# Recording Automotive Crash Event Data

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National Transportation Safety Board
Symposium On Recorders

# Crash Scene

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# 1914 Car Crash in Scotland

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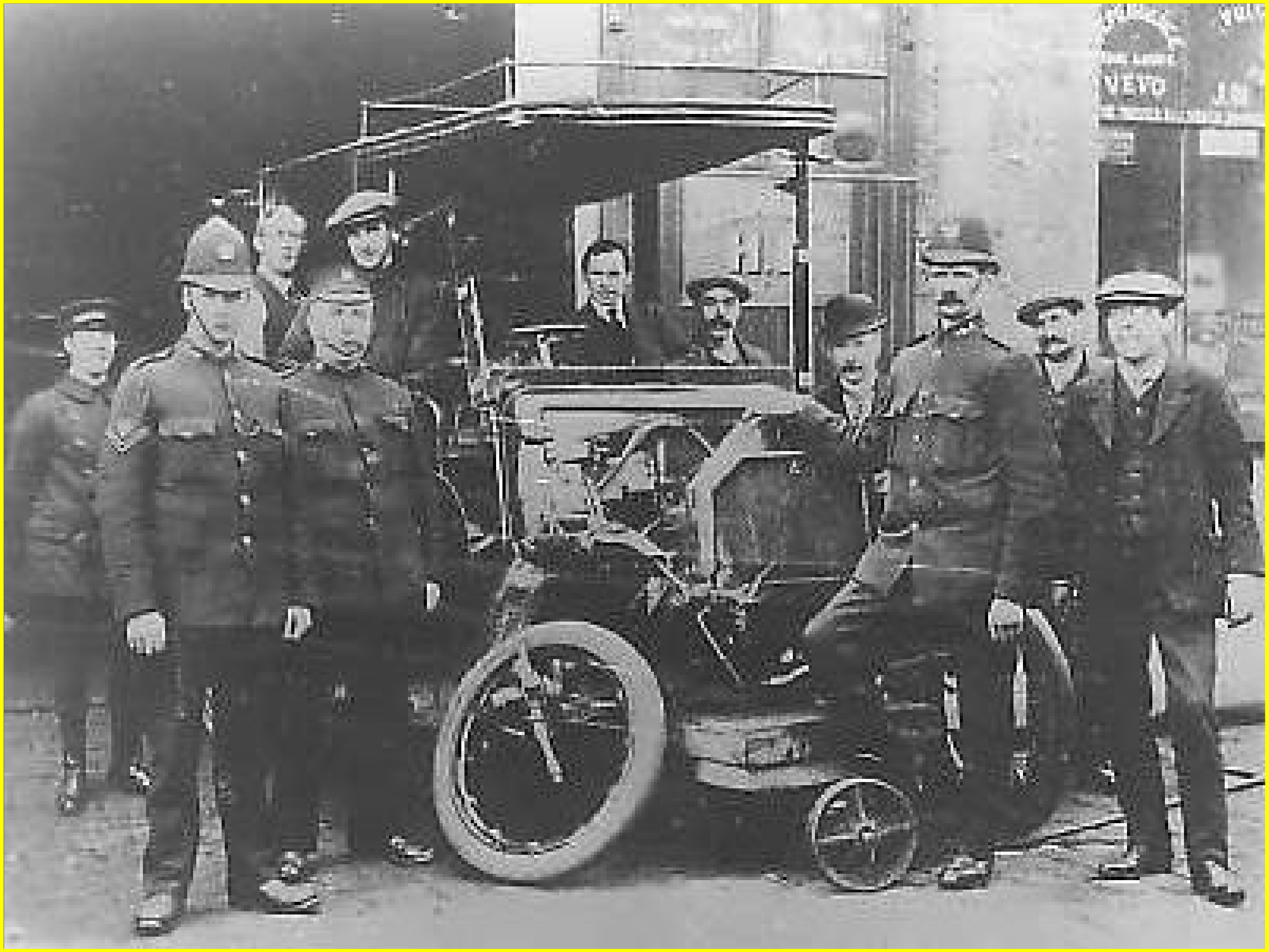

Source: http://www.sol.co.uk/s/scott.wilson/Old_Traffic_DundAcc1914.jpg

# *Crash Scene*

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# *The Opportunities Are Vast*

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- 18,000 Tow-away crashes per day
- Equivalent to about $600 million worth of crash Tests per day (18,000 crashes * $35,000 / test)
- Current total production of crash tests conducted for US vehicles is estimated around 5,000 / year

# *Background*

- **Need for real world crash data - crash pulses**
- **Today - methodology based on observation of post crash vehicle deformation**
- **Need for more detailed data to define crash conditions (pre-impact conditions, detailed deceleration data)**
- **Recommendations from NTSB & JPL**

# *NTSB*

- **NTSB public forum on air bags and child passenger safety (March 1997)**
- **NHTSA (H-97-18)**
  - "Develop and implement, in conjunction with the domestic and international manufacturers, a plan to gather better information on crash pulses and other crash parameters in actual crashes, utilizing current or augmented sensing and recording devices."

