RECOMMENDATIONS REGARDING THE USE OF ELECTRONIC ON-BOARD RECORDERS (EOBRS) FOR REPORTING HOURS OF SERVICE (HOS)

FINAL REPORT
September 28, 2005

Prepared For:
U.S. Department of Transportation
Federal Motor Carrier Safety Administration
Office of Bus and Truck Standards
and Operations, MC-PS
400 7th Street, SW
Washington, DC 20590

Prepared By:
U.S. Department of Transportation
Research and Innovative Technology Administration
John A. Volpe National Transportation
Systems Center
Motor Carrier Safety Assessment Division, DTS-47
55 Broadway
Cambridge, MA 02142

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Recommendations Regarding the Use of Electronic On-Board Recorders (EOBRs) for Reporting Hours of Service (HOS)		5. Report Date September 28, 2005
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
9. Performing Organization Name and Address U.S. Department of Transportation Research and Innovative Technology Administration John A. Volpe National Transportation Systems Center Motor Carrier Safety Assessment Division 55 Broadway Cambridge, MA 02142-1093		10. Work Unit No. (TRAIS)
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Motor Carrier Safety Administration Office of Bus and Truck Standards and Operations 400 7th Street, SW Washington, DC 20590		13. Type of Report and Period Covered Final Report
		14. Sponsoring Agency Code

15. Supplementary Notes:
Project Manager: Deborah M. Freund, Federal Motor Carrier Safety Administration

16. Abstract
This report provides a synthesis of all relevant information on EOBRs and formulates a variety of recommendations, including proposed performance standards for EOBRs, regarding the potential use of EOBRs in satisfying HOS recording and reporting requirements.

This report concludes that at the current time, the prudent course of action is to defer any decision to mandate EOBRs industry-wide. This recommendation is dictated by the continuing uncertainties and insufficient amounts of reliable, documented empirical data regarding a variety of issues, such as the costs, benefits, and operational impacts on motor carriers that are characterized as small businesses. In addition, it is recommended that FMCSA continue with a research program that may provide the additional information upon which a future decision might be based regarding mandating the use of EOBRs for either certain sub-segments of the motor carrier industry or industry-wide. Such a research program might include, for example, a comprehensive cost-benefit analysis of the use of EOBRs, the development of more detailed performance specifications for EOBRs in conjunction with industry and equipment vendors, and a field operational test of various EOBR system designs in order to obtain additional information regarding practical operational issues.

Despite this finding, this report recommends that EOBRs that comply with current 49 CFR § 395 regulations regarding AOBRDs continue to be allowed, and that the 49 CFR § 395 regulations regarding AOBRDs be updated to reflect both recent advances in technology and operational experience that has been gained from the use of AOBRDs under 49 CFR § 395. A variety of recommendations regarding potential revisions to the 49 CFR § 395 regulations regarding AOBRDs are proposed, and a series of recommended next steps are also provided.

17. Key Words Hours of Service; Electronic On-Board Recorder; Automatic On-Board Recording Device; Record of Duty Status		18. Distribution Statement	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 171	22. Price

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

Metric Conversion Factors

SI* (MODERN METRIC) CONVERSION FACTORS				
APPROXIMATE CONVERSIONS TO SI UNITS				
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa
APPROXIMATE CONVERSIONS FROM SI UNITS				
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

Acronym List

AES: Advanced Encryption Standard
ANPRM: Advance Notice of Proposed Rulemaking
AOBRD: Automatic On-Board Recording Device
ASCII: American Standard Code for Information Interchange
ATA: American Trucking Associations
AVL: Automatic Vehicle Location
CCD: Census County Division
CD: Compact Disc
CD-RW: Compact Disc Rewritable
CDL: Commercial Driver's License
CFR: Code of Federal Regulations
CMV: Commercial Motor Vehicle
COO: Cell of Origin
COTS: Commercial-off-the-Shelf
CPU: Central Processing Unit
CR: Compliance Review
CVISN: Commercial Vehicle Information Systems and Networks
DES: Data Encryption Standard
DGPS: Differential Global Positioning System
DOT: Department of Transportation
DR: Dead Reckoning
DSRC: Dedicated Short Range Communications
E911: Enhanced 911
ECM: Engine Control Module
EOBR: Electronic On-Board Recorder
EU: European Union
FCC: Federal Communications Commission
FHWA: Federal Highway Administration
FIPS: Federal Information Processing Standards
FMCSA: Federal Motor Carrier Safety Administration
FMCSR: Federal Motor Carrier Safety Regulation
FOIA: Freedom of Information Act
GICS: Geographic Identification Code Scheme
GPS: Global Positioning System
GNIS: Geographic Names Information System
GNSS: Global Navigation Satellite System
HHG: Household Goods
HOS: Hours of Service
ICC: Interstate Commerce Commission
ID: Identification
IEEE: Institute of Electrical and Electronics Engineers
ISO: International Organization for Standardization
ITS: Intelligent Transportation Systems

LTL: Less Than Truckload
MCD: Minor Civil Division
MCSAP: Motor Carrier Safety Assistance Program
MOU: Memorandum of Understanding
NHTSA: National Highway Traffic Safety Administration
NIST: National Institute of Standards and Technology
NPRM: Notice of Proposed Rulemaking
ODM: Original Design Manufacturer
OEM: Original Equipment Manufacturer
PDA: Personal Digital Assistant
PKI: Public Key Infrastructure
PTO: Patent and Trademark Office
RODS: Record of Duty Status
RTC: Real-Time Clock
SAE: Society of Automotive Engineers
SPS: Standard Positioning Service
TCM: Transmission Control Module
TDC: Transportation and Development Center (of Transport Canada)
TL: Truckload
TOA: Time of Arrival
TWIC: Transportation Worker Identification Credential
UMTRI: University of Michigan Transportation Research Institute
USB: Universal Serial Bus
USGS: United States Geological Survey
UTC: Coordinated Universal Time

Preface

This report provides a synthesis of all relevant information on EOBRs and formulates a variety of recommendations, including proposed performance standards for EOBRs, regarding the potential use of EOBRs in satisfying HOS recording and reporting requirements.

The Volpe Center program manager for this project was Nancy Kennedy of the Motor Carrier Safety Assessment Division. The Volpe Center technical project manager for this report was Robert Armstrong, also of the Motor Carrier Safety Assessment Division. Volpe Center technical staff who contributed to this report include Krishna Jain of the Motor Carrier Safety Assessment Division, Kam Chin of the Technology Applications & Deployment Division, Joe LoVecchio of the Telecommunications Division, Neil Meltzer of the Advanced Safety Technology Division, Chris Daskalakis of the Surveillance and Assessment Division, and Garth Brazelton of the Economic and Industry Analysis Division. Technical editing was performed by Deirdre Hering of Chenega Advanced Solutions & Engineering (CASE) under contract to the Volpe Center, and research support services were provided by Susan Dresley of the Volpe Center Technical Reference Center.

Table of Contents

List of Tables

List of Figures

Executive Summary

E.1 Background

On May 2, 2000, FMCSA published a NPRM proposing a comprehensive revision of the hours-of-service regulations requiring motor carriers to provide drivers with better opportunities to obtain sleep, and thereby reduce the risk of drivers operating commercial motors vehicles (CMVs) while drowsy, tired, or fatigued, thus reducing crashes involving these drivers. One element of the proposed revision to the hours-of-service regulations contained in the May 2, 2000 ANPRM called for the use of an automated time-record system, the equivalent of what is now generically termed an electronic on-board recorder (EOBR), in CMVs used by drivers in long-haul operations (referred to in the NPRM as Type 1 carriers) and regional operations (referred to in the NPRM as Type 2 carriers).[1] FMCSA believed that the presence of EOBRs on vehicles would facilitate enforcement both by reducing the time required to inspect records, and by improving the quality of the evidence upon which compliance with the rules would be determined and, when appropriate, violations charged. The proposal for mandating the use of EOBRs for Type 1 and Type 2 carriers was based on data that indicated:

(1) Fatigue-related crashes are more likely to involve long-haul drivers than local or short-haul drivers[2]; and
(2) Substantial noncompliance with the hours-of-service regulations, particularly among some segments of long-haul drivers.[3]

In order to address these issues, FMCSA believed that:

(1) Equipping vehicles used in long-haul movements with EOBRs would significantly improve compliance with hours-of-service regulations;
(2) Improving the compliance of long-haul drivers with the HOS regulations would help reduce fatigue-related crashes; and
(3) Conforming devices would be available in sufficient supply at a reasonable cost.

FMCSA received and transcribed 700 comments at eight nationwide public hearings in May, June, and July 2000. After holding the first seven public hearings, the agency identified several recurring themes and issues that warranted additional stakeholder and public discussion. The agency conducted three two-day public roundtable discussions in September and October 2000 in Washington, D.C. for that purpose. FMCSA extended the comment period for the May 2000 NPRM twice, first to October 31, 2000, and then to December 15, 2000. FMCSA ultimately recorded more

---

[1] Federal Register, Volume 65, Number 85. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Notice of proposed rulemaking (NPRM); request for comments*. May 2, 2000. Page 25540.

[2] Federal Register, Volume 65, Number 85. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Notice of proposed rulemaking (NPRM); request for comments*. May 2, 2000. Pages 25546.

[3] Federal Register, Volume 65, Number 85. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Notice of proposed rulemaking (NPRM); request for comments*. May 2, 2000. Page 25558.

than 53,750 written (paper and electronic submissions to the docket) and transcribed oral comments in response to the May 2000 NPRM.[4]

On April 28, 2003, FMCSA published the final rule concerning revisions to the hours-of-service (HOS) rules.[5] This final rule noted that on-board recording devices had been in use by some motor carriers at least since 1985, and that since the late 1990's motor carriers had made substantial investments in on-board technology for tracking cargo and equipment performance.[6] In addition, FMCSA noted that global positioning systems were increasingly being utilized in the motor carrier industry, and the FMCSA already was piloting the application of such a system in cooperation with a large truckload carrier to monitor drivers' compliance with the hours-of-service (HOS) rules.[7]

Despite this, FMCSA elected to not include the proposed requirement for mandatory use of EOBRs in the final rule published on April 28, 2003.[8] This decision was based largely upon the conclusion by FMCSA that insufficient economic and safety data existed at the time of the final rulemaking, and that there was a lack of support from the transportation community at large at the time of the final rulemaking as well.

The April 28, 2003 final rule concerning hours of service (HOS) went into effect on January 4, 2004. Approximately six months later, on July 16, 2004, the United States Court of Appeals for the District of Columbia Circuit vacated the April 28, 2003 final rule concerning hours of service (HOS) for commercial motor vehicle (CMV) drivers (Public Citizen et al. v. FMCSA, No. 03-1165). Although the Court's reasons for vacating the rule were not related to the issue of EOBRs, the Court observed that Section 408 of the Interstate Commerce Commission (ICC) Termination Act "required the agency, at a minimum, to collect and analyze data on the costs and benefits of requiring EOBRs." On September 1, 2004, FMCSA issued an Advance Notice of Proposed Rulemaking (ANPRM) for that purpose.[9]

This report supports the need by FMCSA to synthesize all of the relevant information on EOBRs and formulate recommendations on their potential use in satisfying HOS recording and reporting requirements.

---

[4] Federal Register, Volume 68, Number 81. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Final Rule*. April 28, 2003. Page 22458.

[5] Federal Register, Volume 68, Number 81. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Final Rule*. April 28, 2003.

[6] Federal Register, Volume 68, Number 81. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Final Rule*. April 28, 2003. Page 22485.

[7] Federal Register, Volume 68, Number 81. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Final Rule*. April 28, 2003. Page 22485.

[8] Federal Register, Volume 68, Number 81. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Final Rule*. April 28, 2003. Page 22488.

[9] Federal Register, Volume 69, Number 169. *Electronic On-Board Recorders for Hours of Service Compliance. Advance notice of proposed rulemaking; request for comments*. September 1, 2004.

E.2 Recommendations

At the current time, the prudent course of action is to defer any decision to mandate EOBRs industry-wide. This recommendation is dictated by the continuing uncertainties and insufficient amounts of reliable, documented, empirical data regarding a variety of issues, such as the costs, benefits, and operational impacts on motor carriers that are characterized as small businesses. In addition, it is recommended that FMCSA continue with a research program that may provide the additional information upon which a future decision might be based regarding mandating the use of EOBRs for either certain sub-segments of the motor carrier industry or industry-wide. Such a research program might include, for example, a comprehensive cost-benefit analysis of the use of EOBRs, the development of more detailed performance specifications for EOBRs in conjunction with industry and equipment vendors, and a field operational test of various EOBR system designs in order to obtain additional information regarding practical operational issues.

Though it is felt that a recommendation to mandate EOBRs industry-wide cannot be made at this time, it is recommended that the use of EOBRs that comply with 49 CFR § 395 regulations regarding AOBRDs continue to be allowed, and that the 49 CFR § 395 regulations regarding AOBRDs be updated to reflect recent advances in technology as well as the operational experience that has been gained from the use of AOBRDs to date under 49 CFR § 395.

Even though, as noted above, a recommendation mandating EOBRs industry-wide cannot be made at the current time, the following recommendations are made regarding potential revisions to the Part 395 regulations regarding AOBRDs, which include 49 CFR § 395.2 and 49 CFR § 395.15.

The term AOBRD is currently defined in 49 CFR § 395.2 as “an electric, electronic, electromechanical, or mechanical device capable of recording driver's duty status information accurately and automatically as required by 49 CFR § 395.15. The device must be integrally synchronized with specific operations of the commercial motor vehicle in which it is installed. At a minimum, the device must record engine use, road speed, miles driven, the date, and time of day.”

Recommendations concerning potential revisions to 49 CFR § 395 regarding AOBRDs and EOBRs include the following:

- Revise 49 CFR § 395.2 and 49 CFR § 395.15 to reflect and incorporate the recommended EOBR performance standards presented in Section 6.1.

- Specify a consistent electronic file format (e.g., ASCII[10]) and record layout for the data to facilitate electronic transfer of records to roadside safety enforcement personnel that are so equipped. One approach might be to specify a file format compatible with the ASPEN software and CAPRI software often used for roadside enforcement and compliance reviews.

[10] ASCII (American Standard Code for Information Interchange) is a character set and a character encoding system based on the Roman alphabet as used in modern English and other Western European languages. ASCII is commonly used by computers and other communication equipment. The specifications for the ASCII standard (the most widely used form of which is ANSI X3.4-1986) are described in the document *Information Systems - Coded Character Sets - 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII)* (ANSI document # ANSI INCITS 4-1986 (R2002)) published by ANSI (American National Standards Institute).

- Specify a consistent display format (e.g., graph grid) for the RODS information to be viewed by roadside safety enforcement personnel.

- Specify warnings regarding faults and malfunctions in the EOBR system, and that the EOBR provide a reminder to the driver to revert to the use of paper RODS in case of such faults and malfunctions occurring.

- Require driver input to indicate changes in duty status (i.e., that EOBRs do not "estimate" what the driver duty status is based on information gathered from the vehicle such as vehicle motion, etc.).

- Require that drivers have the ability to view and inspect their own electronic records.

- Improve the process and requirements by which devices are certified as being compliant with Part 395 (see Appendix E for further information regarding certification and conformity issues)

- Consider eliminating the requirement that an AOBRD "be integrally synchronized with specific operations of the commercial motor vehicle in which it is installed" as is currently required under 49 CFR § 395.2. For example, with regards to measuring and recording information concerning vehicle miles driven, the required performance standard should simply require that vehicle miles driven be recorded and be accurate to within some agreed upon tolerance level (e.g. +/- 5%) of actual vehicle miles driven. Although in current practice it is likely that the most cost effective way to achieve this is by use of miles driven data obtained from the vehicle ECM or odometer cable in older vehicles with no ECM, it may be the case that at some time in the future other technologies (e.g., inertial guidance systems, etc.) that can measure miles driven without relying upon the vehicle ECM may be developed as cost effective options for achieving this performance standard. The use of a performance-based standard as recommended here would allow such an innovative technology to be utilized, where as requiring the device to be "integrally synchronized with specific operations of the commercial motor vehicle" may not.

- Consider eliminating the requirement to record "road speed" and "engine use" that is currently specified under 49 CFR § 395.2. A sufficiently accurate measure of miles traveled by the vehicle (regardless of what speed that travel took place, or whether the engine was in use or not) should be adequate for electronic RODS without the need for information on "road speed" or "engine use." Also, a requirement for recording "road speed" may reduce driver acceptance of EOBRs, since as noted in Section 2.3.7 in the review of public comments received by FMCSA regarding the September 1, 2004 ANPRM on EOBRS, drivers worry about possible use of electronically recorded data for enforcement of speed violations.

E.3 Recommended Next Steps

Based on the findings of this report, the following next steps are recommended:

- Revise 49 CFR § 395.2 and 49 CFR § 395.15 to reflect and incorporate the recommended EOBR performance standards presented in Section 6.1 and the other considerations recommended in Section 6.3.

- Conduct an up-to-date comprehensive cost-benefit analysis of the use of EOBRs.

- Develop more detailed performance specifications for EOBRs in conjunction with industry and equipment vendors.

- Design and implement a field operational test of various EOBR system designs in order to obtain additional information regarding practical operational issues surrounding the use of EOBRs.

- Conduct outreach with commercial motor carriers and EOBR vendors to discuss issues, trends and concerns related to the use of EOBRs.

- Evaluate roadside enforcement and compliance review processes and training needs to ensure that they address the use of EOBRs.

These steps should provide the additional information and foundation upon which a decision can be made to potentially mandate the use of EOBRs at some time in the future for either certain sub-segments of the motor carrier industry or industry-wide.

Section 1: Project Overview

1.1 Background

On May 2, 2000, FMCSA published a NPRM proposing a comprehensive revision of the hours-of-service regulations requiring motor carriers to provide drivers with better opportunities to obtain sleep, and thereby reduce the risk of drivers operating commercial motors vehicles (CMVs) while drowsy, tired, or fatigued, thus reducing crashes involving these drivers. One element of the proposed revision to the hours-of-service regulations contained in the May 2, 2000 ANPRM called for the use of an automated time-record system, the equivalent of what is now generically termed an electronic on-board recorder (EOBR), in CMVs used by drivers in long-haul operations (referred to in the NPRM as Type 1 carriers) and regional operations (referred to in the NPRM as Type 2 carriers).[11] FMCSA believed that the presence of EOBRs on vehicles would facilitate enforcement both by reducing the time required to inspect records, and by improving the quality of the evidence upon which compliance with the rules would be determined and, when appropriate, violations charged. The proposal for mandating the use of EOBRs for Type 1 and Type 2 carriers was based on data that indicated:

(1) Fatigue-related crashes are more likely to involve long-haul drivers than local or short-haul drivers[12]; and
(2) Substantial noncompliance with the hours-of-service regulations, particularly among some segments of long-haul drivers.[13]

In order to address these issues, FMCSA believed that:

(1) Equipping vehicles used in long-haul movements with EOBRs would significantly improve compliance with hours-of-service regulations;
(2) Improving the compliance of long-haul drivers with the HOS regulations would help reduce fatigue-related crashes; and
(3) Conforming devices would be available in sufficient supply at a reasonable cost.

FMCSA received and transcribed 700 comments at eight nationwide public hearings in May, June, and July 2000. After holding the first seven public hearings, the agency identified several recurring themes and issues that warranted additional stakeholder and public discussion. The agency conducted three two-day public roundtable discussions in September and October 2000 in Washington, D.C. for that purpose. FMCSA extended the comment period for the May 2000 NPRM twice, first to October 31, 2000, and then to December 15, 2000. FMCSA ultimately recorded more

---

[11] Federal Register, Volume 65, Number 85. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Notice of proposed rulemaking (NPRM); request for comments*. May 2, 2000. Page 25540.

[12] Federal Register, Volume 65, Number 85. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Notice of proposed rulemaking (NPRM); request for comments*. May 2, 2000. Pages 25546.

[13] Federal Register, Volume 65, Number 85. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Notice of proposed rulemaking (NPRM); request for comments*. May 2, 2000. Page 25558.

than 53,750 written (paper and electronic submissions to the docket) and transcribed oral comments in response to the May 2000 NPRM.[14]

On April 28, 2003, FMCSA published the final rule concerning revisions to the hours-of-service (HOS) rules.[15] This final rule noted that on-board recording devices had been in use by some motor carriers at least since 1985, and that since the late 1990's motor carriers had made substantial investments in on-board technology for tracking cargo and equipment performance.[16] In addition, FMCSA noted that global positioning systems were increasingly being utilized in the motor carrier industry, and the FMCSA already was piloting the application of such a system in cooperation with a large truckload carrier to monitor drivers' compliance with the hours-of-service (HOS) rules.[17]

Despite this, FMCSA elected to not include the proposed requirement for mandatory use of EOBRs in the final rule published on April 28, 2003.[18] This decision was based largely upon the conclusion by FMCSA that insufficient economic and safety data existed at the time of the final rulemaking, and that there was a lack of support from the transportation community at large at the time of the final rulemaking as well.[19]

The April 28, 2003 final rule concerning hours of service (HOS) went into effect on January 4, 2004. Approximately six months later, on July 16, 2004, the United States Court of Appeals for the District of Columbia Circuit vacated the April 28, 2003 final rule concerning hours of service (HOS) for CMV drivers.[20] Although the Court's reasons for vacating the rule were not related to the issue of EOBRs, the Court observed that Section 408 of the ICC Termination Act "required the agency, at a minimum, to collect and analyze data on the costs and benefits of requiring EOBRs." On September 1, 2004, FMCSA issued an ANPRM for that purpose.[21] This report supports the need by FMCSA to synthesize all of the relevant information on EOBRs and formulate recommendations on their potential use in satisfying HOS recording and reporting requirements.

---

[14] Federal Register, Volume 68, Number 81. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Final Rule*. April 28, 2003. Page 22458.

[15] Federal Register, Volume 68, Number 81. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Final Rule*. April 28, 2003.

[16] Federal Register, Volume 68, Number 81. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Final Rule*. April 28, 2003. Page 22485.

[17] Federal Register, Volume 68, Number 81. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Final Rule*. April 28, 2003. Page 22485.

[18] Federal Register, Volume 68, Number 81. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Final Rule*. April 28, 2003. Page 22488.

[19] Federal Register, Volume 68, Number 81. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Final Rule*. April 28, 2003. Page 22489.

[20] Public Citizen et al. v. FMCSA, No. 03-1165.

[21] Federal Register, Volume 69, Number 169. *Electronic On-Board Recorders for Hours of Service Compliance. Advance notice of proposed rulemaking; request for comments*. September 1, 2004.

1.2 Timeline of Key Rulemakings and Milestones

To provide context, a brief timeline of key rulemakings and actions leading up to the July 16, 2004 court decision and the September 1, 2004 ANPRM is presented below.

1935 – The Motor Carrier Act of 1935 provides that "[t]he Secretary of Transportation may prescribe requirements for - (1) Qualifications and maximum hours of service of employees of, and safety of operation and equipment of, a motor carrier; and (2) qualifications and maximum hours of service of employees of, and standards of equipment of, a motor private carrier, when needed to promote safety of operation" (49 U.S.C. 31502(b)).

May 15, 1952 – The ICC revised the format in *Ex Parte* No. MC-40, which reduced the number of drivers' duty status categories from 15 to 4 (17 FR 4422 at 4488, May 15, 1952). This revision also added the familiar graph-grid recording format to the driver's record.

November 26, 1982 – The name for the driver's log document changed to "Driver's Record of Duty Status (RODS)" and additional minor changes were made (47 FR 53389, November 26, 1982).

April 17, 1985 – The Federal Highway Administration (FHWA) granted a waiver to Frito-Lay, Inc., to allow it to use on-board computers in lieu of requiring drivers to complete handwritten RODS. Nine other motor carriers were subsequently granted waivers (50 FR 15269, April 17, 1985).

July 13, 1987 – Federal Register, Volume 52, Number 133. *Driver's Record of Duty Status; On-Board Recording Devices; Request for Comments. Advance notice of proposed rulemaking (ANPRM).* July 13, 1987.

March 14, 1988 – Federal Register, Volume 53, Number 49. *Driver's Record of Duty Status. Automatic On-Board Recording Devices. Notice of proposed rulemaking*. March 14, 1988.

September 30, 1988 – The Federal Motor Carrier Safety Regulations (FMCSRs) are changed to allow automatic on-board recording devices (AOBRDs) on a voluntary basis, with certification of AOBRDs by manufacturers. Federal Register, Volume 53, Number 190. *Driver's Record of Duty Status; Automatic On-Board Recording Devices. Final rule and notice of termination of exemptions*. September 30, 1988.

November 5, 1996 – Federal Register, Volume 61, Number 215. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Advance notice of proposed rulemaking; request for comments*. November 5, 1996.

1997 – Werner Enterprises, Inc., requests permission to use an internally developed system as an alternative to handwritten RODS.

April 6, 1998 – Notice of interpretation issued by FMCSA allowing use of GPS[22] based systems to generate electronic RODS. Federal Register, Volume 63, Number 65. *Global Positioning System (GPS) Technology. Notice of interpretation; request for participation in pilot demonstration project*. April 6, 1998.

June 10, 1998 – First memorandum of understanding (MOU) between FMCSA and Werner Enterprises, Inc. granting a waiver of handwritten RODS, and allowing use of an internally developed paperless electronic logging system for entire Werner fleet.

May 2, 2000 – Federal Register, Volume 65, Number 85. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Notice of proposed rulemaking (NPRM); request for comments*. May 2, 2000.

March 26, 2002 – Second memorandum of understanding (MOU) between FMCSA and Werner Enterprises, Inc. revising the June 1998 MOU between FMCSA and Werner Enterprises, Inc. with fewer default duty status settings and more stringent requirements for recording of distance traveled and HOS.

June 2002 – Discussions between Werner Enterprises, Inc. and FMCSA on revision of the paperless electronic logging system to incorporate ECM data for recording of distance traveled.

April 28, 2003 – Federal Register, Volume 68, Number 81. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Final Rule*. April 28, 2003.

September 30, 2003 – Federal Register, Volume 68, Number 189. *Hours of Service of Drivers. Final rule; Technical amendments*. September 30, 2003.

December 11, 2003 – FMCSA published a notice of intent to grant Werner Enterprises, Inc. an exemption from the requirement that drivers of CMVs prepare handwritten RODS, and instead allow the use of paperless electronic RODS in lieu of handwritten RODS. The notice of intent specified a system utilizing GPS technology and related safety management computer systems to document drivers' hours of service, with mileage data collected from the vehicle's electronic control module or other on-board vehicle system. Federal Register, Volume 68, Number 238. *Exemption to Allow Werner Enterprises, Inc. to Use Global Positioning System (GPS) Technology to Monitor and Record Drivers' Hours of Service. Notice of intent to grant exemption; request for comments*. December 11, 2003.

[22] Though the term "GPS" for the U.S. Global Positioning System is sometimes used in a generic sense to refer to satellite-based navigation, there are in fact multiple satellite-based navigation systems available for use by both the military and civilian sectors. These include the GPS system maintained by the U.S. (specifically known as the NAVSTAR system), the GLONASS system maintained by Russia, and the Galileo system being developed by the European Union (currently in the development and in-orbit validation phase), as well as privately operated low-earth orbiting (LEO) satellite systems such as Globalstar, Iridium and ORBCOMM that can be used for both communications and location determination. These types of satellite-based navigation systems are often generically referred to as Global Navigation Satellite Systems (GNSS).

January 4, 2004 – The revised hours of service regulations from the April 28, 2003 Final Rule (*Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Final Rule*) go into effect.

July 16, 2004 – The United States Court of Appeals for the District of Columbia Circuit vacated the 2003 final rule concerning HOS for CMV drivers (Public Citizen et al. v. FMCSA, No. 03-1165). Although the Court's reasons for vacating the rule were not related to the issue of EOBRs, the Court observed that Section 408 of the ICC Termination Act "required the agency, at a minimum, to collect and analyze data on the costs and benefits of requiring EOBRs."

September 1, 2004 – Federal Register, Volume 69, Number 169. *Electronic On-Board Recorders for Hours of Service Compliance. Advance notice of proposed rulemaking; request for comments*. September 1, 2004.

September 21, 2004 – FMCSA published a notice in the Federal Register of a grant of exemption to Werner Enterprises, Inc., per the notice of intent published in December 2003. The exemption is in effect for two years and may be renewed. Federal Register, Volume 69, Number 182. *Exemption to Allow Werner Enterprises, Inc. to Use Global Positioning System (GPS) Technology to Monitor and Record Drivers' Hours of Service*. September 21, 2004.

November 3, 2004 – Federal Register, Volume 60, Number 212. *Hours of Service of Drivers; Supporting Documents. Supplemental notice of proposed rulemaking; request for comments*. November 3, 2004.

January 24, 2005 – Federal Register, Volume 70, Number 14. *Hours of Service of Drivers. Notice of proposed rulemaking; request for comments*. January 24, 2005.

1.3 Objective

The objective of this report is to present findings and analysis to support the Federal Motor Carrier Safety Administration (FMCSA) in:

(1) developing recommendations for either
  a. continuing to allow the use of EOBRs at the motor carrier's option, or
  b. proposing to require the use of EOBRs in place of handwritten Records of Duty Status;

(2) developing recommendations concerning potential revisions to the 49 CFR § 395 definition for "automatic on-board recording device" (AOBRD) irrespective of any recommendation concerning mandating EOBRs.

Sections 2 and 3 of this report provide a synthesis of relevant background information on EOBRs, and Sections 4 and 5 describe and implement the approach to assessing EOBRs used in this report. Based on the findings of these sections, Section 6 of this report presents recommendations.

1.4 Approach

CMV drivers are required to maintain RODS to record their working times. The basis for this regulation stems from evidence that many highway crashes occur as a result of CMV driver error, that driver error is often the result of inattention, that inattention can often be the result of fatigue, that the fatigue that causes inattention is often related to sleep deprivation, and that sleep deprivation is often related to working conditions of drivers.[23] Furthermore, in-depth studies of crashes have found that inattention and other mental lapses contribute to as many as 50 percent of all crashes. While fatigue may not be a factor in all of these crashes, it clearly contributes to some of them.[24]

Traditionally, drivers have met the RODS requirement by manually handwriting their activities in a paper driver's daily log. In 1988, a final rule was published to allow motor carriers, at their option, to use certain AOBRDs to record their drivers' RODS. The advancement in technologies with on-board recording devices since 1988 has created an opportunity for FMCSA to review existing and new technologies.

For the purpose of this study, the following three types of RODS are defined as follows.

- **Handwritten Record of Duty Status (RODS)**: This is a paper graph grid form that allows the driver to graph time and location over a 24-hour period (49 CFR § 395(a)(l)). The paper graph grid form to be utilized is described in 49 CFR § 395.8(g). It is referred to as a "driver's daily log" and is by far the most common form of RODS.

- **AOBRD**: An electric, electronic, electromechanical, or mechanical device capable of recording driver's duty status information accurately and automatically as required by 49 CFR § 395.15. The device must be integrally synchronized with specific operations of the commercial motor vehicle in which it is installed. At a minimum, the device must record engine use, road speed, miles driven, the date, and time of day.[25]

- **EOBR**: An electronic on-board recorder used to record a CMV driver's hours of service in order to provide documentation to determine compliance with 49 CFR § 395. An EOBR has features providing additional functions beyond those of an AOBRD. It must provide a means to record and store the date and time of each data entry, the status of the engine (on/off) and the location of the CMV. The EOBR also must calculate and display the distance traveled and the road speed.[26]

For the purposes of this study, the generic term "EOBR" will be used. This term encompasses any new devices as well as AOBRDs that comply with the current definition of 49 CFR § 395.2 and the

---

23 *Proposed Hours-of-Service: Hours of Service NPRM Background and Synopsis*. URL <http://www.fmcsa.dot.gov/español/english/background_index.htm.>

24 *Proposed Hours-of-Service: Hours of Service NPRM Background and Synopsis*. URL <http://www.fmcsa.dot.gov/español/english/background_index.htm.>

25 49 Code of Federal Regulations (CFR) § 395.2. *Hours of Service of Drivers. Definitions*.

26 Federal Register, Volume 69, Number 169. *Electronic On-Board Recorders for Hours of Service Compliance. Advance notice of proposed rulemaking; request for comments*. September 1, 2004. Page 53394.

operational requirements 49 CFR § 395.15. The term AOBRD will be used by itself, however, to refer only to the earlier-generation devices designed to comply with the current requirements.

The approach for this analysis included a comprehensive literature review of FMCSA regulations and related documentation as well as the review of a number of studies and demonstration projects that have been conducted. These studies examined the costs, benefits, and feasibility of using on-board recorders to record drivers' hours of service.

This study also included an examination of the current market for EOBRs in terms of cost, market penetration, and lessons learned from demonstration projects.

Based on the literature and market reviews as well as expertise in on-board recording devices and related technologies, performance benchmarks are identified for the three types of RODS recording methods (handwritten paper, AOBRDs, and EOBRs) for seven key research factors. These seven key research factors, presented in both the April 28, 2003 final rule on hours of service of drivers[27] and the September 1, 2004 ANPRM concerning the use of electronic on-board recorders for hours of service compliance[28], have been identified to assist in the development of performance benchmarks for EOBRs. These seven key research factors are that EOBRs:

(1) have the ability to identify the individual driver operating the CMV;
(2) be tamper resistant;
(3) have the ability to produce records of duty status required for carrier Compliance Review;
(4) allow roadside enforcement personnel to access the hours-of-service information quickly and easily;
(5) provide a level of protection for personal, operational, or proprietary information;
(6) not be cost prohibitive; and
(7) have driver acceptability.

These seven key research factors are meant to address those issues most pertinent to the development of recommendations for the use of EOBRs for recording and reporting CMV drivers' hours of service.

The performance benchmarks are then compared to the identified classes of EOBRs. This analysis helps to identify what classes of technologies are feasible in terms of meeting the proposed EOBR performance benchmarks. This study concludes with a set of recommendations related to either:

(a) continuing to allow the use of EOBRs at the motor carrier's option, or
(b) proposing to require the use of EOBRs in place of handwritten RODS.

This study also provides recommendations concerning potential revisions to the 49 CFR § 395 definition for AOBRD irrespective of any recommendation allowing or mandating EOBRs.

---

[27] Federal Register, Volume 68, Number 81. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Final Rule*. April 28, 2003. Page 22489. URL <http://www.fmcsa.dot.gov/rulesregs/fmcsr/final/hos_997.pdf>

[28] Federal Register, Volume 69, Number 169. *Electronic On-Board Recorders for Hours of Service Compliance. Advance notice of proposed rulemaking; request for comments*. September 1, 2004. Page 53389. URL <http://www.fmcsa.dot.gov/rulesregs/fmcsr/final/04-19907_EOBRs.pdf>

Section 2: Literature Review

The literature review conducted for this study included a review of all FHWA and FMCSA rulemaking actions and research reports and assessments related to EOBRs and AOBRDs; the regulatory guidance and interpretations related to HOS, AOBRDs and EOBRs that is found in 49 CFR § 395; and a review of the motor carrier industry trade press.

2.1 Overview and Findings

The various studies and demonstration projects that have been conducted to examine the costs, benefits, and feasibility of using on-board recorders to record drivers' hours of service have produced mixed results and findings. A June 1998 study conducted by the University of Michigan Transportation Research Institute (UMTRI) was the first major assessment of the state-of-the-practice and the costs and benefits of using electronic recorders to monitor driver compliance with hours-of-service regulations.[29] The original literature review and the interviews conducted in 2001[30] with technology vendors and staff from FMCSA are listed below, along with updates that emerged during the 2004-2005 update to the original literature review and interviews, as well as review of comments to the September 1, 2004 ANPRM. The findings include:

- In 1998, the FHWA recognized that the regulation outlined in 49 CFR § 395.15 was potentially outdated, and that GPS technology could provide an opportunity to improve motor carrier compliance with hours-of-service regulations. The agency introduced a voluntary program that allowed carriers using GPS technology and related safety management computer systems to use these systems to record and monitor drivers' hours of service in lieu of handwritten RODS. One carrier (Werner Enterprises) that already had been using GPS technology participated in what came to be known as the GPS Technologies Pilot Project. The goal of this project was to determine whether electronic RODS created using this type of system could provide an acceptable level of safety and monitoring accuracy. The project also sought to determine whether 49 CFR § 395.15 should be amended to recognize GPS-type systems. The participating carrier claimed that the use of GPS had reduced their hours-of-service compliance costs and had produced other operational benefits. The participating carrier (Werner Enterprises) has transitioned from a demonstration project to an exemption program and is now operating under an exemption that took effect on September 21, 2004. The original June 1998 MOU between FMCSA and the carrier was revised in July 2002 to update the requirements for the paperless electronic logging system, and in June 2002 further discussions took place between FMCSA and the carrier regarding implementing a hybrid system that combines GPS data with ECM data and driver input to create electronic records of duty status and distance traveled.

[29] Campbell, Kenneth L, Sylvia Wanner Lang, and Michael C. Smith. *Electronic Recorder Study. Final Report*. University of Michigan Transportation Research Institute (UMTRI) and Science Applications International (SAIC). June 1998.

[30] U.S. Department of Transportation, Federal Motor Carrier Safety Administration, Office of Policy and Program Development. *On-Board Recorders: Literature and Technology Review*. Prepared by Brad Wright and Erin Fogel, Cambridge Systematics, Inc. July 2002.

- A June 1998 study conducted by UMTRI examined the costs and benefits of using electronic recorders to monitor driver compliance with hours-of-service regulations. The study also explored industry attitudes toward mandatory use of electronic recorders. The survey that was conducted revealed that electronic recorders are not cost-effective for operators of small fleets and that there was strong opposition to the notion of mandatory on-board recorders. This report was not revisited in the updated report *On-Board Recorders: Literature and Technology Review (2005 Update)*, because no significant updates have been reported.

- In 2001, few on-board technologies available in the marketplace were designed specifically to capture RODS. Nevertheless, a number of technologies, (e.g., digital tachographs, ECMs, wireless satellite communications equipment, GPS) whether used as stand-alone technology or coupled with other technologies, were recognized as potentially able to provide some or all of the functionality required by 49 CFR § 395.15. Research conducted for the updated report *On-Board Recorders: Literature and Technology Review (2005 Update)* indicated that more vendors are developing FMCSA-compliant HOS recording technologies in anticipation of a potential regulation.

- By 2001, the European Union (EU) had already made significant advances both in promoting the use of on-board technology and in defining performance requirements for on-board technology used to monitor compliance with hours of service. The EU traditionally has relied on tachograph technology, which has been criticized by North American vendors and regulators because it is viewed as being susceptible to tampering. Since the writing of the original report, a European Commission regulation was signed in 2002 requiring the installation of digital tachographs in all newly registered commercial vehicles beginning in August 2004. This implementation deadline was later extended to August 2005 to provide tachograph manufacturers additional time to submit their equipment for approval.

- Interviews that were conducted in 2001 with technology vendors and engine manufacturers revealed a number of products on the market that provided some or all of the functionality defined in 49 CFR § 395.15. At that time, however, few vendors actively marketed these features or had developed products to provide this functionality. This lack of action was attributed to a lack of demand from the marketplace and/or uncertainty on the part of vendors regarding the Federal requirements. Conversations with several vendors in January 2005 indicated that at least one large manufacturer of on-board recorders was planning to introduce a web-based application specifically to monitor hours of service.

- Interviews that were conducted in 2001 with FMCSA staff regarding the GPS Technologies Pilot Project and general perceptions about on-board recorders revealed that staff were concerned about the technology limitations (e.g., the ability of one system to capture all of the data that is perceived to be important), how clearly defined or how well understood today's performance requirements are by the motor carrier industry, and the extent to which the enforcement community is prepared to rely on on-board devices for determining compliance.

- The report *On-Board Recorders: Literature and Technology Review (July 2002)* stated that in June 2001, Transport Canada's Transportation and Development Center (TDC) contracted with TECSULT, a consulting company, to undertake Phase 1 of a research project concerning on-board recorders, smart cards, and digital signature technologies. The objectives of the overall project were to analyze on-board recorder and related technologies in order to demonstrate their use in actual operating situations; assess their ability to improve vehicle fleet management from the perspectives of safety, regulatory enforcement, and transport operations; develop minimum requirements for the use of these technologies in interprovincial and international transport; and assess the costs and benefits of using them. The report *On-Board Recorders: Literature and Technology Review (July 2002)* included the results of Phase 1, which had culminated with the submission of a final report in December 2001. As of January 2005, research conducted for the updated report revealed that Phase 2 of the study was nearly complete and is expected to yield an operational test plan that will detail parameters to be tested, candidate technologies to be tested, and candidate carriers to host the test.

- Follow-up research and interviews with FMCSA staff conducted in 2004-2005 concerning the GPS Pilot Project confirmed that the inability of Werner's original electronic logging system to accurately measure distance traveled and average speed was not due to limitations of GPS positioning, but rather was the result of the infrequent updates of vehicle position being recorded by the system. They also confirmed that accurate recording of driver duty status will require input from the driver. Automation of the function in order to minimize driver input to the system would be likely to result in inaccurate recording of driver duty status due to the subtleties of distinguishing between the three possible conditions of non-driving duty status, and issues related to attempting to estimate duty status based on average speeds especially while operating in urban areas where traffic congestion may be present.

2.2 Review of Studies and Demonstration Projects

The report *On-Board Recorders: Literature and Technology Review (July 2002)*, conducted by Cambridge Systematics, Inc. on behalf of FMCSA in late 2001 and published in July 2002, consisted of the following:

- A review of ongoing or completed studies that examined the use of on-board recorders by commercial vehicle operators as a tool for managing drivers' hours-of-service compliance;

- A review of existing hours-of-service regulations and on-board recorder performance requirements;

- An Internet search to identify technologies used by the motor carrier industry to manage a variety of fleet and driver activities, including monitoring of hours of service;

- Interviews with technology vendors regarding existing technology capabilities, limitations, and future plans; and

- Interviews with FMCSA staff to gain insight regarding the use of on-board recorders to monitor hours-of-service compliance.

This July 2002 report was updated by the Volpe Center in coordination with Cambridge Systematics during late 2004 and early 2005. The updated version includes additional reviews of the most recent changes that have occurred since its original publication in 2002, including:

- A description of the 2003 Final Rule regarding hours of service that went into effect on January 4, 2004, replacing the hours-of-service regulations that were in effect when the report *On-Board Recorders: Literature and Technology Review (July 2002)* was published;
- An expanded discussion of the European experience and details of the European legislation that was passed in 2002 requiring the installation of digital tachographs in all newly registered commercial vehicles beginning in August 2005;
- An update of the findings of the GPS Technologies Pilot Project;
- Stakeholder comments in response to the agency's NPRM regarding hours of service and the use of EOBRs that was published in the Federal Register in May 2000; and
- An updated appendix that provides a sampling of on-board technologies offered by over 60 North American vendors.

