Humanetics Innovative Solutions, Inc.
23300 Haggerty Road
Farmington Hills, Michigan
48335 USA
Tel: +1 248 778 2000
Fax: +1 248 778 2001
www.humaneticsatd.com

August 3, 2020

James Clayton Owens, Acting Administrator
National Highway Traffic Safety Administration
Docket Management Facility, M-30
U.S. Department of Transportation
1200 New Jersey Avenue S.E.
West Building Ground Floor, Room W12-140
Washington, DC 20590-0001

Subject: NHTSA NPRM HIII 5F Request for Comments
Docket No. NHTSA-2019-0023

Humanetics Innovative Solutions appreciates the opportunity to provide the following supplemental information regarding on NHTSA's Notice of Proposed Rulemaking (NPRM) announced December 26, 2019 to update the Hybrid III 5th Female ATD chest jacket specifications.

Humanetics is the leading global designer, manufacturer and supplier of crash test dummies, calibration equipment, crash sensors, and crash simulation software models and has been dedicated to the advancement of occupant safety testing to create safer vehicles for over 65 years. Humanetics serves every major OEM and Tier I safety supplier worldwide with over 850 employees across 24 facilities strategically located around the globe with the corporate headquarters situated in Farmington Hills, Michigan, USA.

We are proud that we are an industry partner that relentlessly brings advanced technologies to market, raising the bar on vehicle safety standards and ultimately saving lives.

The supplemental information herein is complimentary to the comments provided by Humanetics to the original NPRM closing February 20, 2020 (italicized) on the Hybrid III 5th Female ATD and address item 3 of that response.

Hybrid III 5th Percentile Female ATD (HIII-5F) Item 3 comments provided 2/20/2020:

3. *NPRM Page 14: Our proposed additional specifications for the jacket's contour adds breadth, depth, and circumference dimensions at different section levels of the jacket on the main assembly drawing of the dummy (880105-000, Rev. J, Sheet 5).*

   Humanetics cannot support the enhanced physical dimensional check of the jacket as proposed at this time. Humanetics welcomes the efforts of NHTSA to further define the jacket geometry to ensure no barriers are in place for new suppliers. However, we need to fully investigate if this is a practical dimensional check that can realistically be met using the procedural updates provided, both on and off the ATD.

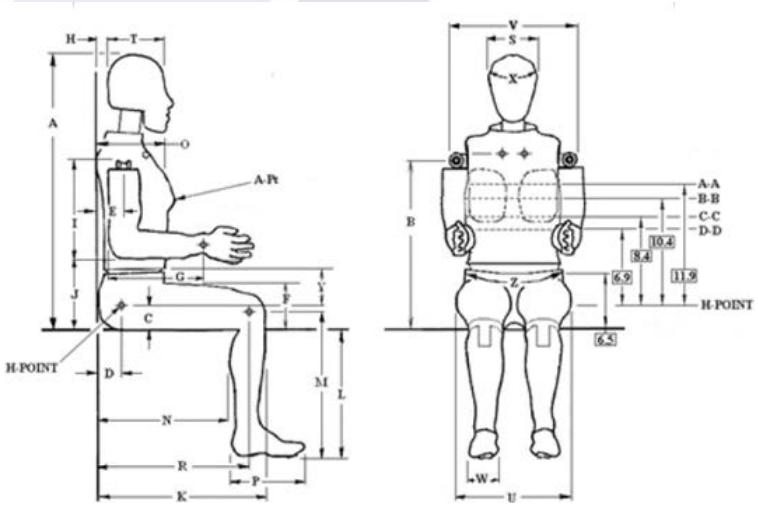
   We have concerns regarding lab to lab R&R when measuring the completely assembled ATD on the bench as proposed. The use of the mandrel can serve as a precision tool to constrain the torso and provide a more repeatable setup. With the torso portion of the dummy constrained, users are then able to focus on the jacket and gather measurements with a higher level of certainty than if measuring the jacket while on the ATD, especially when using a CMM.

   We welcome the opportunity to provide data comparing measurements taken as prescribed in the NPRM and with the chest jacket mounted on a mandrel. We request a ninety-day extension to the NPRM comment period to collect data regarding the additional specifications while also ensuring a sufficient sample size.

   As the manufacturer, we will measure a population of new jackets for this data set. We suggest a collaborative effort be taken to ensure that older SAE J2921 compliant jackets in the field meet the specification and are measured as well.

