

## Instrumented Manikin Data Experiments 1 & 2

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**PURPOSE:** In this report, pressure-time histories from a shock front propagating past an instrumented manikin head are presented for two separate experiments. Data represents physical measurements to support an ongoing collaboration between with the US Army Medical Research and Development Center (MRDC) and the US Army Engineer Research and Development Center (ERDC).

**BACKGROUND:** The instrumented manikin head was created from a full-scale finite element (FE) model supplied by MRDC as a computer-aided design (CAD) model (Subramaniam et al. 2021). MRDC stated the CAD model was a representation of a 3D anatomically correct US male head in the 50th percentile of size. The solid layered model was developed for FE analysis research ongoing with MRDC. Extracting the outer surface layer of the MRDC model, a 3D printed model was created to match the FE surface elements. The surface was extruded inward to the appropriate thickness (approximately 0.5 in.) to support placement of surface flush-mounted pressure sensors (Figure 1).<sup>1</sup>

Presented below are results from Experiments 1 and 2,<sup>2</sup> which used five pressure piezoresistive sensors, model HKS-LP-375-25SG manufactured by Kulite Semiconductors, Inc., to measure the propagation of the shock front around the head. Positions, description, and corresponding labels are found in Table 1. The sensors are labeled as follows: top of head (TH), right of head (RH), left of head (LH), front of head (FH) and back of head (BH). Data records are presented as unfiltered records, measured at 1 M-Sample/sec, using an Echelon manufactured by Hi-Techniques, Inc., with high-speed modules. The time of arrival (TOA) of the blast wave is relative to the same time zero. The overall time scale was shifted by an equal amount to a baseline near-zero time. This series of experiments recorded the pressure on the “rigid” surface of the manikin head, attached to a surrogate torso. The surrogate human torso was a modified 165 lb Rescue Randy Combat Challenge Manikin manufactured by GT Simulators (Figure 2). No global movement was observed on either the head or the torso during the passing of the shock wave.

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1. For a full list of the spelled-out forms of the units of measure used in this document and their conversions, please refer to *US Government Publishing Office Style Manual*, 31st ed. (Washington, DC: US Government Publishing Office, 2016), 248–52 and 345–47, <https://www.govinfo.gov/content/pkg/GPO-STYLEMANUAL-2016/pdf/GPO-STYLEMANUAL-2016.pdf>.

2. Fulk et al., 2021. *Personnel Bunker Assessment for Protection: Quick Look Report*. Pending SP# (GEPRS 4988). Vicksburg, MS: Engineer Research and Development Center.



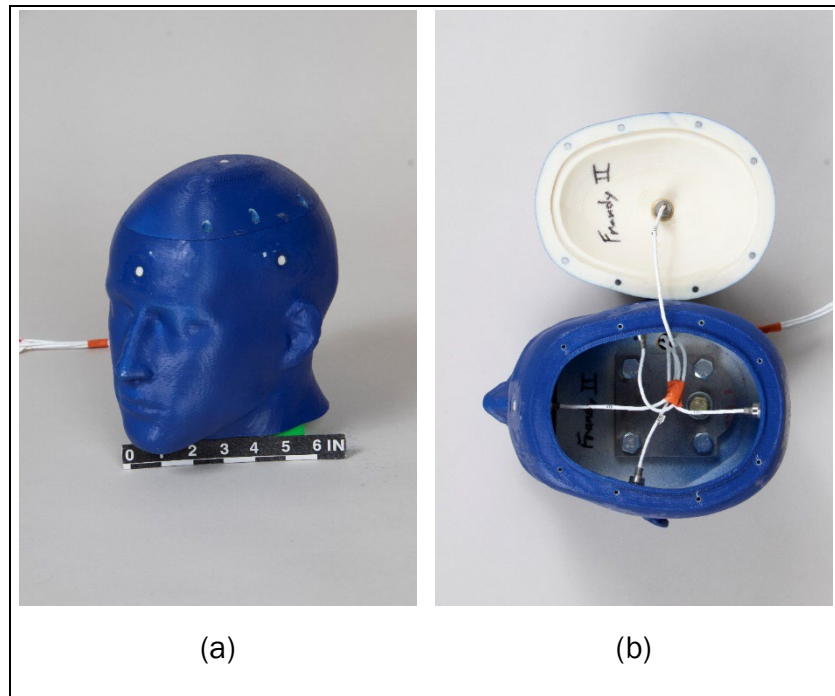


Figure 1. Instrumented manikin: (a) profile of installed sensors and (b) interior of the head.