2.3 Werner Enterprises Paperless Electronic Logging System Demonstration Project "Lessons Learned"

In order to obtain a better understanding of the current market for EOBRs and related equipment, and the issues currently faced by motor carriers who utilize similar equipment, the Volpe Center is conducting a review of the experience of Werner Enterprises with its paperless electronic logging system to identify potential lessons learned. This review is based directly on discussions with FMCSA sources involved in reviewing the Werner pilot.

2.3.1 Overview

The Werner paperless electronic logging system demonstration project has evolved since its inception several years ago. Below are some of the significant milestones in that evolution and the agreement between Werner and FMCSA.

September 30, 1988 – FMCSRs are changed to allow AOBRDs on a voluntary basis, with certification of AOBRDs by manufacturers.

1997 – Werner requests permission to use an internally developed system as an alternative to handwritten RODS.

April 6, 1998 – Notice of interpretation issued by FMCSA allowing use of systems using GPS technology to generate electronic logs.

June 10, 1998 – First memorandum of understanding (MOU) between FMCSA and Werner Enterprises, Inc. granting a waiver of handwritten RODS, and allowing use of an internally developed paperless electronic logging system for entire Werner fleet.

March 26, 2002 – Second memorandum of understanding (MOU) between FMCSA and Werner Enterprises, Inc. revising the June 1998 MOU between FMCSA and Werner Enterprises, Inc. with fewer default duty status settings and more stringent requirements for recording of distance traveled and HOS.

June 2002 – Discussions between Werner and FMCSA on revision of the paperless electronic logging system to incorporate ECM data for recording of distance traveled.

December 11, 2003 – FMCSA published a notice of intent to grant Werner an exemption from the requirement that drivers of CMVs prepare handwritten RODS, and instead allow the use of paperless electronic logs in lieu of handwritten RODS. The notice of intent specified a system utilizing GPS technology[31] and related safety management computer systems to document drivers' hours of service, with mileage data collected from the vehicle's electronic control module or other on-board vehicle system.

September 21, 2004 – FMCSA published a notice in the Federal Register of a grant of exemption to Werner Enterprises per the notice of intent published in December 2003. The exemption has an option for renewal every two years.

Werner is continuing to use the latest version of its paperless electronic logging system for all of its CMVs under the September 21, 2004 exemption granted by FMCSA.

2.3.2 Relevant Experience from the Werner Enterprises Paperless Electronic Logging System Demonstration Project

The review of the Werner paperless electronic logging system demonstration project has as a primary focus an assessment of the "technology-related" (i.e., GPS technology) provisions agreed to in the revised MOU, and a review of the accuracy of Werner's RODS produced by its paperless electronic logging system. The review primarily covers the first several years of Werner's experience (1998 to 2002), and contains a discussion of issues and findings relevant to a number of topics. This review is based upon a variety of information obtained from FMCSA, including discussions with FMCSA staff.

It should be noted that the original Werner paperless electronic logging system was not specifically designed to assist the carrier in meeting the requirements of the RODS FMCSRs, but rather as a fleet management and tracking system to maximize utilization and efficiency of Werner's fleet.

---

[31] The paperless electronic logging system used by Werner Enterprises utilizes GPS for position determination. Though the OmniTRACS system produced by Qualcomm, upon which the paperless electronic logging system used by Werner Enterprises is based, offers one of two satellite-based positioning technologies (either the Qualcomm Automatic Satellite Position Reporting (QASPR) system, or GPS), the Werner system uses GPS for position determination. In addition to GPS satellite-based positioning, the paperless electronic logging system used by Werner Enterprises utilizes satellite-based communications for communications between vehicles and the main office/dispatcher, since the change of duty status and the location of the change are not recorded independently aboard the vehicle.

2.3.3 Recording of Duty Status

The initial version of the Werner paperless electronic logging system used a number of defaults for duty status, based on whether the vehicle's position had or hadn't changed in the past hour. The intent was to minimize the input required by the driver and move as closely as possible to the automated generation of RODS. Recording a change of duty status with the Werner system requires communication with the main office/dispatcher, since the change of duty status and the location of the change are not recorded independently aboard the vehicle.

Under the original June 1998 MOU, the system defaults recorded truck stationary time of less than two hours as "off-duty" time, and truck stationary time of greater than two hours as "sleeper berth" time on the driver RODS, unless the driver input a different duty status. In addition, truck movement of less than 15 miles with a trailer and 25 miles without a trailer was not automatically recorded as driving time, which in effect assumed that this time was driver "personal" time while off-duty. Finally, the system automatically defaulted to 15 minutes on-duty time for fuel stops, loading and unloading etc., with drivers having the option of recording more time if appropriate. Experience showed that drivers often did not change the system defaults, that the defaults were not necessarily accurate, and that they in fact tended to underestimate driver's driving time.

The system was revised to minimize the use of defaults in its updated version, although in the event that a vehicle is stationary for more than 15 minutes and no change in duty status is input by the driver, the system defaults to "on-duty, not driving." It was felt that this was a sufficient inducement to get drivers to input a duty status while stationary (e.g., sleeper berth) unless they were actually "on-duty, not driving." However, there were still problems with drivers entering duty status changes during fuel stops, due to blockage of communication to the main office/dispatcher by the metal canopies that cover many fuel stations. It is unclear whether this simply caused a delay in reporting duty status changes, or caused these duty status changes to be missed entirely.

The implication for EOBRs is that the recording of duty status information, as well as provision to roadside enforcement personnel for inspection, should not be entirely reliant on communications to a main office or dispatcher which might be blocked. For example, if an EOBR system were reliant upon communication with a main dispatching office in order to receive RODS data during a roadside inspection (i.e., the data were not stored locally on the vehicle), and the CMV was pulled over for inspection in an area with either poor reception of satellite communications or terrestrial communications, then the RODS data could not be provided to roadside enforcement personnel. Intermittent loss of certain types of satellite or terrestrial communications or navigation signals would be acceptable, and in fact would be likely (e.g., while traveling through tunnels, etc.), however the system must be robust enough such that the temporary and short-term loss of such signals does not impair its ability to function.

2.3.4 Verification of RODS

FMCSA conducted an audit of Werner's paperless electronic logging system in 2002. Part of the audit included a verification of the electronic RODS produced by the system, based on payroll records and a number of electronic records provided by Werner, such as:

- Spot checks based on 12 electronic fuel purchase records
- Spot checks based on 13 electronic billing records for roads and bridges tolls
- GPS position history records, in which positions were recorded at least on an hourly basis
- Time-dated electronic transcripts of driver and dispatch messages

The FMCSA audit of the Werner RODS found perfect agreement for the fuel purchase and toll records that were sampled. The electronic records sampled were taken from the six month period prior to the audit.

During the course of prior monitoring audits, RODS for drivers that were paid for unloading or assisting in unloading were compared against payroll records and driver/dispatch message histories to determine if drivers were properly recording "on-duty, not driving" time when loading and unloading. In the majority of instances, the drivers reviewed from the targeted sample were not reporting accurate on-duty time and were understating their total hours by recording "off-duty" or "sleeper berth" time when they were in fact loading or unloading. As a result, FMCSA suggested that Werner internally monitor driver duty status for loading and unloading operations.

The 2002 audit once again compared transcripts of driver and dispatch messages and payroll against RODS for 15 drivers from specific accounts with known requirements for loading/unloading assistance. Instances were once again discovered in which drivers understated their on-duty time, but not to the extent observed in the earlier audits. It should be noted that some AOBRD manufacturers in fact recommend that motor carriers currently use AOBRDs incorporate the hours of service data collected from their AOBRDs into their payroll system. This can help to provide an important incentive for drivers to accurately report their hours of service as recorded on the AOBRD, since if driver hours and miles driven are not accurately recorded, then drivers are not paid for those hours or miles.

There are implications for meeting regulations covering RODS and the supporting documents currently required for CRs, in terms of the kind of supporting documents that will be required or will be acceptable with the use of EOBRs. For example, it may be desirable to establish separate standards for supporting documents for the CR process as opposed to roadside inspections in the case of EOBR-generated RODS.

2.3.5 Recording of Distance Traveled

The Werner system initially used relatively loose tolerances for the measurement of distance traveled, with truck movements of less than 15 miles with a trailer, and 25 miles without a trailer, that occurred between hourly position readings defaulting to "driver personal time while off-duty." In effect, this meant that if average vehicle speed was calculated as less than 15 miles per hour with a trailer, or 25 miles per hour without a trailer, the system would default to a duty status for that time period of "driver personal time off duty." This was later reduced to a 1 mile "tolerance" (or an average vehicle speed of 1 mile per hour), since in some instances it was felt that driving time in congested urban areas where average speeds were low was sometimes being incorrectly recorded as a duty status of "driver personal time off duty" rather than the actual duty status of "driving." Werner ultimately implemented a system in 2002 that was designed to default to a duty status of "off-duty" only if a distance of less than 2 miles was traveled in an hour, though reportedly this was causing problems with inaccurate logs as well.

The reason for the low level of precision in the measurement of distance traveled by the Werner system was that the system typically only reported the truck's position (based on GPS readings) once per hour. Distance was calculated based on the distance between GPS readings, which is a straight-line distance, as opposed to the actual road miles traveled. Obviously, in the event of travel that does not occur in a straight line, this would underestimate the number of miles traveled as compared to the actual miles traveled. The same readings were also used to estimate average driving speed, with a similar lack of precision and corresponding accuracy problems.

The lack of precision was not due to the GPS system's inability to measure location accurately, but rather was a function of the overall system used by Werner, which only updated vehicle position once per hour. The low frequency of vehicle position updates in Werner's system is essentially a legacy of the system's primary function as a fleet-management tool, which does not necessarily require frequent vehicle position updates. Current GPS systems have very high accuracy – in some cases with tolerances of less than 1 meter (in the case of differential GPS (DGPS) systems).

Since 2002, Werner and FMCSA have agreed to standards for updating the paperless electronic logging system to record mileage from the vehicle ECM in order to rectify the deficiencies caused by relying upon GPS readings alone. FMCSA's September 2004 notice granting Werner an exemption that allows the use of paperless electronic logs is based on an agreement that Werner record distance traveled and vehicle speed information using the ECM on the vehicle, rather than relying exclusively upon GPS readings.

2.3.6 Driver Interaction with the System While Driving

Driver distraction due to the need for interaction with the system is a safety concern, and current regulations in 49 CFR § 395.15(i)(2) specifically state: "The automatic on-board recording device permits duty status to be updated only when the commercial vehicle is at rest, except when registering the time a commercial motor vehicle crosses a state boundary."

Werner expressed concern that disabling drivers' interaction with its system while the vehicle was in motion would increase the risk of crashes, due to the need for the driver to stop the vehicle more frequently and subsequently perform more merges back into traffic. However, change of duty status information should only be entered while the vehicle is stationary – once a vehicle is in motion there should not be any change of duty status from "driving" unless the vehicle stops, in which case the status could change to "on-duty, not-driving," "sleeper berth," or "off-duty." As has been stated before, Werner's system is actually part of an overall fleet management system, which includes a two-way messaging capability between the driver and main office/dispatcher, and it is this function (unrelated to paperless RODS) that appears to be the most likely source of driver distraction.

Recording the time when a CMV crosses a state boundary is the one RODS-related situation where the driver may have to interact with the system while the vehicle is in motion. As noted above, 49 CFR § 395.15(i)(2) currently allows information regarding the time when a state boundary crossing occurs to be updated while the vehicle is in motion. Whether some limited or minimal interaction should be specified for EOBR systems for recording this data, or it should be required to be automatic, is a question for consideration.

In the case of the Werner pilot, the FMCSA team evaluating the project recommended that Werner *not* be required to disable driver input as a condition for continuation of the project, but did recommend that the entire issue of driver interaction with electronic RODS systems, communications systems, and other devices while driving be studied.

2.3.7 Backup Mode in the Event of System Failure

Under the series of MOUs and the exemption granted to Werner, in the event of a failure of the paperless electronic logging system, drivers are required to immediately begin recording HOS information using traditional handwritten RODS. FMCSA recommended that drivers be trained on this requirement as part of the implementation of any paperless electronic logging system.

2.3.8 Lessons Learned

Based on a review of the Werner paperless electronic logging system demonstration project, the issues that were addressed during the program through revised MOUs with FMCSA, and discussions with FMCSA personnel involved with the program, a number of "lessons learned" relevant to the development of EOBR performance benchmarks can be identified.

- Accurate recording of driver duty status will require that drivers be required to explicitly record data regarding change of duty status. Automation of this function in order to minimize driver input to the system would be likely to result in inaccurate recording of driver duty status due to the subtleties of distinguishing between the three possible conditions of non-driving duty status; exceptions under 49 CFR § 395.8 in which the use of an unladen CMV for personal reasons may be considered off-duty time despite the fact that the vehicle is moving; and issues related to attempting to estimate duty status based on average speeds, especially while operating in urban areas where traffic congestion may be present.

- Criteria for accuracy and precision of position recordings must be established. It is possible that GPS systems could support this function if GPS position recordings are frequent enough, or it may be better achieved by use of ECM data, as specified in the conditions of the recent exemption granted to Werner. Other possibilities include terrestrial navigation systems, such as those based on cellular phone or inertial navigation systems. The inability of the original Werner/Qualcomm system to meet the accuracy and precision requirements for measurement of distance traveled and average speed were not due to limitations of GPS positioning, but rather due to the infrequent updates of vehicle position being recorded by the system.

- Specification of supporting documents or data, electronic or handwritten, for verification of electronic RODS during a CR must be developed. These requirements may differ from, and be more extensive than, the requirements for roadside verification of RODS. Consideration of the type and form of electronic verification that would be acceptable must be made.

- For safety reasons, driver interaction with the system while driving should be eliminated or minimized. Research by the National Traffic Highway Safety Administration (NHTSA) on the topic of driver distraction should be reviewed with regards to this potential aspect of EOBRs.

2.4 Overview of Public Comments to the September 1, 2004 ANPRM

Approximately 330 comments regarding the September 1, 2004 ANPRM were received by FMCSA. Although another FMCSA contractor is conducting a more in-depth review of these docket comments, this review was conducted in order to gain a general perspective and to gather any substantive technical and operational information that might have been provided. The Volpe Center review was conducted from the perspective of the seven key research factors noted earlier in Section 1.4 and discussed later in Section 4.2, and from the perspective of whether the comment came from an organization (e.g., a motor carrier, an EOBR vendor, etc.) or the general public.

From this review, Volpe Center staff have categorized the comments that were thought to offer substantive information or insights into the potential issues related to the use of EOBRs. This categorization is presented in Table 1. EOBR cost data that were derived in part from the comments to the ANPRM are presented in Section 3.1.

Table 1: Number of Substantive Responses to DOT Docket 18940 by EOBR Key Research Factor

Key Research Factor	Individuals	Organizations
Identify individual driver	3	11
Tamper resistance	2	7
Produce records for audit and compliance review	3	12
Ability of roadside enforcement personnel to access HOS information quickly and easily	5	14
Level of protection for personal, operational, or proprietary information	5	9
Cost	7	20
Driver acceptability	10	6

Notes:
(1) For comments from the general public / individuals, 26 have so far been identified by Volpe as containing substantive information.
(2) For comments from organizations, 43 comments were identified by Volpe as containing substantive information.
(3) Each submitted comment may appear more than once in the table if multiple key research factor areas were addressed in the comment.

The primary categories of respondents that provided comments to FMCSA on the September 1, 2004 ANPRM included the following:

(1) Drivers
(2) Carriers
(3) Carrier and Trade Associations
(4) Law Enforcement
(5) Public Safety Organizations
(6) Vendors

The following is a summary overview of respondent comments organized by the seven key research factors.

2.4.1 Key Research Factor #1: Identify Individual Driver

The need for more accurate driver identification and authentication than is currently achievable with both handwritten RODS and AOBRDs is widely recognized. There is a variety of opinions, however, about the extent of necessary automation and/or security involved. Drivers are concerned about retaining flexibility in operations. Carriers are predisposed to using a keyboard and password ID. Public safety organizations want to take advantage of advances in smart cards and biometric identification technologies. Some point to the Transportation Worker Identification Credential (TWIC) program as a potential platform to adopt for EOBR.[32]

2.4.2 Key Research Factor #2: Tamper Resistance

The few comments in this area focused on electronic tampering or on falsification of HOS records by drivers. Scheduling and other work demands placed upon drivers, along with the potential economic incentives for both drivers and carriers, were frequently cited as overwhelming factors leading to falsification of records. Safety concerns, however, belie the need for so-called flexibility in recording off-duty status, or sharing driver hours, for example. Many believe automated means are necessary to guarantee such data-entry integrity.

---

[32] The TWIC program, overseen by the U.S. Department of Homeland Security, Transportation Security Administration, has as its primary goal the development of a secure, uniform and system-wide common credential for all transportation modes to prevent potential terrorist threats from entering sensitive areas of the transportation system. The TWIC is being designed as a tamper-resistant credential that contains biometric information about the holder which renders the card useless to anyone other than the rightful owner. Using this biometric information, each transportation facility can positively authenticate and verify the identity of a worker and help prevent unauthorized individuals from accessing secure areas, while still allowing access by authorized personnel requiring unescorted physical and/or electronic access to secure areas of the national transportation system. The TWIC will positively tie the person, to the background check, to the credential, which can then be used in conjunction with access control to critical components of the national transportation system. In addition to the added security provided by the verification of the card holder's identity, it is hoped that the use of a single, universally recognized credential will also provide TWIC users with additional benefits such as the convenience and reduced expense in being able to avoid the current process which typically involves having to obtain multiple redundant identification cards, with their requisite background investigations, in order to enter secure areas at multiple facilities. Despite these potential benefits, the use of TWIC as a standard for driver identification for EOBR applications is not recommended at this time, since this would essentially result in a technical standard for driver identification for EOBR applications, rather than a performance-oriented standard. In addition, the performance standards for EOBRs would then be dependent upon DHS TWIC standards.

2.4.3 Key Research Factor #3: Produce Records for Audit and Compliance Review

Comments related to producing driving records for purposes of compliance were primarily focused on the means for establishing a valid audit trail for EOBR entries from points of origin to the carrier place of business, and for quality assurance review by both motor carriers and compliance review personnel. Many noted acceptable formats to best organize and display this information. More importantly, the processes for quality data transfer, integration, and reporting are paramount in reviewing and regulating motor carrier operations. The system required to reconcile all the disparate data sources, however, could be difficult and costly for the carriers to develop and maintain, and could weaken or derail current safety efforts by the industry. Use of third-party software for compliance auditing could aggravate this complexity.

2.4.4 Key Research Factor #4: Ability of Roadside Enforcement to Access Hours of Service Information Quickly and Easily

There are many ideas about procedures and formats for roadside inspection, ranging from sharing instrument readings, duplicate printouts, and visual display, to remote access of "broadcast" data from the carriers, with and without third-party inputs.

2.4.5 Key Research Factor #5: Level of Protection for Personal, Operational, or Proprietary Information

Not surprisingly, automated HOS recording and inspection raise considerable concern over driver privacy and protection of motor carrier's proprietary business information. Several respondents suggested guarantees of legal protection, like those provided against discoverability to air carriers of black-box information in judicial proceedings. While current regulations offer no assurance of confidentially, practical considerations associated with handwritten RODS and even current AOBRDs effectively limit the extent of disclosure of personal, operational or proprietary information. The widespread use of EOBRs, however, may reduce some of these practical impediments to disclosure that currently exist, and therefore possible methods for better protecting this information were suggested. Storing driver HOS information on secure, personal smart cards may offer considerable protection to the driver. Others believe that simply parsing the sensitive data from the enforcement data, or even using sophisticated encryption schemes, will not provide realistic protection from unauthorized access. Still others believe that concerns related to the protection of personal, operational or proprietary data are focused on in order to weaken the potential for the use of EOBRs to reduce the falsification of RODS, and that providing extremely high levels of privacy would unduly compromise public safety.

2.4.6 Key Research Factor #6: Cost

While costs of the unit modules, software, communications and other equipment, as well as associated training, back-office operations and data processing, are widely cited as critical factors, there is wide divergence on the actual market cost. This divergence is evident in Table 2 in Section 3.1. (While most of the numbers in the responses closely reflected those proposed in the rulemaking notice, recent communications and industry information indicate the availability of other, less expensive equipment.) At this time, there are many possibilities envisioned for EOBR component and service configurations, presenting innumerable difficulties in cost estimation. Furthermore, the cost profiles could vary significantly according to the extent to which EOBRs are mandated.

2.4.7 Key Research Factor #7: Driver Acceptability

Although drivers differ widely on their acceptance of and attitudes toward both current HOS regulations and electronic recording, many are resigned to its future use and how it may, or may not, benefit them and their employers. Potential use of GPS location data in compliance reviews as a result of potential rulemakings reinforces the growing perception of the presence of "big brother." Currently, many worry about possible use of electronically recorded data for enforcement of speed violations. Some cite concerns over privacy, perceived lack of precision in electronic readings, and overriding confidence in their own safety regimen that may be compromised by electronic recording of HOS information. Smaller motor carriers and owner-operators offer a variety of reasons as to why their operational segment of the industry should be excluded from any potential mandate regarding the use of EOBRs. For example, some feel that requiring EOBRs may put many smaller motor carriers and owner-operators out of business because of the additional cost that would be imposed.[33] Another reason sometimes cited by smaller motor carriers and owner-operators are concerns about retaining older drivers that these firms often employ. This segment of the motor carrier industry believes that older drivers would be uncomfortable with using new technology, and also believes that older drivers would view EOBRs as an intrusion on their personal liberties and an insult to their intelligence.[34]

[33] Federal Register, Volume 68, Number 81. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Final Rule*. April 28, 2003. Page 22486.

[34] Federal Register, Volume 68, Number 81. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Final Rule*. April 28, 2003. Pages 22486.

Section 3: Market Review

This section presents information regarding the current market for EOBRs and related technologies. The analysis included reviewing available cost data, examining market penetration of different EOBR technologies, reviewing the lessons learned from the Werner Enterprises Paperless Electronic Logging System Demonstration Project and, based on Internet research, provides a sample of on-board technologies offered by approximately 60 North American vendors (see Appendix A and Appendix B). While not all of the products listed are capable of recording hours of service, many could be adapted for this purpose. Many of the vendors chosen for review were listed in Appendix C of the *Hazmat Safety and Security Field Operational Test Final Report*, published by FMCSA in August 2004.[35]

3.1 EOBR Cost Data

A limited amount of data pertaining to the cost of on-board recorder systems and technologies was obtained from the updated report *On-Board Recorders: Literature and Technology Review (July 2002)*, in particular, from the review of the 1998 study conducted by UMTRI for FHWA. The 1998 UMTRI study provided information pertaining to electronic recorder installation costs, as well as operating and maintenance costs. The amount of time required by drivers to record hours of service using electronic logs versus paper logs also was compared.[36] In addition, the administrative tasks associated with hours of service, including time spent monitoring, summarizing, storing/retrieving, and auditing hours-of-service records, were examined. The most relevant findings of the 1998 UMTRI study are summarized below:

- Carriers install electronic recorders for various reasons, including managing operating costs and supporting real-time communication with vehicle drivers. Less than 25 percent of the carriers surveyed installed electronic recorders primarily for hours-of-service recording.

- Electronic recorder acquisition and installation costs an average of $2,000 or less per vehicle. This cost can vary substantially depending on when the unit is acquired and what level of functionality is provided. Annual operating costs are typically less than $200 per vehicle. Most carriers that have purchased electronic recorders for their fleets believe that they have recovered their investment within three years of purchasing the device.

- Carriers that do not use electronic recorders to conduct hours-of-service monitoring cited excessive cost as the primary reason that they do not use the devices.

- Survey respondents indicated that the primary operational benefit of electronic hours-of-service recording is a reduction in time required for drivers to record hours of service and

---

[35] Williams, D., et. al. *Hazmat Safety & Security Field Operational Test. Final Report*. August 31, 2004. Document approved for public disclosure. Prepared by Battelle, in association with Qualcomm, the American Transportation Research Institute, the Commercial Vehicle Safety Alliance, and the Spill Center, for the U.S. DOT, Federal Motor Carrier Safety Administration. URL <http://www.cvsa.org/committees/documents/hmfotfinalreportpublic.pdf>

[36] *Supporting Statement Hours of Service of Drivers Regulations*. Information Collection Budget Supporting Statement for 49 CFR § 395. December 21, 2004.

the administrative time fleet managers spend summarizing, storing, retrieving, and auditing hours-of-service records. Use of electronic recorders to maintain hours-of-service records saves drivers on average 20 minutes per day in comparison to using paper logbooks. Administrative personnel also save 20 minutes per driver per month using electronic recorders.

- Benefits of using electronic recorders include better and more economical fleet management as well as reduced administration costs.

- Most carriers that were surveyed saw no significant operational benefits of mandatory use of electronic recorders to record drivers' hours of service, and believe such a requirement would result in high initial capital and system maintenance costs, while having little or no effect on commercial vehicle safety.

Some initial cost data were also obtained from the public comments received by FMCSA on the September 1, 2004 ANPRM; these data are presented in Table 2. In addition, some cost ranges for technologies related to AOBRDs and EOBRs, including vehicle tracking, software and biometrics, were obtained from the FMCSA report *Hazmat Safety & Security Field Operational Test* (Final Report, August 31, 2004).[37] These cost ranges are presented below according to the three categories of technology from that report with possible relevance to developing recommendations regarding the use of EOBRs for recording hours of service: *vehicle tracking products*, *biometric identification products*, and *software products*.

3.1.1 Vehicle Tracking Products

As part of the FMCSA report *Hazmat Safety & Security Field Operational Test*, a number of companies volunteered pricing information for their vehicle tracking products. However, due to the competitive nature of the vehicle tracking market, some companies were unwilling to provide pricing information. For those reporting data, per unit base costs ranged from $429 to $2,275.[38] This is generally consistent with a limited amount of information that was obtained from a small number of AOBRD vendors that suggested costs of between $1,000 to several thousand dollars per truck, depending on the type of system and number of options selected. The less expensive tracking systems were turnkey solutions with prices ranging from $429 to $995 for some of these technologies. The more expensive tracking systems and technologies were integrated units with many options and ranged in price from $1,290 to $2,275. In most units, the actual GPS hardware portion of the device only adds approximately $60 to the cost of the system, with the required hardware to add such a capability now widely available in substantial quantities and at reasonable cost.

---

[37] Williams, D., et. al. *Hazmat Safety & Security Field Operational Test. Final Report.* August 31, 2004. Document approved for public disclosure. Prepared by Battelle, in association with Qualcomm, the American Transportation Research Institute, the Commercial Vehicle Safety Alliance, and the Spill Center, for the U.S. DOT, Federal Motor Carrier Safety Administration.

[38] Williams, D., et. al. *Hazmat Safety & Security Field Operational Test. Final Report.* August 31, 2004. Document approved for public disclosure. Prepared by Battelle, in association with Qualcomm, the American Transportation Research Institute, the Commercial Vehicle Safety Alliance, and the Spill Center, for the U.S. DOT, Federal Motor Carrier Safety Administration. pg. C-7.

Installation costs were found to vary from approximately $75 to $300, with some of the technologies available for installation directly by the vendor if desired. Monthly service fees were found to vary significantly depending upon how the customer configures location status. These fees ranged from $10 to $50, and can be dependent on the method of wireless used (i.e., satellite, terrestrial, or hybrid), with terrestrial monthly fees costing less than those for satellite-based systems.[39]

3.1.2 Biometric Identification Products

Biometric authentication devices range from fingerprint to facial recognition products. Some of these products already have or are able to integrate the use of smart cards as well. Based on the pricing information that was available, the biometric products ranged in price from $6 to $1,200.[40] The more expensive units utilize better fingerprint-reading technology and are complete systems. The average price is approximately $1,000, and most of the systems have the ability to integrate with smart cards and other technologies. None of the biometric products reviewed had installation costs or monthly service fee data available.[41]

3.1.3 Software Products

The software category includes integration software, supporting software for some technologies, and mapping and fleet management software. Due to the many different configurations and applications of the software programs, there was very little pricing information available. However, those vendors able to provide pricing information offered software site licenses ranging from $10,000 to $33,000, which represent fleetwide licenses allowing more than one terminal to use the software.[42] Some technology vendors sell software that is associated with a particular product. One company that does this provided a $995 software price per power unit. The software programs represented several different categories. These were:

- Software for monitoring vehicle functions (engine performance, cargo condition, etc.)
- Software that supports vehicle tracking
- Mapping software, such as Spatial FX, which provides mapping and routing capabilities and integration with vehicle tracking systems
- Fleet management software, which may include engine-diagnostic and maintenance information, HOS information, etc.

---

[39] Williams, D., et. al. *Hazmat Safety & Security Field Operational Test. Final Report.* August 31, 2004. Document approved for public disclosure. Prepared by Battelle, in association with Qualcomm, the American Transportation Research Institute, the Commercial Vehicle Safety Alliance, and the Spill Center, for the U.S. DOT, Federal Motor Carrier Safety Administration. pg. C-7.

[40] The $6 product is the actual fingerprint sensor that a specific company provides to other manufacturers that it partners with to provide biometrics systems to OEMs and original design manufacturers (ODMs).

[41] Williams, D., et. al. *Hazmat Safety & Security Field Operational Test. Final Report.* August 31, 2004. Document approved for public disclosure. Prepared by Battelle, in association with Qualcomm, the American Transportation Research Institute, the Commercial Vehicle Safety Alliance, and the Spill Center, for the U.S. DOT, Federal Motor Carrier Safety Administration. pp. C-3 to C-4.

[42] Williams, D., et. al. *Hazmat Safety & Security Field Operational Test. Final Report.* August 31, 2004. Document approved for public disclosure. Prepared by Battelle, in association with Qualcomm, the American Transportation Research Institute, the Commercial Vehicle Safety Alliance, and the Spill Center, for the U.S. DOT, Federal Motor Carrier Safety Administration. pp. C-5 to C-6.

Table 2: AOBRD and EOBR Cost Data Derived from Public Comments

	Equipment			Services				Backoffice / Recordkeeping		
Comment No.	*CMV modules*	*Software / comms*	*Servers / other*	*Install*	*Maint.*	*Repair*	*Ops. Training*	*DP*	*Storage*	*Office Training*
56	$3k/truck; $6k-$7k/truck if ruggedized									
94	$1-2k/truck	$1.5k/truck			Multiyear MTBF		3 hr/driver			3-4 days
105	$1.5 – 3k/truck DrID $30-500		$3.0 k							
170	$25/truck-mo. or $500 /truck	$40/mo. fleet								
158	$3.2k/truck									
231	$2 – 3.4k/truck	$2k/truck + $10/mo. monitoring								
269	$500 – 3k/truck	$350 –1k/truck + 800/mo. truck								
214	$500/ new truck $3-7k/truck retrofit									
188	$4k/truck									

Table 2: AOBRD and EOBR Cost Data Derived from Public Comments (continued)

	Equipment			Services				Backoffice / Recordkeeping		
Comment No.	*CMV modules*	*Software / comms*	*Servers / other*	*Install*	*Maint.*	*Repair*	*Ops. Training*	*DP*	*Storage*	*Office Training*
126	$4.1k/truck	$20k upgrade		$150/truck	$40/hr		3 hr/driver			3 days
241	$1.5-3k/bus	$10-80k upgrade								
245	$1-3k/truck (concrete)									
250	>$40 M / large fleet (13,000 trucks)	$1.6 – 2.6 M +2M modif			$5.0-7.5M /yr		$1.5M	$5M/yr		
263	$75 M/ 25,000 trucks									
255							4.5 hr + $150/driv			
314	$24M/8,000 trucks		$75 k	$165/hr				25 k/yr		
283	$1k/truck (propane) $35k / fleet		$15k/carrier							
281	$500 – 3k/truck + $1-3k/PC + $100 GPS+		$1-3 k		$ 1k/yr		10 hr/driv			

3.2 EOBR Market Penetration

3.2.1 Description of the Current Market for Technologies Related to EOBRs

It is difficult to project the market penetration of EOBRs solely from current implementation rates of HOS logging devices. The market will clearly depend on the precise specifications for EOBR functionality, and the extent of any regulatory mandate. It will also depend on a variety of corresponding supply chains that emerge from the adoption of EOBRs. One approach for estimating current market penetration is to establish an 'envelope of availability' based on forecasts of related telematics applications, platforms, and systems for commercial fleet vehicles. Once the broader market is framed and projected, individual product and technology estimates can be placed in the appropriate segments, and reasonable assessments can be made without relying on specific market factors for each application.

The EOBR-related commercial vehicle telematics market can be defined primarily by its customer base, which is estimated here based on an overview of the size of the vehicle fleet and the number of drivers. For this review, an industry overview provided in a recent regulatory impact analysis is used to provide a baseline.[43] Based on this 2002 ICF report, Table 3 provides a summary of the U.S. heavy/medium truck population and the number of carrier firms by operational segment in 2002. While there is some question about the relative accuracy of estimates for the respective subsegments (e.g., private vs. for-hire, short-haul vs. long-haul, less-than-truckload (LTL) vs. truckload (TL)), each cell provides a reasonable estimate of the total number of trucks (and firms) hosting an EOBR unit for a particular subsegment and their combined accumulations.

This review also provides bottom-line placeholders for total baseline estimates of electronic logbooks and overall revenue for fleet telematics applications. The latter, often used by market prognosticators as a basis for overall growth projection, can be paired with population estimates for any given segment and transition period for further validation checking.

3.2.2 Typology for Commercial Fleet Telematics Applications

In the ITS America *Market Intelligence Report* for January 2003, Alfonso Corredor (Frost & Sullivan) classifies types of truck telematics services by user group.[44] This classification is presented below. Here we highlight those applications that are "EOBR-ready," both intrinsically (****** EOBR-central) and with possible interfaces (***** EOBR-ancillary). Again, we assume here that the market for these technology applications will characterize the market for EOBR technology, for each forecast period.

---

[43] U.S. Department of Transportation, Federal Motor Carrier Safety Administration. *Regulatory Impact Analysis and Small Business Analysis for Hours of Service Options*. Prepared by ICF Consulting, Inc., and Jack Faucett Associates. December 2002. Pages 3-1 to 3-7, and A-1 to A-11.

[44] Corredor, Alfonso, PhD. *Commercial Vehicle Telematics Development Strategies*. ITS America News, Vol. 13, No. 1, January 2003.

Productivity

- Automatic Vehicle Location (AVL) systems (and mobile location identifiers)**
- two-way messaging
- Speed, mileage, fuel usage, engine running time**
- Navigation (incl. mapping software, geofencing, and routing)*

Managerial

- Trip logging (e.g., electronic logbooks)**
- Fleet tracking*
- Fuel tax software
- Reporting, accounting, and management software (incl. data processing for HOS roadside inspection and compliance review)**

Remote Diagnostics

- Diagnostic code and engine operation remote readings
- Low battery notice

Safety and Security

- Enable/disable engine, positive driver ID*
- Emergency buttons*
- Lock/unlock doors

Cargo Related

- Pickup and delivery notification*
- Proof of delivery, invoicing*

Information

- Traffic and weather
- Directory services, e.g., fuel and repair, restaurants
- Internet access

3.2.3 Market Estimation

Given the potential customer base and target product types, relevant data points were selected for insertion into the market segment review. Based on the available information, estimates are provided for both 2003 and 2005. The data points are presented in Tables 4 and 5, and highlighted below.

On-board Computers

The American Trucking Associations (ATA) estimated that in 1998 10% of US carriers in 1998 used onboard computers – mostly larger fleets, with time-sensitive LTL shipments and firms with safety performance as their prime objective. Worldwide in 2004, MobileAria, Inc. estimated that 1 million commercial trucks (approximately 14% of 7 million trucks estimated to be in fleets of 10 vehicles or more) were equipped with onboard computers. This is generally consistent with a limited amount of information that was obtained from a small number of AOBRD vendors that suggested that these vendors had combined total cumulative sales of approximately 800,000 units over the past several years.

Electronic Logbooks

The ATA estimated that 6% of carriers in 1998 used electronic logbooks; 3-4% of the for-hire carriers, and 18% of private carriers.[45]

Location Devices

Driscoll[46] estimated that by early 2005, there would be approximately 425,000 trucks used in long-haul and short-haul operations equipped with AVL units (representing 9% growth since 2003).

Market Forecasts

Several market forecasting firms, such as Frost & Sullivan, Freedonia, and ABI Research, monitor the growth of commercial telematics for the US trucking industry, and for all vehicle fleets in North America and worldwide. We used only the numbers available in the public domain, understanding that the more detailed accounts and projections can be purchased if relevant and necessary. Purchase may be appropriate when the need for more precise EOBR specifications becomes clear.

Vendor and Carrier Literature

Trade journals and vendor literature are replete with various estimates of fleet distribution, sales, market share, etc. for the range of EOBR-related telematics products. However, a complete accounting of product distribution is hindered by several factors, most notably a wide variation in industry policies toward public disclosure of sales figures.

Product Information on Public Docket

A number of the public-docket comments highlight current and expected use of EOBR-related telematics products.

---

[45] U.S. Department of Transportation, Federal Motor Carrier Safety Administration. *Motor Carrier Technologies: Fleet Operational Impacts and Implications for Intelligent Transportation Systems/Commercial Vehicle Operations*. Prepared by the ATA Foundation. October 1999. Page 7.

[46] Driscoll, Clem and Dick Wolfe. Driscoll-Wolfe Marketing and Research Consulting. *Survey of Telematic Systems Owners and Users*. August 2004.

3.2.4 Summary of Market Penetration Findings

Based on year 2000 commercial vehicle population estimates, there are approximately 1.75 million heavy/medium trucks (950,000 for hire and 800,000 private) used in long-haul and short-haul operations that potentially may host an EOBR system. These numbers appear rather small for private and other for-hire carriers. Frost & Sullivan estimate a total of 25 million commercial vehicles[47] and 5 million trailers in North America equipped with such technologies. Given the relative certainty of the TL and LTL carrier base, their respective estimates appear more valid than the other segments (see Table 3).

It is estimated that in 2000, approximately 4% of for-hire heavy/medium trucks utilized electronic logbooks, with an additional 18% of heavy/medium trucks in private fleets also estimated as utilizing electronic logbooks.[48] Using estimates of the heavy/medium truck fleet contained in a December 2002 regulatory impact analysis for the HOS rule[49], this comprises a total of 182,000 heavy/medium trucks (38,000 for-hire, and 144,000 private fleet). For the same time period, aftermarket sales of electronic logging-related telematics were estimated at $122.5 million[50], out of an estimated total of $705 million for all commercial fleet telematics sold in North America (see Table 3).[51]

In 2003, Driscoll estimates that a total 350,000 to 400,000 (approximately 20%) of on-board telematics units were available as EOBR-ready (240,000 on for-hire vehicles, and as many as 390,000 on long-haul and regional operations). Aftermarket sales for electronic logging-related telematics were approximately $139 million[52] (of the $771 million[53] total for all commercial fleet telematics in North America). It was widely reported that Qualcomm's OmniTRACS had the majority market share (see Table 4).

In 2005, the total forecast for EOBR-ready applications (including newly available GPS-cell phones) deployed in trucks used in long-haul and short-haul operations is estimated to range from between 425,000 to 450,000 (approximately 25% of the estimated population of trucks used in long-haul and short-haul operations). Aftermarket sales for electronic logging-related telematics are estimated at $154 million.[54] Much of this

---

[47] This includes Class 8 trucks, plus most other commercial vehicles (e.g., Class 1 through Class 7 vehicles, delivery vans, etc.)

[48] U.S. Department of Transportation, Federal Motor Carrier Safety Administration. *Motor Carrier Technologies: Fleet Operational Impacts and Implications for Intelligent Transportation Systems/Commercial Vehicle Operations.* Prepared by the ATA Foundation. October 1999. Page 7.

[49] U.S. Department of Transportation, Federal Motor Carrier Safety Administration. *Regulatory Impact Analysis and Small Business Analysis for Hours of Service Options*. Prepared by ICF Consulting, Inc., and Jack Faucett Associates. December 2002. Pages 3-1 to 3-7, and A-1 to A-11.

[50] The Freedonia Group. *Electrical/Electronic Products - Medium & Heavy Truck Aftermarket*. 2003.

[51] Frost & Sullivan Research Report. *North American Commercial Vehicle Telematics Markets.*

[52] The Freedonia Group. *Electrical/Electronic Products - Medium & Heavy Truck Aftermarket*. 2003.

[53] Frost & Sullivan Research Report. *North American Commercial Vehicle Telematics Markets.*

[54] The Freedonia Group. *Electrical/Electronic Products - Medium & Heavy Truck Aftermarket*. 2003.

growth is attributable to the proliferation of GPS-enabled cell phone[55] use in local CMV operations.

It is also worth noting that the total projections may be underestimated due to both the difficulty in accounting for the entire population of the private carrier subsegments (see Table 5) and the relative scarcity of market data related to telematics from these subsegments.

[55] GPS-enabled cell phones are considered "EOBR ready" since theoretically they could provide GPS coordinate data to an EOBR system.

Table 3: Approximate Population of U.S. Heavy / Medium Trucks and Carrier Firms 2000 ICF Estimates

		For-hire				
		Truckload (TL)	Less-than-truckload (LTL)	Other (packages, HHG, etc)	*Private*	**TOTAL**
Long-haul and regional	Number of trucks	670,000	105,000	42,500	700,000	**1,500,000**
	Number of firms	36,000	350	(not available)	(not available)	**(not available)**
Short-haul and local	Number of trucks	100,000	10,000	22,500	100,000	**250,000**
	Number of firms	17,000	500	(not available)	(not available)	**(not available)**
Subtotal	Number of trucks	770,000	115,000	65,000	800,000	**1,750,000**
	Number of firms	53,000	850	(not available)	(not available)	**(not available)**
TOTAL	Number of trucks	**950,000(1) (4% with electronic logbooks)(2)**			**800,000(1) (18% with electronic logbooks)(2)**	**1,750,000 (10% with electronic logbooks)**
	Number of firms	**(not available)**			**(not available)**	**(not available)**

Footnotes:

(1) U.S. Department of Transportation, Federal Motor Carrier Safety Administration. *Regulatory Impact Analysis and Small Business Analysis for Hours of Service Options*. Prepared by ICF Consulting, Inc., and Jack Faucett Associates. December 2002. Pages 3-1 to 3-7, and A-1 to A-11.

(2) U.S. Department of Transportation, Federal Motor Carrier Safety Administration. Motor Carrier Technologies: *Fleet Operational Impacts and Implications for Intelligent Transportation Systems/Commercial Vehicle Operations*. Prepared by the ATA Foundation. October 1999. Page 7.

Notes:

Year 2000 annual commercial telematics sales of navigation, fleet and tracking devices are estimated at $122,500,000 for the aftermarket. (Source: The Freedonia Group. *Electrical/Electronic Products - Medium & Heavy Truck Aftermarket*. 2003).

Year 2000 annual commercial telematics sales of navigation, fleet and tracking devices are estimated at $705,000,000 for the total North American market (source: Frost & Sullivan Research Report. *North American Commercial Vehicle Telematics Markets*).

