

Investigation of the Certification Tests of the BioRID-II Dummy for GTR7-Phase2 / MR1

JAMA / JARI 6th MAY 2019

To establish GTR7-Phase2/MR1, JAMA/JARI investigated the effect of test facilities on repeatability & reproducibility of the BioRID-II dummies owned by Japanese institutes, conducting a series of certification tests for the BioRID-II dummy as follows;

Component Certification Tests (Test facilities: HIS-J & NTSEL)



- Jacket Certification Test
- Pelvis Bottom Certification Test

BioRID-II Certification Tests (Test facilities: HIS-J & NTSEL)

- Without Headrest
- With Headrest

The BioRID-II certification test with headrest was conducted based on the past GTR7 meeting materials, since the "Certification Manual" issued by HIS does not include the procedure. The other certification tests were conducted according to the "Certification Manual".

- HIS-J ; Humanetics Innovative Solutions - Japan
- NTSEL ; National Traffic Safety and Environment Laboratory

Test Setup Image	① Jacket		② Pelvis Bottom		
					
Impact Probe	Hybrid-III 5F Dummy Thorax Impactor (13.97 ± 0.023 kg)				
Impact Vel.	1.50 ~ 1.55 m/s				
Probe Force	1110 ~ 1360 N		3250 ~ 4620 N		
Sled Vel.	0.378 ~ 0.422 m/s		0.325 ~ 0.375 m/s		
Compression	18.3 ~ 20.3 mm		17.8 ~ 19.5 mm		
Reference	BioRID II Dummy Certification Manual ARA-9901 [Rev. A] (tested 2016)				
Dummies	095G (JARI)	102G (JARI)	115G (HIS-J)	DP1998 (NTSEL)	DO7357 (NTSEL)

- The jacket tests conducted in this study demonstrated good repeatability and reproducibility in two different test facilities. On the other hand, the repeatability and reproducibility were acceptable for the Pelvis-bottom tests in both the test facilities.

Jacket page 5-7, Pelvis page 8-10

- Some parameters were affected by different test facilities. Future work would include test data provided from more test facilities for further investigation on the corridors.

