	3	2
		Data Type: Raw	Occurrence Error Count:	Occurrence Error:			
		Value ***Type*** ***Description***		***Error***			
		00 Off Not Fully Operational					
		01 On Fully Operational					
		10 Off Reserved					
		11 Off Don't Care/Take No Action					
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					

Table C-8. T3 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1319	37	4F4DC90B49A04C3193341CC345AE2216	TT:XBR	XBR - Requested Deceleration	Value	1	16
		Data Type: Raw	Multiplier: 0.00048828125	Offset:	Range Min: -15.687	Range Max: 15.687	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1318	38	8AEDF18CB022422EB9DAA2FF98ED9D6F	TT:ERC1_1 (Long)	ERC1_1 (Long)	Ignore		
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1317	39	C1E1BEF9462843D39352DBB7A9C0F761	TT:EBC1_1 (Long)	EBC1_1 (Long) - Brake Pedal Position	Value	17	8
		Data Type: Raw	Multiplier: 0.4	Offset:	Range Min: 0	Range Max: 101	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1335	39	C1E1BEF9462843D39352DBB7A9C0F761	TT:EBC1_1 (Long)	EBC1_1 (Long) - Engine Retarder Selection	Ignore	33	8
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1336	39	C1E1BEF9462843D39352DBB7A9C0F761	TT:EBC1_1 (Long)	EBC1_1 (Long) - ABS Fully Operational	Bits	41	2
		Data Type: Raw	Occurrence Error Count:	Occurrence Error:			

Value	*Type*	*Description*	*Error*
00	Off	Not Fully Operational	
01	On	Fully Operational	
10	Ignore	Ignore	
11	Ignore	Ignore	

Ignore Vehicle Configuration(s)
T2C1
T2C2
T2C4
T2C3

Table C-8. T3 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1337	39	C1E1BEF9462843D39352DBB7A9C0F761	TT:EBC1_1 (Long)	EBC1_1 (Long) - ABS Trailer Warning Lamp State		Bits	63

Data Type: Raw Occurrence Error Count: Occurrence Error:

Value	Type	Description	Error
00	Off	Available Not Active	
01	On	Active	
10	Ignore	Reserved	2021 - Not Available: Bits indicate a value that should not happen
11	Ignore	Not Available or Not Supported	2021 - Not Available: Bits indicate a value that should not happen

Ignore Vehicle Configuration(s)
T2C1
T2C2
T2C4
T2C3

1316	40	C1E1BEF9462843D39352DBB7A9C0F762	TT:EBC3 Brake Press	Brake_Pressures	Value		

Data Type: Raw Multiplier: Offset: Range Min: Range Max:

Ignore Vehicle Configuration(s)
T2C1
T2C2
T2C4
T2C3

1315	41	4F63B1C530E1448AA00591A69CB8B564	TT:Brake Lining Wear	Brake_Lining	Bits	1	8

Data Type: Raw Occurrence Error Count: Occurrence Error:

Value	Type	Description	Error
00000000	Off	Lamp Off	
00000001	On	Lamp On - Protect	
00000100	On	Lamp On - Amber	
00000101	On	Lamp On - Amber, Protect	
00010000	On	Lamp On - Red	
00010001	On	Lamp On - Red, Protect	
00010100	On	Lamp On - Red, Amber	
00010101	On	Lamp On - Red, Amber, Protect	
01000000	On	Lamp On - Malfunction	
01000001	On	Lamp On - Malfunction, Protect	
01000100	On	Lamp On - Malfunction, Amber	
01000101	On	Lamp On - Malfunction, Amber, Protect	
01010000	On	Lamp On - Malfunction, Red	
01010001	On	Lamp On - Malfunction, Red, Protect	
01010100	On	Lamp On - Malfunction, Red, Amber	
01010101	On	Lamp On - Malfunction, Red, Amber, Protect	

Ignore Vehicle Configuration(s)
T2C1
T2C2
T2C4
T2C3

Table C-8. T3 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1338	42	4F63B1C530E1448AA00591A69CB8B566	TT:TSC1	TSC1 - Requested Speed/Speed Limit	Value	9	16
		Data Type: Raw	Multiplier: 0.125	Offset:	Range Min: 0	Range Max: 8031.875	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C3					
		T2C4					
		T3					
1314	42	4F63B1C530E1448AA00591A69CB8B566	TT:TSC1	TSC1 - Requested Torque/Torque Limit	Value	25	8
		Data Type: Raw	Multiplier:	Offset: -125	Range Min: -125	Range Max: 125	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C3					
		T2C4					
		T3					
1313	43	4F63B1C530E1448AA00591A69CB8B567	TT:MD1 EBS	MD1 EBS	Ignore		
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1312	44	4F63B1C530E1448AA00591A69CB8B568	TT:MD2 EBS	MD2 EBS	Ignore		
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1311	45	4F63B1C530E1448AA00591A69CB8B569	TT:RSC/VDC	RSC/VDC	Ignore		
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C3					
		T2C4					
		T3					
1310	46	4F63B1C530E1448AA00591A69CB8B56A	TT:RSA	RSA	Ignore		
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C3					
		T2C4					
		T3					

Table C-8. T3 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1309	47	E306E28E200011D5A1BD0001031E1AE7	TT:TlrRoadFrontPsi	TlrRoadFrontPsi	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -5	Range Max: 150	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1308	48	E306E28E200111D5A1BD0001031E1AE7	TT:TlrCurbFrontPsi	TlrCurbFrontPsi	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -5	Range Max: 150	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1307	49	E306E28E200211D5A1BD0001031E1AE7	TT:TlrRoadRearPsi	TlrRoadRearPsi	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -5	Range Max: 150	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1306	50	E306E28E200311D5A1BD0001031E1AE7	TT:TlrCurbRearPsi	TlrCurbRearPsi	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -5	Range Max: 150	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1305	51	E306E28E200411D5A1BD0001031E1AE7	TT:TlrAirBag	TlrAirBag	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -5	Range Max: 100	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1304	52	E306E28E200711D5A1BD0001031E1AE7	TT:TlrFrontLeftWhlSpd	TlrFrontLeftWhlSpd	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min:	Range Max:	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					

Table C-8. T3 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1303	53	E306E28E200811D5A1BD0001031E1AE7	TT:TlrFrontrightWhlSpd	TlrFrontrightWhlSpd	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min:	Range Max:	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1302	54	E306E28E200911D5A1BD0001031E1AE7	TT:TlrRearAxleLeftRear	TlrRearLeftWhlSpd	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min:	Range Max:	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1301	55	E306E28E200A11D5A1BD0001031E1AE7	TT:TlrRearAxleRightRear	TlrRearRightWhlSpd	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min:	Range Max:	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1300	56	E306E28E200B11D5A1BD0001031E1AE7	TT:Tlr_Lat	Tlr_Lat	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -1	Range Max: 1	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1299	57	E306E28E200C11D5A1BD0001031E1AE7	TT:Tlr_F/A	Tlr_F/A	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -2	Range Max: 1	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					
1298	58	E306E28E200D11D5A1BD0001031E1AE7	TT:TlrYawRate	TlrYawRate	Value		
		Data Type: Short	Multiplier:	Offset:	Range Min: -20	Range Max: 20	
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C4					
		T2C3					

Table C-8. T3 Tractor Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
1297	59	E306E28E200F11D5A1BD0001031E1AE7	TT:Tlr_ID	Tlr_ID	Ignore		
		Ignore Vehicle Configuration(s)					
		T2C1					
		T2C2					
		T2C3					
		T2C4					
		T3					
1339	60	D7BE63F25F004FB9BCD8BF0DA013B2BD	TT:ACC_Mode	ACC_Mode - Adaptive Cruise Control Mode	Bits	1	3

Data Type: Short Occurrence Error Count: Occurrence Error:

Value	Type	Description	Error
000	Off	Off (Standby, enabled, ready for activation)	
001	On	Speed control active	
010	On	Distance control active	
011	On	Overtake mode	
100	On	Hold mode	
101	On	Finish mode	
110	Error	Disabled or Error Condition	2011 - Error Condition: Bits indicate an error condition
111	Error	Not Available/Not Valid	2021 - Not Available: Bits indicate a value that should not happen

1340	60	D7BE63F25F004FB9BCD8BF0DA013B2BD	TT:ACC_Mode	ACC_Mode - Set Distance Mode	Bits	4	3

Data Type: Short Occurrence Error Count: Occurrence Error:

Value	Type	Description	Error
000	Ignore	ACC Distance mode #1 (largest distance)	
001	Ignore	ACC Distance mode #2	
010	Ignore	ACC Distance mode #3	
011	Ignore	ACC Distance mode #4	
100	Ignore	ACC Distance mode #5 (shortest distance)	
101	Ignore	Conventional Cruise Control Mode	
110	Error	Error Condition	2011 - Error Condition: Bits indicate an error condition
111	Error	Not Available/Not Valid	2021 - Not Available: Bits indicate a value that should not happen

Table C-9. T2 Trailer Validation Information

Columns: *17*

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
482	1	FLTRC00000000020420040001031E1AE7	Relative Time	Relative Time	Value		
		Data Type: Short ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min:	Range Max:	
483	2	FLTRC00000010204200400001031E1AE7	HH:MM:SS	HH:MM:SS	Value		
		Data Type: Time ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min:	Range Max:	
484	3	E82ACA4AB86A4824844BCDF8B1184A24	TT:GPS Lat (long)	GPS Lat (long)	Value		
		Data Type: Long ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: 30	Range Max: 49	
485	4	0C346CD9EEE645F88A7B176103BDFB40	TT:GPS Long(long)	GPS Long (long)	Value		
		Data Type: Long ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: -125	Range Max: -90	
486	5	E3B285952F4941D68F25E7DFE0F3E497	TT:GPS Alti(long)	GPSAlti (long)	Value		
		Data Type: Long ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: 0	Range Max: 10000	
487	6	62E23439CD18476A9E56698A3EF50596	TT:Pressure 1	TlrRoadFrontPsi	Value		
		Data Type: Short ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: -5	Range Max: 150	
488	7	86657F01E9FF4DE5BC2268DB922FA0D9	TT:Pressure 2	TlrCurbFrontPsi	Value		
		Data Type: Short ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: -5	Range Max: 150	
489	8	1E5359F4D9E942B7AFEAB2DD4313241D	TT:Pressure 3	TlrRoadRearPsi	Value		
		Data Type: Short ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: -5	Range Max: 150	
490	9	E8CB8FD5CEEA44038AAA5B86939D25DB	TT:Pressure 4	TlrCurbRearPsi	Value		
		Data Type: Short ***Ignore Vehicle Configuration(s)*** T3	Multiplier:	Offset:	Range Min: -5	Range Max: 150	

Table C-9. T2 Trailer Validation Information (continued)

ID	Col #	Channel UUID	Message Desc	Channel Desc	Type	Bit Index	Bit Length
491	10	7AF342FE9E4C4474A7CED2BE1AA4D632	TT:Pressure 5	TlrAirBag Psi	Value		
		Data Type: Short *Ignore Vehicle Configuration(s)* T3 T2C1 T2C2	Multiplier:	Offset:	Range Min: 0	Range Max: 100	
492	11	7BB1618782CD455FB4F57810359E7784	TT:whlSpeed 6	TlrFrontLeftWhlSpd	Value		
		Data Type: Short *Ignore Vehicle Configuration(s)* T3	Multiplier:	Offset:	Range Min: 0	Range Max: 110	
493	12	7349C386111B416F8827A4208ADD63E8	TT:whlSpeed 7	TlrFrontrightWhlSpd	Value		
		Data Type: Short *Ignore Vehicle Configuration(s)* T3	Multiplier:	Offset:	Range Min: 0	Range Max: 110	
494	13	F23B95F08F324C4BA757E82B6BEC9320	TT:whlSpeed 8	TlrRearAxleLeftRear	Value		
		Data Type: Short *Ignore Vehicle Configuration(s)* T3	Multiplier:	Offset:	Range Min:	Range Max:	
495	14	268019F247C54EF2A2F6E786B687603F	TT:WhlSpeed 9	TlrRearAxleRightRear	Value		
		Data Type: Short *Ignore Vehicle Configuration(s)* T3	Multiplier:	Offset:	Range Min:	Range Max:	
496	15	29CB2CF3A7454C56A3ED76E46993380A	TT:Lat DC	Lat DC	Value		
		Data Type: Short *Ignore Vehicle Configuration(s)* T3	Multiplier:	Offset:	Range Min: -1	Range Max: 1	
497	16	DE1527BBDC894504972917DD47B01446	TT:F/A DC	F/A DC	Value		
		Data Type: Short *Ignore Vehicle Configuration(s)* T3	Multiplier:	Offset:	Range Min: -2	Range Max: 1	
498	17	CDB0B86EF11E4BE0BA8384F1ED00DDC9	TT:YawRate	YawRate	Value		
		Data Type: Short *Ignore Vehicle Configuration(s)* T3	Multiplier:	Offset:	Range Min: -20	Range Max: 20	

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APPENDIX D. QUALITY CONTROL CHECKLISTS

QUALITY ASSURANCE DOCUMENT

PROCEDURE FOR INSTALLING INSTRUMENTATION FOR FREIGHTLINER ECBS FIELD OPERATIONAL TEST

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(October 1, 2004)

APPROVED BY

Program Technical Manager Date	Department Manager Date
Program Manager Date	Program QA Manager Date

PROCEDURE FOR INSTALLING INSTRUMENTATION FOR FREIGHTLINER ECBS FIELD OPERATIONAL TEST

1.0 Scope

1.1 The Freightliner electronically controlled braking system (ECBS) field operational test (FOT) is a U.S. Department of Transportation-sponsored program to establish the efficacy of ECBS systems in preventing the rate of fatalities associated with commercial highway heavy truck incidents. This document describes the procedures for installing instrumentation on a fleet of highway tractors and trailers to collect data to determine the effectiveness of ECBS systems. The purpose of this document is to ensure that the instrumentation is installed in a consistent manner such that no critical steps in the installation process are omitted.

2.0 Objective

2.1 The objective of the Freightliner FOT is to develop and demonstrate an improved understanding of ECBS in terms of performance, reliability, durability, maintainability and safety benefits in a real-world operating environment.

3.0 Approach

3.1 A fleet of 48 Wal★Mart tractors and 100 trailers will be instrumented with transducers to sense braking and truck/trailer performance with and without ECBS systems. Two configurations, so called Templates, will be considered: 1) Mixed Tractor-trailer, and 2) “Optimized” Tractor-Trailer. In the mixed template, Template 2, tractors and trailers with ECBS may be mixed with units with or without ECBS systems. In the optimized template, Template 3, tractors and trailers will both have ECBS systems. There is no Template 1 in the current program.

3.2 Data will be collected for a 12-month period: 6 months without the ECBS systems active to provide baseline data, and 6 months with ECBS functional. The baseline and active systems phases will enable evaluation of the potential safety benefits of the ECBS systems. The data will be evaluated by an independent evaluator.

3.3 Table 1 summarizes the data that will be collected during the FOT. All data are recorded at 10 Hz as long as the tractor is running or a trailer is powered. The FOT data are collected by a data acquisition system (DAS) mounted on the tractor/trailer for the FOT.

Table 1 Data to be Collected During the FOT

Unit	Value
Tractor	GPS data
	J1939 bus data
	J1708/J1587 bus data
	Brake chamber pressures
	Wheel speeds
	Longitudinal acceleration
	Lateral acceleration
	Yaw rate
	Steering angle
	Suspension pressure
	Compressor pressure
	Trailer control valve pressure
	Treadle valve pressure
	Headlight on/off
	Turn signal indicators on/off
	Wiper on/off
Trailer	GPS data
	Brake chamber pressures
	Wheel speeds
	Longitudinal acceleration
	Lateral acceleration
	Yaw rate

4.0 Configurations

4.1 Tables 2 and 3 define the various configurations in the FOT. Consistent with real-world conditions, different technologies will be randomly paired with each other in the FOT. The various configurations reflect this situation.

Table 2 FOT Tractor Configurations

Template	Configuration	Braking System
2	1	Meritor WABCO ABS Drum Brake
	2	Meritor WABCO ABS Disc Brake
	3	Meritor WABCO ECBS Disc Brake
	4	Bendix ABS6 Disc Brake
3	-	Meritor WABCO ECBS Disc Brake

Table 3 FOT Trailer Configurations

Template	Configuration	Suspension	Braking System	Brakes
2	1	Binkley Duralite Spring	4S-2M ABS	Drum
	2	Binkley Duralite Spring	4S-2M ABS	Meritor EX225 Disc
	3	Hendrickson HKANT-40	Meritor WABCO ECBS	Bendix-Knorr 225X Disc
	4	Hendrickson HKANT-40	Bendix-Knorr ECBS	Bendix-Knorr 225X Disc
3	-	Hendrickson HKANT-40	Meritor WABCO ECBS	Bendix-Knorr 225X Disc

4.2 Each tractor and trailer configuration natively has a set of sensors to support ABS and ECBS functions. These ABS/ECBS data are available on data busses on the vehicles and will be collected during the FOT. Additional transducers will be added for the FOT to supplement the available bus data. Because the bus data are not identical for the various configurations, the set of transducers that the FOT will add to each tractor and trailer is slightly different. A separate procedure addresses the QA installation process for each possible configuration.

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
1.0 Vehicle Serial Number _____	_____/_____
2.0 Wal★Mart ID _____	_____/_____
3.0 Disconnect Ground at Ground Jumper Between Batteries	_____/_____
4.0 Install GPS	_____/_____
4.1 Transducer S/N: _____	_____/_____
4.2 Mount the GPS on curbside of QualComm antenna bracket	_____/_____
4.3 Remove existing grommet where QualComm antenna enters vehicle	_____/_____
4.4 Drill 1/2" hole in grommet	_____/_____
4.5 Feed antenna cable through 1/2" hole in grommet	_____/_____
4.6 Drop bunk down and remove two light panels from corner post at back of cab	_____/_____
4.7 Feed antenna cable down from top of cab	_____/_____
4.8 Lift bunk up and pull cable from below	_____/_____
4.9 Re-install light panels at corner post	_____/_____
4.10 Route GPS cable to the DAS through wiring channel at back of cab	_____/_____
4.11 Trim wire to length	_____/_____
4.12 Strip outer jacket back 1-1/2 inches	_____/_____
4.13 Strip wires 3/16 inches	_____/_____
4.14 Crimp MS39029/31-240 pins onto stripped wire	_____/_____
4.15 Insert green wire into MS3126F16-26P connector pin N	_____/_____
4.16 Insert white wire into MS3126F16-26P connector pin P	_____/_____
4.17 Insert red wire into MS3126F16-26P connector pin R	_____/_____
4.18 Insert black wire into MS3126F16-26P connector pin S	_____/_____
5.0 Prepare Cabin for Installation	_____/_____
5.1 Remove mattress	_____/_____
5.2 Remove lower curbside cabinet (4 nuts/washers on wall, 2 bolts/washers on floor)	_____/_____
5.3 Remove curbside seat belt cover (it pops off)	_____/_____
5.4 Remove curbside sill plate (3 screws)	_____/_____
5.5 Remove cover at base of curbside pillar (1 screw)	_____/_____
5.6 Remove 2 screws holding B pillar cover in place	_____/_____
5.7 Pull weatherstripping off edge of door	_____/_____
5.8 Remove B pillar grab handle (2 bolts)	_____/_____
5.9 In storage area under bed, under floor mat at curbside, remove three plastic plugs	_____/_____
5.10 Place floor mat back in place and mark three holes from under the cab with a Sharpie	_____/_____
5.11 Drill 1/4-inch holes at the marked locations in the mat	_____/_____
5.12 With mat in place in the truck, locate DAS mounting plate on floor and mate to the three holes	_____/_____

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
5.13 Loosely install plate with 3 1/4-20 1-1/2" bolts with washers and locking nuts on the outside	_____/_____
5.14 Using the mounting plate as a guide, center punch two remaining mounting holes	_____/_____
5.15 Drill two 5/16" holes in truck floor for DAS mounting plate	_____/_____
5.16 Vacuum the area to remove drill cuttings	_____/_____
5.17 Install 2 more 1/4-20 1-1/2" bolts with washers and locking nuts	_____/_____
5.18 Tighten all DAS mounting plate bolts	_____/_____
5.19 Mark location for bulkhead connector: 2 inches from front of rivet, 3-1/8 inches from side rail	_____/_____
5.20 Center punch, drill pilot hole, and punch 1-5/8 inch hole for DAS bulkhead connector in floor of cab at the bottom of the curbside pillar	_____/_____
5.21 Vacuum the area to remove drill cuttings	_____/_____
5.22 Install bulkhead fitting with washer and nut	_____/_____
5.23 Route DAS bulkhead cables	_____/_____
5.23.1 Remove HVAC cover under bed (2 screws)	_____/_____
5.23.2 Take backshells off cables	_____/_____
5.23.3 Tape wires together to prevent untwisting of pairs	_____/_____
5.23.4 Feed cables up through B pillar	_____/_____
5.23.5 Continue towards rear into trim channel	_____/_____
5.23.6 Drop down slightly into channel	_____/_____
5.23.7 Feed wire behind lower bed liner	_____/_____
5.23.8 Route wires out through upper corner of HVAC	_____/_____
5.24 Remove curbside upper and lower dashboard	_____/_____
5.24.1 Remove PDM cover	_____/_____
5.24.2 Pop out upper trim piece from inside	_____/_____
5.24.3 Remove lower panel (4 screws)	_____/_____
5.25 Loosen curbside kick panel	_____/_____
5.25.1 Pull floor mat up	_____/_____
5.25.2 Lift out floor plate	_____/_____
5.25.3 Take out two screws in floor	_____/_____
5.25.4 Pull weatherstripping from lower edge of door	_____/_____
5.26 Remove lower steering shaft cover by pulling bottom out, lifting up and pulling out	_____/_____
5.27 Remove steering column cover (3 nuts/washers)	_____/_____
5.28 Remove fire extinguisher	_____/_____
5.29 Remove roadside sill plate (3 screws)	_____/_____
5.30 Loosen roadside kick panel	_____/_____
5.30.1 Pop off yellow button	_____/_____
5.30.2 Pull floor mat up	_____/_____
5.30.3 Take out two screws in floor	_____/_____
5.30.4 Pop up center of fastener in upper side of panel	_____/_____
5.30.5 Pull weatherstripping from lower edge of door	_____/_____

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
5.31 Move roadside seat belt cover out of the way	_____/_____
5.32 Open roadside access panel with a flat blade screw driver	_____/_____
6.0 Disable ACC Display	_____/_____
6.1 Remove cup holder by pulling upwards	_____/_____
6.2 Remove HVAC trim piece	_____/_____
6.2.1 Remove two screws	_____/_____
6.2.2 Pull away from clips	_____/_____
6.3 Remove dash panel outer contour trim piece	_____/_____
6.3.1 Remove one screw	_____/_____
6.3.2 Pull away from clip	_____/_____
6.4 Remove dash piece trim located between the instrument cluster and the dash panel by pushing up and away on the bottom section to free it	_____/_____
6.5 Remove trailer air supply and parking brake knobs	_____/_____
6.6 Remove dash panel	_____/_____
6.6.1 Remove four screws	_____/_____
6.6.2 Release panel from metal clips by pushing up on panel and pulling the bottom away and down	_____/_____
6.7 Disconnect ACC connector	_____/_____
6.8 Label with red tape marked "ACC Display"	_____/_____
6.9 Tie wrap the connector to the large diameter black pneumatic hose (~3" recessed into dash)	_____/_____
6.10 Reinstall dash panel	_____/_____
6.10.1 Latch panel in metal clips by lifting panel up, seating it on the clips and pushing down	_____/_____
6.10.2 Reinstall four screws	_____/_____
6.11 Reinstall trailer supply and parking brake knobs	_____/_____
6.12 Reinstall dash piece trim located between the instrument cluster and the dash panel by setting in place and pushing down	_____/_____
6.13 Reinstall dash panel outer contour trim piece	_____/_____
6.13.1 Push onto clip	_____/_____
6.13.2 Reinstall one screw	_____/_____
6.14 Reinstall HVAC trim piece	_____/_____
6.14.1 Push onto clips	_____/_____
6.14.2 Reinstall two screws	_____/_____
6.15 Reinstall cup holder by pushing downwards	_____/_____
7.0 Install Steering Sensor Assembly	_____/_____
7.1 Transducer: ATC 5K geared potentiometer	_____/_____
7.2 Transducer S/N: _____	_____/_____
7.3 Install the drive gear on the steering shaft, gear side down, up against U-joint. If gear is loose on shaft, shim under gear with electrical tape.	_____/_____
7.4 Center the potentiometer by turning it completely clockwise and then	

