

Improving Test Repeatability and Methods

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Federal Aviation
Administration



Improved Test Methods

- **Whether evaluating design iterations or comparing sled test results to simulation results, accurate and precise sled test data are required**
- **Several factors that effect sled results have been examined with an eye towards improving the quality of sled test data**

Talk Overview

- **Part 1: ATD Seating Methodology for Increased Test Repeatability**
- **Part 2: Improved Knee Target**
- **Part 3: Marking the H-pt on an ATD**



Need for Improved Seating Method

- **Perceived lack of repeatability in download tests of Hybrid II**
- **SAE AS 8049b method [5.3.8.3]**
- **Current seating procedure does not adequately control fore/aft position or angle of the ATD pelvis since the amount of rearward force applied to the ATD is not specified**

Need for Improved Seating Method

- **Lack of specificity leads to inconsistent initial fore/aft pelvis position which can affect test results.**
 - Forward Tests: Head Path affected since head arc directly related to pelvis initial X position
 - Vertical Tests: Lumbar load may be affected if cushion or seat pan stiffness varies along X axis
- **The affect of initial pelvis angle on lumbar load is being studied**
 - Initial angle can affect the amount of compressible foam under the contact area of the pelvis
 - Initial angle can affect the difference between the resultant force and the Z component measured

Proposed 1-G Seating Method

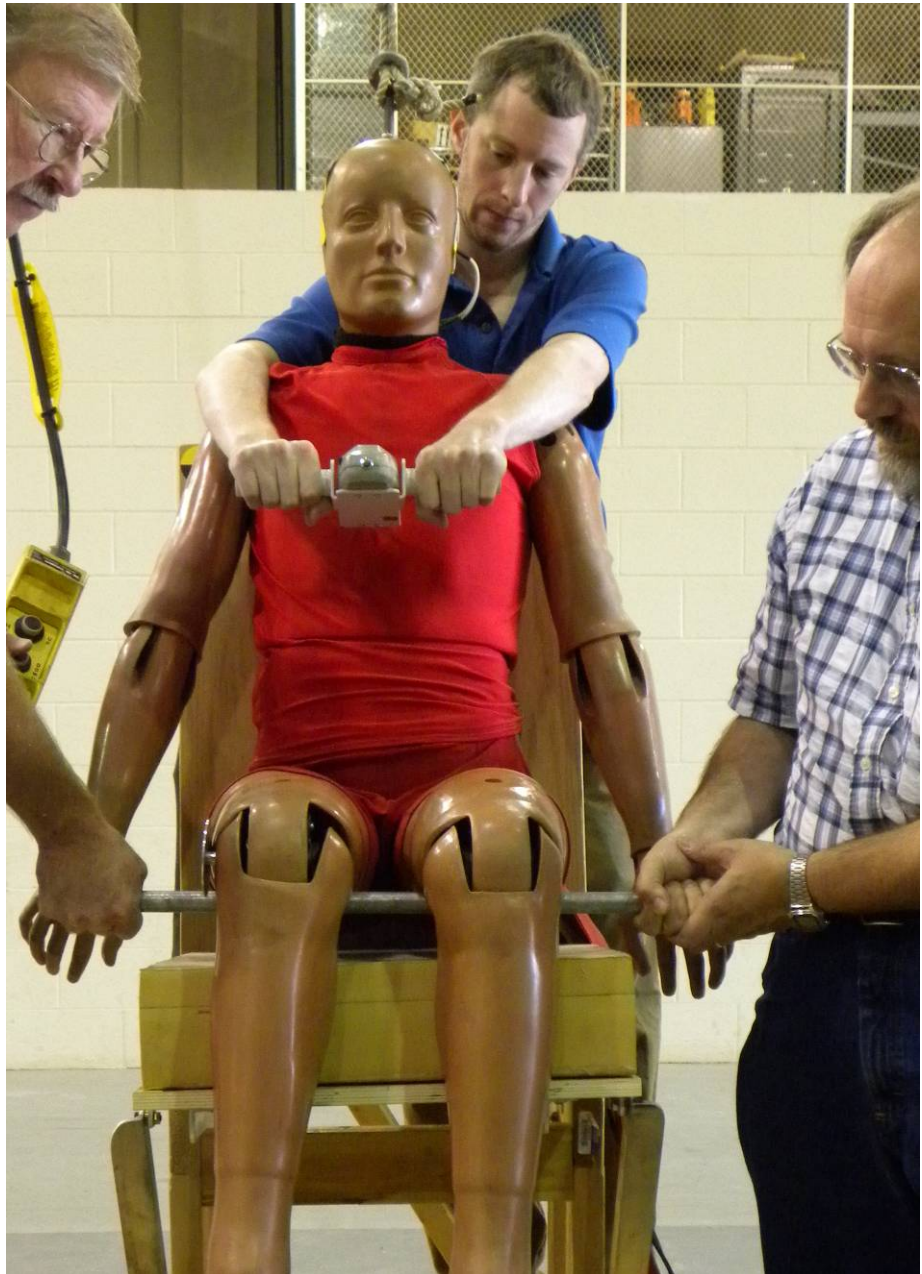
- Adjust friction in ATD joints
- Position dummy above seat
- Lower dummy while applying 20 lb. of pressure to sternum while holding knees up
- Rock dummy side to side to settle the pelvis in the seat
- Position arms and feet
- Measure position and angle of pelvis, position of head, knee and ankle, and torso angle*

*Torso angle estimated from H-pt and Head CG positions

Position the dummy ½" to 1" above the bottom cushion with the aft surface of the dummy just in contact with the seat back