Continuation of comments providing data as of 8/3/2020:
(Note: All data, keys and templates for the measurements are in the attachments)

External Dimensions on-dummy as prescribed in the NPRM:



The external dimension measurements were structured as a standard gage study using 10 chest jackets spanning a range of different dates of manufacture and 3 technicians. Each technician measured all 10 jackets on the same ATD before passing the task on to the next. Two replicates were conducted for a total of 60 tests. Study variation of four standard deviations is being used to determine goodness. The measurements were conducted over a 10-day period. (Note: Updated procedure provided by NHTSA was provided after we conducted the study)

The first jacket measured on-dummy, took approximately 1.5 hours to complete. It was quickly found that one person could not perform the measurements alone due to the inability to hold the multiple tools required to capture each data point. To speed up the process, each technician utilized the help from an engineering intern and a second technician recorded the measurements as they were read aloud. We added two sets of lasers to help define critical features. A vertical line laser was used to illuminate the vertical plane passing through the midline of the dummy. A second vertical laser was positioned at the target vertical planes left and right of the dummy midline. This was a useful reference for capturing the circumference, along with making a cross section to help the A-Pt section of measurements. The average left and right H-point height from the seating surface was added to the vertical reference targets for each of the section views.

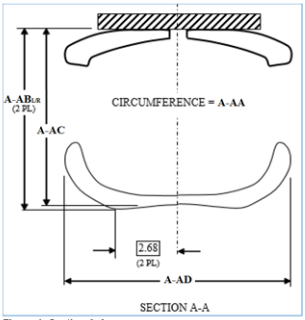


Figure 1. Section A-A

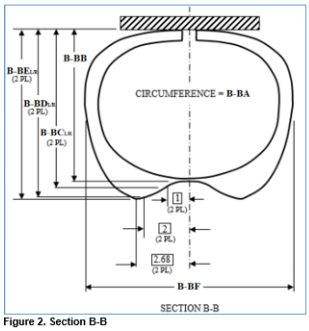


Figure 2. Section B-B

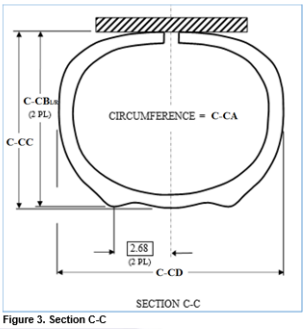


Figure 3. Section C-C

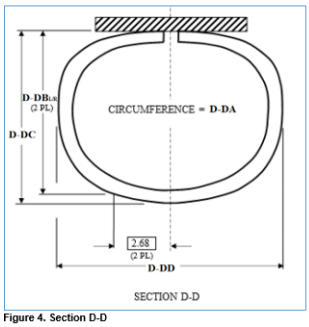


Figure 4. Section D-D

The subsequent tables compare the average measurements of each jacket to the NPRM targets and show partial Gage R&R results as the % of Tolerance. The complete set of data for the Gage R&R analysis is in the attachments.

The Gage R&R for each section shows concerns with the measurement system having Total Gage R&R values ranging between 33% and 201%. Typically, the Total Gage R&R should be equal to or less than 30% of the study variation or %Tolerance depending on which is more significant.

Table 1. Jacket Frontal Measurements Gage Study Summary

Measurement	Tolerance	% Tolerance (SV/Tolerance)					
		Total Gage R&R	Repeatability	Reproducibility	Operators	Part To Part	Total Variation
Y	0.6	83.24	83.24	0.00	0.00	70.15	108.86
A-Pt (Lt-X)	0.8	66.70	61.56	25.68	25.68	10.96	67.60
A-Pt (Lt-Y)	0.8	80.37	62.10	51.02	51.02	0.00	80.37
A-Pt (Lt-Z)	0.8	109.09	106.26	24.72	24.72	31.92	113.67
A-Pt (Rt-X)	0.8	68.88	56.04	40.04	40.04	19.65	71.62
A-Pt (Rt-Y)	0.8	59.64	51.49	30.10	30.10	21.31	63.34
A-Pt (Rt-Z)	0.8	83.49	80.86	20.80	20.80	34.11	90.19

Table 2. Jacket Section A-A Measurements Gage Study Summary

Measurement	Tolerance	% Tolerance (SV/Tolerance)					
		Total Gage R&R	Repeatability	Reproducibility	Operators	Part To Part	Total Variation
A-AA	0.6	186.99	129.30	135.08	135.08	62.24	197.08
A-AC	0.6	132.80	132.54	8.34	8.34	0.00	132.80
A-ABR	0.6	109.28	102.91	36.76	36.76	0.00	109.28
A-ABL	0.6	165.88	148.87	73.18	73.18	0.00	165.88
A-AD	0.6	58.96	55.55	19.76	19.76	22.23	63.02