Figure 2. Instrumented manikin:  
example of torso and head  
combination.

**EXPERIMENTAL RESULTS:** Figures 3 and 5 present pressure and impulse for the entire event for Experiments 1 and 2, respectively. Figures 4 and 6 are zoomed in on the positive phase of the pressure-time history with the impulse removed. The offset of the TOAs shows the directionality of the shock front as it wraps the manikin head. Peak pressures and impulses are presented in with additional sensor location information in Figure 7. Peaks in Table 1 were determined by a scan on the unfiltered data.

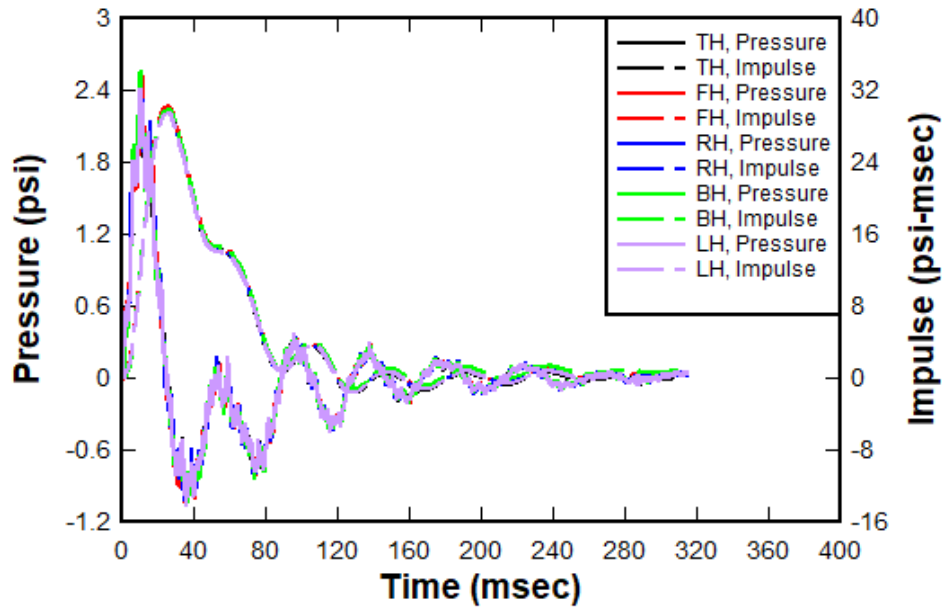


Figure 3. Experiment 1—instrumented manikin head.