Table 4: EOBR-ready Telematics Penetration - U.S. Truck Fleet 2003 Estimates (applied to 2000 ICF population estimates)

	For-hire				
	Truckload (TL)	Less-than-truckload (LTL)	Other (packages, HHG, etc)	*Private*	**TOTAL**
Long-haul and regional - level and % of market penetration	200,000, 30% [1] 140,000, 21% [2]	(not available)	(not available)	(not available)	**390,000** [1] **300,000** [2] **35,000** [3]
Short-haul and local - level and % of market penetration	(not available)	(not available)	(not available)	(not available)	**12,500, 5%** [1] **84,000** [4] **50,000** [5] **40,000** [6]
Subtotal	214,000	14% [1]			**351,200 - 402,500**
		16,100	9,100	112,000	
TOTAL	**239,200**			**112,000**	**351,200 - 402,500**

Footnotes:

(1) Driscoll, Clem and Dick Wolfe. Driscoll-Wolfe Marketing and Research Consulting. *Survey of Telematic Systems Owners and Users*. August 2004.

(2) Qualcomm. Werner Enterprises system based on Qualcomm OmniTRACS is approximately 9,000 units for long-haul / regional. In 2003, it is reported that Qualcomm shipped 38,000 units for long-haul TL carriers.

(3) XATA OpCenter.

(4) @Road (includes public vehicles).

(5) Teletrac.

(6) Minorplanet.

Notes:

Year 2003 annual commercial telematics sales of navigation, fleet and tracking devices are estimated at $138,750,000 for the aftermarket (source: The Freedonia Group. *Electrical/Electronic Products - Medium & Heavy Truck Aftermarket*. 2003).

Year 2003 annual commercial telematics sales of navigation, fleet and tracking devices are estimated at $771,300,000 for the total North American market (source: Frost & Sullivan Research Report. *North American Commercial Vehicle Telematics Markets*).

Table 5: EOBR-ready Telematics Penetration - U.S. Truck Fleet 2005 Estimates (applied to 2000 ICF population estimates)

	For-hire				
	Truckload (TL)	Less-than-truckload (LTL)	Other (packages, HHG, etc)	*Private*	**TOTAL**
Long-haul and regional - level and % of market penetration	200,000, 40% [1] 193,000, 35% [2]	(not available)	(not available)	55 (fleets) [2] 106 [3]	**425,000 [1]** **300,000 [2]** **35,000 or more [4]**
Short-haul and local - level and % of market penetration	(not available)	(not available)	1,800 [5] 200,000 [4] 70,000 [6]	(not available)	**20,000, 8%[1]**
Subtotal	270,000	14% [1]			**407,500 - 445,000**
		16,100	9,100	112,000	
TOTAL	**295,200**			**112,000**	**407,500 - 445,000**

Footnotes:

(1) Driscoll, Clem and Dick Wolfe. Driscoll-Wolfe Marketing and Research Consulting. *Survey of Telematic Systems Owners and Users*. August 2004.
(2) Qualcomm. FleetAdvisor is approximately 7,500 for private fleets, plus OmniTRACS in the U.S. in Canada.
(3) PeopleNet, Petroleum Transport Co.
(4) XATA, Xatanet.
(5) USPS.
(6) UPS.

Notes:

Year 2005 annual commercial telematics sales of navigation, fleet and tracking devices are estimated at $154,000,000 for the aftermarket (source: The Freedonia Group. *Electrical/Electronic Products - Medium & Heavy Truck Aftermarket*. 2003).

Year 2009 annual commercial telematics sales of navigation, fleet and tracking devices are estimated to be $4.5 billion for the total NorthAmerican market (source: Frost & Sullivan Research Report. *North American Commercial Vehicle Telematics Markets*).

Nextel, 2 million GPS wireless handsets

It is reported that Qualcomm shipped 38,000 units for long-haul TL carriers in 2004.

3.3 Summary of Market Review Findings

A review of the literature provided a variety of categorical and quantitative data that was integrated for purposes of characterizing and estimating the potential market for EOBRs. Sources reviewed for cost data included the report *On-Board Recorders: Literature and Technology Review (July 2002)*[56], the September 1, 2004 ANPRM[57], and a recent FMCSA field operational test of technologies related to hazardous materials transport by truck.[58] The latter report provides a reasonable baseline for projecting per-unit costs for EOBR-related technologies. They ranged from $429 to $2,275 (plus monthly service fees) for vehicle tracking products; from $6 to $1200 (with an average of approximately $1,000) for biometric identification products; and from $10,000 to $30,000 for fleet-wide software licenses.

Sources of information for framing the extent of potential market penetration included a 2002 review of the CMV population[59], ATA surveys regarding automation, information regarding the use of telematics[60], and various industry consultant forecasts. Information regarding numerous individual products and vehicle fleets, obtained from vendor websites, sales literature, and the public-docket comments submitted by carriers and vendors, was also utilized. A summary of the products currently produced by a variety of EOBR-related equipment and software manufacturers appears in Appendix A, and an overview of their capabilities in Appendix B.

It is estimated that in 2000, approximately 4% of the estimated 950,000 for-hire heavy/medium trucks[61] and 18% of heavy/medium trucks in private fleets utilized electronic logbooks, for a total of 182,000 heavy/medium vehicles. Aftermarket sales for electronic logging-related telematics were estimated at $122.5 million[62] for the same time period. In 2003, 350,000 to 400,000 (approximately 20%) of on-board telematics units were available as EOBR-ready (240,000 in for-hire vehicles, and as many as 390,000 in vehicles used in long-haul and regional operations), and aftermarket sales for electronic logging devices were estimated at approximately $139 million.[63]

---

[56] U.S. Department of Transportation, Federal Motor Carrier Safety Administration, Office of Policy and Program Development. *On-Board Recorders: Literature and Technology Review*. Prepared by Brad Wright and Erin Fogel, Cambridge Systematics, Inc. July 2002.

[57] Federal Register, Volume 69, Number 169. *Electronic On-Board Recorders for Hours of Service Compliance. Advance notice of proposed rulemaking; request for comments*. September 1, 2004.

[58] Williams, D., et. al. *Hazmat Safety & Security Field Operational Test. Final Report.* August 31, 2004. Document approved for public disclosure. Prepared by Battelle, in association with Qualcomm, the American Transportation Research Institute, the Commercial Vehicle Safety Alliance, and the Spill Center, for the U.S. DOT, Federal Motor Carrier Safety Administration.

[59] U.S. Department of Transportation, Federal Motor Carrier Safety Administration. *Regulatory Impact Analysis and Small Business Analysis for Hours of Service Options*. Prepared by ICF Consulting, Inc., and Jack Faucett Associates. December 2002. Pages 3-1 to 3-7, and A-1 to A-11.

[60] Corredor, Alfonso, PhD. *Commercial Vehicle Telematics Development Strategies*. ITS America News, Vol. 13, No. 1, January 2003.

[61] U.S. Department of Transportation, Federal Motor Carrier Safety Administration. *Regulatory Impact Analysis and Small Business Analysis for Hours of Service Options*. Prepared by ICF Consulting, Inc., and Jack Faucett Associates. December 2002. Pages 3-1 to 3-7, and A-1 to A-11.

[62] The Freedonia Group. *Electrical/Electronic Products - Medium & Heavy Truck Aftermarket*. 2003.

[63] The Freedonia Group. *Electrical/Electronic Products - Medium & Heavy Truck Aftermarket*. 2003.

In 2005, the total forecast for EOBR-ready applications (including newly available GPS-cell phones) deployed in heavy/medium trucks used in long-haul and short-haul operations is estimated to range from between 425,000 to 450,000 (approximately 25% of the estimated population of heavy/medium trucks used in long-haul and short-haul operations). Aftermarket sales for electronic logging-related telematics are estimated at $154 million for the same time period.[64] Much of this growth is attributable to the proliferation of GPS-enabled cell phone use[65] in local CMV operations. It is felt that these figures are illustrative of the current and potential market for EOBR technologies within the U.S. trucking industry.

[64] The Freedonia Group. *Electrical/Electronic Products - Medium & Heavy Truck Aftermarket*. 2003.

[65] GPS-enabled cell phones are considered "EOBR ready" since theoretically they could provide GPS coordinate data to an EOBR system.

Section 4: Performance Benchmarks

This section focuses on developing specific guidance regarding the performance standards for on-board recorders for monitoring hours-of-service compliance.

4.1 Assessment Approach

Figure 1 below provides a broad overview of the assessment approach that was utilized to develop reasonable, operationally practicable EOBR performance benchmarks; review and better understand the potential range of technologies that could be utilized in satisfying these performance benchmarks; and ultimately develop recommendations concerning the potential for either allowing or mandating EOBRs.

As shown in the figure, there are three major overarching components to the assessment approach. These include:

(1) EOBR Key Research Factors

- Five "technical"
- Two "non-technical"

(2) Performance Benchmarks

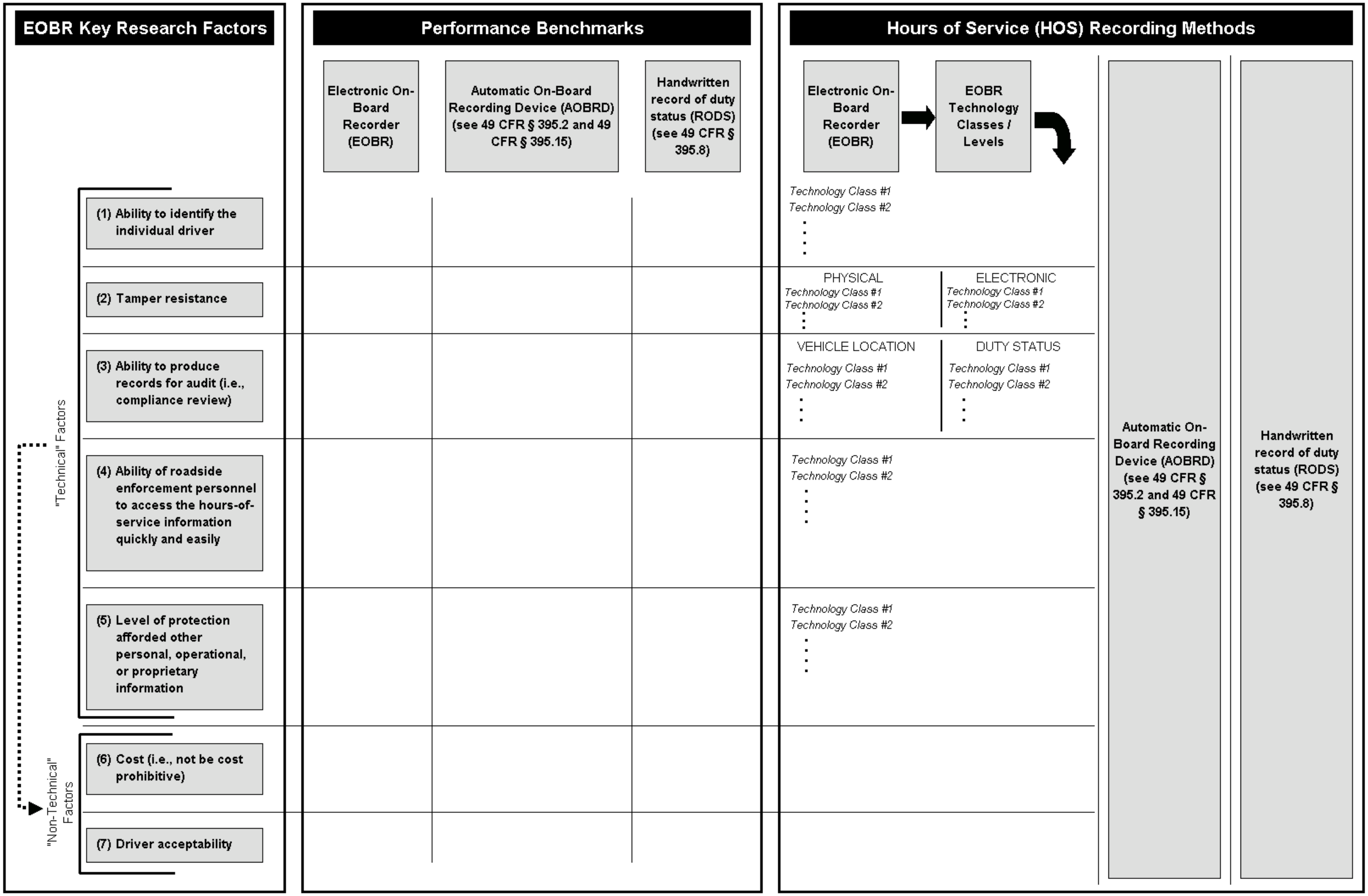
- For each of the seven Key Research Factors, *and*
- For each of the three HOS Recording Methods

(3) Hours of Service (HOS) Recording Methods

- Handwritten RODS
- AOBRD
- EOBR

Further details regarding each of the above elements are provided below.

Figure 1: EOBR Assessment Approach



4.1.1 EOBR Key Research Factors

The seven key research factors noted in Figure 1 are meant to address those issues most pertinent to the development of recommendations for the use of EOBRs for recording and reporting CMV drivers' hours of service. These seven key research factors were presented in both the April 28, 2003 final rule on hours of service of drivers[66], and the September 1, 2004 ANPRM concerning the use of electronic on-board recorders for hours of service compliance.[67]

The first five of the seven areas are classified here as "technical" in that they can be primarily thought of in terms of the various possible technologies and methods that could be used for addressing them (for example, technologies that could be used to identify the individual driver, encryption methods that could be used for electronic tamper resistance of the EOBR and the data it produces and records, etc.). The remaining two areas, cost and driver acceptability, are classified here as "non-technical" because they are largely dependent on the five technical areas. That is, the characteristics and functions of an EOBR device or system will largely dictate the cost of that system and the level to which drivers will find the system acceptable for use.

4.1.2 Performance Benchmarks

The performance benchmarks for AOBRDs and handwritten RODS are in large part defined by the FMCSRs (primarily 49 CFR § 395.15 and 49 CFR § 395.8, respectively). A review of these regulations was used to characterize the existing performance benchmarks for AOBRDs and handwritten RODS and recast them here along the lines of the seven key research factors, to define a baseline against which the proposed EOBR benchmarks can be compared.

In contrast to AOBRDs and handwritten RODS, the performance benchmarks for EOBRs and the technologies and methods that will comprise EOBRs have yet to be defined. To help provide a logical and systematic framework for developing proposed EOBR performance benchmarks, the benchmarks are organized here along the lines of the seven EOBR key research factors. Where possible, performance benchmarks are articulated such that they are performance based and functionally oriented. For example, the data fields required to be collected and stored will be specified, but *not* the technologies or methods that could be used to collect and store these data fields. The technologies and methods that could potentially satisfy the performance benchmarks will be reviewed under the description of the various EOBR levels. In some cases, the performance benchmarks are quantitative, and in other cases they are expressed in qualitative terms.

As noted in Figure 1, the process of developing reasonable, operationally practicable EOBR performance benchmarks is in part an iterative one, whereby the various levels of technologies and methods available to satisfy the proposed performance benchmarks, and their costs and

---

[66] Federal Register, Volume 68, Number 81. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Final Rule*. April 28, 2003. Page 22489. URL <http://www.fmcsa.dot.gov/rulesregs/fmcsr/final/hos_997.pdf>

[67] Federal Register, Volume 69, Number 169. *Electronic On-Board Recorders for Hours of Service Compliance. Advance notice of proposed rulemaking; request for comments*. September 1, 2004. Page 53389. URL <http://www.fmcsa.dot.gov/rulesregs/fmcsr/final/04-19907_EOBRs.pdf>

driver acceptability, influence whether the proposed performance benchmarks actually qualify as reasonable and operationally practicable. EOBR performance benchmarks should not be set such that they are only achievable using technologies and methods that are cost prohibitive or not yet available. However, the possible technologies and methods that comprise EOBRs must at least achieve the proposed minimum performance requirements once those are established by the performance benchmarks.

4.1.3 Hours of Service Recording Methods

At their most basic level, handwritten RODS, AOBRDs and EOBRs can all be broadly categorized as HOS recording methods. Again, as noted above, AOBRDs and handwritten RODS are in large part known and specified by the FMCSRs (primarily 49 CFR § 395.15 and 49 CFR § 395.8, respectively). However, in contrast to AOBRDs and handwritten RODS, EOBRs and the technologies and methods that will comprise EOBRs are still undefined.

It must be emphasized that as part of our analytical approach, our "levels" are simply meant to be *illustrative* of the possible range of available or near-term technologies that could satisfy the proposed EOBR performance benchmarks. Despite the fact that a more advanced level of technology may be presented as one of the levels for a specific technology area (e.g., vehicle location), this is not meant to suggest that use of these more advanced technological approaches will necessarily be required to ultimately satisfy the proposed benchmarks for an EOBR system. Rather, as discussed in more detail below, the various levels of technology for a given area are screened through comparison with the proposed EOBR performance benchmarks.

4.1.4 Approach

With the proposed EOBR performance benchmarks developed, and the various possible levels of technologies and methods of satisfying these benchmarks described, the various levels of technologies and methods are subjected to a systematic screening process by which they are compared to the proposed benchmarks for each of the key research factors.

The specific method or technology level for a given technology area that is thought to be minimally compliant in satisfying the proposed benchmark is selected as most illustrative of an element of an EOBR system that would satisfy (but not exceed) the proposed EOBR performance benchmarks. More advanced levels of technologies and methods may, of course, both satisfy and *exceed* the proposed EOBR performance benchmark, but would also likely have higher costs or other associated operational burdens.

The combination of levels of technologies and methods that satisfy the proposed EOBR performance benchmarks, but do not unnecessarily exceed them, form what is illustrative of an EOBR system that would be compliant with the proposed performance benchmarks. This approach can also be viewed from various perspectives. For example, it can be viewed from the perspective of the seven key research factors with each of the three HOS recording methods addressed in turn, or alternatively from the perspective of the three HOS recording methods with each of the seven key research factors addressed in turn.

4.2 Key Research Factors

Seven key research factors have been identified to assist in the development of performance benchmarks for EOBRs. These seven key research factors are that EOBRs:

(1) have the ability to identify the individual driver operating the CMV;
(2) be tamper resistant;
(3) have the ability to produce records of duty status required for carrier Compliance Review;
(4) allow roadside enforcement personnel to access the hours-of-service information quickly and easily;
(5) provide a level of protection for personal, operational, or proprietary information;
(6) not be cost prohibitive; and
(7) have driver acceptability.

4.2.1 Possible Additional Key Research Factors for Future Consideration

Based on comments received by FMCSA to the September 1, 2004 ANPRM, the following three potential additional key research factors were identified as possible areas for future consideration.

Potential Key Research Factor: Ability to automatically cross-reference and validate recording of driving time and duty status

Comments to the September 1, 2004 ANPRM applicable to this area include the following:

- EOBRs should facilitate compliance with proposed rules to "put a little more onus on drivers and carriers to link supporting documents [and hard information] and records of duty status."
- EOBRs should automatically "reduce the record-keeping responsibilities [burden] for motor carriers."
- Provide justification for sleep time by requiring prior explicit or logically implicit close-out of on-duty activities
- Allowing drivers to amend duty status "leaves the EOBR system more vulnerable to the possibility of falsification and requires verification of the data to ensure accuracy."
- "For non-driving time, drivers should be able to select the proper duty status based on their activities. If they make an error and need to add on-duty, not driving time, they should be permitted to do so. However, to reduce on-duty time, a driver should be required to request management review and correction.
- "The driver should be able to select a predetermined Remark from a menu listed on a dashboard viewscreen and have it added to the EOBR as a late entry associated to a prior time. Default conditions for on-duty-not-driving should ensure proper status relative to the CMV's motion so that remarks or actions to amend Duty status are not available or permissible."
- "The suggestion of eyelid (sic) scanners as required input for factory-installed EOBRs should be studied most closely.…False claims entered as off-duty/sleeper status would be

suspected when the EOBR documents eyelid scanner alarms within hours of returning to driving-time."

- To help minimize the number of [valid] corrections, a verification function could be employed prior to each entry being permanently recorded."
- "EOBRs must be able to distinguish between drivers so that one driver's duty status or driving hours are not mistaken for the other driver's"
- "The EOBRs still have no way to tell what the duty status of a driver is when the truck is not moving…it can not measure whether the driver is actually in a sleeper berth position getting restorative sleep. In addition, a driver can currently use the truck as a personal conveyance, and log time as off-duty. The EOBR mandate would have to address that situation as well."
- "Records should not be amended by anyone. Annotations that explain line 4 (not-driving, on-duty) activity will be required unless other regulatory requirements are changed, Pre- and Post-trip Inspections, Fueling Activity, Loading and Unloading, and Roadside inspections, to mention a few.

The data integrity envisioned for EOBRs would eliminate, or at least significantly reduce, the accounting "flexibility" inherent in current handwritten RODS systems and even some AOBRDs, further reducing the potential for record falsifications generated through attempts to gain productivity advantages. The EOBR should therefore facilitate, and self-document, accurate and authorized duty status changes, and include provisions for annotations to be made by the driver and carrier. Where it is clear that the new approach penalizes certain parties, the data generated from such usage should be available to help better understand and potentially address these impacts.

Potential Key Research Factor: Required reliability and self-verification of operation

Comments to the September 1, 2004 ANPRM applicable to this area include the following:

- EOBRs should contain read-only memory that performs and documents a self-check of its inputs as well as constant monitoring of their performance to within each specification. Included in its self-check [are] the results of modules that control the other systems integral for HOS…and plainly indicate the component(s) failure on the dashboard viewscreen along with its level of concern."
- "A driver, supervisor reviewing records, or safety official could require different levels of verification…. We suggest that FMCSA examine the NHTSA Federal Motor Vehicle Safety Standards…along with the European Council regulation…."
- "Hold the manufacturers to MilSpec type standards reducing the possibility of failures to near-zero… If all data is stored on the driver's memory device, and is uploaded by the carrier, there should be no missing data… [If it fails]… allow [third-party leased item] replacement at the next truck stop. Down-time indicators would be reported by the EOBR itself…once the unit is replaced, the memory device needs to be updated… There is no need for calibration…."
- "The EOBR system should automatically detect system failures and notify the driver and dispatch supervisor that the system is not functioning and that paper logs should be used."

- "A defined self-test with a display of results could validate key elements such as a link to the vehicle, clock, adjustments, and other failures… Any detectable failure should be displayable on the host system via the audit trail and other failures should be required to be documented in the carrier and either a paper RODS or manually generated electronic RODS created for the days in question."
- "There are definitely exceptions that will prevent the automatic capturing of malfunctions and the driver should be required to record the date, time, and nature of the malfunction on the paper RODS even if the EOBR has already captured in electronically."
- "EOBRs must meet appropriate Society of Automotive Engineers (SAE) standards for vibration, ambient temperature range, impact, radiated emissions, and susceptibility."
- "A diagnostic screen should be made available including the GPS signal strength, wireless connectivity, and data from ECM. If not operating correctly, the device should prompt the driver with the known issue and provide a troubleshooting screen for correcting the issue."
- "The software application running on the wireless handset provides an interface intuitive enough for a driver and law enforcement officer to deduce whether or not it is functioning properly. In addition, handset software can easily display how long the handset has been in service…and GPS satellite fixes are easily demonstrable from the handset… [In case of a failure at a roadside inspection]… and the law enforcement officer has mobile access to the Internet, he could log into the application and determine how long the handset has been in operable."

A number of comments are directed to questions in the current and previous rulemaking notices, about both required reliability of the devices and automatic notification of malfunctions. Some applicable industry standards, as well as descriptions of possible self-test, diagnostics, calibration checks, troubleshooting options, and notifications are provided.

Potential Key Research Factor: Ability to generate statistics for understanding the effects of automation on compliance and safety performance

Comments to the September 1, 2004 ANPRM applicable to this area include the following:

- To further promote or mandate EOBRs, the government needs to take the "seemingly obvious step of testing EOBRs on the road… to estimate their benefits on imperfect empirical assumptions."
- Need to "carry out a Congressional directive to evaluate EOBRs and their impact on HOS compliance (prior to further HOS rulemaking)."

Consideration should be given to generating research data from electronic records that can be used to ascertain the effectiveness of such systems on compliance, crash involvement, and other transportation performance measures. Especially given the lack of previous research, such data may be crucial to understanding and confirming the roles of technological and regulatory advancement.

4.3 Identify Performance Benchmarks for Handwritten RODS, AOBRDs, and EOBRs

Performance benchmarks for handwritten RODS and AOBRDs are developed in this section based on existing regulations and guidance, these being primarily 49 CFR § 395.2, § 395.8, and § 395.15. The development of new quantitative (where possible) and qualitative performance benchmarks for EOBR technology for each of the key research factors is based primarily on the literature review in Section 2, the market review in Section 3, and other research and technical knowledge regarding EOBRs including digital tachographs, ECMs, wireless satellite communications equipment, and GPS navigation.

For the purpose of this study, the following three types of record of duty status are defined as:

- **Handwritten Record of Duty Status (RODS)**: This is a graph grid paper form that allows the driver to graph time and location over a 24-hour period (49 CFR § 395(a)(l)). The rules provide the form (49 CFR § 395.8(g)). It is referred to as a "driver's daily log" and is by far the most common form of RODS.

- **AOBRD**: An electric, electronic, electromechanical, or mechanical device capable of recording driver's duty status information accurately and automatically as required by 49 CFR § 395.15. The device must be integrally synchronized with specific operations of the commercial motor vehicle in which it is installed. At a minimum, the device must record engine use, road speed, miles driven, the date, and time of day.[68]

- **EOBR**: An electronic on-board recorder used to record a CMV driver's hours of service in order to provide documentation to determine compliance with 49 CFR § 395. An EOBR has features providing additional functions beyond those of an AOBRD. It must provide a means to record and store the date and time of each data entry, the status of the engine (on/off) and the location of the CMV. The EOBR also must calculate and display the distance traveled and the road speed.[69]

For the purposes of this study, the generic term "EOBR" will be used. This term encompasses any new devices as well as AOBRDs that comply with the current definition of 49 CFR § 395.2 and the operational requirements 49 CFR § 395.15. The term AOBRD will be used by itself, however, to refer only to the earlier-generation devices designed to comply with the current requirements.

Performance benchmarks for handwritten RODS, AOBRDs, and EOBRs are presented below for each of the seven Key Research Factors noted earlier in Section 4.2.

---

[68] 49 Code of Federal Regulations (CFR) § 395.2. *Hours of Service of Drivers. Definitions*.

[69] Federal Register, Volume 69, Number 169. *Electronic On-Board Recorders for Hours of Service Compliance. Advance notice of proposed rulemaking; request for comments*. September 1, 2004. Page 53394.

4.3.1 Performance Benchmarks for Key Research Factor #1: Identify Individual Driver

Handwritten RODS

The driver's RODS has no specific requirement to record the driver's name, however the driver's signature is required to certify the accuracy and correctness of the driver's duty status record. If a co-driver is present, the co-driver is also required to prepare his/her own RODS and verify their accuracy and correctness as well. As part of recording the driver's RODS, the name of the motor carrier, the motor carrier's office address, the truck/tractor's license plate and the state of issuance is also recorded.

AOBRD

The driver's AOBRD-generated RODS has no specific requirement to record the driver's name, however the submission of the record constitutes certification that all entries made are true and correct. The driver's signature is required to certify that all hard copy records generated by the AOBRD unit relating to the driver's duty status are accurate and truthful.

EOBR

- It is recommended that EOBRs have the ability to request and record driver identity. As a minimum, the identification information must include a driver name or some other type of suitable unique identifier to distinguish drivers from one another and from co-drivers.

    - Consideration of more stringent requirement: requiring a unique government-issued identification number, such as his/her commercial driver's license (CDL) number and state code. If a co-driver is present, the EOBR should also have the ability to record the identity of the co-driver. Linking driver identification to a government-issued number will ensure that the identity of the driver can be quickly verified during a roadside inspection. During a routine inspection, the inspector simply has to compare the driver's license of the operator with the stored EOBR information to positively confirm driver identity. This approach could help to discourage operators from swapping, borrowing, or otherwise falsifying driver identity.

- It is recommended that EOBRs record the date and time a driver logs onto the system. The EOBR should trigger an audible and visual alert if the driver fails to supply his/her identity, front-end information, and duty status information before setting the motor vehicle in motion. It is recommended that EOBRs record the absence of driver identity in accordance with Key Research Factor #3.

- The driver and co-driver's IDs and associated names should appear in all records produced by the EOBR.

- It is recommended that EOBRs record the duty status of individual drivers on board, the date, and the start and stop times of each duty status change. Duty status includes the following duty status categories:
    - Off Duty
    - Sleeper Berth
    - Driving
    - On-Duty, Not Driving

- It is recommended that EOBRs require the driver to record location information (state and city, town or village name) related to each change of duty status using a standard set of city and town names that is practically useful to both drivers and to enforcement personnel (see Appendix F for further information regarding the recording of location information for EOBR applications). If a positioning system (e.g., a GNSS such as GPS) is available, the EOBR may compute (for example via a lookup table based on latitude and longitude coordinates) and automatically enter the state and city, town or village name, and calculate the direction and compass heading from the current vehicle location to the nearest city, town or village. If a positioning system is *not* available, a manual hierarchical input scheme should be used to facilitate the entry of the standardized location names by the driver (for example, by using a series of "pick lists" provided by the system to select the state, and then the name of the city, town or village).

- It is recommended that EOBRs require the driver to enter a standard location code for state border crossing events. A standard numeric location code should be developed and used for these state border crossings. If a positioning system (e.g., a GNSS such as GPS) is available, the EOBR may compute (for example via a lookup table) and automatically enter the proper standard numeric location code. If a positioning system is *not* available, a manual hierarchical input scheme should be used to facilitate the entry of the standardized codes by the driver (for example, by using a series of "pick lists" provided by the system to select the states being crossing into and from, and then the route number or street name.

- It is recommended that EOBRs only allow a change in duty status to be entered when the vehicle is at rest.

- Data identifying the individual driver can be entered in the EOBR through either manual or automatic methods.

  An example of manual entry is via the use of a keyboard on the EOBR console. The EOBR would confirm the driver's identity and could display the name of the driver, a photo of the driver, etc., on the console screen. Such an approach would also likely be useful for providing the ability to enter other trip-related information, such as shipping document number, name or ID of co-driver, etc. For safety reasons, it should be required that the vehicle be stationary before allowing EOBR keyboard entry of any information.

An example of automatic entry is the use of an ID card (smart card, magnetic strip, etc.) that, when inserted into or swiped through the EOBR, would log the driver onto the system. As with the manual data entry approach, the EOBR would then confirm the driver's identity and could display the name of the driver, a photo of the driver, etc., on the console screen, and any additional trip information could then be entered via a keyboard. A contactless identification card could be used as an alternative to manual card insertion, since a practical issue with the use of identification cards and smart cards is that they tend to warp over time from being carried in wallets, making insertion into card readers problematic in some cases. Some form of biometric identification (finger print scanner, etc.) could also be used.

4.3.2 Performance Benchmarks for Key Research Factor #2: Tamper Resistance

Handwritten RODS

The driver's RODS requires the driver to sign the handwritten driver's daily log to certify that the data entered is correct, truthful, and accurate. 49 CFR § 395.8 requires the driver, in his own handwriting, to enter all entries into the driver's daily log. 49 CFR § 395.8 also allows the driver to alter the RODS and resubmit them to the motor carrier. It is suggested the carrier mark the second submission "corrected copy" and staple it to the original submission for the required retention period.

AOBRD

49 CFR § 395.15 requires that the AOBRD unit and the additional support equipment be manufactured, "to an extent practicable," to prevent tampering by the user and alteration of the hours-of-service information stored within the AOBRD. The manufacturer of the AOBRD device must identify the conditions under which the AOBRD will be tested and certify that the device met the requirements stated within 49 CFR § 395.15. As part of the AOBRDs functionality, the device also must identify and record sensor failures and indicate any edits or changes to the previously recorded data. The AOBRD must also be maintained and recalibrated according to specifications established by the manufacturer.

If the AOBRD becomes inoperative, the driver is required to note the failure and record entries in handwritten RODS. The entries must be legible and in the driver's own handwriting. The driver is also required to reconstruct his duty status records for the current day and the previous 7 days. Preparation of handwritten records shall continue until the AOBRD unit has been repaired and made operational. When written records are submitted to the employing carrier, the driver must review and sign all records, certifying that all entries are accurate and true.

AOBRDs are - to the maximum extent possible - tamper resistant, and do not permit altering of information. All amendments must be hand written on paper RODS with a supervisor's signature.

EOBR

Physical Tamper Resistance

- It is recommended that EOBRs be designed to indicate any attempts of tampering, whether physical or electronic.

- The EOBR enclosure must provide sufficient physical security to dissuade or prevent potential tampering. The unit must be able to withstand everyday abuse caused by road vibrations and harsh operating environments. Physical tamper resistance begins with an equipment enclosure that prevents disassembly with common tools. Special anti-tampering fasteners may be used to hinder access to the unit's internal components. In addition, external interface connections with other on-board systems such as ECMs and Transmission Control Modules (TCMs) may also require tamper-resistant couplers or fasteners to prevent intentional disconnection.

- Tamper-evident techniques also may be utilized to further enhance physical security. The use of security tags might also be considered. Such tags are similar to the devices used on electric power meters, where the service personnel are required to physically cut the tag ring before the device can be opened for service. Only authorized service personnel or law enforcement authorities are able to replace the tamper-detection device. Also, the use of security seal tape, such as that found on consumer electronics, may be used to detect if the unit's enclosure has been compromised. Internally, critical electronic components, such as an EOBR system processor or memory storage module, can be encapsulated in epoxy or a tamper-resistant film to prevent physical tampering or removal.

- It is recommended that EOBRs be fully operational within the industrial temperature range of -40ºC to +85ºC (-40ºF to 185ºF), and within a humidity range of 10 percent to 90 percent.

- Internal components of the EOBR will be protected against damage from liquid and dust.

Electronic Tamper Resistance

- It is recommended that EOBRs have a date and time keeping device (clock) for which the allowable absolute deviation, plus or minus, from official time should never exceed 10 minutes (see Appendix D for further information). In practice, this equates to a rate of time drift of the EOBR clock of approximately +/- 1.7 seconds per day over the course of one year. Date and time information on the clock should be resynchronized with at least one additional external source of accurate time information, which could include an external source such as GPS, or an on-board vehicle data system such as an ECM and TCM, on a regular basis to maintain this recommended performance standard for time keeping accuracy. Widely available and relatively inexpensive integrated real-time clocks (RTCs) based on economical quartz crystals can achieve typical accuracies of at least approximately +/- 2 seconds per day, which would require EOBR clocks to be resynchronized with official time infrequently, approximately once per year, in order to maintain the recommended performance standard of 10 minutes of absolute accuracy for time keeping accuracy. The EOBR should also maintain time accurately in accordance with this time keeping performance standard for up to 12 months after external power to the device has been removed. The recommended performance standard of 10 minutes should allow sufficient accuracy or resolution in terms of time to provide compliance review personnel the ability to be able to reasonably and easily correlate time stamped supporting documents to a driver's hours of service information. The recommended performance standard of 10 minutes should allow sufficient accuracy or resolution in terms of time to provide compliance review personnel the ability to be able to reasonably and easily correlate time stamped supporting documents to a driver's hours of service information.

- It is recommended that EOBRs use Coordinated Universal Time (UTC)[70] as the reference time base or time standard for recording and processing electronic HOS duty status information.

- It is recommended that EOBRs record time information in increments of 1 second.

- It is recommended that EOBRs record the occurrence (date, time and type) of system-related events and diagnostic events. This is discussed further in Section 6.1.2, with a list of some possible EOBR diagnostic event codes presented for illustrative purposes in Table 7 in that section.

- It is recommended that EOBRs record the date and time if the system detects the absence of data from the ECM, TCM, or other integrated system.

- It is recommended that prior to system shutdown, EOBRs capture and store system validation parameters from the ECM or TCM. These parameters should include ECM/TCM time, odometer/mileage readings, and serial numbers of system components (if available). Upon unit restart, it is recommended that EOBRs compare their stored ECM/TCM readings with the present values and record any discrepancies.

- It is recommended that drivers not be allowed to edit driving records on-board the vehicle. Rather, edits should only be allowed by authorized personnel of the motor carrier at the main office or terminal. In addition, whenever driving records are edited in this manner, the fact that a change has taken place should be flagged, and both the newly edited and the original un-edited data should be maintained for review during a compliance review. Data downloaded from EOBRs should be secured to ensure that only authorized motor carrier personnel and enforcement personnel can access the data.

---

[70] UTC (Coordinated Universal Time) is the international civil time standard, determined by using highly precise atomic clocks. It is the basis for civil standard time in the United States and its territories. UTC time refers to time kept on the Greenwich meridian (longitude zero), five hours ahead of Eastern Standard Time. UTC times are expressed in terms of a 24-hour clock. Standard time within U.S. time zones is an integral number of hours offset from UTC.

- Methods for tracking changes or attempted changes to the electronic hardware or software utilized by the EOBR should be incorporated. For example, the detection of such attempts could be flagged in the data record, along with the time at which the attempt was detected.

- In connection with the necessity for tamper resistance in an EOBR, it is recommended that information and identifying information be recorded in the form of an audit trail or event log. An audit trail must reflect the driver's activities while on duty and tie them to the specific CMV(s) that the driver operated. Its design must balance privacy with the need for a verifiable record. The presentation should include audit trail markers to alert safety officials and personnel in the motor carrier's safety department to records that have been modified.

4.3.3 Performance Benchmarks for Key Research Factor #3: Produce Records for Audit and Compliance Review

Handwritten RODS

Drivers currently indicate their hours of service using daily logs, which the driver must produce for each 24-hour period of performance. As part of this 24-hour reporting period, the driver maintains a record for each of the following categories of duty status:

- Off Duty
- Sleeper Berth
- Driving
- On-Duty Not Driving

As part of maintaining this record, the driver records the change of duty status along with the name of the location where the change of duty status occurred, as described in 49 CFR § 395.8, subsection (c). The driver, at all times, must maintain in his possession a copy of each record of duty status for the previous 7 consecutive days. 49 CFR § 395.8 also requires the driver's carrier to maintain RODS status for all drivers for the previous 6 months from the date of receipt. Drivers must submit their RODS to their company within 13 days after their completion.

AOBRD

49 CFR § 395.15 requires that AOBRD supporting systems located at the driver's home terminal or the motor carrier's main office be capable of producing summaries of individual driver's hours of service records and information required in 49 CFR § 395.8 for inspection by authorized federal, state, and local officials.

There are 13 items required by regulation for AOBRD-generated duty status records in 49 CFR § 395.15 (c) and (d). The driver's duty status records must be submitted electronically or by mail to the carrier's home office within 13 days following the completion of each daily log. Upon request, the motor carrier must make the driver's duty status records available for the Safety Investigator conducting a Compliance Review.

Although 49 CFR § 395.15 does not specify how information is displayed on screen, it does require support systems to comply with 49 CFR § 395.8(d), including the use of a graph grid.

EOBR

- It is recommended that EOBRs use a portable storage media capable of storing driver-oriented RODS data for a minimum of 8 days, such that the driver can maintain in his/her possession a copy of each record of duty status for the current day and the previous 7 consecutive days, as is the current requirement for handwritten RODS under 49 CFR § 395.8, even when having operated multiple vehicles during that time period. Similar to the requirement under 49 CFR § 395.8 for handwritten RODS, drivers must submit their electronic RODS to their company within 13 days after their completion.

- 49 CFR § 395.8(k)(1) requires that each motor carrier shall maintain RODS and all supporting documents for each driver it employs for a period of 6 months from the date of receipt. Similar requirements are recommended for electronic RODS for each driver should be required to be maintained by the carrier for a period of 6 months from the date of receipt. Also, it is recommended that electronic RODS for each vehicle (and all drivers having used that vehicle) be maintained on board the EOBR on each vehicle for a period of 6 months. This would provide an additional set of information that could be used to reconcile both the driver-oriented electronic RODS and vehicle-oriented electronic RODS during an audit or compliance review, and thus potentially improve the ability to detect possible tampering with either of the two sets of records.

- It is recommended that EOBRs utilize industry standard, non-propriety, portable storage media for transferring individual driver's HOS records between vehicles or to the main office. The HOS records may also be transferred via wireless data communications services, however, the responsibility still lies with the driver and the carrier organization to maintain and produce HOS records for roadside inspections and compliance reviews. For those systems that use portable storage media, consideration should be given to requiring that a spare backup storage device be available on-board the vehicle in case the storage media or device being used by the driver fails.

- HOS data must be periodically transferred off of the EOBR to permanent data storage (e.g., via media such as flash memory card, floppy disk, CD-RW[71], etc., or a wired connection (e.g., to a personal digital assistant (PDA), etc.) or a wireless connection (Bluetooth[72], 802.11[73], etc.) (see Appendix C for further information regarding the

---

[71] CD-RW (Compact Disc - ReWriteable) is an optical disc digital storage format which allows digital data to be erased and re-written many times. The technical and physical specifications for CD-RW are described in the document *Orange Book Part III: CD-RW*, published by Royal Philips Electronics.

[72] Bluetooth is a short range wireless data communications standard typically used to exchange information between electronic devices such personal digital assistants (PDAs), mobile phones, and portable laptop computers. The technical specifications for

relative advantages and disadvantages of various wired and wireless data communications standards). Therefore, data interchange standards would need to be considered (see Section 6.1.4 for further discussion regarding data interchange standards). Also, the EOBR system should indicate to the operator/driver that on-board storage is nearing capacity so as to prevent data from being lost.

- EOBRs should allow enforcement inspection officials to retrieve the HOS records for the current driver and co-driver.

- It is highly recommended that the HOS records contain the information related to the driver's HOS as currently required under 49 CFR § 395.8 and 49 CFR § 395.15.

- For the relevant data items, dates should be given as mm/dd/yyyy.

- It is recommended that the date and time (UTC hours, minutes and seconds) when each duty status change occurs be recorded by the EOBR. The total elapsed time in each duty status category can then be calculated from this information.

- It is recommended that the EOBR record vehicle miles driven, and that vehicle miles driven should be accurate to within some agreed upon tolerance level (e.g. +/- 5%) of actual vehicle miles driven (as certified according to procedures that will need to be developed by FMCSA).

4.3.4 Performance Benchmarks for Key Research Factor #4: Ability of Roadside Enforcement Personnel to Access HOS Information Quickly and Easily

Handwritten RODS

Daily logs enable roadside enforcement officials to easily review the driver's hours of service for the previous 24 hours. The roadside enforcement official is able to review the driver's off duty; sleeper berth; driving; and on-duty, not driving graph grid from the daily logs. Change of duty status is documented, as are the time and location of each change in duty status. To verify the driver's RODS, the enforcement official may request that the driver provide supporting documents to corroborate the events indicated on the graph grid. The roadside inspector may retain the original copy of the driver's RODS, thus requiring the driver to create a replica of the original in the truck/tractor.