Table 3. Jacket Section B-B Measurements Gage Study Summary

Measurement	Tolerance	% Tolerance (SV/Tolerance)					
		Total Gage R&R	Repeatability	Reproducibility	Operators	Part To Part	Total Variation
B-BA	0.6	61.35	48.06	38.13	38.13	92.22	110.76
B-BB	0.6	113.74	109.73	29.95	29.95	0.00	113.74
B-BER	0.6	93.39	89.72	25.93	25.93	0.00	93.39
B-BDR	0.6	96.08	94.19	18.96	18.96	0.00	96.08
B-BCR	0.6	124.07	119.03	34.99	34.99	0.00	124.07
B-BCL	0.6	148.35	130.33	70.86	70.86	33.96	152.19
B-BDL	0.6	170.72	146.95	86.89	86.89	0.00	170.72
B-BEL	0.6	181.50	149.99	102.19	102.19	0.00	181.50
B-BF	0.6	55.30	54.37	10.12	10.12	30.95	63.37

Table 4. Jacket Section C-C Measurements Gage Study Summary

Measurement	Tolerance	% Tolerance (SV/Tolerance)					
		Total Gage R&R	Repeatability	Reproducibility	Operators	Part To Part	Total Variation
C-CA	0.6	163.60	125.91	104.47	104.47	134.80	211.98
C-CC	0.6	184.98	180.92	38.55	38.55	0.00	184.98
C-CBR	0.6	157.67	141.52	69.51	69.51	0.00	157.67
C-CBL	0.6	201.88	184.58	81.76	81.76	0.00	201.88
C-CD	0.6	33.63	31.97	10.44	10.44	39.42	51.81

Table 5. Jacket Section D-D Measurements Gage Study Summary

Measurement	Tolerance	% Tolerance (SV/Tolerance)					
		Total Gage R&R	Repeatability	Reproducibility	Operators	Part To Part	Total Variation
D-DA	0.6	49.29	46.31	16.88	16.88	123.90	133.34
D-DC	0.6	145.48	137.22	48.32	48.32	0.00	145.48
D-DBR	0.6	152.54	142.75	53.77	53.77	0.00	152.54
D-DBL	0.6	181.20	167.44	69.29	69.29	0.00	181.20
D-DD	0.6	56.42	56.42	0.00	0.00	33.61	65.67

Repeatability was shown to be a significant source of variability. The range of repeatability values fluctuated between 31.97 to as high as 184.58 percent of tolerance. These high repeatability values indicate there is variability in measurements when the same part is measured multiple times by the same operator, even on a single dummy. If multiple dummies were used to measure the jackets, this variability would be expected to increase even further.

Beyond repeatability, there were also a large amount of technician to technician differences as indicated by the reproducibility numbers ranging as high as 135% of tolerance. This shows that different technicians, even in the same lab with one set of equipment and common procedures were unable to get the same average measurements.

These high variations for both repeatability and reproducibility (operator to operator) show that either tremendous improvements in procedures and tools are needed, or else a complete replacement of the approach to measure jackets. This leads to the proposal to use a mandrel to check jackets instead of checking them on a dummy.

The technicians indicated tremendous difficulty in acquiring the section view measurements due to lack of suitable instruments. Even trying to use scales, levels, and lasers there were many sources to introduce error into the measurement.

The amount of measurements was also noted as being overwhelming by technicians, with all 10 jackets (assortment of old and new) failing numerous measurements, the yield will be near 0% if the criteria were to remain unchanged.

By improving the measurement system, the reproducibility values may improve. However, the time, personnel requirement and lack of ease may render this unacceptable to maintain in a production environment.

External Measurements on Mandrel:

Unfortunately, we were not able to complete the mandrel cross sectional measurements in time. Due to unforeseen circumstances, relating to resources strained due to COVID-19, we will be providing additional late results for the cross-sectional values on the mandrel within the next thirty-sixty days.

