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**National Highway**
**Traffic Safety Administration**

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FINAL REGULATORY EVALUATION

# EVENT DATA RECORDERS (EDRs)

Office of Regulatory Analysis and Evaluation
National Center for Statistics and Analysis
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**People Saving People**

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## EXECUTIVE SUMMARY

This Final Regulatory Evaluation (FRE) analyzes the potential impacts of the final rule for voluntarily installed Event Data Recorders (EDRs) in light vehicles. An EDR is a device or function in a vehicle that records a vehicle's dynamic, time-series data just prior to or during a crash, intended for retrieval after the crash.

### Final Rule

The final rule requires voluntarily installed EDRs in vehicles with a gross vehicle weight rating (GVWR) of 3,855 kilograms (8,500 pounds) or less to:

a. Record 15 essential data elements,
b. Record up to 30 additional data elements if the vehicle is equipped to record these elements,
c. Record these data elements in a standardized format, with specifications for range, accuracy, resolution, sampling rate, recording duration, and filter class,
d. Function after full-scale vehicle crash tests specified in FMVSS Nos. 208 and 214, and
e. Have the capacity to record two events in a multi-event crash.

In addition, the final rule requires vehicle manufacturers to make a retrieval tool for the EDR information commercially available. The rule also requires vehicle manufacturers to include a standardized statement in the owner's manual indicating that the vehicle is equipped with an EDR and describing its purposes.

**Technological Feasibility**

Currently, about 9.8 million (64 percent) new light vehicles are equipped with some type of EDR. Many of the EDRs already collect the data elements required by the final rule but with slightly different formats. For these EDRs, their software algorithms might require minor modification. For EDRs that do not record all the required essential data elements, their memory chips and computer processors might require upgrades to accommodate the increase in data flow and storage. These EDRs may also require software algorithm redesigns and other improvements for their computer area networks.

**Benefits**

The final rule will standardize and enhance the amount of recorded crash information that is available through EDRs. Safety researchers would utilize the standardized information to better understand crash dynamics and to identify more effective crashworthiness and crash-avoidance countermeasures, thereby helping to improve motor vehicle safety. EDRs meeting with the requirements of the final rule may also provide a more comprehensive and useful set of data for automatic collision notification (ACN) systems, which evaluate the need for and the level of emergency response to traffic crashes.

**Costs**

At the current level of usage of EDRs, the estimated costs associated with the rule would be up to $1.7 million (2004 dollars). This aggregate cost figure reflects the need for technology improvements, as well as assembly costs, compliance costs, and paperwork maintenance costs. Technological improvements account for majority of these costs.

The cost of the rule would potentially increase to $5.2 to $8.4 million if future rulemakings (e.g., FMVSS No. 214) make the recording of additional data elements inevitable or if the manufacturers voluntarily design their current EDRs to record all the additional data elements. If all 15.5 million new light vehicles became voluntarily equipped with an EDR, the cost would be rise to $10.9 million for the present final rule and $11.8 to $33.3 million if additional data elements are required due to future rulemakings.

**Leadtime**

The compliance date of the final rule is September 1, 2010. Multi-stage vehicle manufacturers and alterers must comply with the rule beginning on September 1, 2011. The long leadtime should enable vehicle manufacturers to make design changes to their EDRs as they introduce new make/models, which will minimize the compliance costs towards the lower bound of estimates.

# CHAPTER I. INTRODUCTION

This final regulatory evaluation accompanies the National Highway Traffic Safety Administration's (NHTSA) final rule to specify requirements for voluntarily installed Event Data Recorders (EDRs) in light vehicles with a gross vehicle weight rating (GVWR) not more than 3,855 kg (8,500 pounds). An EDR is a device or function in a vehicle that records vehicle performance characteristics just prior to or during a crash. The final rule's requirements cover the data elements and their recording formats, compliance tests, survivability and retrievability of the EDR data, disclosure and reporting of EDR information.

## Background

EDRs have been available in various forms in certain vehicles since the 1970s. In 1991 the agency, in cooperation with General Motors (GM), began to utilize EDRs as one of the crash investigative tools for the agency's Special Crash Investigations (SCI) program. Between 1991 and 1997, staff from the SCI program worked with manufacturers to read approximately 40 EDRs in support of its program.

In 1997, the National Transportation Safety Board (NTSB) issued Safety Recommendation H-97-18 to NHTSA, recommending that the agency "pursue crash information gathering using EDRs." In the same year, the National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory (JPL) recommended that NHTSA "study the feasibility of installing and obtaining crash data for safety analyses from crash recorders on vehicles." Later, in 1999, NTSB made additional EDR recommendations, suggesting that EDRs be installed in school buses and motor coaches.

In response, NHTSA sponsored two EDR working groups since 1998. The working groups were comprised of members from industry, academia, and other government organizations. The groups' missions were to facilitate the collection and utilization of collision avoidance and crashworthiness data from on-board EDRs. In August 2001, the first EDR Working Group published a final report on the results of its deliberations[1]. In May 2002, the second working group, the NHTSA Truck & Bus EDR Working Group, published its final report[2]. NHTSA also developed a website for highway-based EDRs. This website includes the current development on EDRs. The web address is "http://www-nrd.nhtsa.dot.gov/edr-site/index.html".

**Petitions**

Almost in parallel to the agency's EDR research, the agency received three rulemaking petitions pertaining to EDRs. Two of the petitions were from private individuals, Mr. Price T. Bingham and Ms. Marie E Birnbaum. The third one was from Dr. Ricardo Martinez, President of Safety Intelligence Systems Corporation.

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[1] Event Data Recorders, Summary of Findings by the NHTSA EDR Working Group, August 2001, Final Report. (Docket No. NHTSA-99-5218-9).
[2] Event Data Recorders, Summary of Findings by the NHTSA EDR Working Group, May 2002, Final Report, Volume II, Supplemental Findings for Trucks, Motorcoaches, and School Buses (Docket No. NHTSA-2000-7699-6).

Mr. Bingham and Ms. Brinbaum both petitioned the agency in late 1990's. Mr. Bingham asked the agency to initiate rulemaking to require air bag data to be recorded during a crash and to be read later by crash investigators. The second petitioner, Ms. Marie E. Birnbaum, asked the agency to initiate rulemaking to require passenger cars and light trucks to be equipped with "black boxes" (i.e., EDRs) analogous to those found on commercial aircraft.

In responding to these two petitions, the agency stated that EDRs could provide valuable information to better understand crashes. The recorded information could be used in a variety of ways to improve motor vehicle safety. Nevertheless, the agency denied these two petitions because the motor vehicle industry was already voluntarily moving in the direction recommended by the petitioners, and because the agency believed "this area presents some issues that are, at least for the present time, best addressed in a non-regulatory context." (63 FR 60270; November 9, 1998 and 64 FR 29616; June 2, 1999.)

The third petitioner, Dr. Ricardo Martinez, petitioned the agency in October 2001 to "mandate the collection and storage of onboard vehicle crash event data, in a standardized data and content format and in a way that is retrievable from the vehicle after the crash." The petitioner reasoned that crash information is the cornerstone of safety decision-making for designing the vehicle, making policy, identifying a potential problem, or evaluating the effectiveness of safety systems. However, the petitioner felt that the industry's overall response has been "sluggish and disjointed" and that a NHTSA rulemaking on EDRs is necessary. The NHTSA-sponsored Working Group on EDRs, the

Institute of Electrical and Electronics Engineers (IEEE), and the Society of Automotive Engineers (SAE) all had begun to work on guidance for standardizing data sets for EDRs. In addition, the petitioner argued that a rulemaking would greatly accelerate the deployment of automatic crash notification (ACN) since the advent of advanced ACN is dependent upon the standardized collection of crash information in the vehicle.

Finally, the petitioner stated that privacy issues could be overcame by ensuring that the vehicle owner is the one who owns the data collected by the EDR and can provide permission for its use and transmission. The EDR data does not have personal identifier information and is only stored in the event of a crash. Current crash information in the form of police reports and insurance claims have much more personal identifying information than EDRs.

The petition from Dr. Martinez was submitted shortly after the first NHTSA EDR Working Group had published its final report and while the agency was waiting for the conclusions from the second EDR working group. In October 2002, after the second working group had completed its work, the agency decided to request public comments on the future role the agency should take related to the continued development and installation of EDRs in motor vehicles. After the consideration of the pubic comments, the agency then decided to respond to Dr. Martinez's petition in a notice for proposed rulemaking (NPRM).

**Request for Comments**

On October 11, 2002, NHTSA published in the **Federal Register** (67 FR 63493; Docket No. NHTSA-02-13546), a request for comments concerning EDRs and as to what future role the agency should take related to the continued development and installation of EDRs in motor vehicles.

The agency received comments from light and heavy vehicle manufacturers, equipment manufacturers, vehicle users, the medical community, advocacy organizations, safety research organizations, crash investigators, insurance companies, academia, government agencies, and private individuals. Generally, the commenters believed that EDRs will improve vehicle safety by providing necessary and accurate data for crash analysis, information for potential injury prediction, and data for vehicle/roadway design improvement. However, commenters also expressed concern that the complexity of and incompatibility among existing EDRs might prevent the recorded data from being fully utilized for vehicle occupant safety improvements. Thus, the commenters concluded that a standardization of EDR data would be desirable and helpful. Both the SAE and IEEE commented that they are working on drafting standards for use with EDRs (which have since been finalized).

As for NHTSA's role in the future of EDRs, the commenters' opinions varied. However, most commenters stated that NHTSA should perform research, work with manufacturers to increase the availability of the data, and encourage the development of EDR standards.

After considering these inputs, the agency decided to issue a Notice of Proposed Rulemaking (NPRM) to propose a standardized set of data elements and formats for all voluntarily installed EDRs. The goal of the proposal would be to enhance the use of the recorded data in ACN systems, crash investigation, the evaluation of safety countermeasures, and advanced restraint and safety countermeasure research and development.

**Notice of Proposed Rulemaking (NPRM)**

On June 14, 2004, NHTSA published an NPRM for EDRs (69 FR 32932; NHTSA-04-18029). The NPRM proposed that voluntarily installed EDRs in light vehicles with GVWR no greater than 3,855 kg (8,500 pounds) shall:

(1) record a minimum set of 18 specified data elements useful for crash investigations, analysis of the performance of safety equipment, *e.g.*, advanced restraint systems, and automatic collision notification systems;

(2) record an additional 24 data elements if light vehicles were equipped with these data elements;

(3) specify data format requirements including range, accuracy, precision, sampling rate, recording time duration, and filter class for the required data elements;

(4) record up to 3 events in an multi-event crash;

(5) increase the survivability of the EDRs and their data by requiring that the EDRs would function during and after the front, side and rear vehicle crash tests specified in Federal Motor Vehicle Safety Standard (FMVSS) Nos. 208, 214, and 301;

(6) require that the EDR data would retrievable at least 30 days after the crash;

(7) require vehicle manufacturers to make publicly available information that would enable crash investigators to retrieve data from the EDR; and

(8) require vehicle manufacturers to include a brief standardized statement in the owner's manual indicating that the vehicle is equipped with an EDR and describing the purposes of EDRs.

The NPRM would allow the agency to better evaluate the performance of advanced restraint systems, allow crash investigators to obtain better crash data for reconstruction purposes, and enhance the development and installation of ACNs. Essentially, with the NPRM, the agency granted partly (i.e., standardization of EDR data) and denied partly (i.e., mandating EDRs) the third petition.