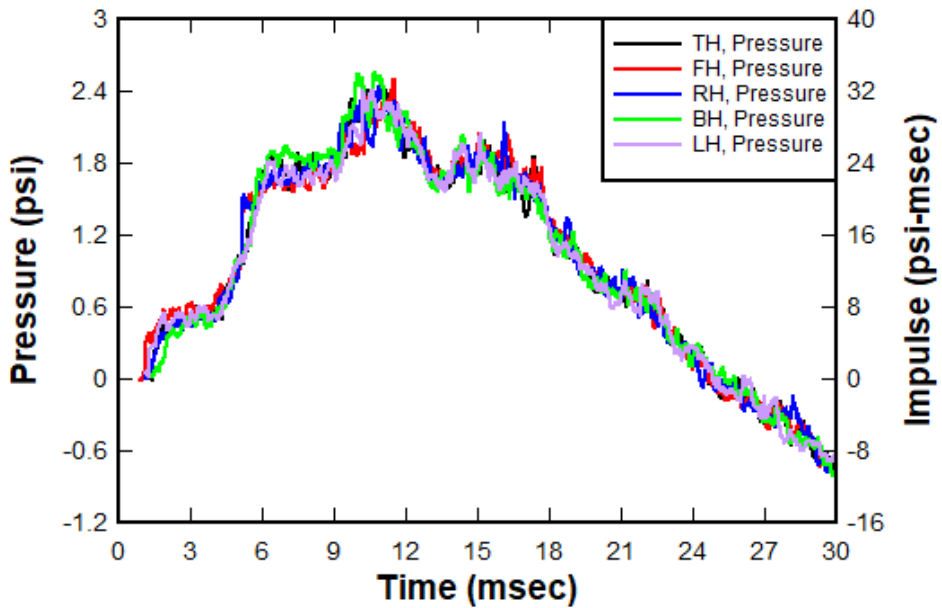


Figure 4. Experiment 1 (zoomed 0–30 msec)—instrumented manikin head.

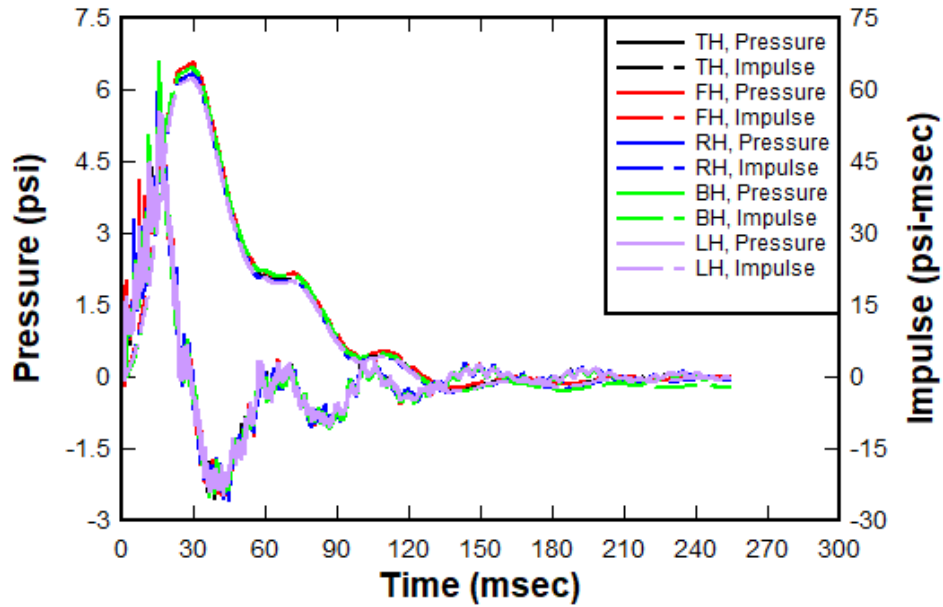


Figure 5. Experiment 2—instrumented manikin head.