# *JPL*



- **1997 recommendation for NHTSA to work on EDRs**
- **Study feasibility of installing and obtaining crash data for safety analyses from crash recorders on vehicles**
- **JPL findings**
  - Crash recorders exist already on some vehicles with electronic air bag sensors, but data recorded are determined by the OEMs
  - These recorders could be basis for an evolving data-recording capability that could be expanded to serve other purposes

# *JPL (cont'd)*

- **Emergency rescues - information could be combined with occupant smart keys to provide critical crash & personal data to paramedics**
- **Questions of data ownership and data protection would have to be resolved, however**
  - Where data ownership concerns arise, consultation with experts in the aviation community regarding use of aircraft flight recorder data is recommended

# Potential Uses of Event Data

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| Category | Potential Examples |
|---|---|
| Improve Vehicle Design/Highway Infrastructure | vehicle systems<br>- airbag sensing system deployment criteria<br>highway systems<br>- roadside safety feature design standards |
| Provide a Basis for Regulatory & Consumer Information Initiatives | - offset frontal impact severity<br>- average/extreme vehicle decel pulses |
| Provide Objective Data for Crash Reconstruction | alleged defects & litigation<br>- unintended vehicle acceleration<br>- crash & airbag deployment sequence |
| Develop an Objective Driver Behavior Database | - pre-crash driver braking/steering<br>- belt use<br>- vehicle speed |

# The Haddon Matrix w/o EDR

| | Human | Vehicle | Environment |
| --- | --- | --- | --- |
| **Pre Crash** | | Skid Marks | |
| **Crash** | | Calculated Delta-V | |
| **Post Crash** | Injury | Collision Damage | Environment after crash |

# The Haddon Matrix w/ EDR

| | Human | Vehicle | Environment |
|---|---|---|---|
| Pre Crash | Belt Use<br>Steering<br>Brake | Speed<br>ABS<br>Other Controls | Conditions<br>During Crash |
| Crash | Air Bag Data<br>Pre Tensioners | Crash Pulse<br>Delta-V<br>Yaw<br>A/B Activation Time | Location |
| Post Crash | ACN (Automatic Collision Notification) | ACN | ACN |

# GM EDR Systems

# GM Airbag Systems Data Stored

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| Parameter | 1990 DERM | 1994 SDM | 1999 SDM |
|---|---|---|---|
| State of Warning Indicator when event occurred (ON/OFF) | ★ | ★ | ★ |
| Length of time the warning lamp was illuminated | ★ | ★ | ★ |
| Crash-sensing activation times or sensing criteria met | ★ | ★ | ★ |
| Time from vehicle impact to deployment | ★ | ★ | ★ |
| Diagnostic Trouble Codes present at the time of the event | ★ | ★ | ★ |
| Ignition cycle count at event time | ★ | ★ | ★ |
| Maximum Delta-V for near-deployment event | | ★ | ★ |
| Delta-V vs. time for frontal airbag deployment event | | ★ | ★ |
| Time from vehicle impact to time of maximum Delta-V | | ★ | ★ |
| State of driver's seat belt switch | | ★ | ★ |
| Time between near-deploy and deploy event (if within 5 seconds) | | ★ | ★ |
| Passenger's airbag enabled or disabled state | | | ★ |
| Engine speed (5 sec before impact) | | | ★ |
| Vehicle speed (5 sec before impact) | | | ★ |
| Brake status (5 sec before impact) | | | ★ |
| Throttle position (5 sec before impact) | | | ★ |