**Comments on the NPRM**

NHTSA received a total of 104 comments to the NPRM. Of these, 61 were from private citizens, and 43 were from 40 various groups, including automotive and EDR manufacturers, insurance companies, safety organizations, government agencies, health/medical institutes, and other small groups. Among the 61 individual responders, 54 opposed, 6 supported, and 1 abstained the NHTSA proposal. Invasion of privacy, violation of constitutional rights of the vehicle owners, and ambiguity regarding ownership of the EDR data were the fundamental reasons for their opposition.

Among the 40 various groups (43 comments), 4 groups opposed, 35 groups supported, and 1 group abstained the NPRM proposal. Their 43 comments tended to be more complex than those of individual commenters and covered a variety of issues. Issues of concern included privacy, ownership of the EDR data, accessibility of EDR data, whether EDRs should be mandatory, the authentication of the EDR data, the definition of EDR, the appropriateness of data elements and data formats, the stringency of survivability requirements, low cost estimates, and short leadtime. Of the four groups opposed to the proposal, three were small private research organizations and one was a European automobile manufacturer (Porsche). The three small private groups opposed the proposal with reasons echoing those made by the individual commenters (i.e., privacy, constitutional rights, and ownership). Porsche, on the other hand, opposed the proposed rule by citing that the industry was already moving in this direction and other EDR technical problems.

Of the 35 groups supporting the EDR proposal, some of these commenters expressed concern about privacy and ownership issues, and other commented on the "voluntarily" aspect of rule. But, the major shared concerns among these groups were centered on the EDR technical issues: (a) EDR specifications, i.e., appropriateness of the data elements, format, and accuracy requirements, (b) functioning and survivability requirements, and (c) the cost estimates. These commenters argued that the NPRM proposal is excessive. For example, commenters stated that the data format requirements (range, sampling rate, accuracy, resolution, and filter) significantly exceeded the current industry practices, and in some aspects, the sensor technologies for achieving the proposed data format requirements might not be feasible in the near future. To comply with the NPRM proposal, the commenters argued that the manufacturers would be required to incur a substantially higher cost for updating their sensors/accelerometers, computer processing units (CPUs), and back-up power supplies in order to handle the data flow and comply with the functioning/survivability proposal. The commenters suggested that the total cost per EDR could be up to $500 with the majority of the cost attributable to the need for back-up power supplies.

Other concerns raised by the commenters included whether there should be a mandatory requirement for EDRs, exemption of the multi-stage vehicles, preemption of State Law, clarification on the definition of “EDR”, and clarification of the test procedures, and the accessibility of EDR data by EMS responders. Specific comments are available for review in Docket No. NHTSA-04-18029.

**Meetings With Industry**

After the comment period, the agency arranged meetings with Ford, GM, Toyota, and Delphi to further discuss the EDR technology and cost issues. Memoranda documenting these meetings are also contained in Docket No. HNTSA-04-18029. The agency gained valuable knowledge and information on current/future EDR designs and their costs from the participant companies.

**The Agency's Response to Public Comments**

The agency largely agrees with the commenters' concerns related to the EDR technical issues and cost estimates. After careful consideration of all the comments, the agency acknowledges that the NPRM proposal would impose a much higher cost than estimated but it would still be significantly less than $150 per vehicle, as suggested by some of the commenters. The manufacturers misinterpreted the NPRM proposed requirements for survivability, which drove up their cost estimates substantially. Nevertheless, to ensure the technology feasibility and to balance the cost and the safety needs, the agency has decided to revise the requirements in this final rule. The revisions make the rule less intrusive and burdensome, while maintaining the integrity of the data requirements and usefulness to ACN, crash investigation, and advanced restraint system research and development. Consequently, the cost estimate is revised accordingly in this FRE. Cost related responses to public comments are summarized in Appendix A. In addition, interested parties may consult the preamble of the final rule for a comprehensive analysis of comments on the NPRM.

**Organization of the Remaining Analysis**

Chapter II of this FRE discusses the final rule requirements and it also lists the changes between the NPRM proposal and final rule. Chapter III discusses the benefits of the final rule. Chapter IV estimates the costs of the final rule and discusses leadtime. Finally, Chapter V examines the impacts of the rule on small business entities. Appendix A details the agency responses to cost- related comments on the NPRM.  Appendix B lists the changes in data elements and their formats between the final rule and NPRM.

## CHAPTER II. REQUIREMENTS OF THE FINAL RULE

This chapter discussed the requirements of the final rule. The final rule specifies requirements for voluntarily installed EDRs in light passenger vehicles. An EDR is defined as "a device or function in a vehicle that captures the vehicle's dynamic, time-series data during the time period just prior to a crash event (e.g., vehicle speed vs. time) or during a crash event (e.g., delta-V vs. time), intended for retrieval after the crash event." The recorded data does not include audio and video data. Light vehicles covered by the rule include passenger cars, multipurpose passenger vehicles, light trucks, and vans with a GVWR of 3,855 kilograms (8,500 pounds) or less and an unloaded vehicle weight of 2,495 kg (5,500 lbs) or less with the exception of walk-in type vans or vehicles that are designated to be sold exclusively to the U.S. Postal Service.

For light vehicles equipped with an EDR, the final rule requires:

1) EDRs to record 15 essential data elements with a standardized data format including sampling rate, recording time duration, range, accuracy, resolution, and filter class for each event,
2) EDRs to record up to 30 additional data elements with a standardized data format (including sampling rate, recording time duration, range, accuracy, resolution, and filter class for each event), if the vehicle is equipped to record these elements[3],
3) EDRs to have the capacity to capture and record the required data elements for two events in a multi-event crash,

[3] "If recorded" means if the data are recorded in non-volatile memory for the purpose of subsequent downloading.

4) EDRs to function during and after the full-scale vehicle crash tests specified in the FMVSS Nos. 208 and 214. The data elements must be retrievable for at least 10 days after the crash tests,
5) vehicle manufacturers to ensure the availability of download tools for the EDR dara, and
6) vehicle manufacturers to include a standardized statement in the owner's manual indicating that the vehicle is equipped with an EDR and describing the purposes of EDRs.

**Data Requirements**

The final rule requires a voluntarily installed EDR to record 15 essential data elements with specific formats including recording time, data range, sampling rate, accuracy, resolution, and filter type. These data elements and their format requirements are listed in Table II-1. In addition, the final rule requires up to 30 additional data elements to be recorded if the EDR-equipped vehicles already have on-board technologies to record these data for later download. Table II-2 lists these 30 additional data elements to be recorded under specified conditions along with their data formats. Twenty-eight of the 30 additional data elements are required if vehicles were equipped to record these elements intended for downloading later. The remaining two data elements "Frontal air bag deployment, time to $n^{th}$ stage, driver" and "Frontal air bag deployment, time to $n^{th}$ stage, right front passenger" are required if vehicles were equipped with frontal air bags with a multi-stage inflator. An EDR is required to record these elements for up to two events in a multi-event crash.

The following briefly explains the format requirements of the final rule. “Recording Time” specifies the duration of time relative to the time of crash (time zero) for which an EDR must record that specific data element. A negative time designation means pre-crash. “Range” specifies the possible responses of a particular data element. “Accuracy” specifies the magnitude that the recorded data can deviate from the laboratory test results. “Resolution” specifies the maximum allowable increment in measurement unit.

For example, for delta-V, longitudinal (essential data element #1), the possible recorded response of this element is limited between –100 and 100 km/h. The recorded delta-V is allowed to deviate by a maximum of 5% from the laboratory test measurement. In a case of a laboratory measurement of 50 km/h, an EDR-recorded delta-V would be 50 $\pm$ 2.5 km/h. The 1 km/h resolution requirement allows recorded delta-V to be rounded to the nearest integer. For example, if the EDR measured the delta-V to be 50.7 km/h, the reported delta-V from the EDR would be 51 km/h.

Data elements such as lateral, longitudinal, and normal accelerations have an additional filter specification. The time history data to measure these three elements are required to be filtered using an SAE J211 Class 60 filter. Several data elements are binary (i.e., the recorded response (or range) is yes/no or on/off). For these elements, occupant size classification determines the size of an occupant. For the driver side, “yes” means a small stature driver. For the front right passenger side, a "yes" indicates that the passenger is a child. Occupant position classification determines whether the specific occupant was out-of-position, and is recorded as "yes" indicating out-of-position.

**Table II-1**
**Required Essential Data Elements and Formats**

| Item # | Data Elements | Recording Time* | Sampling Rate | Range | Accuracy | Resolution | Filter |
|---|---|---|---|---|---|---|---|
| 1 | Delta-V, Longitudinal | 0 – 250 ms | 100/s | -100 to 100 km/h | ± 5% | 1 km/h | N.A. |
| 2 | Maximum delta-V, Longitudinal | 0 – 300 ms | N.A. | -100 to 100 km/h | ± 5% | 1 km/h | N.A. |
| 3 | Time, Maximum delta-V, Longitudinal | 0 – 300 ms | N.A. | 0 – 300 ms | ± 3 ms | 2.5 ms | N.A. |
| 4 | Speed, vehicle indicated | -5.0 to 0 s | 2/s | -200 to 200 km/h | ± 1 km/h | 1 km/h | N.A. |
| 5 | Engine throttle, % full (accelerator pedal % full) | -5.0 to 0 s | 2/s | 0 – 100% | ± 5% | 1% | N.A. |
| 6 | Service brake, on/off | -5.0 to 0 s | 2/s | On/off | N.A. | N.A. | N.A. |
| 7 | Ignition cycle, crash | -1.0 s | N.A. | 0 – 60,000 | ± 1 cycle | 1 cycle | N.A. |
| 8 | Ignition cycle, download | At time of download | N.A. | 0 – 60,000 | ± 1 cycle | 1 cycle | N.A. |
| 9 | Safety belt status, driver | -1.0 s | N.A. | On/off | N.A. | On/off | N.A. |
| 10 | Frontal air bag warning lamp | -1.0 s | N.A. | On/off | N.A. | On/off | N.A. |
| 11 | Frontal air bag deployment time, Driver (1st stage, in case of multi-stage air bags) | Event | N.A. | 0 – 250 ms | ±2 ms | 1 ms | N.A. |
| 12 | Frontal air bag deployment time, RFP (1st stage, in case of multi-stage air bags) | Event | N.A. | 0 – 250 ms | ±2 ms | 1 ms | N.A. |
| 13 | Multi-event, number of events (1 or 2) | Event | N.A. | 1, 2 | N.A. | 1, 2 | N.A. |
| 14 | Time from event 1 to 2 | As needed | N.A. | 0 - 5.0 s | 0.1 s | 0.1 s | N.A. |
| 15 | Complete file recorded (yes or no) | After Other Data | N.A. | Yes/no | N.A. | Yes/no | N.A. |

s: second; ms: millisecond; km/h: kilometer per hour; RFP: right front passenger; N.A.: not applicable
* Relative to time zero