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
turn it counter-clockwise 5 complete turns	_____/_____
7.5 Center the vehicle steering	_____/_____
7.6 Mate the potentiometer gear with the drive gear	_____/_____
7.6.1 Slip the potentiometer assembly up over the steering shaft	_____/_____
7.6.2 Mate with fixed gear	_____/_____
7.6.3 Adjust pot position till gears mate nicely	_____/_____
7.6.4 Secure to steering column supports with set screws	_____/_____
7.7 Route steering sensor wires to DAS location	_____/_____
7.7.1 Up over steering column support toward roadside	_____/_____
7.7.2 Into roadside sill channel with other wires	_____/_____
7.7.3 Up into access panel area	_____/_____
7.7.4 Continue up to bunk support channel and moving towards back of cab	_____/_____
7.7.5 Continue in wire channel at back of bunk support	_____/_____
7.7.6 Exit at upper corner of HVAC (where DAS wires exit)	_____/_____
7.8 Trim wire to length	_____/_____
7.9 Strip wires 3/16 inches	_____/_____
7.10 Crimp MS39029/31-240 pins onto stripped wire	_____/_____
7.11 Insert white wire into MS3126F20-41P (J1) connector pin e	_____/_____
7.12 Insert black wire into MS3126F20-41P (J1) connector pin f	_____/_____
7.13 Insert red wire into MS3126F20-41P (J1) connector pin g	_____/_____
8.0 Install J1939 Tap	_____/_____
8.1 Cut 20 feet of yellow and green Anixter 6GXL-2001 wire	_____/_____
8.2 Strip yellow and green Anixter 6GXL-2001 wires 0.1 inches	_____/_____
8.3 Crimp Deutsch #0460-202-20141 pins onto stripped wire	_____/_____
8.4 Insert yellow wire into terminal 1 into Deutsch DTM04-2P connector	_____/_____
8.5 Insert green wire into terminal 2 into Deutsch DTM04-2P connector	_____/_____
8.6 Finish connector by pushing in Deutsch WM-2P wedge	_____/_____
8.7 Route J1939 wires to DAS location	_____/_____
8.7.1 Into bunk support channel and moving towards back of cab	_____/_____
8.7.2 Continue in wire channel at back of bunk support	_____/_____
8.7.3 Exit at upper corner of HVAC (where DAS wires exit)	_____/_____
8.8 Cut wires to length	_____/_____
8.9 Strip wires 3/16 inches	_____/_____
8.10 Crimp MS39029/31-240 pins onto stripped wire	_____/_____
8.11 Insert yellow wire into MS3126F16-26P connector pin T	_____/_____
8.12 Insert green wire into MS3126F16-26P connector pin U	_____/_____
9.0 Install J1708/J1587 Tap	_____/_____
9.1 Cut 20 feet of orange and green Anixter 6GXL-2001 wire	_____/_____
9.2 Slide cable seals onto orange and green wire ends	_____/_____
9.3 Strip wires 0.200 inches	_____/_____

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
9.4 Crimp female Metri-Pack #12047767 terminal onto stripped wire	_____/_____
9.5 Insert green wire into Metri-Pack #12052832 2-way connector terminal A	_____/_____
9.6 Insert orange wire into Metri-Pack #12052832 2-way connector terminal B	_____/_____
9.7 Apply Metri-Pack #12047764 terminal assurance protection device	_____/_____
9.8 Plug connector into J1708 terminal block	_____/_____
9.9 Route J1708/J1587 wires from terminal block to DAS	_____/_____
9.9.1 Into bunk support channel and moving towards back of cab	_____/_____
9.9.2 Continue in wire channel at back of bunk support	_____/_____
9.9.3 Exit at upper corner of HVAC (where DAS wires exit)	_____/_____
9.10 Cut wires to length	_____/_____
9.11 Strip wires 3/16 inches	_____/_____
9.12 Crimp MS39029/31-240 pins onto stripped wire	_____/_____
9.13 Insert orange wire into MS3126F16-26P connector pin V	_____/_____
9.14 Insert green wire into MS3126F16-26P connector pin W	_____/_____
10.0 Install Windshield Wiper Sensor	_____/_____
10.1 Cut 15-foot length of yellow Anixter 6GXL-2001 wire	_____/_____
10.2 Tap wiper wire 315P (left most pancake connector row D) with Scotchlok 804 tap	_____/_____
10.2.1 Open hinged side wall	_____/_____
10.2.2 Place unstripped run wire inside run channel and close hinged side wall	_____/_____
10.2.3 Insert unstripped tap wire completely into tap port	_____/_____
10.2.4 Hold pliers perpendicular to the wire and make connection by crimping u-contact down flush with top of insulator	_____/_____
10.2.5 Close cover until latched	_____/_____
10.3 Route wiper wire from lower dash area to DAS location	_____/_____
10.3.1 To curbside sill channel area	_____/_____
10.3.2 Feed wire up through B pillar	_____/_____
10.3.3 Continue towards rear into trim channel	_____/_____
10.3.4 Drop down slightly into channel	_____/_____
10.3.5 Feed wire behind lower bed liner	_____/_____
10.3.6 Route wires out through upper corner of HVAC	_____/_____
10.4 Trim wire to length	_____/_____
10.5 Strip wires 3/16 inches	_____/_____
10.6 Crimp MS39029/31-240 pins onto stripped wire	_____/_____
10.7 Insert wire into DAS connector MS3126F16-26P (J3) pin E	_____/_____
11.0 Install DAS Power	_____/_____
11.1 Cut 15-foot length of #E18C9-0STW 2-conductor cable	_____/_____
11.2 Strip outer jacket back 3 inches	_____/_____
11.3 Solder fuse holder in-line on white wire	_____/_____
11.4 Solder circular lug on fuse wire	_____/_____
11.5 Crimp and solder Freightliner spade lug on black wire	_____/_____

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
11.6 Put heat shrink over fuse-to-wire connection	_____/_____
11.7 Put fuse in fuse holder	_____/_____
11.8 Route power wire from fuse panel to DAS location	_____/_____
11.8.1 Behind dash area	_____/_____
11.8.2 To curbside sill channel area	_____/_____
11.8.3 Feed wire up through B pillar	_____/_____
11.8.4 Continue towards rear into trim channel	_____/_____
11.8.5 Drop down slightly into channel	_____/_____
11.8.6 Feed wire behind lower bed liner	_____/_____
11.8.7 Route wires out through upper corner of HVAC	_____/_____
11.9 Cut wire to length	_____/_____
11.10 Strip outer jacket back 1-1/2 inches on free end	_____/_____
11.11 Strip wires 3/16 inches	_____/_____
11.12 Crimp MS39029/31-240 pins onto stripped wire	_____/_____
11.13 Insert white wire into MS3126F16-26P connector pin b	_____/_____
11.14 Insert black wire into MS3126F16-26P connector pin c	_____/_____
11.15 At fuse panel, screw lug on fused wire to ignition terminal (+12V)	_____/_____
11.16 At fuse panel, push lug from black wire onto ground terminal (by big yellow wire)	_____/_____
12.0 Wire MS3126F20-41P (J1) connector	_____/_____
12.1 Slide strain relief onto cable	_____/_____
12.2 Insert brown wire from brown-black pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin A	_____/_____
12.3 Insert black wire from brown-black pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin B	_____/_____
12.4 Insert white wire from white-green pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin C	_____/_____
12.5 Insert green wire from white-green pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin D	_____/_____
12.6 Insert blue wire from green-blue pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin E	_____/_____
12.7 Insert green wire from green-blue pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin F	_____/_____
12.8 Insert orange wire from orange-red pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin G	_____/_____
12.9 Insert red wire from orange-red pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin H	_____/_____
12.10 Insert brown wire from brown-red pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin J	_____/_____
12.11 Insert red wire from brown-red pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin K	_____/_____
12.12 Insert yellow wire from yellow-red pair of Alpha #2219	

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
15pr cable into MS3126F20-41P (J1) connector pin L	_____/_____
12.13 Insert red wire from yellow-red pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin M	_____/_____
12.14 Insert blue wire from blue-red pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin N	_____/_____
12.15 Insert red wire from blue-red pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin P	_____/_____
12.16 Insert green wire from green-red pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin R	_____/_____
12.17 Insert red wire from green-red pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin S	_____/_____
12.18 Insert yellow wire from yellow-black pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin T	_____/_____
12.19 Insert black wire from yellow-black pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin U	_____/_____
12.20 Insert orange wire from orange-black pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin V	_____/_____
12.21 Insert black wire from orange-black pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin W	_____/_____
12.22 Insert white wire from white-black pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin X	_____/_____
12.23 Insert black wire from white-black pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin Y	_____/_____
12.24 Insert red wire from red-black pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin Z	_____/_____
12.25 Insert black wire from red-black pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin a	_____/_____
12.26 Insert blue wire from blue-black pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin b	_____/_____
12.27 Insert black wire from blue-black pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin c	_____/_____
12.28 Insert green wire from green-black pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin d	_____/_____
12.29 Insert black wire from green-black pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin h	_____/_____
12.30 Insert white wire from white-red pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin i	_____/_____
12.31 Insert red wire from white-red pair of Alpha #2219 15pr cable into MS3126F20-41P (J1) connector pin j	_____/_____
12.32 Cut 4-inch length of scrap wire	_____/_____
12.33 Strip ends 3/16 inches	_____/_____
12.34 Crimp MS39029/31-240 pins onto stripped wire	_____/_____

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

Work by/Date

12.35 Insert one end into MS3126F20-41P (J1) connector pin k _____/_____
12.36 Insert the other end into MS3126F20-41P (J1) connector pin p _____/_____
12.37 Insert MS39029/31-240 pins into unused pins _____/_____
12.37.1 NC: MS3126F20-41P (J1) connector pin m _____/_____
12.37.2 NC: MS3126F20-41P (J1) connector pin n _____/_____
12.37.3 NC: MS3126F20-41P (J1) connector pin q _____/_____
12.37.4 NC: MS3126F20-41P (J1) connector pin r _____/_____
12.37.5 NC: MS3126F20-41P (J1) connector pin s _____/_____
12.37.6 NC: MS3126F20-41P (J1) connector pin t _____/_____
12.38 Slide strain relief up to connector, screw it on and tighten clamp _____/_____

13.0 Wire MS3126F16-26P (J3) connector _____/_____
13.1 Slide strain relief onto cable _____/_____
13.2 Insert black wire from black-green pair of Alpha #2219
9pr cable into MS3126F16-26P (J3) connector pin A _____/_____
13.3 Insert green wire from black-green pair of Alpha #2219
9pr cable into MS3126F16-26P (J3) connector pin B _____/_____
13.4 Insert blue wire from blue-black pair of Alpha #2219
9pr cable into MS3126F16-26P (J3) connector pin C _____/_____
13.5 Insert black wire from blue-black pair of Alpha #2219
9pr cable into MS3126F16-26P (J3) connector pin D _____/_____
13.6 Black wire from black-brown pair of Alpha #2219 9pr cable is unused _____/_____
13.7 Insert brown wire from black-brown pair of Alpha #2219
9pr cable into MS3126F16-26P (J3) connector pin G _____/_____
13.8 Insert black wire from black-yellow pair of Alpha #2219
9pr cable into MS3126F16-26P (J3) connector pin H _____/_____
13.9 Insert yellow wire from black-yellow pair of Alpha #2219
9pr cable into MS3126F16-26P (J3) connector pin J _____/_____
13.10 Insert black wire from black-orange pair of Alpha #2219
9pr cable into MS3126F16-26P (J3) connector pin K _____/_____
13.11 Insert orange wire from black-orange pair of Alpha #2219
9pr cable into MS3126F16-26P (J3) connector pin L _____/_____
13.12 Insert green wire from green-red pair of Alpha #2219
9pr cable into MS3126F16-26P (J3) connector pin M _____/_____
13.13 Insert green wire from GPS cable into MS3126F16-26P (J3) connector pin N _____/_____
13.14 Insert white wire from GPS cable into MS3126F16-26P (J3) connector pin P _____/_____
13.15 Insert red wire from GPS cable into MS3126F16-26P (J3) connector pin R _____/_____
13.16 Insert black wire from GPS cable into MS3126F16-26P (J3) connector pin S _____/_____
13.17 Insert white wire from black-white pair of Alpha #2219
9pr cable into MS3126F16-26P (J3) connector pin Z _____/_____
13.18 Insert remaining red wire from Alpha #2219
9pr cable into MS3126F16-26P (J3) connector pin a _____/_____
13.19 Insert MS39029/31-240 pins into unused pins _____/_____

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

Work by/Date

13.19.1 NC: MS3126F20-41P (J1) connector pin F _____/_____
13.19.2 NC: MS3126F20-41P (J1) connector pin X _____/_____
13.19.3 NC: MS3126F20-41P (J1) connector pin Y _____/_____
13.20 Unused wires _____/_____
13.20.1 Red wire from green-red pair of Alpha #2219
9pr cable is unused (former MS3126F16-26P (J3) connector pin N) _____/_____
13.20.2 White wire from white-red pair of Alpha #2219
9pr cable is unused (former MS3126F16-26P (J3) connector pin P) _____/_____
13.20.3 Red wire from white-red pair of Alpha #2219
9pr cable is unused (former MS3126F16-26P (J3) connector pin R) _____/_____
13.20.4 Black wire from black-white pair of Alpha #2219
9pr cable is unused (former MS3126F16-26P (J3) connector pin S) _____/_____
13.21 Slide strain relief up to connector, screw it on and tighten clamp _____/_____

14.0 Install Brake Chamber Pressure Transducer - Roadside Steer _____/_____
14.1 Remove air line from bulkhead flare fitting on frame rail _____/_____
14.2 Remove supply pressure line from brake chamber _____/_____
14.3 Install street tee with pipe dope on brake chamber _____/_____
14.4 Orient street tee such that the transducer will point toward the road _____/_____
14.5 Connect pressure line to street tee with pipe dope _____/_____
14.6 Reinstall air line at flare fitting on frame rail _____/_____
14.7 Transducer: Measurement Specialties MSP400-150-P-3/8" NPT-4 _____/_____
14.8 Transducer S/N: _____ _____/_____
14.9 Attach transducer to street tee with pipe dope _____/_____
14.10 Apply and shrink heat shrink over bare wires exposed
below connector on pre-made cable _____/_____
14.11 Route sensor cable along supply pressure line to lefthand frame rail, and
along frame rail to transmission cooler cross-member, and over to DAS
bulkhead connector location _____/_____

15.0 Install Brake Chamber Pressure Transducer - Curbside Steer _____/_____
15.1 Remove air line from bulkhead flare fitting on frame rail _____/_____
15.2 Remove supply pressure line from brake chamber _____/_____
15.3 Install street tee with pipe dope on brake chamber _____/_____
15.4 Orient street tee such that the transducer will point toward the road _____/_____
15.5 Connect pressure line to street tee with pipe dope _____/_____
15.6 Reinstall air line at flare fitting on frame rail _____/_____
15.7 Transducer: Measurement Specialties MSP400-150-P-3/8" NPT-4 _____/_____
15.8 Transducer S/N: _____ _____/_____
15.9 Attach transducer to street tee with pipe dope _____/_____
15.10 Apply and shrink heat shrink over bare wires exposed below connector on
pre-made cable _____/_____
15.11 Route sensor cable along supply pressure line to righthand frame rail and

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
along frame rail to DAS bulkhead connector location	_____/_____
16.0 Install Brake Chamber Pressure Transducer - Roadside Intermediate	_____/_____
16.1 Remove supply pressure line from 45˚ fitting attached to brake chamber	_____/_____
16.2 Remove 45˚ fitting from brake chamber	_____/_____
16.3 Install street tee with pipe dope on brake chamber	_____/_____
16.4 Orient street tee such that transducer will point outward towards the wheel set	_____/_____
16.5 Attach 45˚ fitting to street tee with pipe dope	_____/_____
16.6 Connect pressure line to 45˚ fitting	_____/_____
16.7 Transducer: Measurement Specialties MSP400-150-P-3/8" NPT-4	_____/_____
16.8 Transducer S/N: _____	_____/_____
16.9 Attach transducer to street tee with pipe dope	_____/_____
16.10 Apply and shrink heat shrink over bare wires exposed below connector on pre-made cable	_____/_____
16.11 Route sensor cable along lefthand frame rail to cross-member at back of cab, over to righthand frame rail, on to DAS bulkhead connector location	_____/_____
17.0 Install Brake Chamber Pressure Transducer - Curbside Intermediate	_____/_____
17.1 Remove supply pressure line from 45˚ fitting attached to brake chamber	_____/_____
17.2 Remove 45˚ fitting from brake chamber	_____/_____
17.3 Install street tee with pipe dope on brake chamber	_____/_____
17.4 Orient street tee such that transducer will point outward toward the wheel set	_____/_____
17.5 Attach 45˚ fitting to street tee with pipe dope	_____/_____
17.6 Connect pressure line to 45˚ fitting	_____/_____
17.7 Transducer: Measurement Specialties MSP400-150-P-3/8" NPT-4	_____/_____
17.8 Transducer S/N: _____	_____/_____
17.9 Attach transducer to street tee with pipe dope	_____/_____
17.10 Apply and shrink heat shrink over bare wires exposed below connector on pre-made cable	_____/_____
17.11 Route sensor cable along righthand frame rail to DAS bulkhead connector location	_____/_____
18.0 Install Brake Chamber Pressure Transducer - Roadside Rear	_____/_____
18.1 Remove supply pressure line from 45˚ fitting attached to brake chamber	_____/_____
18.2 Remove 45˚ fitting from brake chamber	_____/_____
18.3 Install street tee with pipe dope on brake chamber	_____/_____
18.4 Orient street tee such that transducer will point upward	_____/_____
18.5 Attach 45˚ fitting to street tee with pipe dope	_____/_____
18.6 Connect pressure line to 45˚ fitting	_____/_____
18.7 Transducer: Measurement Specialties MSP400-150-P-3/8" NPT-4	_____/_____
18.8 Transducer S/N: _____	_____/_____
18.9 Attach transducer to street tee with pipe dope	_____/_____
18.10 Apply and shrink heat shrink over bare wires exposed below connector on	

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
pre-made cable	_____/_____
18.11 Route sensor cable along lefthand frame rail to cross-member at back of cab, over to righthand frame rail, on to DAS bulkhead connector location	_____/_____
19.0 Suspension Pressure Transducer - Roadside Rear	_____/_____
19.1 Remove supply pressure line from 90˚ fitting on suspension airbag	_____/_____
19.2 Remove 90˚ fitting from suspension airbag	_____/_____
19.3 Install street tee with pipe dope on airbag	_____/_____
19.4 Orient street tee such that the transducer will be parallel with the ground, pointed towards the front of the truck when installed	_____/_____
19.5 Connect 90˚ fitting to street tee with pipe dope	_____/_____
19.6 Connect pressure line to 90˚ fitting	_____/_____
19.7 Transducer: Measurement Specialties MSP400-150-P-N-4 (1/4" NPT)	_____/_____
19.8 Transducer S/N: _____	_____/_____
19.9 Attach transducer to street tee with pipe dope	_____/_____
19.10 Apply and shrink heat shrink over bare wires exposed below connector on pre-made cable	_____/_____
19.11 Route sensor cable along lefthand frame rail to cross-member at back of cab, over to righthand frame rail, and on to DAS bulkhead connector location	_____/_____
20.0 Install Brake Chamber Pressure Transducer - Curbside Rear	_____/_____
20.1 Remove supply pressure line from 45˚ fitting attached to brake chamber	_____/_____
20.2 Remove 45˚ fitting from brake chamber	_____/_____
20.3 Install street tee with pipe dope on brake chamber	_____/_____
20.4 Orient street tee such that transducer will point upward	_____/_____
20.5 Attach 45˚ fitting to street tee with pipe dope	_____/_____
20.6 Connect pressure line to 45˚ fitting	_____/_____
20.7 Transducer: Measurement Specialties MSP400-150-P-3/8" NPT-4	_____/_____
20.8 Transducer S/N: _____	_____/_____
20.9 Attach transducer to street tee with pipe dope	_____/_____
20.10 Apply and shrink heat shrink over bare wires exposed below connector on pre-made cable	_____/_____
20.11 Route sensor cable along righthand frame rail to DAS bulkhead connector location	_____/_____
21.0 Install Compressor Governor Signal Pressure Transducer	_____/_____
21.1 Remove pressure relief valve so that pressure supply line may be accessed	_____/_____
21.2 Remove compressor supply pressure line and fitting	_____/_____
21.3 Install street tee with pipe dope on compressor	_____/_____
21.4 Orient street tee such that transducer will point downward towards the road when installed	_____/_____
21.5 Connect pressure line and fitting to street tee	_____/_____
21.6 Connect pressure relief valve to compressor with pipe dope	_____/_____

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
21.7 Transducer: Measurement Specialties MSP400-150-P-N-4 (1/4" NPT)	_____/_____
21.8 Transducer S/N: _____	_____/_____
21.9 Attach transducer to street tee with pipe dope	_____/_____
21.10 Apply and shrink heat shrink over bare wires exposed below connector on pre-made cable	_____/_____
21.11 Route sensor cable along compressor line to righthand frame rail, and back along frame rail to DAS bulkhead connector location	_____/_____
22.0 Install Tractor Protection Valve Signal Pressure Transducer	_____/_____
22.1 Remove tractor protection valve supply pressure line (black on Wabco braking systems - Configurations 1 and 2, orange on Bendix braking systems - Configuration 4)	_____/_____
22.2 Install street tee with pipe dope on tractor protection valve	_____/_____
22.3 Connect pressure line to street tee with pipe dope	_____/_____
22.4 Transducer: Measurement Specialties MSP400-150-P-3/8" NPT-4	_____/_____
22.5 Transducer S/N: _____	_____/_____
22.6 Attach transducer to street tee with pipe dope	_____/_____
22.7 Apply and shrink heat shrink over bare wires exposed below connector on pre-made cable	_____/_____
22.8 Route sensor cable along transmission cooler cross-member to DAS bulkhead connector location	_____/_____
23.0 Install Treadle Valve Signal Pressure Transducer	_____/_____
23.1 Remove treadle valve (green) supply pressure line	_____/_____
23.2 Remove 90˚ fitting from treadle valve	_____/_____
23.3 Connect street tee with pipe dope to treadle valve	_____/_____
23.4 Orient street tee such that transducer will point downwards when installed	_____/_____
23.5 Connect 90˚ fitting with pipe dope to street tee	_____/_____
23.6 Connect pressure line to 90˚ fitting	_____/_____
23.7 Transducer: Measurement Specialties MSP400-150-P-3/8" NPT-4	_____/_____
23.8 Transducer S/N: _____	_____/_____
23.9 Attach transducer to street tee with pipe dope	_____/_____
23.10 Apply and shrink heat shrink over bare wires exposed below connector on pre-made cable	_____/_____
23.11 Route sensor cable down with pressure lines to lefthand frame rail, back to transmission cooler cross-member and across cross-member to DAS bulkhead connector location	_____/_____
24.0 Install Headlight/Turn Indicator Sensors	_____/_____
24.1 Prepare headlight/turn signal harness	_____/_____
24.1.1 Insert wires into Metri-Pack #12047938 7-way female connector	_____/_____
24.1.1.1 Cut 8" yellow wire	_____/_____
24.1.1.2 Slide cable seal onto one end of wire	_____/_____

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
24.1.1.3 Strip end of wire with cable seal 0.200 inches	_____/_____
24.1.1.4 Crimp female Metri-Pack #12048074 terminal onto stripped wire	_____/_____
24.1.1.5 Plug lead into terminal G of Metri-Pack #12047938 7-way female connector	_____/_____
24.1.1.6 Cut 8" green wire	_____/_____
24.1.1.7 Slide cable seal onto one end of wire	_____/_____
24.1.1.8 Strip end of wire with cable seal 0.200 inches	_____/_____
24.1.1.9 Crimp female Metri-Pack #12048074 terminal onto stripped wire	_____/_____
24.1.1.10 Plug lead into terminal A of Metri-Pack #12047938 7-way female connector	_____/_____
24.1.1.11 Cut 8" white wire	_____/_____
24.1.1.12 Slide cable seal onto one end of wire	_____/_____
24.1.1.13 Strip end of wire with cable seal 0.200 inches	_____/_____
24.1.1.14 Crimp female Metri-Pack #12048074 terminal onto stripped wire	_____/_____
24.1.1.15 Plug lead into terminal E of Metri-Pack #12047938 7-way female connector	_____/_____
24.1.1.16 Apply Metri-Pack #12047936 terminal position assurance device to Metri-pack #12047938 7-way female connector	_____/_____
24.1.2 Insert wires into Metri-Pack #12162144 4-way female connector	_____/_____
24.1.2.1 Cut 4" yellow color wire	_____/_____
24.1.2.2 Slide cable seal onto one end of wire	_____/_____
24.1.2.3 Strip end of wire with cable seal 0.200 inches	_____/_____
24.1.2.4 Crimp female Metri-Pack #12047767 terminal onto stripped wire	_____/_____
24.1.2.5 Plug lead into terminal A of Metri-Pack #12162144 4-way female connector	_____/_____
24.1.2.6 Cut 4" green color wire	_____/_____
24.1.2.7 Slide cable seal onto one end of wire	_____/_____
24.1.2.8 Strip end of wire with cable seal 0.200 inches	_____/_____
24.1.2.9 Crimp female Metri-Pack #12047767 terminal onto stripped wire	_____/_____
24.1.2.10 Plug lead into terminal B of Metri-Pack #12162144 4-way female connector	_____/_____
24.1.2.11 Apply Metri-Pack #12047948 terminal position assurance device to Metri-pack 4-way female plug	_____/_____
24.1.3 Insert wires into Metri-Pack #12047933 7-way male connector	_____/_____
24.1.3.1 Pair yellow wire from terminal G of Metri-Pack #12047938 7-way connector with yellow wire from terminal A of Metri-Pack #12162144 4-way female connnector	_____/_____
24.1.3.2 Slide cable seal onto end of wire pair	_____/_____
24.1.3.3 Strip end of both wires 0.200 inches	_____/_____
24.1.3.4 Crimp a single male Metri-Pack #12045773 terminal onto stripped wires	_____/_____
24.1.3.5 Plug lead into terminal G of Metri-Pack #12047933 7-way	