**Support the legs of the
ATD with a rod placed
under the legs just
behind the knees to
keep the legs from
contacting the cushion
while...**



**applying 20 lbs of force
to the lower sternum as
the dummy is lowered
into the seat**



Measure known points on the pelvis that can be related to the H-Point and its absolute angle



New Method: Repeatability (3 seatings)

Cushion: Green DAX (t=4")

	Range	
Target	X (in)	Z (in)
H-pt	0.15	0.05
Head CG	0.31	0.22
Knee	0.17	0.16
Ankle	0.37	0.10
Pelvis Angle	0.99°	

Cushion: Airflex 40-50 (t=2")

	Range	
Target	X (in)	Z (in)
H-pt	0.28	0.02
Head CG	0.32	0.21
Knee	0.30	0.12
Ankle	0.13	0.07
Pelvis Angle	1.32°	

60° Seating Technique

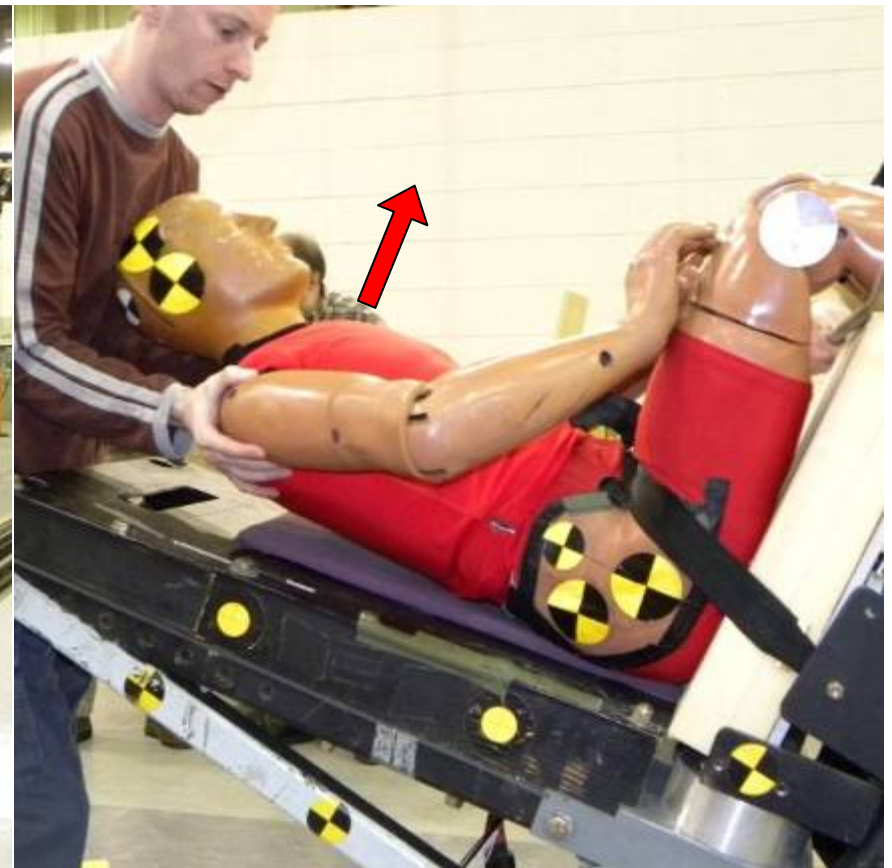
- **ATD initial position can affect 60° pitch test results**
- **A series of tests were conducted with initial position carefully controlled**
- **Consistent ATD position yielded fairly consistent test results**



60° Seating Technique (Iterative)

- **Position back shims as necessary**
- **Lower dummy into the seat**
- **Attach lap belt and tighten while pushing down on the shoulders to match H-point goal (x,y,z)**
- **Position feet and knees**
- **Adjust pelvic angle as necessary**
- **Verify torso angle and ankle position**
- **Position arms**
- **Document final position**

Adjust the pelvic angle by either lifting the head or lifting the knees until correct.



Input Repeatability

			Range of Values		
Cushion	Thickness (in)	# of Tests	Pelvis X (in)	Pelvis Z (in)	Pelvis Angle
DAX 90	4.6	2	0.22	0.14	0.19°
DAX 47	4.5	3	0.1	0.1	0.3°
DAX 47 w/ leather cover	4.5	3	0.2	0.1	0.3°
Airflex 40-50	4.5	3	0.01	0.04	1.36°
Airflex 40-50	3.5	4	0.09	0.25	1.41°
Airflex 40-50	2.0	3	0.07	0.06	1.08°