**Table II-2**
**Required Additional Data Elements and Formats Under Specified Conditions**

| Item # | Data Elements | Recording Time* | Sampling Rate | Range | Accuracy | Resolution | Filter |
|---|---|---|---|---|---|---|---|
| 1 | Lateral acceleration | 0 – 250 ms | 500/s | (±) 50 g | ±5% | 0.01 g | SAE J211 Class 60 |
| 2 | Longitudinal acceleration | 0 – 250 ms | 500/s | (±) 50 g | ± 5% | 0.01 g | SAE J211 Class 60 |
| 3 | Normal acceleration | 0 – 250 ms | 500/s | (±) 50 g | ±5% | 0.01 g | SAE J211 Class 60 |
| 4 | Delta-V, Lateral | 0 – 250 ms | 100/s | (±) 100 km/h | ±5% | 1 km/h | N.A. |
| 5 | Maximum delta-V, Lateral | 0 – 300 ms | N.A. | (±) 100 km/h | ±5% | 1 km/h | N.A. |
| 6 | Time, maximum delta-V, Lateral | 0 – 300 ms | N.A. | 0 – 300 ms | ± 3 ms | 2.5 ms | N.A. |
| 7 | Time, maximum delta-V, resultant | 0 – 300 ms | N.A. | 0 – 300 ms | ± 3 ms | 2.5 ms | N.A. |
| 8 | Engine RPM | -5.0 to 0 s | 2/s | 0 – 10,000 rpm | ± 100 rpm | 100 rpm | N.A. |
| 9 | Vehicle roll angle (degree) | -1.0 to 5 s | 10/s | (±) 1,080 $^{0}$ | ± 10 $^{0}$ | 10 $^{0}$ | N.A. |
| 10 | ABS activity | -5.0 to 0 s | 2/s | On/off | N.A. | On/off | N.A. |
| 11 | Stability control | -5.0 to 0 s | 2/s. | On/off/ engaged | N.A. | On/off/ engaged | N.A. |
| 12 | Steering wheel angle | -5.0 to 0 s | 2/s | ± 250 $^{0}$ | ± 5 $^{0}$ | 5 $^{0}$ | 2/s |
| 13 | Safety belt status, RFP | -1.0 s | N.A. | On/off | N.A. | On/off | N.A. |
| 14 | Frontal air bag suppression switch status, RFP | -1.0 s | N.A. | On/off | N.A. | On/off | N.A. |
| 15 | Frontal air bag deployment, time to N$^{th}$ stage, Driver[1] | Event | N.A. | 0 – 250 ms | ± 2 ms | 1 ms | N.A. |
| 16 | Frontal air bag deployment, time to N$^{th}$ stage, RFP[1] | Event | N.A. | 0 – 250 ms | ± 2 ms | 1 ms | N.A. |
| 17 | Frontal air bag deployment, N$^{th}$ stage disposal, Driver[1] | Event | N.A. | Yes/no | N.A. | Yes/no | N.A. |
| 18 | Frontal air bag deployment, N$^{th}$ stage disposal, RFP[1] | Event | N.A. | Yes/no | N.A. | Yes/no | N.A. |
| 19 | Side air bag deployment time, Driver | Event | N.A. | 0 – 250 ms | ± 2 ms | 1 ms | N.A. |
| 20 | Side air bag deployment time, RFP | Event | N.A. | 0 – 250 ms | ± 2 ms | 1 ms | N.A. |
| 21 | Curtain/tube air bag deployment time, Driver | Event | N.A. | 0 – 250 ms | ± 2 ms | 1 ms | N.A. |
| 22 | Curtain/tube air bag deployment time, RFP | Event | N.A. | 0 – 250 ms | ± 2 ms | 1 ms | N.A. |
| 23 | Pretensioner deployment time, Driver | Event | N.A. | 0 – 250 ms | ± 2 ms | 1 ms | N.A. |
| 24 | Pretension deployment time, RFP | Event | N.A. | 0 – 250 ms | ± 2 ms | 1 ms | N.A. |
| 25 | Seat position, Driver | -1.0 s | N.A. | Yes/no | N.A. | Yes/no | N.A. |
| 26 | Seat position, RFP | -1.0 s | N.A. | Yes/no | N.A. | Yes/no | N.A. |
| 27 | Occupant size classification, Driver | -1.0 s | N.A. | Yes/no | N.A. | Yes/no | N.A. |
| 28 | Occupant size classification, RFP | -1.0 s | N.A. | Yes/no | N.A. | Yes/no | N.A. |
| 29 | Occupant position classification, Driver | -1.0 s | N.A. | Yes/no | N.A. | Yes/no | N.A. |
| 30 | Occupant position classification, RFP | -1.0 s | N.A. | Yes/no | N.A. | Yes/no | N.A. |

s: second; ms: millisecond; km/h: kilometer per hour; RFP: right front passenger; N.A.: not applicable

[1] List this element n-1 times, once for each stage of a multi-stage air bag system.

* Relative to time zero

The required essential data elements are particularly useful to crash investigations, ACN, and restraint system evaluation. Of these elements, Delta-V, Longitudinal, Maximum Longitudinal Delta-V, and Time for Maximum Longitudinal Delta-V are important data elements in determining vehicle crash severity. Delta-V, Longitudinal measures the time-stamped crash severity. Maximum Longitudinal Delta-V represents the maximum crash severity of the whole crash event. Time for Maximum Longitudinal Delta-V indicates the impact duration to reach the maximum crash severity. Service Brake Status is important in understanding the human response in seeking to avoid a pending crash. Pre-crash vehicle dynamic and system status elements – e.g., Vehicle Speed and Engine Throttle - are helpful in determining crash causation. Ignition Cycle, Crash and Downloaded elements are used to determine whether the recorded data are related to a specific event of interest. Elements related to the usage and operation of the restraint systems such as Safety Belt Use Status and air bag data are important in analyzing and validating the performance of these restraint/countermeasure systems.

These EDR-recorded crash severity and restraint system status elements would also be essential to ACN applications. The standardization of the EDR data elements would greatly improve the availability, accessibility, and readability of crash data. In the future, the integration of EDR technology, ACN, global positioning systems, and other advanced communication systems, could provide an early notification of the occurrence, location, nature, and severity of a crash. With the majority of the vehicle fleets already equipped with an EDR, EDR standardization may help ACN systems to potentially reach substantially more vehicles and accrue significantly more safety benefits with a reduced system and service cost.  This would increase consumers' interest and provide an incentive for automotive manufacturers, local governments, and medical facilities to actively promote the development and installation of ACN systems.

We note that both the SAE and the IEEE are interested in EDR standardization issues. SAE established a committee to specify a common format for data recorded by an EDR The SAE Vehicle Event Data Interface (J1698-1) Committee has completed common data definitions for specific data elements and other aspects of EDR standardization[4]. IEEE Motor Vehicle Data Recorder (MVDER) working group (P1616) also completed a data dictionary and standards documents for EDRs in 2004[5].

**Functioning and Survivability**

The final rule requires that an EDR must function during and after the compliance tests specified in FMVSS Nos. 208 and 214, except for two data elements: (1) "engine throttle, %full" and (2) "service brake, on/off."  These elements have been excluded from these requirements because vehicles are crash tested without the engine running for safety reasons, so the EDR would not be able to record the above data elements under those circumstances.

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[4]J1698 Dec 2003 - Vehicle Event Data Interface - Vehicular Output Data Definition
J1698-1 Mar 2005 - Vehicle Event Data Interface - Output Data Definition
J1698-2 May 2004 - Vehicle Event Data Interface - Vehicular Data Extraction

[5] IEEE Std 1616TM-2004, IEEE Standard for Motor Vehicle Event Data Recorders (MVEDRs), IEEE Vehicular Technology Society

Beginning in 2008, these tests will include a frontal rigid barrier crash test up to 56 km/h (35 mph), a 40 mph (25 mph) frontal deformable barrier offset test, and a 50 km/h (33.5 mph) side impact test. The EDR's stored data would be required to be retrievable 10 days after the crash tests. This requirement would provide a basic functioning and survivability level for EDRs, although it would not ensure that EDRs survive extremely severe crashes, fire, or fluid immersion.

**Paperwork Maintenance**

The final rule requires the vehicle manufacturers to make commercially available a retrieval tool for downloading EDR data. Vehicle manufacturers are also required to include a standardized statement in the owner's manual indicating that the vehicle is equipped with an EDR and describing the purposes of EDRs.

**Changes from the NPRM**

The final rule requirements differ from those proposed in the NPRM in many aspects. The changes in the final rule reflect the agency's consideration of the public comments to NPRM[6]. Specifically, changes in data elements and formats, number of events, compliance tests for survivability, and data retrieval are the agency's response to its concerns raised about technological feasibility and cost assessment. Table II-3 briefly summarizes the major differences, which influence the cost estimates between the NPRM

[6] Appendix A provides the agency's responses to the cost-related public comments.

proposal and finale rule. Appendix B lists the differences in the data elements and formats between the NPRM proposal and final rule requirements in detail.

**Table II-3**
**Highlighted Changes Between the Final Rule and NPRM Proposal**

| **Area** | **Final Rule** | **NPRM** |
|---|---|---|
| Data Elements | 15 essential<br>Up to 30 additional | 18 essential<br>Up to 24 additional |
| Data formats* | According to current industry practice | Based on advanced technologies |
| Number of Events | 2 events for a multi-event crash | 3 events for a multi-event crash |
| Survivability | | |
| Complying Tests | FMVSS Nos. 208 and 214 | FMVSS Nos. 208, 214, and 301 |
| Retrieval Duration | Within 10 days of crashes | Within 30 days of crashes |
| Reporting Information to the Agency | None | 30 days prior to start of production |
| Leadtime | September 1, 2010<br>September 1, 2011 for multi-stage manufacturers | September 1, 2008 |

* See Table B-2 for detail

## CHAPTER III. BENEFITS

This chapter discusses the benefits of the final rule for EDRs. Benefits are discussed qualitatively because the final rule only requires EDRs to store certain event-related information (e.g., air bag deployment) before or during a crash. The stored data, although extremely valuable for safety research and emergency response, does not itself directly improve vehicle safety. It would also be difficult to estimate the portion of the benefits that could be credited to EDR data after a vehicle standard or a network of safety systems is implemented or a safety countermeasure is developed.

This final rule requires 15 basic event-related data elements with specific data formats, for up to two crash events, to be recorded if the manufacturers choose to install an EDR in their vehicles. In addition, the final rule also requires up to 30 additional data elements to be recorded only if the EDR-equipped vehicles already have on-board technologies to acquire and record these data. See Tables II-1 and II-2 for these data elements and required formats.

The agency estimates that about 9.8 million (64 percent[7]) of the 15.5 million[8] new light vehicles with a GVWR less than or equal to 3,855 kg (8,500 pounds) are already equipped with electronic control systems, which, in one form or another, are equivalent to an EDR. In other words, about 9.8 million new light vehicles have an EDR.

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[7] 2005 NCAP industry survey

[8] Passenger car sales were based on the 2004 Wards Automotive Year Book, December 2004; light trucks/vans with GVWR<=3,855 kg (8,500 lbs) were derived from Mid-Model Year Fuel Economic Report Data

Table III-1 lists vehicle manufacturers, their share of the market, the estimated portion of each manufacturer's production that is equipped with EDRs, and the weighted market share of EDRs.  As noted in the table, passenger cars and light trucks sales were derived from two separate sources: the 2004 Words Automotive Book for passenger cars and the Mid-Term Mid-Model Year Fuel Economic Report Data for light trucks with GVWR less than or equal to 3,855 kg (8,500 pounds).