---

the Bluetooth standard are described in the document *Bluetooth Specification Version 2.0 + EDR [vol 0]* available from the Bluetooth Special Interest Group (SIG).

[73] 802.11 is a set of communications and product compatibility standards for wireless local area networks (WLAN). The 802.11 standards are also known as WiFi by marketing convention. The 802.11 standard includes three amendments to the original standard, 802.11a, 802.11b and 802.11g. The technical specifications for 802.11a, 802.11b and 802.11g are published by IEEE (Institute of Electrical and Electronics Engineers).

AOBRD

Most states receive grants from FMCSA under the Motor Carrier Safety Assistance Program (MCSAP). As a condition of receiving these grants, states agree to adopt the FMCSRs, including the HOS rules, formally as state law. They also agree to enforce them. As a result, state enforcement inspectors at the roadside use the RODS to determine compliance with the HOS rules by both interstate and intrastate CMV drivers.

The AOBRD allows inspection officials to check the status of a driver's HOS upon request. The AOBRD must produce a driver's HOS chart, on an electronic display or via hard copy printout, showing time and sequence of duty status changes including the starting time at the beginning of each day. An instruction sheet describing how to retrieve the information from the unit must be available in the cab of the vehicle. The inspection official may use the AOBRD record, along with handwritten or printed records from the previous 7 days, to reconstruct the duty status history and determine whether the driver complies with HOS rules.

Though 49 CFR § 395.15 does not specify how information is displayed on screen, it does require that support systems comply with 49 CFR § 395.8(d) including the use of graph grid.

An AOBRD with an electronic display also has the capability to display the following information to roadside inspection officials:

- Driver's total hours of driving today
- The total hours of duty today
- Total miles driven today
- Total hours on duty for the 7 consecutive day period, including today
- Total hours on duty for the prior 8 consecutive day period, including today
- The sequential changes in duty status and the time the changes occurred for each driver using the device.

EOBR

- It is recommended that EOBRs provide data access to allow for the retrieval of stored HOS data by roadside enforcement personnel. It is recommended that EOBRs use a non-proprietary industry standard data access connector. In addition, the data connector should be clearly labeled as "EOBR Data Access" and made accessible to a person of average height so that the inspection official can reach the data connector without physically entering the cab or stepping on the vehicle's running board.

- The interface standard should be a common standard, such as serial RS-232[74], Universal Serial Bus (USB)[75], or IEEE 1394 FireWire[76] (see Appendix C for further information regarding the relative advantages and disadvantages of various wired data communications standards). Alternatively, if wireless capability is desired or deemed necessary, the EOBR may be equipped with short range Bluetooth or a wireless network interface (802.11 a/b/g) (see Appendix C for further information regarding the relative advantages and disadvantages of various wireless data communications standards). Developments in the intelligent transportation systems (ITS) field will also technologically support remote-access capability (Dedicated Short Range Communications (DSRC), for instance). As with the use of any wireless technology, it is necessary to safeguard access to the EOBR data and system-access passwords from potential electronic "eavesdroppers." The relative advantages and disadvantages of each of the above wired and wireless communications standards are discussed in more detail in Appendix C.

- A typical operating scenario might include a roadside inspector connecting to the EOBR with his data terminal device. Either the inspector or his/her terminal supplies the connected EOBR with the proper identification and system access codes. The on-board unit presents the inspector with a list of available logs for download or display. The inspector selects the needed files and downloads the relevant logs to his system. If necessary, the retrieved files are automatically decoded by the terminal before displaying the information to the inspector. The EOBR records the event and notes which files were viewed during the inspection.

- In order to facilitate the electronic transfer of records to roadside inspection personnel and compliance review personnel, and provide the ability of various third party and proprietary EOBR devices to be interoperable, a consistent electronic file format and record layout for the electronic RODS data to be recorded by EOBRs is recommended. As outlined in Module 1, Section 5 of the January 2003 *Hours of Service Research and Analysis Modules* report, there are 15 discrete HOS data elements, which are required by 49 CFR § 395.15, that must be recorded by the EOBR.[77] Using a common data standard will allow compatible software applications to automatically access, retrieve, analyze and display the HOS information for review, and will shorten the amount of time required for

[74] RS-232 is a standard for serial binary data interconnection. The technical specifications for the RS-232 standard are described in the document *Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange (ANSI/TIA-232-F-1997 (R2002)*, September 1, 1997, published by the Telecommunications Industry Association (TIA).

[75] USB (Universal Serial Bus) is a serial bus interface standard for connecting electronic devices. The technical and physical specifications for USB are described in the document *Universal Serial Bus Revision 2.0 Specification*, published by the USB Implementers Forum (USBIF), an industry standards body incorporating leading companies from the computer and electronics industries.

[76] IEEE 1394 is high-speed serial bus interface standard for connecting electronic devices. The IEEE 1394 standard is also known as FireWire or i.Link by marketing convention. The technical and physical standards for the IEEE 1394 standard are described in the document *1394-1995 IEEE Standard for a High Performance Serial Bus - Firewire*, published by IEEE (Institute of Electrical and Electronics Engineers).

[77] U.S. Department of Transportation, Federal Motor Carrier Safety Administration, Office of Business and Truck Standards and Operations. *Hours of Service (HOS) Research and Analysis Modules*. January 21, 2003. Page 27. URL <http://dmses.dot.gov/ docimages/pdf89/294137_web.pdf>

roadside inspections. Using a common data record structure will also allow various third-party software solutions to be used on, or in support of, any compliant EOBR, regardless of the particular manufacturer or model of the hardware and software used.[78]

Regardless of the particular electronic file type (e.g., ASCII, XML[79], etc.) ultimately utilized for recording the electronic RODS produced by an EOBR, it is envisioned that electronic RODS data could be recorded according to a "flat file" database model. A flat file is a simple database in which all information is stored in a plain text format with one database "record" per line. Each of these data records is divided into "fields" using delimiters (as in a comma-separate-values data file) or based on fixed column positions. This database model is referred to as "flat" as compared to more complex database models such as relational databases which contain multiple data tables that are related to one another via a series of one-to-many or many-to-one relationships among data fields contained in the each of the tables. Table 6 below presents the general concept of a flat data file consisting of data "fields" (columns) and data "records" (rows).

Table 6: Flat Data File Database Model

FIELDS →

RECORDS ↓

Person First Name	Person Last Name	Driver PIN	Event Date	Event Time	Status Code
William	Smith	978354	20050718	12:11	D
William	Smith	978354	20050718	15:17	SB
William	Smith	978354	20050718	18:53	D
William	Smith	978354	20050718	21:43	ON
William	Smith	978354	20050718	22:14	OFF
William	Smith	978354	20050719	06:25	ON
William	Smith	978354	20050719	06:47	D
William	Smith	978354	20050719	13:32	SB
William	Smith	978354	20050719	15:27	D
William	Smith	978354	20050719	20:04	SB

In the envisioned EOBR data file, individual data records are produced and recorded whenever there is either a change in driver duty status, a state border crossing, an EOBR diagnostic event (such as power-on/off, self test, etc.), or when one or more data fields of

[78] For older ABORDs and EOBRs already in use as of a certain date (e.g., the date of any final rule that may mandate use of EOBRs or allow the use of EOBRS), these older units could be "grandfathered" such that if they utilize a proprietary data file format that is non-compliant with any new regulation for EOBRs, they could comply with the regulation by simply having the electronic RODS available for visual inspection (e.g., on a video screen or a hard copy print out) at the time of a roadside inspection or compliance review.

[79] XML (Extensible Markup Language) is a flexible nonproprietary set of standards for annotating or "tagging" information so as to include information about its conceptual structure. The primary purpose of XML is to facilitate the sharing of data across different computer systems. The technical specifications for XML are described in the document *Extensible Markup Language (XML) 1.0 (Third Edition)*, published by the World Wide Web Consortium (W3C).

an existing data record are later corrected or edited (in which case the corrected record is recorded and noted as "current" in the "Event Status Code" data field, however the original record is also maintained in its unedited form and is noted as "historical" in the "Event Status Code" data field).

Though this is conceptually different from the current method of recording of information on handwritten RODS in a graph grid format, the essential data elements necessary to construct a graph grid representation of the RODS data (e.g., using software such as ASPEN or CAPRI to conduct a roadside inspection or compliance review, respectively, or using the software on-board the CMV on the EOBR device so that a driver could view his own records) would be present in the EOBR data file.

4.3.5 Performance Benchmarks for Key Research Factor #5: Level of Protection for Personal, Operational, or Proprietary Information

Handwritten RODS

The current regulations do not provide any level of protection from unauthorized access for personal, operational, or proprietary information recorded to handwritten RODS. Drivers and carriers may regard the hours of duty status to be highly sensitive and must maintain strict physical control of this data.

AOBRD

FMCSA offers respondents no assurances of confidentiality. The Freedom of Information Act (FOIA) (5 U.S.C. § 552) requires agencies to release information upon request unless it falls into one of nine categories not subject to the statute [5 U.S.C. § 552(b)(l)-(9)]. The data to be submitted under this information collection is not covered by any of the FOIA exceptions. RODS are releasable as an Exhibit Abstract in connection with an enforcement case that has been closed.

This information collection does not involve any sensitive information.

The current regulations do not provide provisions to ensure that personal, operational, or proprietary information are protected from unauthorized access.

EOBR

- It is recommended that EOBR records be accessible only to authorized government officials and members of the carrier organization. A data access protection scheme may be implemented so that viewing or downloading HOS records will require a password. The act of entering the driver's data access password may be used as substitute for his signature, certifying that his electronic HOS records are true and correct.

- It is recommended that EOBRs record the date and time of any data retrieval or any attempt of data retrieval.

- Any EOBR data collected by the Government is subject to FOIA and may be available to any entity or the general public. RODS are releasable as an Exhibit Abstract in connection with an enforcement case that has been closed.

- Passwords, access codes or smart cards can be required to allow access to personal, operational and proprietary information on the EOBR. Data encryption methods, as discussed earlier regarding electronic tamper resistance, also may be able to protect the information from being read by unauthorized personnel.

- EOBRs should have two independent major data storage areas:

    - One area would record and store the information of interest to FMCSA, such as the RODS to be accessed by roadside enforcement personnel. FMCSA offers respondents no assurances of confidentiality. FOIA (5 U.S.C. § 552) requires agencies to release information upon request unless it falls into one of nine categories not subject to the statute [5 U.S.C. § 552(b)(l)-(9)]. The data to be submitted under this information collection is not covered by any of the FOIA exceptions. RODS are releasable as an Exhibit Abstract in connection with an enforcement case that has been closed.

      This information collection does not involve any sensitive information.

    - A second data storage area could be reserved for proprietary data accessible only to motor carriers.

4.3.6 Performance Benchmarks for Key Research Factor #6: Cost

Handwritten RODS

Costs associated with maintaining handwritten RODS include the actual purchasing or printing of the blank daily logs, the driver updating and maintaining RODS, and the carrier maintaining the records. The cost of the actual purchasing or printing of the blank daily logs is estimated at $15 per year per driver, which equates to a total of $63.3 million annually for the industry.[80] The number of hours required by CMV drivers to fill out handwritten RODS is estimated at 26 hours per year per driver, which equates to a total of 109.7 million hours annually for the industry.[81] The number of hours required by motor carriers to review and retain handwritten RODS is estimated at 12 hours per year per driver, which equates to a total of 50.6 million hours annually for the industry.[82]

[80] *Supporting Statement, Hours of Service of Drivers Regulations*. Information Collection Budget Supporting Statement for 49 CFR § 395. Section 13. December 21, 2004.
[81] *Supporting Statement, Hours of Service of Drivers Regulations*. Information Collection Budget Supporting Statement for 49 CFR § 395. Section 12. December 21, 2004.
[82] *Supporting Statement, Hours of Service of Drivers Regulations*. Information Collection Budget Supporting Statement for 49 CFR § 395. Section 12. December 21, 2004.

AOBRD

FMCSA estimates that if AOBRDs were employed there would be a reduction in the time required to prepare, file and store RODS of as much as 90% as compared with the time involved in preparing, filing, and storing handwritten paper records. Cost savings would be reflected in the time saved.

EOBR

- The perceived value of the EOBR will determine the price threshold that drivers or fleet owners may deem cost prohibitive. Similar to driver acceptability, if the use of EOBR automates the burden of record keeping and helps streamline operations or increase productivity, then owners will be more willing to pay a higher price. If, on the other hand, the device is seen only as a monitoring tool for law enforcement purposes, then owners will be less willing to pay a higher price.

- Current technology and use of commercial-off-the-shelf (COTS) hardware / software components could lead to sufficient capabilities and decreased unit costs if widespread adoption of EOBRs occurs.

- EOBRs may be considered costly both to purchase and to operate. Estimates of installed costs per unit range from approximately $500 for hardware supplied to an original equipment manufacturer (OEM) for installation in a new vehicle, to $3,000 for installation of a retrofit unit in an in-service CMV.[83] These cost estimates generally do not include back-office systems for data tracking, verification, and information management, or training for drivers and others. However, these cost estimates represent costs as of early 2005, and do not account for potential reductions in per unit costs that may result from large volume production resulting from the potential for widespread adoption of EOBRs throughout the motor carrier industry. Also, the capabilities and functions of current EOBRs typically far exceed those of older AOBRDs of the type that 49 CFR § 395.15 was originally meant to address.

4.3.7 Performance Benchmarks for Key Research Factor #7: Driver Acceptability

Handwritten RODS

49 CFR § 395.8 mandates that all drivers maintain and record their hours of duty status

AOBRD

49 CFR § 395.15 allows drivers to maintain and record their hours of duty status more accurately, particularly with respect to driving time, with on-board recorders.

---

[83] Federal Register, Volume 69, Number 169. *Electronic On-Board Recorders for Hours of Service Compliance. Advance notice of proposed rulemaking; request for comments*. September 1, 2004. Page 53395.

Data is more readily available to motor carriers to improve their operations and scheduling.

Use of AOBRDs serves as a reminder to motor carriers and drivers that compliance with the HOS regulations is serious.

Use of AOBRDs reduces the time involved in preparing, filing, and storing handwritten paper records.

Training might be an issue for drivers in terms of the time required and their familiarity with the use of technology.

EOBR

- It is recommended that EOBRs provide a means for the driver to examine their own HOS records. The data presented to the driver for review should include all relevant HOS information currently required under 49 CFR § 395.8 and 49 CFR § 395.15.

- It is recommended that EOBRs alert the driver with sufficient advance notice (e.g., a minimum of 1 hour, with a greater advance notice allowable depending upon carrier operating characteristics, etc.) prior to reaching his maximum HOS compliance time limits in order to allow the driver sufficient time to drive to a suitable location to obtain rest prior to being in violation of HOS limits.

- To gain driver acceptance, information recorded using EOBRs should be used only for HOS compliance assurance purposes, and not for the assessment of speeding penalties or other disciplinary actions not related to HOS compliance.

- In some cases, AOBRDs are used to facilitate the downloading of accident event data from truck ECMs to aid in accident reconstruction and court cases, particular when fatalities are involved. Although both event data recording and HOS recording may rely on data from the vehicle ECM, both should be treated as separate issues. Combining these issues together may serve to inhibit adoption of regulations allowing or mandating the use of EOBRs, since motor carriers and drivers might then associate use of EOBRs with accident event data recording, when they should only be associated with hours of service recording.

- EOBRs should be easy to use for drivers, and present minimal or no additional workload to the driver as compared to the current use of handwritten RODS. Use of EOBRs may potentially reduce workload for drivers. System operation should be intuitive and unobtrusive.

- If possible, EOBRs should have the ability to interface with optional vehicle navigation systems which would, for example, be able to provide routing and real-time vehicle location information to the driver for carriers that choose to provide such an optional add-on capability. These types of capabilities are sometimes used by carriers as a benefit in order to help retain drivers. The ability to provide such an optional add-on capability if so desired could assist the driver in finding the most efficient route and updating estimated time-of-arrival information.

- If EOBRs include communications capabilities, then incorporation of a safety or alarm system should be considered. For example, an “emergency button” or silent alarm that sends out a signal when a driver or truck is in trouble, is being hijacked, or has been in a serious accident, could alert a dispatch center and law enforcement of the incident and the location of the truck. This security feature could also be used in the effort to seek wider driver acceptance.

- Potential safety benefits to the driver should be highlighted. For example, it is recommended that EOBRs alert the driver with sufficient advance notice (e.g., a minimum of 1 hour, with a greater advance notice allowable depending upon carrier operating characteristics, etc.) prior to reaching his maximum HOS compliance time limits in order to allow the driver sufficient time to drive to a suitable location to obtain rest prior to being in violation of HOS limits.

- Benefits to carriers, and therefore perhaps indirectly to drivers, should be highlighted. For example, the increased amount of data more readily available to motor carriers could be used to improve their operations and their scheduling of drivers.

- Benefits resulting from reduced time involved in preparing, filing, and storing handwritten paper records should be highlighted. Since RODS record keeping by drivers will be largely automated with the use of EOBRs, time formerly spent on retrieving and manually filling out the driver’s daily log would be available for other on-duty activities or to increase off-duty time.

- Training might be an issue for drivers in terms of the time required and their familiarity with the use of technology. For example, some evidence suggests that younger drivers perceive the technology aspects of on-board recorders more favorably than older drivers, perhaps because younger drivers – who may be less financially well off than their more senior peers – recognize that the on-board recorders might be advantageous for drivers seeking to maximize their driving time and therefore their compensation This differential impact upon driver acceptability based on age should be evaluated as part of any future field operational tests of EOBRs.

Section 5: Assessment of EOBR Classes

Based on review of the January 2003 report *HOS Research and Analysis Modules* and other available research and literature, an initial classification of EOBR systems and technologies has been developed for analysis purposes. The classes are defined according to complexity and functionality available in the device, with a definition presented for each.

5.1 Identify Classes of EOBRs

As part of the assessment approach noted earlier in Section 4.1, a range of "levels" or classes of EOBR methods and technologies for accomplishing the necessary functions of an EOBR system were developed. These classes encompass a wide range of approaches and technologies, and are simply meant to be *illustrative* of the possible range of available or near-term technologies that could satisfy the proposed EOBR performance benchmarks. Despite the fact that a more advanced level of technology may be presented as one of the higher level technology classes for a specific technology area (i.e., vehicle location), this is not meant to suggest that use of these more advanced technological approaches will necessarily be required to ultimately satisfy the proposed benchmarks for an EOBR system. Rather, in Section 5.2, the various levels of technology for a given area are screened through comparison with the proposed EOBR performance benchmarks. The specific level for a given technology area that is thought to be minimally compliant in satisfying the proposed benchmark is then selected as that which is most illustrative of an element of an EOBR system that would satisfy (but not exceed) the proposed EOBR performance benchmarks.

The range of technology levels or classes for accomplishing the necessary functions of an EOBR system are presented below, with each key research factor and related technology area discussed in turn.

5.1.1 Key Research Factor #1: Identify the individual driver

Classes of EOBR Methods & Technologies for Driver Identification

A variety of potential methods and technologies are available for use in identifying the individual driver in an EOBR system. These range from simple manual input of basic identification information, to identification cards that facilitate input of identification information, to identification cards combined with forms of authentication and verification, such as login authentication to relatively advanced biometric identification verification techniques.

A practical issue with the use of identification cards and smart cards is that they tend to warp over time from being carried in wallets, making insertion into card readers problematic in some cases. As an alternative, a contactless card and reader arrangement could be utilized.

Any use of biometric hardware in the cab of the truck should be designed so as to be suitable for a rugged environment and to be as unobtrusive as possible with regard to the ergonomic design and layout of the cab. In some cases, drivers have indicated their interest in the use of biometric information as an alternative to CDLs and other credentials that utilize personal information such as home addresses and social security numbers.[84] On the other hand, driver authentication with user name and password login is currently more widely used than are biometric verification systems, and field operational tests have shown that some drivers are more familiar with, and prefer the use of, a username and password login to the use of biometric verification. Also, field operational tests have shown that biometric systems are often subject to more frequent technical problems than simpler verification systems using login authentication.

Technology Class #1(a): Manual Data Entry

The driver (and co-driver if present) manually input driver identification information (such as last name of driver, first name of driver, middle initial of driver, name of motor carrier, address of motor carrier home office) with a keyboard or other input device (e.g., LCD touch screen display). This information could automatically carry over from the records for one day to the next day if there has been no change in driver, tractor or trailer, shipping documents, etc. The information regarding the name of the motor carrier and the motor carrier home office could be pre-loaded and resident on the truck itself, and not require manual input by the driver.

Technology Class #1(b): Manual Data Entry with Login Authentication

This is the equivalent of Technology Class #1(a) above, with the addition of the driver being required to enter both a username and a password or personal identification number (PIN) to successfully verify and authenticate their identity to the EOBR system.

Technology Class #2(a): Basic Smart Card Identification Card

A basic identification card (magnetic stripe or optical) pre-loaded with personal identification information including: last name of driver, first name of driver, middle initial of driver, name of motor carrier, address of motor carrier home office. To accommodate the identification of the driver, the EOBR would have to incorporate a compatible card reader. Smart Cards can incorporate significant storage capacity for data at reasonable cost, and can be based on variety of standards such as the Multi Media Card (MMC) standard, Secure Digital (SD) standard, and CompactFlash (CF) standard. For example, CompactFlash cards with 256MB capacity can be purchased for approximately $30, and those with 1GB capacity can be purchased for approximately $90. Far greater data storage capacities of 8GB and greater are available, though at significant cost.

[84] Williams, D., et. al. *Hazmat Safety & Security Field Operational Test. Final Report*. August 31, 2004. Document approved for public disclosure. Prepared by Battelle, in association with Qualcomm, the American Transportation Research Institute, the Commercial Vehicle Safety Alliance, and the Spill Center, for the U.S. DOT, Federal Motor Carrier Safety Administration. Page 63.

Technology Class #2(b): Basic Smart Card Identification Card with Login Authentication

This is the equivalent of Technology Class #2(a) above, with the addition of the driver (and co-driver if applicable) being required to enter both a username and a password or PIN to successfully verify and authenticate their identity to the EOBR system.

Technology Class #3: Biometric Smart Card Identification Card

A higher storage capacity identification card (smart card) pre-loaded with personal identification information including: last name of driver, first name of driver, middle initial of driver, name of motor carrier, address of motor carrier home office. To accommodate the identification of the driver, the EOBR would have to incorporate a compatible card reader. Instead of using login authentication with a username and password to verify the driver identification, authentication of driver identification is accomplished with biometric verification techniques (e.g., finger print, facial recognition, iris scan). The selected biometric data are stored on the smart card. Verification of the driver's identity is accomplished by then comparing the biometric data stored on the card to the biometric data obtained from the driver via a fingerprint scanner or other biometric device. This is similar to approaches being proposed under the Transportation Work Identification Credential (TWIC) program by the U.S. Department of Homeland Security, Transportation Security Administration.[85]

Technology Class #4: Two-Factor Identification

This is the equivalent of Technology Class #3 above, with the addition of the driver being required to enter both a username and a password or PIN to further verify and authenticate their identity to the EOBR system in addition to use of biometric identification. For even stronger authentication, the password can be generated using a one-time password (OTP) "token," which is typically some type of smart card, a USB flash memory device ("thumb drive") or similar hardware device that often also incorporates a small, integrated LCD screen so that one-time passwords can still be used to login even on systems where a compatible card reader or USB port may not be available.

Technology Class #5: Two-Factor Identification with Remote Verification

This is the equivalent of Technology Class #4 above, with the addition of remote verification of identification in addition to local (on the truck) verification. This would require a wireless communication system capable of communicating with the main dispatching office of the motor carrier in order to confirm user supplied login authentication or biometric information.

---

[85] The TWIC program, overseen by the U.S. Department of Homeland Security, Transportation Security Administration, has as its primary goal the development of a secure, uniform and system-wide common credential for all transportation modes to prevent potential terrorist threats from entering sensitive areas of the transportation system. The TWIC is being designed as a tamper-resistant credential that contains biometric information about the holder which renders the card useless to anyone other than the rightful owner. Using this biometric information, each transportation facility can positively authenticate and verify the identity of a worker and help prevent unauthorized individuals from accessing secure areas, while still allowing access by authorized personnel requiring unescorted physical and/or electronic access to secure areas of the national transportation system. The use of TWIC as a standard for driver identification for EOBR applications is not recommended at this time, since this would essentially result in a technical standard for driver identification for EOBR applications, rather than a performance-oriented standard. In addition, the performance standards for EOBRs would then be dependent upon DHS TWIC standards.

5.1.2 Key Research Factor #2: Tamper Resistance

Classes of EOBR Methods & Technologies for Electronic Tamper Resistance

Information stored internal to the EOBR is safe from tampering, e.g., EOBR internal operating system, software routines and file system are locked from the users. Access to data stored within the device must be under EOBR program control.

The individual driver's RODS information is transferred from the EOBR to a portable storage media, such as a smart card, flash memory card, CD-ROM, magnetic media, etc. The portable media will serve as a "temporary" data storage device until the RODS information can be transferred to another vehicle's EOBR or to the carrier's main office for archival and compliance review purposes.

Technology Class #1: RODS Data Storage using Standard Text Files

In this approach, the HOS information is stored on the portable device using un-encrypted standard text (ASCII) file format. This approach does not offer any protection against data tampering once the information is stored on the portable data storage device. The information can be altered on a PC with a simple text editor.

Data tampering can be detected if the information from the driver's portable storage device is compared with the reconstructed logs directly off-loaded from the vehicles that the driver has driven. Inconsistencies between the two logs can be easily detected and flagged for further investigation. This approach requires not only the RODS data from the driver's portable storage device, but also records downloaded directly and separately from the EOBR in order to combine and recreate the driver's RODS for comparison purposes.

American Standard Code for Information Interchange (ASCII) is the de facto world-wide standard for the code numbers used by computers to represent all the upper and lower-case Latin letters, numbers, punctuation, etc. There are 128 standard ASCII codes each of which can be represented by a 7 digit binary number: 0000000 through 1111111, plus parity.

Technology Class #2: RODS Data Storage using Binary Format

Data stored on the portable media is not encrypted. However, unlike a standard ASCII or a plain text file, the data is written in binary such that it is unintelligible to someone who is using a text editor to attempt to view or edit the log file. This approach offers an improved level of data tampering protection, as the non-text based record structure prevents the "casual" user from easily altering the information using a PC with a text editor. Binary data storage, coupled with comparison between EOBR and driver RODS logs, as discussed previously in Class #1, should enhance the detectability of tampered records.

Storing information in binary is the most efficient in terms of storage space, as the information is essentially compressed. For example, storing a "yes" or "no" condition in ASCII would require at least one character or 8-bits. However, the same information can be stored in binary using only 1 bit, the 0 or 1 state. This leaves the remaining seven bits for storage of other information.

Technology Class #3: RODS Data Storage using Secured Media

Smart cards with data access security features can be implemented to prevent the user from directly tampering with the data stored on the card. In this approach, the storage device will only allow access to its internal storage area or data files if the proper password is provided. The storage device may also have separate access codes for read, write and other administrative functions. It is recommended that EOBRs have access file rights for creating, writing, reading, and deleting in order to transfer the RODS information and perform routine file system maintenance. The EOBR operating system must also ensure that system users (drivers) do not have direct access control over the many systems functions relating to file modification. Access to file manipulation routines must be under EOBR program control at all times.

Technology Class #4: RODS Data Storage using Encryption

In this approach, the data stored in the portable media is encrypted using encryption algorithms such as Data Encryption Standard (DES) or Advanced Encryption Standard (AES). The EOBR encrypts the RODS data. The encryption can be performed on-the-fly as the data is stored internally in the EOBR. Alternatively, the encryption process can take place at the time the RODS data is transferred from the EOBR to the temporary storage media. Digital Signature Standards can also be used to ensure that the data source can be identified and authenticated.

Technology Class #5: Encryption using Public Key Infrastructure (PKI)

To ensure maximum data security using the PKI approach, the public key used by the EOBR to encrypt the data should be renewed periodically to maintain maximum security. In this approach, the EOBR stores two logs for each driver - encrypted and plain text files. Depending on the final design, these files can be stored internally and then "copied" to the portable media, or the two files can be generated during data transfer. The private key for decrypting the data is known only to the enforcement or compliance review officials. The public key used for encryption can be periodically changed during the annual state safety inspection for trucks, or more frequently via automatic download to the EOBR using the vehicle's wireless communications service.

Classes of EOBR Methods & Technologies for Physical Tamper Resistance

Consideration should be given to the establishment of regulatory and legal measures that would institute punitive measures such as fines or imprisonment for unauthorized tampering with or alteration of EOBR equipment.

Technology Class #1: Use of Non-Standard Fasteners

This approach would include the use of rivets, one-way screws, etc., to minimize the ease with which internal components could be accessed.

Technology Class #2: Use of Protective Internal Coatings

This approach is the equivalent of Technology Class #1, with the addition of a hard epoxy or flexible resin compound being applied to all internal components (circuit boards, etc.) to inhibit physical access to these components even if the enclosure or case is opened. It should also be noted that a byproduct of the continued miniaturization of many components and circuit boards in most electronic equipment today is that physical alteration of components that require soldering or physical manipulation has become increasingly more difficult.

Technology Class #3: Use of Tamper-Evident Seals on Connectors

This approach is the equivalent of Technology Class #2 above, with the addition of connections between components being made with tamper-evident seals in place (if seal if broken, this indicates evidence of physical tampering with the connector or connection).

Technology Class #4: Use of "Self-Destructive" Components

This approach would utilize "self-destructive" (e.g., photo sensitive) components to disable EOBR operation when component enclosures are physically opened.

Technology Class #5: Use of Electronic Codes to Prevent Component Replacement

This approach would utilize electronic codes in each major component of the EOBR system, such that no individual component could be replaced with a non-compliant or altered component that did not have the correct code. This would be similar to anti-theft codes that are sometimes utilized in passenger vehicle audio systems.

5.1.3 Key Research Factor #3: Ability to produce records for audit and compliance review

Classes of EOBR Methods & Technologies for Vehicle Location

An important factor in the electronic recording of hours of service data is determining the location of the vehicle at a given time, ideally independent of operator input. In the past, an operator with reference to a map could estimate his position in such a manner as "15 miles north of Baltimore on I-95," for example. Without an independent, accurate indication of location, the accuracy of duty status records can sometimes be called into in question.

With the advent of GPS satellite navigation and the terrestrial cellular wireless telephone system, electronic measurement of position has became an increasingly practical possibility. In addition, technology developments have made the cost of GPS receivers, cell phones, and other related electronic equipment increasingly affordable. Though Loran-C is another type of radionavigation system utilized for position determination with an accuracy generally to within 1,500 feet, it is used primarily in marine transportation. Because of the limited availability of suitable receivers and uncertainty over the future maintenance and availability of the Loran-C system, the use of Loran-C for EOBR applications is not recommended.

With GPS, except in areas where there is signal blockage such as in tunnels, some valleys, and in city areas where tall buildings can cause an "urban canyon" effect, a location accuracy of approximately 45 feet can be achieved with the Standard Positioning Service (SPS) signal that is available to all users. While location measurement by GPS is by far the predominant approach, measurement of location with the terrestrial cellular telephone system, while not as accurate as GPS, is also possible. If the vehicle is within range of three or more cellular towers, then a position determination can be made with an accuracy of approximately several hundred feet. However, it should be noted that most cellular systems have converted or are in the process of converting to use of a GPS chip built into cell phone handsets themselves to determine position. Federal Communications Commission (FCC) wireless Enhanced 911 (E911) rules seek to provide 911 dispatchers with additional location-based information on wireless 911 calls. The wireless E911 program is divided into Phase I and Phase II. Phase I requires wireless carriers, upon appropriate request by public safety officials, to report both the telephone number of a wireless 911 caller and the location of the specific antenna that received the call (i.e., the location of the "cell of origin" (COO)). Phase II requires wireless carriers to provide more precise location information, within 50 to 300 meters in most cases. The FCC established a four-year rollout schedule for Phase II, beginning October 1, 2001 and to be completed by December 31, 2005, however the FCC does grant limited waivers of the Phase II rules to certain wireless carriers on a case-by-case basis. Finally, other terrestrial approaches to supplementing satellite based navigation are also currently being developed. For example, in one approach currently under development, television signals in metropolitan areas are combined with GPS signals to provide seamless location determination in dense urban areas, even indoors, where standard GPS signals are usually blocked or unreliable.[86]

What follows are broad descriptions of classes of methods and technologies for determining vehicle location for an EOBR system. To facilitate comparisons, the most basic approach,

[86] For example, for additional information regarding a system called "TV-GPS" that is currently under development, see http://www.rosum.com/.

Technology Class #1, corresponds to the manual insertion of location information by the operator. Technology Classes 2, 3, 4(a) and 4(b) represent increasingly more sophisticated, accurate and automated determination of location for EOBR systems.

Technology Class #1: Manual Data Entry

This technology class is represented by older vehicles with no supplementary engine status (e.g., ECM or TCM) or vehicle location equipment. The approach is simply to determine location manually by identifying distance (from odometer reading) from a nearby town or city, and a direction relative to that nearest city by referring to a map. A location identity code (FIPS codes for populated places, etc.) that is either looked up manually from a handbook, or selected from a standardized list of locations provided by the EOBR system, can then be manually entered by the driver into the electronic log using a keyboard or other input device.

Technology Class #2(a): Manual Data Entry Augmented by Electromechanical Data

This approach is represented by older vehicles equipped with an elementary electromechanical linkage to the CMV speedometer, odometer and tailshaft assemblies to provide engine status and mileage readings. This information is used to verify distance traveled information. Location derived from odometer mileage from the ECM supplemented by operator input.

Technology Class #2(b): Manual Data Entry Augmented by ECM Data

This is approach is represented by more recent vehicles equipped with an ECM with an electronic linkage to the engine and transmission. Information provided includes engine on/off, status of vehicle movement, date and time, and mileage driven, which is used to verify distance traveled information. The derived location supplemented by operator input is automatically recorded. The operator input through a keypad or similar device is to document duty status during vehicle not moving and engine off times.

Technology Class #3: Network-Based Terrestrial Cellular Methods

In this approach, location is measured using the terrestrial cellular telephone system using techniques such as (in order of increasing positional accuracy) Cell of Origin (COO), Time of Arrival (TOA) or GPS in the case of GPS-enabled cellular telephone handsets. For COO positioning, the location of the particular cell in use is used as a proxy for the location of the caller. COO is relatively inaccurate, and depending on the number or density of cellular base stations in an area, accuracy may be as close as within one hundred meters or as far off as thirty kilometers where base stations are less densely concentrated. If the vehicle is within range of three or more cellular towers, then a more accurate position determination can be made using TOA, with an accuracy of approximately several hundred feet often being attainable. Finally, GPS-enabled cellular telephone handsets utilize a GPS chip built into the handsets to determine position. Use of GPS is discussed further under Technology Class #4 below.

Technology Class #4(a): ECM Integrated with a Positioning System

This approach represents vehicles equipped with both a current ECM and a positioning determination system (most likely based on a GNSS such as the GPS system). The ECM and positioning determination equipment are linked to a CPU, and location information derived from the ECM and positioning determination equipment and an associated processor is automatically recorded. The ECM is utilized to determine mileage driven, vehicle movement status and engine on/off data. The positioning determination equipment, besides providing a crosscheck on mileage and location, is also used for time and date data. Many systems in this category also have associated communications capability (satellite-based or terrestrial cellular phone based) to allow carrier tracking of vehicles and to remotely monitor vehicle and operator or vehicle performance such as speed, fuel consumption, maintenance status of the vehicle, unscheduled stops and deviations from planned routes. Communications are also used by some carriers to facilitate the preparation of back-end records.

Technology Class #4(b): ECM Integrated with an Enhanced Positioning System (e.g., DGPS & Gyroscope)

This approach is the equivalent of Technology Class #4(a) above, with the addition of the use of an enhanced positioning systems (such as differential GPS) in combination with a low cost gyroscope for enhanced positional accuracy. The use of a low cost gyroscope would allow the use of dead reckoning (DR) to estimate position when a satellite-based navigation signal is not available. Differential satellite-based navigation systems enhance standard satellite navigation through the use of differential corrections to the basic satellite measurements. This is achieved through accurate knowledge of the geographic location of one or more reference stations, which is used to compute corrections to satellite ranging measurements and resultant positions. These differential corrections are then transmitted to users, whose equipment can apply the corrections to their received satellite navigation signals and compute a more accurate position. For example, for a civil user of the SPS component of GPS, differential corrections can improve navigation accuracy to approximately 23 feet.

Technology Class #5: Portable EOBR without Integration with ECM

This approach represents the use of an EOBR that is a portable or personal device that is *not* physically attached to the vehicle and does not utilize information from the vehicle ECM to measure vehicle miles traveled information and vehicle position information. Though "on-board" is often interpreted to mean a device that is physically attached to a CMV, this may not necessarily have to be the case. A portable EOBR unit could incorporate an inexpensive solid-state gyroscope built in, as well as an accelerometer[87] built in, so that sufficiently accurate position information (and therefore distance traveled information) could be estimated by means

[87] A gyroscope only provides data related to heading or direction. Data regarding speed and movement requires the use of an accelerometer in addition to a gyroscope. In combination, gyroscopes and accelerometers form an inertial navigation system that estimates position based on changes from a known position (in this case, the last known GPS-derived position).

of DR during times when satellite or terrestrial navigation signals were unavailable (e.g., in tunnels, some valleys, city areas where tall buildings cause an "urban canyon" effect, etc.). These times are likely to be limited (this could be determined in practice during a field operational test), so that a relatively inexpensive gyroscope and accelerometer might be sufficient to provide adequate positional accuracy. Such a device would, however, require a sufficiently robust external antenna if GPS is used (the portable EOBR unit could be placed into a vehicle-mounted "cradle" which in turn is wired into an external antenna, etc.).

A portable EOBR *could* also be connected to the ECM port in the vehicle, but this wouldn't necessarily be *required* - it could be recommended in order to provide an additional layer of validation to the miles traveled information, but a satellite-based or terrestrial-based position determination systems augmented by a solid state gyroscope and accelerometer built into the portable EOBR unit could possibly be considered sufficient, though this would require further study to confirm. The concept of a portable EOBR device was noted by the California Trucking Association (CTA) in the April 28, 2003 HOS final rule, where they suggested that the option of "personal technology devices" be considered along with EOBRs installed in the vehicle.[88]

The potential benefits of a portable EOBR device of this type would likely include that it is a "driver centric" approach, similar to current handwritten RODS, and may be more acceptable to drivers in that its "concept of operation" could be generally similar to current handwritten RODS. Such devices would likely be able to accommodate multi-driver situations in a more straightforward manner with each driver simply having their own portable EOBR unit and no need for a vehicle-based EOBR to accommodate more than one driver ID card or data storage card. If a portable EOBR fails or has maintenance problems, the CMV tractor does not have to be taken out of service in order to fix the problem - since the EOBR is portable and driver based, the driver could simply utilize another portable EOBR unit. Though on a per unit basis, such an approach may be more expensive due to the requirements for a device with a small form factor and portability, the use of an accelerometer and gyroscope built into the device, and the need for the unit to be sufficiently ruggedized for the CMV operational environment, potential operational benefits such as that noted above may provide cost savings to offset this to some extent. For roadside enforcement, the portable unit could be physically handed to enforcement personnel who could then either visually inspect the electronic RODS, or take the portable unit back to their vehicle to download into ASPEN or other software.

Potential disadvantages of a portable EOBR device are that only one source of "distance traveled" information would be available since there would be no requirement for the vehicle ECM to provide an independent source of vehicle miles traveled data. Also, as noted above, on a per unit basis it may potentially be a more expensive option. A portable device may have a higher risk of theft or loss due to its portability. Finally, portable devices may potentially be somewhat more susceptible to tampering, particularly electronic tampering, if the devices utilize a common operating system such as Windows CE, Palm OS, etc.

Classes of EOBR Methods & Technologies to Record Duty Status

---

[88] Federal Register, Volume 68, Number 81. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Final Rule*. April 28, 2003. Page 22486.

As noted in the experience with the Werner Enterprises electronic logging system, accurate recording of driver duty status will require that drivers continue to be required to explicitly record data regarding change of duty status. Automation of this function in order to minimize driver input to the system would be likely to result in inaccurate recording of driver duty status due to the subtleties of distinguishing between the three possible conditions of non-driving duty status, exceptions under 49 CFR § 395.8 in which the use of an unladen CMV for personal reasons may be considered off-duty time despite the fact that the vehicle is moving, and issues related to attempting to estimate duty status based on average speeds, especially while operating in urban areas where traffic congestion may be present.

A key function of an EOBR system will be to record when the operator is in each of the following duty status categories:

- Off Duty
- Sleeper Berth
- Driving
- On Duty (Not Driving)

Currently, RODS are maintained by the driver as a series of handwritten entries into a paper or hard copy form.

The advent of monitoring engine performance through ECMs has allowed an independent means of determining and recording some aspects of operator duty status. When the truck is not moving, operator input is required to determine whether the operator is on or off duty, and what the operator is doing during the non-movement periods.

What follows are broad descriptions of general classes of differing approaches to document duty status for an EOBR. To facilitate comparisons, the most basic approach, Level 1, corresponds to the manual insertion of duty status information by the operator into the duty status record. Levels 2, 3 and 4 represent increasingly more sophisticated and verifiable determination of duty status for EOBR records. There is a direct linkage of levels with the age of the vehicles involved – the most basic level, Level 1, corresponding to the oldest vehicles in the fleet, and the highest level, Level 4, with the newest vehicles in the fleet.

Technology Class #1: Manual Data Entry

This approach is represented by older vehicles with no supplementary engine status or location equipment. The operator manually enters duty status into the recording device via a keyboard or similar device.

Technology Class #2(a): Manual Data Entry with Verification by Electromechanical Data

This approach is represented by older vehicles equipped with an elementary electromechanical linkage to the CMV speedometer, odometer and tailshaft assemblies to provide engine status information and mileage readings. On-duty status declared by engine-on status and vehicle movement is automatically recorded. This information is supplemented by operator input via keypad or similar device. Off-duty information is manually entered via keyboard or keypad.

Technology Class #2(b): Manual Data Entry with Verification by ECM Data

This approach is represented by more recent vehicles equipped with an ECM with an electronic linkage to the engine and transmission. Information provided includes engine on/off, status of vehicle movement, date and time, and mileage driven. The derived duty status information supplemented by operator input is automatically recorded. Operator input through a keypad or similar device is used to document duty status during vehicle not moving and engine off times.

Technology Class #3: Manual Data Entry with Verification by ECM Data and Positioning System

This approach is represented by most recent vehicles equipped with both current ECM and GPS modules. In such an arrangement, the ECM and positioning system are electronically linked to a CPU. Duty information derived from the ECM and positioning system and associated processor is automatically recorded. The ECM is utilized to determine mileage driven, vehicle movement status and engine on/off data. The positioning system, besides providing a crosscheck on mileage and location, is also used for time and date data. Operator input through a keypad or similar device is still needed to document duty status during vehicle non-movement and engine off times.