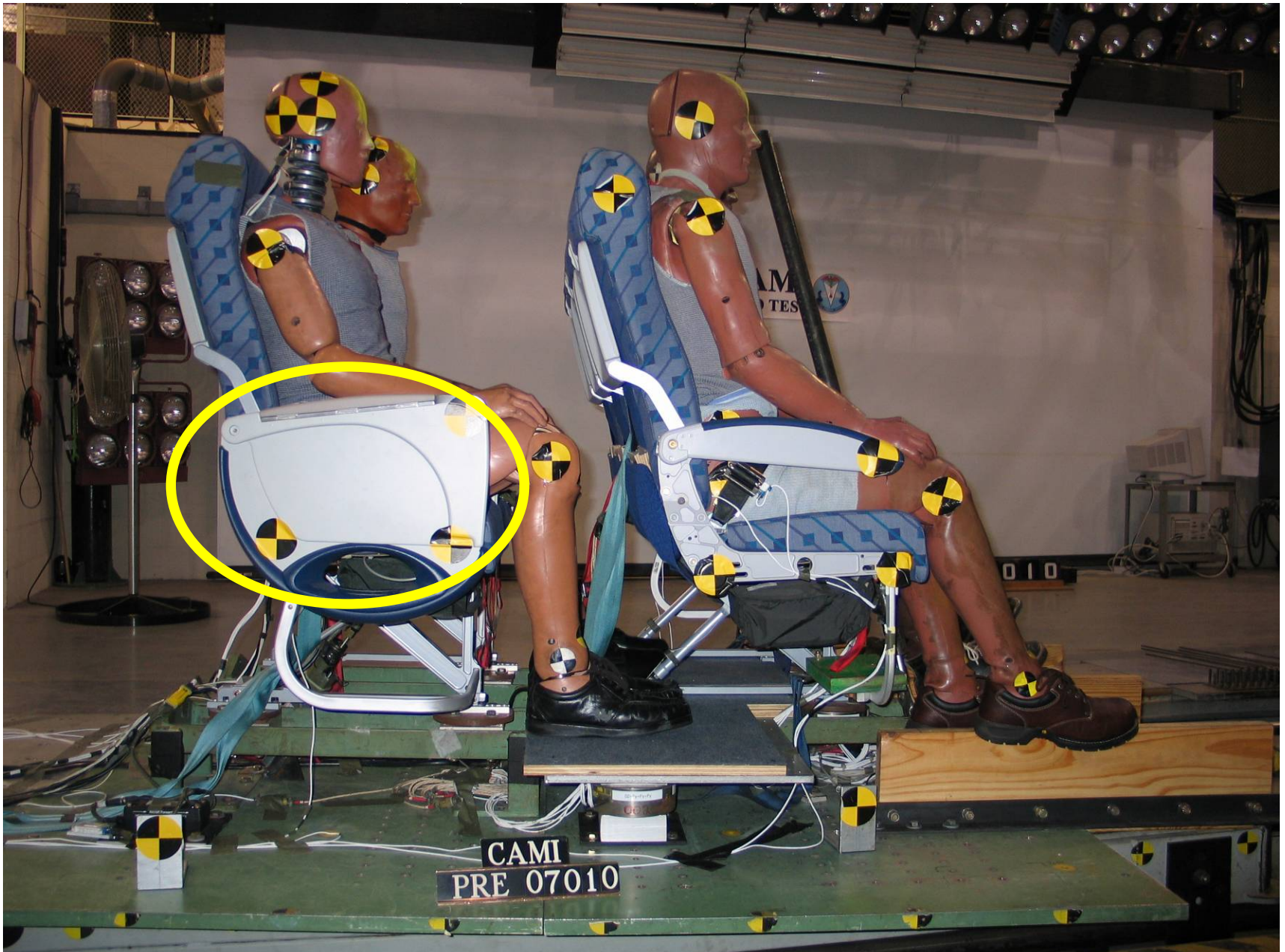
Output Repeatability – Lumbar Load

Cushion	Thickness (in)	# of Tests	Low (lbs)	High (lbs)	Range (lbs)
DAX 90	4.6	2	981	1042	61
DAX 47	4.5	3	1333	1363	30
DAX 47 w/ leather cover	4.5	3	1178	1237	59
Airflex 40-50	4.5	3	1796	1996	200
Airflex 40-50	3.5	4	1604	1936	332
Airflex 40-50	2.0	3	1385	1493	108

