



# THE ASSOCIATION

NOVEMBER 2012

## EFFECTS OF G-FORCES IN CRASH INVESTIGATION

### INSIDE THIS ISSUE:

**EFFECTS OF G-FORCES IN CRASH INVESTIGATION** 1

**FACTUAL DIAGRAM RELEASES CDR REPOWERING RIG KIT** 2

**CRASH INVESTIGATION SCHOOL SCHEDULES** 3

**IACAI SKILL REVIEW** 5

**NOVEMBER SEMINAR ANNOUNCEMENT** 6

**C**rash reconstruction involves the application of general physical laws, some of which was given to us by the famous English scientist, Sir. Isaac Newton in the seventeenth century. Ever since that fateful day when the apples rained from the sky, we have been held to three of his most famous laws: The first law, known as the Law of Inertia, says that a body at rest or a body in motion will remain in that state unless acted upon by an outside or external force.

The second law states that the rate of change of momentum of an object is directly proportional to the resultant force acting upon it. The sum of this law can be expressed as: Force = Mass x Acceleration.

The third law states that for every action, there is an equal and opposite reaction.

The purpose of this mini-refresher course is to help understand the topic for this article, all about G-Forces. The term G-

Force, commonly shown in formulas as a 'g,' is defined as "the force of gravity or acceleration on a body." (Merriam Webster Dictionary). One 'g' is an acceleration unit equal to that generated by a free fall in the earth's gravitational field, i.e., 32.2 feet per second per second.

The concept of a g-force wasn't really understood until 1903. Around the time of World War I, the concerns related to g-forces became more apparent when pilots were mysteriously losing consciousness during dog-fights. Based on the survival rates calculated, it was determined that no pilot could survive more than 18g's. This belief lasted for more than 30 years until a USAAF Flight Surgeon, Col. John Stapp, began looking into the effects of g-forces on pilots. With the advent of jet aircraft now on the horizon, he was concerned about the higher g-forces these pilots would be experiencing. He set out to test these effects on a rocket propelled sled, named "Gee Whiz." By the time Col. Stapp had made

his final run, he had sustained speeds of over 632 miles per hour in the course of 5 seconds, sustained 46.2g's on his body during the 45 foot stop at the end of his 2000 foot run. He broke bones, suffered eye injuries and other assorted issues, but lived to show that g-forces were survivable in the right circumstances. For one instant, Stapp's 168 lb body weighed over 7,700 lbs! In crash investigation, much like in parachuting, when it comes to g-forces, it's not the speed that kills you, it's the sudden stop.. Humans can sustain g-forces of 3-4g's with little effect for short periods(roller coasters, for example); pilots can endure g-forces up to 8-9g's for limited amounts of time. Human tolerances depend on the magnitude, direction and duration of the g-force. Humans can sustain g-forces of 20-35g's for very short periods of time. Football players can sustain impacts of 20-40g's without injury;

(Continued on Page #4)

## COL. JOHN STAPP, SAFETY BELT ADVOCATE, G-FORCE PIONEER

Beginning in 1947, the United States began studies into the amount of G-forces that the human body could safely endure. This came as the result of the development of jet engines and the faster aircraft that followed. Conventional wisdom was that a human could only safely endure up to 18g's before succumbing to the effects of the G-forces. The fear was that ejections made from these newer, faster aircraft would

kill the pilot trying to escape from his aircraft. One of the pioneers in the study of G-forces on the human body was a USAAF Flight Surgeon named John Stapp (1910-1999). Colonel Stapp was involved in 74 rocket sled tests from 1947 to 1951, riding the 1,500 pound sled 2,000 feet before stopping in a very short distance of 45 feet. Stapp endured up to 46.2g's during these tests, fracturing ribs, limbs,

and bursting blood vessels in his eyes and sustaining a retinal detachment. The force Stapp sustained at the end of run was the equivalent of hitting a brick wall at 120 mph! He proved, however, that man could survive intense g-forces.

Col. Stapp became a strong advocate of safety restraints in motor vehicles and was pivotal in getting the law in place which mandated safety belts in cars in 1966.