# 1999 EDR Simplified Block Diagram

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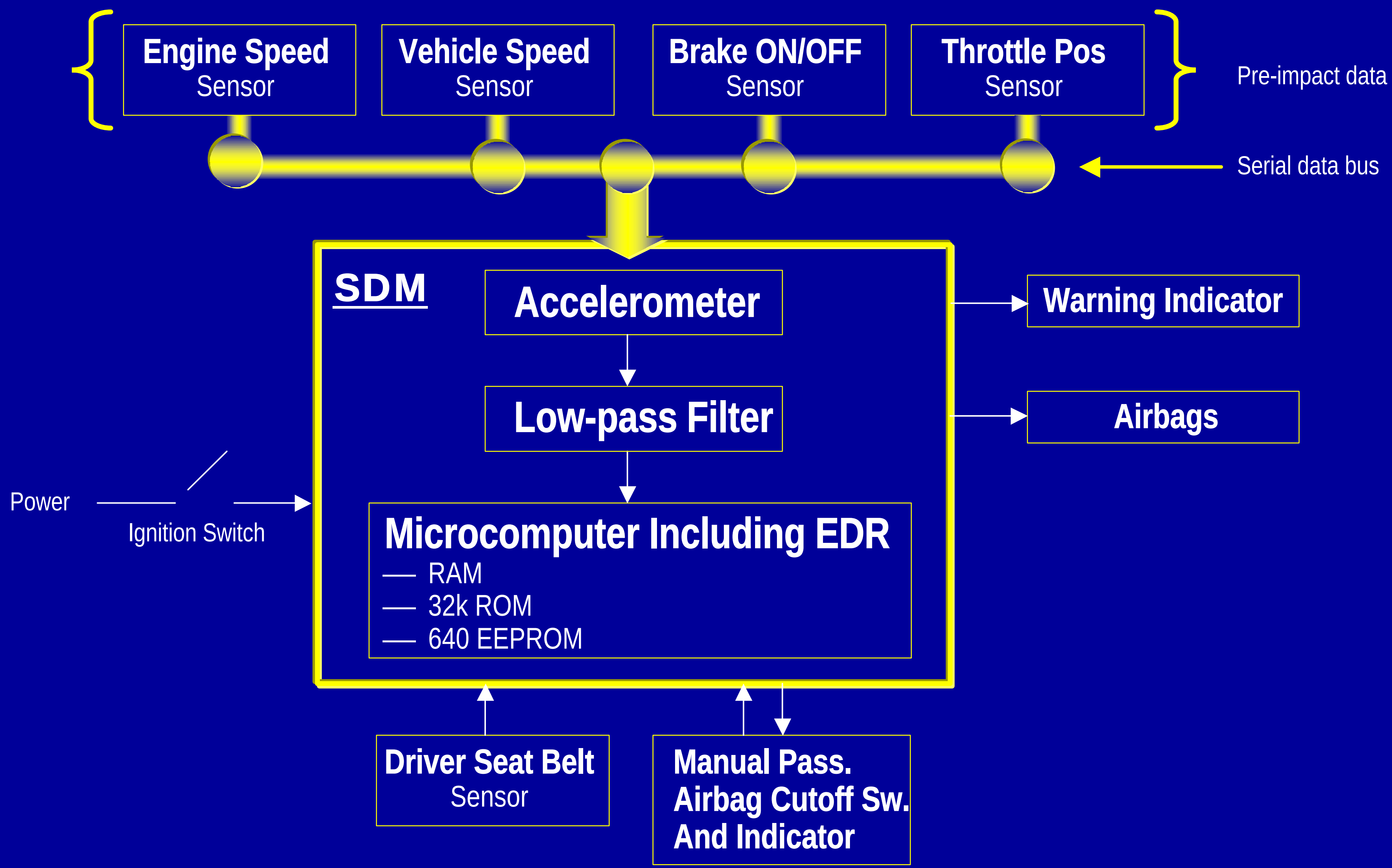
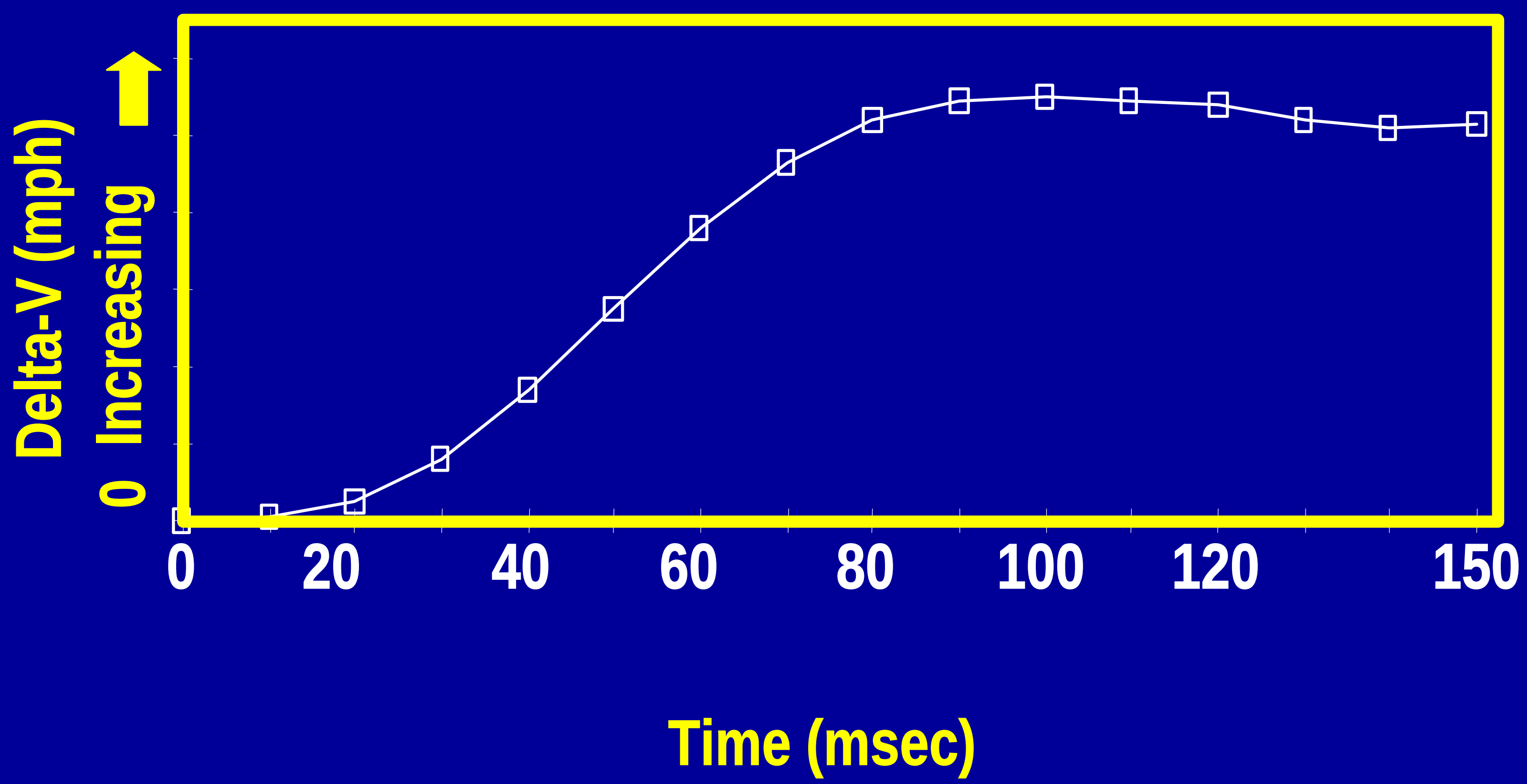
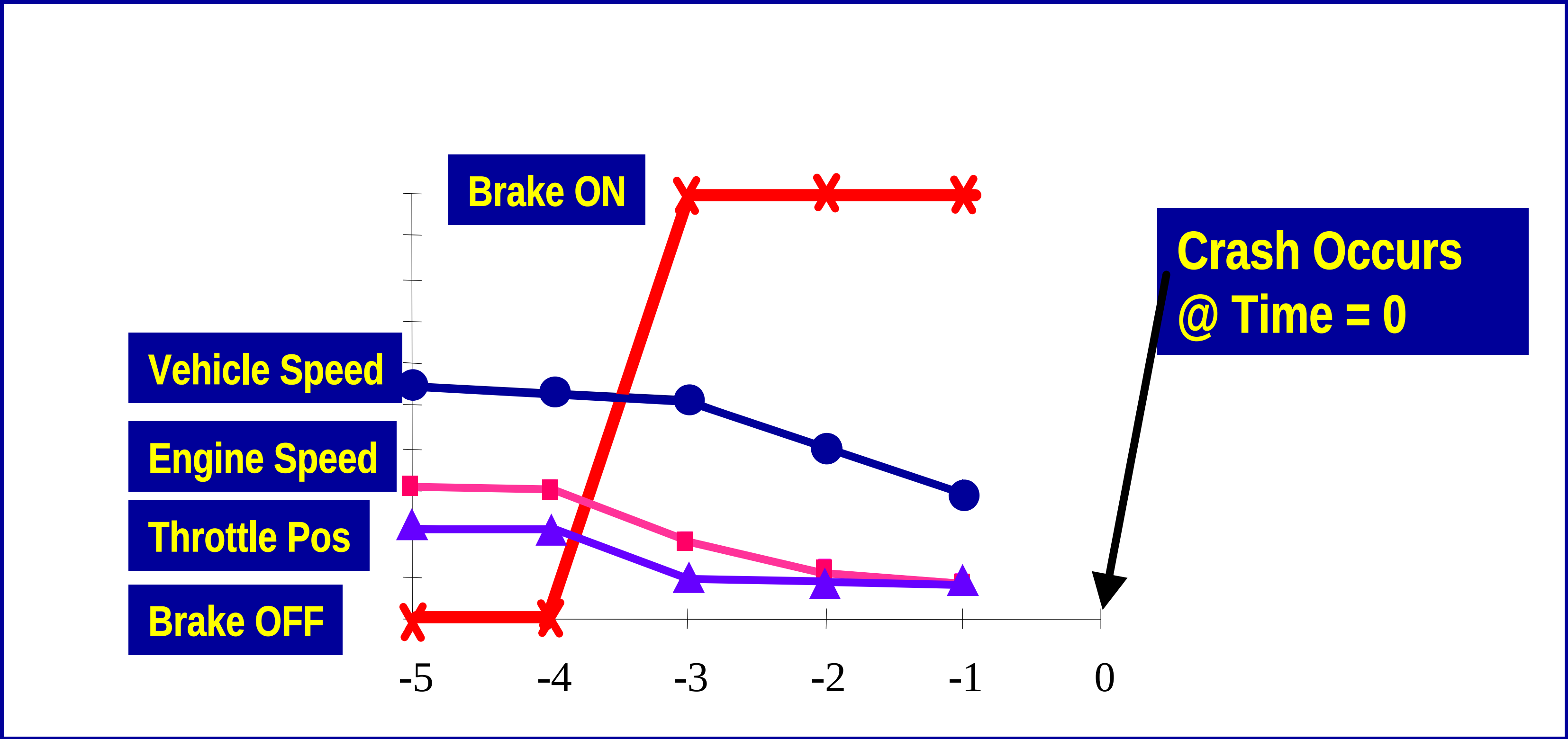


