

	SURFACE VEHICLE INFORMATION REPORT	SAE J1460/1 MAY2012
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Human Mechanical Impact Response Characteristics - Dynamic Response of the Human Abdomen		

RATIONALE

The members of the SAE Human Biomechanics and Simulations Standards Steering Committee have reviewed SAE J1460/1 and made a conscientious decision to stabilize this Information Report. Additional research into the dynamic response of the human abdomen has been conducted since this Information Report was last revised. However, the committee has decided not to undertake the extensive work to revise SAE J1460/1 at this time. This Information Report has historical value.

STABILIZED NOTICE

This document has been declared "Stabilized" by the SAE Human Biomechanics and Simulations Standards Steering Committee and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

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Foreword—Human mechanical impact response is defined as the reaction of a body segment in terms of measurable engineering parameters such as forces, accelerations, and deflections due to direct or indirect impact loading. The impact response of a body region can depend upon the test conditions used to generate the data (such as impactor shape, stiffness, mass, and body region boundary conditions) and thus, in most cases, can only be defined in terms of those conditions. Accordingly, the impact response of a test dummy component must be evaluated under test conditions similar to those used to obtain the defined response data.

A number of problems need to be addressed in defining human impact response characteristics, since most impact response studies use cadaver or animal surrogates to obtain data at severe impact levels. The impact response of surrogates can differ from that of living humans due to lack of physiological effects, such as muscle tone in the cadaver subject, and lack of geometric similitude with animal subjects. In cases where sub-injury tests are conducted with volunteers, there are also problems with extrapolation of the response data to represent the response at higher impact severities. Some studies only include response of the body region up to the injurious level while others include response well beyond the initiation of tissue structural failure associated with injury.

In addition, the human form is not of unique size, shape, and proportion. There are significant geometric differences between and among adults and children, and males and females. The available response data in the literature dictates that treatment of this topic be constrained essentially to guidelines for average adult male responses, with scaling used to define equivalent responses for the small adult female and the large adult male.

Finally, there may be response variability introduced by age, physical conditioning, and other factors not discussed here. This variability is discussed for those body regions where such information is available.

1. **Scope**—This series of reports provides response characteristics of the head, face, neck, shoulder, thorax, lumbar spine, abdomen, pelvis, and lower extremities. In each report, the descriptions of human impact response are based on data judged by the subcommittee to provide the most appropriate information for the development of human surrogates.
- 1.1 **Purpose**—This is one of a series of reports which define human mechanical impact response characteristics for specific body regions. These reports update SAE J1460 which is intended for use by anthropomorphic test dummy designers and analytical modelers who need quantitative definitions of human mechanical impact behavior. These reports do not discuss criteria for assessing human impact injury potential, which are the subject of a separate SAE Information Report SAE J885. Each document in the series covers material specific to a body region and will be independently updated when new response data become available.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. Unless otherwise specified, the latest issue of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J885—Human Tolerance to Impact Conditions as Related to Motor Vehicle Design

SAE J1460 MAR85—Human Mechanical Response Characteristics

SAE 840884—A Procedure for Normalizing Impact Response Data, Mertz, H. J.

SAE 861878—Lower Abdominal Tolerance and Response, Proceedings of the 30th Stapp Car Crash Conference, Cavanaugh, J. M., Nyquist, G. W., Goldberg, S. J., and King, A. I.

SAE 892432—Biomechanical Response and Injuries in Blunt Lateral Impact, Viano, D. C.

SAE 892440—Assessing Submarining and Abdominal Injury Risk in the Hybrid III Family of Dummies, Proceedings of the 33rd Stapp Car Crash Conference, Rouhana, S. W., Viano, D. C., Jedrzejczak, E. A., and McCleary, J. D.

SAE 902317—Assessing Submarining and Abdominal Injury Risk in the Hybrid III Family of Dummies: Part II Development of the Small Female Frangible Abdomen, Proceedings of the 34th Stapp Car Crash Conference, Rouhana, S. W., Jedrzejczak, E. A., and McCleary, J. D.

2.1.2 IRCOBI PUBLICATION—Available from IRCOBI Secretariat, ONSER, 109 Ave Salvador Allende, 69500 Bron France.

IRCOBI—Designing of a Dummy's Abdomen for Detecting Injuries in Side Impact Collisions, Proceedings of the 5th International Research Conference on Biokinetics of Impacts, Walfisch, G., Fayon, A., Tarriere, C., Rosey, J., Guillon, F., Got, C., Patel, A., and Stalnaker, R.

2.1.3 ISO/TR PUBLICATION—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ISO/TR 9790-5—Road vehicles—Anthropomorphic side impact dummy—Part 5: Lateral abdominal impact response requirements to assess biofidelity of dummy

2.1.4 MVMA PUBLICATION—Available from MVMA, American Automobile Manufacturers Association, 7430 Second Avenue, Suite 300, Detroit, MI 48202.

MVMA Report UMTRI-88-19—Steering System Abdominal Impact Trauma, Nusholtz, G. S., Kaiker, P. S., and Lehman, R. J.

2.1.5 UMTRI PUBLICATION—Available from University of Michigan, Transportation Research Institute, 2901 Baxter Avenue, Ann Arbor, MI 48109.