S/N_____

Data Sheet D-1: T2C1 Tractor

Work by/Date

male connector _____/_____
24.1.3.6 Pair green color wire from terminal A of Metri-Pack #12047938 7-way female connector with green color wire from terminal B of Metri-Pack #12162144 4-way female connector _____/_____
24.1.3.7 Slide cable seal onto end of wire pair _____/_____
24.1.3.8 Strip end of both wires 0.200 inches _____/_____
24.1.3.9 Crimp a single male Metri-Pack #12045773 terminal onto stripped wires _____/_____
24.1.3.10 Plug lead into terminal A of Metri-Pack #12047933 7-way male connector _____/_____
24.1.3.11 Slide cable seal onto end of white wire from terminal E of Metri-Pack #12047938 7-way female connector _____/_____
24.1.3.12 Strip end of wire with cable seal 0.200 inches _____/_____
24.1.3.13 Crimp a single male Metri-Pack #12045773 terminal onto stripped wires _____/_____
24.1.3.14 Plug lead into terminal E of Metri-Pack #12047933 7-way male connector _____/_____
24.1.3.15 Apply Metri-Pack #15324525 terminal position assurance device to Metri-pack #12047933 7-way male connector _____/_____
24.2 Connect headlight indicator wires _____/_____
24.2.1 Unplug connector from tractor curbside headlight _____/_____
24.2.2 Plug headlight wiring harness onto headlight _____/_____
24.2.3 Plug tractor headlight wire into tap _____/_____
24.3 Tap curbside turn indicator wire 38R with Scotchlok 804 tap _____/_____
24.3.1 Open hinged side wall _____/_____
24.3.2 Place unstripped run wire inside run channel and close hinged side wall _____/_____
24.3.3 Locate tap wire: wire C (yellow) in the Metri-Pack 150 4-way connector in the harness _____/_____
24.3.4 Trim wire to length _____/_____
24.3.5 Insert unstripped tap wire completely into tap port _____/_____
24.3.6 Hold pliers perpendicular to the wire and make connection by crimping u-contact down flush with top of insulator _____/_____
24.3.7 Close cover until latched _____/_____
24.4 Install roadside turn indicator tap _____/_____
24.4.1 Route yellow Anixter #6GXL-2001 wire from curbside turn indicator/headlight location to roadside turn indicator in wire loom along wiring harness under radiator _____/_____
24.4.2 Trim wire to length _____/_____
24.4.3 Slide cable seal onto curbside wire end _____/_____
24.4.4 Strip curbside wire 0.200 inches _____/_____
24.4.5 Crimp female Metri-Pack #12047767 terminal onto stripped wire _____/_____
24.4.6 Plug lead into terminal D _____/_____
24.4.7 Apply Metri-Pack #12047948 terminal protection assurance device to

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
Metri-pack 4-way female plug	_____/_____
24.4.8 Trim wire to length at roadside end	_____/_____
24.4.9 Tap roadside turn indicator wire 38L with Scotchlok 804 tap	_____/_____
24.4.9.1 Open hinged side wall	_____/_____
24.4.9.2 Place unstripped run wire inside run channel and close hinged side wall	_____/_____
24.4.9.3 Insert unstripped tap wire completely into tap port	_____/_____
24.4.9.4 Hold pliers perpendicular to the wire and make connection by crimping u-contact down flush with top of insulator	_____/_____
24.4.9.5 Close cover until latched	_____/_____
24.5 Route Wires	_____/_____
24.5.1 Select headlight/turn signal connector extension wire: Coleman 22/2pr 4-conductor	_____/_____
24.5.2 Strip outer jacket back 1-1/2 inches	_____/_____
24.5.3 Slide cable seals onto wire ends	_____/_____
24.5.4 Strip wires 0.200 inches	_____/_____
24.5.5 Crimp female Metri-Pack #12047767 terminal onto stripped wire	_____/_____
24.5.6 Plug green wire into terminal A	_____/_____
24.5.7 Plug white wire into terminal B	_____/_____
24.5.8 Plug red wire into terminal C	_____/_____
24.5.9 Plug black wire into terminal D	_____/_____
24.5.10 Apply Metri-Pack #12047948 terminal protection assurance device to Metri-pack 4-way female plug	_____/_____
24.5.11 Mate 4-position headlight/turn signal connector to extension wire	_____/_____
24.5.12 Route cable to DAS bulkhead connector location along ???	_____/_____
25.0 Pin Exterior Wiring to Bulkhead Connector	_____/_____
25.1 Pin Roadside Steer Pressure Transducer Wires	_____/_____
25.1.1 Trim Roadside Steer Pressure Transducer wire to length	_____/_____
25.1.2 Strip outer jacket of Roadside Steer Pressure cable back 1-1/2 inches	_____/_____
25.1.3 Strip white wire 0.250 inches	_____/_____
25.1.4 Crimp Deutsch #0460-202-16141 pin onto stripped wire	_____/_____
25.1.5 Insert white wire into bulkhead connector pin 1	_____/_____
25.1.6 Strip red and black wires 0.200 inches	_____/_____
25.1.7 Crimp Deutsch #0460-202-20141 pins onto stripped wire	_____/_____
25.1.8 Insert black wire into bulkhead connector pin 2	_____/_____
25.1.9 Insert red wire into bulkhead connector pin 3	_____/_____
25.2 Pin Curbside Steer Pressure Transducer Wires	_____/_____
25.2.1 Trim Curbside Steer Pressure Transducer wire to length	_____/_____
25.2.2 Strip outer jacket of Curbside Steer Pressure cable back 1-1/2 inches	_____/_____
25.2.3 Strip wires 0.250 inches	_____/_____
25.2.4 Crimp Deutsch #0460-202-16141 pin onto stripped wire	_____/_____
25.2.5 Insert white wire into bulkhead connector pin 4	_____/_____

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
25.2.6 Insert black wire into bulkhead connector pin 5	_____/_____
25.2.7 Insert red wire into bulkhead connector pin 6	_____/_____
25.3 Pin Roadside Intermediate Pressure Transducer Wires	_____/_____
25.3.1 Trim Roadside Intermediate Pressure Transducer wire to length	_____/_____
25.3.2 Strip outer jacket of Roadside Intermediate Pressure cable back 1-1/2 inches	_____/_____
25.3.3 Strip wires 0.200 inches	_____/_____
25.3.4 Crimp Deutsch #0460-202-20141 pins onto stripped wire	_____/_____
25.3.5 Insert white wire into bulkhead connector pin 7	_____/_____
25.3.6 Insert black wire into bulkhead connector pin 8	_____/_____
25.3.7 Insert red wire into bulkhead connector pin 9	_____/_____
25.4 Pin Curbside Intermediate Pressure Transducer Wires	_____/_____
25.4.1 Trim Curbside Intermediate Pressure Transducer wire to length	_____/_____
25.4.2 Strip outer jacket of Curbside Intermediate Pressure cable back 1-1/2 inches	_____/_____
25.4.3 Strip wires 0.200 inches	_____/_____
25.4.4 Crimp Deutsch #0460-202-20141 pins onto stripped wire	_____/_____
25.4.5 Insert white wire into bulkhead connector pin 10	_____/_____
25.4.6 Insert black wire into bulkhead connector pin 11	_____/_____
25.4.7 Insert red wire into bulkhead connector pin 12	_____/_____
25.5 Pin Roadside Rear Pressure Transducer Wires	_____/_____
25.5.1 Trim Roadside Rear Pressure Transducer wire to length	_____/_____
25.5.2 Strip outer jacket of Roadside Rear Pressure cable back 1-1/2 inches	_____/_____
25.5.3 Strip wires 0.200 inches	_____/_____
25.5.4 Crimp Deutsch #0460-202-20141 pins onto stripped wire	_____/_____
25.5.5 Insert white wire into bulkhead connector pin 13	_____/_____
25.5.6 Insert black wire into bulkhead connector pin 14	_____/_____
25.5.7 Insert red wire into bulkhead connector pin 15	_____/_____
25.6 Pin Rear Suspension Pressure Transducer Wires	_____/_____
25.6.1 Trim Rear Suspension Pressure Transducer wire to length	_____/_____
25.6.2 Strip outer jacket of Rear Suspension Pressure cable back 1-1/2 inches	_____/_____
25.6.3 Strip wires 0.200 inches	_____/_____
25.6.4 Crimp Deutsch #0460-202-20141 pins onto stripped wire	_____/_____
25.6.5 Insert white wire into bulkhead connector pin 22	_____/_____
25.6.6 Insert black wire into bulkhead connector pin 23	_____/_____
25.6.7 Insert red wire into bulkhead connector pin 24	_____/_____
25.7 Pin Curbside Rear Pressure Transducer Wires	_____/_____
25.7.1 Trim Curbside Rear Pressure Transducer wire to length	_____/_____
25.7.2 Strip outer jacket of Curbside Rear Pressure cable back 1-1/2 inches	_____/_____
25.7.3 Strip wires 0.200 inches	_____/_____
25.7.4 Crimp Deutsch #0460-202-20141 pins onto stripped wire	_____/_____
25.7.5 Insert white wire into bulkhead connector pin 16	_____/_____
25.7.6 Insert black wire into bulkhead connector pin 17	_____/_____

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
25.7.7 Insert red wire into bulkhead connector pin 18	_____/_____
25.8 Pin Air Compressor Governor Pressure Transducer Wires	_____/_____
25.8.1 Trim Air Compressor Pressure Transducer wire to length	_____/_____
25.8.2 Strip outer jacket of Air Compressor Governor Pressure cable back 1-1/2 inches	_____/_____
25.8.3 Strip wires 0.200 inches	_____/_____
25.8.4 Crimp Deutsch #0460-202-20141 pins onto stripped wire	_____/_____
25.8.5 Insert white wire into bulkhead connector pin 19	_____/_____
25.8.6 Insert black wire into bulkhead connector pin 20	_____/_____
25.8.7 Insert red wire into bulkhead connector pin 21	_____/_____
25.9 Pin Tractor Protection Valve Pressure Transducer Wires	_____/_____
25.9.1 Trim Tractor Protection Valve Pressure Transducer wire to length	_____/_____
25.9.2 Strip outer jacket of Tractor Protection Valve Pressure cable back 1-1/2 inches	_____/_____
25.9.3 Strip wires 0.200 inches	_____/_____
25.9.4 Crimp Deutsch #0460-202-20141 pins onto stripped wire	_____/_____
25.9.5 Insert white wire into bulkhead connector pin 25	_____/_____
25.9.6 Insert black wire into bulkhead connector pin 26	_____/_____
25.9.7 Insert red wire into bulkhead connector pin 27	_____/_____
25.10 Pin Treadle Valve Pressure Transducer Wires	_____/_____
25.10.1 Trim Treadle Valve Pressure Transducer wire to length	_____/_____
25.10.2 Strip outer jacket of Treadle Valve Pressure cable back 1-1/2 inches	_____/_____
25.10.3 Strip wires 0.200 inches	_____/_____
25.10.4 Crimp Deutsch #0460-202-20141 pins onto stripped wire	_____/_____
25.10.5 Insert white wire into bulkhead connector pin 28	_____/_____
25.10.6 Insert black wire into bulkhead connector pin 29	_____/_____
25.10.7 Insert red wire into bulkhead connector pin 30	_____/_____
25.11 Pin Headlight / Turn Signal Wires	_____/_____
25.11.1 Trim Headlight / Turn Signal wire to length	_____/_____
25.11.2 Strip outer jacket of Headlight / Turn Signal cable back 1-1/2 inches	_____/_____
25.11.3 Strip wires 0.250 inches	_____/_____
25.11.4 Crimp Deutsch #0460-202-16141 pin onto stripped wire	_____/_____
25.11.5 Insert the red wire into bulkhead connector pin 31	_____/_____
25.11.6 Insert the black wire into bulkhead connector pin 32	_____/_____
25.11.7 Insert the green wire into bulkhead connector pin 33	_____/_____
25.11.8 Insert white wire into bulkhead connector pin 34	_____/_____
26.0 Complete Deutsch Bulkhead Connector	_____/_____
26.1 Insert Deutsch #0413-204-2005 sealing plugs in unused pin locations	_____/_____
26.1.1 Bulkhead connector pin 35 (open)	_____/_____
26.1.2 Bulkhead connector pin 36 (RS-232 RX)	_____/_____
26.1.3 Bulkhead connector pin 37 (RS-232 TX)	_____/_____
26.1.4 Bulkhead connector pin 38 RS-485 RX)	_____/_____

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
26.1.5 Bulkhead connector pin 39 (RS-485 TX)	_____/_____
26.1.6 Bulkhead connector pin 40 (Curbside wheel speed ground)	_____/_____
26.1.7 Bulkhead connector pin 41 (Roadside wheel speed ground)	_____/_____
26.1.8 Bulkhead connector pin 42 (former GPS TX)	_____/_____
26.1.9 Bulkhead connector pin 43 (former GPS RX)	_____/_____
26.1.10 Bulkhead connector pin 44 (former GPS +12V supply)	_____/_____
26.1.11 Bulkhead connector pin 45 (former GPS gnd)	_____/_____
26.1.12 Bulkhead connector pin 46 (Curbside wheel speed signal)	_____/_____
26.1.13 Bulkhead connector pin 47 (Roadside wheel speed signal)	_____/_____
27.0 Reconnect Battery Ground	_____/_____
28.0 Install/Hook Up DAS	_____/_____
28.1 Install DAS on mounting plate with one bolt	_____/_____
28.2 Check for 5A fuse in power lead	_____/_____
28.3 With truck ignition on, verify that the DAS power wires have been correctly wired with a voltmeter	_____/_____
28.3.1 Check for +12V power on MS3126F16-26P connector pin b	_____/_____
28.3.2 Check for ground continuity on MS3126F16-26P connector pin c	_____/_____
28.4 Plug wireless LAN antenna connector into DAS J5	_____/_____
28.5 Plug MS3126F20-41P (J1) connector into DAS J1	_____/_____
28.6 Plug MS3126F16-26P (J3) connector into DAS J3	_____/_____
28.7 Ensure no connection on DAS J4	_____/_____
29.0 Static Checkout	_____/_____
29.1 Disconnect pressure transducers and install simulators	_____/_____
29.1.1 9.93 K ohms	_____/_____
29.1.2 17.01 K ohms	_____/_____
29.1.3 20.42 K ohms	_____/_____
29.1.4 41.5 K ohms	_____/_____
29.1.5 68.2 K ohms	_____/_____
29.1.6 88.7 K ohms	_____/_____
29.1.7 99.5 K ohms	_____/_____
29.1.8 128.1 K ohms	_____/_____
29.1.9 159.4 K ohms	_____/_____
29.1.10 206.8 K ohms	_____/_____
29.2 Connect serial cable	_____/_____
29.3 Connect Ethernet cable	_____/_____
29.4 Disconnect MS3126F20-41P (J1) and install shorting plug	_____/_____
29.5 Apply truck power	_____/_____
29.6 Watch startup routine	_____/_____
29.6.1 Startup sensible	_____/_____
29.7 Execute GetDevStatus command	_____/_____

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
29.7.1 VIN present	_____/_____
29.8 Execute GPSon command	_____/_____
29.8.1 GPS data present?	_____/_____
29.8.2 If no GPS data Run GPSsetup	_____/_____
29.8.3 Re-execute GPSon command	_____/_____
29.9 Execute CANon command	_____/_____
29.9.1 CANbus data present	_____/_____
29.10 Execute AnalogOffset command	_____/_____
29.11 Execute Monitor command	_____/_____
29.12 Check data	_____/_____
29.12.1 Scroll to bottom of channel list, find rsfrontpress channel and highlight it and the next 16 channels	_____/_____
29.12.2 Highlight DIO channel	_____/_____
29.13 Ensure all of the pressures except air compressor and air bag pres = 0	_____/_____
29.14 Disconnect J1 shorting plug and reconnect MS3126F20-41P (J1)	_____/_____
29.15 Execute cmdOpenFile command	_____/_____
29.16 Test digital channels and observe presence of signals	_____/_____
29.16.1 Turn on headlights on	_____/_____
29.16.2 Turn on headlights off	_____/_____
29.16.3 Turn high beams on	_____/_____
29.16.4 Turn high beams off	_____/_____
29.16.5 Turn right turn signal on	_____/_____
29.16.6 Turn right turn signal off	_____/_____
29.16.7 Turn left turn signal on	_____/_____
29.16.8 Turn left turn signal off	_____/_____
29.16.9 Turn on wipers on	_____/_____
29.16.10 Turn wipers to high	_____/_____
29.16.11 Turn wipers off	_____/_____
29.17 Test analog channels	_____/_____
29.17.1 Verify simulator pressure values	_____/_____
29.17.1.1 Roadside front pressure	_____/_____
29.17.1.2 Curbside front pressure	_____/_____
29.17.1.3 Roadside intermediate pressure	_____/_____
29.17.1.4 Curbside intermediate pressure	_____/_____
29.17.1.5 Roadside rear pressure	_____/_____
29.17.1.6 Curbside rear pressure	_____/_____
29.17.1.7 Air compressor	_____/_____
29.17.1.8 Suspension pressure	_____/_____
29.17.1.9 Tractor protection valve pressure	_____/_____
29.17.1.10 Treadle valve pressure	_____/_____
29.18 Execute cmd Open file command	_____/_____
29.19 Download file and save	_____/_____
29.20 Turn off truck	_____/_____

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
29.21 Disconnect pressure transducer simulators and reconnect pressure transducers	_____/_____
29.21.1 Roadside front pressure	_____/_____
29.21.2 Curbside front pressure	_____/_____
29.21.3 Roadside intermediate pressure	_____/_____
29.21.4 Curbside intermediate pressure	_____/_____
29.21.5 Roadside rear pressure	_____/_____
29.21.6 Curbside rear pressure	_____/_____
29.21.7 Air compressor	_____/_____
29.21.8 Suspension pressure	_____/_____
29.21.9 Tractor protection valve pressure	_____/_____
29.21.10 Treadle valve pressure	_____/_____
30.0 Steering Calibration	_____/_____
30.1 Start truck	_____/_____
30.2 Turn steering fully CCW	_____/_____
30.3 Mark shaft with a Sharpie up at the bulkhead using slit in bushing as reference mark	_____/_____
30.4 Record steering sensor voltage	_____/_____
30.5 Turn steering CW in 360-degree increments to the lock, recording voltage at each increment	_____/_____
30.6 Turn steering fully CW	_____/_____
30.7 Mark shaft with a Sharpie up at the bulkhead using slit in bushing as reference mark	_____/_____
30.8 Record steering sensor voltage	_____/_____
30.9 Turn steering CCW in 360-degree increments to the lock, recording voltage at each increment	_____/_____
30.10 Calculate scale factor	_____/_____
Scale factor _____	_____/_____
31.0 Return Cabin to Original Condition	_____/_____
31.1 Reinstall curbside upper and lower dashboard	_____/_____
31.1.1 Reinstall lower panel (4 screws)	_____/_____
31.1.2 Reinstall upper trim piece by pushing it on	_____/_____
31.1.3 Reinstall PDM cover	_____/_____
31.2 Reinstall curbside kick panel	_____/_____
31.2.1 Reinstall two screws in floor	_____/_____
31.2.2 Replace floor plate	_____/_____
31.2.3 Replace floor mat	_____/_____
31.2.4 Push weatherstripping on lower edge of door	_____/_____
31.3 Reinstall cover at base of curbside pillar (1 screw)	_____/_____
31.4 Reinstall curbside sill plate (3 screws)	_____/_____
31.5 Reinstall B pillar grab handle (2 bolts)	_____/_____

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
31.6 Reinstall 2 screws holding B pillar cover in place	_____/_____
31.7 Push weatherstripping on edge of door	_____/_____
31.8 Reinstall curbside seat belt cover (it snaps on)	_____/_____
31.9 Reinstall steering column cover (3 nuts/washers)	_____/_____
31.10 Reinstall lower steering shaft cover by pushing top in, lowering, and snapping bottom into place	_____/_____
31.11 Reinstall roadside kick panel	_____/_____
31.11.1 Replace two screws in floor	_____/_____
31.11.2 Install pop up center fastener in upper side of panel	_____/_____
31.11.3 Push weatherstripping on lower edge of door	_____/_____
31.11.4 Replace floor	_____/_____
31.11.5 Replace yellow button	_____/_____
31.12 Put roadside seat belt cover back in place being careful to not pinch any wires	_____/_____
31.13 Reinstall roadside sill plate (3 screws)	_____/_____
31.14 Reinstall lower curbside cabinet (4 nuts/washers on wall, 2 bolts/washers on floor)	_____/_____
31.15 Clean (vacuum), as necessary the inside of the vehicle	_____/_____
31.16 Replace fire extinguisher	_____/_____
31.17 Close roadside access panel with flat blade screw driver	_____/_____
31.18 Remove DAS and secure MS3126F20-41P (J1), MS3126F16-26P (J3), wireless antenna connection (J5)	_____/_____
31.19 Replace mattress	_____/_____
32.0 Road Test	_____/_____
32.1 Drive truck over prescribed course	_____/_____
32.1.1 Right turn out out ALF building	_____/_____
32.1.2 Right turn at corner and proceed along side of ALF	_____/_____
32.1.3 Check point 1 at end of building	_____/_____
32.1.3.1 Stop	_____/_____
32.1.3.2 Hard brake application	_____/_____
32.1.3.3 Right turn signal	_____/_____
32.1.3.4 Right turn	_____/_____
32.1.4 Proceed past front of ALF	_____/_____
32.1.5 Check Point 2 at end of building	_____/_____
32.1.5.1 Left turn signal	_____/_____
32.1.5.2 Left turn	_____/_____
32.1.6 After turn, proceed along drive toward TMP	_____/_____
32.1.7 Left turn on road before TMP	_____/_____
32.1.8 Check Point 3 just after turn	_____/_____
32.1.8.1 Low beam headlights on	_____/_____
32.1.9 Proceed along TMP	_____/_____
32.1.10 Right turn at end of TMP	_____/_____
32.1.11 Check Point 4 just after turn	_____/_____

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
32.1.11.1 High beams on	_____/_____
32.1.12 Proceed along back of TMP	_____/_____
32.1.13 Left turn at major intersection toward trailers	_____/_____
32.1.14 Check Point 5 just after turn	_____/_____
32.1.14.1 Headlights off	_____/_____
32.1.15 Proceed down to trailer parking area	_____/_____
32.1.16 Check Point 6 at T	_____/_____
32.1.16.1 Turn around at T to retrace route with a stop and back up maneuver	_____/_____
32.1.17 Proceed back towards TMP	_____/_____
32.1.18 Right turn behind TMP	_____/_____
32.1.19 Check Point 7 just after turn	_____/_____
32.1.19.1 Wipers on	_____/_____
32.1.20 Proceed along behind TMP	_____/_____
32.1.21 Left turn at end of TMP	_____/_____
32.1.22 Check Point 8 just after turn	_____/_____
32.1.22.1 Wipers on high	_____/_____
32.1.23 Proceed along side of TMP to driveway leading to ALF	_____/_____
32.1.24 Right turn towards ALF	_____/_____
32.1.25 Check Point 9 just after turn	_____/_____
32.1.25.1 Wipers off	_____/_____
32.1.26 Proceed towards ALF	_____/_____
32.1.27 Right turn in front of ALF	_____/_____
32.1.28 Left turn at end of ALF	_____/_____
32.1.29 Check Point 10 just after turn	_____/_____
32.1.29.1 Constant speed of 10 MPH to end of building	_____/_____
32.1.30 If ACC system has not acquired a target during the course of the Road Test:	_____/_____
32.1.30.1 Approach potential target (ie - parked truck or building) with front of test vehicle	_____/_____
32.1.30.2 Back away from target at a minimum of 5 mph until ACC system acquires the target	_____/_____
32.1.31 Put vehicle in park	_____/_____
32.1.32 Create fault condition by removing rear ABS modulator valve control connection	_____/_____
32.1.33 Verify that fault condition was created by using truck's onboard computer	_____/_____
32.1.34 End of test at end of building	_____/_____
32.2 Close out data file	_____/_____
32.3 Data evaluation	_____/_____
32.3.1 File header	_____/_____
32.3.1.1 ID	_____/_____
32.3.1.2 Date	_____/_____