Jacket Only Measurements:

The Jacket measurement study was not conducted as a blind study due to technician availability. The study was conducted with one quality technician and included (5) jackets to measure. The technician was instructed to form the jacket to the reference dimension as shown on drawings from the NPRM documents and determine the best method to take measurements. They chose to use blocks to hold the bottom of jacket and packing paper to stuff inside to hold top of jacket geometry and use a FARO to select all target measurements. Figure 6 were supplied drawings indicating the measurements required. A total of 19 measurements were taken from each jacket with many being left and right-side measurements. A jacket measurement template was created to record the data (located in the attachments). The technician repeated each series of jackets a total of 3 times.

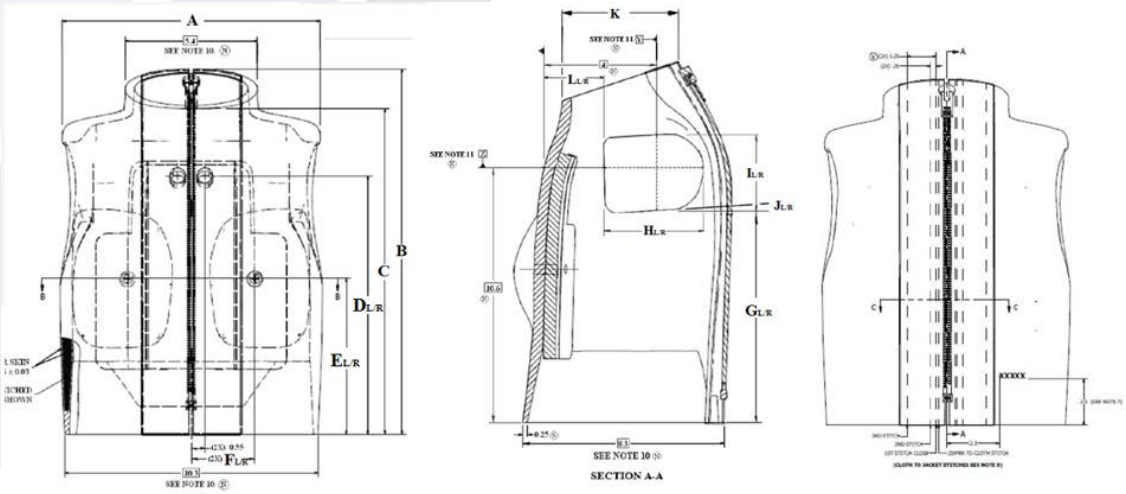


Figure 1. Jacket Measurement - Front View and lateral section view

The technician set the jacket upright and zipped on a measurement table using blocks to hold the bottom width and depth at 10.3 and 8.3 inches respectively. In order to hold the core of the jacket constrained, an insert (in this case packing material) was used to secure the inside of the

jacket against the blocks. The technician was unable to set the neck width measurement of 5.4 inches due to lack of physical constraints available.

When looking at the average of all 3 measurements on each jacket (Table 6), the jacket front view measurements had many average measurements passing the parameter. Measurement "A" (Shoulder Breadth) failed for 4 of the 5 jackets, with the oldest of jackets being the only one passing. However, the lateral section measurements (Table 7) incurred more failures. All jackets failed 4 or more measurements.

Table 6. Average Jacket Measurement Summary

Measurement		A	B	C	D_L	D_R	E_L	E_R	F_L	F_R
Target		10.5	15	13.4	10.63	10.63	6.4	6.4	2.59	2.59
Upper (+1%)		10.61	15.15	13.53	10.74	10.74	6.46	6.46	2.62	2.62
Lower (-4%)		10.08	14.40	12.86	10.20	10.20	6.14	6.14	2.49	2.49
Average	DP6834	10.44	14.82	12.99	10.36	10.35	6.29	6.30	2.52	2.60
	DS3967	10.70	14.85	13.11	10.42	10.42	6.35	6.40	2.51	2.49
	EO8881	10.72	14.99	13.31	10.59	10.59	6.40	6.41	2.57	2.59
	EP0160	10.65	14.95	13.38	10.53	10.54	6.39	6.37	2.51	2.52
	EP0467	10.71	14.88	13.29	10.56	10.55	6.37	6.41	2.60	2.57