Jacket page 12, Pelvis page 13

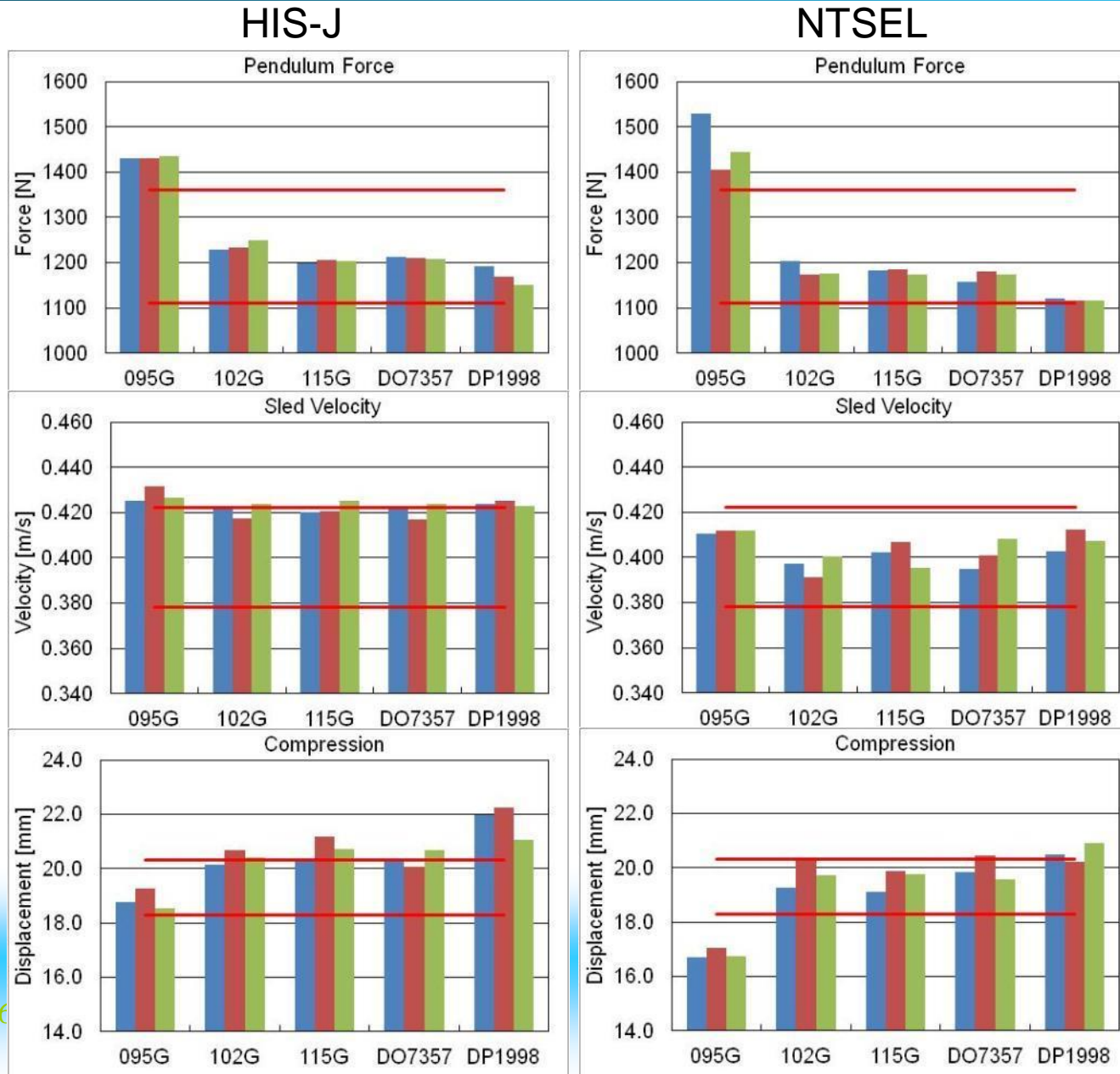
- The current corridors of the certification manual ($\pm 2\sigma$ ranges proposed by Humanetics) are narrower than the range of $\pm 1\sigma$ of the test results obtained in this study, for the compression in the Jacket test and the Pelvis-bottom test.

This make us difficult to have develop and compliance tests.

Jacket page 15, Pelvis page 16

- ← JAMA/JARI would like to ask HIS to reconsider the requirements,-including the certification test data provided by JAMA/JARI.

① Jacket Test Results - Peak Values



➤ Pendulum force and show similar tendency between HIS-J and NTSEL.

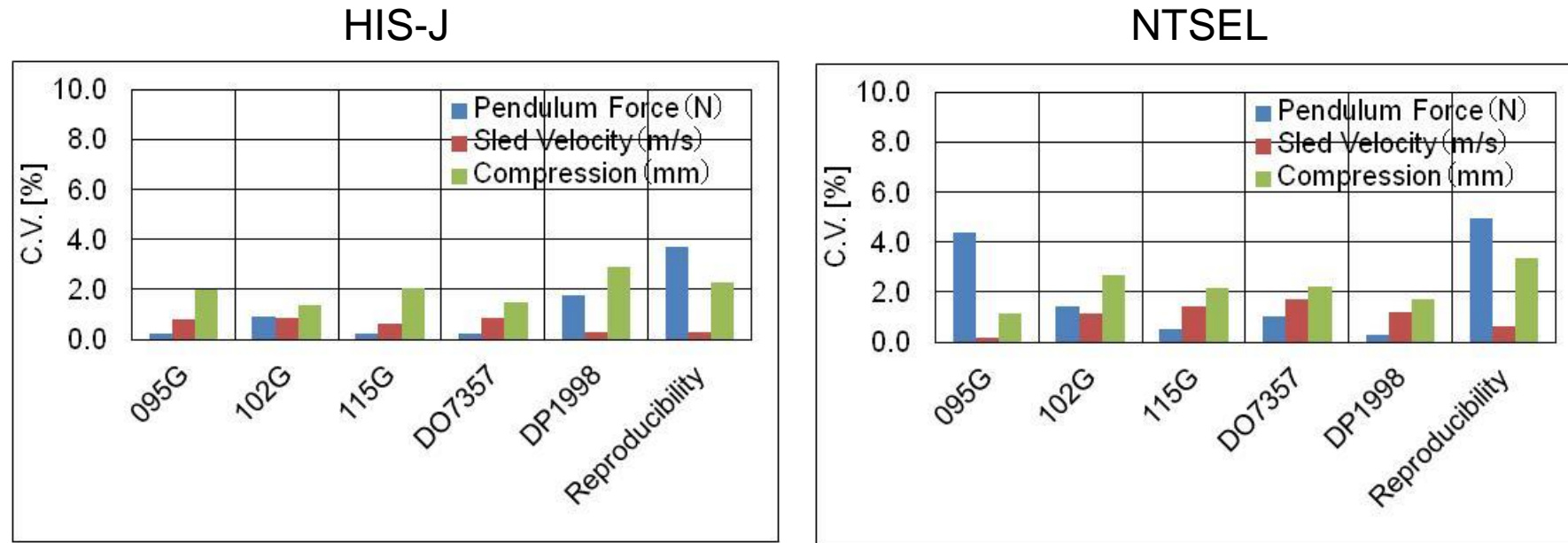
➤ Sled velocity is affected by test facilities. It might be caused by a difference of the force to start moving the mini sled between test facilities as follows.