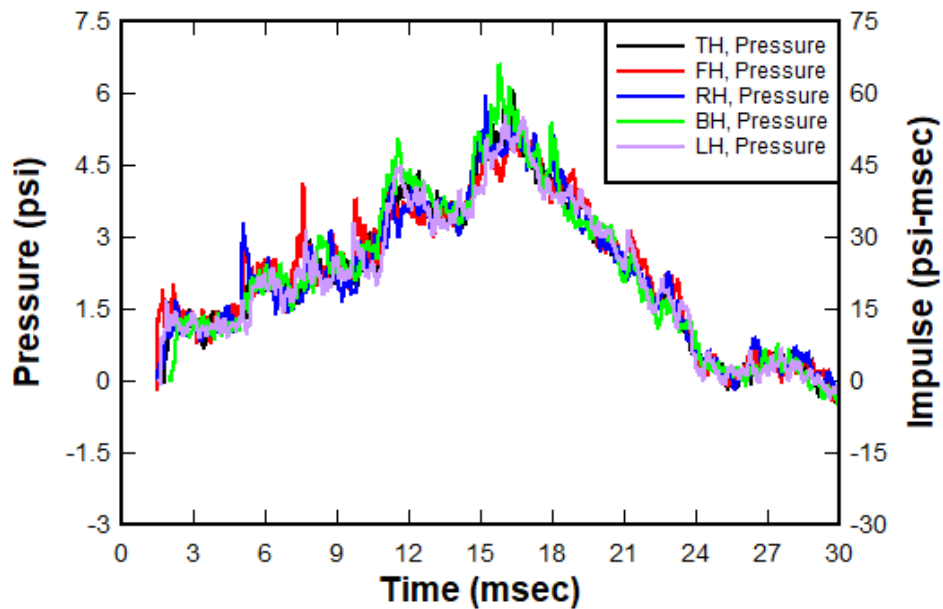


Figure 6. Experiment 2 (zoomed 0–30 msec)—instrumented manikin head.

| <b>Table 1. Summary of peak results.</b> |                       |                    |                            |                                |
|--|-----------------------|--------------------|----------------------------|--------------------------------|
| <b>Sensor Name</b>                       | <b>Experiment No.</b> | <b>Description</b> | <b>Peak Pressure (psi)</b> | <b>Peak Impulse (psi-msec)</b> |
| TH                                       | Exp. 1                | top of head        | 2.44                       | 29.7                           |
| FH                                       | Exp. 1                | front of head      | 2.51                       | 30.2                           |
| RH                                       | Exp. 1                | right of head      | 2.45                       | 29.8                           |

(cont.).

|    |        |               |      |      |
|----|--------|---------------|------|------|
| BH | Exp. 1 | back of head  | 2.56 | 29.9 |
| LH | Exp. 1 | left of head  | 2.42 | 29.5 |
| TH | Exp. 2 | top of head   | 6.08 | 63.4 |
| FH | Exp. 2 | front of head | 5.32 | 65.6 |
| RH | Exp. 2 | right of head | 5.97 | 63.5 |
| BH | Exp. 2 | back of head  | 6.62 | 64.5 |
| LH | Exp. 2 | left of head  | 5.55 | 62.3 |

<sup>a</sup> Orientation is from the prospective of being the manikin.

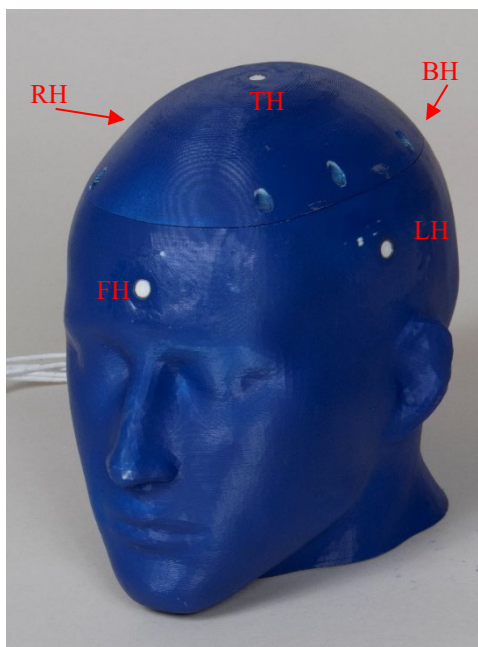


Figure 7. Sensor locations.

**ADDITIONAL INFORMATION:** Data represents physical measurements to support an ongoing collaboration between MRDC and ERDC. This ERDC/GSL TN-23-3 should be cited as follows:

Hoemann, J., J. Fulk, and J. Sherburn. 2023. *Instrumented Manikin Data Experiments 1 & 2*. ERDC/GSL TN-23-3. Vicksburg, MS: US Army Engineer Research and Development Center. <http://dx.doi.org/10.21079/11681/48026>.

## REFERENCES

Subramaniam, D. R., G. Unnikrishnan, A. Sundaramurthy, J. E. Rubio, V. B. Kote, and J. Reifman. 2021. "The Importance of Modeling the Human Cerebral Vasculature in Blunt Trauma." *BioMedical Engineering Online* 20 (11): 1–19. <https://doi.org/10.1186/s12938-021-00847-x>.

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