5.1.4 Key Research Factor #4: Ability of roadside enforcement personnel to access hours of service information quickly and easily

Classes of EOBR Methods & Technologies for Providing Access by Roadside Enforcement Personnel to HOS Information

The EOBR records on duty status are produced and stored aboard the truck. Roadside inspectors need to access the duty status records to determine compliance with HOS regulations. Record inspection is best conducted without the need for physically entering the truck cab. The records must include information such as the operator's RODS on the current trip, mileage driven today, time and location of state border crossings, and RODS over the last 7 days.

At this time there are three main alternative approaches to access these records. These approaches, which all require that the truck be stopped, and that access to HOS records be requested from the driver, are outlined below.

Technology Class #1: Hardcopy Output

In this approach, the EOBR is tied to a printer aboard the truck. The printer can be part of the EOBR assembly, or it can be a separate unit. Upon a request from a roadside inspector, the driver arranges for a hard copy of the duty records to be printed. The printed record is then handed to the inspector.

Technology Class #2: Electronic Display

In this approach, an electronic display is included as part of the EOBR assembly and is used to display the duty status records. At the request of a roadside inspector to see the duty status records, the driver arranges for the records to be displayed. The display must be readable at night and in bright sun conditions by a roadside inspector stationed outside the vehicle. As the inspector needs to see different records, the operator is requested to arrange for display of that record.

Technology Class #3: Electronic Download to Portable External Device

In this approach, the duty status records are made available through a cable and a standard data transfer connector. The connector cable must be long enough so that a roadside inspector, while standing outside of the vehicle, can insert the connector into a hand carried data terminal device. The inspector can then scroll through the various records as needed.

Technology Class #4: Wireless Electronic Download to Portable External Device

This approach leverages short-range wireless truck clearance functions developed under the ITS CVISN[89] program to provide safety inspectors access to records through wireless means.

5.1.5 Key Research Factor #5: Level of protection for personal, operational, or proprietary information

Classes of EOBR Methods & Technologies for Protecting Personal, Operational, or Proprietary Information

As noted earlier, the current regulations for handwritten RODS and AOBRDs do not provide provisions to ensure that personal, operational, or proprietary information are protected from unauthorized access. This is due to the fact that the data collection does not require or involve the collection of any sensitive information. FMCSA offers respondents no assurances of confidentiality. FOIA (5 U.S.C. § 552) requires agencies to release information upon request unless it falls into one of nine categories not subject to the statute [5 U.S.C. § 552(b)(l)-(9)]. The data to be submitted under this information collection is not covered by any of the FOIA exceptions. RODS are releasable as an Exhibit Abstract in connection with an enforcement case that has been closed.

This area is also related in many way to that of electronic tamper resistance and data encryption methods discussed earlier.

Technology Class #1: Data Field Separation

---

[89] Commercial Vehicle Information Systems and Networks.

In this approach, both the data required by the FMCSA and any personal, operational or proprietary information would be stored in the same data file, but separated into clearly distinguishable and separate data fields.

Technology Class #2: Data File Separation

In this approach, the data required by the FMCSA would be stored in a separate data file or files, where as any personal, operational or proprietary information would be stored on another separate data file or files.

Technology Class #3: Logical Separation on a Single Storage Device

In this approach, the data required by the FMCSA would be stored on a separate "logical" partition on a single physical storage device, and any personal, operational or proprietary information would be stored on another separate "logical" partition on the same physical storage device.

Technology Class #4: Physical Separation with Multiple Storage Devices

In this approach, the data required by the FMCSA would be stored on a physically separate storage device, and any personal, operational or proprietary information would be stored on another physically separate storage device.

5.2 Comparison of EOBR Classes to Performance Benchmarks for Handwritten RODS, AOBRDs, and EOBRs

Proposed performance benchmarks for EOBRs were described earlier in Section 4.3. The various possible levels of technologies and methods that could potentially be used in satisfying these EOBR performance benchmarks were subsequently described in Section 5.1. Below, these various levels of technologies and methods are subjected to a systematic screening process by which they are compared to the proposed EOBR performance benchmarks for each of the key research factors. The specific method or technology level for a given technology area that is thought to be minimally compliant in satisfying the proposed EOBR benchmark is then selected as being most illustrative of an element of an EOBR system that would satisfy (but not exceed) the proposed EOBR performance benchmarks. More advanced levels of technologies and methods may, of course, both satisfy and *exceed* the proposed EOBR performance benchmark, but as noted earlier, would also likely have higher costs or other associated operational burdens. The technological and methodological approaches highlighted below are simply meant to be illustrative of the possible range of currently available approaches that could be used to satisfy the proposed EOBR performance benchmarks and standards. The technological and methodological approaches highlighted below *are not themselves the standards*, but rather were developed to ensure that the proposed performance standards were technically and economically feasible.

The primary focus is on the comparison of each EOBR technology class to the proposed EOBR performance benchmarks. The resultant combination of levels of technologies and methods, presented below, is meant to be illustrative of an EOBR system that would satisfy the proposed EOBR performance benchmarks, but would not unnecessarily exceed them.

5.2.1 Key Research Factor #1: Identify the individual driver

Basic Smart Card Identification Card with Login Authentication

The minimally compliant approach for this technology area is a basic identification card (magnetic stripe or optical) pre-loaded with personal identification information including: last name of driver, first name of driver, middle initial of driver, name of motor carrier, address of motor carrier home office. The driver (and co-driver if applicable) are required to enter both a username and a password or PIN to successfully verify and authenticate their identity to the EOBR system. Smart Cards can incorporate significant storage capacity for data at reasonable cost, and can be based on variety of standards such as the Multi Media Card (MMC) standard, Secure Digital (SD) standard, and CompactFlash (CF) standard. For example, CompactFlash cards with 256MB capacity can be purchased for approximately $30, and those with 1GB capacity can be purchased for approximately $90. Far greater data storage capacities of 8GB and greater are available, though at significant cost.

5.2.2 Key Research Factor #2: Tamper Resistance - Electronic Tamper Resistance

RODS Data Storage using Secured Media

The minimally compliant approach for this technology area is a smart card with data access security features to prevent the user from directly tampering with its stored content. In this approach, the storage device will only allow access to its internal storage area or data files if the proper password is provided. The storage device may also have separate access codes for read, write, and other administrative functions. It is recommended that EOBRs have access file rights for creating, writing, reading, and deleting in order to transfer the RODS information and perform routine file system maintenance. The EOBR operating system must also ensure that system users (drivers) do not have direct access control over the many systems functions relating to file modification. Access to file manipulation routines must be under EOBR program control at all times.

5.2.3 Key Research Factor #2: Tamper Resistance - Physical Tamper Resistance

Use of Non-Standard Fasteners, Protective Internal Coatings, and Tamper-Evident Seals on Connectors

The minimally compliant approach for this technology area includes a combination of the use of non-standard fasteners, protective internal coatings, and tamper-evident seals. Non-standard fasteners include the use of rivets, one-way screws, etc., in order to minimize the ease with which internal components could be accessed. The use of protective internal coatings includes all internal components (circuit boards, etc.) being sealed with a hard epoxy or flexible resin compound to inhibit physical access to the components even if the component enclosure or case is opened. It should also be noted that a byproduct of the continued miniaturization of many components and circuit boards in most electronic equipment today is that physical alteration of internal components that require soldering or physical manipulation has become increasingly more difficult. Finally, in addition to the non-standard fasteners and internal coatings, the use of tamper-evident seals on the connections between components of the EOBR system would indicate evidence of physical tampering with the connector or connection.

5.2.4 Key Research Factor #3: Ability to produce records for audit and compliance review - Vehicle Location

ECM Integrated with a Positioning System

The minimally compliant approach for this technology area includes a vehicle equipped with both a current ECM and a positioning determination system (most likely based on a GNSS such as the GPS system). The ECM and positioning determination equipment are linked to a CPU, and location information derived from the ECM and positioning determination equipment and associated processor is automatically recorded. The ECM is utilized to determine mileage driven, vehicle movement status and engine on/off data. The positioning determination equipment, besides providing a crosscheck on mileage and location, is also used for time and date data.

5.2.5 Key Research Factor #3: Ability to produce records for audit and compliance review - Duty Status

Manual Data Entry with Verification by ECM Data and Positioning System

As noted in the experience with the Werner Enterprises electronic logging system, accurate recording of driver duty status will require that drivers explicitly record data regarding changes of duty status. The minimally compliant approach for this technology area is represented by driver input via a keypad or similar device to document changes in duty status. Recent vehicles equipped with both current ECM and a positioning system can use the information recorded (mileage driven, vehicle movement status, engine on/off data and vehicle location information) to help verify certain types of duty status entries, since some, though not all, duty status categories are not consistent with vehicle information that could be obtained from either the ECM or the positioning system. For example, if “sleeper berth” is selected by the driver as a duty status entry, yet the EOBR detects that the vehicle is moving and there is no co-driver present, this information could be used to flag or possibly even override the driver entry.

5.2.6 Key Research Factor #4: Ability of roadside enforcement personnel to access the hours of service information quickly and easily

Electronic Download to Portable External Device

The minimally compliant approach for this technology area is represented by an EOBR that provides an easily accessible (to roadside enforcement personnel) standard data transfer port (e.g., USB, serial port, etc.) (see Appendix C for further information regarding the relative advantages and disadvantages of various wired data communications standards). Duty status records are then made available to roadside enforcement personnel via a cable that could be connected to this data transfer port. The connector cable must be long enough so that a roadside inspector, while standing outside of the vehicle, can insert the connector into a hand carried data terminal device (laptop computer, PDA, etc.). The inspector can then inspect the duty status records as needed. A consistent electronic file format (e.g., ASCII) and record layout for the electronic RODS data will be necessary to facilitate the electronic transfer of records to roadside safety enforcement personnel that are equipped to do. One approach might be to specify a file format compatible with the ASPEN software and CAPRI software often used for roadside enforcement and compliance reviews. Similarly, a consistent display format (e.g., graph grid, etc.) for the RODS information to be viewed by roadside safety enforcement personnel will be necessary to facilitate accurate and efficient review by roadside enforcement personnel.[90]

5.2.7 Key Research Factor #5: Level of protection for personal, operational, or proprietary information

Logical Separation of Public Data and Proprietary Data on a Single Storage Device

The minimally compliant approach for this technology area is represented by the use of “logical” partitions, in which the data required by the FMCSA would be stored on a separate logical partition on a single physical storage device, and any personal, operational or proprietary information would be stored on another separate logical partition on the same physical storage device.

[90] The September 1, 2004, ANPRM regarding *Electronic On-Board Recorders for Hours-of-Service Compliance* notes on page 53392 that there have been numerous reports of State enforcement officials purposely avoiding reviewing electronic records because they are unfamiliar with their appearance. This highlights the need for a consistant display format for the records so that roadside enforcement personnel can review electronic records accurately and efficiently.

Section 6: Recommendations

6.1 Recommendations Concerning Draft EOBR Performance Standards

These recommendations regarding draft EOBR performance standards closely follow the information provided in Section 4.3 regarding the proposed performance benchmarks for EOBRs. These general performance standards could provide the basis for more specific performance specifications that would be required to develop compliant prototype EOBR devices and systems. Organized by each of the key research factors, the proposed EOBR performance requirements are presented below.

6.1.1 Recommended Performance Benchmarks for Key Research Factor #1: Identify Individual Driver

- It is recommended that EOBRs have the ability to request and record driver identity. As a minimum, the identification information must include a driver name or some other type of suitable unique identifier to distinguish drivers from one another and from co-drivers.
    - Consideration of more stringent requirement: requiring a unique government-issued identification number, such as his/her commercial driver's license (CDL) number and state code. If a co-driver is present, the EOBR should also have the ability to record the identity of the co-driver. Linking driver identification to a government-issued number will ensure that the identity of the driver can be quickly verified during a roadside inspection. During a routine inspection, the inspector simply has to compare the driver's license of the operator with the stored EOBR information to positively confirm driver identity. This approach could help to discourage operators from swapping, borrowing, or otherwise falsifying driver identity.
- It is recommended that EOBRs record the date and time a driver logs onto the system. The EOBR should trigger an audible and visual alert if the driver fails to supply his/her identity, front-end information, and duty status information before setting the motor vehicle in motion. It is recommended that EOBRs record the absence of driver identity in accordance with Key Research Factor #3.
- The driver and co-driver's IDs and associated names should appear in all records produced by the EOBR.
- It is recommended that EOBRs record the duty status of individual drivers on board, the date, and the start and stop times of each duty status change. Duty status includes the following duty status categories:

  - Off Duty
  - Sleeper Berth
  - Driving
  - On-Duty, Not Driving

- It is recommended that EOBRs require the driver to record location information (state and city, town or village name) related to each change of duty status using a standard set of city and town names that is practically useful to both drivers and to enforcement personnel (see Appendix F for further information regarding the recording of location information for EOBR applications). If a positioning system (e.g., a GNSS such as GPS) is available, the EOBR may compute (for example via a lookup table based on latitude and longitude coordinates) and automatically enter the state and city, town or village name, and calculate the direction and compass heading from the current vehicle location to the nearest city, town or village. If a positioning system is *not* available, a manual hierarchical input scheme should be used to facilitate the entry of the standardized location names by the driver (for example, by using a series of "pick lists" provided by the system to select the state, and then the name of the city, town or village).

- It is recommended that EOBRs require the driver to enter a standard location code for state border crossing events. A standard numeric location code should be developed and used for these state border crossings. If a positioning system (e.g., a GNSS such as GPS) is available, the EOBR may compute (for example via a lookup table) and automatically enter the proper standard numeric location code. If a positioning system is *not* available, a manual hierarchical input scheme should be used to facilitate the entry of the standardized codes by the driver (for example, by using a series of "pick lists" provided by the system to select the states being crossing into and from, and then the route number or street name.

- It is recommended that EOBRs only allow a change in duty status to be entered when the vehicle is at rest.

- Data identifying the individual driver can be entered in the EOBR through either manual or automatic methods.

  An example of manual entry is via the use of a keyboard on the EOBR console. The EOBR would confirm the driver's identity and could display the name of the driver, a photo of the driver, etc., on the console screen. Such an approach would also likely be useful for providing the ability to enter other trip-related information, such as shipping document number, name or ID of co-driver, etc. For safety reasons, it should be required that the vehicle be stationary before allowing EOBR keyboard entry of any information.

  An example of automatic entry is the use of an ID card (smart card, magnetic strip, etc.) that, when inserted into or swiped through the EOBR, would log the driver onto the system. As with the manual data entry approach, the EOBR would then confirm the driver's identity and could display the name of the driver, a photo of the driver, etc., on the console screen, and any additional trip information could then be entered via a keyboard. A contactless identification card could be used as an alternative to manual card insertion, since a practical issue with the use of identification cards and smart cards is that they tend to warp over time from being carried in wallets, making insertion into card readers problematic in some cases. Some form of biometric identification (finger print scanner, etc.) could also be used.

6.1.2 Recommended Performance Benchmarks for Key Research Factor #2: Tamper Resistance

Physical Tamper Resistance

- It is recommended that EOBRs be designed to indicate any attempts of tampering, whether physical or electronic.

- The EOBR enclosure must provide sufficient physical security to dissuade or prevent potential tampering. The unit must be able to withstand everyday abuse caused by road vibrations and harsh operating environments. Physical tamper resistance begins with an equipment enclosure that prevents disassembly with common tools. Special anti-tampering fasteners may be used to hinder access to the unit's internal components. In addition, external interface connections with other on-board systems such as ECMs and Transmission Control Modules (TCMs) may also require tamper-resistant couplers or fasteners to prevent intentional disconnection.

- Tamper-evident techniques also may be utilized to further enhance physical security. The use of security tags might also be considered. Such tags are similar to the devices used on electric power meters, where the service personnel are required to physically cut the tag ring before the device can be opened for service. Only authorized service personnel or law enforcement authorities are able to replace the tamper-detection device. Also, the use of security seal tape, such as that found on consumer electronics, may be used to detect if the unit's enclosure has been compromised. Internally, critical electronic components, such as an EOBR system processor or memory storage module, can be encapsulated in epoxy or a tamper-resistant film to prevent physical tampering or removal.

- It is recommended that EOBRs be fully operational within the industrial temperature range of -40ºC to +85ºC (-40ºF to 185ºF), and within a humidity range of 10 percent to 90 percent.

- Internal components of the EOBR will be protected against damage from liquid and dust.

Electronic Tamper Resistance

- It is recommended that EOBRs have a date and time keeping device (clock) for which the allowable absolute deviation, plus or minus, from official time should never exceed 10 minutes (see Appendix D for further information). In practice, this equates to a rate of time drift of the EOBR clock of approximately +/- 1.7 seconds per day over the course of one year. Date and time information on the clock should be resynchronized with at least one additional external source of accurate time information, which could include an external source such as GPS, or an on-board vehicle data system such as an ECM and TCM, on a regular basis to maintain this recommended performance standard for time keeping accuracy. Widely available and relatively inexpensive integrated real-time clocks (RTCs) based on economical quartz crystals can achieve typical accuracies of at least approximately +/- 2 seconds per day, which would require EOBR clocks to be resynchronized with official time infrequently, approximately once per year, in order to maintain the recommended performance standard of 10 minutes of absolute accuracy for time keeping accuracy. The EOBR should also maintain time accurately in accordance with this time keeping performance standard for up to 12 months after external power to the device has been removed.

- It is recommended that EOBRs use Coordinated Universal Time (UTC) as the reference time base or time standard for recording and processing electronic HOS duty status information.

- It is recommended that EOBRs record time information in increments of 1 second.

- It is recommended that EOBRs record the occurrence (date, time and type) of system-related events and diagnostic events. Table 7 provides a list of some possible EOBR diagnostic event codes for illustrative purposes.

- It is recommended that EOBRs record the date and time if the system detects the absence of data from the ECM, TCM, or other integrated system.

- It is recommended that prior to system shutdown, EOBRs capture and store system validation parameters from the ECM or TCM. These parameters should include ECM/TCM time, odometer/mileage readings, and serial numbers of system components (if available). Upon unit restart, it is recommended that EOBRs compare their stored ECM/TCM readings with the present values and record any discrepancies.

- It is recommended that drivers not be allowed to edit driving records on-board the vehicle. Rather, edits should only be allowed by authorized personnel of the motor carrier at the main office or terminal. In addition, whenever driving records are edited in this manner, the fact that a change has taken place should be flagged, and both the newly edited and the original un-edited data should be maintained for review during a compliance review. Data downloaded from EOBRs should be secured to ensure that only authorized motor carrier personnel and enforcement personnel can access the data.

- Methods for tracking changes or attempted changes to the electronic hardware or software utilized by the EOBR should be incorporated. For example, the detection of such attempts could be flagged in the data record, along with the time at which the attempt was detected.

- In connection with the necessity for tamper resistance in an EOBR, it is recommended that information and identifying information be recorded in the form of an audit trail or event log. An audit trail must reflect the driver's activities while on duty and tie them to the specific CMV(s) that the driver operated. Its design must balance privacy with the need for a verifiable record. The presentation should include audit trail markers to alert safety officials and personnel in the motor carrier's safety department to records that have been modified.

Table 7: Examples of Possible EOBR Diagnostic Event Codes

Code Class	Code	Brief Description	Full Description
General System Diagnostic	PWR_ON	power on	EOBR initial power-on
General System Diagnostic	PWROFF	power off	EOBR power-off
General System Diagnostic	TESTOK	test okay	EOBR self test successful
General System Diagnostic	SERVIC	service	EOBR Malfunction (return unit to factory for servicing)
General System Diagnostic	MEMERR	memory error	System memory error
General System Diagnostic	LOWVLT	low voltage	Low system supply voltage
General System Diagnostic	BATLOW	battery low	Internal system battery backup low
General System Diagnostic	CLKERR	clock error	EOBR system clock error (clock not set or defective)
General System Diagnostic	BYPASS	bypass	EOBR system bypassed (RODS data not collected)
Data Storage Diagnostic	INTFUL	internal memory full	Internal storage memory full (requires download or transfer to external storage)
Data Storage Diagnostic	DATACC	data accepted	System accepted driver data entry
Data Storage Diagnostic	EXTFUL	external memory full	External memory full (smartcard or other external data storage device full)
Data Storage Diagnostic	EXTERR	external data access error	Access external storage device failed
Data Storage Diagnostic	DLOADY	download yes	EOBR data download successful
Data Storage Diagnostic	DLOADN	download no	Data download rejected (unauthorized request / wrong Password)
Driver Identification Issue	NODRID	no driver ID	No driver information in system and vehicle is in motion
Driver Identification Issue	PINERR	PIN error	Driver PIN / identification number invalid
Driver Identification Issue	DRIDRD	driver ID read	Driver information successfully read from external storage device (transferred to EOBR)
Peripheral Device Issue	DPYERR	display error	EOBR display malfunction
Peripheral Device Issue	KEYERR	keyboard error	EOBR keyboard/input device malfunction
External Sensor Issue	NO_GPS	no GPS data	No GPS sensor information available
External Sensor Issue	NOLTLN	no latitude longitude	No latitude and longitude from positioning sensor
External Sensor Issue	NOTSYC	no time synchronization	Unable to synchronize with external time reference input
External Sensor Issue	COMERR	communications error	Unable to communicate with external data link (to home office or wireless service provider)
External Sensor Issue	NO_ECM	no ECM data	No sensory information received from vehicle's Engine Control Module (ECM)
External Sensor Issue	ECM_ID	ECM ID number mismatch	ECM identification/serial number mismatch (with preprogrammed information)

6.1.3 Recommended Performance Benchmarks for Key Research Factor #3: Produce Records for Audit and Compliance Review

- It is recommended that EOBRs use a portable storage media capable of storing driver-oriented RODS data for a minimum of 8 days, such that the driver can maintain in his/her possession a copy of each record of duty status for the current day and the previous 7 consecutive days, as is the current requirement for handwritten RODS under 49 CFR § 395.8, even when having operated multiple vehicles during that time period. Similar to the requirement under 49 CFR § 395.8 for handwritten RODS, drivers must submit their electronic RODS to their company within 13 days after their completion.

- 49 CFR § 395.8(k)(1) requires that each motor carrier shall maintain RODS and all supporting documents for each driver it employs for a period of 6 months from the date of receipt. Similar requirements are recommended for electronic RODS for each driver should be required to be maintained by the carrier for a period of 6 months from the date of receipt. Also, it is recommended that electronic RODS for each vehicle (and all drivers having used that vehicle) be maintained on board the EOBR on each vehicle for a period of 6 months. This would provide an additional set of information that could be used to reconcile both the driver-oriented electronic RODS and vehicle-oriented electronic RODS during an audit or compliance review, and thus potentially improve the ability to detect possible tampering with either of the two sets of records.

- It is recommended that EOBRs utilize industry standard, non-propriety, portable storage media for transferring individual driver's HOS records between vehicles or to the main office. The HOS records may also be transferred via wireless data communications services, however, the responsibility still lies with the driver and the carrier organization to maintain and produce HOS records for roadside inspections and compliance reviews. For those systems that use portable storage media, consideration should be given to requiring that a spare backup storage device be available on-board the vehicle in case the storage media or device being used by the driver fails.

- HOS data must be periodically transferred off of the EOBR to permanent data storage (e.g., via media such as flash memory card, floppy disk, CD-RW, etc., or a wired connection (e.g., to a personal digital assistant (PDA), etc.) or a wireless connection (Bluetooth, 802.11a/b/g, etc.). Therefore, data interchange standards would need to be considered. Also, the EOBR system should indicate to the operator/driver that on-board storage is nearing capacity so as to prevent data from being lost.

- EOBRs should allow enforcement inspection officials to retrieve the HOS records for the current driver and co-driver.

- It is highly recommended that the HOS records contain the information related to the driver's HOS as currently required under 49 CFR § 395.8 and 49 CFR § 395.15.

- For the relevant data items, dates should be given as mm/dd/yyyy.

- It is recommended that the date and time (UTC hours, minutes and seconds) when each duty status change occurs be recorded by the EOBR. The total elapsed time in each duty status category can then be calculated from this information.

- It is recommended that the EOBR record vehicle miles driven, and that vehicle miles driven should be accurate to within some agreed upon tolerance level (e.g. +/- 5%) of actual vehicle miles driven (as certified according to procedures that will need to be developed by FMCSA).

6.1.4 Recommended Performance Benchmarks for Key Research Factor #4: Ability of Roadside Enforcement Personnel to Access HOS Information Quickly and Easily

- It is recommended that EOBRs provide data access to allow for the retrieval of stored HOS data by roadside enforcement personnel. It is recommended that EOBRs use a non-proprietary industry standard data access connector. In addition, the data connector should be clearly labeled as "EOBR Data Access" and made accessible to a person of average height so that the inspection official can reach the data connector without physically entering the cab or stepping on the vehicle's running board.

- The interface standard should be a common standard, such as serial RS-232, Universal Serial Bus (USB), or IEEE 1394 FireWire (see Appendix C for further information regarding the relative advantages and disadvantages of various wired data communications standards). Alternatively, if wireless capability is desired or deemed necessary, the EOBR may be equipped with short range Bluetooth or a wireless network interface (802.11 a/b/g) (see Appendix C for further information regarding the relative advantages and disadvantages of various wired data communications standards). Developments in the intelligent transportation systems (ITS) field will also technologically support remote-access capability (Dedicated Short Range Communications (DSRC), for instance). As with the use of any wireless technology, it is necessary to safeguard access to the EOBR data and system-access passwords from potential electronic "eavesdroppers." The relative advantages and disadvantages of each of the above wired and wireless communications standards are discussed in more detail in Appendix C.

- A typical operating scenario might include a roadside inspector connecting to the EOBR with his data terminal device. Either the inspector or his/her terminal supplies the connected EOBR with the proper identification and system access codes. The on-board unit presents the inspector with a list of available logs for download or display. The inspector selects the needed files and downloads the relevant logs to his system. If necessary, the retrieved files are automatically decoded by the terminal before displaying the information to the inspector. The EOBR records the event and notes which files were viewed during the inspection.

- In order to facilitate the electronic transfer of records to roadside inspection personnel and compliance review personnel, and provide the ability of various third party and proprietary EOBR devices to be interoperable, a consistent electronic file format and record layout for the electronic RODS data to be recorded by EOBRs is recommended. As outlined in Module 1, Section 5 of the January 2003 *Hours of Service Research and Analysis Modules* report, there are 15 discrete HOS data elements, which are required by 49 CFR § 395.15, that must be recorded by the EOBR.[91] Using a common data standard will allow compatible software applications to automatically access, retrieve, analyze and display the HOS information for review, and will shorten the amount of time required for roadside inspections. Using a common data record structure will also allow various third-party software solutions to be used on, or in support of, any compliant EOBR, regardless of the particular manufacturer or model of the hardware and software used.[92]

Regardless of the particular electronic file type (e.g., ASCII, XML, etc.) ultimately utilized for recording the electronic RODS produced by an EOBR, it is envisioned that electronic RODS data could be recorded according to a "flat file" database model. A flat file is a simple database in which all information is stored in a plain text format with one database "record" per line. Each of these data records is divided into "fields" using delimiters (as in a comma-separate-values data file) or based on fixed column positions. This database model is referred to as "flat" as compared to more complex database models such as relational databases which contain multiple data tables that are related to one another via a series of one-to-many or many-to-one relationships among data fields contained in the each of the tables. Table 6 shown earlier presents the general concept of a flat data file consisting of data "fields" (columns) and data "records" (rows).

Table 8 presents a proposed data elements dictionary for the electronic RODS produced by an EOBR corresponding to the data "fields" component of the conceptual framework shown earlier in Table 6. In the envisioned EOBR data file, individual data records are produced and recorded whenever there is either a change in driver duty status, a state border crossing, an EOBR diagnostic event (such as power-on/off, self test, etc.), or when one or more data fields of an existing data record are later corrected or edited (in which case the corrected record is recorded and noted as "current" in the "Event Status Code" data field, however the original record is also maintained in its unedited form and is noted as "historical" in the "Event Status Code" data field).

Though this is conceptually different from the current method of recording of information on handwritten RODS in a graph grid format, the essential data elements necessary to construct a graph grid representation of the RODS data (e.g., using software such as ASPEN or CAPRI to conduct a roadside inspection or compliance review, respectively, or using the software on-board the CMV on the EOBR device so that a driver could view his own records) would be present in the EOBR data file.

---

[91] U.S. Department of Transportation, Federal Motor Carrier Safety Administration, Office of Business and Truck Standards and Operations. *Hours of Service (HOS) Research and Analysis Modules*. January 21, 2003. Page 27. URL <http://dmses.dot.gov/docimages/pdf89/294137_web.pdf>

[92] For older ABORDs and EOBRs already in use as of a certain date (e.g., the date of any final rule that may mandate use of EOBRs or allow the use of EOBRS), these older units could be "grand fathered" such that if they utilize a proprietary data file format that is non-compliant with any new regulation for EOBRs, they could comply with the regulation by simply having the electronic RODS available for visual inspection (e.g., on a video screen or a hard copy print out) at the time of a roadside inspection or compliance review.

Table 8: Potential EOBR Data Elements Dictionary

Driver Identification Data

Data Element	Data Element Definition	Type	Length	Valid Values & Notes	Current 24 CFR 395 Reference
Driver First Name	First name of the driver.	A	30		395.8(d)(3) [signature only]; 395.15(b)(5) [signature on hardcopies only]
Driver Last Name	Last name, family name or surname of the driver.	A	30		395.8(d)(3) [signature only]; 395.15(b)(5) [signature on hardcopies only]
Driver PIN	Numeric personal identification number assigned to a driver by the motor carrier	A	40		none

Vehicle Identification Data

Data Element	Data Element Definition	Type	Length	Valid Values & Notes	Current 24 CFR 395 Reference
Tractor Number	Motor carrier assigned identification number for tractor unit	A	10		395.8(d)(3); 395.15(c)(7)
Trailer Number	Motor carrier assigned identification number for trailer	A	10		395.8(d)(3); 395.15(c)(7)
Tractor VIN Number	Unique vehicle ID number assigned by manufacturer according to US DOT regulations	A	17		none

Co-Driver Data

Data Element	Data Element Definition	Type	Length	Valid Values & Notes	Current 24 CFR 395 Reference
Co-Driver First Name	First name of the co-driver.	A	30		395.8(d)(9); 395.15(c)(11)
Co-Driver Last Name	Last name, family name or surname of the co-driver.	A	30		395.8(d)(9); 395.15(c)(11)
Co-Driver PIN	Numeric personal identification number assigned to a driver by the motor carrier	A	40		none

Company Identification Data

Data Element	Data Element Definition	Type	Length	Valid Values & Notes	Current 24 CFR 395 Reference
Carrier USDOT Number	The USDOT number of the motor carrier company.	N	8		none
Carrier Name	Name of the motor carrier company.	A	50		395.8(d)(4); 395.15(c)(8)

Company Address Data

Data Element	Data Element Definition	Type	Length	Valid Values & Notes	Current 24 CFR 395 Reference
Address Type ID	Type of the company address: 1= Main/Physical, 2=Mailing, 3=Terminal	N	8	1, 2, 3	395.8(d)(7); 395.8(f)(9); 395.15(c)(9)
Address Street Text	Street address of a person's residence or company's office.	A	50		395.8(d)(7); 395.8(f)(9); 395.15(c)(9)
Address City Name	City of a person's residence or company's office	A	25		395.8(d)(7); 395.8(f)(9); 395.15(c)(9)
Address State Postal Code	State code of a person's residence or company's office.	A	2		395.8(d)(7); 395.8(f)(9); 395.15(c)(9)
Address Zip Code	Zip code of a person's residence or company's office.	A	10		395.8(d)(7); 395.8(f)(9); 395.15(c)(9)
Address Country Code	Country code of a person's residence or company's office.	A	2		395.8(d)(7); 395.8(f)(9); 395.15(c)(9)

Table 8: Potential EOBR Data Elements Dictionary (continued)

Shipment Data

Data Element	Data Element Definition	Type	Length	Valid Values & Notes	Current 24 CFR 395 Reference
Shipping Document Number	Shipping document number	A	40		395.8 (d)(11); 395.8 (f)(12); 395.15(c)(13)

Event Data

Data Element	Data Element Definition	Type	Length	Valid Values & Notes	Current 24 CFR 395 Reference
Event Sequence ID	A unique serial identifier for an event, unique to a particular vehicle and a particular day.	N	4	0001 through 9999	none
Event Status Code	Character codes for the four driver duty status change events, state border crossing event, and diagnostic events.	A	3	OFF= Off Duty SB= Sleeper Berth D= On Duty Driving ON= On Duty Not Driving SBC= State Border Crossing DG=Diagnostic	The four duty status types are noted under 395.8(b)(1); 395.8(b)(2); 395.8(b)(3); 395.8(b)(4); 395.15(c)(1); 395.15(c)(2); 395.15(c)(3); 395.15(c)(4)
Event Date	The date when an event occurred.	N (Date)	8	UTC (universal time) recommended. Format: YYYYMMDD	395.8(d)(1); 395.8(f)(3); 395.15(c)(5); 395.2
Event Time	The time when an event occurred.	N (Time)	6	UTC (universal time) recommended. Format: HHMMSS (hours, minutes, seconds)	395.8(d)(1); 395.8(f)(3); 395.15(c)(5); 395.2
Event Latitude	Latitude of a location where an event occurred.	N	2,6	Decimal format: XX.XXXXXX	none
Event Longitude	Longitude of a location where an event occurred.	N	3,6	Decimal format: XXX.XXXXXX	none
State Postal Code	Two-character alphabetic postal code of the state where event occurred.	A	2	Two-character state postal code	395.8(c); 395.8(h)(5); 395.15 (d)(1)
State FIPS Code	Two-digit numeric FIPS55 code of the state where an event occurred.	N	2	Two-digit state FIPS code	none
Place FIPS Code	Code of the nearest populated place from the FIPS55 list of codes for populated places.	N	5	Unique within a FIPS state code. Lookup list derived from FIPS55..	395.15(d)(2)
Place Distance Miles	Distance in miles to a nearest populated place from the location where an event occurred.	N	4		none
Place Direction Code	Code for a geographical direction to nearest populated place.	A	3	16 directions of the compass rose (N, NNE, NE, ENE, E, ESE, SE, SSE, S, SSW, SW, WSW, W, WNW, NW, NNW)	none
State Border Crossing Code	Unique code assigned to each state border crossing location.	N	5	A list of unique state border crossing codes, similar in concept to the use of FIPS55 codes for place names, would need to be developed by FMCSA.	none
State Departed Code	Two-character alphabetic postal code of the state or province departed.	A	2	Two-character state postal code (including Canadian and Mexican provincial codes for border crossings)	none
State Entered Code	Two-character alphabetic postal code of the state or province entered.	A	2	Two-character state postal code (including Canadian and Mexican provincial codes for border crossings)	none

Table 8: Potential EOBR Data Elements Dictionary (continued)

Event Data

Data Element	Data Element Definition	Type	Length	Valid Values & Notes	Current 24 CFR 395 Reference
State Border Crossing Road	Road traveled while crossing a state border.	A	40	Route number, road name, etc.	none
Total Vehicle Miles	Total vehicle miles (as noted on vehicle odometer or as measured by any other compliant means such as vehicle location system, etc.).	N	7	With total vehicle mileage recorded at the time of each event, vehicle miles traveled while driving, etc., can be computed	395.2; 395.8 (d)(2); 395.8 (f)(4); 395.15(c)(6); 395.15(i)(5)(iii)
Event Status Code	A status of an event, either Current (the most up-to-date update or edit) or Historical (the original record if the record has subsequently been updated or edited).	A	1	C= Current, H= Historical	none
Diagnostic Event Code	For diagnostic events (events where the "Event Status Code" is noted as "DG"), records the type of diagnostic performed (e.g., power-on, self test, power-off, etc.) or error detected	A	6	PWR_ON (power on) PWROFF (power off) TESTOK (test okay) SERVIC (service) MEMERR (memory error) LOWVLT (low voltage) BATLOW (battery low) CLKERR (clock error) BYPASS (bypass) INTFUL (internal memory full) DATACC (data accepted) EXTFUL (external memory full) EXTERR (external data access error) DLOADY (download yes) DLOADN (download no) NODRID (no driver ID) PINERR (PIN error) DRIDRD (driver ID read) DPYERR (display error) KEYERR (keyboard error) NO_GPS (no GPS) NOLTLN (no latitude longitude) NOTSYC (no time synchronization) COMERR (communications error) NO_ECM (no ECM) ECM_ID (ECM ID number mismatch)	none
Event Update Date	The date when an event record was last updated or edited.	N (Date)	8	UTC (universal time) recommended. Format: YYYYMMDD	395.15 (b)(3); 395.15 (i)(7) regarding "identification of edited data"
Event Update Time	Then time when an event record was last updated or edited.	N (Time)	6	UTC (universal time) recommended. Format: HHMMSS (hours, minutes, seconds)	395.15 (b)(3); 395.15 (i)(7) regarding "identification of edited data"
Event Update Person ID	An identifier of a person who the last update or edit to a record.	A	40		none
Event Update Text	A textual note related to the most recent record update or edit.	A	60	Brief narrative regarding reason for record update or edit	none

6.1.5 Recommended Performance Benchmarks for Key Research Factor #5: Level of Protection for Personal, Operational, or Proprietary Information

- It is recommended that EOBR records be accessible only to authorized government officials and members of the carrier organization. A data access protection scheme may be implemented so that viewing or downloading HOS records will require a password. The act of entering the driver's data access password may be used as substitute for his signature, certifying that his electronic HOS records are true and correct.

- It is recommended that EOBRs record the date and time of any data retrieval or any attempt of data retrieval.

- Any EOBR data collected by the Government is subject to FOIA and may be available to any entity or the general public. RODS are releasable as an Exhibit Abstract in connection with an enforcement case that has been closed.

- Passwords, access codes or smart cards can be required to allow access to personal, operational and proprietary information on the EOBR. Data encryption methods, as discussed earlier regarding electronic tamper resistance, also may be able to protect the information from being read by unauthorized personnel.

- EOBRs should have two independent major data storage areas:

    - One area would record and store the information of interest to FMCSA, such as the RODS to be accessed by roadside enforcement personnel. FMCSA offers respondents no assurances of confidentiality. FOIA (5 U.S.C. § 552) requires agencies to release information upon request unless it falls into one of nine categories not subject to the statute [5 U.S.C. § 552(b)(l)-(9)]. The data to be submitted under this information collection is not covered by any of the FOIA exceptions. RODS are releasable as an Exhibit Abstract in connection with an enforcement case that has been closed.

      This information collection does not involve any sensitive information.

    - A second data storage area could be reserved for proprietary data accessible only to motor carriers.

6.1.6 Recommended Performance Benchmarks for Key Research Factor #6: Cost

- The perceived value of the EOBR will determine the price threshold that drivers or fleet owners may deem cost prohibitive. Similar to driver acceptability, if the use of EOBR automates the burden of record keeping and helps streamline operations or increase productivity, then owners will be more willing to pay a higher price. If, on the other hand, the device is seen only as a monitoring tool for law enforcement purposes, then owners will be less willing to pay a higher price.

- Current technology and use of commercial-off-the-shelf (COTS) hardware / software components could lead to sufficient capabilities and decreased unit costs if widespread adoption of EOBRs occurs.

- EOBRs may be considered costly both to purchase and to operate. Estimates of installed costs per unit range from approximately $500 for hardware supplied to an original equipment manufacturer (OEM) for installation in a new vehicle, to $3,000 for installation of a retrofit unit in an in-service CMV.[93] These cost estimates generally do not include back-office systems for data tracking, verification, and information management, or training for drivers and others. However, these cost estimates represent costs as of early 2005, and do not account for potential reductions in per unit costs that may result from large volume production resulting from the potential for widespread adoption of EOBRs throughout the motor carrier industry. Also, the capabilities and functions of current EOBRs typically far exceed those of older AOBRDs of the type that 49 CFR § 395.15 was originally meant to address.

6.1.7 Recommended Performance Benchmarks for Key Research Factor #7: Driver Acceptability

- It is recommended that EOBRs provide a means for the driver to examine their own HOS records. The data presented to the driver for review should include all relevant HOS information currently required under 49 CFR § 395.8 and 49 CFR § 395.15.

- It is recommended that EOBRs alert the driver with sufficient advance notice (e.g., a minimum of 1 hour, with a greater advance notice allowable depending upon carrier operating characteristics, etc.) prior to reaching his maximum HOS compliance time limits in order to allow the driver sufficient time to drive to a suitable location to obtain rest prior to being in violation of HOS limits.

- To gain driver acceptance, information recorded using EOBRs should be used only for HOS compliance assurance purposes, and not for the assessment of speeding penalties or other disciplinary actions not related to HOS compliance.

- In some cases, AOBRDs are used to facilitate the downloading of accident event data from truck ECMs to aid in accident reconstruction and court cases, particular when fatalities are involved. Although both event data recording and HOS recording may rely on data from the vehicle ECM, both should be treated as separate issues. Combining these issues together may serve to inhibit adoption of regulations allowing or mandating the use of EOBRs, since motor carriers and drivers might then associate use of EOBRs with accident event data recording, when they should only be associated with hours of service recording.

---

93 Federal Register, Volume 69, Number 169. *Electronic On-Board Recorders for Hours of Service Compliance. Advance notice of proposed rulemaking; request for comments.* September 1, 2004. Page 53395.

- EOBRs should be easy to use for drivers, and present minimal or no additional workload to the driver as compared to the current use of handwritten RODS. Use of EOBRs may potentially reduce workload for drivers. System operation should be intuitive and unobtrusive.

- If possible, EOBRs should have the ability to interface with optional vehicle navigation systems which would, for example, be able to provide routing and real-time vehicle location information to the driver for carriers that choose to provide such an optional add-on capability. These types of capabilities are sometimes used by carriers as a benefit in order to help retain drivers. The ability to provide such an optional add-on capability if so desired could assist the driver in finding the most efficient route and updating estimated time-of-arrival information.

- If EOBRs include communications capabilities, then incorporation of a safety or alarm system should be considered. For example, an "emergency button" or silent alarm that sends out a signal when a driver or truck is in trouble, is being hijacked, or has been in a serious accident, could alert a dispatch center and law enforcement of the incident and the location of the truck. This security feature could also be used in the effort to seek wider driver acceptance.

- Potential safety benefits to the driver should be highlighted. For example, it is recommended that EOBRs alert the driver with sufficient advance notice (e.g., a minimum of 1 hour, with a greater advance notice allowable depending upon carrier operating characteristics, etc.) prior to reaching his maximum HOS compliance time limits in order to allow the driver sufficient time to drive to a suitable location to obtain rest prior to being in violation of HOS limits.

- Benefits to carriers, and therefore perhaps indirectly to drivers, should be highlighted. For example, the increased amount of data more readily available to motor carriers could be used to improve their operations and their scheduling of drivers.

- Benefits resulting from reduced time involved in preparing, filing, and storing handwritten paper records should be highlighted. Since RODS record keeping by drivers will be largely automated with the use of EOBRs, time formerly spent on retrieving and manually filling out the driver's daily log would be available for other on-duty activities or to increase off-duty time.