### CDR Repowering Rig

For those of you who use the Bosch Crash Data Retrieval system (CDR) as part of their investigations, you know that it can be very frustrating trying to image the Airbag Control Module (ACM) through the Data Link Connector (DLC), only to learn that it is next to impossible to do so since the vehicle's electrical system has been compromised or the ignition system damaged. The CDR Repowering Rig by Factual Diagrams, Inc., is designed to aid the investigator by supplying power directly to the ACM, which would then allow the investigator to image the ACM via the DLC. Factual Diagrams claims that using this method significantly increases

the chance of imaging the module via the DLC, lessens the potential of adding/overwriting airbag related diagnostic trouble codes, allows for imaging when the investigator might not have the correct direct-to-module cables, and, permits the investigator to download without an ignition key.

Factual Diagrams offers a basic repowering kit consisting of a wire harness with a cigarette plug (male) on one end and both power and ground connectors on the other end. It also comes with two fuse block adapters designed to fit both Mini and ATO automotive fuse sockets. This rig does not include a 12volt receptacle and requires a Y-adapter to supply power to the ACM.

The Deluxe rig also includes the built in 12volt receptacle, which eliminates the need for the Y-adapter. A battery power pack is also offered to supply a 12volt source of power to the ACM. The power pack uses 8AA batteries which the company claims will last approximately 50 downloads before needing to be changed. The basic rig set up costs \$30; the deluxe model costs \$40, and the power pack costs \$20. The company also offers combinations of the basic or deluxe model with power pack for \$45 and \$55, respectively. For more information, visit: [www.factualdiagrams.com](http://www.factualdiagrams.com) and click on the CDR Accessories link.



Flight Surgeon Col. John Stapp was not only known for his G-force testing. He is also known for coining the familiar phrase now known as Murphy's law "Whatever can go wrong, will go wrong," after his assistant, Captain Murphy, failed to properly secure his safety harness prior to a rocket sled test.

## THE MOST RISKY DAY OF THE WEEK IS..

According to a recent press release from Nationwide Insurance, Friday may be the most risky day to drive to work. Nationwide analyzed claims data from 2012 and found that it had the highest average number of claims per day on Fridays, coming in at 4,664 claims. Wednesday came in second with an average of 4,197 claims, following by Thursday, Monday, and Tuesday.



## USELESS LAWS FOR YOUR AMUSEMENT

- In California, it is illegal to set a mousetrap without a hunting license.
- In Alabama, putting salt on railroad tracks may be punishable by death.
- In South Bend, IN, monkeys are forbidden to smoke cigarettes.
- In Kentucky, the state law states that a person is considered sober until he or she "cannot hold onto the ground."
- In Fort Madison, Iowa, firemen are required to practice for 15 minutes before attending a fire.
- In Port Huron, Michigan, the speed limit for ambulances is 20 mph.
- In Whitehall, Montana, it is illegal to operate a motor vehicle with icepicks attached to the wheels.
- In Nevada, it is illegal to drive a camel on the highway.
- In New Britain, Connecticut, the speed limit for fire trucks is limited to 25mph, even when responding to a fire.
- In Utah, birds have the right of way on all highways.
- In Seattle, Washington, residents may not carry a concealed weapon longer than 6 feet in length.



The IACAI Board of Directors wishes each of our members the best this holiday season.

Here's hoping that each of you have a safe & great Thanksgiving and a very Merry Christmas!

## ACCIDENT INVESTIGATION TRAINING

### **IPTM**

<http://www.iptm.org/Schedule.aspx>

- 1/14-1/25/2013 **Advanced Crash Investigation**  
\$950 St. Petersburg, FL
- 2/25-3/1/2013 **Energy Methods and Damage Analysis in Accident Reconstruction**  
\$825 Jacksonville, FL
- 3/4-7/2013 **Heavy Vehicle EDR Use in Crash Reconstruction**  
\$1195 Jacksonville, FL
- 3/11-5/25/2013 **At Scene Crash Investigation**  
\$825 On-Line through IPTM
- 3/25-4/5/2013 **At Scene Crash Investigation**  
\$950 Jacksonville, FL
- 4/22-26/2013 **EDR Use in Crash Reconstruction**  
\$695 Jacksonville, FL
- 6/3-7/2013 **Human Factors in Crash Reconstruction**  
\$825 Jacksonville, FL
- 7/22-26/2013 **Digital Photography/Crash Invest.**  
\$795 Jacksonville, FL