Force for moving the mini sled

- HIS-J ; 29N
- NTSEL ; 32N

① Jacket Test Results - Repeatability & Reproducibility



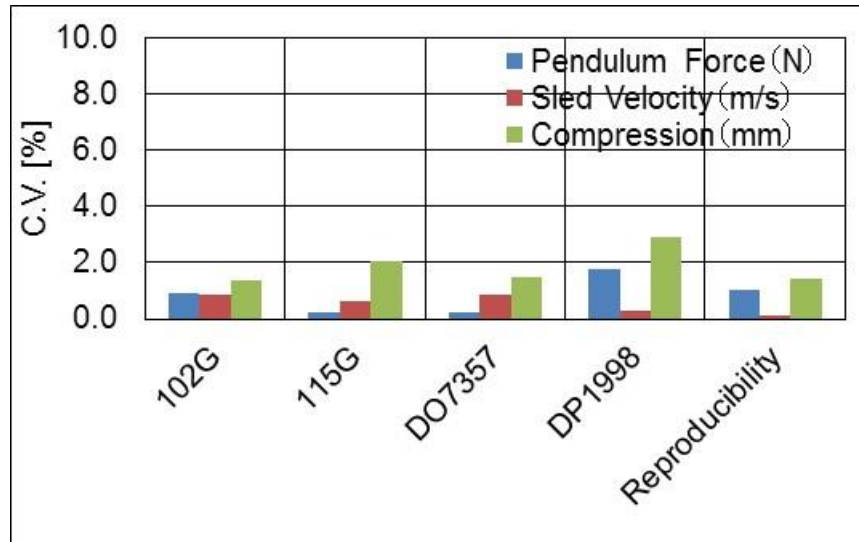
C.V. ; Coefficient of Variation

- For each dummy, C.V. of each parameter is within 5% in both the test facilities.
- In each test facility, C.V.s of repeatability obtained from all of the five dummies are within 5%.
- Therefore, the component tests conducted in this study demonstrated good repeatability and reproducibility with the five different dummies in two different test facilities.