- Training might be an issue for drivers in terms of the time required and their familiarity with the use of technology. For example, some evidence suggests that younger drivers perceive the technology aspects of on-board recorders more favorably than older drivers, perhaps because younger drivers – who may be less financially well off than their more senior peers – recognize that the on-board recorders might be advantageous for drivers seeking to maximize their driving time and therefore their compensation This differential impact upon driver acceptability based on age should be evaluated as part of any future field operational tests of EOBRs.

6.2 Recommendations Concerning Potential for "Mandating" or "Allowing" EOBRs

At the current time, the prudent course of action is to defer any decision to mandate EOBRs industry-wide. This recommendation is dictated by the continuing uncertainties and insufficient amounts of reliable, documented, empirical data regarding a variety of issues, such as the costs, benefits, and operational impacts on motor carriers that are characterized as small businesses. In addition, it is recommended that FMCSA continue with a research program that may provide the additional information upon which a future decision might be based regarding mandating the use of EOBRs for either certain sub-segments of the motor carrier industry or industry-wide. Such a research program might include, for example, a comprehensive cost-benefit analysis of the use of EOBRs, the development of more detailed performance specifications for EOBRs in conjunction with industry and equipment vendors, and a field operational test of various EOBR system designs in order to obtain additional information regarding practical operational issues.

Though it is felt that a recommendation to mandate EOBRs industry-wide cannot be made at this time, it is recommended that the use of EOBRs that comply with 49 CFR § 395 regulations regarding AOBRDs continue to be allowed, and that the 49 CFR § 395 regulations regarding AOBRDs be updated to reflect recent advances in technology as well as the operational experience that has been gained from the use of AOBRDs to date under 49 CFR § 395.

A brief overview of the main points for and against both mandating and allowing EOBRs is presented below.

Mandating EOBRs

Pros

- All motor carriers would be on an equal footing regarding RODS
- Greater confidence in accuracy of records industry-wide would be engendered
- Greater conformity in the types of EOBR systems fielded would be likely
- Per-unit costs of EOBRs may be less, relative to a more limited deployment

Cons

- Despite potentially lower per-unit costs from wider deployment, EOBRs may still be cost prohibitive for many small motor carriers
- Industry resistance would likely be greater if EOBRs are mandated
- Greater scope, challenge, and corresponding need for resources in estimating potential benefits and costs

Allowing EOBRs

Pros

- Industry resistance would be less likely
- Less costly approach for industry - only those motor carriers who perceive the benefits to exceed the costs would deploy EOBRs
- More limited scope, challenge, and corresponding need for resources in estimating potential benefits and costs
- Additional operational experience would likely be gained with on-board recording technologies

Cons

- Less improvement in the accuracy of records industry-wide
- Per-unit costs of EOBRs may be more, relative to a wider deployment
- Continued variation in the record keeping systems deployed in the field

6.3 Recommendations Concerning Potential Revisions to 49 CFR § 395

Irrespective of the above recommendations regarding mandating or allowing the use of EOBRs, the following recommendations are made regarding potential revisions to the Part 395 regulations regarding AOBRDs, which include 49 CFR § 395.2 and 49 CFR § 395.15.

The term AOBRD is currently defined in 49 CFR § 395.2 as "an electric, electronic, electromechanical, or mechanical device capable of recording driver's duty status information accurately and automatically as required by 49 CFR § 395.15. The device must be integrally synchronized with specific operations of the commercial motor vehicle in which it is installed. At a minimum, the device must record engine use, road speed, miles driven, the date, and time of day."

Recommendations concerning potential revisions to 49 CFR § 395 regarding AOBRDs and EOBRs include the following:

- Revise 49 CFR § 395.2 and 49 CFR § 395.15 to reflect and incorporate the recommended EOBR performance standards presented earlier in Section 4.3 and Section 6.1.

- Specify a consistent electronic file format (e.g., ASCII) and record layout for the data to facilitate electronic transfer of records to roadside safety enforcement personnel that are so equipped. One approach might be to specify a file format compatible with the ASPEN software and CAPRI software often used for roadside enforcement and compliance reviews.

- Specify a consistent display format (e.g., graph grid) for the RODS information to be viewed by roadside safety enforcement personnel.

- Specify warnings regarding faults and malfunctions in the EOBR system, and that the EOBR provide a reminder to the driver to revert to the use of paper RODS in case of such faults and malfunctions occurring.

- Require driver input to indicate changes in duty status (i.e., that EOBRs do not "estimate" what the driver duty status is based on information gathered from the vehicle such as vehicle motion, etc.). The use of various assumptions in EOBRs to attempt to estimate or infer duty status in the absence of driver input (e.g., based on vehicle movement and elapsed time, etc.) should be prohibited. Accurate recording of driver duty status will require that drivers be required to explicitly record data regarding change of duty status. Although this would require the driver to input (for example by pressing one of four "duty status" buttons) information at the time of each duty status change, this is still likely less burdensome in terms of the time and effort required than the current baseline of using handwritten RODS. Again, though currently many motor carriers and drivers may like the "hands-off" convenience of not having to input any information at the time of each duty status change, this can potentially lead to inaccurate recording of electronic RODS. This is due to real-world exceptions that may occur that are inconsistent with assumptions that may be used in attempts to infer whether a driver is currently in "driving" duty status or not. For example, because of the exception for use of a commercial motor vehicle as a private conveyance, the fact that a vehicle is in motion does not necessarily mean that the driver is in "driving" duty status. This is just one of many examples of the types of problems that can arise. Therefore, it is recommended that drivers be required to explicitly input data regarding change of duty status.

- Require that drivers have the ability to view and inspect their own electronic records.

- Improve the process and requirements by which devices are certified as being compliant with Part 395 (see Appendix E for further information regarding certification and conformity issues).

- Consider eliminating the requirement that an AOBRD "be integrally synchronized with specific operations of the commercial motor vehicle in which it is installed" as is currently required under 49 CFR § 395.2. For example, with regards to measuring and recording information concerning vehicle miles driven, the required performance standard should simply require that vehicle miles driven be recorded and be accurate to within some agreed upon tolerance level (e.g. +/- 5%) of actual vehicle miles driven. Although in current practice it is likely that the most cost effective way to achieve this is by use of miles driven data obtained from the vehicle ECM or odometer cable in older vehicles with no ECM, it may be the case that at some time in the future other technologies (e.g., inertial guidance systems, etc.) that can measure miles driven without relying upon the vehicle ECM may be developed as cost effective options for achieving this performance standard. The use of a performance-based standard as recommended here would allow such an innovative technology to be utilized, where as requiring the device to be "integrally synchronized with specific operations of the commercial motor vehicle" may not.

- Consider eliminating the requirement to record “road speed” and “engine use” that is currently specified under 49 CFR § 395.2. A sufficiently accurate measure of miles traveled by the vehicle (regardless of what speed that travel took place, or whether the engine was on or not) should be adequate for electronic RODS without the need for information on “road speed” or “engine use.” Also, a requirement for recording “road speed” may reduce driver acceptance of EOBRs, since as noted earlier in Section 2.3.7 in the review of public comments received by FMCSA regarding the September 1, 2004 ANPRM on EOBRS, drivers worry about possible use of electronically recorded data for enforcement of speed violations.

6.4 Recommended Next Steps

Based on the findings of this report, the following next steps are recommended:

- Revise 49 CFR § 395.2 and 49 CFR § 395.15 to reflect and incorporate the recommended EOBR performance standards presented earlier in Section 4.3 and Section 6.1, and the other considerations recommended in Section 6.3.

- Conduct an up-to-date comprehensive cost-benefit analysis of the use of EOBRs.

- Develop more detailed performance specifications for EOBRs in conjunction with industry and equipment vendors.

- Design and implement a field operational test of various EOBR system designs in order to obtain additional information regarding practical operational issues surrounding the use of EOBRs.

- Conduct outreach with commercial motor carriers and EOBR vendors to discuss issues, trends and concerns related to the use of EOBRs.

- Evaluate roadside enforcement and compliance review processes and training needs to ensure that they address the use of EOBRs.

These steps should provide the additional information and foundation upon which a decision can be made to potentially mandate the use of EOBRs at some time in the future for either certain sub-segments of the motor carrier industry or industry-wide.

Bibliography

Research Reports

Campbell, Kenneth L, Sylvia Wanner Lang, and Michael C. Smith. *Electronic Recorder Study. Final Report*. University of Michigan Transportation Research Institute (UMTRI) and Science Applications International (SAIC). June 1998. URL <http://dmses.dot.gov/docimages/pdf89/294145_web.pdf>

Corredor, Alfonso, PhD. *Commercial Vehicle Telematics Development Strategies*. ITS America News, Vol. 13, No. 1, January 2003.

Driscoll, Clem and Dick Wolfe. Driscoll-Wolfe Marketing and Research Consulting. *Survey of Telematic Systems Owners and Users*. August 2004.

The Freedonia Group. *Electrical/Electronic Products - Medium & Heavy Truck Aftermarket*. 2003.

Freund, Deborah. *On-Board Automated Recording for Commercial Motor Vehicle Drivers' Hours-of-Service Compliance: The European Experience*. August 20, 2001. URL <http://dmses.dot.gov/docimages/pdf89/294144_web.pdf>

Frost & Sullivan Research Report. *North American Commercial Vehicle Telematics Markets*.

Thomas, Neill L. and Deborah M. Freund. *On-Board Recording for Commercial Motor Vehicles and Drivers: Microscopic and Macroscopic Approaches*. Presented at the International Symposium on Transportation Recorders. Arlington, VA. May 3-5, 1999.

U.S. Department of Transportation, Federal Highway Administration. *Critical Issues Relating to Acceptance of CVO Services by Interstate Truck and Bus Drivers. Final Report*. August 8, 1995. Prepared by Penn + Schoen Associates, Inc. Washington, DC. Contract No. DTFH61-94-C-00182. Docket number FMCSA-1997-2350-426.

U.S. Department of Transportation, Federal Highway Administration. *Smart Cards in Commercial Vehicle Operation*s. Final Report. December 1996. Prepared by 3-G International, Inc. Washington, DC. FHWA Report No. FHWA-MC-97-022. NTIS No. PB97-130504. Docket Number FMCSA-1997-2350-616.

U.S. Department of Transportation, Federal Motor Carrier Safety Administration. *Motor Carrier Technologies: Fleet Operational Impacts and Implications for Intelligent Transportation Systems/Commercial Vehicle Operations*. Prepared by the ATA Foundation. October 1999.

U.S. Department of Transportation, Federal Motor Carrier Safety Administration, Office of Policy and Program Development. *On-Board Recorders: Literature and Technology Review*. Prepared by Brad Wright and Erin Fogel, Cambridge Systematics, Inc. July 2002. URL <http://dmses.dot.gov/docimages/pdf89/294138_web.pdf>

U.S. Department of Transportation, Federal Motor Carrier Safety Administration. *Regulatory Impact Analysis and Small Business Analysis for Hours of Service Options*. Prepared by ICF Consulting, Inc., and Jack Faucett Associates. December 2002. URL <http://dmses.dot.gov/docimages/pdf85/240882_web.pdf>

U.S. Department of Transportation, Federal Motor Carrier Safety Administration, Office of Business and Truck Standards and Operations. *Hours of Service (HOS) Research and Analysis Modules*. January 21, 2003. URL <http://dmses.dot.gov/docimages/pdf89/294137_web.pdf>

U.S. Department of Transportation, Federal Motor Carrier Safety Administration. *Preliminary Environmental Assessment for Electronic On-Board Recorders for Hours-of-Service Compliance*. September 1, 2004. URL <http://dmses.dot.gov/docimages/pdf89/294905_web.pdf>

U.S. Department of Transportation, Federal Motor Carrier Safety Administration. *On-Board Recorders: Literature and Technology Review. 2005 Update*. Prepared by the U.S. Department of Transportation, Volpe National Transportation Systems Center, and Cambridge Systematics, Inc. March 2005.

Williams, D., et. al. *Hazmat Safety & Security Field Operational Test. Final Report.* August 31, 2004. Document approved for public disclosure. Prepared by Battelle, in association with Qualcomm, the American Transportation Research Institute, the Commercial Vehicle Safety Alliance, and the Spill Center, for the U.S. Department of Transportation, Federal Motor Carrier Safety Administration.

Background Information Regarding Hours-of-Service Regulations

Revised HOS Regulations - Fact Sheet. URL <http://www.fmcsa.dot.gov/Home_Files/hos/faxsheet.pdf>

New Hours of Service (HOS) Rules. Frequently Asked Questions (FAQs). February 24, 2004. URL <http://www.fmcsa.dot.gov/Home_Files/hos/hos_faqs.pdf>

Supporting Statement Hours of Service of Drivers Regulations. Information Collection Budget Supporting Statement for 49 CFR § 395. December 21, 2004.

Revised HOS Regulations. PowerPoint presentation. April 2003. URL <http://www.fmcsa.dot.gov/Home_Files/hos/HOS_Presentation12.ppt>

Federal Register Notices

Federal Register, Volume 52, Number 133. *Driver's Record of Duty Status; On-Board Recording Devices; Request for Comments. Advance notice of proposed rulemaking (ANPRM).* July 13, 1987.

Federal Register, Volume 53, Number 49. *Driver's Record of Duty Status. Automatic On-Board Recording Devices. Notice of proposed rulemaking*. March 14, 1988.

Federal Register, Volume 53, Number 190. *Driver's Record of Duty Status; Automatic On-Board Recording Devices. Final rule and notice of termination of exemptions*. September 30, 1988.

Federal Register, Volume 61, Number 215. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Advance notice of proposed rulemaking; request for comments*. November 5, 1996.

Federal Register, Volume 63, Number 65. *Global Positioning System (GPS) Technology. Notice of interpretation; request for participation in pilot demonstration project*. April 6, 1998. URL <http://www.fmcsa.dot.gov/rulesregs/fmcsr/final/040698n.pdf>

Federal Register, Volume 65, Number 85. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Notice of proposed rulemaking (NPRM); request for comments*. May 2, 2000.

Federal Register, Volume 68, Number 81. *Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations; Final Rule*. April 28, 2003. URL <http://www.fmcsa.dot.gov/rulesregs/fmcsr/final/hos_997.pdf>

Federal Register, Volume 68, Number 189. *Hours of Service of Drivers. Final rule, Technical amendments*. September 30, 2003. URL <http://www.fmcsa.dot.gov/rulesregs/fmcsr/final/03-24765HOS_TechnicalAmendment.pdf>

Federal Register, Volume 68, Number 238. *Exemption to Allow Werner Enterprises, Inc. to Use Global Positioning System (GPS) Technology to Monitor and Record Drivers' Hours of Service. Notice of intent to grant exemption; request for comments*. December 11, 2003. URL <http://www.fmcsa.dot.gov/rulesregs/fmcsr/final/03-30692_WernerEnterprise_intenttogrant_exemption.pdf >

Federal Register, Volume 69, Number 169. *Electronic On-Board Recorders for Hours of Service Compliance. Advance notice of proposed rulemaking; request for comments*. September 1, 2004. URL <http://www.fmcsa.dot.gov/rulesregs/fmcsr/final/04-19907_EOBRs.pdf>

Federal Register, Volume 69, Number 182. *Exemption to Allow Werner Enterprises, Inc. to Use Global Positioning System (GPS) Technology to Monitor and Record Drivers' Hours of*

Service. September 21, 2004. URL <http://www.fmcsa.dot.gov/rulesregs/fmcsr/final/04-21139_Werner_
Exemption.pdf>

Federal Register, Volume 60, Number 212. *Hours of Service of Drivers; Supporting Documents. Supplemental notice of proposed rulemaking; request for comments*. November 3, 2004. URL <http://www.fmcsa.dot.gov/rulesregs/fmcsr/final/04-24176_hos_
supporting_documents.pdf>

Federal Register, Volume 70, Number 14. *Hours of Service of Drivers. Notice of proposed rulemaking; request for comments*. January 24, 2005. URL <http://dmses.dot.gov/
docimages/p80/312470.pdf>

Regulatory Guidance for the Federal Motor Carrier Safety Regulations (FMCSRs)

49 CFR § 395.2. *Hours of Service of Drivers. Definitions*.

49 CFR § 395.8. *Hours of Service of Drivers. Driver's record of duty status*.

49 CFR § 395.15. *Hours of Service of Drivers. Automatic On-Board Recording Devices*.

Documents Related to the Werner Enterprises Paperless Electronic Logging System Demonstration Project

Federal Register, Volume 63, Number 65. *Global Positioning System (GPS) Technology. Notice of interpretation; request for participation in pilot demonstration project*. April 6, 1998. URL <http://www.fmcsa.dot.gov/rulesregs/fmcsr/final/
040698n.pdf>

Memorandum of Understanding (MOU) Between Werner Enterprises, Inc., and Federal Motor Carrier Safety Administration. Establishing the Terms of the Werner Pilot. June 10, 1998. URL <http://dmses.dot.gov/docimages/pdf89/
294141_web.pdf >

Memorandum of Understanding (MOU) Between Werner Enterprises, Inc., and Federal Motor Carrier Safety Administration. Revising the Terms of the Werner Pilot. March 26, 2002. URL <http://dmses.dot.gov/docimages/pdf89/
294139_web.pdf>

Federal Register, Volume 68, Number 238. *Exemption to Allow Werner Enterprises, Inc. to Use Global Positioning System (GPS) Technology to Monitor and Record Drivers' Hours of Service. Notice of intent to grant exemption; request for comments*. December 11, 2003. URL <http://www.fmcsa.dot.gov/rulesregs/fmcsr/final/03-
30692_WernerEnterprise_intenttogrant_exemption.pdf >

Federal Register, Volume 69, Number 182. *Exemption to Allow Werner Enterprises, Inc. to Use Global Positioning System (GPS) Technology to Monitor and Record Drivers' Hours of Service. Grant of Exemption*. September 21, 2004. URL <http://www.fmcsa.dot.gov/rulesregs/fmcsr/final/04-21139_Werner_Exemption.pdf>

Public Comments and Other Docket Materials FMSCA

Public Comments regarding Proposed EOBR Rulemaking (as of January 26, 2005, approximately 330 had been received. URL <http://dms.dot.gov/search/searchResultsSimple.cfm?searchType=docket&numberValue=18940>

Letter from FMCSA to Abbott Tachograph. September 23, 1991. URL <http://dmses.dot.gov/docimages/pdf89/294147_web.pdf>

Letter from FMCSA to Delphi Corporation. December 1, 2003. URL<http://dmses.dot.gov/docimages/pdf89/294135_web.pdf>

Appendix A: Commercial Motor Vehicle (CMV) Monitoring, Tracking, and Logistics Management Products, 2005

This Appendix contains a brief overview of monitoring, tracking and logistics management products currently produced by a variety of equipment and software manufacturers. Many of these products provide EOBR-like functionality but are not necessarily compliant with 49 CFR § 395.15. The product descriptions presented in the table are based primarily on information provided by each manufacturer's website.

Company	Website	Product	Product Description
AOBRD. EOBR and Related Equipment and Software Vendors			
@Road (Mobile Resource Management)	www.atroad.com	GeoManager	See traveled paths with 15-minute update rate; receive real-time alerts for speed violations; generate reports on-demand, or schedule for delivery; export reports to any standard databases or applications; retrieve stored data for up to 90 days; receive text messages.
Advanced Productivity Computing	www.advancedproductivity.com	Coyote Vehicle Location Manager	Provides two-minute real-time updates, including map location, current address, speed, and heading; offers many reporting, history, and status features; senses key on/off, door open/close, or other such activity.
Air IQ, Inc.	www.airiq.com	AirIQ OnBoard	Tracks vehicle location, speed, and direction; records and reports additional vital information; remotely disables or enables a vehicle and locks and unlocks doors; incorporates a Windows-based graphical user interface and digitized mapping.
AirLink, Inc.	www.airlink.com	AirLink Tracking System	Track one, all, or groups of vehicles; update vehicle position by time or distance; view fleet from multiples PCs from anywhere on the Internet; permits two-way messaging.
Burdilla Lanser Technologies LLC	www.trakwhere.com	TrakWhere	GPS tracking unit that tracks assets with an external power source; attaches to top of cargo container, railcar, or container; cargo door open, "panic" button, high temperature, etc.; sends information to Globalstar satellites that relay information to ground stations, where the information is processed and made available to the user via the Internet; provide location updates at user-defined intervals as well as up to four customizable alarms; provide geo-fencing that alerts the user if the cargo has crossed a user-defined geographic boundary.

Appendix A: CMV Monitoring, Tracking, and Logistics Management Products, 2005 (continued)

Company	Website	Product	Web Site Description
AOBRD. EOBR and Related Equipment and Software Vendors (continued)			
Burdilla Lanser Technologies LLC	www.trakwhere.com	InfoTrak	GPS tracking, monitoring and management tool that can locate and identify any vehicle or asset; report on any environmental variables such as speed and temperature, set rules such as geo-boundaries, time of use, and speed, and instantly alert managers when rules are broken.
Cabit Systems	www.cabit.com	Cabit Online Service Bureau (OSB)	Real-time messaging and delivery acknowledgments; customizable data packets; touch-screen commands; customizable screens; electronic signature capture; electronic bills of lading; dispatch messaging; log book reports; fuel reports
Cadec	www.cadec.com	Mobius TTS	Automatic vehicle location; automatic border crossing notification; clerical automation; driver performance information; custom prompts; electronic DOT logs; electronic tachograph with split screen GPS location; flexible routing; global positioning system receiver; industry standard platform uses Windows CE; instant messaging
Cheetah Software Systems	www.cheetah.com	Cheetah Freight, Cheetah Delivery, Cheetah Tracks	Cheetah Freight and Cheetah Delivery offer real-time routing, delivery, and dispatch information to LTL companies while running on existing Windows computers; Cheetah Tracks is ideal for small fleets and connects dispatchers to employees using two-way wireless messaging and GPS-enabled mobile phones.
Cloudberry Wireless Services	www.cloudberry.com	Cloudberry	GPS tracking and communication system that gives managers real-time visibility and control of their mobile workers, vehicles, and assets; locate and track large fleets in real-time across broad geographies; exchange text messages with mobile employees; analyze a variety of management reports to streamline operations; and integrate real-time location data into enterprise applications.

Appendix A: CMV Monitoring, Tracking, and Logistics Management Products, 2005 (continued)

Company	Website	Product	Web Site Description
AOBRD. EOBR and Related Equipment and Software Vendors (continued)			
CSI Wireless	www.csi-wireless.com	Fleet-Link	Location and status information for containers, trailers, leased vehicles, hazardous shipments and other high-value cargo; can operate independently of the truck or other power source for up to 18 days, or indefinitely with optional solar panel; advanced GPS for 15-meter location accuracy; eight inputs and outputs to and from sensors, relays, engine controls are customizable for all monitoring and tracking applications; programs up to 65 exceptions, meters, actions, events and engine exclusions/inclusions, such as unscheduled entry, load weight change, excessive speed, engine use and idle time, refrigeration tem changes, alarm alerts, geo-fence infractions, and more; report continuously, hourly, or upon demand.
Darby Corporate Solutions	www.dcs.com	Diplomat	Integrated GPS/wireless remote tracking units; Diplomat can track through Diplomat Express, Darby's slimline wireless communication platform, using either CDPD or iDen technology; uploaded location and sensor reports (such as engine on/off status) are processed in DCS servers, then downloaded to the secure Diplomat web site; authorized users can see and access near real-time data through maps or a suite of 17 customizable reports.
Datacom	www.datacom.com	Mobicom	Monitors distances traveled, engine running time, engine failures, power take-offs and variations in temperature of vehicles used to transport perishable goods; calculates fuel consumption, idling time, engine speeds and use of auxiliary heating; monitors safety factors, including excess driving speeds, alarm events, violations of geographic or temporal boundaries, remote engine shutdowns, and unauthorized vehicle use or stops.
EarthTRAK	www.earthtrak.com	VTS-1000 Realtime Tracking System	Integrated GPS and Cellular system that provides over 98 percent coverage of the United States and parts of Mexico and Canada; remote starter interrupt; door unlock capability; up to three configurable boundaries; three months of online data logging; incident schedules and triggers on a monthly calendar; real-time phone or e-mail notification of speeding, theft, or unexpected zone boundary crossings.

Company	Website	Product	Web Site Description
AOBRD. EOBR and Related Equipment and Software Vendors (continued)			
EarthTRAK	www.earthtrak.com	GeoTAB GO Passive Tracking System	GPS technology stores detailed information about vehicle's speed, idle time, position, and optional information such as door open/close events; records up to 10,000 miles of activity in detail; records one hour of second-by-second data for use in accident reconstruction; CheckMate Software displays start/stop reports with addresses, idle time reports, engine over-rev reports, over-speed reports, etc.
Elcon Mobility (Germany)	www.elcon-mobility.de	E-Trip	Records vehicle, driver, and environmental data; transmits data via GSM; electronic toll registration, accident data recorder, display of limits and threshold values, and states of alert; can be configured according to individual requirements.
Fleetilla	www.fleetilla.com	Fleetilla FL 1700	Real-time GPS fleet and truck tracking; Intelligent Coverage Sensing provides reliability in outlying cellular areas; optional keypad provides one-touch communications; automatic and on-demand location updates; all location updates include status information – moving, stopped, etc.; searchable route history; variety of detailed reports.
Fleet Management Solutions, Inc.	www.fleetmanagementsolutions.com	MLT-300 Mobile Location Tracking System	Includes a GPS receiver and two-way satellite communications modem that provides contact with the Fleet Management Solutions data center from virtually any location around the globe; features include real-time vehicle location, speed and direction, automated DOT logs and reports, stop and idle reports, excessive speed alerts, boundary and geofencing with automated alerts, scheduling and dispatch functions, optional two-way messaging terminal (MDT-PRO), optional cargo sensing (CST-300), additional sensors available for overheat, temperature, weight, fuel, etc.; MDT-PRO Message Display Terminal enables real-time, two-way communication between central operations and remote drivers.

Appendix A: CMV Monitoring, Tracking, and Logistics Management Products, 2005 (continued)

Company	Website	Product	Web Site Description
AOBRD. EOBR and Related Equipment and Software Vendors (continued)			
GeoLogic Solutions	http://www.gogeologic.com	MobileMax	Dual-mode technology; vehicle fault code monitoring; built-in distress alert; automatic state line crossing reports; on-board GPS standard; dispatch messaging; real-time messaging; integration with leading dispatch software; street-level mapping; proximity notifications; driver performance monitoring.
GeoLogic Solutions	http://www.gogeologic.com	TrailerMax	Real-time untethered trailer tracking; event monitoring and notification, including arrival at delivery/loading location, departure from delivery/loading location, door open/closed illegal entry, door open/closed normal delivery, device tampering alert.
GE Trailer Fleet Services	www.trailerservices.com	VeriWise	Uses dual satellite technology to provide trailer location anywhere in North America; GPS reports trailer position; intelligent battery power management gives 120-day untethered capability; web-based reporting for easy 24/7 access to fleet data at no extra cost and with no extra software needed.
GPS Management	www.gpsmanagement.com	Eye in the Sky Active D1000	Digital tracking system combines GPS technology with digital wireless communication to monitor vehicle location, speed, stops, use of cargo doors, engine temperature, etc.; transmits information about the vehicle via digital wireless technology to a PC, using GPS Management's Eye in the Sky software; locate vehicles in real-time, retrace vehicle routes, run and print a variety of custom reports.
GPS Management	www.gpsmanagement.com	Eye in the Sky Passive P3000	Stores information about vehicle location, heading, speed, stops, use of cargo doors, and other vehicle functions; stores up to one week's worth of positions in memory that cannot be erased by power failure; automatically downloads all records to a base station PC each night when vehicle returns to yard; uses Eye in the Sky software to map vehicles' location and movement and print custom reports, including detail tracking, average speed, fastest speed, stops, and discretes.

Appendix A: CMV Monitoring, Tracking, and Logistics Management Products, 2005 (continued)

Company	Website	Product	Web Site Description
AOBRD. EOBR and Related Equipment and Software Vendors (continued)			
GPS Management	www.gpsmanagement.com	Eye in the Sky Asset Tracking	Mobile Locating Unit can track location, heading, and speed of any vehicle; can remotely disable or enable vehicle ignition and lock or unlock vehicle doors from a PC; can send an alarm through fax, e-mail, or pager if vehicle crosses predetermined boundaries.
Homeland Security Technology Corporation	www.hstcglobal.com	Secur-It-Trac	Enables shippers, carriers, and authorized third parties to monitor each truck and its contents; on-board system provides 24/7 route monitoring, route planning, trailer tampering alert, reefer monitoring alert, off-route alert, trailer disconnect alert, panic button, geofencing, reverse geofencing, geo-routing, vehicle immobilization, two-way messaging, customs flow control, position reporting, and history logging (location, speed, direction).
Ida Corporation	www.idaco.com	TRAKIT-15	Intelligent GPS data logging; more than 1,200 record data buffer; data port for use in personal navigation while recording vehicle activity for analysis; dynamic speed settings for recording positions at different time intervals at different speeds; data ports are programmable for custom applications; data can be downloaded to the office computer for analysis.
Ida Corporation	www.idaco.com	TRAKIT-20	Use for both real-time monitoring and data logging; attaches to radio and circuit switched cellular communications equipment; intelligent triggering of real-time position reporting; intelligent position recording in the on-board data buffer; download buffer data over the air to office computer; event alerts to dispatcher.
Infosat Telecommunications	www.infosat.com	Fleet Management Service	Automatic vehicle locating (AVL) and routing; dispatch system automation; real-time messaging; data logging of vehicle messaging; driver logs; fuel tax reporting; proof of delivery; customs expediting

Appendix A: CMV Monitoring, Tracking, and Logistics Management Products, 2005 (continued)

Company	Website	Product	Web Site Description
AOBRD. EOBR and Related Equipment and Software Vendors (continued)			
Insight USA	www.mds-inc.com	StreetEagle Delivery Solution	GPS tracking system that shows the exact routes any vehicle traveled for any time period; logs information when sensors on doors, pumps, etc. are triggered; shows a dispatcher the current location, status, speed, and heading for each vehicle; generates reports showing hours worked, arrival and departure times, and all aspects of vehicle activity during a self-definable time period; provides notification when vehicles enter or leave a zone defined by the dispatcher.
InterTrak	www.trackmenow.com	InterTrak	On-board GPS/cellular transponder supported by wireless/ web/telephone-based control system that provides real-time fleet location data, trailer gear up or down, tractor door open or closed, out of temperature reefer operation, and out of area operation or vehicle theft; Geo-fencing provides dispatch per-sonal with an automated and rapid notification tool should a vehicle leave a predefined geographic area; fleet personnel can be notified of a geographic event at their desk, at home by phone, e-mail or two-way pager.
International Road Dynamics, Inc.	www.irdinc.com	Automated Vehicle Compliance Monitoring System (AVCMS)	Uses GPS and GIS systems to locate and track vehicles; automatically collects truck movement information that can be integrated with other vehicle information such as total weight, tire pressure, and other measurable truck parameters; information is stored by the on-board equipment and automatically reported to the Centralized Database Administration System via wireless communication; using GIS, each trip can be traced back to specific roads used throughout the day, month, and year; applications include electronic permitting, electronic log books, and automatic billing.

Appendix A: CMV Monitoring, Tracking, and Logistics Management Products, 2005 (continued)

Company	Website	Product	Web Site Description
AOBRD. EOBR and Related Equipment and Software Vendors (continued)			
International Road Dynamics, Inc.	www.irdinc.com	Service Fleet Vehicle Driver Management System	Collects driver performance and vehicle operations data and provide concise reports, enabling objective tracking of driver performance; automatically tracks average speed and top speed, acceleration and braking, pick-up and drop-off times, time at site, vehicle stop time, routes and distances traveled, back-up lights, warm-up and idle time, second-by-second accident recording, payroll hours, and after hours use.
LinksPoint	www.linkspoint.com	GlobalPoint RouteTrak	Combines a GPS receiver with a handheld computer to collect the travel history of vehicles or personnel; captures a “breadcrumb trail” of GPS points and stores them on the handheld computer when the vehicle is on the road, then uploads the data for analysis when the vehicle returns to the office or depot; can display travel history and create a map and report of actual route taken, stop location and times, vehicle speed, actual miles traveled, etc.
Lorantec Systems, Inc.	www.lorantec.com	LoranTrack	Provides real-time tracking anywhere in the world together with proprietary dynamic alert and exception notification software; allows customers to identify estimated time of arrival of each shipment, and the precise location of each shipment or asset displayed on a GIS map; automatically notifies customers of status changes, shipment delays, geofence violations, security violation, and cargo integrity violations (if the container is jolted, contaminated by water, or the inside temperature changes).
Minor Planet (UK)	www.minorplanet.com	Vehicle Management Information (VMI)	Continually monitors and records vehicle’s location, status, direction and speed using GPS; allows captured data to be retrieved automatically by FM radio when the vehicle returns or with a GSM cellular telephone when the vehicle is away from base; generates detailed maps of where the vehicle has been, the route it has taken, and how long it has been stopped; generates reports that can be used for a variety of purposes, including electronic timesheets; permits route planning and text messaging.

Appendix A: CMV Monitoring, Tracking, and Logistics Management Products, 2005 (continued)

Company	Website	Product	Web Site Description
AOBRD. EOBR and Related Equipment and Software Vendors (continued)			
Mobiapps	www.mobiapps.com	m-Trak	Mobile vehicle tracking system that integrates GPS technology and wireless communications offering real-time tracking information such as position, time and speed traveled on map display; two-way data transmission of voice/text between fleet managers and the vehicle facilitating optimal routing; comprehensive event monitoring such as detours, stoppages, temperature, pressure, over speeding, etc.; alert signals for emergencies and predefined events such as detouring, over speeding, etc.; numerous types of reports and charts; digital map interface and full-fledged GIS capability; customizable visual settings for easy navigation; and user-friendly software and tamper-proof devices.
Mobilearia, Inc.	www.mobilearia.com	FleetOutlook	Fleet Tracking blends GPS technology, dispatcher-optimized views and zoomable maps to show where vehicles are and where they've been; Trip Information provide precise two-way communications across the entire loading, unloading, pickup and delivery cycle; Vehicle Diagnostics evaluates j-bus data, discrete inputs and select analog parameters in real-time; Driver Log enables automatic creation and submission of reliable DOT- and FMCSA 395-compliant driver logs.
Network Innovations	www.networkinv.com	TT-3002C Inmarsat C Land/Mobile Transceiver	Allows in-vehicle position reporting to multiple locations at programmable intervals, data monitoring, route planning, messaging services, and more; can be controlled by the TT-3606C portable Message Terminal (which features a back-lit keyboard and 16 x 32 character LCD display), by an attached PC, or remotely using a Capsat Manager program; allows e-mail, telex, mobile-to-land fax, and X.25 data transmissions worldwide.

Appendix A: CMV Monitoring, Tracking, and Logistics Management Products, 2005 (continued)

Company	Website	Product	Web Site Description
AOBRD. EOBR and Related Equipment and Software Vendors (continued)			
Network Innovations	www.networkinv.com	EasyTrack Mini-C System	Offers global data communication via the Inmarsat-C Satellite Network, and supports all Inmarsat-C services, including e-mail, position reporting and polling, fax, telex, X.25, as well as between Inmarsat-C mobiles; can be used in Automatic Vehicle Location, Vehicle Monitoring System, Supervisory Control and Data Acquisition, and e-mail applications; permits position reporting, data monitoring, messaging, loading and unloading information, route planning, etc.
Ortivus North America	www.ortivusna.com	AVeL-BASE	Displays vehicle reports and status graphically on a high-resolution map display; view vehicles anytime, anywhere, in real-time; provides messaging functions, which enable all vehicles to have coordinated communications with the control center; render different types of vehicles with different icons or symbols; automatically update and record fleet status for later playback and analysis.
Pana-Pacific	www.panaoem.com	Truck Productivity Computer	Track vehicles in real-time; streamline the creation of daily driver logs; stay current with driver, load, and vehicle status electronically.
PeopleNet	www.peoplenetonline.com	eDriver Logs	Automatically calculates driving hours of service through a combination of GPS location and PerformX engine diagnostic information; drivers indicate on duty/off duty/sleeper berth/driving status through the Palm handheld device or message display; this information is then available to the driver, dispatcher, or compliance officer through the PeopleNet Fleet Manager web-based interface; drivers can present up-to-date logbook information to law enforcement/DOT on demand.
PlanetLink Communications, Inc.	www.planettraks.com	PlanetTraks	Permits real-time tracking of vehicles from any Internet-enabled device; can provide in-vehicle navigation and driving instructions; permits monitoring of fleet operations from multiple, simultaneous locations; permits automated inventory control allowing real-time reporting of delivery status and the preparation of shipping plans while a fleet is still in the field; allows for the analysis and archiving of fleet operations data to support maintenance planning and operations.

Appendix A: CMV Monitoring, Tracking, and Logistics Management Products, 2005 (continued)

Company	Website	Product	Web Site Description
AOBRD. EOBR and Related Equipment and Software Vendors (continued)			
Prophesy Transportation Solutions, Inc.	www.prophesymc.com	Prophesy Mobile Comm TrackerPlus	Mobile tracking system that uses GPS-enabled phones to transmit data between drivers and company headquarters, permitting dispatchers to track vehicles in real-time, send trip and other critical information to drivers (detailed load information, scheduled arrival and departure times, text messages), and receive trip and other critical information from drivers (actual arrival and departure times, BOL and POD, actual goods quantities).
Qualcomm	www.qualcomm.com	OmniTRACS	Automatic satellite vehicle positioning incorporating one of two available satellite-position technologies - the standard Qualcomm Automatic Satellite Position Reporting (QASPR) system or the optional Global Positioning System (GPS); two-way text and data communications; QTRACS fleet management solution to display data from OmniTRACS solution; customizable reports; AS/400 server, Windows server, or web-hosted operation; message delivery; Qualcomm Network Operations Center; driver authentication; driver and vehicle performance monitoring; tamper-detection alerts; automated arrival and departure; remote vehicle disablement
Qualcomm	www.qualcomm.com	FleetAdvisor	Supports full-function, on-board computing, electronic DOT logs, state line crossing, vehicle tracking, integrated back-office software, and real-time wireless communications; runs on the MVPc in-vehicle computer, which uses the Windows CE platform; can be used with automated dispatch systems and other back-office applications such as dispatch, route planning, and accounting/payroll.

Appendix A: CMV Monitoring, Tracking, and Logistics Management Products, 2005 (continued)

Company	Website	Product	Web Site Description
AOBRD. EOBR and Related Equipment and Software Vendors (continued)			
Remote Dynamics	www.remotedynamics.com	Vehicle Management Information (VMI)	GPS-based vehicle management system calculates and records vehicle position, speed, and distance traveled; proprietary software allows users to view vehicle location on a map plus historical information that can be analyzed in detail; data collection unit will store approximately two to three weeks of data based on an eight-hour work day and one-minute logging intervals; remote downloading provides automatic downloading of data from a vehicle either immediately or at a scheduled day and time.
Remote Dynamics	www.remotedynamics.com	REDIView (forthcoming)	Provides real-time mapping, trip replay, and vehicle activity reports; includes a series of exception-based reports designed to highlight inefficiencies in the operations of a vehicle fleet.
Safefreight Technology	www.safefreight-tech.com	SecurityGuard	Driver or dispatcher activated trailer security system that features an alarm signal transmitter, trailer-mounted sensors, control panel and audible and visible theft deterrents.
Sage Quest	www.sage-quest.com	SageQuest	GPS mobile tracking unit that transmits the minute-by-minute location of a vehicle across a wireless network and through the Internet to a dispatch office; builds a complete history of vehicle activity; sends e-mails; generates reports that include routing information, mileage tracking, length and location of stops, verification of services, vehicle maintenance status, ignition/alarm on or off, speed, door open and closed, and temperature reports.
Satellite Security Systems	www.satsecurity.com	GlobalGuard	Command and control system comprised of GPS technology and wireless data communication networks that link field transponders to a centralized monitoring center; capabilities include virtual perimeter, location monitoring, routing, two-way command and control, and automated notification of events.
Scanware, Inc.	www.scanware.com	LogSCAN Plus	In-house auditing solution with features that include distributing reports or images over the Internet, generating e-mail from LogSCAN plus, and data input from multiple sources.

Appendix A: CMV Monitoring, Tracking, and Logistics Management Products, 2005 (continued)

Company	Website	Product	Web Site Description
AOBRD. EOBR and Related Equipment and Software Vendors (continued)			
Scanware, Inc.	www.scanware.com	EZLog Machine	Provides the benefits of LogSCAN in an outsourcing format; logs are scanned in-office, electronically transmitted to Scanware, processed through LogSCAN, and the results retransmitted to the office within three days.
Shelby Solutions, Inc.	www.shelbysolutions.com	VIM-NET	Vehicle tracking and data acquisition system that interfaces with any vehicle's data bus; allows users to access a secured Web site and obtain GPS street-level mapping information on a vehicle's location; allows users to gather information on odometer data, electrical content, fuel level, oil life, diagnostic trouble codes, vehicle speed, door openings/closures and other parameters; provides electronic fencing to establish a predefined radius of activity; can be used as a full service data retrieval system for diagnostics and fleet statistics.
SiriComm, Inc.	www.siricomm.com	e Logs	Software that allows drivers with a Palm to enter time and activity into a calendar; the information is automatically checked to insure that the HOS are legal; the system maintains a rolling tally of available hours for the driver as he makes new log entries; as entries are made, a graphic similar to current paper logs is displayed that is optimized for handheld computers.
TeleTouch	www.teletouch.com	GeoFleet	Customizable software package that receives data from multiple networks and the Teletouch family of devices, and displays that information on a computer in an easy to read map display; data is available for integration with existing third-party tracking solutions and management programs; features include detailed street-level mapping of North America or Europe using Microsoft MapPoint, text messaging, vehicle routing, geofencing, "breadcrumb" trail of vehicle movement, remote control of vehicle's installed switches and relays, and customizable icons and alerts.
Telogis	www.telogis.com	OnTrack	Web-based fleet management system that provides a database for storing and managing information need to manage a vehicle fleet; can generate a full suite of reports in an easy-to-read format meant for printing or saving; can provide real-time notice of arrival/departure, speeding, geofencing violations, stop duration, unknown stops, idle time.