Table 7. Average Jacket Lateral Section A-A Summary

Measurement		G_L	G_R	H_L	H_R	I_L	I_R	J_L	J_R	L_L	L_R
Target		8.7	8.7	3.9	3.9	3.2	3.2	4	4	2.3	2.3
Upper (+1%)		8.79	8.79	3.94	3.94	3.23	3.23	4.04	4.04	2.32	2.32
Lower (-4%)		8.35	8.35	3.74	3.74	3.07	3.07	3.84	3.84	2.21	2.21
Average	DP6834	8.64	8.74	3.94	3.94	3.04	3.07	4.47	3.86	2.38	2.23
	DS3967	8.78	8.75	3.87	3.93	3.05	3.04	4.66	3.90	2.33	2.40
	EO8881	8.79	8.80	3.99	4.00	3.12	3.13	3.74	3.52	2.33	2.41
	EP0160	8.80	8.83	4.06	4.05	3.14	3.17	3.51	3.79	2.37	2.33
	EP0467	8.70	8.74	3.99	4.08	3.14	3.14	3.91	3.79	2.31	2.34

The data was also analyzed using Minitab gage R&R analysis. The reproducibility was not applicable due to a single operator performing the measurements. The repeatability values provide a comparison of the measurements to the test corridor. As stated previously, a typical gage study has the percent tolerance of the total variation as less than 30% to be marginally acceptable. All jackets were within tolerance and deemed acceptable prior to this study. The repeatability of the jacket front view measurements (Table 8) had 3 jackets fall within less than 30% of tolerance, with the remaining jackets less than 73% indicating an improvement is needed in the measurement system. The repeatability of the jacket lateral section A-A measurements had much higher repeatability values (Table 9) with all values greater than 66% of tolerance. This indicates the technician had great difficulty in measuring the same jacket artifact multiple times.

Table 8. Jacket Measurement Analysis

Measurement	Tolerance	% Tolerance (SV/Tolerance)				
		Total Gage R&R	Repeatability	Reproducibility	Part To Part	Total Variation
A	0.53	72.71	72.71	N/A	78.10	107.15
B	0.75	21.95	21.95	N/A	35.16	41.45
C	0.67	65.25	65.25	N/A	80.40	88.22
D_L	0.54	13.33	13.33	N/A	72.03	73.26
D_R	0.54	13.58	13.58	N/A	73.54	74.79
E_L	0.32	30.90	30.90	N/A	50.09	58.85
E_R	0.32	62.12	62.12	N/A	40.98	74.42
F_L	0.13	70.78	70.78	N/A	29.94	76.86
F_R	0.13	49.43	49.43	N/A	51.00	71.02

Table 9. Jacket Lateral Section A-A Measurement Analysis

Measurement	Tolerance	% Tolerance (SV/Tolerance)				
		Total Gage R&R	Repeatability	Reproducibility	Part To Part	Total Variation
G_L	0.44	66.22	66.22	N/A	49.52	82.69
G_R	0.44	111.89	111.89	N/A	0.00	111.89
H_L	0.2	90.30	90.30	N/A	135.73	163.02
H_R	0.2	94.15	94.15	N/A	123.05	154.94
I_L	0.16	110.91	110.91	N/A	108.85	155.40
I_R	0.16	113.40	113.40	N/A	114.89	161.42
J_L	0.2	1075.35	1075.35	N/A	756.76	1314.94
J_R	0.2	1010.27	1010.27	N/A	0.00	1010.27
L_L	0.11	250.02	250.02	N/A	0.00	250.02
L_R	0.11	292.37	292.37	N/A	201.94	355.33

The jacket only measurements also had all 5 jackets measurements failing 4 or more measurement. An improvement to the measurement process and/or change in corridors is needed if this update is implemented. At present the pass yield to the jackets is going to be very small approaching near 0%.

On Mandrel – Jacket Only Measurements:

The improved mandrel design provides locating pins at the access holes to assist in orienting the jacket. The removeable arm feature provides added structure for the jacket to rest upon, while doubling to accommodate the arm opening measurements once removed. The mandrel also tapers to the current SAE jacket modifications made subsequent of the original designs from Denton and FTSS, ensuring the appropriate fit. Reference surfaces were implemented to

establish a coordinate system; a compliment to the FARO used to capture measurements. The mandrel keeps the jacket conformed to the design shape as if on an ideal dummy and provides support of the flexible vinyl to allow the best repeatability of measurements possible.

Two of the five jackets were measured using the mandrel due to timing issues. Additional measurements will be taken and submitted in the coming weeks. The technician did note having difficulty performing measurements with the FARO at the arm opening due to the double curvature design of the flesh. More work is needed to help alleviate this concern. Nevertheless, we were able to see a marked improvement in standard deviation and repeatability values while using the mandrel.