# *EDR Data*



# *Pre-Impact Data*
# *1999 EDR*




**Crash Time (sec)**

# Accuracy and Resolution

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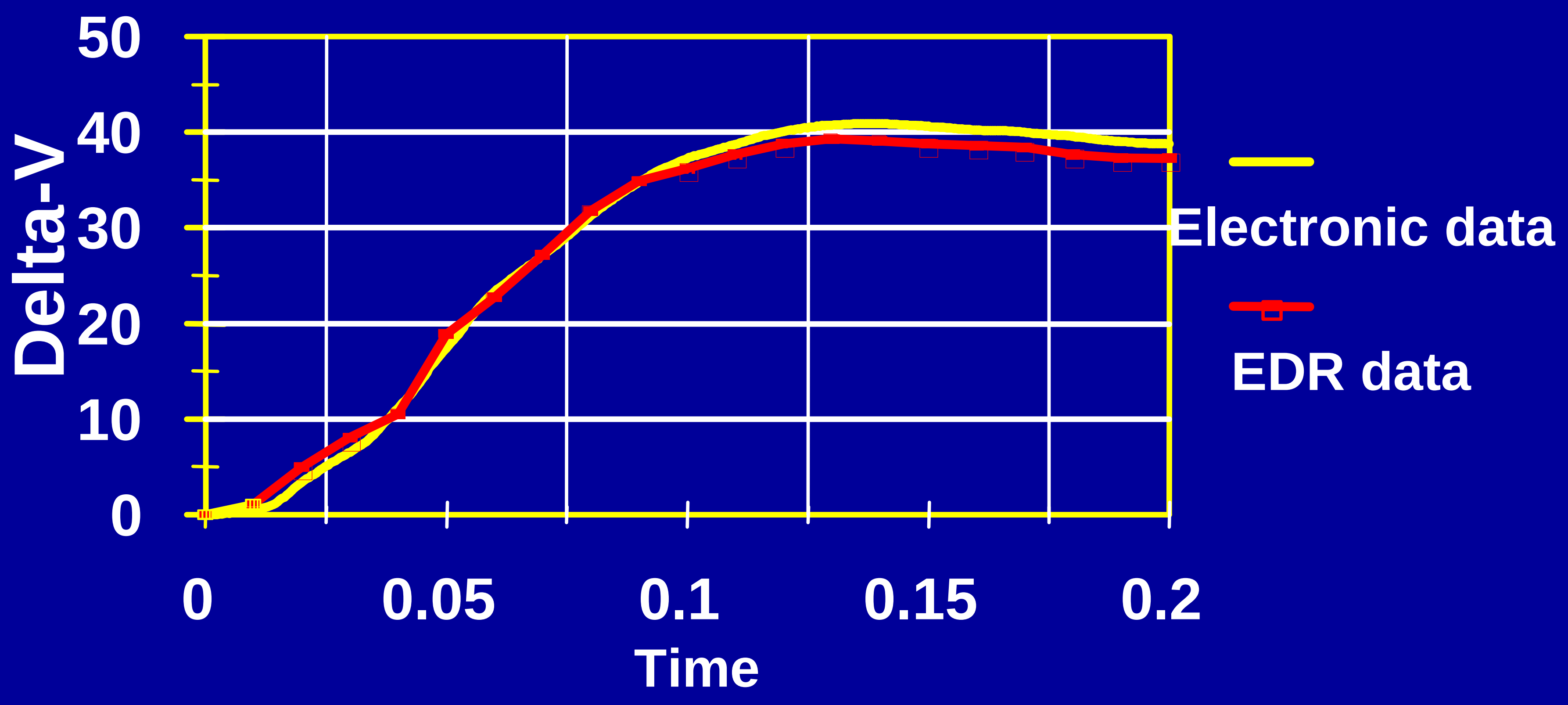
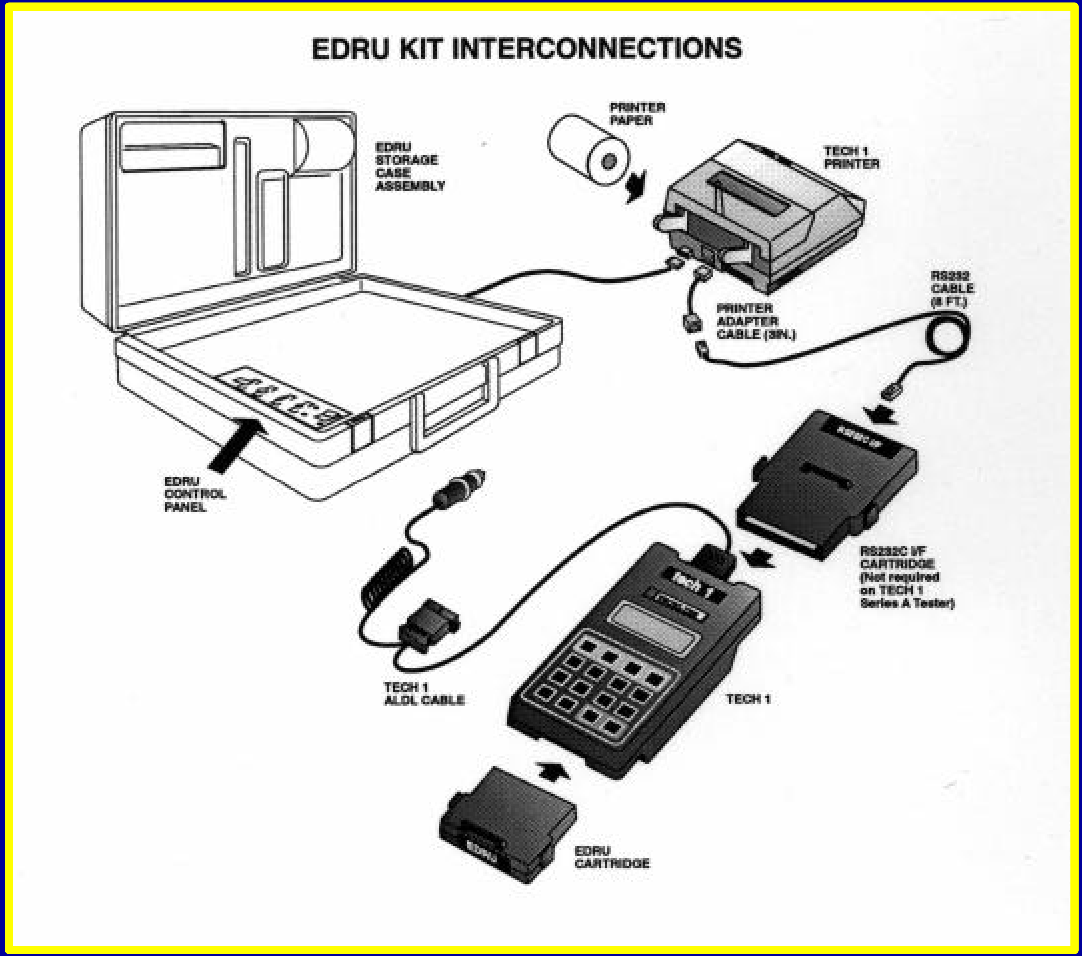
EDR Data