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
32.3.1.3 Time	_____/_____
32.3.2 GPS reading correct position at Check Point 1	_____/_____
32.3.2.1 Stop observed	_____/_____
32.3.2.2 Hard brake application observed	_____/_____
32.3.2.3 Right turn signal indication observed	_____/_____
32.3.2.4 Steering shows right turn	_____/_____
32.3.2.5 Lateral acceleration shows right turn	_____/_____
32.3.2.6 Yaw shows CW rotation	_____/_____
32.3.2.7 Right turn signal off observed	_____/_____
32.3.3 GPS reading correct position at Check Point 2	_____/_____
32.3.3.1 Left turn signal indication observed	_____/_____
32.3.3.2 Steering shows left turn	_____/_____
32.3.3.3 Lateral acceleration shows left turn	_____/_____
32.3.3.4 Yaw shows CCW rotation	_____/_____
32.3.3.5 Left turn signal off observed	_____/_____
32.3.4 GPS reading correct position at Check Point 3	_____/_____
32.3.4.1 Low-beam headlight indication observed	_____/_____
32.3.5 GPS reading correct position at Check Point 4	_____/_____
32.3.5.1 Hi-beam headlight indication observed	_____/_____
32.3.6 GPS reading correct position at Check Point 5	_____/_____
32.3.6.1 Headlight off indication seen	_____/_____
32.3.7 GPS reading correct position at Check Point 6	_____/_____
32.3.7.1 Longitudinal acceleration shows stop	_____/_____
32.3.7.2 Brake pressures show brake application	_____/_____
32.3.7.3 Longitudinal acceleration shows reverse	_____/_____
32.3.7.4 Brake pressures show brake application	_____/_____
32.3.8 GPS reading correct position at Check Point 7	_____/_____
32.3.8.1 Wiper on indication observed	_____/_____
32.3.9 GPS reading correct position at Check Point 8	_____/_____
32.3.9.1 High wiper observed	_____/_____
32.3.10 GPS reading correct position at Check Point 9	_____/_____
32.3.10.1 Wiper off observed	_____/_____
32.3.11 GPS reading correct position at Check Point 10	_____/_____
32.3.10.1 Wheel speeds show expected speed	_____/_____
32.3.12 Check for compressor pressure	_____/_____
32.3.13 Check for suspension pressure	_____/_____
33.0 Finishing Touches	_____/_____
33.1 Tape connector end of roadside steer brake chamber pressure transducer	_____/_____
33.2 Tape connector end of curbside steer brake chamber pressure transducer	_____/_____
33.3 Tape connector end of roadside intermediate brake chamber pressure transducer	_____/_____
33.4 Tape connector end of roadside rear brake chamber pressure transducer	_____/_____

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

	Work by/Date
33.5 Tape connector end of roadside rear suspension pressure transducer	_____/_____
33.6 Tape connector end of curbside intermediate brake chamber pressure transducer	_____/_____
33.7 Tape connector end of curbside rear brake chamber pressure transducer	_____/_____
33.8 Tape connector end of compressor governor signal pressure transducer	_____/_____
33.9 Tape connector end of compressor governor signal pressure transducer	_____/_____
33.10 Tape connector end of tractor protection valve signal pressure transducer	_____/_____
33.11 Tape connector end of treadle valve signal pressure transducer	_____/_____
33.12 Tape left turn signal Scotchlok tap	_____/_____
33.13 Tape right turn signal Scotchlok tap	_____/_____
33.14 Conduct Freightliner inspection per sheet	_____/_____
34.0 Documentation	_____/_____
34.1 Q/A Check List	_____/_____
34.2 Pressure transducer calibration sheets	_____/_____
34.2.1 Roadside steer	_____/_____
34.2.2 Curbside steer	_____/_____
34.2.3 Roadside intermediate	_____/_____
34.2.4 Curbside intermediate	_____/_____
34.2.5 Roadside rear	_____/_____
34.2.6 Curbside rear	_____/_____
34.2.7 Suspension pressure	_____/_____
34.2.8 Governor pressure	_____/_____
34.2.9 Tractor protection valve	_____/_____
34.2.10 Treadle valve pressure	_____/_____
34.3 Steering angle sensor calibration sheet	_____/_____
34.4 Freightliner inspection sheet	_____/_____

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

Vehicle Instrumentation Cry Sheet

Serial #: _____ **Date Received: _____**

Wal★Mart ID: _____ **Date Completed: _____**

Ref #	Description of Incident / Finding	Resolution
1.		
2.		
3.		
4.		

QA review by _____ Date_____

S/N_____

Data Sheet D-1: T2C1 Tractor

VEHICLE **TRAILER** **PROJECT:_____**

VEHICLE OVERVIEW

- ☐ VISIBLE DAMAGE
- ☐ VEHICLE LEANING
- ☐ FLUIDS ON GROUND
- ☐ HAZARDS TO VEHICLE

ENGINE COMPARTMENT

- ☐ ENGINE OIL LEVEL
- ☐ COOLANT LEVEL
- ☐ POWER STEERING LEVEL
- ☐ CONDITION OF HOSES
- ☐ WASHER FLUID LEVEL
- ☐ BATTERY FLUID LEVEL
- ☐ HOLD DOWNS & COVER
- ☐ BELT TIGHTNESS
- ☐ FLUID LEAKS
- ☐ WIRING

INSIDE CAB

- ☐ START ENGINE
  LISTEN FOR UNUSUAL NOISE
- ☐ OIL PRESSURE GAUGE
- ☐ AMMETER/VOLTMETER
- ☐ COOLANT TEMP GAUGE
- ☐ ENGINE OIL TEMP
- ☐ WARNING LIGHTS & BUZZERS
- ☐ STEERING WHEEL
  10 DEGREES OF PLAY
- ☐ CLUTCH
  I TO 28 FREE PLAY
- ☐ ACCELERATOR

BRAKE CONTROLS

- ☐ –FOOT BRAKE
- ☐ –PARKING BRAKE
- ☐ –RETARDER CONTROLS
- ☐ TRANSMISSION CONTROLS
- ☐ INTERAXLE DIFFERENTIAL LOCK
- ☐ HORNS
- ☐ WINDSHIELD WIPER/WASHER

LIGHTS

- ☐ – HEADLIGHTS
- ☐ – DIMMER SWITCH
- ☐ – TURN SIGNAL
- ☐ – FOUR-WAY FLASHERS
- ☐ – CLEARANCE/MARKER LIGHT SWITCH

INSPECTED BY

WALKAROUND INSPECTION

- ☐ SET PARKING BRAKE
- ☐ REMOVE KEY
- ☐ TURN ON HEADLIGHTS
- ☐ TURN ON 4-WAY FLASHERS

LEFT FRONT SIDE

- ☐ ADJUST MIRROR
- ☐ DOOR LATCHES/LOCKS
- ☐ CHECK LEFT FRONT WHEEL
- ☐ TIRE CONDITION
- ☐ LEFT FRONT SUSPENSION
- ☐ LEFT FRONT BRAKE

FRONT

- ☐ TURN SIGNALS OPERATION
- ☐ FRONT AXLE CONDITION
- ☐ STEERING CONDITION
- ☐ WINDSHIELD CONDITION

RIGHT FRONT SIDE

- ☐ RH WHEEL CONDITION
- ☐ TIRE CONDITION
- ☐ SUSPENSION CONDITION
- ☐ BRAKE CONDITION
- ☐ CAB/HOOD LOCKS SECURED
- ☐ FUEL TANK MOUNTS
- ☐ EXHAUST CONDITION
- ☐ AIR FAIRING CONDITION

RIGHT SIDE REAR

- ☐ CONDITION OF DRIVE

WHEELS & STUOS

- ☐ DRIVE TIRE CONDITION
- ☐ SUSPENSION SYSTEM DEFECTS
- ☐ BRAKE CONDITION
- ☐ LIGHTS AND REFLECTORS

WALKAROUND (CONT.)

TRACTOR LEFT SIDE

- ☐ DRIVE WHEEL AND STUD CONDITION
- ☐ BRAKE CONDTION
- ☐ SUSPENSION DEFECTS
- ☐ BATTERY BOX MOUNTING
- ☐ FUEL TANK MOUNTING
- ☐ HEADLIGHTS
- ☐ HIGH BEAM/LOW BEAM
- ☐ CLEARANCE LIGHTS TRACTOR/TRAILER
- ☐ CHECK THAT FIFTH WHEEL IS TILTED & GREASED

FUEL GAL.

STEER	
DRIVES	
TRAILER	
GROSS	

COMMENTS

DRIVER DATE---' ---'

QA review by _____ Date_____

QUALITY ASSURANCE DOCUMENT

PROCEDURE FOR INSTALLING INSTRUMENTATION FOR FREIGHTLINER ECBS FIELD OPERATIONAL TEST

BATTELLE
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Columbus, Ohio 43201-2693

Richard J. Olson

(December 13, 2004)

APPROVED BY

Program Technical Manager Date	Department Manager Date
Program Manager Date	Program QA Manager Date

PROCEDURE FOR INSTALLING INSTRUMENTATION FOR FREIGHTLINER ECBS FIELD OPERATIONAL TEST

3.0 Scope

3.1 The Freightliner electronically controlled braking system (ECBS) field operational test (FOT) is a U.S. Department of Transportation-sponsored program to establish the efficacy of ECBS systems in preventing the rate of fatalities associated with commercial highway heavy truck incidents. This document describes the procedures for installing instrumentation on a fleet of highway tractors and trailers to collect data to determine the effectiveness of ECBS systems. The purpose of this document is to ensure that the instrumentation is installed in a consistent manner such that no critical steps in the installation process are omitted.

4.0 Objective

4.1 The objective of the Freightliner FOT is to develop and demonstrate an improved understanding of ECBS in terms of performance, reliability, durability, maintainability and safety benefits in a real-world operating environment.

3.0 Approach

3.2 A fleet of 48 Wal★Mart tractors and 100 trailers will be instrumented with transducers to sense braking and truck/trailer performance with and without ECBS systems. Two configurations, so called Templates, will be considered: 1) Mixed Tractor-trailer, and 2) “Optimized” Tractor-Trailer. In the mixed template, Template 2, tractors and trailers with ECBS may be mixed with units with or without ECBS systems. In the optimized template, Template 3, tractors and trailers will both have ECBS systems. There is no Template 1 in the current program.

3.2 Data will be collected for a 12-month period: 6 months without the ECBS systems active to provide baseline data, and 6 months with ECBS functional. The baseline and active systems phases will enable evaluation of the potential safety benefits of the ECBS systems. The data will be evaluated by an independent evaluator.

3.3 Table 1 summarizes the data that will be collected during the FOT. All data are recorded at 10 Hz as long as the tractor is running or a trailer is powered. The FOT data are collected by a data acquisition system (DAS) mounted on the tractor/trailer for the FOT.

Table 1 Data to be Collected During the FOT

Unit	Value
Tractor	GPS data
	J1939 bus data
	J1708/J1587 bus data
	Brake chamber pressures
	Wheel speeds
	Longitudinal acceleration
	Lateral acceleration
	Yaw rate
	Steering angle
	Suspension pressure
	Compressor pressure
	Trailer control valve pressure
	Treadle valve pressure
	Headlight on/off
	Turn signal indicators on/off
	Wiper on/off
Trailer	GPS data
	Brake chamber pressures
	Wheel speeds
	Longitudinal acceleration
	Lateral acceleration
	Yaw rate

4.0 Configurations

4.1 Tables 2 and 3 define the various configurations in the FOT. Consistent with real-world conditions, different technologies will be randomly paired with each other in the FOT. The various configurations reflect this situation.

Table 2 FOT Tractor Configurations

Template	Configuration	Braking System
2	1	Meritor WABCO ABS Drum Brake
	2	Meritor WABCO ABS Disc Brake
	3	Meritor WABCO ECBS Disc Brake
	4	Bendix ABS6 Disc Brake
3	-	Meritor WABCO ECBS Disc Brake

Table 3 FOT Trailer Configurations

Template	Configuration	Suspension	Braking System	Brakes
2	1	Binkley Duralite Spring	4S-2M ABS	Drum
	2	Binkley Duralite Spring	4S-2M ABS	Meritor EX225 Disc
	3	Hendrickson HKANT-40	Meritor WABCO ECBS	Bendix-Knorr 225X Disc
	4	Hendrickson HKANT-40	Bendix-Knorr ECBS	Bendix-Knorr 225X Disc
3	-	Hendrickson HKANT-40	Meritor WABCO ECBS	Bendix-Knorr 225X Disc

4.2 Each tractor and trailer configuration natively has a set of sensors to support ABS and ECBS functions. These ABS/ECBS data are available on data busses on the vehicles and will be collected during the FOT. Additional transducers will be added for the FOT to supplement the available bus data. Because the bus data are not identical for the various configurations, the set of transducers that the FOT will add to each tractor and trailer is slightly different. A separate procedure addresses the QA installation process for each possible configuration.

Wal★Mart ID _____

Data Sheet D-1: T2 Trailer

	Work by/Date
1.0 Trailer Serial Number _____	_____/_____
2.0 Install Brake Chamber Pressure Transducer - Roadside Front	_____/_____
2.1 Remove supply pressure line from brake chamber	_____/_____
2.2 Remove 90 Deg Fitting	_____/_____
2.3 Install street tee with pipe dope on brake chamber	_____/_____
2.4 Re-Install 90 deg fitting with pipe dope	_____/_____
2.5 Connect pressure line to street tee with pipe dope	_____/_____
2.6 Transducer: Measurement Specialties MSP400-150-P-3/8" NPT-4	_____/_____
2.7 Transducer S/N: _____	_____/_____
2.8 Attach transducer to 90 deg fitting with pipe dope	_____/_____
2.10 Attach pressure sensor connector to transducer	_____/_____
2.11 Loop wire to form service/strain-relief loop and secure to transducer with wire tie.	_____/_____
2.12 Route sensor cable to DAS location along existing airlines to front manifold	_____/_____
2.13 Trim wire to length	_____/_____
3.0 Install Wheel Speed Transducer - Roadside Front	_____/_____
3.1 Transducer: Meritor WABCO #441 032 814	_____/_____
3.2 Wipe off any dirt on wheel speed sensor mount	_____/_____
3.3 Apply lubricant to sensor spring clip and sensor bushing bore	_____/_____
3.4 Install spring clip in the bushing. Make sure the spring clip tabs are on the inboard side of the vehicle.	_____/_____
3.5 Push the spring clip into the bushing bore until the spring clip tabs contact the bushing	_____/_____
3.6 Push the sensor into the spring clip until the sensor contacts the tone ring. After installation, there should be no gap between the sensor and the tone ring.	_____/_____
3.7 Wipe excess lubricant from the front and back of the sensor	_____/_____
3.8 Install tie wrap around wheel speed sensor cable inside brake assembly and outside assembly around caliper plate	_____/_____
3.9 Route sensor cable along existing airlines to front manifold	_____/_____
3.10 Trim wire to length	_____/_____
4.0 Install Brake Chamber Pressure Transducer - Curbside Front	_____/_____
4.1 Remove supply pressure line from brake chamber	_____/_____
4.2 Remove 90 Deg Fitting	_____/_____
4.3 Install street tee with pipe dope on brake chamber	_____/_____
4.4 Re-Install 90 deg fitting with pipe dope	_____/_____
4.5 Connect pressure line to street tee with pipe dope	_____/_____
4.6 Transducer: Measurement Specialties MSP400-150-P-3/8" NPT-4	_____/_____
4.7 Transducer S/N: _____	_____/_____
4.8 Attach transducer to 90 deg fitting with pipe dope	_____/_____

QA review by _____ Date_____

Wal★Mart ID _____

Data Sheet D-1: T2 Trailer

	Work by/Date
4.9 Apply and shrink heat shrink over bare wires exposed below connector on pre-made cable	_____/_____
4.10 Attach pressure sensor connector to transducer	_____/_____
4.11 Loop wire to form service/strain-relief loop and secure to transducer with wire tie.	_____/_____
4.12 Route sensor cable to DAS location along existing airlines to front manifold	_____/_____
4.13 Trim wire to length	_____/_____
5.0 Install Wheel Speed Transducer - Curbside Front	_____/_____
5.1 Transducer: Meritor WABCO #441 032 814	_____/_____
5.2 Wipe off any dirt on wheel speed sensor mount	_____/_____
5.3 Apply lubricant to sensor spring clip and sensor bushing bore	_____/_____
5.4 Install spring clip in the bushing. Make sure the spring clip tabs are on the inboard side of the vehicle.	_____/_____
5.5 Push the spring clip into the bushing bore until the spring clip tabs contact the bushing	_____/_____
5.6 Push the sensor into the spring clip until the sensor contacts the tone ring. After installation, there should be no gap between the sensor and the tone ring.	_____/_____
5.7 Wipe excess lubricant from the front and back of the sensor	_____/_____
5.8 Install tie wrap around wheel speed sensor cable inside brake assembly and outside assembly around caliper plate	_____/_____
5.9 Route sensor cable along existing airlines to front manifold	_____/_____
5.10 Trim wire to length	_____/_____
6.0 Install Brake Chamber Pressure Transducer - Roadside Rear	_____/_____
6.1 Remove supply pressure line from brake chamber	_____/_____
6.2 Remove 90 Deg Fitting	_____/_____
6.3 Install street tee with pipe dope on brake chamber	_____/_____
6.4 Re-Install 90 deg fitting with pipe dope	_____/_____
6.5 Connect pressure line to street tee with pipe dope	_____/_____
6.6 Transducer: Measurement Specialties MSP400-150-P-3/8" NPT-4	_____/_____
6.7 Transducer S/N: _____	_____/_____
6.8 Attach transducer to 90 deg fitting with pipe dope	_____/_____
6.9 Apply and shrink heat shrink over bare wires exposed below connector on pre-made cable	_____/_____
6.10 Attach pressure sensor connector to transducer	_____/_____
6.11 Loop wire to form service/strain-relief loop and secure to transducer with wire tie.	_____/_____
6.12 Route sensor cable to DAS location along existing airlines to front manifold	_____/_____
6.13 Trim wire to length	_____/_____
7.0 Install Wheel Speed Transducer - Roadside Rear	_____/_____
7.1 Transducer: Meritor WABCO #441 032 814	_____/_____

QA review by _____ Date_____

Wal★Mart ID _____

Data Sheet D-1: T2 Trailer

	Work by/Date
7.2 Wipe off any dirt on wheel speed sensor mount	_____/_____
7.3 Apply lubricant to sensor spring clip and sensor bushing bore	_____/_____
7.4 Install spring clip in the bushing. Make sure the spring clip tabs are on the inboard side of the vehicle.	_____/_____
7.5 Push the spring clip into the bushing bore until the spring clip tabs contact the bushing	_____/_____
7.6 Push the sensor into the spring clip until the sensor contacts the tone ring. After installation, there should be no gap between the sensor and the tone ring.	_____/_____
7.7 Wipe excess lubricant from the front and back of the sensor	_____/_____
7.8 Install tie wrap around wheel speed sensor cable inside brake assembly and outside assembly around caliper plate	_____/_____
7.9 Route sensor cable along existing airlines to front manifold	_____/_____
7.10 Trim wire to length	_____/_____
8.0 Suspension Pressure Transducer - Curbside Front	_____/_____
8.1 Remove supply pressure line from suspension airbag	_____/_____
8.2 Remove 90 degree fitting	_____/_____
8.3 Install street tee with pipe dope on suspension airbag	_____/_____
8.4 Reinstall 90 degree fitting with pipe dope	_____/_____
8.5 Connect pressure line to street tee with pipe dope	_____/_____
8.6 Transducer: Measurement Specialties MSP400-150-P-N-4 (1/4" NPT)	_____/_____
8.7 Transducer S/N: _____	_____/_____
8.8 Attach transducer to 90 degree fitting with pipe dope	_____/_____
8.9 Apply and shrink heat shrink over bare wires exposed below connector on pre-made cable	_____/_____
8.10 Attach pressure sensor connector to transducer	_____/_____
8.11 Route sensor cable along cross member, down to existing airlines and towards front of trailer to DAS location	_____/_____
8.12 Trim wire to length	_____/_____
9.0 Install Brake Chamber Pressure Transducer - Curbside Rear	_____/_____
9.1 Remove supply pressure line from brake chamber	_____/_____
9.2 Remove 90 Deg Fitting	_____/_____
9.3 Install street tee with pipe dope on brake chamber	_____/_____
9.4 Re-Install 90 deg fitting with pipe dope	_____/_____
9.5 Connect pressure line to street tee with pipe dope	_____/_____
9.6 Transducer: Measurement Specialties MSP400-150-P-3/8" NPT-4	_____/_____
9.7 Transducer S/N: _____	_____/_____
9.8 Attach transducer to 90 deg fitting with pipe dope	_____/_____
9.9 Apply and shrink heat shrink over bare wires exposed below connector on pre-made cable	_____/_____
9.10 Attach pressure sensor connector to transducer	_____/_____
9.11 Loop wire to form service/strain-relief loop and secure to transducer with	

QA review by _____ Date_____

Wal★Mart ID _____

Data Sheet D-1: T2 Trailer

	Work by/Date
wire tie.	_____/_____
9.12 Route sensor cable to DAS location along existing airlines to front manifold	_____/_____
9.13 Trim wire to length	_____/_____
10.0 Install Wheel Speed Transducer - Curbside Rear	_____/_____
10.1 Transducer: Meritor WABCO #441 032 814	_____/_____
10.2 Wipe off any dirt on wheel speed sensor mount	_____/_____
10.3 Apply lubricant to sensor spring clip and sensor bushing bore	_____/_____
10.4 Install spring clip in the bushing. Make sure the spring clip tabs are on the inboard side of the vehicle.	_____/_____
10.5 Push the spring clip into the bushing bore until the spring clip tabs contact the bushing	_____/_____
10.6 Push the sensor into the spring clip until the sensor contacts the tone ring. After installation, there should be no gap between the sensor and the tone ring.	_____/_____
10.7 Wipe excess lubricant from the front and back of the sensor	_____/_____
10.8 Install tie wrap around wheel speed sensor cable inside brake assembly and outside assembly around caliper plate	_____/_____
10.9 Route sensor cable along existing airlines to front manifold	_____/_____
10.10 Trim wire to length	_____/_____
11.0 Install DAS Power	_____/_____
11.1 Locate EB1-C W/CAN mounted on front cross rail of slider	_____/_____
11.2 Disconnect connector assembly on cable extending from W/CAN	_____/_____
11.3 Install power T tap (Phillips 60-4031-03)in trailer power connector	_____/_____
11.4 Route power wires along diagonal cross member from T tap to DAS location	_____/_____
11.5 Cut wire to length	_____/_____
12.0 Wire unused pins of MS3126F16-26S (J3) connector	_____/_____
12.1 Insert plugs into unused pins	_____/_____
12.1.1 NC: MS3476W20-41P (J1) connector pin E	_____/_____
12.1.2 NC: MS3476W20-41P (J1) connector pin F	_____/_____
12.1.3 NC: MS3476W20-41P (J1) connector pin L	_____/_____
12.1.4 NC: MS3476W20-41P (J1) connector pin M	_____/_____
12.1.5 NC: MS3476W20-41P (J1) connector pin T	_____/_____
12.1.6 NC: MS3476W20-41P (J1) connector pin U	_____/_____
12.1.7 NC: MS3476W20-41P (J1) connector pin W	_____/_____
12.1.8 NC: MS3476W20-41P (J1) connector pin V	_____/_____
13.0 Pin Wiring to MS3126F16-26S (J3) connector	_____/_____
13.1 Pin Roadside Front Wheel Speed Transducer Wires	_____/_____
13.1.1 Strip outer jacket back 4 inches	_____/_____
13.1.2 Strip wires 3/16 inches	_____/_____