**Table III-1**
**Estimate of the Number EDRs in Light Vehicles with**
**A GVWR of 3,855 Kilograms (8,500 Pounds) or Less**

| Line | Sales* | Percent of Sales | % With EDRs** | # of EDRs |
|---|---|---|---|---|
| BMW | 279,706 | 1.7% | 0% | 0 |
| Daewoo[1] | 37,851 | 0.2% | 0% | 0 |
| DaimlerChrysler | 1,997,346 | 12.8% | 21% | 419,443 |
| Ford | 3,125,780 | 20.6% | 100% | 3,125,780 |
| GM | 4,407,110 | 28.3% | 100% | 4,407,110 |
| Honda | 1,380,153 | 8.1% | 0% | 0 |
| Hyundai | 397,458 | 2.4% | 0% | 0 |
| Isuzu | 75,440 | 0.2% | 100% | 75,440 |
| Kia | 234,792 | 1.4% | 0% | 0 |
| Mazda | 163,694 | 1.6% | 100% | 163,694 |
| Mercedes | 186,553 | 1.3% | 0% | 0 |
| Mitsubishi | 161,523 | 1.5% | 100% | 161,523 |
| Nissan* | 785,719 | 4.8% | 0% | 0 |
| Porsche | 16,773 | 0.2% | 0% | 0 |
| Subaru | 131,330 | 1.1% | 100% | 131330 |
| Suzuki | 70,441 | 0.4% | 100% | 70,441 |
| Toyota | 1,723,027 | 11.2% | 71% | 1,224,449 |
| VW | 372,057 | 2.3% | 0% | 0 |
| Total | 15,546,753 | | 64.3% | 9,778,110 |

* Passenger cars were based on the 2004 Wards Automotive Year Book, December 2004; light trucks/vans with GVWR<=3,855 kg (8,500 pounds) were based on the Mid-Model Year Fuel Economic Report Data
** Based on 2005 NCAP survey
1. 2002 figures

The type of data recorded and the data formats used by these current EDRs varies significantly. Thus, the results are cumbersome to decipher and difficult to fully utilize to improve vehicle occupant protection. The agency believes that a standardized set of EDR data elements and formats will enhance the utilization of the recorded information and further improve vehicle safety and reduce fatalities and injuries through ACN system implementation, crash investigation, the evaluation of safety countermeasures, and advanced restraint and safety countermeasure research and development.

An ACN on-board system automatically determines the occurrence of a collision, notifies emergency response teams of the collision location, provides information concerning the crash, and establishes a voice link between the vehicle and emergency response personnel (Backhman & Preziotti, 2001). The required EDR data elements such as the Delta V, Longitudinal and Maximum Delta-V, and Safety Belt Status could feed into an ACN system to notify emergency response teams of the occurrence of a crash, assess the severity of the crash, and estimate the probability of serious injury. Thus, lives could be saved due to shorter response time for proper medical assistance and the prioritization of the need for emergency response.

Crash investigations gather insightful information about the dynamics of crashes. However, some of these parameters cannot be determined (such as ABS Functioning Status) or as accurately measured (such as Delta-V) by traditional post-crash investigation procedures. In contrast, EDRs directly measure actual crash parameters. Thus, EDRs improve crash investigation and crash data quality. These data help safety researchers, vehicles manufacturers, and the agency to better understand vehicle crashes. In turn, the safety researchers and vehicle manufacturers are able to build better vehicles and to develop more effective vehicle safety countermeasures. Standardized of EDR data will permit the agency to better prioritize its regulatory agenda and to develop state-of-the-art vehicle safety standards. For example, the requirement for EDRs to record parameters of advanced restraint systems during an event of interest would help industry and the agency monitor the real-world performance of these systems and detect injury trends. As a result, vehicle manufacturers could more quickly improve advanced restraint systems and other occupant protection countermeasures. The agency would promulgate the necessary vehicle standards to further protect vehicle occupants. Similarly, these EDR data could be helpful to highway engineers in improving highway or roadway designs.

In addition, many vehicle manufacturers have developed active safety systems (or crash avoidance systems) to actively assist drivers to reduce the likelihood of crash occurrence. For example, the electronic stability control (ESC) was developed to prevent skidding and unstable condition before they cause a crash. The EDR recorded pre-crash data (e.g., vehicle speed, engine throttle, vehicle roll angle, and etc.) could be used to further improve and these active safety systems and reduce crash rates.

## CHAPTER IV. COSTS AND LEADTIME

This chapter estimates the costs of the final rule and discusses leadtime. The costs are the incremental costs for current EDRs to comply with the requirements. The agency estimates that about 64 percent (9.8 million) of new light vehicles are already equipped with an EDR. Of these new light vehicles in the fleet equipped with an EDR, GM accounted for 45 percent (4.4 million), Ford 32 percent (3.1 million), Toyota 13 percent (1.2 million), and the remaining manufacturers for 10 percent (1.0 million). Currently, GM and Ford already release their EDR recorded data and formats to a third party (i.e., a download tool manufacturer[9]), so their EDRs are thus relatively well understood. Toyota's EDRs, according to the agency's discussions with the company, are believed to have similar capacity as GM's models. Both GM and Toyota EDRs record some pre-crash and crash information, as opposed to recording only the information during a crash as in Ford EDRs. For this reason, this analysis treats GM and Toyota as a group (GM/Toyota).

Since the GM/Toyota and Ford EDRs are relatively well understood and the agency believes the cost deviation for them is small, this analysis uses the best point cost estimates for the GM/Toyota and Ford EDRs. However, a wider range of costs is used for other, less understood EDR models. This analysis uses a cost range for this latter group of EDRs to ensure that the agency considers the different levels of complexity existing among these EDRs. The overall cost is the weighted cost of GM/Toyota, Ford,

[9] Santa Barbara-based Vetronix sells a $2,500 "crash data recovery" tool, which will download the logs from GM and Ford EDRs.

and the other EDRs. Weights are established based upon their corresponding EDR market shares (i.e., 0.58 [=0.45+0.13], 0.32, and 0.10 for GM/Toyota, Ford, and other EDRs, respectively. The cost per vehicle can be represented as:

$$\text{Cost per vehicle} = C_G * w_G + C_F * w_F + C_O * w_O$$

Where,

$C_i$ = cost per vehicle for GM/Toyota (i = G), Ford (i = F), and Other (i = O)

$w_i$ = weights for GM/Toyota (i = G), Ford (Ford = F), and Other (i = O).

The analysis provides four sets of cost estimates. The first set of costs is for all current EDRs to comply with the essential data requirements (i.e., this is the cost of the final rule). The second set of costs is for all current EDRs to comply with the additional data requirements (potential cost). The third set of cost estimates is the cost of the rule if all new light vehicles were voluntarily equipped with an EDR. The last set of cost is for all new light vehicles equipped with an EDR to comply with the additional data requirements. Note that all these cost estimates take into consideration the EDR improvements that the manufacturers have already planned before the effective date of the rule.

**Costs**

The potential costs include technology costs, functioning and survivability cost, assembly cost, paperwork maintenance costs, and compliance costs. Technology costs include costs for sensors/accelerometers and computer-information technologies. The cost for functioning and survivability includes costs for an additional power supply and enhancements for computer area network (CAN)[10] such as wiring, data bus, and harness. Assembly costs would be the labor cost for assembling additional integrated circuits and wiring data bus and harness for in-vehicle CAN. The paperwork maintenance cost includes the cost for modifying owners' manuals. The compliance cost is the cost to conduct the required tests.

Technology Costs

S*ensors/Filters*. Vehicles equipped with frontal air bags already have sensors/filters to acquire longitudinal acceleration information, which are used to calculate delta-V against time. The current sensors/accelerometers have adequate precision, accuracy, and resolution to comply with the data format requirements. No additional costs for sensors are required. However, some manufacturers other than GM, Toyota, and Ford might need to upgrade their filter. The agency estimates that the filter would cost $0.60 per vehicle. Overall, there is no additional sensor/filter cost for GM/Toyota and Ford, but the cost would be up to $0.60 per vehicle for other manufacturers. Due to the proprietary nature of these EDRs, the agency does not know the percentage of these EDRs that would require new filters. Without this information, the agency does not have a basis to estimate the average cost for this group of EDRs. Instead, the agency uses the possible range of cost for this group (i.e., from $0.00 representing no new filter required for this group of vehicles to the maximum cost of $0.60).

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[10] Representing either CAN required by EPA for motor vehicle emission systems or other OEM data bus systems

*Computer-information technologies*. Vehicle manufacturers might need to upgrade their computer memory chips, enhance the capacity of their computer processing units (CPU), and redesign software in order to comply with the final rule. Currently, manufacturers use the electronically erasable programmable read-only memory (EEPROM) or flash card types of memory in their EDRs to store data for downloading. Tables IV-1 and IV-2 list the memory required for the rule. Table IV-1 is for the essential data element requirements. Table IV-2 is for both essential and additional data elements requirements.

As shown in Table IV-1, a 72-byte of EEPROM would be required to record the 15 essential data elements for one event, and 144 bytes would be required for two events. If the manufacturers choose to implement the redundancy option in their recording scheme, 432 bytes are needed. GM/Toyota and Ford EDRs are capable of recording much more information than the final rule requirements, so it is not necessary for these manufacturers to upgrade their EEPROMs. No additional EEPROM costs are required for GM/Toyota and Ford EDRs.

Other types of memory chips are ROM and RAM. The size requirement for ROM would depend on the number of lines of software coding. The size requirement for RAM would depend on the EDR engineering design and size of data needed for quick access for the software algorithm (e.g., data for air bag firing). Due to proprietary concerns, the adequacy of existing ROM and RAM chips to meet the final rule is not known. However, the final rule’s data requirements are comparable to the current known industry EDR practices. GM/Toyota and Ford EDRs have the capacity to handle the data flow generated by the final rule.  Although GM/Toyota and Ford will presumably need to redesign their software algorithm, the redesign would be minor, including only changing the specifications in their codes.  The line number of codes, however, would not increase significantly as to require a larger ROM and RAM.  No additional costs on RAM and ROM are expected for GM/Toyota and Ford EDRs.

**Table IV-1**
**Required Essential Data Elements**

| | **Data Element Name** | **# of Sample** | **Bytes per Sample** | **Total Bytes** |
|---|---|---|---|---|
| 1 | Delta-V, Longitudinal | 26 | 1 | 26 |
| 2 | Maximum delta-V, Longitudinal | 1 | 1 | 1 |
| 3 | Time, Maximum delta-V, Longitudinal | 1 | 1 | 1 |
| 4 | Speed, vehicle indicated | 11 | 1 | 11 |
| 5 | Engine throttle, % full | 11 | 1 | 11 |
| 6 | Service brake, on/off | 11 | 1 | 11 |
| 7 | Ignition cycle, crash | 1 | 2 | 2 |
| 8 | Ignition cycle, download | 1 | 2 | 2 |
| 9 | Safety belt status, driver | 1 | 1 | 1 |
| 10 | Frontal air bag warning lamp | 1 | 1 | 1 |
| 11 | Frontal air bag deployment time, Driver (1st, multi) | 1 | 1 | 1 |
| 12 | Frontal air bag deployment time, RFP (1st, multi) | 1 | 1 | 1 |
| 13 | Multi-event, number of events | 1 | 1 | 1 |
| 14 | Time from event 1 to 2 | 1 | 1 | 1 |
| 15 | Complete file recorded | 1 | 1 | 1 |
| | **Total** | | | 72 |
| | **Total for 2 Events** | | | 144 |
| | **With Redundancy ( =Total for 2 events x 3)** | | | 432 |

The CPU in an EDR handles the decision-making (e.g., air bag firing) and controls data flow.  Since GM/Toyota and Ford EDRs are adequate to handle the data flow generated by the final rule requirements, GM/Toyota and Ford would not need to upgrade their CPU.  However, GM/Toyota and Ford would need to redesign their software algorithm to comply with the data format requirements.  The redesign is expected to be minor.  Also, GM/Toyota and Ford indicated that they are planning to improve/redesign their EDR modules for 2006 and newer vehicle models.  With a longer leadtime than proposed in the NPRM, the agency estimates that the cost of algorithm redesign per vehicle would be negligible on a per vehicle basis. There is no computer-information cost for GM/Toyota and Ford models.