Feature Measurement	Tolerance	Off Mandrel % Tolerance (SV/Tolerance)			On Mandrel % Tolerance (SV/Tolerance)		
		Mean	St Dev	Repeatability	Mean	St Dev	Repeatability
A	0.53	10.64	0.10	**72.71**	10.35	0.0356137	**26.88**
B	0.75	14.90	0.04	**21.95**	14.72	0.030687	**16.37**
C	0.67	13.22	0.11	**65.25**	13.13	0.025199	**15.04**
D_L	0.54	10.49	0.02	**13.33**	10.23	0.01533	**11.36**
D_R	0.54	10.49	0.02	**13.58**	10.23	0.022509	**16.67**
E_L	0.32	6.36	0.02	**30.90**	6.31	0.016299	**20.37**
E_R	0.32	6.38	0.05	**62.12**	6.32	0.016633	**20.79**
F_L	0.13	2.54	0.06	**70.78**			
F_R	0.13	2.56	0.04	**49.43**			
G_L	0.44	8.74	0.07	**66.22**	8.77	0.032275	**29.34**
G_R	0.44	8.77	0.12	**111.89**	8.77	0.030441	**27.67**
H_L	0.2	3.97	0.05	**90.30**	4.20	0.0387513	**77.5**
H_R	0.2	4.00	0.05	**94.15**	4.20	0.0439128	**87.83**
I_L	0.16	3.10	0.04	**110.91**	3.03	0.0314378	**78.59**
I_R	0.16	3.11	0.05	**113.40**	3.03	0.0261167	**65.29**
J_L	0.2	4.06	0.54	**1075.35**			
J_R	0.2	3.77	0.51	**1010.27**			
L_L	0.11	2.34	0.07	**250.02**			
L_R	0.11	2.34	0.08	**292.37**			

On vs Off Mandrel Jacket Only Comparison Table – Jacket Only Dimensions

Mandrel coordinate system Repeatability mini study results using a FARO:

Mandrel UCS Repeatability						
	REP PLANE FRONT HOLE			REP PLANE BACK HOLE		
	X VAL	Y VAL	Z VAL	X VAL	Y VAL	Z VAL
	10.3449	4.9716	14.4124	10.335	7.1384	14.4166
	10.3549	4.9699	14.4092	10.3394	7.1389	14.4141
	10.3473	4.9775	14.4086	10.3377	7.1392	14.4155
	10.3481	4.9728	14.4065	10.3376	7.1346	14.4114
	10.3406	4.976	14.4045	10.3362	7.1387	14.4124
	10.3489	4.9714	14.4063	10.3388	7.1421	14.4073
	10.3468	4.9713	14.4035	10.3373	7.136	14.4077
	10.3482	4.9734	14.4015	10.3388	7.135	14.4087
	10.346	4.9721	14.4027	10.3364	7.1368	14.4062
	10.344	4.9757	14.4101	10.3343	7.138	14.4045
Average	10.347	4.97317	14.4065	10.3372	7.13777	14.4104
StDev	0.0037	0.0025	0.0035	0.0017	0.0022	0.0042
%CV	**0.04%**	**0.05%**	**0.02%**	**0.02%**	**0.03%**	**0.03%**

This table illustrates the repeatability of the coordinate system on the mandrel only (no jacket measurements)