QA review by _____ Date_____

Wal★Mart ID _____

Data Sheet D-1: T2 Trailer

	Work by/Date
13.1.3 Crimp MS39029/32-259 sockets onto stripped wire	_____/_____
13.1.4 Slide wire into MS3126F16-26S (J3) strain relief	_____/_____
13.1.5 Insert black wire into MS3126F16-26S (J3) connector pin A	_____/_____
13.1.6 Insert brown wire into MS3126F16-26S (J3) connector pin X	_____/_____
13.2 Pin Curbside Front Wheel Speed Transducer Wires	_____/_____
13.2.1 Strip outer jacket back 4 inches	_____/_____
13.2.2 Strip wires 3/16 inches	_____/_____
13.2.3 Crimp MS39029/32-259 sockets onto stripped wire	_____/_____
13.2.4 Slide wire into MS3126F16-26S (J3) strain relief	_____/_____
13.2.5 Insert black wire into MS3126F16-26S (J3) connector pin B	_____/_____
13.2.6 Insert brown wire into MS3126F16-26S (J3) connector pin Y	_____/_____
13.3 Pin Roadside Rear Wheel Speed Transducer Wires	_____/_____
13.3.1 Strip outer jacket back 4 inches	_____/_____
13.3.2 Strip wires 3/16 inches	_____/_____
13.3.3 Crimp MS39029/32-259 sockets onto stripped wire	_____/_____
13.3.4 Slide wire into MS3126F16-26S (J3) strain relief	_____/_____
13.3.5 Insert black wire into MS3126F16-26S (J3) connector pin C	_____/_____
13.3.6 Insert brown wire into MS3126F16-26S (J3) connector pin Z	_____/_____
13.4 Pin Curbside Rear Wheel Speed Transducer Wires	_____/_____
13.4.1 Strip outer jacket back 4 inches	_____/_____
13.4.2 Strip wires 3/16 inches	_____/_____
13.4.3 Crimp MS39029/32-259 sockets onto stripped wire	_____/_____
13.4.4 Slide wire into MS3126F16-26S (J3) strain relief	_____/_____
13.4.5 Insert black wire into MS3126F16-26S (J3) connector pin D	_____/_____
13.4.6 Insert brown wire into MS3126F16-26S (J3) connector pin a	_____/_____
13.5 Pin DAS Power Wires	_____/_____
13.5.1 Strip outer jacket back 4 inches	_____/_____
13.5.2 Strip wires 3/16 inches	_____/_____
13.5.3 Crimp MS39029/32-259 sockets onto stripped wire	_____/_____
13.5.4 Slide wire into MS3126F16-26S (J3) strain relief	_____/_____
13.5.5 Insert black wire into MS3126F16-26S connector pin b	_____/_____
13.5.6 Insert white wire into MS3126F16-26S connector pin c	_____/_____
13.6 Pin GPS wires (Great Dane has already installed GPS and routed wires to DAS location)	_____/_____
13.6.1 Strip outer jacket back 4 inches	_____/_____
13.6.2 Strip wires 3/16 inches	_____/_____
13.6.3 Crimp MS39029/32-259 sockets onto stripped wire	_____/_____
13.6.4 Slide wire into MS3126F16-26S (J3) strain relief	_____/_____
13.6.5 Insert the green wire into MS3126F16-26S (J3) connector pin N	_____/_____
13.6.6 Insert the white wire into MS3126F16-26S (J3) connector pin P	_____/_____
13.6.7 Insert the red wire into MS3126F16-26S (J3) connector pin R	_____/_____
13.6.8 Insert the black wire into MS3126F16-26S (J3) connector pin S	_____/_____
13.7 Slide strain relief up to connector, screw it on and tighten clamp	_____/_____

QA review by _____ Date_____

Wal★Mart ID _____

Data Sheet D-1: T2 Trailer

Work by/Date

14.0 Wire unused pins of MS3476W20-41P (J1) connector _____/_____
14.1 Cut 27 2-inch lengths of 20 AWG wire _____/_____
14.2 Strip one end of each wire 3/16 inches _____/_____
14.3 Crimp MS39029/4-110 pin onto stripped wires _____/_____
14.4 Insulate unstripped ends _____/_____
14.5 Insert wires into unused pins _____/_____
14.5.1 NC: MS3476W20-41P (J1) connector pin S _____/_____
14.5.2 NC: MS3476W20-41P (J1) connector pin T _____/_____
14.5.3 NC: MS3476W20-41P (J1) connector pin U _____/_____
14.5.4 NC: MS3476W20-41P (J1) connector pin V _____/_____
14.5.5 NC: MS3476W20-41P (J1) connector pin W _____/_____
14.5.6 NC: MS3476W20-41P (J1) connector pin X _____/_____
14.5.7 NC: MS3476W20-41P (J1) connector pin Y _____/_____
14.5.8 NC: MS3476W20-41P (J1) connector pin Z _____/_____
14.5.9 NC: MS3476W20-41P (J1) connector pin a _____/_____
14.5.10 NC: MS3476W20-41P (J1) connector pin b _____/_____
14.5.11 NC: MS3476W20-41P (J1) connector pin c _____/_____
14.5.12 NC: MS3476W20-41P (J1) connector pin d _____/_____
14.5.13 NC: MS3476W20-41P (J1) connector pin e _____/_____
14.5.14 NC: MS3476W20-41P (J1) connector pin f _____/_____
14.5.15 NC: MS3476W20-41P (J1) connector pin g _____/_____
14.5.16 NC: MS3476W20-41P (J1) connector pin h _____/_____
14.5.17 NC: MS3476W20-41P (J1) connector pin i _____/_____
14.5.18 NC: MS3476W20-41P (J1) connector pin j _____/_____
14.5.19 NC: MS3476W20-41P (J1) connector pin k _____/_____
14.5.20 NC: MS3476W20-41P (J1) connector pin l _____/_____
14.5.21 NC: MS3476W20-41P (J1) connector pin m _____/_____
14.5.22 NC: MS3476W20-41P (J1) connector pin n _____/_____
14.5.23 NC: MS3476W20-41P (J1) connector pin p _____/_____
14.5.24 NC: MS3476W20-41P (J1) connector pin q _____/_____
14.5.25 NC: MS3476W20-41P (J1) connector pin r _____/_____
14.5.26 NC: MS3476W20-41P (J1) connector pin s _____/_____
14.5.27 NC: MS3476W20-41P (J1) connector pin t _____/_____

15.0 Pin Wiring to MS3476W20-41P (J1) connector _____/_____
15.1 Pin Roadside Front Pressure Transducer Wires _____/_____
15.1.1 Strip outer jacket back 1-1/2 inches _____/_____
15.1.2 Strip wires 3/16 inches _____/_____
15.1.3 Crimp MS39029/4-110 pin onto stripped wires _____/_____
15.1.4 Slide wire into MS3476W20-41P (J1) strain relief _____/_____
15.1.5 Insert white wire into MS3476W20-41P (J1) connector pin A _____/_____
15.1.6 Insert black wire into MS3476W20-41P (J1) connector pin B _____/_____

QA review by _____ Date_____

Wal★Mart ID _____

Data Sheet D-1: T2 Trailer

	Work by/Date
15.1.7 Insert red wire into MS3476W20-41P (J1) connector pin C	_____/_____
15.2 Pin Curbside Front Pressure Transducer Wires	_____/_____
15.2.1 Strip outer jacket back 1-1/2 inches	_____/_____
15.2.2 Strip wires 3/16 inches	_____/_____
15.2.3 Crimp MS39029/4-110 pin onto stripped wires	_____/_____
15.2.4 Slide wire into MS3476W20-41P (J1) strain relief	_____/_____
15.2.5 Insert white wire into MS3476W20-41P (J1) connector pin D	_____/_____
15.2.6 Insert black wire into MS3476W20-41P (J1) connector pin E	_____/_____
15.2.7 Insert red wire into MS3476W20-41P (J1) connector pin F	_____/_____
15.3 Pin Roadside Rear Pressure Transducer Wires	_____/_____
15.3.1 Strip outer jacket back 1-1/2 inches	_____/_____
15.3.2 Strip wires 3/16 inches	_____/_____
15.3.3 Crimp MS39029/4-110 pin onto stripped wires	_____/_____
15.3.4 Slide wire into MS3476W20-41P (J1) strain relief	_____/_____
15.3.5 Insert white wire into MS3476W20-41P (J1) connector pin G	_____/_____
15.3.6 Insert black wire into MS3476W20-41P (J1) connector pin H	_____/_____
15.3.7 Insert red wire into MS3476W20-41P (J1) connector pin J	_____/_____
15.4 Pin Curbside Rear Pressure Transducer Wires	_____/_____
15.4.1 Strip outer jacket back 1-1/2 inches	_____/_____
15.4.2 Strip wires 3/16 inches	_____/_____
15.4.3 Crimp MS39029/4-110 pin onto stripped wires	_____/_____
15.4.4 Slide wire into MS3476W20-41P (J1) strain relief	_____/_____
15.4.5 Insert white wire into MS3476W20-41P (J1) connector pin K	_____/_____
15.4.6 Insert black wire into MS3476W20-41P (J1) connector pin L	_____/_____
15.4.7 Insert red wire into MS3476W20-41P (J1) connector pin M	_____/_____
15.5 Pin Suspension Pressure Transducer Wires	_____/_____
15.5.1 Strip outer jacket back 1-1/2 inches	_____/_____
15.5.2 Strip wires 3/16 inches	_____/_____
15.5.3 Crimp MS39029/4-110 pin onto stripped wires	_____/_____
15.5.4 Slide wire into MS3476W20-41P (J1) strain relief	_____/_____
15.5.5 Insert white wire into MS3476W20-41P (J1) connector pin N	_____/_____
15.5.6 Insert black wire into MS3476W20-41P (J1) connector pin P	_____/_____
15.5.7 Insert red wire into MS3476W20-41P (J1) connector pin R	_____/_____
15.6 Slide strain relief up to connector, screw it on and tighten clamp	_____/_____

QA review by _____ Date_____

Revision 2
November 4, 2004

QUALITY ASSURANCE DOCUMENT

PROCEDURE FOR INSTALLING INSTRUMENTATION FOR FREIGHTLINER ECBS FIELD OPERATIONAL TEST

BATTELLE
505 King Avenue
Columbus, Ohio 43201-2693

Richard J. Olson

(November 4, 2004)

APPROVED BY

Program Technical Manager Date	Department Manager Date
Program Manager Date	Program QA Manager Date

Truck S/N _____

Data Sheet DAS1: Tractor DAS Checkout

	Work by/Date
1.0 DAS S/N _____	_____/_____
2.0 Verify DAS Hardware	_____/_____
2.1 Open DAS unit	_____/_____
2.2 Verify that the board on the top of the stack is an ATC01-CM102	_____/_____
2.3 Replace lid on DAS	_____/_____
3.0 Connections	_____/_____
3.1 Make sure the MS3126F20-41P connector is on J5	_____/_____
3.2 Make sure the MS3126F16-26P connector is on J4	_____/_____
3.3 Attach Ethernet cable from laptop to connector J5	_____/_____
4.0 Prepare DAS for Testing	_____/_____
4.1 Unbolt DAS from mounting plate	_____/_____
5.0 Test Sequence	_____/_____
5.1 Run Hyperterminal on laptop with DAS configuration (19200, 8, n, 1)	_____/_____
5.2 Start the tractor to power the DAS	_____/_____
5.3 Wait 30 seconds	_____/_____
5.4 Watch for startup routine on laptop via Terminal window	_____/_____
5.5 Check GPS	_____/_____
5.5.1 In Terminal window enter, "GPSon" command	_____/_____
5.5.2 If no GPS scrolls across the screen, enter "GPSsetup" command and follow on screen Instructions	_____/_____
5.5.2.1 Return to 5.5.1	_____/_____
5.5.3 GPS data should begin to scroll in Terminal window	_____/_____
5.5.4 Enter "GPSoff" command to stop scrolling data	_____/_____
5.6 Execute "CANon" command	_____/_____
5.6.1 CANbus data present	_____/_____
5.7 Execute "GetDevStatus" command	_____/_____
5.7.1 VIN acquired	_____/_____
5.8 Run "Monitor" program using Internet Explorer and enter IP address	_____/_____
5.9 If IP address is not known	_____/_____
5.9.1 Type "ifShow" in terminal window	_____/_____
5.9.2 Return to 5.7	_____/_____
5.10 Scroll to bottom of channel list, find RsFrontPress channel, highlight it and the next 16 channels, thru Wipers/Lights	_____/_____

QA review by _____ Date_____

Truck S/N _____
Data Sheet DAS1: Tractor DAS Checkout

	Work by/Date
5.11 Enter "AnalogOffset" command	_____/_____
5.12 Ensure that all pressure channels read 0	_____/_____
5.12.1 Roadside front pressure	_____/_____
5.12.2 Curbside front pressure	_____/_____
5.12.3 Roadside intermediate pressure	_____/_____
5.12.4 Curbside intermediate pressure	_____/_____
5.12.5 Roadside rear pressure	_____/_____
5.12.6 Curbside rear pressure	_____/_____
5.12.7 Tractor protection valve pressure	_____/_____
5.12.8 Treadle valve pressure	_____/_____
5.12.9 Steering angle	_____/_____
5.13 Execute "cmdOpenFile" command	_____/_____
5.14 Check pressure transducer channels	_____/_____
5.14.1 Apply brakes with hard application	_____/_____
5.14.2 Check that all pressure channels go to about 100 psi	_____/_____
5.14.2.1 Roadside front pressure	_____/_____
5.14.2.2 Curbside front pressure	_____/_____
5.14.2.3 Roadside intermediate pressure	_____/_____
5.14.2.4 Curbside intermediate pressure	_____/_____
5.14.2.5 Roadside rear pressure	_____/_____
5.14.2.6 Curbside rear pressure	_____/_____
5.14.2.7 Tractor protection valve pressure	_____/_____
5.14.2.8 Treadle valve pressure	_____/_____
5.15 Check steering angle sensor, monitoring for appropriate signal changes	_____/_____
5.15.1 Turn steering wheel 360 CW	_____/_____
5.15.2 Turn steering wheel back to original position	_____/_____
5.15.3 Turn steering wheel 360 CCW	_____/_____
5.15.4 Turn steering wheel back to original position	_____/_____
5.16 Test digital channels and observe presence of signals	_____/_____
5.16.1 Turn headlights on	_____/_____
5.16.3 Turn high beams on	_____/_____
5.16.4 Turn high beams off	_____/_____
5.16.2 Turn headlights off	_____/_____
5.16.5 Turn right turn signal on	_____/_____
5.16.6 Turn right turn signal off	_____/_____
5.16.7 Turn left turn signal on	_____/_____
5.16.8 Turn left turn signal off	_____/_____
5.16.9 Turn on wipers on	_____/_____
5.16.10 Turn wipers to high	_____/_____
5.16.11 Turn wipers off	_____/_____
5.17 Check accelerometers	_____/_____
5.17.1 Tilt the DAS 90-degrees backward and observe -1g	_____/_____
5.17.2 Tilt the DAS 90-degrees to the side and observe -1 g	_____/_____

QA review by _____ Date_____

Truck S/N _____
Data Sheet DAS1: Tractor DAS Checkout

	Work by/Date
5.18 Check yaw rate	_____/_____
5.18.1 With DAS level, rotate CW and CCW and observe + and - yaw rates	_____/_____
5.19 Execute "cmdOpenfile" command	_____/_____
5.20 Download file and save	_____/_____
5.21 Ensure orderly DAS shutdown	_____/_____
5.21.1 Turn off the tractor	_____/_____
5.21.2 Observe proper DAS shut down	_____/_____
5.22 Checkout complete	_____/_____

QA review by _____ Date_____

Loveland Instrumentation Checkout Plan
Tractors

May 1, 2005

Perform the checkout as described below on all 47 Freightliner tractors and record information in *Tractor Final Checkout* spreadsheet.

1) Turn on tractor and record vehicle mileage.

2) Record DAS serial number

3) Remove data card from DAS and record removal date and data card number.

4) Conduct DAS checkout by connecting PC to DAS using serial connection
    a. Insert "checkout" data card into DAS.
    b. Verify:
        i. Proper DAS boot up
        ii. Version of Firmware (VxWorks)
        iii. Configuration file number (active and default).
        Correct to latest if needed: FLTRC_20 (T2 tractors), EBST3_07 (T3 tractors) or EBST3_91 (T3 VSTC tractors).
    c. Double-check:
        i. Zero out analog channel offsets
        ii. GPS coordinates
    d. Turn off tractor and remove checkout data card.

5) Insert new FOT data card into tractor. Record data card number and date installed.

6) Document all CB noise reduction steps that have been taken in the tractor (grounding wires, cardboard, wood, etc.).

7) Perform quick visual checkout of tractor instrumentation, looking for any obvious defects. Note and attempt to repair any defects.

8) Document front axle brake hose modifications.

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APPENDIX E. SURVEYS

DRIVER PROFILE

(To be filled in once - prior to FOT start)

Driver ID#: _____ Location: _____

Truck #: _____ Date: _____

1. What is your age? Circle one: **18-30** **30-40** **40-50** **50-60** **Above 60**

2. How many years experience do you have driving commercial vehicles?
   Circle one: **0-2** **3-5** **6-10** **More than 10**

3. What kind of freight do you normally haul? _____

4. What is the normal loaded weight of your tractor-trailer? _____

5. What is your average daily mileage? _____

6. Have you driven a tractor equipped with disc brakes? Circle one: Yes No
   If so, which manufacturer's system(s)? Circle one: **Bendix** **ArvinMeritor**

   Have you driven a trailer equipped with disc brakes? Circle one: Yes No
   If so, which manufacturer's system(s)? Circle one: **Bendix** **ArvinMeritor**

7. Have you driven a tractor equipped with a next generation or "advanced" anti-lock braking system with stability control? Circle one: Yes No
   If so, which manufacturer's system(s)? _____

   Have you driven a trailer equipped with a next generation or "advanced" anti-lock braking system with stability control? Circle one: Yes No
   If so, which manufacturer's system(s)? _____

8. Have you driven a tractor equipped with an electronically controlled braking system (ECBS)? Circle one: Yes No
   If so, which manufacturer's system(s)? Circle one: MeritorWabco Bendix

   Have you driven a **trailer** equipped with an electronically controlled braking system (ECBS)? Circle one: **Yes** **No**
   If so, which manufacturer's system(s)? Circle one: **MeritorWabco** **Bendix**

9. Have you driven a **tractor** equipped with adaptive cruise control (SmartCruise)?
Circle one: **Yes** **No**
If so, which manufacturer's system(s)? _____

10. Have you driven a **tractor** equipped with a collision warning system (CWS)?
Circle one: **Yes** **No**

Circle the types of CWS that you've driven:
A) Side Collision Warning
B) Forward Collision Warning
C) Rear Collision Warning
If yes, which manufacturer's system(s)? _____

11. What have you heard about each of the following technologies? If so, what are your thoughts or perceptions about each of these technologies? (If this is the first time the driver has heard about a technology, please note that).

a. Air disc brakes

b. Advanced anti-lock braking system with stability control

c. Electronically controlled braking system (ECBS)

d. Adaptive Cruise Control (ACC or SmartCruise)

e. Forward Collision Warning (FCW or Eaton Vorad)

f. Side Collision Warning (SCW)

g. Lane Tracking/Road Departure (SafeTrac)

h. Rear Collision Warning (RCW)

12. If you had the opportunity to add a new technology to your truck, what would it be?

DRIVER INTERVIEW
T2C1- MW ABS and Drum Brakes
(To be completed by each driver after 6 months)

Driver ID#: _____ Date: _____

Truck #: _____

Technology Definitions:

Next Generation Anti-lock Brake (ABS) System provides the same anti-lock brake features as current systems, but also include hardware to support anti-rollover and future vehicle handling support programs. Two next generation ABS systems from MeritorWabco (MW) and Bendix are under evaluation in this field operation test. The MW system supports anti-rollover programs.

Next Generation ABS Questions

1. How would you rate your level of acceptance in next generation anti-locking brakes?
   Circle one: **High** **Moderate** **Neutral** **Low** **Very Low**

Why?

2. How would you rate your level of confidence or trust in next generation anti-locking brakes? Circle one: **High** **Moderate** **Neutral** **Low** **Very Low**

Why?

3. Has the ABS warning light come on to indicate a problem during the test period?
   Circle one: **Yes** **No**
   If yes, did it happen often? Circle one: **Yes** **No**
   Was it clear to you why the light was coming on?
   Circle one: **Yes** **No**
   How did you respond? Circle one:
   A.) Pulled-over/called for tow
   B.) Continued operating until next service station
   C.) Did nothing

4. Did you notice when the ABS was operating during the test period?
Circle one: **Yes** **No**

If yes, when did it primarily operate?

5. During the testing program, have you experienced any issues with hauling a trailer with one of the following technologies:

A) Air Disc brakes: **Yes** **No** (circle one).

If yes, explain:

B) Electronically controlled braking system (Can be identified by a second connector on the front of the trailer): **Yes** **No** (circle one).

If yes, explain:

DRIVER INTERVIEW
T2C2- MW ABS and Air Disc Brakes
(To be completed by each driver after 6 months)

Driver ID#: _____ Date: _____

Truck #: _____

Technology Definitions:

Next Generation Anti-lock Brake (ABS) System provides the same anti-lock brake features as current systems, but also include hardware to support anti-rollover and future vehicle handling support programs. Two next generation ABS systems from MeritorWabco (MW) and Bendix are under evaluation in this field operation test. The MW system supports anti-rollover programs.

Air Disc Brakes are a new foundation brake design for heavy-duty vehicles. They consist of a caliper, brake pads, and rotor. Your truck is equipped with air disc brakes.

Next Generation ABS Questions

1. How would you rate your level of acceptance in next generation anti-locking brakes? Circle one: **High** **Moderate** **Neutral** **Low** **Very Low**

Why?

2. How would you rate your level of confidence or trust in next generation anti-locking brakes? Circle one: **High** **Moderate** **Neutral** **Low** **Very Low**

Why?

3. Has the ABS warning light come on to indicate a problem during the test period?
   Circle one: **Yes** **No**
   If yes, did it happen often? Circle one: **Yes** **No**
   Was it clear to you why the light was coming on?
   Circle one: **Yes** **No**
   How did you respond? Circle one:
   A.) Pulled-over/called for tow
   B.) Continued operating until next service station
   C.) Did nothing

4. Did you notice when the ABS was operating during the test period?
Circle one: **Yes** **No**

If yes, when did it primarily operate?

5. During the testing program, have you experienced any issues with hauling a trailer with one of the following technologies:

A) Air Disc brakes: **Yes** **No** (circle one).

If yes, explain:

B) Electronically controlled braking system (Can be identified by a second connector on the front of the trailer): **Yes** **No** (circle one).

If yes, explain:

Air Disc Brake Questions

6. How would you rate your level of acceptance in air disc brakes?
Circle one: **High** **Moderate** **Neutral** **Low** **Very Low**

Why?

7. How would you rate your level of confidence/trust in air disc brakes?
Circle one: **High** **Moderate** **Neutral** **Low** **Very Low**

Why?

8. Do you feel that air disc brakes improve pedal feel? Circle one: **Yes** **No**

9. Do you feel that you are able to better modulate air disc brakes?
Circle one: **Yes** **No**

10. Do you feel that air disc brakes improve braking performance?
Circle one: **Yes** **No**
If yes, how much? (circle one) **A Little** **Moderately** **A lot**

11. Have you had a state inspection?
Circle one: **Yes** **No**
If yes, have state inspectors had any difficulties in inspecting air disc brakes?
Circle one: **Yes** **No**
If yes, how much? (circle one) **A Little** **Moderately** **A lot**
Do you feel that air disc brakes make it easier to pass state inspections?
Circle one: **Yes** **No**

12. Do you operate air disc brake tractors in a different manner than drum brake tractors?
Circle one: **Yes** **No**

If so, how?

13. During this test period, have you experienced any issues with hauling a **trailer** with one of the following technologies:

A) Air disc brakes: Circle one: **Yes** **No**

If yes, explain:

B) Drum brakes: Circle one: **Yes** **No**

If yes, explain:

C) Electronically controlled braking system (Can be identified by a second connector on the front of the trailer): Circle one: **Yes** **No**

If yes, explain:

DRIVER INTERVIEW
T2C3- MW ECBS and Air Disc Brakes
(To be completed by each driver after 6 months)

Driver ID#: _____ Date: _____

Truck #: _____

Technology Definitions:

Electronically Controlled Braking System (ECBS) controls the service brakes electronically rather than pneumatically. The system has an improved ABS function and supports anti-rollover and vehicle handling support programs. Your truck is equipped with ECBS from MeritorWabco. The anti-rollover and handling support programs were not active for this phase of the test program.

Air Disc Brakes are a new foundation brake design for heavy-duty vehicles. They consist of a caliper, brake pads, and rotor. Your truck is equipped with air disc brakes.

ECBS Questions

1. How would you rate your level of acceptance in electronically controlled brakes (ECBS)?
   Circle one: **High** **Moderate** **Neutral** **Low** **Very Low**

Why?

2. How would you rate your level of confidence/trust in electronically controlled brakes?
   Circle one: **High** **Moderate** **Neutral** **Low** **Very Low**

Why?

3. Has the ECBS warning light come on to indicate a problem during the test period?
   Circle one: **Yes** **No**
   If yes, how did you respond? Circle one:
   A) Pulled-over /called for tow
   B) Continued operating until next service station
   C) Did nothing

   If yes, did you notice a change in the operation of the brakes? Circle one: Yes No

If yes, explain:

4. How long did it take you to adjust to the feel of the brake pedal? Circle one:
   A) less than 2 weeks
   B) 1 month
   C) 3 months
   D) 3 to 6 months
   E) greater than 6 months (specify: _____)

5. Do you feel that ECBS reduces pedal feedback?
   Circle one: **Yes** **No**
   If yes, how much? Circle one: **A Little** **Moderately** **A lot**

6. Have you had any difficulties connecting the communication link (wire harness) between an ECBS tractor and an ECBS trailer? Circle one: **Yes** **No**

If yes, what were the difficulties?