**Table IV-2**
**Required Additional Data Elements**

| | Data Element Name | # of Sample | Bytes per Sample | Total Bytes |
|---|---|---|---|---|
| 1 | Lateral acceleration | 126 | 2 | 252 |
| 2 | Longitudinal acceleration | 126 | 2 | 252 |
| 3 | Normal acceleration | 126 | 2 | 252 |
| 4 | Delta-V, Lateral | 26 | 1 | 26 |
| 5 | Maximum delta-V, Lateral | 1 | 1 | 1 |
| 6 | Time, maximum delta-V, Lateral | 1 | 1 | 1 |
| 7 | Time, maximum delta-V, Resultant | 1 | 1 | 1 |
| 8 | Engine RPM | 11 | 1 | 11 |
| 9 | Vehicle roll angle | 11 | 1 | 11 |
| 10 | ABS activity | 11 | 1 | 11 |
| 11 | Stability control | 11 | 1 | 11 |
| 12 | Steering wheel angle | 11 | 1 | 11 |
| 13 | Safety belt status, RFP | 1 | 1 | 1 |
| 14 | Frontal air bag suppression switch status, RFP | 1 | 1 | 1 |
| 15 | Frontal air bag deployment, time to N$^{th}$ stage, Driver[1] | 1 | 1 | 1 |
| 16 | Frontal air bag deployment, time to N$^{th}$ stage, RFP[1] | 1 | 1 | 1 |
| 17 | Frontal air bag deployment, N$^{th}$ stage disposal, Driver[1] | 1 | 1 | 1 |
| 18 | Frontal air bag deployment, N$^{th}$ stage disposal, RFP[1] | 1 | 1 | 1 |
| 19 | Side air bag deployment time, Driver | 1 | 1 | 1 |
| 20 | Side air bag deployment time, RFP | 1 | 1 | 1 |
| 21 | Curtain/tube air bag deployment time, Driver | 1 | 1 | 1 |
| 22 | Curtain/tube air bag deployment time, RFP | 1 | 1 | 1 |
| 23 | Pretensioner deployment time, Driver | 1 | 1 | 1 |
| 24 | Pretension deployment time, RFP | 1 | 1 | 1 |
| 25 | Seat position, Driver | 1 | 1 | 1 |
| 26 | Seat position, RFP | 1 | 1 | 1 |
| 27 | Occupant size classification, Driver | 1 | 1 | 1 |
| 28 | Occupant size classification, | 1 | 1 | 1 |
| 29 | Occupant position classification, Driver | 1 | 1 | 1 |
| 30 | Occupant position classification, RFP | 1 | 1 | 1 |
| | **Total** | | | 857 |
| | **Total for 2 Events** | | | 1,714 |
| | **With Redundancy ( =Total for 2 events x 3)** | | | 5,142 |

As for other EDRs, some would need to increase their EEPROM, ROM, and RAM memory chips and to enhance their CPU capability. The agency estimates the computer-information costs would be up to $0.60 per vehicle for other EDRs to comply with the 15 essential data element requirements. These manufacturers might also be required to redesign their software algorithm so their recorded data would comply with the data format requirements. Again, we expect that the algorithm redesign cost per vehicle would be negligible. Table IV-3 lists the detailed itemized costs.

As shown in Table IV-2, a maximum of an additional 1,714 to 5,142 bytes of EEPROM are required to comply with the added data element requirements. Many of these data elements are either recorded by current EDRs or will be acquired due to the agency's other on-going regulations. For example, all new vehicles must comply with the FMVSS No. 208, the advanced air bag final rule. These vehicles will be able to record all the frontal air bag related data elements listed in Table IV-2. Future rulemakings could require other EDR data elements. Consequently, the EDRs might automatically be required to record the majority of the additional data elements. However, the agency does not expect that the manufacturers would increase their EEPROM by 1,714 to 5,142 bytes to record the additional data elements, especially since the final rule does not require EDRs to record accelerations, which occupy the majority of EEPROM spaces. Manufacturers also commented that they are moving away from recording accelerations. Therefore, the most likely amount of memory that manufacturers would add is a 202 byte (= 2*[857 – 3*252]) of EEPROM for additional data elements with no redundancy option and 606 bytes with redundancy consideration. Thus, a total 346 (144 for essential data elements plus 202 for additional) to 1,038 (432 essential plus 606 additional) bytes of EEPROMs would be required for the additional data elements, depending on the redundancy option. The agency does not expect that the manufacturers would change their recording scheme. In order words, if a current EDR design has no redundancy option, the final rule is not expected to change the design to include the redundancy option. Based on this assumption, the agency estimates that the computer-technology costs to include the added data elements would be $0.20 for GM/Toyota and $0.60 for Ford EDRs. These costs include larger EEPROMs, a faster CPU, and software redesign. For other EDRs, the agency estimates the costs per vehicle to include the added data elements would range from $0.76 to $2.14. Table IV-4 lists the detailed itemized cost estimates.

Functioning and Survivability.

The final rule requires an EDR to be functioning during and after FMVSS Nos. 208 and 214 compliance tests. The rule also requires that recorded data must be downloadable 10 days after the crash tests using an external power supply. Based on current EDR designs, which are installed in close proximity to the front portion of the vehicles, the FMVSS No. 208, 56 kilometers per hour (km/h, = 35 miles per hour) rigid barrier test might be the most stringent among the specified tests for EDR functioning and survivability. The 56 km/h (35 mph) rigid barrier test is one of the tests currently conducted for the NHTSA's New Car Assessment Program (NCAP). We note that the NHTSA's crash investigation team has downloaded the EDR data from GM vehicles that completed NCAP tests with no problems. These downloads have been performed before and after the NPRM-proposed 30-days survivability requirement, which was significantly more than the 10-day requirement which is in the final rule. Also, based on the vehicle inspection, the

NCAP tests did not damage the GM EDRs. Data recorded in these EDRs were downloadable with equipment such as personal computers and interface cables.
In addition to the NCAP experience, NHTSA's Special Crash Investigation (SCI) and Crashworthiness Data Systems (CDS) have downloaded about 2,700 EDR files involving GM and Ford EDRs under various crash conditions. SCI and CDS crash investigators have not documented an EDR survivability problem except in rare and extremely severe events such as fire and submergence. Thus, the agency expects that there would be no additional costs for GM/Toyota and Ford EDRs to comply with the functioning requirements and the survival of the essential data elements. However, several manufacturers commented that they would need to add capacitors and enhance the vehicle CAN systems to ensure the functionality of EDRs during the crash tests. We estimated that the cost of ensuring the survival of essential data elements for these manufacturers would be up to $0.30 per vehicle.

If the manufacturers chose to comply with the essential and the additional data element requirements, the cost for EDR functioning and survivability would be higher for a larger capacitor and additional enhancements for CAN. The agency estimates the cost per vehicle for these enhancements would be $0.10, $0.15, and $0.30 - $1.20 for GM/Toyota, Ford, and other EDRs, respectively.

Assembly Cost

Assembly costs would be the labor cost to assemble extra integrated circuits and to wire an extra data bus and harness for in-vehicle CAN. GM/Toyota and Ford EDRs designs and the in-vehicle computer area network are, or will be, adequate after their planned improvement during the leadtime period. The agency estimates that no extra assembly cost will be required for GM/Toyota and Ford. For other EDRs, the assembly cost would be up to $0.10 per vehicles if their EDRs comply with the essential data element requirements and $0.05 to $0.25 for both essential and additional data elements requirements.

Paperwork Maintenance Cost

The final rule requires the vehicle manufacturers to make a retrieval tool for downloading EDR data commercially available. Based upon vehicle manufacturer comments, we expect that this obligation would be met through a contractual arrangement with a third party entity. Some paperwork maintenance would be involved. However, the cost of associated with this is expected to be negligible. In addition, the vehicle manufacturers are required to include statements in the owner's manual indicating that the vehicle is equipped with an EDR and describing the purposes of EDRs. The costs for updating their owners' manuals by adding a simple paragraph would also be negligible.

Certification and Compliance Costs

The final rule does not require any additional compliance tests. The only additional costs would be the additional time required to download and analyze the data, and the cost of storing the vehicles due to the 10-day survivability requirement. However, such costs are expected to be negligible for both vehicle manufacturers and the agency.

Total Costs

The total cost per vehicle for the essential data element requirements would be close to negligible on a per vehicle basis for GM, Toyota, and Ford EDRs, and up to $1.60 for other EDRs. The weighted cost per vehicle of the rule (i.e., complying with the essential data element requirements) would be up to $0.17[11]. The total cost of the rule would be up to $1.7 million (= $0.17 * 9.8 million). Table IV-3 summarizes these costs. As shown in Table IV-3, the costs mainly reflect the cost for technological improvements, since the other costs are either small or negligible.

The manufacturers might be required to comply with rulemaking requirements arising from amendments to the FMVSSs during the leadtime period (e.g., FMVSS No. 214). Some of these rulemakings may impact EDRs and might automatically require EDRs to acquire certain additional data elements specified in the final rule (e.g., side air bag data elements). If manufacturers of current EDRs also choose to comply with the additional

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[11] $C_G$ = $0.00, $C_F$ = $0.00, and $C_O$ = $0.00 to $1.60. Multiplying these costs by their corresponding weights of 0.56, 0.32, and 0.12 derives the weighted cost per vehicle up to $0.17 (= $0.00 * 0.58 + $0.00 * 0.32 + $1.60 *0.10).

data requirements, the estimated total potential cost would increase to $5.2 - $8.4 million (see Table IV-4).

If all the 15.5 million new light vehicles (GVWR<=3,855 kg or 8,500 pounds) produced annually were voluntarily equipped with an EDR by September 2010, the cost of the rule is estimated to be up to $10.9 million (see Table IV-3), and the total potential cost would be $11.8 - $33.3 million (see Table IV-4). Note that the cost for the new EDRs is assumed to be close to that of "other EDRs". That is, the cost of the newer EDRs would be up to $1.60 per vehicle for essential data element requirements and $1.15 to $4.30 for added data element requirements. Under this assumption, the costs of the 15.5 million EDRs would be categorized into three groups: GM/Toyota, Ford, and the remaining EDRs. Their corresponding weights are 0.36, 0.20, and 0.44. The weighted cost per vehicle of the rule would be up to $0.70. The weighted potential cost per vehicle would be $0.76 - $2.14.