UMTRI Report 83-53-1/NHTSA Reports DOT HS 806 715-806 717—Development of Anthropometrically Based Design Specifications for an Advanced Adult Anthropomorphic Dummy Family, Schneider, L. W., Robbins, D. H., Pflug, M. A., and Snyder, R. G., Vols. 1-3

2.1.6 OTHER PUBLICATIONS

2.1.6.1 Anatomy, Descriptive and Surgical, Gray, H., Bounty Books, New York, 1977

2.1.6.2 The Biomechanical Response of the Lower Abdomen to Belt Restraint Loading, Miller, M. A., Journal of Trauma, Vol. 29, No. 11, 1989

3. Dynamic Response of the Human Abdomen

3.1 Introduction—Occupant kinematics in automotive collisions can result in loading of the abdominal region for the unbelted or belted occupant. In either case, abdominal response may affect kinematics of the other body regions and human-like abdominal response is vital to realistic assessment of risk of abdominal injury. This section provides an overview of studies performed to determine abdominal response to impact loading conditions. It includes a brief discussion of abdominal anatomy, and frontal and lateral impact response under various loading conditions. This is new material not contained in SAE J1460 MAR85.

3.2 Anatomy—Some organs of the abdomen are “solid” while others are “hollow”, and some are located within the lower parts of the rib cage while others are surrounded only by soft tissue. Classical anatomy separates the abdomen into nine parts, consisting of three rows and three columns as in Figure 1 (2.1.6.1). The top row includes the organs beneath the diaphragm and above the tip of the ninth rib (liver, stomach, spleen, pancreas, duodenum, part of the kidneys). The second row includes organs from the tip of the ninth rib to the highest point on the pelvis called the iliac crest (ascending, descending, and transverse colon, part of the small intestine, the pancreas, and the rest of the kidneys). The bottom row includes all the abdominal organs below the iliac crests (cecum, sigmoid colon, bladder, the rest of the small intestine, and, in females, the uterus).

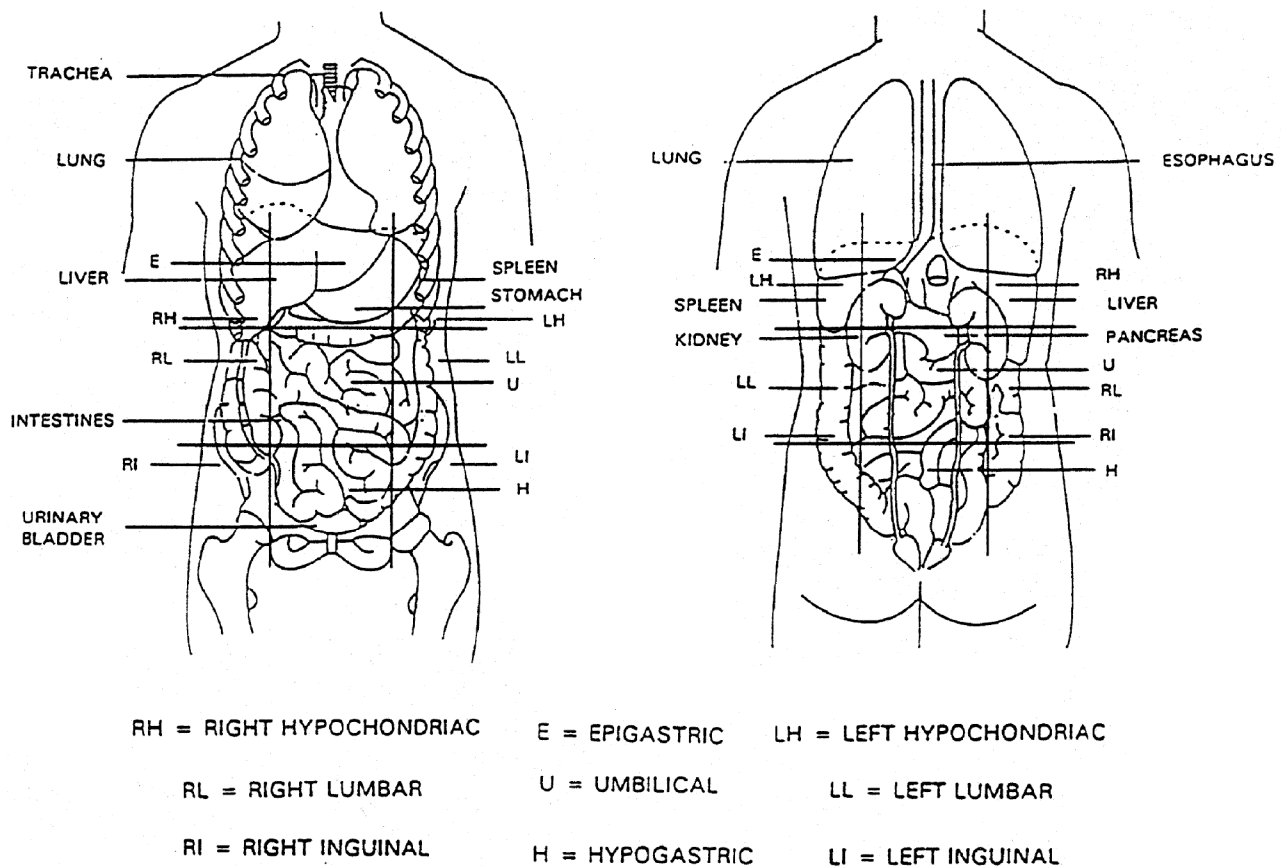


FIGURE 1—THE CLASSICAL SEPARATION OF THE ABDOMEN

In terms of impact response, it is noteworthy that the majority of the organs within the abdomen are, unlike the thorax, not surrounded by bony structures. However, the organs of the top row are partially surrounded by the lower rib cage which can affect the response of this region. Also, the bottom row is partially flanked by the pelvis, hence the lateral abdominal response for this row is undefined.