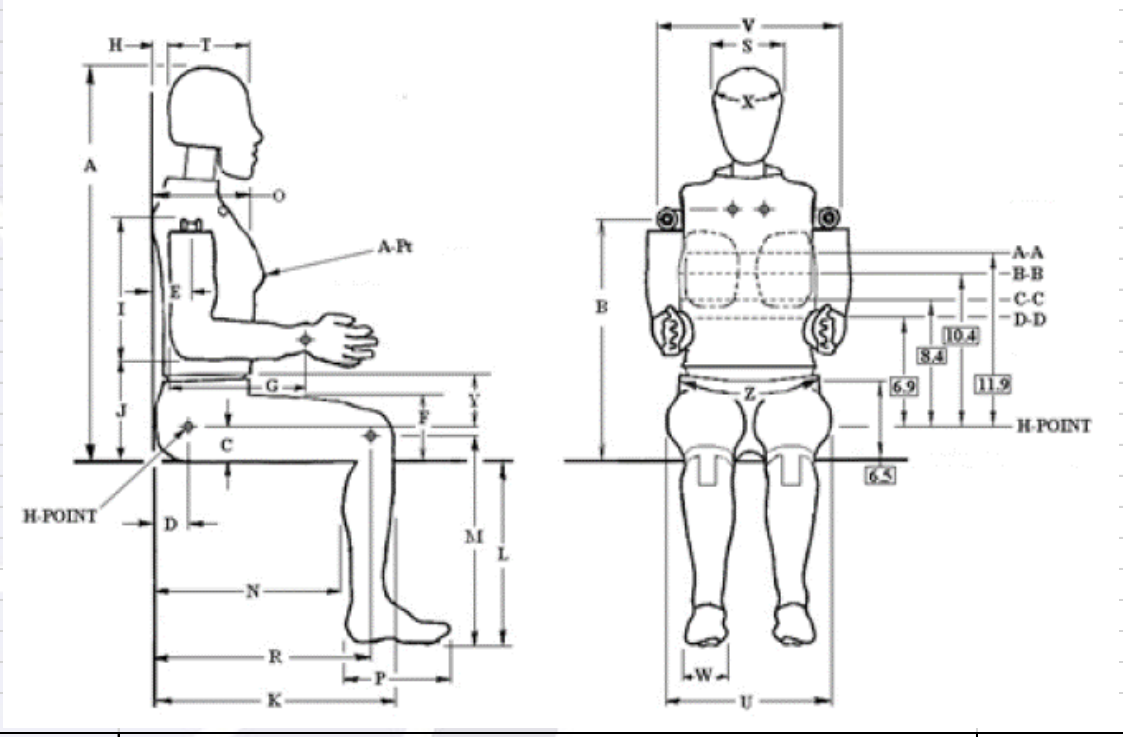
CAD information for the mandrel is available in the attachments. Humanetics is willing to provide NHTSA with a mandrel for evaluation purposes upon request. If there is any additional questions, don't hesitate to contact us. Thank you.

Additional data is forthcoming. We plan to make another response with our additional measurement data within 30-60 days, as soon as we finish measurements of cross sections and more jackets on the mandrel. A more complete repeatability and reproducibility analysis, as well as a more detailed comparison to on dummy R&R will be included.

-END-

Appendices:

Take all external and section view measurements	
Use the Huron Hybrid III 5F lab dummy	
Set H-Point 59mm below center of square hole	
Set H-Point 68mm forward of square hole	
Set dummy to where left and right H-Point Height is 3.3in +/-0.1in above bench top	
Set dummy to where left and right H-Point is 5.8in +/-0.1in from backline	



Symbol	Hybrid III 5F External Dimensions	Measurement (in)
C_R	Hip Pivot Height (Right Side)	
D_R	Hip Pivot From Backline (Right Side)	
C_L	Hip Pivot Height (Left Side)	
D_L	Hip Pivot From Backline (Left Side)	
Y	Height of lower edge of jacket at anterior-most point on dummy midline	
Z	Waist Circumference @ 6.5" above seating surface	
A-Pt (Lt-X)	Left X Distance to the anterior most point on breast from backplate	
A-Pt (Lt-Y)	Left Y Distance to the anterior most point on breast from Dummy midline	
A-Pt (Lt-Z)	Left Z Distance to the anterior most point on breast from the average H-Point	
A-Pt (Rt-X)	Right X Distance to the anterior most point on breast from backplate	
A-Pt (Rt-Y)	Right Y Distance to the anterior most point on breast from Dummy midline	
A-Pt (Rt-Z)	Right Z Distance to the anterior most point on breast from the average H-Point	
Section A-A Meaurements @ 11.9" above average H-Point Location		
A-AA	Section A-A Circumference	
$A\text{-}AB_L$	Chest Depth @ 2.68" (Left Side of Dummy Midline)	
$A\text{-}AB_R$	Chest Depth @ 2.68" (Right Side of Dummy Midline)	
A-AC	Chest Depth Mid Line of Dummy	
A-AD	Section A-A Chest Breadth	

Section B-B Meaurements @10.4" above average H-Point Location		
B-BA	Section B-B Circumference	
B-BB	Chest Depth Mid Line of Dummy	
B-BC_L	Chest Depth @ 1" (Left Side of Dummy Midline)	
B-BC_R	Chest Depth @ 1" (Right Side of Dummy Midline)	
B-BD_L	Chest Depth @ 2" (Left Side of Dummy Midline)	
B-BD_R	Chest Depth @ 2" (Right Side of Dummy Midline)	
B-BE_L	Chest Depth @ 2.68" (Left Side of Dummy Midline)	
B-BE_R	Chest Depth @ 2.68" (Right Side of Dummy Midline)	
B-BF	Section B-B Chest Breadth	
Section C-C Measurements @ 8.4" above average H-Point Location		
C-CA	Section C-C Circumference	
C-CB_L	Chest Depth @ 2.68" (Left Side of Dummy Midline)	
C-CB_R	Chest Depth @ 2.68" (Right Side of Dummy Midline)	
C-CC	Chest Depth Mid Line of Dummy	
C-CD	Section C-C Chest Breadth	
Section D-D Measurements @ 6.9" above average H-Point Location		
D-DA	Section D-D Circumference	
D-DB_L	Chest Depth @ 2.68" (Left Side of Dummy Midline)	
D-DB_R	Chest Depth @ 2.68" (Right Side of Dummy Midline)	
D-DC	Chest Depth Mid Line of Dummy	
D-DD	Section D-D Chest Breadth	