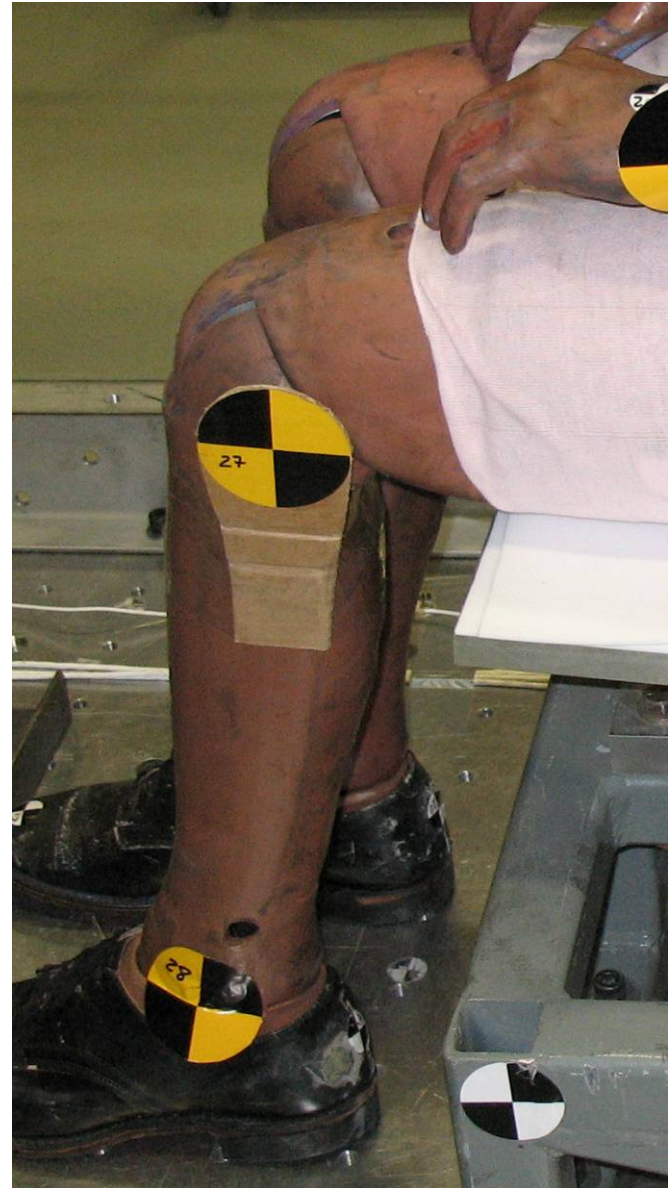
Lumbar Loads Normalized to 14 g

Part 2: Improved Knee Target

Obscured Pelvic Targets



Evolution of Knee Targets



Images courtesy of NIAR

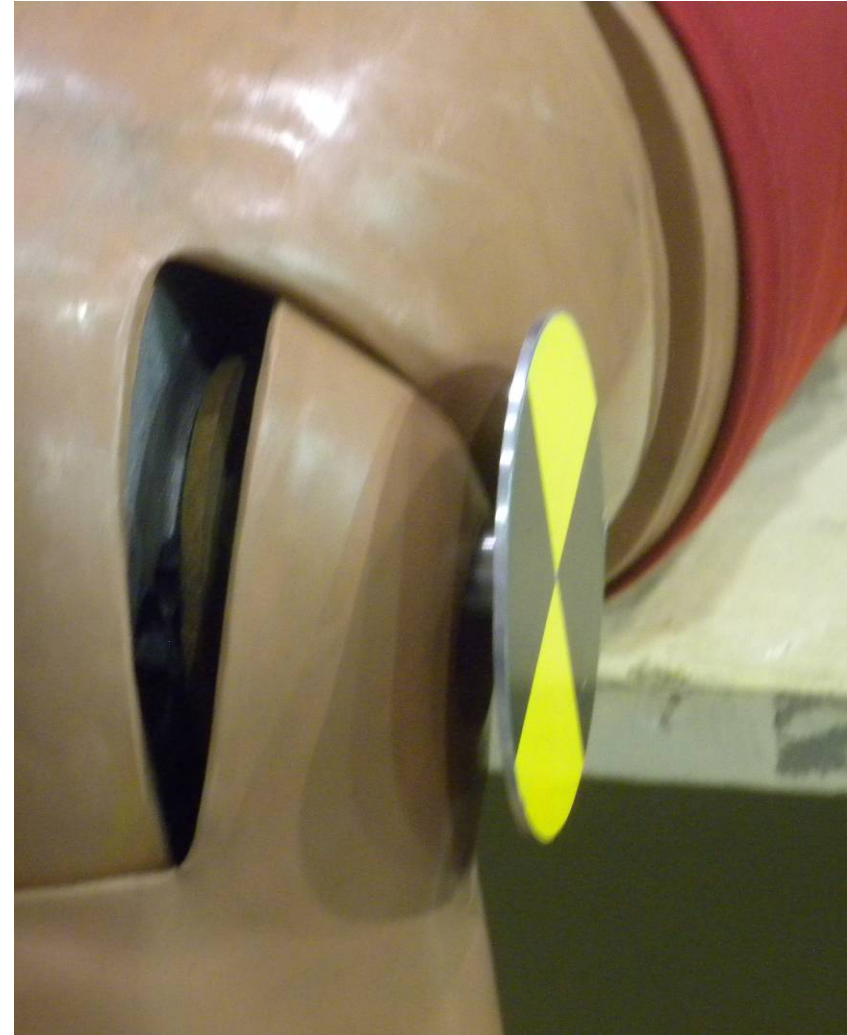
Evolution of Knee Targets



Loss of Data

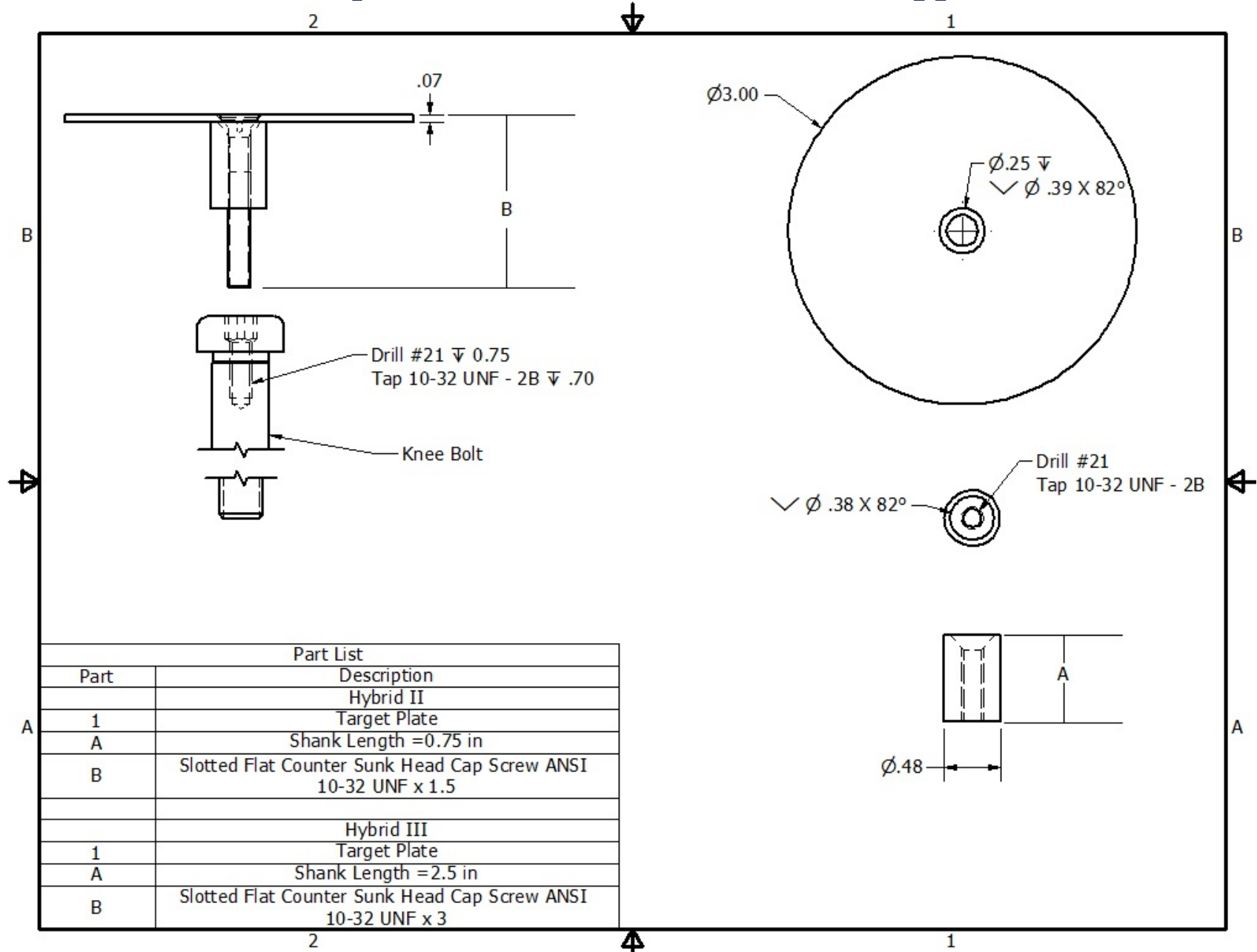