| Parameter | Full Scale | Resolution | Accuracy | How Measured | When Updated |
|---|---|---|---|---|---|
| Delta V | ± 55.9 mph | 0.4 mph | ~ ± 10% | Integrated acceleration | recorded every .010s, calculated every .00125s |
| Vehicle speed | 158.4 mph | 0.6 mph | ± 4 % | Magnetic pickup | vehicle speed changes by ≥ 0.1 mph |
| Engine Speed | 16383 RPM | 1/4 RPM | ± 1 RPM | Magnetic pickup | RPM changes by ≥ 32 RPM. |
| Throttle Position | 100% Wide open throttle | 0.4 % | ± 5% | Rotary potentiometer | Throttle position changes by ≥ 5%. |

# *Validation*


50
40
30
20
10
0
Delta-V
0
0.05
0.1
0.15
0.2
Time
Electronic data
EDR data

# GM Tech 1 Retrieval Unit



# Vetronix EDR Retrieval Tool

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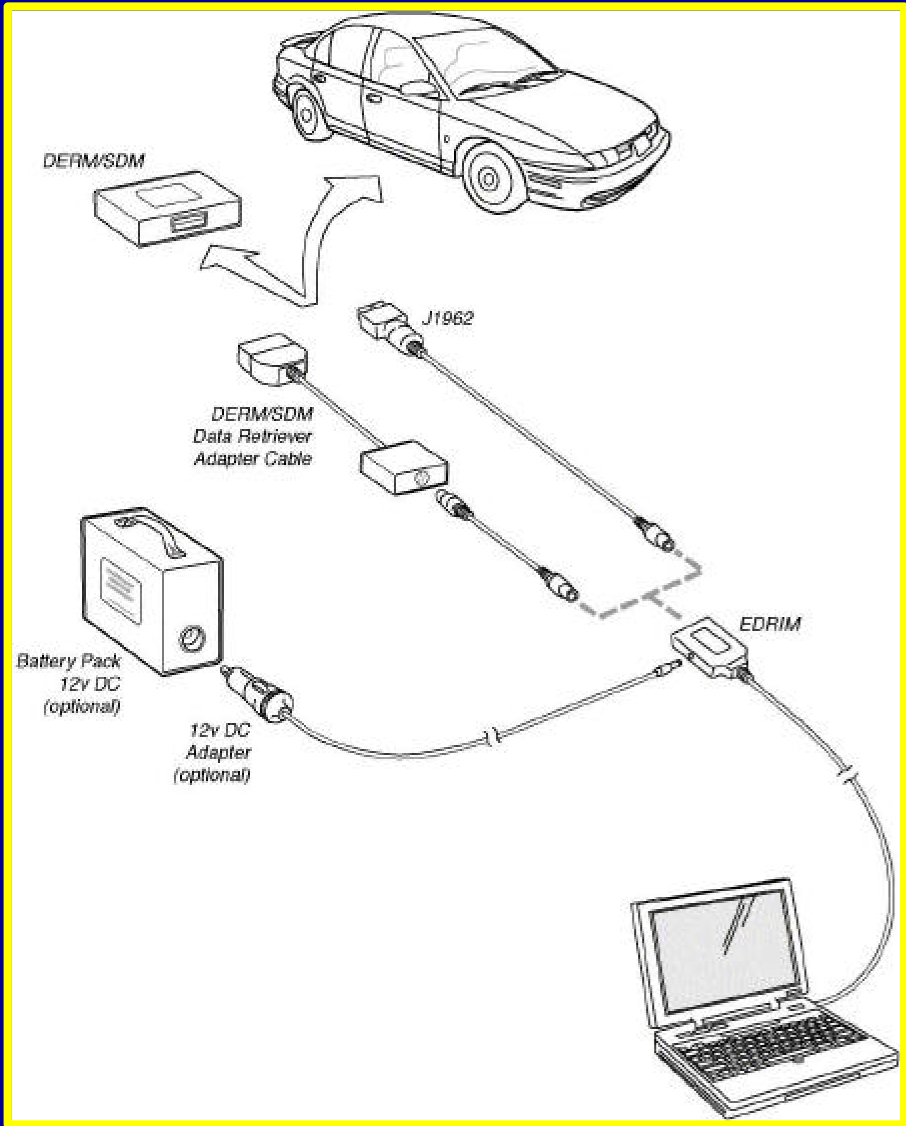
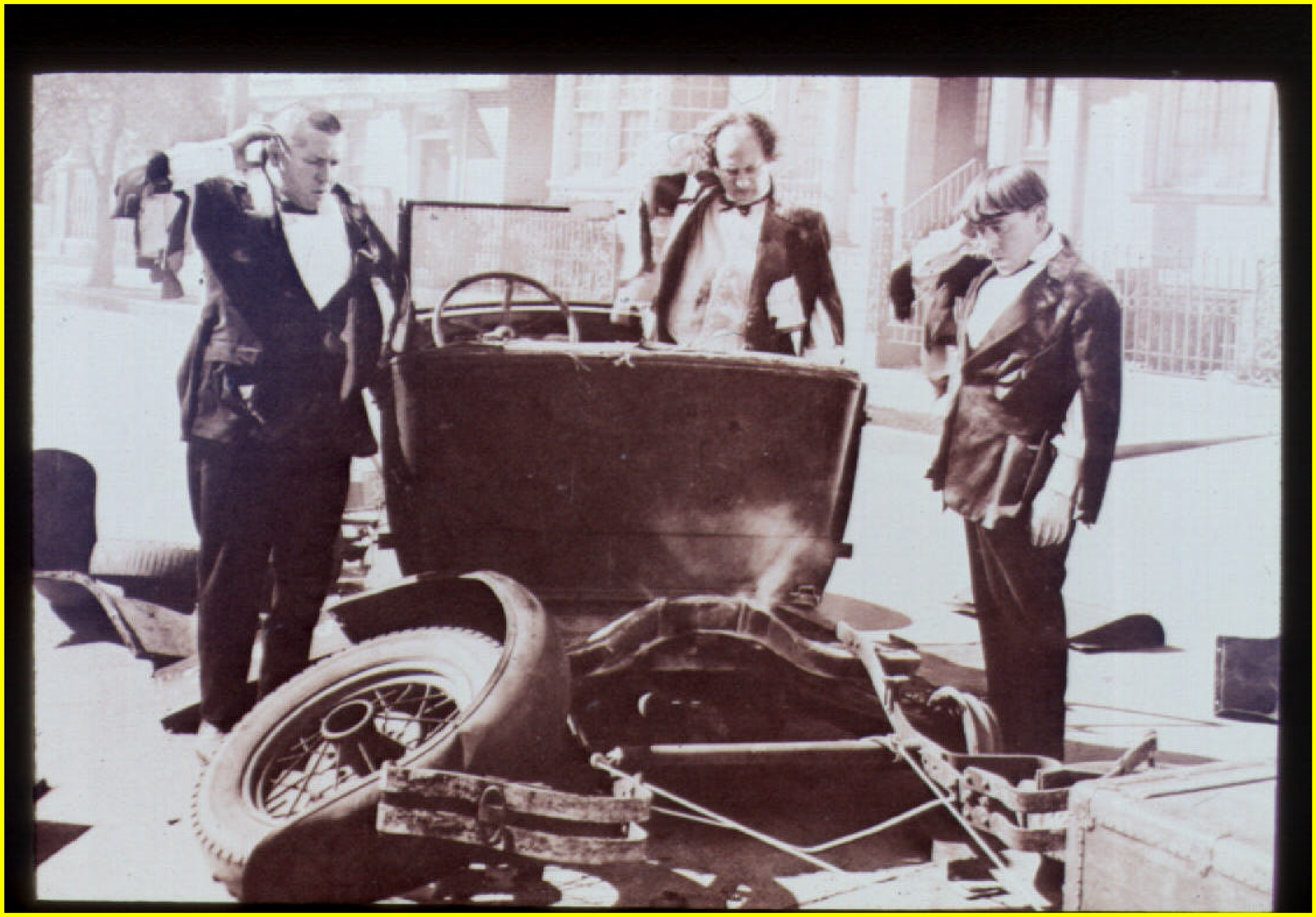