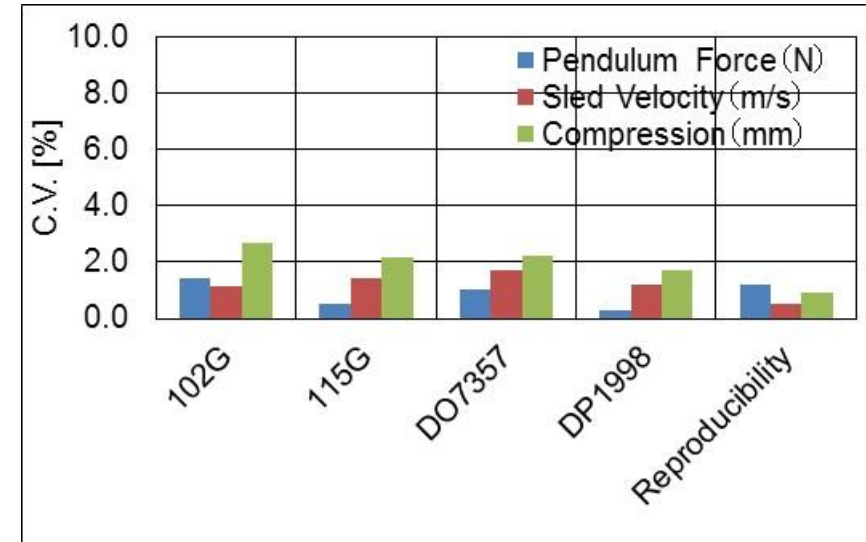
① Jacket Test Results

- Repeatability & Reproducibility **without 095G**

HIS-J

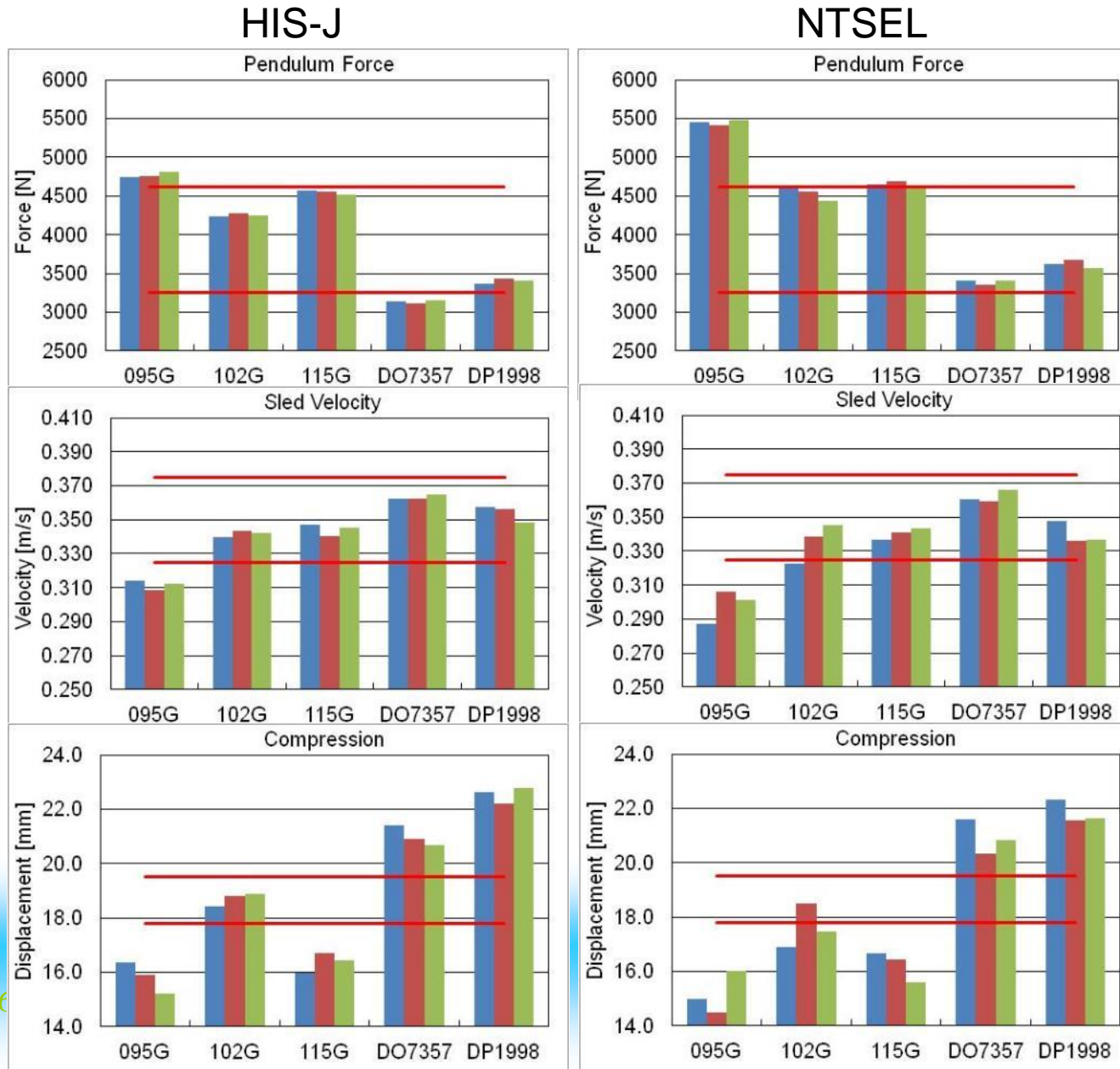


NTSEL



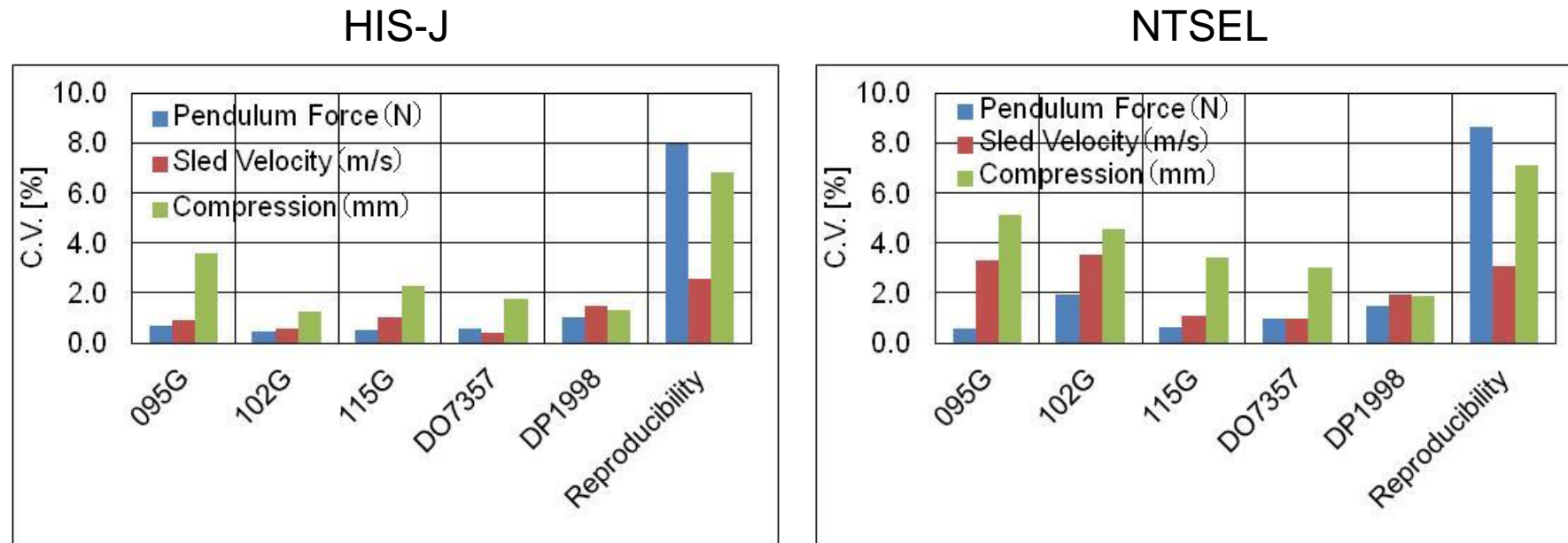
- All C.V.s were within 5% when excluding the 095G dummy data. The jacket tests conducted in this study demonstrated good reproducibility.

② Pelvis-Bottom Test Results - Peak Values



- All five dummies show a similar tendency between HIS-J and NTSEL for all three parameters, except the pendulum force of 095G dummy.
- One out of the five dummies did not meet the compression corridor in both the test facilities.