7. Do you operate a tractor with an ECBS differently than you would a tractor without ECBS? Circle one: **Yes** **No**

If yes, how?

8. Do you feel that ECBS improves braking performance?
   Circle one: **Yes** **No**
   If yes, how much? (circle one) **A Little** **Moderately** **A lot**

9. During this test period, have you had any issues with hauling a trailer equipped with ECBS? Circle one: **Yes** **No**

If yes, explain:

10. Has the ABS warning light come on to indicate a problem during the test period?
Circle one: **Yes** **No**
If yes, did it happen often? Circle one: **Yes** **No**
Was it clear to you why the light was coming on?
Circle one: **Yes** **No**
How did you respond? Circle one:
A.) Pulled-over/called for tow
B.) Continued operating until next service station
C.) Did nothing

11. Did you notice when the ABS was operating during the test period?
Circle one: **Yes** **No**

If yes, when did it primarily operate?

Air Disc Brake Questions

12. How would you rate your level of acceptance in air disc brakes?
Circle one: **High** **Moderate** **Neutral** **Low** **Very Low**

Why?

13. How would you rate your level of confidence/trust in air disc brakes?
Circle one: **High** **Moderate** **Neutral** **Low** **Very Low**

Why?

14. Do you feel that air disc brakes improve pedal feel? Circle one: **Yes** **No**

15. Do you feel that you are able to better modulate air disc brakes?
Circle one: **Yes** **No**

16. Do you feel that air disc brakes improve braking performance?
Circle one: **Yes** **No**
If yes, how much? (circle one) **A Little** **Moderately** **A lot**

17. Have you had a state inspection?
Circle one: **Yes** **No**
If yes, have state inspectors had any difficulties in inspecting air disc brakes?
Circle one: **Yes** **No**
If yes, how much? (circle one) **A Little** **Moderately** **A lot**
Do you feel that air disc brakes make it easier to pass state inspections?
Circle one: **Yes** **No**

18. Do you operate air disc brake tractors in a different manner than drum brake tractors?
Circle one: **Yes** **No**

If so, how?

19. During this test period, have you experienced any issues with hauling a <u>trailer</u> with one of the following technologies:

A) Air disc brakes: Circle one: **Yes** **No**

If yes, explain:

B) Drum brakes: Circle one: **Yes** **No**

If yes, explain:

C) Electronically controlled braking system (Can be identified by a second connector on the front of the trailer): Circle one: **Yes** **No**

If yes, explain:

DRIVER INTERVIEW
T2C4- Bendix ABS and Air Disc Brakes
(To be completed by each driver after 6 months)

Driver ID#: _____ Date: _____

Truck #: _____

Technology Definitions:

Next Generation Anti-lock Brake (ABS) System provides the same anti-lock brake feature as current systems, but also includes hardware to support future roll stability and vehicle handling support programs. Your truck is equipped with a next generation ABS system from Bendix. It is not equipped with a roll stability or a vehicle handling support program.

Air Disc Brakes are a new foundation brake design for heavy-duty vehicles. They consist of a caliper, brake pads, and rotor. Your truck is equipped with air disc brakes.

Next Generation Anti-lock Brake (ABS) System Questions

1. How would you rate your level of acceptance in Bendix's new anti-lock braking system (ABS)?
   Circle one: **High** **Moderate** **Neutral** **Low** **Very Low**

Why?

2. How would you rate your level of confidence/trust in Bendix's new anti-lock braking system?
   Circle one: **High** **Moderate** **Neutral** **Low** **Very Low**

Why?

3. Did the ABS warning light come on to indicate a problem during the test period?
   Circle one: **Yes** **No**
   If yes, did it happen often? Circle one: **Yes** **No**
   Was it clear to you why the light was coming on? Circle one: **Yes** **No**
   How did you respond? Circle one:
   A.) Pulled-over/called for tow
   B.) Continued operating until next service station
   C.) Did nothing

4. Have you noticed the ABS operating during the test period?
Circle one: **Yes** **No**

If yes, when did it primarily operate?

Air Disc Brake Questions

5. How would you rate your level of acceptance in air disc brakes?
Circle one: **High** **Moderate** **Neutral** **Low** **Very Low**

Why?

6. How would you rate your level of confidence/trust in air disc brakes?
Circle one: **High** **Moderate** **Neutral** **Low** **Very Low**

Why?

7. Do you feel that air disc brakes improve pedal feel? Circle one: **Yes** **No**

8. Do you feel that you are able to better modulate air disc brakes?
Circle one: **Yes** **No**

9. Do you feel that air disc brakes improve braking performance?
Circle one: **Yes** **No**
If yes, how much? (circle one) **A Little** **Moderately** **A lot**

10. Have you had a state inspection?
Circle one: **Yes** **No**
If yes, have state inspectors had any difficulties in inspecting air disc brakes?
Circle one: **Yes** **No**
If yes, how much? (circle one) **A Little** **Moderately** **A lot**
Do you feel that air disc brakes make it easier to pass state inspections?
Circle one: **Yes** **No**

11. Do you operate air disc brake tractors in a different manner than drum brake tractors?
Circle one: **Yes** **No**

If so, how?

12. During this test period, have you experienced any issues with hauling a trailer with one of the following technologies:

A) Air disc brakes: Circle one: **Yes** **No**

If yes, explain:

B) Drum brakes: Circle one: **Yes** **No**

If yes, explain:

C) Electronically controlled braking system (Can be identified by a second connector on the front of the trailer): Circle one: **Yes** **No**

If yes, explain:

DRIVER INTERVIEW
T3- MW ECBS and Air Disc Brakes
(To be completed by each driver after 6 months)

Driver ID#: _____ Date: _____

Truck #: _____

Technology Definitions:

Electronically Controlled Braking System (ECBS) controls the service brakes electronically rather than pneumatically. The system has an improved ABS function and supports anti-rollover and vehicle handling support programs. Your truck is equipped with ECBS from MeritorWabco. The anti-rollover and handling support programs were not active for this phase of the test program.

Air Disc Brakes are a new foundation brake design for heavy-duty vehicles. They consist of a caliper, brake pads, and rotor. Your truck is equipped with air disc brakes.

1. How would you rate your level of acceptance in electronically controlled brakes (ECBS)?
   Circle one: **High** **Moderate** **Neutral** **Low** **Very Low**

Why?

2. How would you rate your level of confidence/trust in electronically controlled brakes?
   Circle one: **High** **Moderate** **Neutral** **Low** **Very Low**

Why?

3. Has the ECBS warning light come on to indicate a problem during the test period?
   Circle one: **Yes** **No**
   If yes, how did you respond? Circle one:
   A) Pulled-over /called for tow
   B) Continued operating until next service station
   C) Did nothing

If yes, did you notice a change in the operation of the brakes? Circle one: **Yes** **No**

If yes, explain:

4. How long did it take you to adjust to the feel of the brake pedal? Circle one:
   A) less than 2 weeks
   B) 1 month
   C) 3 months
   D) 3 to 6 months
   E) greater than 6 months (specify: _____)

5. Do you feel that ECBS reduces pedal feedback?
   Circle one: **Yes** **No**
   If yes, how much? Circle one: **A Little** **Moderately** **A lot**

6. Have you had any difficulties connecting the communication link (wire harness) between an ECBS tractor and an ECBS trailer? Circle one: **Yes** **No**

If yes, what were the difficulties?

7. Do you operate a tractor with an ECBS differently than you would a tractor without ECBS? Circle one: **Yes** **No**

If yes, how?

8. Do you feel that ECBS improves braking performance?
   Circle one: **Yes** **No**
   If yes, how much? (circle one) **A Little** **Moderately** **A lot**

9. During this test period, have you had any issues with hauling a trailer equipped with ECBS? Circle one: **Yes** **No**

If yes, explain:

10. Has the ABS warning light come on to indicate a problem during the test period?
    Circle one: **Yes** **No**
    If yes, did it happen often? Circle one: **Yes** **No**
    Was it clear to you why the light was coming on?
    Circle one: **Yes** **No**
    How did you respond? Circle one:
    A.) Pulled-over/called for tow
    B.) Continued operating until next service station
    C.) Did nothing

11. Did you notice when the ABS was operating during the test period?
    Circle one: **Yes** **No**

If yes, when did it primarily operate?

Air Disc Brake Questions

12. How would you rate your level of acceptance in air disc brakes?
Circle one: **High** **Moderate** **Neutral** **Low** **Very Low**

Why?

13. How would you rate your level of confidence/trust in air disc brakes?
Circle one: **High** **Moderate** **Neutral** **Low** **Very Low**

Why?

14. Do you feel that air disc brakes improve pedal feel? Circle one: **Yes** **No**

15. Do you feel that you are able to better modulate air disc brakes?
Circle one: **Yes** **No**

16. Do you feel that air disc brakes improve braking performance?
Circle one: **Yes** **No**
If yes, how much? (circle one) **A Little** **Moderately** **A lot**

17. Have you had a state inspection?
Circle one: **Yes** **No**
If yes, have state inspectors had any difficulties in inspecting air disc brakes?
Circle one: **Yes** **No**
If yes, how much? (circle one) **A Little** **Moderately** **A lot**
Do you feel that air disc brakes make it easier to pass state inspections?
Circle one: **Yes** **No**

18. Do you operate air disc brake tractors in a different manner than drum brake tractors?
Circle one: **Yes** **No**

If so, how?

19. During this test period, have you experienced any issues with hauling a trailer with one of the following technologies:

A) Air disc brakes: Circle one: **Yes** **No**

If yes, explain:

B) Drum brakes: Circle one: **Yes** **No**

If yes, explain:

C) Electronically controlled braking system (Can be identified by a second connector on the front of the trailer): Circle one: **Yes** **No**

If yes, explain:

DRIVER INTERVIEW
T2C1- MW ABS and Drum Brakes
(To be completed by each driver after 12 months)

Truck #: _____ **Driver ID#:** _____ **Date:** _____
(Will be kept confidential)

Your truck is equipped with Anti-Lock Braking System (ABS), Roll Stability Control (RSC) and Adaptive Cruise Control (ACC). As you may recall, RSC and ACC were activated earlier this year for the second phase of the test program.

ABS and RSC Questions

The Anti-lock Brake System (ABS) on your truck provides the same anti-lock brake feature as current systems, but also includes hardware to support Roll Stability Control (RSC) technology. As detailed in the training package you received in January 2006, Roll stability control (RSC) is a tractor-ABS-based system designed to help you manage road conditions that can lead to vehicle rollovers.

1. How would you rate your level of acceptance in the anti-locking brakes? Circle one:

   High **Moderate** **Neutral** **Low** **Very Low**

   Why?

2. How would you rate your level of confidence or trust in the anti-locking brakes? Circle one:

   High **Moderate** **Neutral** **Low** **Very Low**

   Why?

3. Has the ABS warning light come ON to indicate a problem during the test period?
   Circle one: **Yes** **No**

   If yes, did it happen often? Circle one: **Yes** **No**

   Was it clear to you why the light was coming on? Circle one: **Yes** **No**

   How did you respond? Circle one:
   A.) Pulled-over/called for tow
   B.) Continued operating until next service station
   C.) Did nothing

4. Did you notice when the ABS was operating during the test period? Circle one:

   Yes **No**

   If yes, when did it primarily operate?

5. Did you notice the roll stability control operating during the test period? Circle one:

   Yes **No**

   If yes, did it happen often? Circle one: **Yes** **No**

   If yes, when did it primarily operate?

   If yes, did you feel that the roll stability program (circle one):

   A) Assisted you in maintaining control
   B) Had no effect on your control of the vehicle
   C) Contributed to loss of vehicle control

6. Do you operate an ABS tractor <u>equipped with a roll stability control</u> system in a different manner than a tractor <u>not equipped</u> with a roll stability control system? Circle one:

   Yes **No**

   If yes, how?

7. During the testing program, have you experienced any issues with hauling a trailer with one of the following technologies:

   A) Air Disc brakes: **Yes** **No** (circle one).
   If yes, explain:

   B) Electronically controlled braking system (Can be identified by a second connector on the front of the trailer): **Yes** **No** (circle one).
   If yes, explain:

Adaptive Cruise Control (ACC) Questions

As detailed in the training package you received in January 2006, the Adaptive Cruise Control (ACC) is a radar-based tracking system that:

- Maintains a set speed when no vehicle is ahead, i.e. acts similarly to a conventional cruise control, and
- Maintains a predetermined time gap when there is a vehicle detected ahead.

8. How would you rate your level of acceptance of adaptive cruise control (ACC)?
   Circle one:

   High **Moderate** **Neutral** **Low** **Very Low**

   Why?

9. How would you rate your level of confidence/trust in ACC? Circle one:

High **Moderate** **Neutral** **Low** **Very Low**

Why?

10. Do you feel that ACC assists in reducing driver fatigue…

At night? **Yes** **No** (Circle one)

During the day? **Yes** **No** (Circle one)

Explain:

11. Compared to conventional cruise control, would you say you like ACC :

Better **The same** **Less** (Circle one)

Why?

<u>Thank You very much</u> for taking the time to respond to this survey!

DRIVER INTERVIEW
T2C2- MW ABS and Air Disc Brakes
(To be completed by each driver after 12 months)

Truck #: _____ **Driver ID#:** _____ **Date:** _____
(Will be kept confidential)

Your truck is equipped with Air Disc Brakes, Anti-Lock Braking System (ABS), Roll Stability Control (RSC) and Adaptive Cruise Control (ACC). As you may recall, RSC and ACC were activated earlier this year for the second phase of the test program.

ABS and RSC Questions

The Anti-lock Brake System (ABS) on your truck provides the same anti-lock brake feature as current systems, but also includes hardware to support Roll Stability Control (RSC) technology. As detailed in the training package you received in January 2006, Roll stability control (RSC) is a tractor-ABS-based system designed to help you manage road conditions that can lead to vehicle rollovers.

1. How would you rate your level of acceptance in the anti-locking brakes? Circle one:

   High **Moderate** **Neutral** **Low** **Very Low**

   Why?

2. How would you rate your level of confidence or trust in the anti-locking brakes? Circle one:

   High **Moderate** **Neutral** **Low** **Very Low**

   Why?

3. Has the ABS warning light come ON to indicate a problem during the test period? Circle one:
   Yes **No**

   If yes, did it happen often? Circle one: **Yes** **No**

   Was it clear to you why the light was coming on? Circle one: **Yes** **No**

   How did you respond? Circle one:
   A.) Pulled-over/called for tow
   B.) Continued operating until next service station
   C.) Did nothing

4. Did you notice when the ABS was operating during the test period? Circle one:

   Yes **No**

   If yes, when did it primarily operate?

5. Did you notice the roll stability control operating during the test period? Circle one:

   Yes **No**

   If yes, did it happen often? Circle one: **Yes** **No**

   If yes, when did it primarily operate?

   If yes, did you feel that the roll stability program (circle one):

   A) Assisted you in maintaining control
   B) Had no effect on your control of the vehicle
   C) Contributed to loss of vehicle control

6. Do you operate an ABS tractor equipped with a roll stability control system in a different manner than a tractor not equipped with a roll stability control system? Circle one:

   Yes **No**

   If yes, how?

Air Disc Brakes Questions

Air Disc Brakes are an alternative foundation brake design to drum brake design for heavy-duty vehicles. They consist of a caliper, brake pads, and rotor.

7. How would you rate your level of acceptance in air disc brakes?
   Circle one:

   High **Moderate** **Neutral** **Low** **Very Low**

   Why?

8. How would you rate your level of confidence/trust in air disc brakes?
   Circle one:

   High **Moderate** **Neutral** **Low** **Very Low**

   Why?

9. Do you feel that air disc brakes improve pedal feel?
   Circle one: **Yes** **No**

10. Do you feel that you are able to better modulate air disc brakes than drum brakes?
    Circle one: **Yes** **No**

11. Do you feel that air disc brakes improve braking performance?
    Circle one: **Yes** **No**

    If yes, how much? **A Little** **Moderately** **A lot** (circle one)

12. Have you had a state inspection?
    Circle one: **Yes** **No**

    If yes, have state inspectors had any difficulties in inspecting air disc brakes?
    Circle one: **Yes** **No**

    If yes, how much?
    Circle one: **A Little** **Moderately** **A lot**

Do you feel that air disc brakes make it easier to pass state inspections?
Circle one: **Yes** **No**

13. Do you operate a tractor equipped with air disc brakes in a different manner than one equipped with drum brakes?

Yes **No** **(**Circle one)

If yes, how?

14. During the testing program, have you experienced any issues with hauling a trailer with one of the following technologies:

A) Air Disc brakes: **Yes** **No** (circle one).

If yes, explain:

B) Drum brakes: **Yes** **No** (circle one).

If yes, explain:

C) Electronically controlled braking system (Can be identified by a second connector on the front of the trailer): **Yes** **No** (circle one).

If yes, explain:

Adaptive Cruise Control (ACC) Questions

As detailed in the training package you received in January 2006, the Adaptive Cruise Control (ACC) is a radar-based tracking system that:

- Maintains a set speed when no vehicle is ahead, i.e. acts similarly to a conventional cruise control, and
- Maintains a predetermined time gap when there is a vehicle detected ahead.

15. How would you rate your level of acceptance of adaptive cruise control (ACC)? Circle one:

High **Moderate** **Neutral** **Low** **Very Low**

Why?

16. How would you rate your level of confidence/trust in ACC? Circle one:

High **Moderate** **Neutral** **Low** **Very Low**

Why?

17. Do you feel that ACC assists in reducing driver fatigue…

At night? **Yes** **No** (Circle one)

During the day? **Yes** **No** (Circle one)

Explain:

18. Compared to conventional cruise control, would you say you like ACC :

Better **The same** **Less** (Circle one)

Why?

<u>Thank you very much</u> for taking the time to respond to this survey!

DRIVER INTERVIEW
T2C3- MW ECBS and Air Disc Brakes
(To be completed by each driver after 12 months)

Truck #: _____ **Driver ID#:** _____ **Date:** _____
(Will be kept confidential)

Your truck is equipped with Air Disc Brakes, Electronically Controlled Braking Systems (ECBS), Electronic Stability Control (ESC) and Adaptive Cruise Control (ACC). As you may recall, ESC and ACC were activated earlier this year for the second phase of the test program.

ECBS Questions

Electronically Controlled Braking System (ECBS) is an integrated brake control system which controls the service brakes electronically rather than pneumatically (as with ABS). As detailed in the training package you received in January 2006, the system supports stability control programs (e.g., ESC) and other advanced control systems requiring active braking.
Electonic Stability Control (ESC) is designed to detect and assist you in avoiding vehicle instabilities, including roll over or yaw conditions, to help you stay on course.

1. How would you rate your level of acceptance in ECBS? Circle one:

   High **Moderate** **Neutral** **Low** **Very Low**

   Why?

2. How would you rate your level of confidence or trust in ECBS? Circle one:

   High **Moderate** **Neutral** **Low** **Very Low**

   Why?

3. Has the ECBS warning light come ON to indicate a problem during the test period?
   Circle one: **Yes** **No**

   If yes, did it happen often? Circle one: **Yes** **No**

   Was it clear to you why the light was coming on? Circle one: **Yes** **No**

   If yes, how did you respond? Circle one:
   A.) Pulled-over/called for tow
   B.) Continued operating until next service station
   C.) Did nothing

If yes, did you notice a change in the operation of the brakes? Circle one: **Yes** **No**
Explain

4. Has the ABS warning light come ON to indicate a problem during the test period?
   Circle one: **Yes** **No**

   If yes, did it happen often? Circle one: **Yes** **No**

   Was it clear to you why the light was coming on? Circle one: **Yes** **No**

   How did you respond? Circle one:
   A.) Pulled-over/called for tow
   B.) Continued operating until next service station
   C.) Did nothing

5. Did you notice when the ABS was operating during the test period? Circle one:

   Yes **No**

   If yes, when did it primarily operate?

6. Did the brake pedal feel different to you (compared to an ABS equipped tractor)?

   Yes **No** (circle one)

   If yes, how long did it take you to adjust to the feel of the brake pedal on ECBS? Circle one:
   A) **Less than 2 weeks**
   B) **2 weeks to 1 month**
   C) **1 to 3 months**
   D) **3 to 6 months**
   E) **More than 6 months** (specify: _____)

7. Do you feel that ECBS reduces pedal feedback? Circle one:

   Yes **No**

   If yes, how much? Circle one: **A Little** **Moderately** **A lot**

8. Do you feel that ECBS improves braking performance?
   Circle one: **Yes** **No**
   If yes, how much? (circle one) **A Little** **Moderately** **A lot**

9. Have you noticed the stability control program (ESC) operating during the test period?

   Yes **No** (circle one)

   If yes, do you feel that the stability program (circle one):
   A) Assisted in maintaining control
   B) Had no effect
   C) Contributed to loss of control (circle one)

10. Do you operate a tractor with ECBS and ESC differently than you would a tractor with a conventional brake systems (ABS and no stability control)? Circle one:

    Yes **No**

    If yes, how?

11. Have you had any difficulties connecting the communication link (wire harness) between an ECBS tractor and an ECBS trailer? Circle one:

    Yes **No**

    If yes, what were the difficulties?

Air Disc Brakes Questions

Air Disc Brakes are an alternative foundation brake design to drum brake design for heavy-duty vehicles. They consist of a caliper, brake pads, and rotor.

12. How would you rate your level of acceptance in air disc brakes? Circle one:

    High **Moderate** **Neutral** **Low** **Very Low**

    Why?

13. How would you rate your level of confidence/trust in air disc brakes? Circle one:

High **Moderate** **Neutral** **Low** **Very Low**

Why?

14. Do you feel that air disc brakes improve pedal feel?
Circle one: **Yes** **No**

15. Do you feel that you are able to better modulate air disc brakes than drum brakes?
Circle one: **Yes** **No**

16. Do you feel that air disc brakes improve braking performance?
Circle one: **Yes** **No**

If yes, how much? **A Little** **Moderately** **A lot** (circle one)

17. Have you had a state inspection?
Circle one: **Yes** **No**

If yes, have state inspectors had any difficulties in inspecting air disc brakes?
Circle one: **Yes** **No**

If yes, how much?
Circle one: **A Little** **Moderately** **A lot**

Do you feel that air disc brakes make it easier to pass state inspections?
Circle one: **Yes** **No**

18. Do you operate a tractor equipped with air disc brakes in a different manner than one equipped with drum brakes?

Yes **No** (Circle one)

If yes, how?

19. During the testing program, have you experienced any issues with hauling a trailer with one of the following technologies:

A) Air Disc brakes: **Yes** **No** (circle one).

If yes, explain:

B) Drum brakes: **Yes** **No** (circle one).

If yes, explain:

C) Electronically controlled braking system , ECBS (Can be identified by a second connector on the front of the trailer): **Yes** **No** (circle one).

If yes, explain:

Adaptive Cruise Control (ACC) Questions

As detailed in the training package you received in January 2006, the Adaptive Cruise Control (ACC) is a radar-based tracking system that:

- Maintains a set speed when no vehicle is ahead, i.e. acts similarly to a conventional cruise control, and
- Maintains a predetermined time gap when there is a vehicle detected ahead.

20. How would you rate your level of acceptance of adaptive cruise control (ACC)?
Circle one:

High **Moderate** **Neutral** **Low** **Very Low**

Why?

21. How would you rate your level of confidence/trust in ACC? Circle one:

High **Moderate** **Neutral** **Low** **Very Low**

Why?

22. Do you feel that ACC assists in reducing driver fatigue…

At night? **Yes** **No** (Circle one)

During the day? **Yes** **No** (Circle one)

Explain:

23. Compared to conventional cruise control, would you say you like ACC :

Better **The same** **Less** (Circle one)

Why?

<u>Thank you very much</u> for taking the time to respond to this survey!

DRIVER INTERVIEW
T2C4- Bendix ABS and Air Disc Brakes
(To be completed by each driver after 12 months)

Truck #: _____ **Driver ID#:** _____ **Date:** _____
(Will be kept confidential)

Your truck is equipped with Air Disc Brakes and a next-generation Antilock Braking Systems (ABS6).

Next Generation ABS Questions

Next Generation Anti-lock Brake System (ABS6) provides the same anti-lock brake feature as current systems, but also includes hardware to support future roll stability and vehicle handling support programs.

1. How would you rate your level of acceptance in the anti-locking brakes? Circle one:

   High **Moderate** **Neutral** **Low** **Very Low**

   Why?

2. How would you rate your level of confidence or trust in the new anti-lock braking system? Circle one:

   High **Moderate** **Neutral** **Low** **Very Low**

   Why?