In summary, the cost estimates are (in 2004 dollars):

At the current EDR level (9.8 million vehicles, 64% of new light vehicles with GVWR<=3,855 kg or 8,500 pounds):

| | Cost Per Vehicle | Total Cost |
|---|---|---|
| The cost of the final rule: | Up to $0.17 | Up to $1.7 million |
| Potential costs: | $0.53 to $0.86 | $5.2 to $8.4 million |

If all light vehicles were voluntarily equipped with an EDR (15.5 million vehicles):

| | Cost Per Vehicle | Total Cost |
|---|---|---|
| The cost of the final rule: | Up to $0.70 | Up to $10.9 million |
| Potential costs: | $0.76 to $2.14 | $11.8 to $33.3 million |

**Leadtime**

The date for full compliance with the final rule is September 1, 2010. This compliance date should enable manufacturers to make design changes to their EDRs as they make other planned design changes to their vehicles, thereby minimizing costs towards the lower end of the estimates. In addition, the longer leadtime should also enable vehicle manufacturers to design their EDRs so that the data may be downloaded by non-proprietary technologies.

**Table IV – 3**
**Cost Components Per Vehicle for Essential Data Element Requirements**

| Cost Estimates Per Vehicle | GM/ Toyota | Ford | Other EDRs Lower Cost | Other EDRs Upper Cost |
|---|---|---|---|---|
| Technology | $0.00 | $0.00 | $0.00 | $0.60 |
| Sensors | $0.00 | $0.00 | $0.00 | $0.00 |
| Filter | $0.00 | $0.00 | $0.00 | $0.60 |
| Computer | negligible* | negligible* | negligible* | $0.60 |
| CPU | negligible* | negligible* | negligible* | $0.30 |
| RAM&ROM&EEPROM | $0.00 | $0.00 | $0.00 | $0.25 |
| Software + Board Redesign | negligible* | negligible* | negligible* | $0.05 |
| Functioning & Survivability | $0.00 | $0.00 | $0.00 | $0.30 |
| Reserve Power, Capacitors | $0.00 | $0.00 | $0.00 | $0.05 |
| CAN (Computer Area Network) Wiring +Data Bus/Harness | $0.00 | $0.00 | $0.00 | $0.25 |
| Assembly (for extra ICs & Circuit) | $0.00 | $0.00 | $0.00 | $0.10 |
| Paperwork | negligible* | negligible* | negligible* | negligible* |
| Compliance | negligible* | negligible* | negligible* | negligible* |
| Total Cost Per Vehicle | negligible* | negligible* | negligible* | $1.60 |
| Weights to Calculate Weighted Cost | 0.58 | 0.32 | 0.10 | |
| | | Lower Cost | Upper Cost | |
| Weighted Costs per Vehicle | | negligible* | $0.17 | |
| Total Costs for Current EDRs[1] | | negligible* | $1,662,279 | |
| **If** All 15.5 Million New Light Vehicles Had an EDR | | | | |
| Weights to Calculate Weighted Cost | 0.36 | 0.20 | 0.44** | |
| | | Lower Cost | Upper Cost | |
| Weighted Cost Per Vehicle | | negligible* | $0.70 | |
| Total Potential Costs[2] | | negligible* | $10,882,727 | |

1 = weighted costs per vehicle * 9.8 million vehicles with an EDR
2 = weighted costs per vehicle * 15.5 million vehicles with an EDR
* Insignificant cost
** Including both "other" and newer EDRs

**Table IV – 4**
**Cost Components Per Vehicle for Essential and Additional Data Element Requirements**

| **Cost Estimates Per Vehicle** | **GM/ Toyota** | **Ford** | **Other EDRs Lower Cost** | **Other EDRs Upper Cost** |
|---|---|---|---|---|
| Technology | $0.00 | $0.00 | $0.00 | $0.60 |
| Sensors | $0.00 | $0.00 | $0.00 | $0.00 |
| Filter | $0.00 | $0.00 | $0.00 | $0.60 |
| Computer | $0.20 | $0.60 | $0.80 | $2.25 |
| CPU | $0.10 | $0.25 | $0.35 | $1.25 |
| RAM&ROM&EEPROM | $0.10 | $0.25 | $0.35 | $0.50 |
| Software + Board Redesign | negligible* | $0.10 | $0.10 | $0.50 |
| Functioning & Survivability | $0.10 | $0.15 | $0.30 | $1.20 |
| Reserve Power, Capacitors | $0.00 | $0.05 | $0.05 | $0.50 |
| CAN (Computer Area Network) Wiring +Data Bus/Harness | $0.10 | $0.10 | $0.25 | $0.70 |
| Assembly (for extra ICs & Circuit) | $0.00 | $0.00 | $0.05 | $0.25 |
| Paperwork | negligible* | negligible* | negligible* | negligible* |
| Compliance | negligible* | negligible* | negligible* | negligible* |
| Total Cost Per Vehicle | $0.30 | $0.75 | $1.15 | $4.30 |
| Weights to Calculate Weighted Cost | 0.58 | 0.32 | 0.10 | |
| | | Lower Cost | Upper Cost | |
| Weighted Costs per Vehicle | | $0.53 | $0.86 | |
| Total Costs for Current EDRs[1] | | $5,182,398 | $8,409,175 | |
| **If** All 15.5 Million New Light Vehicles Had an EDR | | | | |
| Weights to Calculate Weighted Cost | 0.36 | 0.20 | 0.44* | |
| | | Lower Cost | Upper Cost | |
| Weighted Cost Per Vehicle | | $0.76 | $2.14 | |
| Total Potential Costs[2] | | $11,815,532 | $33,270,051 | |

1 = weighted costs per vehicle * 9.8 million vehicles with an EDR
2 = weighted costs per vehicle * 15.5 million vehicles with an EDR
* Insignificant cost
** Including both "other" and newer EDRs

# CHAPTER V. REGULATORY FLEXIBILITY ACT AND UNFUNDED MANDATES REFORM ACT ANALYSIS

## A. Regulatory Flexibility Act

The Regulatory Flexibility Act of 1980 (5 U.S.C. § 601 et seq.) requires agencies to evaluate the potential effects of their proposed and final rules on small businesses, small organizations, and small governmental jurisdictions.

5 U.S.C. § 603 requires agencies to prepare and make available for public comment an initial and final regulatory flexibility analysis (RFA) describing the impact of proposed and final rules on small entities if the agency decides that the proposal may have a significant economic impact on a substantial number of small entities. Each RFA must contain:

(1) A description of the reasons why action by the agency is being considered;

(2) A succinct statement of the objectives of, and legal basis for, the final rule;

(3) A description of and, where feasible, an estimate of the number of small entities to which the final rule will apply;

(4) A description of the projected reporting, record keeping and other compliance requirements of a final rule including an estimate of the classes of small entities which will be subject to the requirement and the type of professional skills necessary for preparation of the report or record;

(5) An identification, to the extent practicable, of all relevant Federal rules which may duplicate, overlap or conflict with the final rule;

(6) Each final regulatory flexibility analysis shall also contain a description of any significant alternatives to the final rule which accomplish the stated objectives of applicable statutes and which minimize any significant economic impact of the final rule on small entities.

1. <u>Description of the reasons why action by the agency is being considered</u>

NHTSA has determined that this action would improve EDRs and enhance the utility of recorded crash information. The enhanced crash information would further improve motor vehicle safety through safer vehicle and highway designs and facilitation of ACN.

2. <u>Objectives of, and legal basis for, the final rule</u>

Under 49 U.S>C. 322(a), the secretary of Transportation (the "Secretary") has authority to prescribe regulations to carry out the duties and powers of the Secretary. One of the duties of the Secretary is to administer the National Traffic and Motor Vehicle Safety Act, as amended. The Secretary has delegated the responsibility for carrying out the National Traffic and Motor Vehicle Safety Act to NHTSA[12]. The agency is authorized to issue Federal motor vehicle safety regulations that meet the need for motor vehicle safety. NHTSA is issuing the final rule under 49 U.S.C. 322, 30111, 30115, 30117, 30166, and 30168; delegation of authority at 49 CFR 1.50.

[12] 49 U.S.C. 105 and 322; delegation of authority at 49 CFR 1.50.

3. Description and estimate of the number of small entities to which the final rule will apply

The final regulation would apply to motor vehicle manufacturers. However, the regulation would have economic impact on computer storage manufacturers and software developers as well.

Business entities are defined as small businesses using the North American Industry Classification System (NAICS) code, for the purposes of receiving Small Business Administration assistance. One of the criteria for determining size, as stated in 13 CFR 121.201, is the number of employees in the firm. Affected business categories include: (a) To qualify as a small business in Automotive Manufacturing (NAICS 336111), the firm must have fewer than 1000 employees, (b) In Light Truck and Utility Vehicle Manufacturing (NAICS 336112), the firm must have fewer than 1000 employees, (c) In Motor Vehicle Body Manufacturing, the firm must have fewer than 1000 employees, (d) In All Other Motor Vehicle Parts Manufacturing (NAICS 336399), the firm must have fewer than 750 employees, (e) In Computer Storage Manufacturers (NAICS 334111), the firm must have fewer than 1000 employees, and (f) In Software Reproducing (NAICS 334611), the firm must have fewer than 500 employees.

While there are a significant number of small businesses that handle computer storage and software development, we do not believe the economic impact on them would be significant. The agency believes that the regulation will have a very small positive economic impact on computer storage manufacturers and software developers because the regulation might require the vehicle manufacturers to upgrade their memory chips and re-program their algorithms.

**Small motor vehicle manufacturers**

There are 4 vehicle manufacturers that would qualify as a small business. Table V-1 provides information about the 4 small domestic manufacturers in MY 2004.

**Table V-1**
**Small Vehicle Manufacturers**

| Manufacturer | Employees | Estimated Sales | Sale Price Range | Est. Revenues* |
|---|---|---|---|---|
| Avanti | 22 | 13 | $25,000 to $63,000 | $572,000 |
| Panoz | 50 | 150 | $90,000 to $125,000 | $16,125,000 |
| Saleen | 150 | 1,000 | $39,000 to $59,000 | $49,000,000 |
| Shelby | 44 | 60 | $42,000 to $135,000 | $5,310,000 |

* Assuming an average sales price from the sales price range

As with other systems in the vehicle, these manufacturers will have to rely on suppliers to provide the EDR-related hardware, and then they would have to integrate the system into their vehicles. The average price increase per vehicle is estimated to range up to $4.30. Compared to the least expensive vehicle in Table V-1, the cost is less than two-hundredths of one percent ($4.30/$25,000 = .000172). Compared to a weighted average sales price ($58,000), the cost is about 7 thousandths of one percent ($4.30/$58,000 = .000074).

We believe that the market for the products of these small manufacturers is highly inelastic. Purchasers of these products are enticed by the desire to have an unusual vehicle. Thus, we do not believe that raising the price by this small amount will have any effect on vehicle sales. We suspect these price increases will be passed on to the final customer. Based on this analysis, the agency believes that the final rule will not have a significant economic impact on these four small vehicle manufacturers.

4. Description of the projected reporting, record keeping and other compliance requirements for small entities

The regulation requires motor vehicle manufacturers to make the EDR download tools commercially available. No other reporting and record keeping are required by the final rule. Four vehicle manufacturers are qualified as a small business.