### **NUCPS**

[http://nucps.northwestern.edu/course/crs\\_list.asp](http://nucps.northwestern.edu/course/crs_list.asp)

- 1/14-3/22/2013 **Crash Investigation I**  
\$975 On-Line
- 1/14-3/22/2013 **Crash Investigation II**  
\$975 On-Line
- 2/25-3/1/2013 **Traffic Crash Reconstruction III**  
\$875 Evanston, IL
- 3/4-8/2013 **Heavy Vehicle EDR**  
\$1000 Evanston, IL
- 3/7/2013 **CDR Tech Level I**  
\$125 Evanston, IL
- 3/7-8/2013 **CDR Tech Level I & II**  
\$275 Evanston, IL
- 3/11-15/2013 **CDR Analyst**  
\$695 Evanston, IL
- 4/15-19/2013 **Vehicle Dynamics**  
\$775 Evanston, IL
- 4/22-5/3/2013 **Crash Reconstruction I**  
\$1050 Evanston, IL

To Register, visit the website or call: 904-620-4786

To Register, visit the website or call: 800-323-4011

## MORE ABOUT: G-FORCES IN CRASH INVESTIGATION

(Continued from Page #1)

However, these impacts have a very short duration (measured in milliseconds). In a few cases, helmet to helmet contacts have been measured at near 200g's!

When it comes to car crashes, belted drivers can sustain between 20-40g's. The exposure to these g-forces is brief. These forces get dissipated through safety mechanisms in place by design of the vehicle, and in the vehicle (safety restraints, airbags, etc.), lessening the chance of injury for the occupant. Nascar drivers can sustain upwards of 50-100g's (short duration) during a car crash, usually resulting in nothing more than a bruised ego. In one of the most infamous Nascar crashes to occur, Dale Earnhardt, Sr. was killed after being involved in a seemingly 'routine' crash in the final lap of the 2001 Daytona 500. However, the resulting impact subjected Earnhardt's body to a g-force range of between 48-68g's. These g-forces did not dissipate quickly, however. Without the benefit of the Hahn's device, which restricts the movement of the head during a collision, his head snapped forward, then backward, fracturing the rear of his skull and killing him instantly. Had he used this type of device, he would likely have survived.

Unrestrained occupants experience some of the highest g-forces at the moment of impact. The National Highway Traffic Safety Administration has conducted tests using

unrestrained hybrid dummies in head-on and barrier impact tests. In these tests, the dummy's head impacting the windshield has been measured at g-forces approaching 100g's; all at speeds of 25-30 mph.

One of the most infamous car crashes occurred on August 31, 1997, when a car that England's Princess Diana was riding in struck a concrete pillar head-on at between 60-70 mph, while being pursued by paparazzi. The unrestrained Princess sustained g-forces so great to tear the pulmonary artery from her heart. The g-forces the Princess endured was later determined to be around 70g's (chest) to 100g's (head). Had she been restrained, she would have sustained estimated g-forces of around 35g's (likely survivable).

As discussed previously, the high velocity isn't the culprit when it comes to harmful or fatal injuries. It is the duration and magnitude of the force. A human is more likely to survive a higher g-force when the force is pushing the body backwards (eyeballs in), perpendicular to the spine. When the body is subjected to a g-force pushing the body forward, (eyeballs out), the body has less tolerance and is more susceptible to injury, especially to the retinas. Duration of g-force exposure is as important as the magnitude. Untrained humans have sustained upwards of 17g's (eyeballs in) and 12g's (eyeballs out). Col. John Stapp was able to sustain