3. Has the ABS warning light come ON to indicate a problem during the test period?
   Circle one: **Yes** **No**

   If yes, did it happen often? Circle one: **Yes** **No**

   Was it clear to you why the light was coming on? Circle one: **Yes** **No**

   How did you respond? Circle one:
   A.) Pulled-over/called for tow
   B.) Continued operating until next service station
   C.) Did nothing

4. Did you notice when the ABS was operating during the test period? Circle one:

   Yes **No**

   If yes, when did it primarily operate?

Air Disc Brakes Questions

Air Disc Brakes are an alternative foundation brake design to drum brake design for heavy-duty vehicles. They consist of a caliper, brake pads, and rotor.

5. How would you rate your level of acceptance in air disc brakes? Circle one:

   High **Moderate** **Neutral** **Low** **Very Low**

   Why?

6. How would you rate your level of confidence/trust in air disc brakes? Circle one:

   High **Moderate** **Neutral** **Low** **Very Low**

   Why?

7. Do you feel that air disc brakes improve pedal feel?
   Circle one: **Yes** **No**

8. Do you feel that you are able to better modulate air disc brakes than drum brakes?
   Circle one: **Yes** **No**

9. Do you feel that air disc brakes improve braking performance?
   Circle one: **Yes** **No**

   If yes, how much? **A Little** **Moderately** **A lot** (circle one)

10. Have you had a state inspection?
    Circle one: **Yes** **No**

    If yes, have state inspectors had any difficulties in inspecting air disc brakes?
    Circle one: **Yes** **No**

    If yes, how much?
    Circle one: **A Little** **Moderately** **A lot**

    Do you feel that air disc brakes make it easier to pass state inspections?
    Circle one: **Yes** **No**

11. Do you operate a tractor equipped with air disc brakes in a different manner than one equipped with drum brakes?

    Yes **No** **(**Circle one)

If yes, how?

12. During the testing program, have you experienced any issues with hauling a trailer with one of the following technologies:

    A) Air Disc brakes: **Yes** **No** (circle one).

If yes, explain:

    B) Drum brakes: **Yes** **No** (circle one).

If yes, explain:

    C) Electronically controlled braking system (Can be identified by a second connector on the front of the trailer): **Yes** **No** (circle one).

If yes, explain:

Thank you very much for taking the time to respond to this survey!

DRIVER INTERVIEW
T3- MW ECBS and Air Disc Brakes
(To be completed by each driver after 12 months)

Truck #: _____ **Driver ID#:** _____ **Date:** _____
(Will be kept confidential)

Your truck is equipped with Air Disc Brakes, Electronically Controlled Braking Systems (ECBS), Electronic Stability Control (ESC) and Adaptive Cruise Control (ACC). As you may recall, ESC and ACC were activated earlier this year for the second phase of the test program.

ECBS Questions

Electronically Controlled Braking System (ECBS) is an integrated brake control system which controls the service brakes electronically rather than pneumatically (as with ABS). As detailed in the training package you received in January 2006, the system supports stability control programs (e.g., ESC) and other advanced control systems requiring active braking.
Electonic Stability Control (ESC) is designed to detect and assist you in avoiding vehicle instabilities, including roll over or yaw conditions, to help you stay on course.

1. How would you rate your level of acceptance in ECBS? Circle one:

   High **Moderate** **Neutral** **Low** **Very Low**

   Why?

2. How would you rate your level of confidence or trust in ECBS? Circle one:

   High **Moderate** **Neutral** **Low** **Very Low**

   Why?

3. Has the ECBS warning light come ON to indicate a problem during the test period?
   Circle one: **Yes** **No**

   If yes, did it happen often? Circle one: **Yes** **No**

   Was it clear to you why the light was coming on? Circle one: **Yes** **No**

   If yes, how did you respond? Circle one:
   A.) Pulled-over/called for tow
   B.) Continued operating until next service station
   C.) Did nothing

If yes, did you notice a change in the operation of the brakes? Circle one: **Yes** **No**

Explain

4. Has the ABS warning light come ON to indicate a problem during the test period?
   Circle one: **Yes** **No**

   If yes, did it happen often? Circle one: **Yes** **No**

   Was it clear to you why the light was coming on? Circle one: **Yes** **No**

   How did you respond? Circle one:
   A.) Pulled-over/called for tow
   B.) Continued operating until next service station
   C.) Did nothing

5. Did you notice when the ABS was operating during the test period? Circle one:

   Yes **No**

   If yes, when did it primarily operate?

6. Did the brake pedal feel different to you (compared to an ABS equipped tractor)?

   Yes **No** (circle one)

   If yes, how long did it take you to adjust to the feel of the brake pedal on ECBS? Circle one:
   A) **Less than 2 weeks**
   B) **2 weeks to 1 month**
   C) **1 to 3 months**
   D) **3 to 6 months**
   E) **More than 6 months** (specify: _____)

7. Do you feel that ECBS reduces pedal feedback? Circle one:

   Yes **No**

   If yes, how much? Circle one: **A Little** **Moderately** **A lot**

8. Do you feel that ECBS improves braking performance?
   Circle one: **Yes** **No**
   If yes, how much? (circle one) **A Little** **Moderately** **A lot**

9. Have you noticed the stability control program (ESC) operating during the test period?

   Yes **No** (circle one)

   If yes, do you feel that the stability program (circle one):
   A) Assisted in maintaining control
   B) Had no effect
   C) Contributed to loss of control (circle one)

10. Do you operate a tractor with ECBS and ESC differently than you would a tractor with a conventional brake systems (ABS and no stability control)? Circle one:

    Yes **No**

    If yes, how?

11. Have you had any difficulties connecting the communication link (wire harness) between an ECBS tractor and an ECBS trailer? Circle one:

    Yes **No**

    If yes, what were the difficulties?

Air Disc Brakes Questions

Air Disc Brakes are an alternative foundation brake design to drum brake design for heavy-duty vehicles. They consist of a caliper, brake pads, and rotor.

12. How would you rate your level of acceptance in air disc brakes? Circle one:

    High **Moderate** **Neutral** **Low** **Very Low**

    Why?

13. How would you rate your level of confidence/trust in air disc brakes? Circle one:

    High **Moderate** **Neutral** **Low** **Very Low**

    Why?

14. Do you feel that air disc brakes improve pedal feel?
    Circle one: **Yes** **No**

15. Do you feel that you are able to better modulate air disc brakes than drum brakes?
    Circle one: **Yes** **No**

16. Do you feel that air disc brakes improve braking performance?
    Circle one: **Yes** **No**

    If yes, how much? **A Little** **Moderately** **A lot** (circle one)

17. Have you had a state inspection?
    Circle one: **Yes** **No**

    If yes, have state inspectors had any difficulties in inspecting air disc brakes?
    Circle one: **Yes** **No**

    If yes, how much?
    Circle one: **A Little** **Moderately** **A lot**

    Do you feel that air disc brakes make it easier to pass state inspections?
    Circle one: **Yes** **No**

18. Do you operate a tractor equipped with air disc brakes in a different manner than one equipped with drum brakes?

    Yes **No** **(**Circle one)

If yes, how?

19. During the testing program, have you experienced any issues with hauling a trailer with one of the following technologies:

    A) Air Disc brakes: **Yes** **No** (circle one).

If yes, explain:

    B) Drum brakes: **Yes** **No** (circle one).

If yes, explain:

C) Electronically controlled braking system , ECBS (Can be identified by a second connector on the front of the trailer): **Yes** **No** (circle one).

If yes, explain:

Adaptive Cruise Control (ACC) Questions

As detailed in the training package you received in January 2006, the Adaptive Cruise Control (ACC) is a radar-based tracking system that:

- Maintains a set speed when no vehicle is ahead, i.e. acts similarly to a conventional cruise control, and
- Maintains a predetermined time gap when there is a vehicle detected ahead.

20. How would you rate your level of acceptance of adaptive cruise control (ACC)?
Circle one:

High **Moderate** **Neutral** **Low** **Very Low**

Why?

21. How would you rate your level of confidence/trust in ACC? Circle one:

High **Moderate** **Neutral** **Low** **Very Low**

Why?

22. Do you feel that ACC assists in reducing driver fatigue…

At night? **Yes** **No** (Circle one)

During the day? **Yes** **No** (Circle one)

Explain:

23. Compared to conventional cruise control, would you say you like ACC :

Better **The same** **Less** (Circle one)

Why?

<u>Thank you very much</u> for taking the time to respond to this survey!

MECHANIC PROFILE

(To be filled in once - prior to FOT start)

Mechanics ID#: _____ Date: _____

Location: _____

1. What is your age? Circle one: **18-30 31-40 41-50 51-60 Above 60**

2. How many years experience do you have maintaining commercial vehicles?
   Circle one: **0-2 3-5 6-10 More than 10**

3. What type of vehicles do you maintain? _____

4. What are your typical maintenance duties? _____
   _____

5. How many maintenance jobs do you perform in a typical day? _____

6. Have you maintained a vehicle equipped with air disc brakes? Circle one: Yes No
   If so, which manufacturer's system(s)? _____

7. Have you maintained a vehicle equipped with "advanced" ABS with stability control? Circle one: Yes No
   If so, which manufacturer's system(s)? _____

8. Have you maintained a vehicle equipped with an electronically controlled brake system (ECBS)? Circle one: Yes No
   If so, which manufacturer's system(s)? _____

9. Have you maintained a vehicle equipped with an adaptive cruise control (ACC or SmartCruise) system? Circle one: Yes No
   If so, which manufacturer's system(s)? _____

10. Have you maintained a vehicle equipped with a Collision Warning System (CWS or Eaton Vorad)? Circle one: Yes No
    If so, which manufacturer's system(s)? _____

11. Have you maintained a vehicle equipped with a Lane Tracking/Road Departure (SafeTrac) system? Circle one: Yes No
    If so, which manufacturer's system(s)? _____

12. Have you heard about the technologies listed below? If so, what are your thoughts or perceptions about each of these technologies?

a. Air disc brakes

Circle one: **Yes** **No**

b. Advanced anti-lock braking system with stability control

Circle one: **Yes** **No**

c. Electronically controlled braking system (ECBS)

Circle one: **Yes** **No**

d. Adaptative Cruise Control (ACC or SmartCruise)

Circle one: **Yes** **No**

e. Collision Warning Systems (CWS or Eaton Vorad)

Circle one: **Yes** **No**

g. Lane Tracking/Road Departure (SafeTrac)

Circle one: **Yes** **No**

MECHANIC INTERVIEW
(To be completed after 6 months)

Mechanic ID#: _____ Date: _____

Location: _____

Technology Definitions:

Next Generation Anti-lock Brake (ABS) System provides the same anti-lock brake features as current systems, but also include hardware to support anti-rollover and future vehicle handling support programs. Two next generation ABS systems from MeritorWabco (MW) and Bendix are under evaluation in this field operation test. The MW system supports anti-rollover programs.

Air Disc Brakes are a new foundation brake design for heavy-duty vehicles. They consist of a caliper, brake pads, and rotor. Two air disc brake systems from ArvinMeritor and Bendix are under evaluation.

Electronically Controlled Braking System (ECBS) controls the service brakes electronically rather than pneumatically. The system has an improved ABS function and supports anti-rollover and vehicle handling support programs. Two ECBS from MeritorWabco and Bendix (trailer only) are under evaluation.

Next Generation Anti-lock Brake (ABS) System Questions

1. How would you rate your level of confidence or trust in the reliability and maintainability of next generation ABS?

   Circle one: **High** **Moderate** **Neutral** **Low** **Very Low**

Why?

2. Have you performed any maintenance on next generation ABS during the test period?

   Circle one: **Yes** **No**

If yes, explain?

3. Has the next generation ABS generated any fault codes during the test period?
Circle one: **Yes** **No**

If yes, explain?

4. How would you rate the level of difficulty in diagnosing and repairing next generation ABS? Circle one:

High **Moderate** **Neutral** **Low** **Very Low**

5. How would you rate the frequency of required maintenance for next generation ABS?

High **Moderate** **Neutral** **Low** **Very Low**

6. Overall, how would you rate the maintenance requirements of next generation ABS compared with current ABS technology? Circle one:

A) Less difficult
B) Same difficulty
C) More difficult

Why?

7. Do you feel that next generation ABS require more frequent replacement of electrical components than current anti-lock braking systems?

Circle one: **Yes** **No**

Air Disc Brake Questions

8. How would you rate your level of confidence or trust in the reliability and maintainability of air disc brakes? Circle one:

High **Moderate** **Neutral** **Low** **Very Low**

Why?

9. Have the air disc brake systems required maintenance during the test period?

Circle one: **Yes** **No (If no, skip to question #13)**

If yes, what was the cause? _____

10. How would you rate the level of difficulty in diagnosing and repairing air disc brakes? Circle one:

High **Moderate** **Neutral** **Low** **Very Low**

11. How would you rate the frequency of required maintenance for air disc brakes?

High **Moderate** **Neutral** **Low** **Very Low**

12. Overall, how would you rate the maintenance requirements of air disc brakes compared with S-cam drum brakes? Circle one:
    A) Less difficult
    B) Same difficulty
    C) More difficult

Why?

13. Have you had to perform any brake adjustments to the air disc brake equipped tractors or trailers? Circle one: **Yes** **No**

If yes, how would you rate the brake adjustment procedures (circle one)?

A) Less difficult than drum brakes
B) The same as drum brakes
C) More difficult than drum brakes

Why?

Electronically Controlled Braking System (ECBS) Questions

14. How would you rate your level of confidence or trust in the reliability and maintainability of electronically controlled braking systems (ECBS)? Circle one:

High **Moderate** **Neutral** **Low** **Very Low**

Why?

15. Have the electronically control brake systems required maintenance during the test period? Circle one: **Yes** **No**

If yes, what was the cause? _____

16. Have the electronically controlled brake systems generated any fault codes during the test period?

Circle one: **Yes** **No**

17. How would you rate the level of difficulty in diagnosing and repairing electronically controlled braking systems (ECBS)? Circle one:

High **Moderate** **Neutral** **Low** **Very Low**

18. How would you rate the frequency of required maintenance for electronically controlled braking systems?

High **Moderate** **Neutral** **Low** **Very Low**

19. Overall, how would you rate the maintenance requirements of electronically controlled braking systems compared with current ABS technology? Circle one:

A) Less difficult
B) Same difficulty
C) More difficult

Why?

20. Has the high-speed data cable that attaches between the ECBS equipped tractors and ECBS trailers required any maintenance?

Circle one: **Yes** **No**

If yes, explain:

21. Do you feel that electronically controlled braking systems (ECBS) require more frequent replacement of electrical components than anti-lock braking systems (ABS)?

Circle one: **Yes** **No**

MECHANIC INTERVIEW
(To be completed after 12 months)

Please indicate your name. It will be kept confidential.

Technician ID# or NAME: _____ Date: _____

Anti-lock Brake System (ABS) Questions

Next Generation Anti-lock Brake System (ABS) provides the same anti-lock brake features as current systems, but also include hardware to support anti-rollover (example, RSC) and future vehicle handling support programs. Both a Meritor WABCO and a Bendix antilock braking systems were under evaluation in this field operation test. The MW system supports anti-rollover programs.

1. How would you rate your level of confidence or trust in the reliability and maintainability of next generation ABS?

   Circle one: **High** **Moderate** **Neutral** **Low** **Very Low**

   Why?

2. Have you performed any maintenance on next generation ABS since the last reporting period?

   Circle one: **Yes** **No**

   If yes, explain?

3. Has the next generation ABS generated any fault codes since the last reporting period?

   Circle one: **Yes** **No**

   If yes, explain?

4. How would you rate the level of difficulty in diagnosing and repairing next generation ABS? Circle one:

   High **Moderate** **Neutral** **Low** **Very Low** (Circle one)

5. How would you rate the frequency of required maintenance for next generation ABS?

   High **Moderate** **Neutral** **Low** **Very Low** (Circle one)

6. Overall, how would you rate the maintenance requirements of next generation ABS compared with current ABS technology? Circle one:

   A) Less difficult
   B) Same difficulty
   C) More difficult

Why?

7. Do you feel that next generation ABS require more frequent replacement of electrical components than current anti-lock braking systems?

   Circle one: **Yes** **No**

Air Disc Brake Questions

Air Disc Brakes are an alternative foundation brake design to drum brake design for heavy-duty vehicles. They consist of a caliper, brake pads, and rotor. Two air disc brake systems were under evaluation: ArvinMeritor (selected trailers only) and Bendix (tractors and trailers).

8. How would you rate your level of confidence or trust in the reliability and maintainability of air disc brakes? Circle one:

   High **Moderate** **Neutral** **Low** **Very Low** (Circle one)

Why?

9. Have the air disc brake systems required maintenance since the last reporting period?

   Circle one: **Yes** **No (If no, skip to question #13)**

   If yes, what was the cause? _____

10. How would you rate the level of difficulty in diagnosing and repairing air disc brakes? Circle one:

    High **Moderate** **Neutral** **Low** **Very Low** (Circle one)

11. How would you rate the frequency of required maintenance for air disc brakes?

    High **Moderate** **Neutral** **Low** **Very Low** (Circle one)

12. Overall, how would you rate the maintenance requirements of air disc brakes compared with S-cam drum brakes? Circle one:

    A) Less difficult
    B) Same difficulty
    C) More difficult

Why?

13. Have you had to perform any brake adjustments to the air disc brake equipped tractors or trailers? Circle one: **Yes** **No**

If yes, how would you rate the brake adjustment procedures (circle one)?

A) Less difficult than drum brakes
B) The same as drum brakes
C) More difficult than drum brakes

Why?

Electronically Controlled Braking System (ECBS) Questions

Electronically Controlled Braking System (ECBS) is an integrated brake control system which controls the service brakes electronically rather than pneumatically (as with ABS). The system supports stability control programs (e.g., ESC) and other advanced control systems requiring active braking. ECBS was installed on tractors and on trailers.

14. How would you rate your level of confidence or trust in the reliability and maintainability of electronically controlled braking systems (ECBS)?

High **Moderate** **Neutral** **Low** **Very Low** (Circle one)

Why?

15. Have the electronically control brake systems required maintenance since the last reporting period?
Circle one: **Yes** **No**

If yes, what was the cause? _____

16. Have the electronically controlled brake systems generated any fault codes during the test period?

Circle one: **Yes** **No**

17. How would you rate the level of difficulty in diagnosing and repairing electronically controlled braking systems (ECBS)? Circle one:

High **Moderate** **Neutral** **Low** **Very Low**

18. How would you rate the frequency of required maintenance for electronically controlled braking systems?

High **Moderate** **Neutral** **Low** **Very Low**

19. Overall, how would you rate the maintenance requirements of electronically controlled braking systems compared with current ABS technology? Circle one:

A) Less difficult
B) Same difficulty
C) More difficult

Why?

20. Has the high-speed data cable that attaches between the ECBS equipped tractors and ECBS trailers required any maintenance?

Circle one: **Yes** **No**

If yes, explain:

21. Do you feel that electronically controlled braking systems (ECBS) require more frequent replacement of electrical components than anti-lock braking systems (ABS)?

Circle one: **Yes** **No**

<u>Thank you very much</u> for taking the time to respond to this survey!

APPENDIX F. TRAINING MATERIALS ON ENABLED TECHNOLOGIES

FIELD OPERATIONAL TEST OF ELECTRONICALLY CONTROLLED BRAKING SYSTEMS (ECBS)

DRIVER TRAINING PACKET:

ADVANCED BRAKING TECHNOLOGIES FOR TRUCKS AND TRAILERS

January 2006

Contents Of This Packet

Introduction

You will learn more about the background of this program, with a special message from the US DOT to you.

Survey

Please promptly complete this survey and return to your service manager.

Training Materials

Please read the documents in this section as they will tell you about new exciting technologies which are enabled on either the tractor you are driving and/or the trailer you are pulling

In addition, a training video will be available to you after 1/24/2006.

If you would like to learn more about the systems, go talk to your service manager to view the 1-hour video.

Acknowledgment Form

After reviewing the material contained in this package, please sign the acknowledgment form and return to your service manager

Introduction

The purpose of the Field Operational Test is to help improve safety of trucks operating on our nation's highways by improving our understanding of the performance, reliability and safety benefits of electronically controlled brakes, air disc brakes, adaptive cruise control, and electronic stability control safety systems for heavy trucks. In this study, different combinations of brake systems and advanced safety technologies have been installed on 47 Wal★Mart tractors and 100 Wal★Mart trailers. Data are recorded on the operation and performance of the systems and, if they occur, any faults that might be registered. The information collected will be compiled and analyzed to determine the performance and safety benefits of these new technologies.

There are several phases to this study. Initially, data were collected on select International tractors, the 47 Freightliner tractors, and the 100 trailers to gather basic information about Wal★Mart routes, and general driving practices, with and without electronically controlled brakes and air disc brakes. In the last phase of the study, which begins now, additional safety technologies such as adaptive cruise control and electronic stability control safety systems are activated. These systems are intended to reduce the risk or likelihood of an accident over that of conventional vehicles. This study will help Freightliner and the Department of Transportation demonstrate the reduced risk.

A message from the US Department of Transportation to you:

As the government project manager for this Field Operational Test, I would like to thank you for your participation in this important program to operationally test advanced braking systems. The project is vitally important because it is testing new safety systems that can help drivers reduce their risk of an accident or crash. These new technologies have the potential to reduce thousands of crashes involving heavy trucks on our nation's highways each year. But we need your help to make this test a success!

Your help in responding to driver surveys and in keeping the advanced safety systems and associated data collection equipment operational throughout the test will ensure that the highest quality data is collected, enabling US DOT, and our industry partners, including Wal★Mart, to gain a thorough understanding of the safety benefit, driver acceptance, reliability, and maintainability of these systems.

Again, many thanks for making this a successful research program that will benefit the trucking industry and the general public by enhancing safety on our nation's highways.

Tim Johnson
Government Project Manager for the ECBS FOT and
Chief of Heavy Vehicle Research,
National Highway Traffic Safety Administration (NHTSA)

Survey

Please complete this survey today
and return to your service manager.

Your identity will not be disclosed.

Training Materials

Please read the documents in this section as they will tell you about the new exciting technologies which are enabled on either the tractor you are driving and/or the trailer you are pulling.

After reading this information, please complete the acknowledgement form on the last page, and return it to your manager along with the completed survey.

The table below shows you which technologies are active on vehicles as a function of the tractor ID.

If your truck ID is:	You will be exposed to the following technologies:					
	RSC	ACC	ECBS	ESC	ECBS & RSS (trailer)	ECBS & TRSP (trailer)
T2C1	●	●			●	●
T2C2	●	●			●	●
T3		●	●	●	●	●
T2C3		●	●	●	●	●
T2C4					●	●

RSC – Roll Stability Control

ACC – Adaptive Cruise Control

ECBS – Electronically Controlled Braking System

ESC – Electronic Stability Control

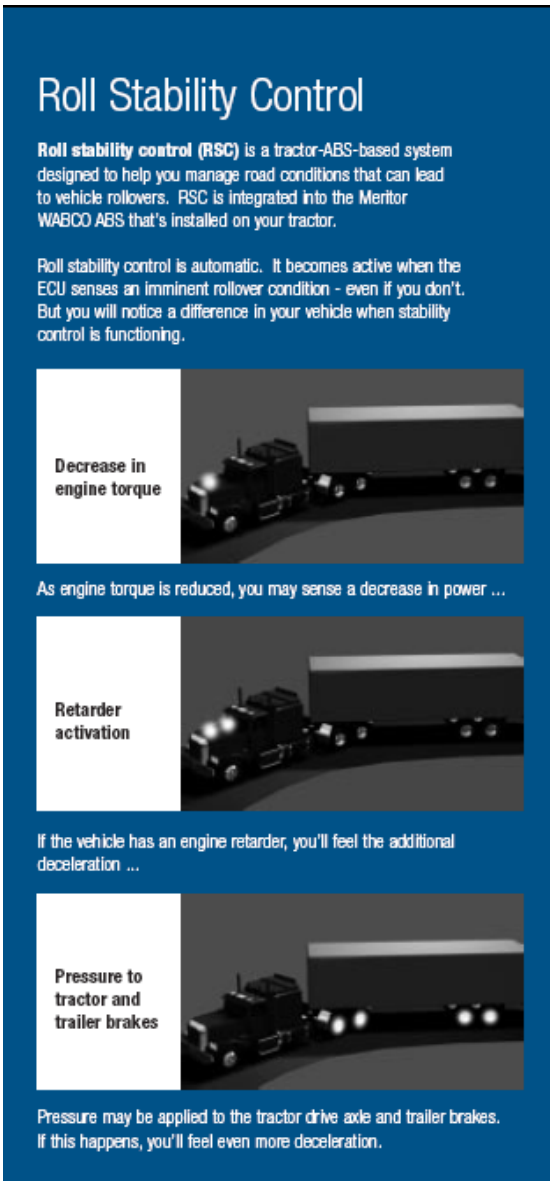
RSS – Roll Stability Support for trailer

TRSP – Trailer Roll Stability Program for trailer

In addition, a training video will be available to you after 1/24/2006.