5. Duplication with other Federal rules

There are no relevant Federal regulations that may duplicate, overlap or conflict with the proposed regulation.

6. Description of any significant alternatives to the final rule

An alternative is to require all vehicles to install EDRs. However, vehicle manufacturers appear to be voluntarily moving in this direction.

In summary, the regulation requires for vehicle manufacturers who voluntarily install EDRs in their light vehicles to standardize EDR data in terms of content and format. There are 18 vehicle manufacturers. Four of them are considered to be small businesses. Most of the intermediate and final stage manufacturers of vehicles built in two or more stages and alterers have 1,000 or fewer employees. However, these small businesses adhere to original equipment manufacturers' instructions in manufacturing modified and altered vehicles.  Based on our knowledge, original equipment manufacturers do not permit a final stage manufacturer or alterer to modify or alter sophisticated devices such as air bags or EDRs.  Therefore, multistage manufacturers and alterers would be able to rely on the certification and information provided by the original equipment manufacturer.  Accordingly, there would be no significant economic impact on small business, small organizations, or small governmental units by this regulation.

**B.  Unfunded Mandates Reform Act**

The Unfunded Mandates Reform Act of 1995 (Public Law 104-4) requires agencies to prepare a written assessment of the costs, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditures by State, local or tribal governments, in the aggregate, or by the private sector, of more than $100 million annually (adjusted annually for inflation with base year of 1995).  Adjusting this amount by the implicit gross domestic product price deflator for the year 2004 results in $118 million (108.237/92.106 = 1.18).  The assessment may be included in conjunction with other assessments, as it is here.

This final rule is not estimated to result in expenditures by State, local or tribal governments of more than $118 million annually.  It is not going to result in the expenditure by the automobile manufacturers and/or their suppliers of more than $118 million annually.  The estimated annual cost would be up to $1.7 million, to potentially $33.3 million annually.   These effects have been discussed previously in this Final Regulatory Evaluation (Chapter IV, Costs and Leadtime).

**REFERENCE**

Bachman, L. R., Preziotti, G. R., Carter, A., "Automotive Collision Notification (ACN) Field Operational Test (FOT)/Evaluation Report", National Highway Traffic Safety Administration, Contract No: DTFH61-95-C-00098, Washington, DC, February 2001, DOT HS 809 304

Chidester, A.C., Hinch, J., Mercer, T.C., Schultz, K.S., "Recording Automotive Crash Event Data", International Symposium on Transportation Records, May 3-5, 1999

## APPENDIX A. RESPONSE TO COMMENTS

This appendix lists the agency's responses to cost/benefit-related public comments. The agency received a total of 104 comments on the EDR NPRM[13]. Of these, 61 were from private citizens, and 43 were from 40 various groups, including automobile and EDR manufacturers, insurance companies, safety organizations, government agencies, health/medical institutes and other small groups. These comments covered a wide range of issues, including privacy, accessibility of EDR data to EMS, data elements, format standardization, data retrieval, survivability tests, application of the rule (e.g., to all vehicles), appropriateness of a mandatory rule, information reporting, cost, and leadtime. For a comprehensive response to non-cost-related comments, please consult the preamble of the final rule.

### Cost-Related Comments on the NPRM

There were 12 groups that commented on cost estimates in the NPRM. Seven were automotive manufacturers (GM, Ford, DaimlerChysler, Nissan, Subaru, Honda, and Toyota); one was an EDR manufacturer (Delphi); three were trade associations (Alliance[14], AIAM[15], and ATA[16]); and one was a public interest group (Public Citizen). Generally, these commenters, except for Public Citizen, commented that the agency underestimated the cost of the EDR rule, as proposed in the NPRM. They stated that the

[13] Docket No. NHTSA-2004-18029
[14] Alliance of Automobile Manufacturers
[15] Association of International Automobile Manufacturers, Inc.
[16] American Trucking Association

manufacturers would have to incur substantially higher compliance costs than estimated in the NPRM. They estimated the cost could range up to $500[17] per vehicle. The lower bound of costs was for certain manufacturers' planned updates from their current EDRs to more advanced systems. The planned advanced EDR would still not comply with the NPRM proposed requirements. The higher bound of the cost estimates reflected the costs for new sensors/accelerometers and additional back-up power supplies, which would be needed to comply with the data format and survivability proposal.

In addition, the agency met with Ford, GM, Toyota, and Delphi to further discuss the cost and EDR technology issues[18]. Several of these companies submitted confidential cost information to respond to the agency's cost/technology inquiries. These commenters addressed issues affecting the cost estimates almost in accordance. Therefore, this analysis treats these comments as a group and provides the agency's responses as a group.

The common concerns and issues raised by these commenters are:

(1) The NPRM proposed range, precision, and accuracy requirements would require sensors and accelerators that are well beyond today's state-of-art technologies used by the manufacturers. Thus, the cost of the proposed requirements would be significant (more than $20 per sensor), and, in some aspects, the technologies would not be feasible.

[17] Ford's estimate
[18] Memorandum of meetings can be found in Docket No. NHTSA-04-18029

(2) The NPRM proposed data element, sampling, and recording time interval requirements would require the manufacturers to increase their computer memory and microprocessor capacity, use a larger housing for extra electronic components, acquire additional data bus/harness/wiring, and improve their in-vehicle CAN. These upgrades would significantly increase the cost for manufacturers.

(3) Most of the current electronic devices are designed in modules. Commenters argued that to comply with the NPRM's excessive data element proposal, the manufacturers would need to redesign their modules and incur substantial costs on engineering, development, tooling, and testing.

(4) The NPRM proposed functioning and survivability requirements would require the manufacturers to add additional back-up power supplies in the vehicles. This would increase the cost of EDRs substantially. Toyota commented that the cost of NPRM-compliant EDRs would be at least $150 per vehicle, with the majority of the cost attributable to the additional in-vehicle back-up power supply.

(5) The cost of paperwork maintenance is much higher than the NPRM estimated because of the quantity of the information required and the frequency of the reporting.

**Response to Comments**

After carefully reviewing all the cost-related comments and discussions, the agency acknowledges that the NPRM proposed data recording range, accuracy, and precision would require manufacturers to install more technologically advanced sensors/ accelerometers, which would be way beyond the current industry practices. The combination of data format requirements (i.e., range, accuracy, sampling rate, recording range) and the requirement for multiple-event recording (3 events) would require the manufacturers to install a more sophisticated CPU, upgrade computer memory, and enhance CAN. Thus, the cost per vehicle for the EDR proposal would be considerably higher than the $0.50 estimated in the NPRM.

Although the agency agrees that the cost per vehicle would be higher than $0.50 for the NPRM proposal, the agency believes that the cost would be significantly less than $150, as cited by Toyota. Toyota has acknowledged that most of the $150 cost would be for the additional back-up power supply. Several other commenters also commented that a substantial cost increase would occur if an additional back-up power supply were required. From this, the agency believes that the industry misinterpreted the NPRM proposed functioning and survivability requirements and thought that no external power supply is allowed. As a result, the manufacturers substantially overestimated the cost of the NPRM proposal.

In response, the agency considered the technical and cost issues raised by the commenters and revised the requirements for data elements, data formats, the number of events, compliance tests for survivability, and information disclosure in the final rule. The final rule also clarifies the language for survivability. Accordingly, the agency also revised the cost estimates. Chapter IV provides the cost estimates for this final rule.

## APPENDIX B.  CHANGES FROM THE NPRM

Table B-1 briefly summarizes the major difference between the final rule and the NPRM proposal.  Table B-2 lists the changes for data elements and data formats.  In Table B-2, the symbol "I" means the essential data elements and "II" means the additional data elements.  For example, the longitudinal acceleration is the first essential data elements (I #1) proposed in the NPRM (see Table I in the NPRM; 69 FR 32932; NHTSA-04-18029).  However, this data element has become the first additional data element (II #1) required in the final rule (see Table II in the final rule).

The final rule requires an EDR to record 15 essential data elements.  Basically, the final rule deletes five data elements from the 18 that were proposed in the NPRM and adds two new data elements.  As shown in Table B-2, the deleted data elements are: (1) Longitudinal Acceleration (moved to II#2 in final rule), (2) Engine PRM (moved to II#8 in final rule),  (3) Frontal Air Bag Deployment Level, Driver (I#11 in NPRM), (4) Frontal Air Bag Deployment Level, Right Front Passenger (I#12 in NPRM), and (5) Time From Event 1 to 3 (I#17 in NPRM).  The added data elements are: (1) Delta V, Longitudinal  (I#1 in final rule) and (2) Time Maximum Longitudinal Delta V (I#3 in final rule).

For the additional data element requirements, the final rule adds six data elements as compared to the NPRM proposal. Two are moved from the NPRM proposed essential data elements: (1) Longitudinal Acceleration, and (2) Engine RPM. Four are new data elements: (1) Delta V, Lateral (II#4 in final rule), (2) Maximum Delta V, Lateral (II#5), (3) Time, Maximum Lateral Delta V (II#6), and (4) Time, Maximum Delta V, Resultant (II#7)

**Table B-1**
**Summary of Area of Changes Between the Final Rule and NPRM Proposal**

| **Area** | **Final Rule** | **NPRM** |
|---|---|---|
| Data Elements | 15 essential<br>Up to 30 additional | 18 essential<br>Up to 24 additional |
| Data formats* | Based on current industry practice | Based on the advanced technologies |
| Number of Events | 2 events for a multi-event crash | 3 events for a multi-event crash |
| Survivability<br>Complying Tests<br><br>Retrieval Duration | <br>FMVSS Nos. 208 and 214<br><br>Within 10 days of crashes | <br>FMVSS Nos. 208, 214, and 301<br><br>Within 30 days of crashes |
| Reporting Information to the Agency | None | 30 days prior to start of production |
| Leadtime | September 1, 2010<br>September 1, 2011 for Multi-Stage Manufacturers | September 1, 2008 |

*See Table B-2 for detailed changes

**Table B-2**
**Changes in Data Elements and Data formats Between the NPRM Proposal and Final Rule**

| Data Elements | NPRM | Final Rule | NPRM | | | | | Final Rule | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **Recording Interval** | **Sampling Rate** | **Data Range** | **Accuracy** | **Precision** | **Recording Interval** | **Sampling Rate** | **Data Range** | **Accuracy** | **Resolution** |
| Longitudinal acceleration | I #1 | II #2 | -0.1 to 0.5 s | 500/s | ±100 g | ± 1 g | 1 g | 0 – 250 ms | 500/s | ±50 g | ±5% | 0.01 g |
| Delta-V, Longitudinal | | I #1 | | | | | | 0 – 250 ms | 100/s | ±100 km/h | ±5% | 1 km/h |
| Maximum delta-V, longitudinal | I #2 | I #2 | N.A. | N.A. | ±100 km/h | ±1 km/h | 1 km/h | 0 – 300 ms | N.A. | ±100 km/h | ±5% | 1 km/h |
| Time, Maximum delta-V, longitudinal | | I #3 | | | | | | 0 – 300 ms | N.A. | 0 – 300 ms | ±3 ms | 2.5 ms |
| Speed, vehicle indicated | I #3 | I #4 | -8.0 to 0 s | 2/s | 0 – 200 km/h | ±1 km/h | 1 km/h | -5.0 to 0 s | 2/s | ±200 km/h | ±1 km/h | 1 km/h |
| Engine RPM | I #4 | II #8 | -8.0 to 0 s | 2/s | 0 – 10,000 rpm | ±100 rpm | 100 km/h | -5.0 to 0 s | 2/s | 0 – 10,000 rpm | ± 100 rpm | 100 km/h |
| Engine throttle, % full | I #5 | I #5 | -8.0 to 0 s | 2/s | 0 – 100% | ±5% | 5% | -5.0 to 0 s | 2/s | 0-100% | ± 5% | 1% |
| Service brake, on/off | I #6 | I #6 | -8.0 to 0 s | 2/s | On/off | N.A. | N.A. | -5.0 to 0 s | 2/s | On/off | N.A. | N.A. |
| Ignition cycle, crash | I #7 | I #7 | -1.0 s | N.A. | 0 – 60,000 | ±1 cycle | 1 cycle | -1.0 s | N.A. | 0 – 60,000 | ± 1 cycle | 1 cycle |
| Ignition cycle, download | I #8 | I #8 | At time of download | N.A. | 0 – 60,000 | ±1 cycle | 1 cycle | At time of download | N.A. | 0 – 60,000 | ± 1 cycle | 1 cycle |
| Safety belt status, driver | I #9 | I #9 | -1.0 s | N.A. | On/off | N.A. | On/off | -1.0 s | N.A. | On/off | N.A. | On/off |
| Frontal air bag warning lamp, on/off | I #10 | I #10 | -1.0 s | N.A. | On/off | N.A. | On/off | -1.0 s | N.A. | On/off | N.A. | On/off |