# EDR Uses



# SCIs Involving GMs' EDRs

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| MY - Make - Model | Driver Belted: Field | Driver Belted: EDR | Delta-V (mph): SMASH | Delta-V (mph): EDR | Comments |
|---|---|---|---|---|---|
| 1998 Chevrolet Malibu | Y | N | 23 | 50 | Final seat belt determination was "not belted. Severe under-ride. |
| 1995 Saturn SL | N | N | 13 | 16 | Very minor damage |
| 1996 Geo Metro | Y* | Y | 19 | 20 | *Physical evidence indicated shoulder portion of the belt under the driver's arm |
| 1995 Saturn | N | N | NR | 11 | Driver stated belt used, no physical evidence |
| 1996 Oldsmobile 98 | Y | Y | NR | 17 | Under-ride - visual of 14-18 mph |
| 1995 Chevrolet Lumina | N | N | 12 | 24 | Under-ride, 24 mph @ 150 msec |
| 1995 Geo Metro | Y | Y | 14 | 9 | The report writer specified the SDM Delta-V data as more representative of this crash |
| 1995 Geo Metro | N | N | NR | 11 | Undercarriage impact. Visual estimate of 9-14 mph |
| 1998 Pont. Grand Prix | Y | Y | NR | 2 | Inadvertent deployment |

**NR = No Results**

# *NHTSA SCI w/ EDR Involvement*

## Delta-V

- Struck a heavy, parked truck in a severe bumper under-ride impact.
- Such crashes typically generate long crash pulses.
- WINSMASH estimated a Delta-V of 23 mph.
- The investigator noted this Delta-V estimate appeared to be low.
- Data from the on-board recorder indicated a Delta-V of approximately 50 mph.

## Belt Use

- Belt use status unsure Investigator.
- EDR was read.
- EDR indicate 'Belt Used."
- EDR was correct.

Chevrolet Malibu

# *Motor Vehicle Safety Research Advisory Committee*

# *MVSRAC Working Group Formed*

- **On April 29, 1998, NHTSA staff presented a briefing to the MVSRAC committee**
- **Purpose was to recommend that a working group be formed**
- **MVSRAC members indicated:**
  - It would be several years before such devices would be wide spread enough to give researchers information on crashes
  - Manufacturers were not far along in EDR technology
- **Working group formed**
- **MVSRAC Crashworthiness Subcommittee would organize EDR working group**

# MVSRAC WG Representatives

- AAAM
- Blue Bird
- CA DMV
- Chrysler
- FHWA
- Ford
- Navistar
- GM
- NASDPTS
- Honda
- NHTSA
- NTSB
- Private
- Transport Canada
- TRB
- UVA
- VW
- Worcester

# *Objectives of MVSRAC W.G.*

- Define functional and performance requirements for on-board crash data recorders
- Understand technology presently available to meet these requirements
- Develop a set of data definitions
- Discuss the various uses of the data

# *Objectives (cont'd)*

- Discussions of legal and privacy issues
- Historical overview of other agency's actions related to data collection

# *Potential Outcomes of the MVSRAC WG*

- **Technical Report (by end of 2000)**
- **Recommendations to Full MVSRAC for EDR actions**
  – Establish National Data Base for EDR Data
  – Encourage all manufacturers to develop EDR technology

# Conclusions

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- Potential to Greatly Improve Highway Safety
- Well-Coordinated Efforts will be Needed to Achieve the Results Envisioned by the NTSB
- NHTSA's MVSRAC Event Data Recorder Working Group will Establish Guidelines for Future On-Board Data Recording Capability
- EDR Data is now being stored in NHTSA's National Crash Data Bases

# The End

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