25g's for up to 1.1 seconds. In most cases, however, this length of exposure could be fatal. One contributing factor is the size/shape of the person. The human body is comprised of different organs; each organ containing its own different density. When a human is placed under high acceleration, the brains, lungs, ribs (bones) and in women, the breasts, all affect the death of the human. The reason is that each different body organ has a higher density than another which causes certain organs to undergo more g-force than other organs. Some organs are more vascular, and therefore, more susceptible to injury. An example of this is the liver, one of the largest organs in the abdominal cavity. The liver is 'braced' in part by a ligament, known as the ligamentum teres. In cases of an unrestrained collision where the g-forces are more sustained, the liver tries to move through the ligament, severing the liver, causing massive bleeding and in many cases, death. The head and brain are equally vulnerable to high g-forces, often resulting in concussions and death in prolonged durations.

If you want to experience the effects of g-forces on your own body, try this simple test: Jump up, and land stiff-legged. The impact is equivalent to a g-force of 100g's! For the less adventurous, try coughing - it produces g-forces of approximately 3.5g's!



### MEMEBERS:

The 2013 IACA membership dues will be out in the mail around the end of December, payable by February 1, 2013. The dues for 2013 will remain the same as for 2012, @ \$35 for renewing members.



**IACAI SKILL REVIEW**

This issue of the IACAI Skill Review involves the skills of time, distance, velocity, and acceleration. Answers will appear in the next edition of the Association.

1. A college student was walking east across University Drive. The student was struck by a vehicle that was traveling north on University. The angle of collision was approximately 90 degrees. The collision took place 32 feet from the west edge of University Drive. Tests performed after the crash concluded that the student was walking at an average velocity of 4.5 feet per second. The vehicle skidded 150 feet before impact and continued skidding until it came to a halt 75 feet beyond the collision point. Test skids were made and it was determined that the drag factor of the accident vehicle was 0.80. The driver's reaction to the hazardous situation was to apply the brakes hard with a reaction time of 1 second. There were no identified view obstructions for the student or motorist.
  - A. What was the distance between the initial contact and the point of perception?
  - B. After the vehicle had skidded for 2 seconds, how far was it from initial contact?
  - C. Assuming the vehicle had been traveling at the same velocity indicated by the skidmarks for ten seconds prior to skidding, how far was the vehicle from initial contact when the student started across the street?  

---
2. Vehicle #1 skids for 150 feet and crashes into Vehicle #2, which was parked at the time. Both vehicles stayed together after the collision. The collision speed of vehicle #1 with vehicle #2 was determined to be 40 mph. Test skids determined the drag factor to be 0.85.
  - A. What was the initial velocity of vehicle #1 at the beginning of the skidmarks?
  - B. Assuming a reaction time of 1 second for driver #1, and that he locked the wheels of the car at the end of his reaction time, how far was vehicle #1 from initial contact when it reached the point of perception?
  - C. What was the velocity of vehicle #1 at the end of the first second of skidding?
  - D. If vehicle #1 came to a complete stop in twenty feet after the collision, what would its rate of acceleration be?
  - E. Using the calculated acceleration rate determined in answer D, how much time was involved from collision to stop?



## SEMINAR ANNOUNCEMENT

*The Indiana Association of Certified Accident Investigators will be sponsoring a seminar on*

### **"Crash Data Retrieval Refresher" & "Legal Update"**

**Wednesday, November 28, 2012 0900 1500 hrs**

at the

Indianapolis Metro Police Department Training Center

901 North Post Road, Room #209

Indianapolis IN

Cost: \$50 for IACAI members; \$75 for non-members

\*No advanced registration is required.\*

Registration begins at 08:30am

Questions regarding this seminar may be directed to IACAI

President Kip Shuter

email: [kipss@warsawpd.org](mailto:kipss@warsawpd.org)

The Indiana Association of Certified Accident Investigators  
P.O. Box 1566  
Warsaw, IN 46581-1566

The Association is published quarterly as a service to members of the Indiana Association of Certified Accident Investigators.

Articles submitted are the responsibility of the author; the IACAI assumes no responsibility as to an article's content..