Appendix A: CMV Monitoring, Tracking, and Logistics Management Products, 2005 (continued)

Company	Website	Product	Web Site Description
AOBRD. EOBR and Related Equipment and Software Vendors (continued)			
Terion	www.terion.com	FleetView 3 Trailer Management System	Web-based interface; dozens of reports; customizable reports; export reports/data to spreadsheet or text; TTIS conformant data interface; current/historical maps; location definition; e-mail/pager alerts
TrackStar	www.trackstar.com	Track Star Pathfinder 1X	Complete vehicle movement data storage-replay trips, generate reports; computer map displays-printable street-level maps; GPS-based location technology; call home indicator-signals driver to call dispatch office; software operates on single PC or on networks; remote “engine idle” capability-stop unauthorized movement of vehicle;
TransCore	www.transcore.com	Linktrak	Uses GPS and satellite communication technology along with web-based interface to locate and track vehicles using the Internet; permits communication with drivers via an in-cab unit; optional interface with vehicle’s on-board computer allows monitoring of idling time, speeding, oil temperature, etc.; sends automatic notifications to dispatch as vehicle enters a new jurisdiction.
TransMobile, Inc.	www.transmobile.us	StealthTrak NH1	Provides real-time GPS location, automatic time/distance activity updates, independent location queries, speed, direction, stops, entry/exit, ignition on/off; connects to mobile data devices for two-way text messaging.
Trimble	www.trimble.com	CrossCheck	Family of products that integrates GPS, wireless communication and computing technologies into a single mobile positioning and communications unit; each unit includes the IQEvent Engine firmware, which supports automated monitoring and reporting of vehicle activity and status; CrossCheck GSM provides automated position, event, and vehicle data logs of 2,500 to 3,000 records, and the ability to exchange messages between dispatch and the driver
Trimble	www.trimble.com	Telvisant Mobile Resource Management	Service that provides vehicle position and status reports, including stop events, speeding events, ignition on/off, generate standard vehicle activity reports; prints or exports vehicle activity report data, and has an available in-cap message terminal.

Appendix A: CMV Monitoring, Tracking, and Logistics Management Products, 2005 (continued)

Company	Website	Product	Web Site Description
AOBRD. EOBR and Related Equipment and Software Vendors (continued)			
Tripmaster	www.tripmaster.com	DT 40/GPS	Automatically captures positional data at each stop, plus automatically records position information at every state line and border crossing; may be integrated with popular handheld computers; integrates with Tripmaster Routes and other routing software, downloads route data; supported by Tripmaster Office open database software for Windows.
VDO (Germany)	www2.vdo.com/vdo	DTCO 1381 Digital Tachograph	Records driving, work, availability and break/rest times for the driver and crew, speed and distance traveled, specific parameters such as rpm and other work processes and events related to the vehicle.
VDO (North America)	www.vdona.com	Electronic tachograph	Track speed and/or rpm, distance traveled plus up to three other status events such as key on or off, doors opened or closed, usage of emergency sirens and lights, or other user-defined events; document excessive speeding, hard braking, and erratic acceleration/braking; collect a record or all vehicle activity over any period, up to eight days.
Vericom Technologies	www.vericomtechnologies.com	Data Management System (VDMS)	Analyze essential data such as routes, vehicle speed, miles driven, fuel consumption, and stop/start times and other operational data; analyze and customize collected data in user-specified formats; view, print and store customized reports detailing levels of vehicle and fleet activity; with Automatic Vehicle Location (AVL), ping vehicles to learn the vehicle's location as well as all other reporting events.
Waveburst Communications, Inc.	www.waveburst.com	Globalstar	Waveburst utilizes Aeris.net's MicroBurst services which uses the control channel portion of standard cellular channel to send and receive small packets of data to and from specialized end-point wireless devices, both fixed and mobile; Waveburst users can log on to web-based application to collect or view data, including vehicle location and geofencing.

Appendix A: CMV Monitoring, Tracking, and Logistics Management Products, 2005 (continued)

Company	Website	Product	Web Site Description
AOBRD. EOBR and Related Equipment and Software Vendors (continued)			
Xata Corporation	www.xata.com	Xatanet Gold	Automatic collection and submission of all driver logs; reports to monitor and analyze current performance of specific drivers, routes and vehicles against historical data; real-time route management through an online, interactive system that automatically monitors delivery status and provides graphical online maps of real-time vehicle location.
Xora	www.xora.com	Xora DOT Logs	Gives drivers the ability to log their duty status information from their mobile phones; stores driving records online for review through any standard Web browser for HOS compliance; runs on GPS-enabled mobile phones to allow administrators to see where all their trucks are on an interactive map.
Heavy-Duty Diesel Engine Manufacturers			
Detroit Diesel	www.detroitdiesel.com	DDEC Data	Dedicated memory in the ECM that records operating information about the engine and the vehicle and is used for diagnostics and reporting; stores three monthly records and a trip file that can be reset after it is extracted from the ECM; has an internal clock/calendar, with an internal battery, which is used to track time and stamps event-based occurrences, such as fault codes, hard braking incidents and last stop records; stores other beneficial information; can be used to generate reports.
Caterpillar	www.cat.com	ADEM 2000	Operating hours; fuel usage; machine start and stop times; machine security/theft protection; location/mapping; product watch alerts; fuel level; operator ID.
Truck Manufacturers			
Mack	www.macktrucks.com	DataMax	On-board data logger records trip and life of vehicle summaries, maintenance and fault information, engine duty cycle, daily driver stop and go cycles, etc.; related product Infomax Wireless delivers the data wirelessly from truck to PC.

Appendix B: On-Board Recorder Capabilities, 2005

This Appendix lists the same companies and products that are listed earlier in Appendix A, in the same order of presentation, and provides information regarding the capabilities of these products, and whether these companies consider their products to be compliant with 49 CFR § 395.15.

Company	Product	Is Product FMCSA Compliant?	Product Has Ability to Record HOS?	Product Has Ability to Record Duty Status?	Product Has Ability to Record Vehicle Location?
AOBRD. EOBR and Related Equipment and Software Vendors					
@Road (Mobile Resource Management)	GeoManager	Yes	Yes	Yes	Yes
Advanced Productivity Computing	Coyote Vehicle Location Manager	No	No	No	Yes
Air IQ, Inc.	AirIQ OnBoard	(unknown)	(unknown)	(unknown)	Yes
AirLink, Inc.	AirLink Tracking System	(unknown)	(unknown)	(unknown)	Yes
Burdilla Lanser Technologies LLC	TrakWhere	Yes	Yes	Yes	Yes
Burdilla Lanser Technologies LLC	InfoTrak	Yes	Yes	Yes	Yes
Cabit Systems	Cabit Online Service Bureau (OSB)	(unknown)	Yes	Yes	Yes
Cadec	Mobius TTS	Yes	Yes	Yes	Yes
Cheetah Software Systems	Cheetah Freight, Cheetah Delivery, Cheetah Tracks	No	No	No	Yes
Cloudberry Wireless Services	Cloudberry	(unknown)	(unknown)	(unknown)	Yes
CSI Wireless	Fleet-Link	No	No	No	Yes

Appendix B: On-Board Recorder Capabilities, 2005 (continued)

Company	Product	Is Product FMCSA Compliant?	Product Has Ability to Record HOS?	Product Has Ability to Record Duty Status?	Product Has Ability to Record Vehicle Location?
AOBRD. EOBR and Related Equipment and Software Vendors (continued)					
Darby Corporate Solutions	Diplomat	No (but is planned)	No	Yes	Yes
Datacom	Mobicom	(unknown)	(unknown)	(unknown)	Yes
EarthTRAK	VTS-1000 Realtime Tracking System	(unknown)	Yes	Yes	Yes
EarthTRAK	GeoTAB GO Passive Tracking System	(unknown)	Yes	Yes	Yes
Elcon Mobility (Germany)	E-Trip	(unknown)	(unknown)	(unknown)	(unknown)
Fleetilla	Fleetilla FL 1700	No (but is planned)	Yes	Yes	Yes
Fleet Management Solutions, Inc.	MLT-300 Mobile Location Tracking System	Yes	Yes	Yes	Yes
GeoLogic Solutions	MobileMax	(unknown)	(unknown)	(unknown)	Yes
GeoLogic Solutions	TrailerMax	(unknown)	(unknown)	(unknown)	Yes
GE Trailer Fleet Services	VeriWise	No	No	No	Yes
GPS Management	Eye in the Sky Active D1000	No	No	No	Yes
GPS Management	Eye in the Sky Passive P3000	No	No	No	No
GPS Management	Eye in the Sky Asset Tracking	No	No	No	Yes

Appendix B: On-Board Recorder Capabilities, 2005 (continued)

Company	Product	Is Product FMCSA Compliant?	Product Has Ability to Record HOS?	Product Has Ability to Record Duty Status?	Product Has Ability to Record Vehicle Location?
AOBRD. EOBR and Related Equipment and Software Vendors (continued)					
Homeland Security Technology Corporation	Secur-It-Trac	No	No	No	Yes
Ida Corporation	TRAKIT-15	No	Yes	Yes	Yes
Ida Corporation	TRAKIT-20	No	Yes	Yes	Yes
Infosat Telecommunications	Fleet Management Service	No	No	No	Yes
Insight USA	StreetEagle Delivery Solution	No	No	(unknown)	Yes
InterTrak	InterTrak	(unknown)	(unknown)	(unknown)	Yes
International Road Dynamics, Inc.	Automated Vehicle Compliance Monitoring System (AVCMS)	Yes	Yes	Yes	Yes
International Road Dynamics, Inc.	Service Fleet Vehicle Driver Management System	Yes	Yes	Yes	Yes
LinksPoint	GlobalPoint RouteTrak	No	No	No	Yes
Lorantec Systems, Inc.	LoranTrack	No (but is planned)	No	No	Yes
Minor Planet (UK)	Vehicle Management Information (VMI)	(unknown)	(unknown)	(unknown)	Yes
Mobiapps	m-Trak	No	Yes	Yes	Yes
Mobilearia, Inc.	FleetOutlook	Yes	Yes	Yes	Yes

Appendix B: On-Board Recorder Capabilities, 2005 (continued)

Company	Product	Is Product FMCSA Compliant?	Product Has Ability to Record HOS?	Product Has Ability to Record Duty Status?	Product Has Ability to Record Vehicle Location?
AOBRD. EOBR and Related Equipment and Software Vendors (continued)					
Network Innovations	TT-3002C Inmarsat C Land/Mobile Transceiver	No	No	Yes	Yes
Network Innovations	EasyTrack Mini-C System	No	No	Yes	Yes
Ortivus North America	AVeL-BASE	No	No	No	Yes
Pana-Pacific	Truck Productivity Computer	(unknown)	(unknown)	(unknown)	Yes
PeopleNet	eDriver Logs	Yes	Yes	Yes	Yes
PlanetLink Communications, Inc.	PlanetTraks	Yes	Yes	Yes	Yes
Prophesy Transportation Solutions, Inc.	Prophesy Mobile Comm TrackerPlus	No (but is planned)	No	No	Yes
Qualcomm	OmniTRACS	Yes	Yes	Yes	Yes
Qualcomm	FleetAdvisor	Yes	Yes	Yes	Yes
Remote Dynamics	Vehicle Management Information (VMI)	(unknown)	(unknown)	(unknown)	Yes
Remote Dynamics	REDIView (forthcoming)	(unknown)	(unknown)	(unknown)	Yes
Safefreight Technology	SecurityGuard	No	No	No	Yes
Sage Quest	SageQuest	(unknown)	(unknown)	(unknown)	Yes
Satellite Security Systems	GlobalGuard	No	No	No	Yes

Appendix B: On-Board Recorder Capabilities, 2005 (continued)

Company	Product	Is Product FMCSA Compliant?	Product Has Ability to Record HOS?	Product Has Ability to Record Duty Status?	Product Has Ability to Record Vehicle Location?
AOBRD. EOBR and Related Equipment and Software Vendors (continued)					
Scanware, Inc.	LogSCAN Plus	Yes	Yes	Yes	Yes
Scanware, Inc.	EZLog Machine	No	No	No	Yes
Shelby Solutions, Inc.	VIM-NET	No	No	No	Yes
SiriComm, Inc.	e Logs	Yes	Yes	Yes	Yes
TeleTouch	GeoFleet	No (but is planned)	No	No	Yes
Telogis	OnTrack	(unknown)	(unknown)	(unknown)	Yes
Terion	FleetView 3 Trailer Management System	No	No	No	Yes
TrackStar	Track Star Pathfinder 1X	No	No	No	Yes
TransCore	Linktrak	No	No	No	Yes
TransMobile, Inc.	StealthTrak NH1	No (but is planned)	No	No	Yes
Trimble	CrossCheck	No (but is planned)	No	Yes	Yes
Trimble	Telvisant Mobile Resource Management	No (but is planned)	No	Yes	Yes
Tripmaster	DT 40/GPS	Yes	Yes	Yes	Yes
VDO (Germany)	DTCO 1381 Digital Tachograph	No	Yes	Yes	No

Appendix B: On-Board Recorder Capabilities, 2005 (continued)

Company	Product	Is Product FMCSA Compliant?	Product Has Ability to Record HOS?	Product Has Ability to Record Duty Status?	Product Has Ability to Record Vehicle Location?
AOBRD. EOBR and Related Equipment and Software Vendors (continued)					
VDO (North America)	Electronic tachograph	No	Yes	Yes	No
Vericom Technologies	Data Management System (VDMS)	(unknown)	(unknown)	(unknown)	Yes
Waveburst Communications, Inc.	Globalstar	No	No	No	No
Xata Corporation	Xatanet Gold	Yes	Yes	Yes	Yes
Xora	Xora DOT Logs	Yes	Yes	Yes	Yes
Heavy-Duty Diesel Engine Manufacturers					
Detroit Diesel	DDEC Data	(unknown)	(unknown)	(unknown)	(unknown)
Caterpillar	ADEM 2000	(unknown)	(unknown)	(unknown)	(unknown)
Truck Manufacturers					
Mack	DataMax	(unknown)	(unknown)	(unknown)	Yes

Appendix C: Communications Standards for the Transmittal of Data Files from Electronic On-Board Recorders (EOBRs)

Because EOBR records regarding duty status are produced and stored onboard the commercial motor vehicle (CMV), roadside inspection personnel in particular will need access to those electronic duty status records that are maintained on the EOBR to determine compliance with HOS regulations.

There are a variety of potential methods and technologies for providing access by roadside enforcement personnel to electronic HOS information. These can generally be categorized into two major approaches: *wired* and *wireless*. Each of these two approaches is considered in turn below, with particular standards for each approach that are currently under consideration addressed individually. For each standard, a brief overview and history of the standard is presented, along with an overview of some of the advantages and disadvantages of each particular standard, in order that a well informed decision may be made concerning the most advantageous approach to be utilized in conjunction with EOBRs.

C.1 Wired Data Communications Standards

Wired or cable-based data communication standards rely upon a cable, typically consisting of a particular number and arrangement of copper wires that are typically found in twisted pairs (for the purposes of canceling out electromagnetic interference), sometimes surrounded by shielding, an outer jacketing, and having specific male or female connectors on each end of the cable with specific connector pin arrangements for compatibility. Three wired data communications standards that are widely utilized in consumer, commercial and industrial electronics and computer equipment are discussed below in the context of their potential applicability to EOBR data transfer.

C.1.1 USB (Universal Serial Bus)

Overview

USB is a serial bus standard for connecting electronic devices such as computer peripheral devices (mice, keyboards, scanners, printers, etc.) and other consumer electronics (digital cameras, etc.) typically to a computer. The USB standard was developed in part to eliminate the need for adding separate expansion cards into a computer's ISA or PCI bus by allowing multiple devices connected via USB to connect to a single host controller. The standard was also meant to improve “plug-and-play” capabilities by allowing devices to be hot swapped, or added to the system without the need for rebooting the computer. As of 2004, it was estimated that there were approximately 1 billion USB devices in the world, and currently, the only major classes of peripherals that do not use USB (because they need a higher data rate than USB can provide) include computer displays and monitors, and high-quality digital video camcorders and components.

The primary versions of the USB standard include 1.0, 1.1 and 2.0. Each of these versions is completely backward compatible with previous versions. Also, older versions are forward compatible with newer versions to the extent that they will function, albeit at the slower data rate of the older version (for example, a peripheral device using USB 1.0 can operate with a host computer equipped only with a USB 2.0 port, but will do so at the slower data rate supported by USB 1.0).

The maximum length of an individual USB cable is 5 meters, which would be more than sufficient for roadside inspection purposes. The standard 4-pin USB cable can supply up to 5 volts and 500 mA of power, allowing low-consumption peripheral devices to operate without utilizing a separate power cord.

The USB 1.0 standard took effect in January 1996, the USB 1.1 standard in September 1998, and the USB 2.0 standard in April 2000. USB 2.0 remains the most current version of the standard.

The data rates associated with each of the three versions of the USB standard are as follows:

USB 1.0: 1.5 mbps[94] (192 KB[95] per second)
USB 1.1: 12 mbps (1.5 MB[96] per second)
USB 2.0: 480 mbps (60 MB per second)

These data rates, however, are theoretical, and in practice actual data rates are typically less than those published in the standard.

In the context of the file sizes anticipated from EOBR use, these data rates are likely to be more than sufficient for downloading data from the EOBR in a reasonable amount of time. If necessary, data compression utilities could also be utilized to further decrease the amount of time necessary to complete downloading of the data. Some current AOBRD manufacturers use data compression in order to maximize the amount of data that can be accommodated on portable smart card media that some manufacturers use to transfer data from EOBRs on the vehicle to motor carrier back office computers.

Advantages

- USB support is nearly ubiquitous on post-1996 Intel-based personal computers, most likely including most existing FMCSA computer equipment. It is also relatively inexpensive to equip Intel-based laptop and desktop personal computers with USB 2.0 support (for example, USB adapter cards that are compatible with PCMCIA Type II slots available on most laptop personal computers are available for approximately $20 to $30, and PCI-based USB 2.0 adapter cards that are compatible with most desktop personal computers are generally available for approximately $30 though these are installed internally which requires the computer case to be removed for installation).

- Data rates, even for USB 1.0, are likely to be more than sufficient to allow for reasonably fast download of EOBR data.

94 Megabits Per Second (mbps).
95 Kilobyte (KB)
96 Megabyte (MB)

- There is widespread availability of relatively inexpensive, high capacity flash memory devices, commonly known as "thumb drives," based on the USB 2.0 standard, which could facilitate the transfer of files between the EOBR and roadside inspection personnel.

- Personal computers and PDA type devices that may already be out in the field are presumably more likely to be Intel-based devices, and therefore to already have a USB interface. This would minimize the need to upgrade existing FMCSA devices such as laptops and PDAs with a different interface (such as IEEE 1394, etc.).

- There is backwards and forwards compatibility among the different USB standards.

- A cable-based standard would be less likely to encounter potential security-related issues that a wireless standard may as a result of interception of RF signals by unauthorized third parties.

- Cables and connectors are likely to be sufficiently robust for use in the field.

Disadvantages

Because of cost considerations, EOBRs are likely to be microcontroller-based[97] devices, that is, they are not likely to have a full motherboard, computer processor and operating system. Because the standard input/output (I/O) interface supported on most microcontrollers is the RS-232 Serial Bus standard, in order to support a USB standard, additional hardware and software may be required, increasing the cost of manufacturing EOBRs. However, within the past year, USB support on microcontroller devices has begun to become increasingly common, and it is expected that in the very near future support for the USB standard on microcontroller devices will become as widespread as that for the RS-232 Serial Bus standard. Furthermore, providing USB support on a microcontroller is thought to be relatively inexpensive, particularly in high volume production, adding approximately $5 to the cost of a microcontroller.

Though the use of USB or other wired approaches may result in some instances in which roadside inspection personnel may need to reach inside the CMV to gain access to the data port (even if this port were located in a convenient location near the passenger door of the CMV), this is easily addressed either procedurally (e.g., whereby roadside inspection personnel are instructed to hand one end of the cable to the CMV driver, who in turn connects the cable to the EOBR data port), or by the use of relatively inexpensive and widely available high capacity flash memory devices, commonly known as "thumb drives," based on the USB 2.0 standard. In the later case, roadside inspection personnel equipped with a portable USB flash memory device could hand the device to the CMV driver, who in turn could connect it to the EOBR data port. Another alternative could be to utilize an external, ruggedized and weather proof data port that is accessible from outside the CMV, but that can only be released or made accessible from inside the vehicle for security purposes in order to prevent unauthorized access.

---

[97] A microcontroller is basically a computer-on-a-chip, optimized to control electronic devices. It emphasizes self-sufficiency and cost-effectiveness, in contrast to a general-purpose microprocessor such as the kind used in a personal computer. A typical microcontroller contains all the memory and I/O interfaces needed in a single self-contained unit, whereas a general-purpose microprocessor requires additional chips to provide these functions.

C.1.2 IEEE 1394 (FireWire / i.Link)

Overview

IEEE 1394 (also known as *FireWire* or *i.Link*) is a high speed serial bus interface standard for connecting computer peripheral devices (particularly those required high data transfer rates such as digital video camcorders) to a computer. The implementation of IEEE 1394 used by Apple Computer is known as *FireWire* primarily due to marketing convention (it is a trademark of Apple Computer), where as the implementation of IEEE 1394 used by Sony is known as *i.Link*, also primarily due to marketing convention. Where as most personal computers, particular those that are Intel-based, are typically equipped with a USB interface, those produced by Apple Computer and Sony are typically equipped with a IEEE 1394 interface as their standard interface port instead of USB. The use of IEEE 1394 is primarily oriented towards applications that benefit substantially from the use of a high data rate, such as downloads from digital video camcorders and high capacity external hard drives, since prior to the development of the USB 2.0 standard, the IEEE 1394 standard provided significantly higher data rates than other standards such as USB 1.1 or USB 1.0. However, it is also popular in industrial systems for machine vision and professional audio systems because it is isochronous, meaning it guarantees a certain minimum data rate, such as is required for time-dependent data such as video or audio. It is used instead of the more common USB standard due primarily to its faster data rates and higher power distribution capabilities.

The original IEEE 1394 standard was developed primarily by Apple Computer in the 1990's, and was proposed as a serial replacement for the SCSI parallel interface. The primary versions of the 1394 standard include 1394, which took effect in 1995, 1394a that took effect in 2000, and 1394b, which took effect in 2002. The 1394a standard was based in part on work contributed by Intel, and when disagreement arose over licensing and royalty agreements, Intel dropped support for the 1394 standard and instead pushed for development of the USB 2.0 standard as an alternative.

Maximum length of an individual IEEE 1394 cable is 4.5 meters, which would be more than sufficient for roadside inspection purposes. The standard six-wire IEEE 1394 cable can supply up to 45 watts of power per port, far more than the USB standard, allowing moderate-consumption peripheral devices to operate without utilizing a separate power cord.

The original 1394 standard defines three data rates, which, in precise terms, are: 98.304, 196.608 and 393.216 mbps (or approximately 100, 200, and 400 mbps, respectively). These rates are referred to in the 1394 standard as S100, S200 and S400. The 1394b specification expands the standard to include 800 and 1,200 mbps data rates. The full IEEE 1394b specification supports optical connections up to 100 meters in length and data rates up to 3.2 gbps[98].

As with the USB standard, these data rates are theoretical, and in practice actual data rates are typically less than those published in the standard.

[98] Gigabits Per Second.

Also, similar to use of the USB standard, in the context of the file sizes anticipated from EOBR use, IEEE 1394 data rates are likely to be more than sufficient for downloading data from the EOBR in a reasonable amount of time. If necessary, data compression utilities could also be utilized to further decrease the amount of time necessary to complete downloading of the data. Some current AOBRD manufacturers use data compression in order to maximize the amount of data that can be accommodated on portable smart card media that some manufacturers use to transfer data from EOBRs on the vehicle to motor carrier back office computers.

Advantages

- A cable-based standard would be less likely to encounter potential security-related issues that a wireless standard may as a result of interception of RF signals by unauthorized third parties.

- Data rates are likely to be more than sufficient to allow for reasonably fast download of EOBR data.

- Cables and connectors are likely to be sufficiently robust for use in the field.

Disadvantages

- Because of cost considerations, EOBRs are likely to be microcontroller-based devices, that is, they are not likely to have a full motherboard, computer processor and operating system. Because the standard input/output (I/O) interface supported on most microcontrollers is the RS-232 Serial Bus standard, in order to support a IEEE 1394 standard, additional hardware and software may be required, increasing the cost of manufacturing EOBRs. Though within the past year USB support on microcontroller devices has begun to become increasingly common, this is not likely to become the case for IEEE 1394 in the foreseeable future.

- Though the use of IEEE 1394 or other wired approaches may result in some instances in which roadside inspection personnel may need to reach inside the CMV to gain access to the data port (even if this port were located in a convenient location near the passenger door of the CMV), this could likely be addressed procedurally (e.g., whereby roadside inspection personnel are instructed to hand one end of the cable to the CMV driver, who in turn connects the cable to the EOBR data port). As noted earlier, another alternative could be to utilize an external, ruggedized and weather proof data port that is accessible from *outside* the CMV, but that can only be released or made accessible from inside the vehicle for security purposes in order to prevent unauthorized access.

- Availability of high capacity flash memory devices, commonly known as "thumb drives," that could facilitate the transfer of files between the EOBR and roadside inspection personnel, are based primarily on the USB standard and are generally not available based on the IEEE 1394 standard.

- Personal computers and PDA type devices that may already be out in the field are presumably more likely to be Intel-based devices, and therefore to already have either a

USB 1.1 or USB 2.0 interface. Therefore, equipping these existing devices to support the IEEE 1394 standard would require the acquisition of appropriate controller cards and their installation.

- IEEE 1394 support is not nearly as widely implemented on Intel-based personal computers as is USB. It is, however, relatively inexpensive to equip Intel-based laptop computers with IEEE 1394 support (FireWire adapter cards that are compatible with PCMCIA Type II slots available on most laptop computers are available for approximately $30) and Intel-based desktop computers as well (PCI-based FireWire adapter cards are also available for approximately $30, though these are installed internally and therefore require a modest amount of effort to install).

- There are a small number of anecdotal reports of peripheral devices such as digital cameras being damaged if the connector pins are accidentally shorted while hot swapping, that is, while connecting the device to a computer while both are powered on. This may be partly the result of the power supplied over the IEEE 1394 cable to peripheral devices, which is substantially higher than the power that is supplied to peripheral devices over USB cables under the USB standard. Though these types of situations are likely very rare, the issue may warrant some additional review to ensure that EOBRs cannot be affected in a similar manner.

C.1.3 RS-232 Serial Port

RS-232 (sometimes referred to as EIA RS-232C) is a standard for serial binary data interconnection. Originally defined in 1962, notable revisions included RS-232C in 1969, RS-232D in 1986, and RS-232F in 1997. When originally developed, the standard was used for specifying the connection between a teletypewriter and modem.

RS-232 is largely considered a legacy standard with regards to its use in personal computers. Most new computers are now shipped without a standard 9 pin RS-232 serial port, as they had been up until the recent past. New standards such as USB are generally considered faster, less expensive, and easier and more convenient to use, and have therefore become the new standard port in most Intel-based personal computers. However, in industrial and commercial devices such as microcontroller-based devices, RS-232 is still in widespread use.

The maximum length of an individual RS-232 cable is 50 feet (approximately 15 meters), which would be more than sufficient for roadside inspection purposes. Though RS-232 was originally intended for bit rates less than 20 kbps[99], data rates have been increased and now reach up to 1 mbps (approximately 125 KB per second, or 7.5 MB per minute) in some applications. In typical practice, 115 kbps (approximately 14 KB per second, or 0.8 MB per minute) is a common data rate used in applications of RS-232.

[99] Kilobits Per Second.

Advantages

- Because of cost considerations, EOBRs are likely to be microcontroller-based devices, that is, they are not likely to have a full motherboard, computer processor and operating system. Because the standard input/output (I/O) interface supported on most microcontrollers is the RS-232 Serial Bus standard, no additional cost would be required in order to support a RS-232 standard. However, within the past year, USB support on microcontroller devices has begun to become increasingly common, and it is expected that in the very near future support for the USB standard on microcontroller devices will become as widespread as that for the RS-232 Serial Bus standard. Furthermore, providing USB support on a microcontroller is thought to be relatively inexpensive, particularly in high volume production, adding approximately $5 to the cost of a microcontroller. Therefore, the relative advantage of RS-232 in this respect is expected to diminish over time.

- Relatively low cost.

- Relatively easy implementation.

- Data transfer rates, though lower than that for USB or IEEE 1394, may still be sufficient to allow for reasonably fast download of EOBR data.

- A cable-based standard would be less likely to encounter potential security-related issues that a wireless standard may as a result of interception of RF signals by unauthorized third parties.

Disadvantages

- The number of laptop computers and desktop computers equipped with a standard RS-232 serial port will likely continue to diminish as it is phased out with regards to its use in personal computers in favor of more recent standards such as USB. However, RS-232 to USB adapters are available for approximately $20 to $30.

- The connectors at the end of a typical serial cable are relatively large as compared to current standards such as USB or IEEE 1394. However, an alternative standard for the connector and pin out design could be developed that is both smaller and more robust than the typical 9-pin RS-232 connector that is typically used on many personal computers. This approach is sometimes taken when producing ruggedized or otherwise specialized commercial or industrial equipment.

- RS-232 has low data rate relative to more current standards such as USB and IEEE 1394.

- Though the use of RS-232 or other wired approaches may result in some instances in which roadside inspection personnel may need to reach inside the CMV to gain access to the data port (even if this port were located in a convenient location near the passenger door of the CMV), this could likely be addressed procedurally (e.g., whereby roadside inspection personnel are instructed to hand one end of the cable to the CMV driver, who in turn connects the cable to the EOBR data port). As noted earlier, another alternative could be to utilize an external, ruggedized and weather proof data port that is accessible from *outside* the CMV, but that can only be released or made accessible from inside the vehicle for security purposes in order to prevent unauthorized access.

C.2 Wireless Data Communications Standards

Wireless communication standards rely upon electromagnetic radio frequency (RF) signals to transmit data. Wireless data communications standards that are widely utilized in consumer, commercial and industrial electronics and computer equipment applications are discussed below in the context of their potential applicability to EOBR data transfer.

In general, issues to be considered in wireless vehicle-to-infrastructure or vehicle-to-vehicle data communications in the context of EOBR data transfer include:

Frequency Band (Radio Frequency Spectrum)

Currently, the most likely part of the spectrum that would be utilized for downloading electronic RODS wirelessly would be in unlicensed bands set aside by the Federal Communications Commission (FCC) for low-power, short-range devices at 900 MHz, 2.4 GHz, and 5.8 GHz.

The 900 MHz band is the most developed and is used for many familiar applications such as electronic toll payment, cordless home telephones, baby monitors and many others. Issues with interference and security must be considered in these bands, since licensing is not required and because there are many users operating many different types of devices in a myriad of applications. In addition, there is no standardization of devices or functions.

In the case of the potential wireless download of data while a CMV is operating at highway speeds, changes in the radio propagation environment that the vehicle might travel through over the course of even a mile or two (equivalent to about 1 to 2 minutes of elapsed time at highway speeds) might result in somewhat more complex radio frequency (RF) interference issues than might otherwise be encountered in a static application where both the CMV and the roadside inspection personnel are not in motion. Similar issues would likely be encountered in the case of a vehicle-to-roadside transmission involving a moving vehicle and roadside inspection personnel that are located in a fixed roadside position.

The 2.4 GHz and 5.8 GHz bands are utilized less than the 900 MHz band, and standards (see 802.11 discussion below) have been developed covering this band.

The FCC has set aside a new band at 5.9 GHz for Dedicated Short Range Communications (DSRC) for Intelligent Transportation Systems (ITS) applications. Applicable standards, and hardware that operates in that band, are currently in development. This band should be of interest to FMCSA since:

- other ITS commercial vehicle functions are under development and can be leveraged
- standards will be in place
- licensing will limit and control use in that band

One-Way or Two-Way Contact

A two-way exchange of data places additional requirements on the link. It is anticipated that downloading HOS data would be a one-way transmission.

Latency

Latency refers to the time delay in receiving information. This is not likely to be a major issue for wirelessly downloading HOS data.

Handshake

A "handshake" may be required, in particular to reduce latency. This is more likely an issue in two-way communications, and thus is not likely to be an important issue for downloading of electronic RODS data. In the future, if FMCSA envisions expanding the roadside function to include the roadside inspector exchanging information with the vehicle, then the handshake issue would be more important.

Shielding of Wireless Signals

It is recommended that any future regulation addressing the use of wireless data communications standards for EOBR applications incorporate a provision prohibiting the intentional shielding, blocking or jamming of wireless signals for the purpose of inhibiting access to electronic HOS information by roadside inspection personnel.

C.2.1 802.11 a/b/g (WiFi)

Overview

The IEEE 802.11 wireless standard (also known due to marketing convention as *WiFi* for "wireless fidelity") is a set of communications and product compatibility standards for wireless local area networks (WLAN). The 802.11 standard includes three amendments to the original standard, 802.11a, 802.11b and 802.11g, upon which most commercial wireless networks are now based. The 802.11b standard, adopted in 1999, was the first widely accepted wireless networking standard. This was followed by 802.11a later in 1999, and then by 802.11g in 2003. Security protocols, though included in the original standard and its amendments, were later enhanced as part of the 802.11i amendment. Other standards in the family (*c* through *f, h* through *j*, and *n*) constitute a variety of service enhancements, extensions, or corrections to prior specifications.

802.11

The original 802.11 standard developed in 1997 operated in the unlicensed 2.4 GHz spectrum, and supported a maximum bandwidth of only 2 mbps, which was too low a data rate for most applications.

802.11a

The 802.11a standard was approved in September 1999 at the same time that the more popular 802.11b standard was approved. Though both 802.11a and 802.11 b were approved at the same time, because 802.11b products became more widely available before 802.11a products did, many mistakenly believe that 802.11a was created after 802.11b.

802.11a operates in the unlicensed 5 GHz spectrum, and has a theoretical data rate of up to 54 mbps though in practice data rates typically range between 17 mbps and 28 mbps. Under optimal conditions, 802.11a has a range of up to 45 meters (150 feet) indoors, and approximately 80 meters (260 feet) outdoors, though in practice its typical indoor range is closer to 15 meters (50 feet).

Because 802.11a uses the unlicensed 5 GHz band rather than the more crowded unlicensed 2.4 GHz band, 802.11a generally encounters less interference. However, using this higher frequency reduces the range of 802.11a, and also means that 802.11a cannot penetrate as far as 802.11b since it is absorbed more readily by walls and other obstructions.

The advantages of 802.11a are its relative high data rate and reduced tendency to encounter interference because it uses the less crowded 5 GHz band.

The disadvantages of 802.11a are the high cost of its equipment relative to other standards, its shorter-range signal that is also more easily obstructed, and its lack of interoperability with 802.11b and 802.11g equipment (though hybrid equipment that implements the three standards side by side is available)

802.11b

The 802.11b standard was approved in September 1999. It operates in the unlicensed 2.4GHz spectrum, and has a theoretical data rate of up to 11 mbps though in practice data rates typically range between 4 mbps and 7 mbps. Under optimal conditions, 802.11b has a range of up to 45 meters (150 feet) indoors, and approximately 100 meters (330 feet) outdoors, though in practice its typical indoor range is closer to 30 meters (100 feet).

802.11b transmits on one of eleven channels in the vicinity of the 2.4 GHz frequency. Of the eleven channels, only channels 1, 6 and 11 are spaced sufficiently far apart in the spectrum so that they can be used simultaneously without interference from each other. This enables 802.11b to avoid potential interference from nearby wireless networks by utilizing a different one of the three non-interfering channels than a nearby network might be using. However, the unlicensed 2.4 GHz frequency band that 802.11b operates in is crowded and subject to interference from other networking technologies, microwave ovens, 2.4GHz cordless phones, and the short range Bluetooth wireless standard.

The advantages of 802.11b are its relatively low cost as compared with many other wireless standards, and its relative long range and reduced tendency of the signal being obstructed by walls and other objects.

The disadvantages of 802.11b are its lower data rate as compared with many other wireless standards, and that the unlicensed 2.4 GHz frequency band that it operates in is crowded and subject to interference from other networking technologies, microwave ovens, 2.4GHz cordless phones, and the short range Bluetooth wireless standard.

802.11g

The 802.11g standard was approved in June 2003. 802.11g was an attempt to combine the best features of both 802.11a and 802.11b, namely the higher data rates of 802.11a and the longer range of 802.11b. Like 802.11b, 802.11g operates in the unlicensed 2.4GHz spectrum. However, in contrast to 802.11b, it has a high theoretical data rate of up to 54 mbps, though in practice data rates typically range between 18 mbps and 30 mbps.

Under optimal conditions, 802.11g has a range of up to 45 meters (150 feet) indoors, and approximately 100 meters (330 feet) outdoors, though in practice its typical indoor range is closer to 30 meters (100 feet).

Like 802.11b, 802.11g transmits on one of eleven channels in the vicinity of the 2.4 GHz frequency. Of the eleven channels, only channels 1, 6 and 11 are spaced sufficiently far apart in the spectrum so that they can be used simultaneously without interference from each other. This enables 802.11g to avoid potential interference from nearby wireless networks by utilizing a different one of the three non-interfering channels than a nearby network might be using. However, the unlicensed 2.4 GHz frequency band that 802.11g operates in is crowded and subject to interference from other networking technologies, microwave ovens, 2.4GHz cordless phones, and the short range Bluetooth wireless standard.

The advantages of 802.11g are its relatively high data rate, low cost as compared with 802.11a, and interoperability with 802.11b.

The disadvantages of 802.11g are that the unlicensed 2.4 GHz frequency band that it operates in is crowded and subject to interference from other networking technologies, microwave ovens, 2.4GHz cordless phones, and the short range Bluetooth wireless standard. 802.11g equipment is also more costly relatively to 802.11b.

It should also be noted that new standards beyond the 802.11 specifications, such as 802.16 (referred to as *WiMAX*), are also currently in development and offer enhancements over the various 802.11 standards such longer range and greater data rates.

Advantages

- Data rates are likely to be sufficient to allow for reasonably fast download of EOBR data.

- The use of 802.11 or other wireless approach would eliminate instances in which roadside inspection personnel might need to reach inside the CMV to gain access to a data port to connect a cable.

Disadvantages

- Potential for radio frequency (RF) interference, particular in the unlicensed bands used by 802.11, and particular in the 2.4 GHz band.

- Potential security issues concerning the possible interception of RF signals and EOBR data by unauthorized third parties, requiring encryption, etc.

- Higher cost relative to wired standards.

- More complicated implementation relative to wired standards.

- Would require use of additional hardware such as wireless adapter cards, potentially resulting in a somewhat higher cost relative to controller cards for common wired standards such as USB. However, the use of a wireless access point would not be necessary, since most wireless adapter cards allow for connections to be made in "ad hoc" mode, from card-to-card in a peer-to-peer manner, without the need for a wireless access point as is the case when implementing 802.11 in "infrastructure mode."

C.2.2 900 MHz

Overview

The 900 MHz frequency uses a longer wavelength and sends less information per second than other frequencies such as 2.4 GHz and 5.8 GHz. However, because the signal from 900 MHz devices can suffer more degradation and still be readable than signals from devices using these other frequencies, 900 MHz devices can usually communicate at a greater range than these other devices, thus increasing their overall reliability. Whereas the 802.11 a/b/g standards noted above are primarily meant to be product compatibility standards to allow interoperability of equipment produced by a variety of manufacturers, data communications equipment that operates on the same 900 MHz frequency may not necessarily be interoperable in the same manner since product compatibility standards for the 900 MHz are not as widespread.

Advantages

- Substantially longer range than other wireless standards.

- Better able to penetrate obstacles such as walls, buildings, etc.

Disadvantages

- Radio frequency (RF) interference, particular in the unlicensed 900 MHz band.
- Relative slow data rate compared to other wireless standards.
- Potential security issues concerning the possible interception of RF signals and EOBR data by unauthorized third parties, requiring encryption, etc.
- Higher cost relative to wired standards and other wireless standards.
- More complicated implementation relative to wired standards.
- Would require use of additional hardware such as wireless adapter cards, potentially resulting in a somewhat higher cost relative to controller cards for common wired standards such as USB.

C.2.3 Other Potential Standards

Dedicated Short-Range Communications (DSRC)

The Dedicated Short Range Communications (DSRC) band has been allocated for intelligent transportation systems (ITS) applications. Standards are currently under development for this band, which offers the potential to effectively support wireless data communications between vehicles, and between vehicles and infrastructure.

The 5.9 GHz DSRC has a maximum range of 1000 meters within the current standards. Under most operating conditions, DSRC will be limited to less than 200 meters in practice.

In North America, 5.9 GHz Dedicated Short-Range Communications (DSRC) systems are being developed to support a wide range of public-safety and private operations in roadside-to-vehicle and vehicle-to-vehicle environments for the transportation industry, and would therefore be consistent with use in an EOBR data transfer application. DSRC has several key benefits, including high data transfer rates of between 6 and 54 mbps, and license-protected authority.

Advantages

- Licensed band, which should minimize the potential for interference from other types of devices.
- Long range.
- High data rate.

- Oriented towards transportation and roadside-to-vehicle and vehicle-to-vehicle communications applications that are consistent with EOBR applications.

- Would be able to support download of EOBR data “on fly” at highway speeds while CMV is in motion, if such an application were introduced at some point in the future.

Disadvantages

- Standards not yet fully developed.

- Like other wireless approaches, potential security issues concerning the possible interception of RF signals and EOBR data by unauthorized third parties, requiring encryption, etc.

- Higher cost relative to wired standards.

- More complicated implementation relative to wired standards.

- Would require use of additional hardware such as wireless adapter cards, potentially resulting in a somewhat higher cost relative to controller cards for common wired standards such as USB.

Bluetooth

Bluetooth is a short range, moderate data rate standard currently used by many commercial users that operates in the unlicensed 2.4 GHz band. It utilizes a frequency hopping spread spectrum approach in order to minimize interference. Bluetooth has a data rate of up to 1 mbps, and depending upon the power class of the device has a typical maximum range of approximately 30 feet though higher power devices can theoretically achieve a range of up to 200 or 300 feet.

Though relatively inexpensive, the relatively short range of Bluetooth of approximately 30 feet might preclude its effective use in many EOBR data transmittal applications. For example, a transmittal of EOBR data from a CMV power unit to the vehicle of a roadside inspector during a roadside inspection of a traffic enforcement nature might require the wireless signal to travel approximately 60 to 80 feet (from the CMV power unit to the inspectors vehicle, assuming the inspectors vehicle is located at the rear of the CMV behind the CMV trailer). This would be beyond the typical range of approximately 30 feet provided by most Bluetooth devices. The use of a Bluetooth standard (as well as a longer range 802.11b or 802.11g standard) might still allow for vehicle-to-vehicle transmission data at speed, for example, while both a CMV and the vehicle of a roadside inspector are in motion and in proximity to each other (such as driving abreast of each other on a two lane highway, etc.). Though both vehicles would be in motion relative to the roadside, relative to each other there would be little change in the distance between them. In the case of the potential wireless download of data while a CMV is operating at highway speeds, changes in the radio propagation environment that the vehicle might travel through over the course of even a mile or two (equivalent to about 1 to 2 minutes of elapsed time at highway speeds) might result in somewhat more complex radio frequency (RF) interference issues than might otherwise be encountered in a static application where both the CMV and the roadside inspection personnel are not in motion. Similar issues would likely be encountered in the case of a vehicle-to-roadside transmission involving a moving vehicle and roadside inspection personnel that are located in a fixed roadside position.