Improved Knee Target



Weight = Hybrid II 0.07 lbs, FAA-Hybrid III 0.1 lbs

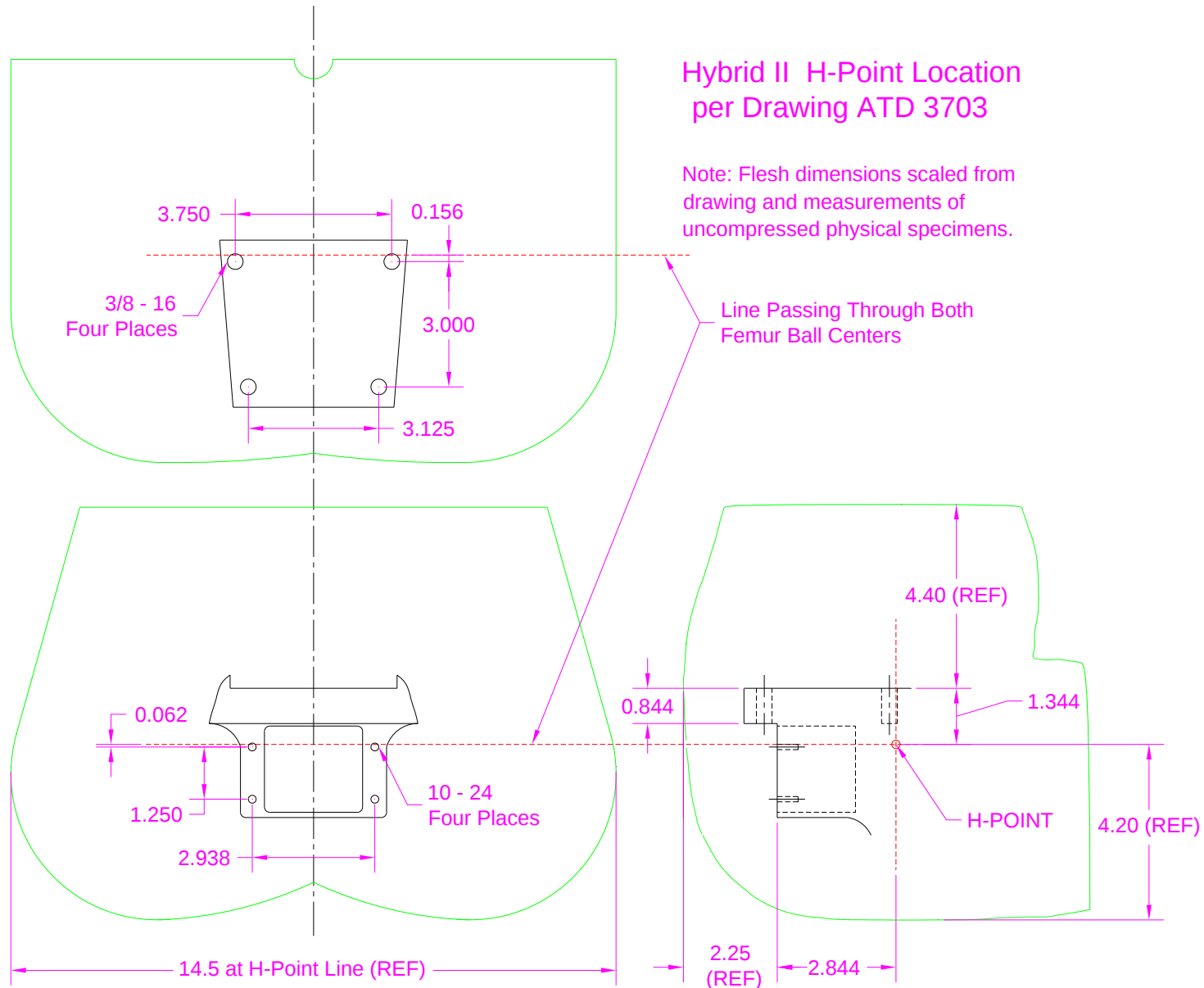
Improved Knee Target



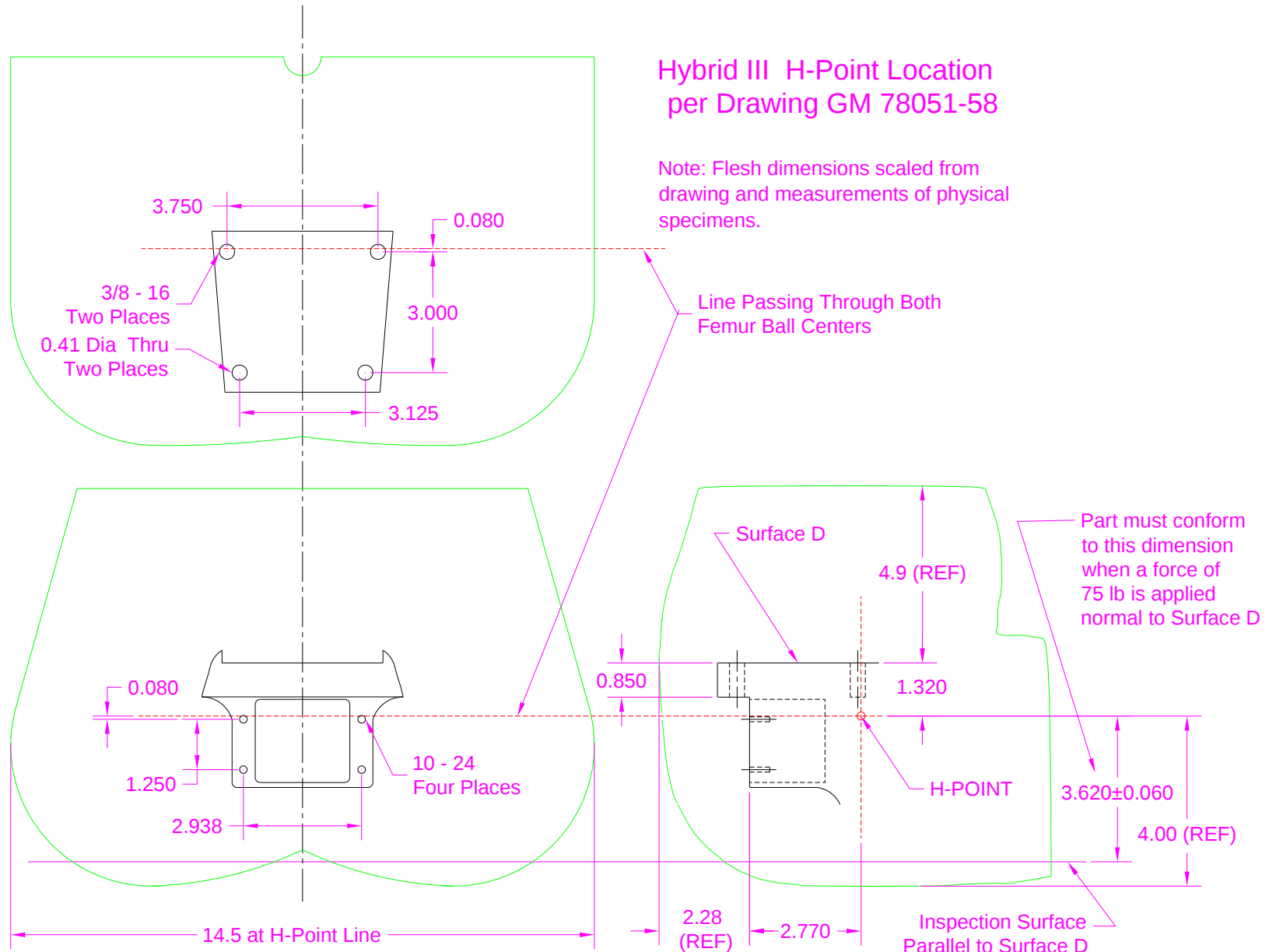
Part 3: Marking the H-pt on a ATD

- **Pelvic access hole is near the H-point; cannot be used reliably to locate a target marker**
- **ATD pelvis drawings define the relationship between the hip ball centers and accessible features such as the lumbar spine mounting surface and instrument cavity cover mounting surface**
- **By referring to these drawings, the points on each side the pelvis that lie on a line passing through the centers of the hip joints can be located**