Table 1. External dimension data collection template

Symbol	Hybrid III 5F External Dimensions	Measurement (in)
Y	Height of lower edge of jacket at anterior-most point on dummy midline	
A-Pt (Lt-X)	Left X Distance to the anterior most point on breast from backplate	
A-Pt (Lt-Y)	Left Y Distance to the anterior most point on breast from Dummy midline	
A-Pt (Lt-Z)	Left Z Distance to the anterior most point on breast from the average H-Point	
A-Pt (Rt-X)	Right X Distance to the anterior most point on breast from backplate	
A-Pt (Rt-Y)	Right Y Distance to the anterior most point on breast from Dummy midline	
A-Pt (Rt-Z)	Right Z Distance to the anterior most point on breast from the average H-Point	
A-AA	Section A-A Circumference	
A-AC	Chest Depth Mid Line of Dummy	
$A\text{-}AB_R$	Chest Depth @ 2.68" (Right Side of Dummy Midline)	
$A\text{-}AB_L$	Chest Depth @ 2.68" (Left Side of Dummy Midline)	
A-AD	Section A-A Chest Breadth	
B-BA	Section B-B Circumference	
B-BB	Chest Depth Mid Line of Dummy	
$B\text{-}BE_R$	Chest Depth @ 2.68" (Right Side of Dummy Midline)	
$B\text{-}BD_R$	Chest Depth @ 2" (Right Side of Dummy Midline)	
$B\text{-}BC_R$	Chest Depth @ 1" (Right Side of Dummy Midline)	
$B\text{-}BC_L$	Chest Depth @ 1" (Left Side of Dummy Midline)	
$B\text{-}BD_L$	Chest Depth @ 2" (Left Side of Dummy Midline)	
$B\text{-}BE_L$	Chest Depth @ 2.68" (Left Side of Dummy Midline)	
B-BF	Section B-B Chest Breadth	
C-CA	Section C-C Circumference	
C-CC	Chest Depth Mid Line of Dummy	
$C\text{-}CB_R$	Chest Depth @ 2.68" (Right Side of Dummy Midline)	
$C\text{-}CB_L$	Chest Depth @ 2.68" (Left Side of Dummy Midline)	
C-CD	Section C-C Chest Breadth	
D-DA	Section D-D Circumference	
D-DC	Chest Depth Mid Line of Dummy	
$D\text{-}DB_R$	Chest Depth @ 2.68" (Right Side of Dummy Midline)	
$D\text{-}DB_L$	Chest Depth @ 2.68" (Left Side of Dummy Midline)	
D-DD	Section D-D Chest Breadth	

Symbol	Hybrid III 5F Jacket Dimensions	Measurement (in)
A	Shoulder breadth	
B	Jacket height at the highest most posterior point	
C	Jacket height at the highest most anterior point	
D_L	Height of left vinyl hole	
D_R	Height of right vinyl hole	
E_L	Height of jacket left "+" symbol	
E_R	Height of jacket right "+" symbol	
F_L	Distance of jacket left "+" symbol from midline	
F_R	Distance of jacket right "+" symbol from midline	
	Lateral Section A-A	
G_L	Bottom arm left hole height @ "Y" datum	
G_R	Bottom arm right hole height @ "Y" datum	
H_L	Width of left arm opening	
H_R	Width of right arm opening	
I_L	Height of left arm opening @"Y" datum	
I_R	Height of right arm opening @"Y" datum	
J_L	Left arm opening angle	
J_R	Right arm opening angle	
L_L	Distance from anterior surface of jacket to anterior surface of left arm hole @ 10.6" above base	
L_R	Distance from anterior surface of jacket to anterior surface of right arm hole @ 10.6" above base	

Figure 2. Jacket only data entry template.