Advantages

- Relatively inexpensive compared to other wireless standards.
- Would most likely have a sufficient data rate for EOBR applications.

Disadvantages

- Shorter range (approximately 30 feet for most types of Bluetooth devices).
- Lower data rate than most other wireless standards, though at 1 mbps still likely suitable for EOBR applications.
- Potential security issues concerning the possible interception of RF signals and EOBR data by unauthorized third parties, requiring encryption, etc., though shorter range signal would reduce this risk somewhat relative to other longer range wireless standards.
- Higher cost relative to wired standards.
- More complicated implementation relative to wired standards.
- Would require use of additional hardware such as wireless adapter cards, potentially resulting in a somewhat higher cost relative to controller cards for common wired standards such as USB.

C.3 Data Communications Standards and XORA Application for Exemption

In the summer of 2005, XORA, Inc., a software development company and provider of location-based mobile workforce management solutions, submitted an application to FMCSA for an exemption from the current requirement under 49 CFR § 395.2 that AOBRDs be integrally synchronized with the specific operations of the vehicle on which they are installed. The notice of application for exemption and request for comments was published in the Federal Register on June 8, 2005, and the comment period for the notice extended through July 8, 2005. As of July 15, 2005, approximately 35 comments had been received.

XORA, working in conjunction with Nextel Communications, a wireless communications service provider, has developed an hours of service (HOS) software application for use with GPS-enabled Java-capable cell phones and its computer system to electronically document drivers' hours of service. The XORA system requires the use of a GPS-enabled, Java-capable Falcon 3-digit phone from Nextel. According to XORA, the following twelve phone models offered for sale by Nextel are compatible with the XORA system:

i265	i275
i325	i355
i605	i710
i730	i733
i736	i830
i850	i860

Of these twelve phones, only the i605 is Bluetooth enabled as a standard feature. However, according to Nextel, accessory adapters are available for approximately $50 that will allow any of the other eleven phones shown above to be Bluetooth enabled. The retail price of these twelve phones ranges from between $50 to $400 depending on features. In addition to the phone, as of July 2005 there is a one time setup fee of $25 per phone, plus recurring monthly charges for the XORA DOT Logs system of approximately $22 per month per phone, plus $20 per user per month for the "5MB Total Connect Data Plan" from Nextel, not including phone and voice service.

C.3.1 Potential Compatibility of XORA System and Potential Wired Data Communications Standards for EOBRs

USB / IEEE 1394 / RS-232

Most cell phones produced during the last several years are equipped with an accessory connector port typically located at the bottom edge of the phone. This port is typically used as both a means of connecting a battery recharger to the phone, and as a means of transferring data between the phone and a personal computer or other device. Though the connector port provided on most phones is a propriety design rather than industry standard common to all cell phones and other portable devices and personal computers, most cell phone manufacturers provide accessory cables that connect to the phone by means of their proprietary connector on one end of the cable, and either a serial or USB connector on the other end of the cable that allows the user to connect to a personal computer or other standard device (PDA, etc.). For example, for the Nextel i830 phone, both an RS-232 Serial data cable and a USB data cable are available as accessories and are sold for approximately $30 each. Therefore, a wired download of data should in theory be possible based on the apparent availability of an accessory connector port on most current cell phones, and the apparent compatibility of most of these propriety connector ports with standard USB or RS-232 ports using adapter cables which adapt the propriety connection on the phone end of the data cable to the standard USB or RS-232 serial port on the other end of the data cable.

C.3.2 Potential Compatibility of XORA System and Potential Wireless Data Communications Standards For EOBRs

802.11g (WiFi)

Though the wireless data communications standard that is currently most widely utilized in cell phones and other portable devices such as PDAs is the Bluetooth standard, the deployment of 802.11g compatible cell phones is expected to emerge in the next few years as a growing trend in these types of portable devices. Though intended in many cell phone applications to be used for

Voice over IP (VoIP)[100] purposes, embedded WiFi capability in these devices should also allow the potential for wireless data communications as well. Alternatively, where WiFi capability is not embedded into a device, the use of an external 802.11 wireless adapter connected via the data accessory port on a cell phone may provide the basis for wireless data communications from cell phone devices for EOBR applications. For example, external 802.11g wireless adapters are currently available that connect, typically to a personal computer, via a USB port (rather than a PCMCIA port, as is often the case with laptop personal computers) and are also powered via the USB cable. Therefore, making a cellphone-based EOBR compatible with wireless data downloads based on a 802.11g wireless standard should in theory be possible either by means of an embedded 802.11g capability integral or native to the cell phone itself

Bluetooth

Currently, the wireless data communications standard that is most widely found in cell phones and other portable devices such as PDAs is the Bluetooth standard. As noted earlier in the overview of the XORA DOT Logs system, of these twelve Nextel phones that are currently compatible with the XORA system, only the i605 is Bluetooth enabled as a standard feature. However, according to Nextel, accessory adapters are available for approximately $50 that will allow any of the other eleven phones shown above to be Bluetooth enabled. Though shorter range than the 802.11 standard, because Bluetooth is currently more widely available in cell phones, it may provide a feasible interim solution for wireless data communications for EOBR applications.

C.4 Transmittal of Data Files for Compliance Review Purposes

Regarding access to electronic records for the purposes of compliance review, the transfer of data will not be directly from an EOBR to a device used by FMCSA personnel (such as a laptop computer), but instead is likely to be from a desktop computer maintained by the motor carrier at their main office or home terminal to a portable storage medium that would in turn be used to transfer data to a device used by FMCSA personal such as a laptop computer in order to facilitate review of the information with CAPRI or other tools. In this case, the electronic transfer of data should be relatively straightforward.

A variety of relatively inexpensive and readily available means of portable data storage are available to facilitate the transfer of electronic RODS data from a motor carrier to compliance review personnel. These methods include, in ascending order of storage capacity, (1) CD-RW, (2) portable flash memory devices, and (3) external hard drives. In additional, other methods of data transmittal such as (4) transfer over a local area network (LAN) and (5) potentially even remote access via conventional or broadband modem may be possible.

Most desktop and laptop computers currently produced incorporate a CD-RW drive that can write to either CD-R (write-once) or CD-RW (re-writeable) media. Disk capacities are typically 700MB per disk. Internally mounted CD-RW drives for a personal desktop computer can typically be purchased for approximately $30, and external CD-RW drives are typically available

---

[100] “Voice Over Internet Protocol” or “Voice over IP” refers to the protocol used for routing voice conversations over the Internet or other IP network using protocols suitable for a packet-switched network, instead of the traditional dedicated, circuit-switched voice transmission network typical of traditional telephone communications networks.

for approximately $80. CD-R media can typically be purchased for approximately $0.30 to $0.40 per disk. CD-RW media can typically be purchased for approximately $0.75 per disk. For larger motor carrier operations, the typical 700MB storage capacity of CD-R and CD-RW media might potentially be exceeded depending upon the size of the electronic RODS files, the number of drivers or vehicles for which data is being collected, and the length of the historical time period for which records will be reviewed. Also, writing data to CD-R and CD-RW media can be a somewhat time consuming process relative to many other methods, with several minutes often required for a full CD-R to be produced, and an even longer time for a full CD-RW to be produced.

High capacity flash memory devices, commonly known as “thumb drives,” based on the USB 2.0 standard, are widely available and relatively inexpensive. For example, a USB thumb drive with a capacity of 1GB can currently be purchased for approximately $75, and as these types of devices become more widespread, prices have continued to decline and higher capacity designs have become increasingly available. These devices can provide equal or greater storage capacity to that of CD-RW drives, and are typically require less time than CD-R or CD-RW drives to transfer an equivalent amount of data.

For even larger data storage capacity, external hard drives with capacities up to 300GB that use either the USB 2.0 standard or the IEEE 1394 FireWire standard (or in some products both standards) are widely available and can be purchased for approximately $150 to $400 depending upon the storage capacity and other features. Relative to CD-R/RW and flash memory devices, external hard drives offer much greater storage capacity, while still providing data transfer rates that often equivalent to that of flash memory devices (since the same USB standard is used) and typically require less time than CD-R or CD-RW drives to transfer an equivalent amount of data.

In addition to these types of physical data storage media, electronic RODS data could be transferred to FMCSA compliance review personnel by having FMCSA devices such as personal laptop computers directly access motor carrier local area networks. However, this assumes the presence of a LAN at the motor carrier main office or home terminal, which is only likely to be the case for larger motor carrier operations. Also, a variety of security-related issues would need to be addressed to prevent the transfer of malicious software such as viruses and spy-ware to and from both FMCSA devices and motor carrier computer networks.

Finally, the use of electronic records might potentially allow a compliance review to be conducted “remotely,” at least in part, without requiring an onsite visit to the motor carrier’s place of business. In this case, motor carrier electronic RODS data would be transferred either via conventional or broadband modem to FMCSA, where they could be reviewed remotely. As with the case above of potentially accessing electronic RODS data via a motor carrier’s LAN, this assumes the presence of a modem connection at the motor carrier main office or home terminal, which again may only be the case for larger motor carrier operations. Also, a variety of security-related issues would need to be addressed to prevent the transfer of malicious software such as viruses and spy-ware to and from both FMCSA devices and motor carrier computer networks.

For all of the methods noted above, the use of standard data compression software could also substantially reduce the data file size to approximately 10% or less of its uncompressed size, if an uncompressed file format such as XML or ASCII is used as the standard format for electronic RODS data.

Appendix D: Standards for Time Keeping Accuracy for EOBR Applications

One of the functions of an EOBR will be to record the time when various events, such as driver duty status changes, occur. Because of this, EOBRs will require an on-board clock that can provide a sufficiently accurate measure of time. Regardless of the particular time base or time standard that may be used (Coordinated Universal Time (UTC), local time at the driver's home terminal, etc.), both the allowable rate of time drift of the EOBR clock, and the absolute deviation from actual time or official time at any given moment, need to be considered. In this context, actual time or official time is the time as measured and provided to the public by international and national standards setting organizations, such as the National Institute of Standards and Technology (NIST), which provides official time to the United States.

As it is applicable to EOBRs, the rate of time drift refers to the amount deviation from official time experienced during a given time period, for example one month. Therefore, if the EOBR clock is synchronized with official time at the beginning of a month, and after one month deviates from official time by 11 seconds, then the rate of time drift would be 11 seconds per month, or 2 minutes and 12 seconds per year. The absolute deviation from official time simply refers to the difference between official time and the EOBR clock as it is measured at any given moment. Of course, the greater the rate of time drift experienced by the EOBR clock, then the greater that this absolute deviation in time will be after a given period of time has elapsed. For instance, referring to the example above, when measured after 7 months, the absolute deviation in time will be 1 minute and 17 seconds, given a rate of time drift of 11 seconds per month. If the rate of time drift is greater than 11 seconds per month, then the absolute deviation in time will be greater than 1 minute and 17 seconds after 7 months has elapsed.

In considering both the allowable rate of time drift and the absolute deviation from official time, both the purpose of the device and the potential consequences of the rate of drift and deviation from official time should be considered. In practice, in the case of an EOBR, extremely precise time keeping on the order of fractions of a second (hundredths, thousandths, etc.) far exceeds the purpose of the device, which is to record the hours of service of drivers for the purpose of reducing the incidence of crashes attributed in whole or in part to drowsy, tired or fatigued drivers. The consequences of a rate of time drift on the order of several seconds per month, or even a few minutes per month, over a period of time of up to several months, for example, are not likely to have an immediate and high consequence impact upon public safety or other areas of concern. However, with regards to recording hours of service for the purposes of roadside inspection and compliance review, the accumulation of a rate of time drift of as little as four or five minutes per month would result in an absolute deviation from official time of nearly one hour after an elapsed time of one year. This amount of absolute deviation from official time could potentially affect the ability of roadside inspection personnel and compliance review personnel to effectively review and interpret the record of duty status information for a driver, and for roadside inspection personnel to correlate the record of duty status information with the supporting documents currently required under 49 CFR § 395.8 (k)(1) that may themselves be time stamped (e.g., fuel receipts, toll receipts, etc.).

For the reasons noted above, and to allow sufficient accuracy or resolution in terms of time to provide compliance review personnel the ability to be able to reasonably and easily correlate time stamped supporting documents to a driver's hours of service information, it is recommended that the absolute deviation, plus or minus, from official time allowable on clocks used for EOBR applications should not exceed 10 minutes at any time. It is assumed that the clock used on EOBRs will be periodically resynchronized with official time as necessary in order to maintain this level of accuracy. In fact, EOBRs that utilize a satellite based position determination system (such as GPS) will be able to obtain highly accurate official time information from such a system. Similarly, EOBRs that utilize a terrestrial-based positioning system (such as those using cell phone networks) for position determination will also be able to obtain highly accurate time base information from the cell phone network system. Therefore, in such cases, the elapsed time during which the clock on an EOBR is likely to be out of contact with an accurate source of official time that is external to the EOBR, during which the clock on the EOBR may drift, is likely to be relatively short and in practice inconsequential. Even in the case of EOBRs that do not use a satellite-based or terrestrial-based positioning system, widely available and relatively inexpensive integrated real-time clocks (RTCs) based on economical quartz crystals can achieve typical accuracies of at least approximately +/- 2 seconds per day (with the time drift typically the result of temperature variations which affect the quartz crystal). This would result in EOBRs that require their clocks be resynchronized with official time infrequently, perhaps once per year.

Appendix E: Certification of EOBRs to Assess Conformity with FMCSA Standards

In order to facilitate the effective use of EOBRs by both motor carriers and by FMCSA safety and enforcement personnel, performance-oriented standards, and to a more limited extent technical standards, for EOBRs are currently under development by FMCSA. Like most products and services, the development and use of standards establishes the requirements and other qualities of the products (in this case EOBRs) to ensure that they will function properly and effectively. For example, because EOBR records regarding duty status will be produced and stored onboard the commercial motor vehicle (CMV), roadside inspection personnel in particular will need access to those electronic duty status records that are maintained on the EOBR to determine compliance with HOS regulations. The use of a wired or wireless communications standard would therefore facilitate the electronic transfer of records to roadside inspection personnel. Similarly, in order to facilitate the electronic transfer of records to roadside inspection personnel and compliance review personnel, and provide the ability of various third party and proprietary EOBR devices to be interoperable, a consistent electronic file format and record layout for the electronic RODS data to be recorded by EOBRs is necessary.

The establishment and use of standards provides a variety of benefits. For example, among the potential advantages of developing standards addressing the use of a standard electronic file format for EOBR applications would be eliminating the potential need for roadside enforcement personnel to master the operation and use of potentially dozens or hundreds of different types of EOBR devices and related software, and instead relying upon a single suite of standard FMCSA tools such as ASPEN and CAPRI to be able to utilize and review the electronic HOS information produced by EOBRs from different manufacturers.

Closely related to the development and use of product standards is the need for conformity assessment in order to ensure that the products produced do indeed comply with the standards in practice. Presented below is a review of typical frameworks or approaches used for conformity assessment programs used in the U.S. For each of the general approaches, a brief overview is presented, along with some examples and a brief review of some of the advantages and disadvantages of each relative to their use for ensuring conformity of EOBRs with proposed FMCSA standards.

While the concepts of *standard*, *testing* and *certification* are closely related, they are in fact distinct. A standard refers to a set of requirements or rules addressing the specification of performance, operations or materials. Testing refers to a technical operation in which one or more characteristics of a given product or process are determined according to a specified procedure. Certification refers to the process by which assurance is provided that a product conforms to a standard. The following discussion focuses primarily on the issue of certification.

E.1 Conformity Assessment and Certification

Conformity assessment refers to the activities concerned with ensuring that the requirements that are embodied in standards or regulations are actually fulfilled in the production of goods and services. Conformity assessment activities are an important link between standards and regulations and the manufactured products that are subject to these standards and regulations.

Conformity assessment activities help to ensure that the products that are manufactured comply with the relevant standards. Conformity assessment typically includes a variety of activities including sampling, testing, inspection, surveillance, auditing, certification, assessment, and accreditation. The conformity assessment process for a given product may include one or more of these distinct conformity assessment activities. The discussion herein focuses primarily on the certification activity.

E.1.1 First Party Certification (Self-Certification)

Overview

In general, the overall regulatory philosophy in the U.S. with regards to conformity assessment is one that relies heavily upon declarations of conformity from product manufacturers, or so-called "first party" certification. In the context of conformity assessment, "first party" refers to the manufacturer, vendor or seller of a product or service, in this case the EOBR manufacturer. Though first party certification can involve self certification by the manufacturers themselves, it might also include instances where a consortium of manufacturers or vendors assumes responsibility for conformity assessment. For example, a group known as the "Wi-Fi Alliance" oversees a certification program that member manufacturers pay to participate in. In practice, virtually all companies that sell 802.11 equipment are members. The Wi-Fi certification mark guarantees interoperability and is trademarked and owned by the group and usable only on compliant equipment.

First party certification is one of the simplest forms of certification, yet has largely proven successful in the U.S. for a variety of reasons including regulations and laws concerning truth in labeling and advertising, the success of the legal and judicial system to exact sometimes severe penalties from the manufacturers of defective or hazardous products, and the availability of substitute products in the U.S. economy which allows consumers to easily switch from products they may be dissatisfied with. The current requirements for the certification of AOBRDs under 49 CFR § 395.15, discussed later, utilize a first party approach to certification.

To ensure that self-certification efforts are effective, typically the federal agency with jurisdiction over the product in question is authorized to take enforcement action against the manufacturer or distributor of the product if requirements are not met. Such action might include, for example, removal of the product from a published list of conforming products, as is discussed later.

Advantages

- Has an extensive track record in the U.S.
- Tends to be less resource intensive than other types of certification approaches.
- Relatively simple as compared with other types of certification approaches.
- Is consistent with the purpose of EOBRs, that is, a more complex, comprehensive and costly certification program may be marginally more effective, but the additional

effectiveness is likely to come are a disproportionately greater cost given the limited benefits of achieving marginally greater effectiveness.

Disadvantages

- May require enforcement action on the part of the federal agency with jurisdiction over the product in question, so as to ensure that self-certification efforts are effective.

- Depending on the nature of product, a more comprehensive but complex and costly certification program such as second party or third party certification may be marginally more effective than a self-certification program, but in the case of EOBRs the additional effectiveness is likely to come are a disproportionately greater cost given the limited benefits of achieving this marginally greater effectiveness.

E.1.2 Second Party Certification

Overview

In the context of conformity assessment, “second party” refers to the buyer of a product or service. In the context of EOBRs, second party would therefore refer to motor carriers. Like first party certification, second party certification is also relatively common in the U.S. In this case, it is usually the buyer who requires and certifies that the products they wish to purchase from suppliers meet the relevant standards. The nature of second party certification programs varies widely depending on the type of product being purchased and the particular needs of the buyer. In general, second party certifications are generally only available to, and often mandatory for, manufacturers or suppliers that wish to become suppliers to a buyer. Though second party certification can involve certification by individual buyers, it might also include instances where a consortium of buyers assumes responsibility for conformity assessment. For example, in the case of the motor carrier industry, this might be an approach whereby the American Trucking Associations (ATA) or a similar motor carrier industry-sponsored group is responsible for certification or EOBRs.

Advantages

- Is relatively common in the U.S.

- Tends to be less resource intensive than third party certification approaches.

- Relatively simple as compared with third party certification approaches.

Disadvantages

- More complex than first party certification.

- Likely to be more resource intensive than first party certification, given the larger number of motor carriers than current and prospective manufacturers of EOBRs.

- The nature of the motor carrier industry, with a large number of small motor carriers, would make a second party approach in which motor carriers carried out certification highly impractical and unnecessarily burdensome for motor carriers.

- Depending on the nature of product, a more comprehensive but complex and costly certification program such as third party verification may be marginally more effective than a second party certification program, but in the case of EOBRs the additional effectiveness is likely to come are a disproportionately greater cost given the limited benefits of achieving this marginally greater effectiveness

E.1.3 Third Party Certification

Overview

In the context of conformity assessment, "third party" refers to an entity or organization other than the seller or buyer of a product, that is also not under the control or influence of either a buyer or a seller. A third party is generally a federal government agency, state or local agency, or a private sector entity such as a privately operated laboratory. Third party certification is a type of certification in which a declaration of conformity by a manufacturer is validated by a competent third party.

The third party entity may be responsible for collecting data, generating test results, or conducting inspections, etc., in addition to reviewing the results of such activities and making a determination regarding the conformance of the product to the relevant standards. The third party may also delegate all or part of these activities to one or more other parties. The degree of confidence that third party certification programs can be viewed with varies depending on (1) the number and types of testing or inspection methods used as part of the program ensure product conformance, the adequacy of the manufacturer's quality control system, and (3) the competence of the entity that conducts the testing or inspection and evaluates the test results of this testing.

Advantages

- May be more comprehensive and effective than other certification approaches, but this may be unnecessary given the nature and use of EOBRs

Disadvantages

- Tends to be more resource intensive than other certification approaches.

- More complex as compared to other certification approaches.

E.2 Declaration of Conformity

It is recommended that a "Declaration of Conformity" be produced by the manufacturers or the first party certification entity for EOBRs. In accordance with USC Title 28, Part V, Chapter 115, § 1746, *Unsworn declarations under penalty of perjury*, this declaration should contain the statement “I declare (or certify, verify, or state) under penalty of perjury that the foregoing is true and correct. Executed on (date). (Signature)”.

USC Title 28, Part V, Chapter 115, § 1746 states “Wherever, under any law of the United States or under any rule, regulation, order, or requirement made pursuant to law, any matter is required or permitted to be supported, evidenced, established, or proved by the sworn declaration, verification, certificate, statement, oath, or affidavit, in writing of the person making the same (other than a deposition, or an oath of office, or an oath required to be taken before a specified official other than a notary public), such matter may, with like force and effect, be supported, evidenced, established, or proved by the unsworn declaration, certificate, verification, or statement, in writing of such person which is subscribed by him, as true under penalty of perjury, and dated, in substantially the following form:” The specific language suggested is noted in the paragraph above.

E.3 Conforming Products List

The use of a “conforming products list” can help to inform both consumers (in this case motor carriers), as well as FMCSA roadside enforcement and compliance review personnel, regarding what specific EOBR models have been declared in conformity with FMCSA standards. Such a list could be published periodically in the federal register or by other suitable methods such as on the FMCSA website. A conforming products list might help to provide further assurance that first party certification efforts are effective, since removal of the product from a published list of conforming products, could potentially be used as an enforcement action against EOBR manufacturers that are found not be in conformity even after self-certifying as being so.

E.4 Certification Marks

Many but not all of the marks of conformity (certification marks) used in various certification programs are registered with the U.S. Patent and Trademark Office (PTO), however, only a few certification programs use federally-registered certification marks that meet the definition of “certification mark” under U.S. law. Furthermore, unregistered marks such as acronyms or symbols are used extensively in U.S. certification programs, due in part to the cost and perceived need for a registered mark. Some federal agencies own certification marks which are registered with the U.S. Patent and Trademark Office and which are used in product approval and certification programs. Examples include the mark used by the U.S. Department of Transportation in its program for tanks used in the transport of hazardous materials, the U.S. Department of Agriculture marks used in connection with poultry and meat grading programs, and the U.S. Environmental Protection Agency mark used for its Energy Star program that promotes the use of more energy efficient appliances.

E.5 Current Requirements for Certification of AOBRDs Under 49 CFR § 395.15

The current requirements regarding the certification of AOBRDs that are compliant with 49 CFR § 395.15 are relatively limited. Specifically, the requirements regarding certifying that the design of an AOBRD has been tested and meets the requirements of 49 CFR § 395 is addressed under 49 CFR § 395.15(i)(1):

> *(i) Performance of recorders. Motor carriers that use automatic on-board recording devices for recording their drivers' records of duty status in lieu of the handwritten record shall ensure that:*
>
> *(1) A certificate is obtained from the manufacturer certifying that the design of the automatic on-board recorder has been sufficiently tested to meet the requirements of this section and under the conditions it will be used;*
>
> *(8) The on-board recording device is maintained and recalibrated in accordance with the manufacturer's specifications;*

49 CFR § 395.15(i)(8) addresses the consideration that, though an AOBRD may meet the requirements of 49 CFR § 395 at the time of manufacture, over time due to in use degradation or other effects it may not be able to meet these requirements without appropriate maintenance or recalibration. Because of this consideration, some basic conformity assessment activities related to ensuring the long term conformity of in-use EOBRs might potentially become part of the standard motor carrier compliance review process. At a minimum, regardless of the entity that carries out conformity assessment activities and certifies EOBRs at their time of manufacture, the responsibility is likely to be upon motor carriers to certify that EOBRs are maintained during their useable lifetimes in conformance with the FMCSA standards for EOBRs.

Appendix F: Recording of Location Information for EOBR Applications

The recording of location information (state and city, town or village name) related to each change of duty status provides roadside enforcement personnel and compliance review personnel the ability to correlate driver records with other information, such as supporting documents currently required under 49 CFR § 395.8 (k)(1), in order to help confirm consistency and accuracy of driver records. The hours of service (HOS) regulations require under 49 CFR § 395.8(b)(4)(c) that for each change of duty status, the name of the city, town, or village, with state abbreviation, where the change of duty status occurs shall be recorded. If a change of duty status occurs at a location other than a city, town, or village, the name of the *nearest* city, town, or village and state abbreviation can be provided, along with either (1) the highway number and nearest milepost, (2) the highway number and the name of the service plaza, or (3) the highway numbers of the nearest two intersecting roadways.

Regarding the use of automatic on-board recording devices (AOBRDs), the HOS regulations similarly require under 49 CFR § 395.15(d) that for each change of duty status, the name of the city, town, or village, with state abbreviation, where the change of duty status occurs shall be recorded. This regulation also allows motor carriers to use a “location code” to represent the city, town, or village, with state abbreviation, provided that a list of such codes showing all possible location identifiers (and the corresponding city, town or village name and state abbreviation) is made available both in the cab of the commercial motor vehicle and at the motor carrier's principal place of business, and is also made available to enforcement officials upon request. The description of the location must be of sufficient precision to enable enforcement personnel to quickly determine the geographic location on a standard map or road atlas.

Based on discussions with FMCSA Division staff, it appears that in practice, the location information provided by drivers on handwritten RODS varies. Some drivers provide the names of larger cities and towns that are likely to either be generally known by enforcement personnel or easily identifiable by referencing a standard map or atlas. In contrast, some drivers provide location information that is so geographically precise that it can be difficult to correlate with information that is likely to appear on a standard map or road atlas.

Geographic Names References

The use of a standard set of city and town names that is practically useful to both CMV drivers and to enforcement personnel in terms of providing a reasonable and functionally useful balance of geographic coverage in combination with sufficient geographic detail should help to facilitate the use of EOBRs. With this goal in mind, several readily available geospatial data sets produced by a number of federal agencies are reviewed later as potential sources of information concerning city, town and village names for use in EOBR applications.

In evaluating these geospatial data sets, one issue that should be considered is that because most sources of geospatial names information related to cities, towns and villages are ultimately based upon the location of populated areas, many of the data sources reviewed below tend to have too many separate named places in metropolitan and suburban areas (i.e., too much geographic detail), while at the same time having too few named places in sparsely populated rural areas (i.e., too little geographic detail). The use of a geographic names reference with such characteristics would likely result in practical difficulties for both enforcement personnel and drivers alike. For example, with regards to urban and suburban areas, enforcement personnel might have difficulty identifying and locating very precise or detailed geographic references since such places may only to be generally known to those living in or in very close proximity to that particular area, and such named places may also not appear on many standard maps or road atlases because of their level of detail. Such a detailed database might also prove cumbersome for drivers to manage or select locations from due to the sheer number of named places in many urban and suburban areas. In contract, with regards to rural areas, enforcement personnel might have difficulty correlating driver records with other information such as supporting documents if so few named places exist in sparsely populated rural areas that a driver is limited to selecting a named place that is located a significant distance (e.g., 20 or 30 miles) away from the location of the duty status change being recorded.

Another issue that should be considered while evaluating these geospatial data sets is the difference between political or governmental units of geography, and statistical or census units of geography. Some confusion arises when these two general types of geography are in practice the same. For example, certain types of statistical or census geography such as “census tracts” often do not have a corresponding political or governmental unit associated with them. They exist primarily for the purpose of statistical tabulation. In contrast, certain types of statistical or census geography such as “minor civil divisions” (MCDs) often do have a corresponding political or governmental unit associated with them in approximately half of the states throughout the U.S.. In the case of “minor civil divisions,” in practice these areas generally correspond to locally identifiable governmental units such as cities, towns or townships in approximately half of the states throughout the U.S.. In the remaining states where this is not the case, “census county divisions” (CCDs) are established by the Census Bureau as comparable statistical units in order to provide a consistent nationwide geography for statistical reporting. The potential confusion caused by both the differences and similarities between political geography and statistical geography, and the fact that in many cases, such as with MCDs and CCDs, the differences and similarities are not consistent throughout the entire U.S., should be kept in mind while evaluating the geospatial data sets discussed below.

FIPS55 Database

Federal information processing standards (FIPS) codes are a standardized set of numeric or alphabetic codes issued by the National Institute of Standards and Technology (NIST) to ensure uniform identification of geographic entities by all federal government agencies. The geographic entities covered by the FIPS standard include states and statistically equivalent entities, counties and statistically equivalent entities, named populated and related location entities (such as places and county subdivisions), and American Indian and Alaska Native areas. FIPS publication 55-3 (FIPS PUB 55-3) specifically addresses FIPS codes for named populated places, primary county divisions, and other locational entities of the United States, Puerto Rico, and the outlying areas of the United States. Maintenance of the FIPS55 database is the responsibility of the U.S. Geological Survey (USGS), and under the authority of NIST, USGS is the only Federal agency authorized by NIST to disseminate the data.

The current FIPS55 database contains 197,136 records (see Table F-1). The U.S. Census Bureau uses the codes in FIPS PUB 55-3 as the basis for identifying geographic entities for county subdivisions, places, and American Indian areas/Alaska Native areas/Hawaiian home lands for the purposes of Census data collection and tabulation activities. It should be noted, however, that the FIPS55 database includes many more entity records than those for which the Census Bureau tabulates demographic data. For example, the current FIPS55 database contains approximately twice as many records as the Census 2000 Geographic Identification Code Scheme (GICS) data that the Census Gazetteer 2000 is based on. Details regarding the number and type of geographic entities currently contained in the FIPS55 database are presented in Table F-1 below.

Table F-1: Type and Number of Locational Entities in the FIPS55 Database

Class	Class Code Description	Number of Geographic Entities
A	Airports	498
B	Post Offices Not Corresponding to Other Locational Entities	1,195
C	Incorporated Places	21,202
D	American Indian Areas	1,125
E	Alaska Natives Area	260
F	Hawaiian Areas	63
H	Counties and County Equivalents	3,199
M	Federal Facilities	1,356
N	State, Local, and International Government Facilities	83
T	Active Minor Civil Divisions	16,645
U	Populated (Community) Places (Except Those Associated with Facilities)	128,029
X	Obsolete or Incorrect Names or Entities	6,907
Z	Inactive or Nonfunctioning Primary County Divisions	16,574
TOTAL NUMBER OF GEOGRAPHIC ENTITIES		**197,136**

A related database, an extract from the USGS Geographic Names Information System (GNIS) known as the "The U.S. Populated Places File," lists information about all communities throughout the United States that are described in the GNIS database, and contains 182,275 populated place records.

Both the USGS GNIS "U.S. Populated Places File" (containing 182,275 records), and the "U" Class (Populated Places) subset of the FIPS55 data (containing 128,029 records), have too many separate place names, particularly in metropolitan and suburban areas, to be of practical use to both CMV drivers and enforcement personnel. The sheer number of records might require drivers to search through needlessly large data sets to select an appropriate place name for each change of duty status, and the level of geographic detail provided in many cases would not allow enforcement personnel to quickly determine many of the geographic locations provided in these databases on a standard map or road atlas, since many of these locations do not appear on most standard maps or road atlases. This limits the usefulness of either the GNIS U.S. Populated Places File, or the FIPS55 data, as a geographic names reference for EOBR applications.

U.S. Census Bureau 2000 Gazetteer Database

Another potential alternative to serve as the basis for a geographic names reference for EOBR applications is the U.S. Census Bureau 2000 Gazetteer. The U.S. Census Bureau publishes a gazetteer, or geographic or cartographic dictionary or index, containing geographic entity information derived from the U.S. Census Bureau Geographic Identification Code Scheme (GICS) data, as a product of each decennial census. The U.S. Census Bureau 2000 Gazetteer contains information regarding places, counties, county subdivisions, and ZCTAs™ (ZIP Code® Tabulation Area). The GICS database on which the Gazetteer 2000 is based contains approximately 100,000 records. Information for approximately 66,000 census tracts is then added, resulting in a total of approximately 164,000 geographic entities in the 2000 Gazetteer. Details regarding the number and type of geographic entities contained in the 2000 Gazetteer are presented in Table F-2 below.

Table F-2: Type and Number of Locational Entities in the Census Bureau 2000 Gazetteer Database

Entity Description	Number of Geographic Entities
Place	25,375
County Subdivision	36,351
Census Tract	66,304
County	3,219
ZCTAs (Zip Code Tabulation Areas)	33,233
TOTAL NUMBER OF GEOGRAPHIC ENTITIES	**164,482**

The geographic entities contained in the 2000 Gazetteer relevant to EOBR applications include the "Place" data set, for which there are 25,375 records, and the "County subdivision" data set for which there are 36,351 records. With regards to potential use as a geographic names reference for EOBR applications, though the 2000 Gazetteer "Place" data has a smaller and more manageable number of place names listed relative to the GNIS and FIPS55 data discussed earlier, the 2000 Gazetteer "Place" data tends to contain too many place names in more densely populated areas such as metropolitan and suburban areas, and too few in less densely populated rural areas. In contrast, however, the 2000 Gazetteer "County Subdivisions" data both has a smaller and more manageable number of places listed relative to the GNIS and FIPS55 data discussed earlier, and tends to be more evenly geographically distributed throughout the country. Relative to the "Places" data, the "County Subdivisions" data has relatively fewer place names in more densely populated areas such as metropolitan and suburban areas, and relatively more and more evenly distributed place names in less densely populated rural areas. For this reason, the "County Subdivisions" data may provide the best starting point with regards to developing a standardized and practically useful city, town and village names list for EOBR applications.

National Atlas, Cities and Towns of the United States Database

This data set is produced by the USGS, and is provided electronically as part of the National Atlas of the United states (http://nationalatlas.gov). The USGS coordinates the efforts of more than 20 Federal agencies in the development of geospatial and geostatistical data for the United States that is made available in the National Atlas. Cities and towns include both incorporated places and populated places that are simply named locations with clustered or scattered buildings and a permanent human population. The Cities and Towns of the United States data contains 35,432 records in the United States, Puerto Rico, and the U.S. Virgin Islands, and is compiled by the USGS using information from the USGS GNIS and the U.S. Census Bureau. Descriptive information provided in the data includes the name and county location, the population (when known), FIPS code for the populated place, county, and state, and an indication of whether the city or town is a state capital or a county seat.

Though this data set appears to provide a somewhat larger number of place names in rural areas, the coverage is still generally not adequate in that it not evenly distributed. In addition, similar to the GNIS, FIPS55, and Census Gazetteer “Place” data, the National Atlas data tends to have too many place names in more densely populated metropolitan and suburban areas, somewhat limiting its usefulness as a geographic names reference for EOBR applications.

Details regarding the number and type of geographic entities contained in the National Atlas Cities and Towns of the United States data are presented in Table F-3 below.

Table F-3: Type and Number of Locational Entities in the National Atlas Cities and Towns of the U.S. Database

Entity Description	Number of Geographic Entities
Populated Place	32,327
County Seat	3,054
State Capital	2
State Capital and County Seat	48
National Capital	1
TOTAL NUMBER OF GEOGRAPHIC ENTITIES	**35,432**

Recommendation

The Census Gazetteer “County Subdivisions” data appears to provide the most suitable starting point with regards to developing a standardized and practically useful city, town and village names list for EOBR applications. As noted above, the GNIS Populated Places file, FIPS55 data, Census Gazetteer “Place” data, and National Atlas Cities and Towns of the United States data are all somewhat limited in their usefulness as a geographic names reference for EOBR applications due to their either having too many place names in metropolitan and suburban areas, and/or too few place names in rural areas. However, the Census Gazetteer “County subdivision” data, containing 36,351 records, has both a smaller and more manageable number of places listed relative to the GNIS and FIPS55 data, while also generally having fewer place names in more densely populated areas such as metropolitan and suburban areas, and relatively more place names in less densely populated rural areas.

If necessary, in counties that are particularly sparsely populated, records from some of the data sets such as the GNIS Populated Places file or the National Atlas Cities and Towns of the United States, which in some areas contain additional geographic detail, could be added to increase the number of available place names where needed. For example, for each the various data sets reviewed earlier, Table F-4 below presents the number of geographic place name records by state, and the number of square miles of area in each state for each geographic name record (which on average provides an indication of level of geographic detail provided by each data set for each state). Nationwide, the Census Bureau 2000 Gazetteer “County Subdivisions” data has approximately one geographic place name per 100 square miles. In western states such as Alaska, Arizona, California, Colorado, Idaho, Montana, New Mexico, Nevada, Oregon, Utah and Wyoming, the Census Bureau 2000 Gazetteer “County Subdivisions” data has far fewer geographic place names and correspondingly less geographic detail. Geographic place names from one of the more detailed data sets such as the GNIS Populated Places files might be used to increase the level of geographic detail available in these particular states, or more specifically, in the counties in these states where there is a relatively low population density. Any duplicate records could be eliminated either a comparison of FIPS codes, or where FIPS code information is insufficient, by using a combination of the name information and relative geographic location. Such a data set could be updated every several years to reflect the relatively few changes that occur over time with the addition of, elimination of, or changes to various populated places or place names.

Table F-4: Comparison of the Number of Available Records and the Approximate Level of Geographic Detail by Data Source

		Number of Geographic Name Records					Square Miles per Populated Place				
State	State Area (Square Miles)	Census Bureau 2000 Gazetteer "Place" data	Census Bureau 2000 Gazetteer "County Subdivision" data	USGS FIPS55 data, Class U (Populated Places	USGS GNIS Populated Places File	National Atlas Cities and Towns of the United States	Census Bureau 2000 Gazetteer "Place" data	Census Bureau 2000 Gazetteer "County Subdivision" data	USGS FIPS55 data, Class U (Populated Places	USGS GNIS Populated Places File	National Atlas Cities and Towns of the United States
AK	576,594	349	36	644	708	429	1,652	16,017	895	814	1,344
AL	51,716	494	390	3,991	6,607	716	105	133	13	8	72
AR	52,913	519	1,330	2,810	4,453	848	102	40	19	12	62
AZ	113,713	250	78	1,970	2,000	378	455	1,458	58	57	301
CA	157,776	1,081	387	5,517	7,516	1,385	146	408	29	21	114
CO	104,101	354	208	1,772	1,636	586	294	500	59	64	178
CT	4,977	120	173	1,073	1,302	130	41	29	5	4	38
DC	66	1	1	73	178	1	66	66	1	0	66
DE	2,055	75	27	916	1,646	88	27	76	2	1	23
FL	55,815	888	299	3,431	3,456	1,116	63	187	16	16	50
GA	58,629	596	577	3,155	7,569	937	98	102	19	8	63
HI	6,381	131	44	615	535	169	49	145	10	12	38
IA	56,258	954	1,661	1,121	2,522	1,106	59	34	50	22	51
ID	83,344	205	170	1,056	1,330	381	407	490	79	63	219
IL	56,299	1,313	1,710	3,618	4,588	1,509	43	33	16	12	37
IN	36,400	601	1,011	3,203	3,448	786	61	36	11	11	46
KS	82,197	631	1,535	1,184	1,681	927	130	54	69	49	89
KY	40,320	467	481	4,834	4,489	934	86	84	8	9	43
LA	45,836	398	597	2,569	4,142	745	115	77	18	11	62
MA	8,173	235	357	2,368	2,428	343	35	23	3	3	24
MD	9,740	368	293	3,731	8,622	541	26	33	3	1	18
ME	32,162	111	535	2,014	2,177	258	290	60	16	15	125
MI	57,899	630	1,569	2,934	2,859	820	92	37	20	20	71
MN	84,520	867	2,778	1,449	2,384	1,143	97	30	58	35	74
MO	69,833	972	1,379	2,795	5,118	1,221	72	51	25	14	57
MS	47,619	329	410	2,246	3,575	641	145	116	21	13	74
MT	147,245	275	191	1,285	2,088	527	535	771	115	71	279
NC	49,048	655	1,055	4,237	7,005	827	75	46	12	7	59
ND	70,812	373	1,790	553	890	483	190	40	128	80	147
NE	77,330	537	1,234	586	1,405	635	144	63	132	55	122
NH	9,260	60	260	993	1,010	105	154	36	9	9	88
NJ	7,508	505	571	2,719	2,590	725	15	13	3	3	10
NM	121,757	234	130	1,410	2,215	487	520	937	86	55	250
NV	110,670	71	72	602	1,147	178	1,559	1,537	184	96	622
NY	48,562	1,050	1,022	6,335	6,299	1,218	46	48	8	8	40
OH	41,194	1,054	1,585	4,354	7,732	1,343	39	26	9	5	31
OK	70,003	691	302	1,452	1,982	811	101	232	48	35	86
OR	97,074	309	211	1,873	1,552	481	314	460	52	63	202
PA	45,360	1,401	2,580	9,374	9,928	1,719	32	18	5	5	26
PR	3,459	225	937	1,295	2,259	219	15	4	3	2	16
RI	1,045	27	40	413	420	27	39	26	3	2	39
SC	30,867	368	296	2,274	5,102	463	84	104	14	6	67
SD	77,195	350	1,361	563	985	488	221	57	137	78	158
TN	42,092	382	462	4,846	7,293	557	110	91	9	6	76
TX	264,436	1,510	860	4,734	9,406	2,325	175	307	56	28	114
UT	84,872	289	90	707	4,255	381	294	943	120	20	223
VA	39,820	371	544	6,346	8,367	618	107	73	6	5	64
VT	9,603	67	255	873	910	113	143	38	11	11	85
WA	67,290	522	242	2,410	2,622	818	129	278	28	26	82
WI	56,088	630	1,914	1,967	2,463	983	89	29	29	23	57
WV	24,229	282	240	3,828	4,235	470	86	101	6	6	52
WY	97,803	198	71	522	587	288	494	1,378	187	167	340
TOTALS	**3,589,956**	**25,375**	**36,351**	**127,640**(1)	**181,716**(2)	**35,427**(3)	**141**	**99**	**28**	**20**	**101**

Notes:
(1) Totals to 128,029 when including the Virgin Islands, American Samoa, Guam, and the Northern Mariana Islanc
(2) Totals to 182,275 when including the Virgin Islands, American Samoa, Guam, the Northern Mariana Islands, an Minor Outlying Islands
(3) Totals to 35,432 when including the Virgin Islands