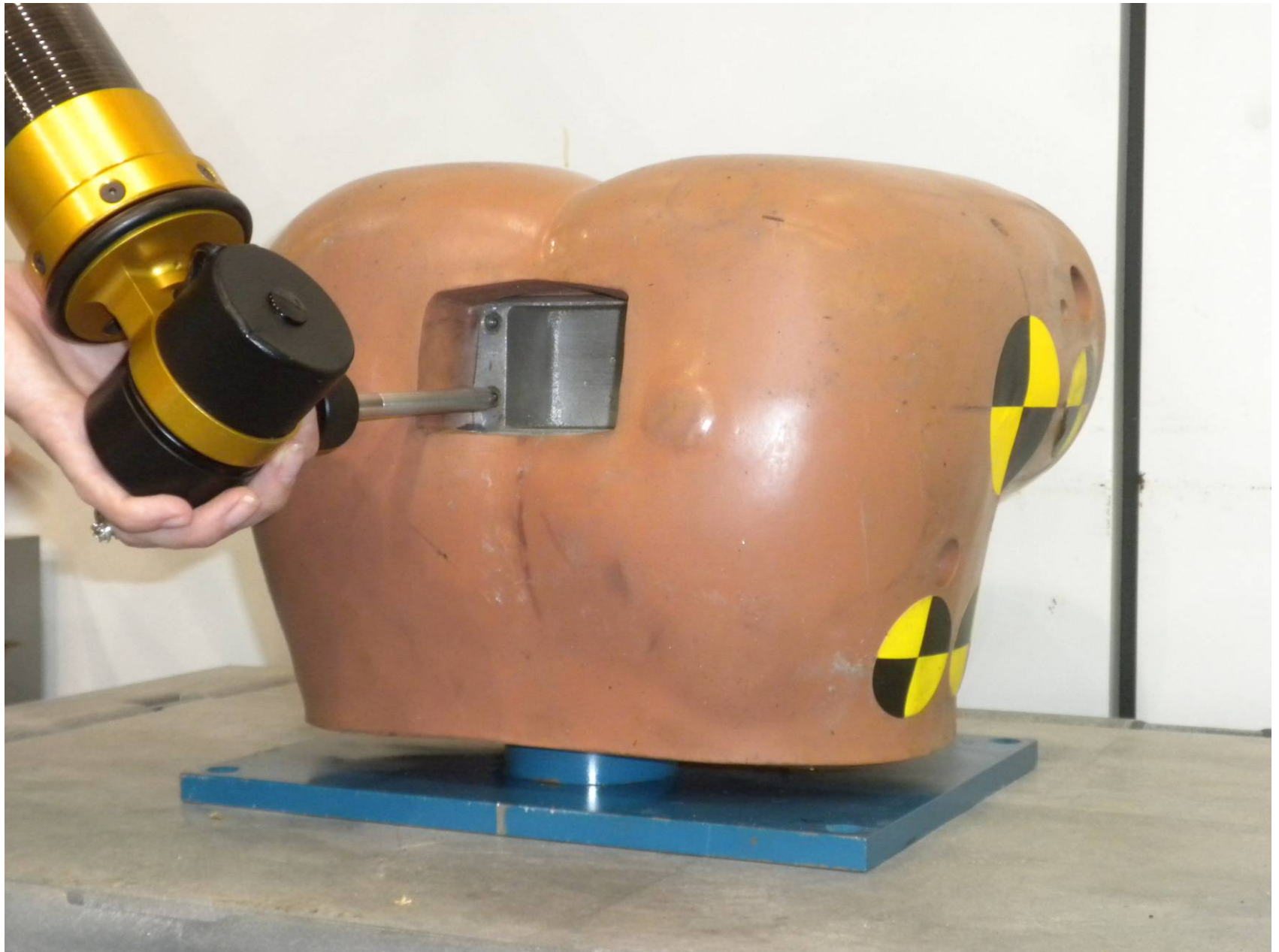
Marking the H-pt on a Hybrid II



Marking the H-pt on a Hybrid III



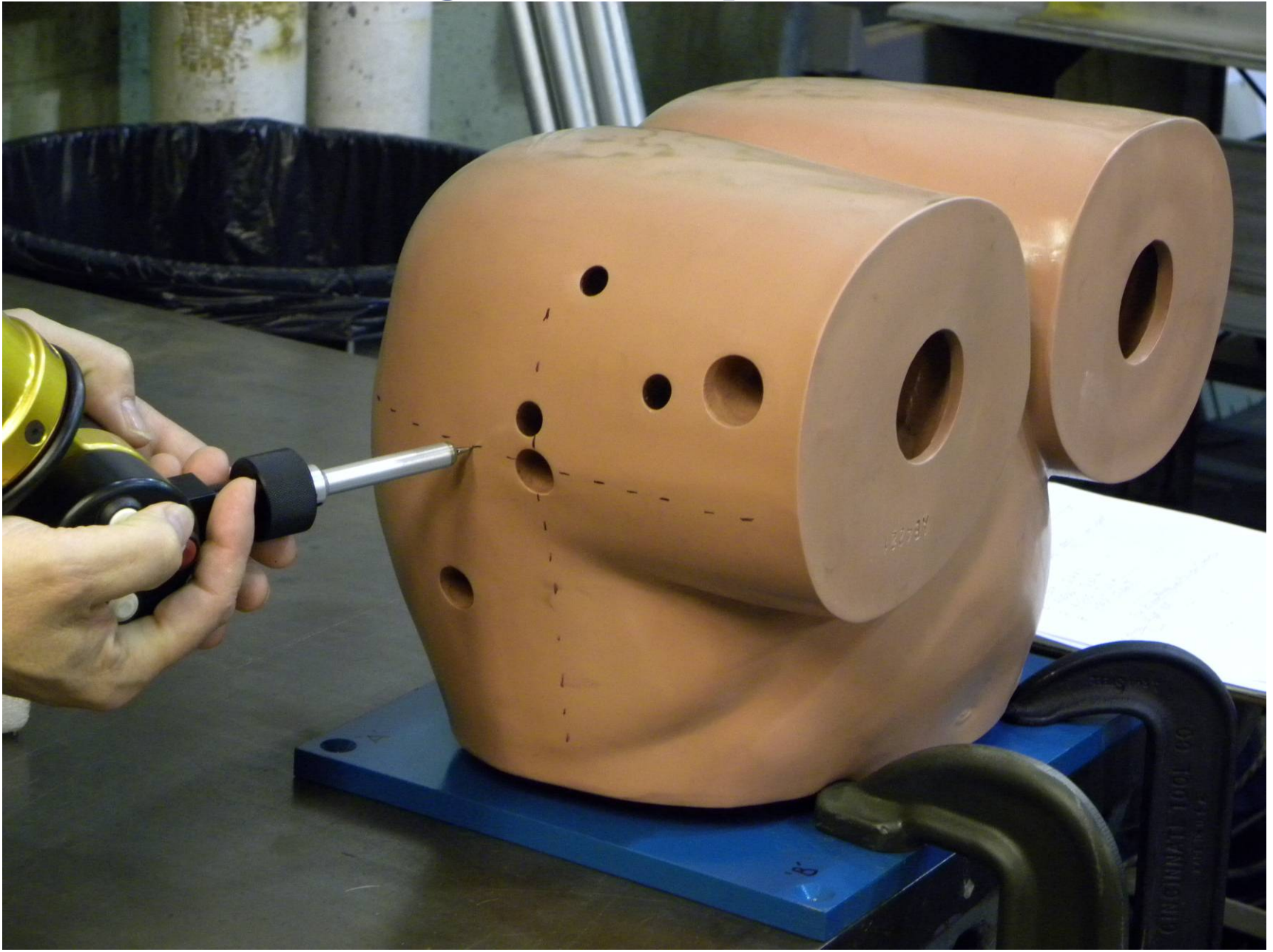
Marking the H-pt on a ATD



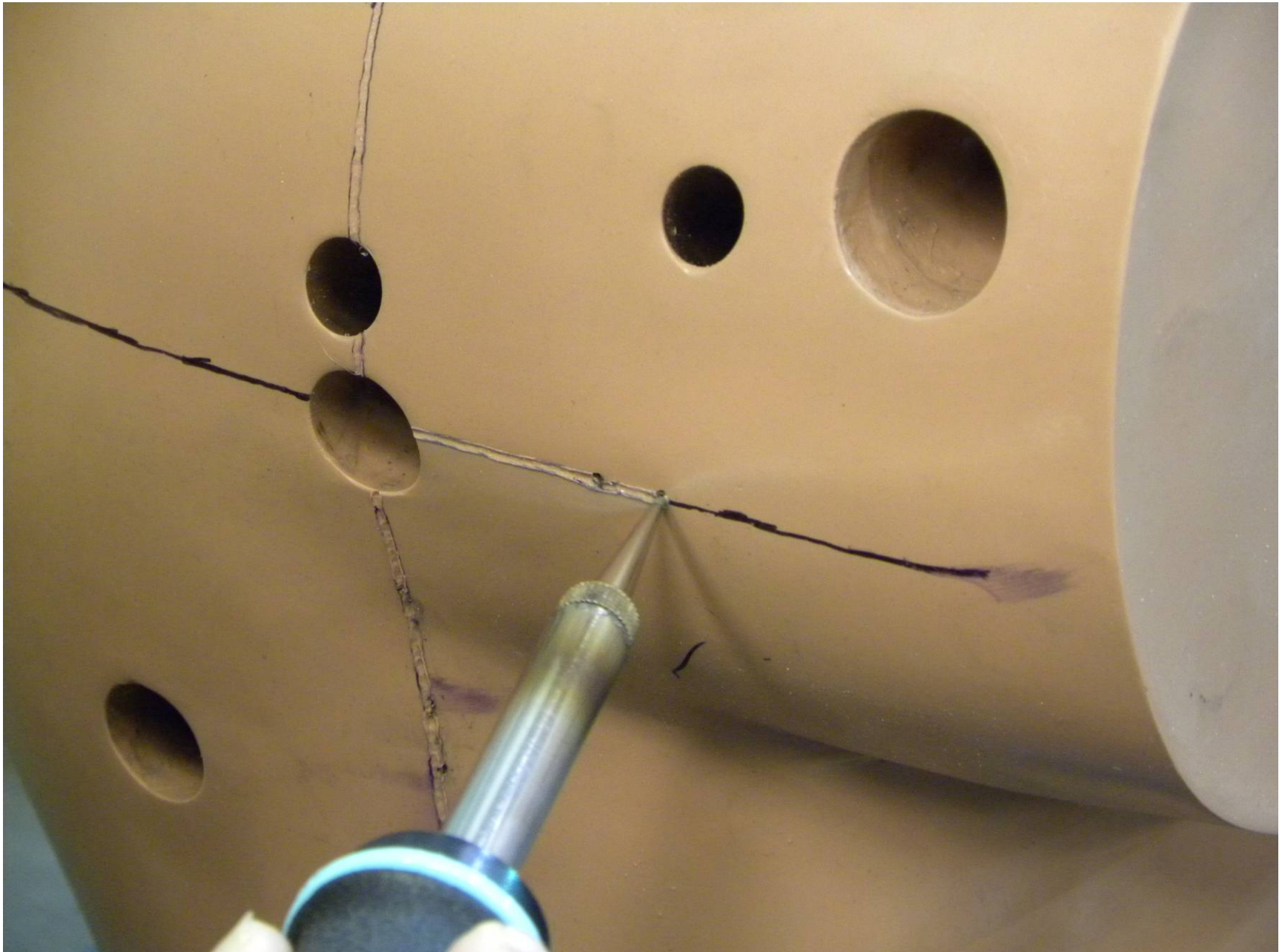
Marking the H-pt on a ATD



Marking the H-pt on a ATD



Marking the H-pt on a ATD



Marking the H-pt on a ATD



H-pt Marker Movement

- Motion of Pelvic Targets at 70 lbs and 130 lbs
- “True” is motion of Instron crosshead

	70 lbs (1) Instron	70 lbs (2) Instron	130 lbs 1-G
True Compression	0.55”	0.42”	-
H-pt	0.50”	0.40”	0.56”
Upper H-pt	0.65”	0.60”	0.72”

Wrap-up

- **Suggested methods should improve consistency of dynamic sled tests**
 - For predictive results
 - For comparison with analytical models
 - For comparison between facilities
- **Methods may flow into SAE AS/ARP documents**