I: essential data elements; II: additional data element; s: second; ms: millisecond; RFP: right front passenger; OOP: out-off-position; N.A.: not applicable

**Table B-2 (Continued)**
**Changes in Data Elements and Data formats Between the NPRM Proposal and Final Rule**

| | | | NPRM | | | | | Final Rule | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Data Elements** | **NPRM** | **Final Rule** | **Recording Interval** | **Sampling Rate** | **Data Range** | **Accuracy** | **Precision** | **Recording Interval** | **Sampling Rate** | **Data Range** | **Accuracy** | **Resolution** |
| Frontal air bag deployment level, Driver | I #11 | | Event | N.A. | 1 – 100 | ± 0 | 1 | | | | | |
| Frontal air bag deployment level, RFP | I #12 | | Event | N.A. | 1 – 100 | ± 0 | 1 | | | | | |
| Frontal air bag deployment time, Driver (1st stage) | I #13 | I #11 | Event | N.A. | 0 – 250 ms | ±2 ms | 1 ms | Event | N.A. | 0 – 250 ms | ±2 ms | 1 ms |
| Frontal air bag deployment time, RFP (1st stage) | I #14 | I #12 | Event | N.A. | 0 – 250 ms | ±2 ms | 1 ms | Event | N.A. | 0 – 250 ms | ±2 ms | 1 ms |
| Multi-event, number of events | I #15 | I #13 | Event | N.A. | 1, 2, or 3 | N.A. | 1, 2, or 3 | Event | N.A. | 1 or 2 | N.A. | 1 or 2 |
| Time from event 1 to 2 | I #16 | I #14 | As Needed | N.A. | 0 – 5.0 s | 0.1 s | 0.1 s | As needed | N.A. | 0 – 5.0 s | 0.1 s | 0.1 s |
| Time from event 1 to 3 | I #17 | | As Needed | N.A. | 0 – 5.0 s | 0.1 s | 0.1 s | | | | | |
| Complete file recorded | I #18 | I #15 | Following other data | N.A. | Yes/no | N.A. | Yes/no | N.A. | N.A. | Yes/no | N.A. | Yes/no |
| Lateral acceleration | II #1 | II #1 | -0.1 to 0.5 s | 500/s | ±100 g | ± 1 g | 1 g | 0 – 250 ms | 500/s | ±50 g | ±5% | 0.01 g |
| Normal acceleration | II #2 | II #3 | -0.1 to 0.5 s | 500/s | ±100 g | ± 1 g | 1 g | 0 – 250 ms | 500/s | ±50 g | ±5% | 0.01 g |

I: essential data elements; II: additional data element; s: second; ms: millisecond; RFP: right front passenger; OOP: out-off-position; N.A.: not applicable

**Table B-2 (Continued)**
**Changes in Data Elements and Data formats Between the NPRM Proposal and Final Rule**

| Data Elements | NPRM | Final Rule | NPRM | | | | | Final Rule | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **Recording Interval** | **Sampling Rate** | **Data Range** | **Accuracy** | **Precision** | **Recording Interval** | **Sampling Rate** | **Data Range** | **Accuracy** | **Resolution** |
| Delta-V, Lateral | | II #4 | | | | | | 0 – 250 ms | 100/s | ±100 km/h | ±5% | 1 km/h |
| Maximum delta-V, Lateral | | II #5 | | | | | | 0 – 300 ms | N.A. | ±100 km/h | ±5% | 1 km/h |
| Time, maximum delta-V, Lateral | | II #6 | | | | | | 0 – 300 ms | N.A. | 0 – 300 ms | ± 3 ms | 2.5 ms |
| Vehicle roll angle | II #3 | II #9 | -1.0 to 6.0 s | 10/s | ±1080 $^0$ | ± 10 $^0$ | 10 $^0$ | -1.0 to 5.0 s | 10/s | ±1080 $^0$ | ± 10 $^0$ | 10 $^0$ |
| ABS activity (engaged, non-engaged) | II #4 | II #10 | -8.0 to 0 s | 2/s | On/off | N.A. | On/off | -5.0 to 0 s | 2/s | On/off | N.A. | On/off |
| Stability control, (on, off, engaged) | II #5 | II #11 | -8.0 to 0 s | 2/s | On/off/ engaged | N.A. | On/off/ engaged | -5.0 to 0 s | 2/s | On/off/ engaged | N.A. | On/off/ engaged |
| Steering wheel angle | II #6 | II #12 | -8.0 to 0 s | 2/s | ± 250 $^0$ | ± 5 $^0$ | 5 $^0$ | -5.0 to 0 s | 2/s | ± 250 $^0$ | ± 5 $^0$ | 5 $^0$ |
| Safety belt status, RFP | II #7 | II #13 | -1.0 s | N.A. | On/off | N.A. | On/off | -1.0 s | N.A. | On/off | N.A. | On/off |
| Frontal air bag suppression switch status, RFP | II #8 | II #14 | -1.0 s | N.A. | On/off | N.A. | On/off | -1.0 s | N.A. | On/off | N.A. | On/off |
| Frontal air bag deployment, time to $N^{th}$ stage, Driver[1] | II #9 | II #15 | Event | N.A. | 0 – 250 ms | ± 2 ms | 2 ms | Event | N.A. | 0 – 250 ms | ± 2 ms | 1 ms |

I: essential data elements; II: additional data element; s: second; ms: millisecond; RFP: right front passenger; OOP: out-off-position; N.A.: not applicable

**Table B-2 (Continued)**
**Changes in Data Elements and Data formats Between the NPRM Proposal and Final Rule**

| Data Elements | NPRM | Final Rule | NPRM | | | | | Final Rule | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Recording Interval | Sampling Rate | Data Range | Accuracy | Precision | Recording Interval | Sampling Rate | Data Range | Accuracy | Resolution |
| Frontal air bag deployment, time to N^th stage, RFP[1] | II #10 | II #16 | Event | N.A. | 0 – 250 ms | ± 2 ms | 2 ms | Event | N.A. | 0 – 250 ms | ± 2 ms | 1 ms |
| Frontal air bag deployment, N^th stage disposal, Driver | II #11 | II #17 | Event | N.A. | Yes/no | N.A. | Yes/no | Event | Yes/no | N.A. | Yes/no | N.A. |
| Frontal air bag deployment, N^th stage disposal, RFP | II #12 | II #18 | Event | N.A. | Yes/no | N.A. | Yes/no | Event | Yes/no | N.A. | Yes/no | N.A. |
| Side air bag deployment time, Driver | II #13 | II #19 | Event | N.A. | 0 – 250 ms | ± 2 ms | 2 ms | Event | N.A. | 0 – 250 ms | ± 2 ms | 1 ms |
| Side air bag deployment time, RFP | II #14 | II #20 | Event | N.A. | 0 – 250 ms | ± 2 ms | 2 ms | Event | N.A. | 0 – 250 ms | ± 2 ms | 1 ms |
| Side curtain/tube air bag deployment time, Driver | II #15 | II #21 | Event | N.A. | 0 – 250 ms | ± 2 ms | 2 ms | Event | N.A. | 0 – 250 ms | ± 2 ms | 1 ms |
| Side curtain/tube air bag deployment time, RFP | II #16 | II #22 | Event | N.A. | 0 – 250 ms | ± 2 ms | 2 ms | Event | N.A. | 0 – 250 ms | ± 2 ms | 1 ms |

I: essential data elements; II: additional data element; s: second; ms: millisecond; RFP: right front passenger; OOP: out-off-position; N.A.: not applicable

**Table B-2 (Continued)**
**Changes in Data Elements and Data formats Between the NPRM Proposal and Final Rule**

| Data Elements | NPRM | Final Rule | NPRM | | | | | Final Rule | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Recording Interval | Sampling Rate | Data Range | Accuracy | Precision | Recording Interval | Sampling Rate | Data Range | Accuracy | Resolution |
| Pretensioner deployment time, Driver | II #17 | II #23 | Event | N.A. | 0 – 250 ms | ± 2 ms | 2 ms | Event | N.A. | 0 – 250 ms | ± 2 ms | 1 ms |
| Pretension deployment time, RFP | II #18 | II #24 | Event | N.A. | 0 – 250 ms | ± 2 ms | 2 ms | Event | N.A. | 0 – 250 ms | ± 2 ms | 1 ms |
| Seat position, Driver (forward of a certain position) | II #19 | II #25 | -1.0 s | N.A. | Yes/no | N.A. | Yes/no | -1.0 s | N.A. | Yes/no | N.A. | Yes/no |
| Seat position, RFP (forward of a certain position) | II #20 | II #26 | -1.0 s | N.A. | Yes/no | N.A. | Yes/no | -1.0 s | N.A. | Yes/no | N.A. | Yes/no |
| Occupant size classification, Driver, 5th female | II #21 | II #27 | -1.0 s | N.A. | Yes/no | N.A. | Yes/no | -1.0 s | N.A. | Yes/no | N.A. | Yes/no |
| Occupant size classification, RFP, child | II #22 | II #28 | -1.0 s | N.A. | Yes/no | N.A. | Yes/no | -1.0 s | N.A. | Yes/no | N.A. | Yes/no |
| Occupant position classification, Driver, OOP | II #23 | II #29 | -1.0 s | N.A. | Yes/no | N.A. | Yes/no | -1.0 s | N.A. | Yes/no | N.A. | Yes/no |
| Occupant position classification, RFP, OOP | II #24 | II #30 | -1.0 s | N.A. | Yes/no | N.A. | Yes/no | -1.0 s | N.A. | Yes/no | N.A. | Yes/no |
| Time, maximum delta-V, resultant | | II #7 | | | | | | 0 – 300 ms | N.A. | 0 – 300 ms | ± 3 ms | 2.5 ms |

I: essential data elements; II: additional data element; s: second; ms: millisecond; RFP: right front passenger; OOP: out-off-position; N.A.: not applicable