If you would like to learn more about the systems, go talk to your manager to view the 1-hour video.

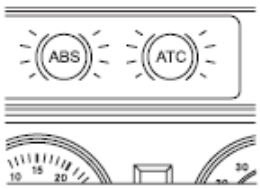
Roll Stability Control (RSC)
Driver Tips
RSC helps manage those road conditions that can contribute to vehicle rollovers.
MERITOR WABCO


Roll Stability Control
Roll stability control (RSC) is a tractor-ABS-based system designed to help you manage road conditions that can lead to vehicle rollovers. RSC is integrated into the Meritor WABCO ABS that's installed on your tractor.
Roll stability control is automatic. It becomes active when the ECU senses an imminent rollover condition - even if you don't. But you will notice a difference in your vehicle when stability control is functioning.
Decrease in engine torque
As engine torque is reduced, you may sense a decrease in power ...
Retarder activation
If the vehicle has an engine retarder, you'll feel the additional deceleration ...
Pressure to tractor and trailer brakes
Pressure may be applied to the tractor drive axle and trailer brakes. If this happens, you'll feel even more deceleration.

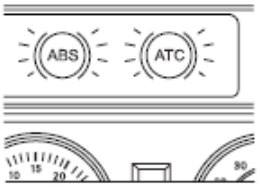
RSC Indicator Lamp

RSC, like ABS and ATC, is automatic. There's no switch or selection device. An indicator lamp on the dash lets you know stability control will be available when you need it.

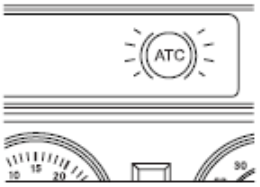
Automatic Traction Control (ATC) and RSC functions share the same dash indicator lamp so it's important to understand how this lamp works:



Both lamps come on at ignition ON and turn off after approximately three seconds. Vehicle equipped with ABS and ATC.



Both lamps come on at ignition ON.



ATC/RSC lamp stays on briefly after ABS lamp goes out. Vehicle equipped with ABS, ATC, RSC.

NOTE: If the **ABS indicator lamp** stays ON after 3 seconds, there could be an existing fault in the ABS, ATC or RSC systems. If this happens, drive the vehicle at speeds above 4 mph (6 km/h).

- If the lamp goes out the system is OK
- If the lamp does not go out, there is an existing fault in the system (ABS, ATC or RSC). Have the vehicle serviced as soon as possible.

ATC or Stability Control Event

The ATC/stability control lamp will come on and stay on during a traction control or stability control event. The lamp will go off when normal driving conditions are resumed.

- If the ABS indicator lamp comes on and stays on during normal operation there is a system fault. If this occurs, take the vehicle in for service as soon as possible.

Safe Vehicle Operation

RSC - or any vehicle control system - is not a reason to take unnecessary risks.

RSC helps reduce the tendency of the vehicle to roll over when cornering or changing directions, however, IT CAN NOT PREVENT ALL ROLLOVERS FROM OCCURRING.

When operating your vehicle always use safe driving techniques. The driver is **always** the most important player in safe vehicle operation.

Other Information For Drivers

Video

What Every Driver Should Know About ABS, T-96159V	$20.00
What Every Driver Should Know About ATC, T-96159V	$20.00
What Every Driver Should Know About Stability Control Systems, T-0483V	$20.00

Pamphlets

ABS Driver Tips, SP-93161
Trailer ABS Warning Lamp Driver Information, TP-97132
Off-Road ABS Function Driver Tips, TP-9898
ATC Driver Tips, TP-9992
Hydraulic ABS Driver Tips, SP-9916
HPB Driver Tips, TP-04109
Electronically Controlled Air Suspension for Buses and Coaches Driver Tips, TP-9929

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Litho in USA
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TP-0519 (47965/11900)

ADAPTIVE CRUISE CONTROL (ACC) and COLLISION WARNING SYSTEM (CWS)

What is ACC? What is CWS?

The Adaptive Cruise Control (ACC) is a radar-based tracking system that acts similarly to a conventional cruise control when no vehicle is ahead. When there is a vehicle ahead, ACC can track it, and display speed and range. The lane prediction function can determine if a vehicle is in your lane.

ACC will maintain a set speed (no vehicle ahead) or a predetermined time gap (vehicle detected) by controlling Engine throttle, Retarder, and/or Foundation brakes.

The ACC has an active braking control and Collision Warning System (CWS).

- The brake control is possible only when the ACC is active and will initiate active braking with both a visual and audible alarm for impending collisions.
- The CWS is always active regardless of ACC but will only display a collision warning and sound an alarm.

Things you should know…

When does ACC detect vehicles? ACC can detect targets up to 400 feet ahead and allows sufficient following distance (300 feet at 65 mph). ACC may be set from 10 mph and up to 65 mph. It will disengage when your vehicle speed drops below 6 mph.

How do can you disengage ACC? ACC can be disengaged by applying the brakes, by depressing the clutch pedal, by activating engine retarder, by reducing engine RPM below idle speed, or simply by switching off. Active braking can be interrupted by driver throttle initiation.

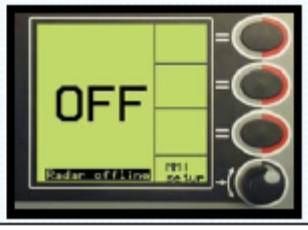
Will the system warn you? An audible alarm will also sound if the ACC is accidentally disengaged or if the engine RPM drops below idle level indicating the clutch needs to be depressed.

When should you not use ACC? The ACC should not be activated when low traction road conditions are present such as wet, snow or ice covered surfaces. The ACC should not be used on exceptionally winding roads where it would lose radar contact and may rapidly increase and reduce speed.

ACC and CWS in summary...

ACC and CWS OFF

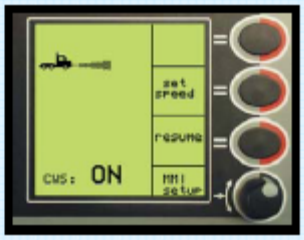
Your vehicle operates as usual, without cruise control.
The CWS will not emit collision warnings.



ACC and CWS ON, Speed Not Set

Your vehicle operates as usual when the cruise control speed is not set. The CWS is on and will emit collision warnings.

When no vehicle is detected...
... the display shows that CWS is on & the radar is tracking.
You can set or resume your speed.

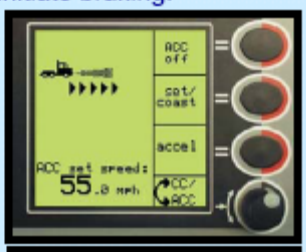


When a vehicle is detected in front of you...
... the display shows that CWS is on, the radar is tracking a target at the speed shown. You can set or resume your speed.

ACC and CWS ON, Speed Set

The ACC set speed is displayed (ex: 55 mph), and five arrows are shown below the radar symbol. The CWS is on, will emit / display collision warnings and will initiate braking.

When no vehicle is detected...
... the system operates similarly to conventional cruise control.



When a vehicle is detected in front of you...
... the system controls your speed to maintain a set distance between you and the detected vehicle. The vehicle detected, its speed and its distance from you are shown on display.

Driver Tips On When To Use ACC

- ACC should be used wherever you would typically use conventional cruise control.
- ACC should only be considered as an aid, and is not intended to replace driver control over the vehicle at any time.
- Safety features of ACC are only intended to initiate braking of the vehicle in an effort to avoid an incident. They should not to be relied on to always function and are merely a backup safety system. In the event the ACC system requires activation of the foundation brakes, there is a limit to its maximum braking ability (by design). The driver is expected to intervene and assume control of the braking of the vehicle.
- ACC should not be relied on to track target vehicles when either or both vehicles have entered and/or are traveling through a curve in the road. Because of this, ACC is not recommended for use on winding (curving) roads.
- ACC is unable to regulate speed on anything more than mild downhill and uphill grades.
- ACC will not track stationary objects (anything stationary or traveling below several mph).
- ACC should not be expected to track smaller objects (e.g. motorcycles, mopeds, bicycles, etc.)
- Just as with conventional cruise control, ACC is not recommended for use in slow moving/congested traffic.

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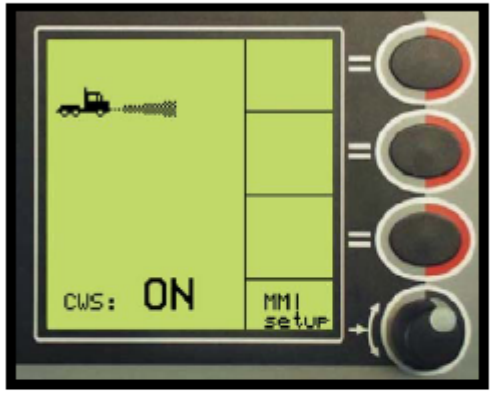
Information Display for ACC/CWS

When the ignition is on, the vehicle is at standstill, or below 10 mph…

… this screen is displayed.



A picture of the vehicle with radar broadcasting is shown.

The only functions active are:

- CWS: ON, and
- MMI setup button

The **MMI (Man Machine Interface) setup button** can be depressed to display the options screen. The options screen will allow for UNITS, BRIGHTNESS and CONTRAST adjustments.

- Pushing the SEL button will select one of the 3 adjustments.
- Turning the knob will change the value displayed.
- When finished, pushing the ESC button will return to the bottom display.

These are the only setup adjustments allowed.

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Information Display for ACC/CWS

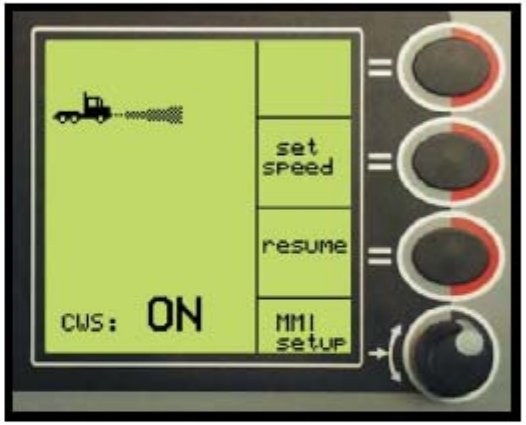
When your vehicle speed is greater than 10mph…

Without a vehicle in front of you

The set speed is now active.

- If the set speed button is pressed the present vehicle speed will be set and maintained.

If a speed has been previously set, the resume button will be active also.



With a vehicle in front of you

The screen is the same except that it also shows that there is vehicle detected 315 feet ahead and traveling at 60 mph.

The MMI button is still displayed on both screens which means the options screen can be displayed.

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Information Display for ACC/CWS

When ACC is active and set at 55 mph.

The screen displays 5 arrows "▶▶▶▶▶" below radar symbol, and your "ACC set speed" (55.0 mph).

- Disengage the ACC by pushing the "ACC Off" button.
- Decrease your speed by pushing the "set/coast" button.
- Increase your speed by pushing the "accel" button.

Without a vehicle in front of you →

With a vehicle in front of you →

A vehicle has been detected at 243ft ahead of you and traveling at 45 mph.

- The system will slow your vehicle down to match the speed of the target, while maintaining a set time gap.

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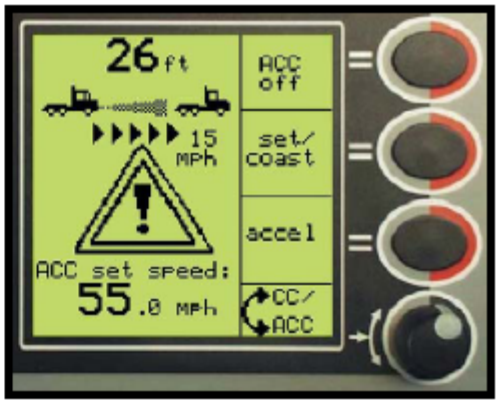
Information Display for ACC/CWS

When there is a Collision Warning Event…

- A collision Warning symbol is displayed
- An audible alarm is sounded

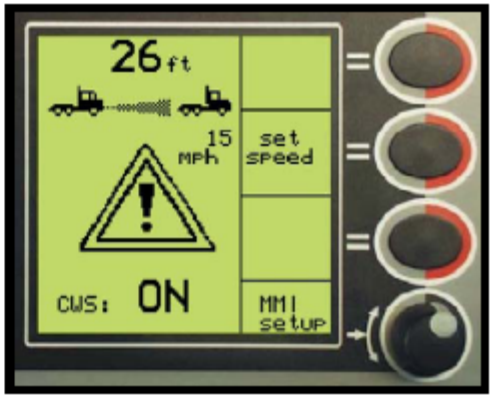
When ACC IS active

- The braking control WILL activate, and slow the vehicle.
- The driver should also initiate braking if needed.



When ACC is NOT active

- The braking control will NOT activate.
- The driver should initiate braking.



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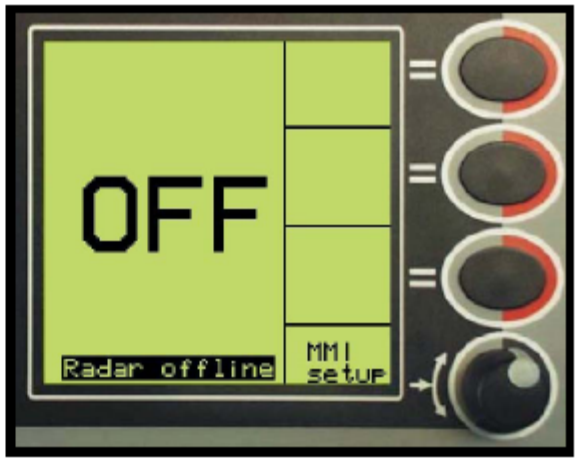
Information Display for ACC/CWS

When the system is off... Your display looks like this…

- The radar sensor not transmitting diagnostic information.
- The ACC and the CWS are not active



If you want to learn more about this new system, a information video will be available to you after 1/24/2006. You may go talk to Patrick Smith to view the 1-hour video.

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Electronically Controlled Braking Systems (ECBS)

Tractor ECBS is an integrated brake control system:

- Tractor ECBS is designed to let drivers select a deceleration rate resulting is shorter brake response time and reduced stopping distance.
- ABS and Automatic Traction Control (ATC) are performance features supported by ECBS.
- The system continuously monitors brake system performance, lining wear and air leakage.
- ECBS is an ideal platform for advanced control systems requiring active braking such as Stability Control (ESC) and Adaptive Cruise Control.

Trailer ECBS is an electronically controlled brake system with an integrated Roll Stability System (RSS).

- If connected to a conventional tractor, it functions independently,
- If connected to a tractor equipped with ECBS, it is controlled by the tractor ECBS through an additional tractor to trailer harness,
- It can function in back-up as a full pneumatic brake system,

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Warning Lamps for ECBS

The tractor ECBS has 3 dash warning lamps :

- The 3 lamps are on at ignition and turn off after 3 seconds: the system is active.
- When either the ABS or EBS lamp stays on more than 3 seconds after ignition, there is a system fault.

Indicates faults that effects ECBS, "The Brake System".

Indicates faults with the stability system (ABS, ATC, ESC or LWC)

Indicates that the ECBS system is in backup mode: The brake system has reverted to a conventional air controlled brake system without ABS, ESC, or ATC. The brake system may have a different pedal feel.

Indicates ATC or ESC is active. When the deep snow and mud switch is activated, the lamp will blink continually.

The trailer ECBS has 2 indicator lamps: one on the tractor dash and one on the side of the trailer.

- If either lamp stays on after ignition, a system fault has been detected. If any fault is detected, the RSS will not function.

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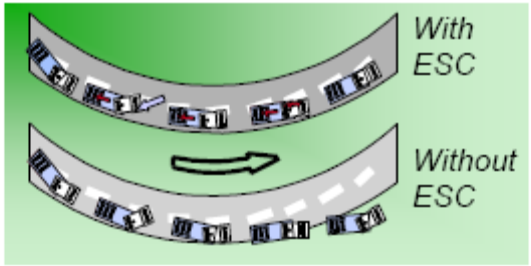
Electronic Stability Control (ESC)

The ESC is an tractor-based advanced safety system designed to detect and assist you in avoiding vehicle instabilities.

- It includes RSC (see instructions) and yaw control to help driver stay on course.
- Driver must ensure physical limits are not exceeded
- ESC is integrated in the tractor ECBS



When an instability occurs, ESC is activated…

- It will rapidly slow the vehicle down by reducing engine torque first, followed, if needed, by activation of the retarder, and/or application of the steer, driver of trailer axle brakes.
- It will activate the Stability Control Lamp in the dash

If an ESC fault occurs, the system will not function and the ABS indicator lamp comes on.

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Rollover Stability Support (RSS) for Trailers

The RSS is a trailer-based advanced safety system designed to detect and assist you in preventing roll or instability events

- RSS is integrated in trailer ECBS
- RSS works independent of the tractor system (conventional or ECBS)
- RSS continuously calculates lateral acceleration from wheel speeds and lateral accelerometer during driving, and automatically takes into consideration load condition.

When it detects an impending instability, RSS is activated…

- It will apply the trailer brakes to slow the vehicle down.
- You will feel a strong deceleration from the trailer pulling against the tractor.
- If you are driving a tractor also equipped with RSC or ESC, the tractor brakes may also be applied.

If either trailer ECBS indicator lamps are on, indicating a system fault has been detected, the RSS will NOT function.

Trailer ABS & TRSP Operator's Manual

Bendix® Trailer Electronically Controlled Brake Systems (TEBS-4)

WARNING

Read, understand and follow the information in this manual, particularly the Important Safety Information about ABS (page 3) and TRSP (page 5).

1

INDEX

Antilock Brake System (ABS) 3

Important Safety Information about ABS 3

Trailer Roll Stability Program (TRSP) 4

Important Safety Information about TRSP 5

Trailer ABS Indicator Lamps 6

UNDERSTANDING ANTILOCK BRAKING SYSTEMS (ABS) FOR AIR BRAKED VEHICLES

What Is ABS?

ABS is an electronic control system that improves vehicle stability by preventing wheel lock during braking.

How Does ABS Work?

The ABS system monitors wheel rotation, and if it detects any wheel locking up, the system automatically reduces the brake pressure at that wheel. If necessary, the ABS system automatically modulates braking forces at one or more of the wheel ends. The system maintains lateral stability by preventing wheel lock during braking.

IMPORTANT SAFETY INFORMATION ABOUT ANTILOCK BRAKING SYSTEMS (ABS)

Braking With ABS

- **Do not pump your brakes.** Use steady, even brake applications. Apply the brake pedal with the same pressure as you would without ABS.
- **Do not attempt to modulate your brake applications to prevent wheel lock.** The system controls braking pressure automatically and independently at each wheel end.

Limitations Of ABS

- **ABS does not apply the brakes automatically.** It's still up to you to apply the brakes at the right time and with the right amount of pedal force. A basic ABS system only starts to do its job after you apply the brake pedal.
  Note: The TRSP stability system **may** apply some or all of the brakes selectively to maintain vehicle stability. See page 4.

- **ABS is not a substitute for safe driving.** Even with ABS, you must remain alert, maintain safe speeds, react appropriately and in a timely manner, and drive defensively. Don't take unnecessary risks. Cautious driving practices, such as maintaining an adequate distance away from the vehicle ahead, not speeding, anticipating obstacles and adjusting your vehicle's speed for traffic, weather and road conditions, are essential for safe operation.

UNDERSTANDING THE TRAILER ROLL STABILITY PROGRAM (TRSP)

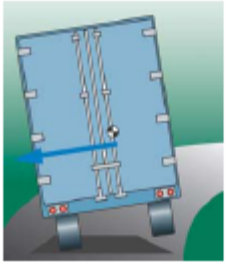
What Is TRSP?
TRSP roll stability system is a feature for stability system-equipped trailers that reduces the risk of rollovers.

How Does TRSP Improve Vehicle Roll Stability?
TRSP counteracts the tendency of a trailer to tip over while changing direction (typically, while turning). The lateral forces during a turn can push a tractor-trailer horizontally and, if the friction between the tires and the road is sufficient, the vehicle may begin to tip and potentially could roll over.

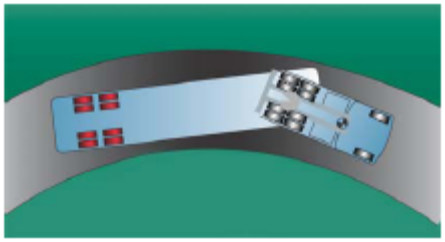
To reduce the risk of rollover, TRSP detects potential rollover conditions and slows the vehicle combination by automatically applying the trailer service brakes as needed at the appropriate wheels.

WARNING! During a TRSP system intervention, the vehicle **automatically decelerates**. TRSP can slow the vehicle with or **without you applying the brake pedal**, and **even when you are applying the throttle**.

During a TRSP system intervention, you can always use your service brake pedal to increase the braking pressure that will be applied. However, if you were to apply less braking pressure than needed — or even if you release the brake pedal entirely during a TRSP intervention — the TRSP system will continue to apply the necessary amount of braking pressure automatically to the appropriate wheels to mitigate a potential rollover.



A Real World Example Of How TRSP Operates:
Excessive speed for road conditions creates forces that exceed the threshold at which a trailer is likely to rollover on a higher-friction surface.



TRSP automatically applies the trailer service brakes (based on the projected rollover risk) to reduce the vehicle speed, thereby reducing the tendency to roll over.

4

IMPORTANT SAFETY INFORMATION ABOUT THE TRSP STABILITY SYSTEM

TRSP May Reduce Your Speed Automatically

TRSP can make your vehicle **decelerate automatically.** TRSP can slow the vehicle with or **without you applying the brake**, and **even when you are applying the throttle.**

To minimize unexpected deceleration and reduce the risk of a collision:

- Avoid aggressive driving maneuvers, such as sharp turns or abrupt lane changes, especially at high speeds, which might trigger the stability system.
- Always operate your vehicle safely, drive defensively, do not speed, anticipate obstacles and pay attention to road, weather and traffic conditions. ABS and TRSP stability systems are no substitute for prudent, careful driving.

Limitations Of The TRSP Stability System

Your TRSP stability system's effectiveness may be greatly reduced if:

- Your load shifts due to improper retention, accident damage or the inherently mobile nature of some loads (for example, hanging meat, live animals or partially laden tankers),
- Your vehicle or load has an unusually high or off-set center of gravity (CG), or
- One side of your vehicle drops off the pavement at an angle that is too great to be counteracted by a reduction in speed.

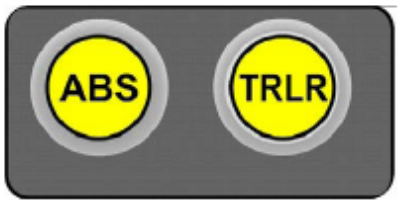
To Maximize The Effectiveness Of TRSP:

- Make sure that the weight of your load is evenly distributed, front to back and side to side, and is properly secured at all times.
- Exercise extreme caution at all times while driving, and avoid sharp turns, sudden steering inputs or abrupt lane changes at high speeds, particularly if:
    - you haul loads that could shift, or
    - your vehicle or load has a high or off-set center of gravity (CG) when loaded

5

UNDERSTANDING YOUR TRAILER ABS INDICATOR LAMPS

Trailer-Mounted ABS Indicator Lamp



In-Cab Dash ABS Indicator Lamps

Trailer-Mounted ABS Indicator Lamp
An amber Trailer ABS Indicator Lamp is mounted on the rear road-side of the trailer.

- At each vehicle ignition your ABS indicator lamp should illuminate as a bulb check for approximately three seconds and then turn off. **If the lamp does not illuminate at ignition, you should have the vehicle serviced by a qualified mechanic as soon as possible.** Note: without a functioning indicator lamp, you may not be able to determine the ABS status without using an external diagnostic tool.
- If the indicator lamp remains on for more than three seconds after ignition, or if it illuminates as you are driving, the ABS system may not be fully functional or its operation may be affected by an electrical short or power interruption. If this happens, your vehicle will continue to have normal service braking, and it can be driven, although without the benefits of ABS. **If you experience this condition, have the vehicle serviced by a qualified mechanic as soon as possible to restore full ABS functionality.**

In-Cab Trailer ABS Indicator Lamp
The Trailer ABS Indicator Lamp is also dash-mounted in the cab.

- All trailers built since March, 2001 communicate with the towing vehicle to operate the trailer ABS indicator lamp on the towing vehicle's dash. The trailer ABS indicator lamp functions just like the tractor ABS indicator lamp (on for three seconds after each vehicle ignition, then off unless a problem develops with the trailer ABS during operation). The in-cab Trailer ABS Indicator Lamp is in addition to the Trailer ABS Indicator Lamp that is mounted on the side of the trailer itself.

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6

Acknowledgment Form

After reviewing the material contained in this package, please sign the acknowledgment form and return to your manager.

I have:

- Completed the survey
- Read the materials describing the new technologies
- Returned the completed survey along with this form.

Participating Driver

_____

Driver or Vehicle ID

_____

Signature Date