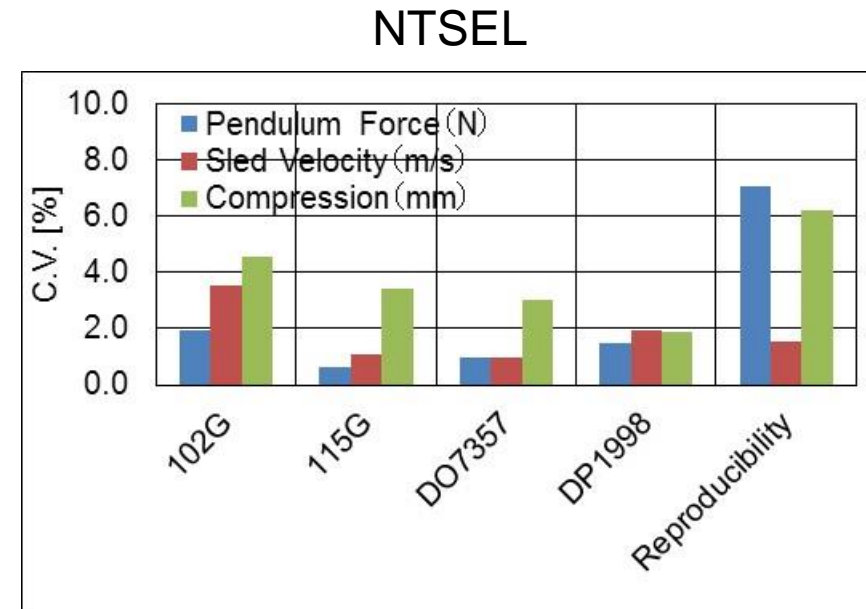
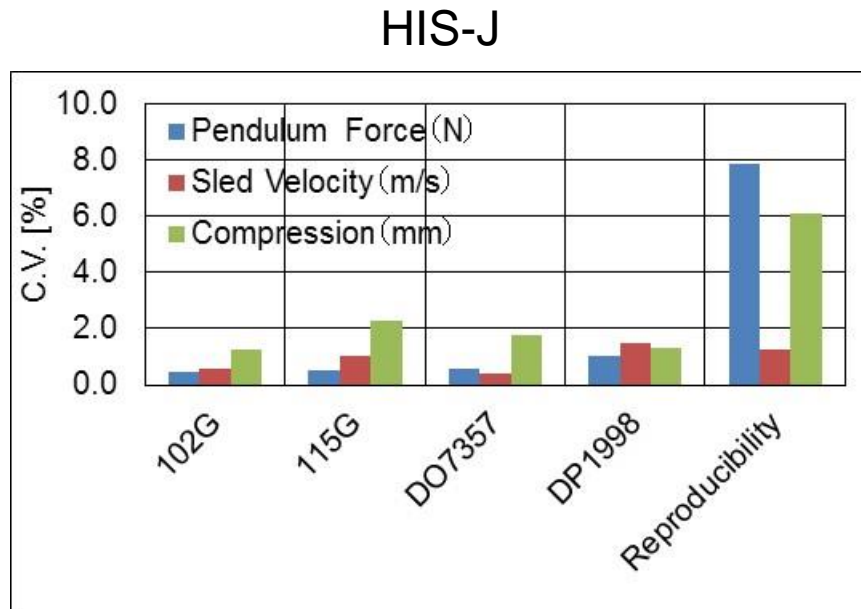
② Pelvis-Bottom Test Results - Repeatability & Reproducibility



C.V. ; Coefficient of Variation

- C.V. of each parameters of each dummies are within 5% in both facilities, so the repeatability is good.
- C.V. of pendulum force and compression by five dummies are within 10% in both facilities, so the reproducibility is acceptable.

② Pelvis-Bottom Test Results - Repeatability & Reproducibility **without 095G**



- C.V. of the reproducibility was within 10%. The reproducibility without the 095G dummy data was acceptable in the both test facilities.

- The jacket tests conducted in this study demonstrated good repeatability and reproducibility in two different test facilities. On the other hand, the repeatability and reproducibility were acceptable for the Pelvis-bottom tests in both the test facilities.

Jacket page 5-7, Pelvis page 8-10

- Some parameters were affected by different test facilities. Future work would include test data provided from more test facilities for further investigation on the corridors.

Jacket page 12, Pelvis page 13

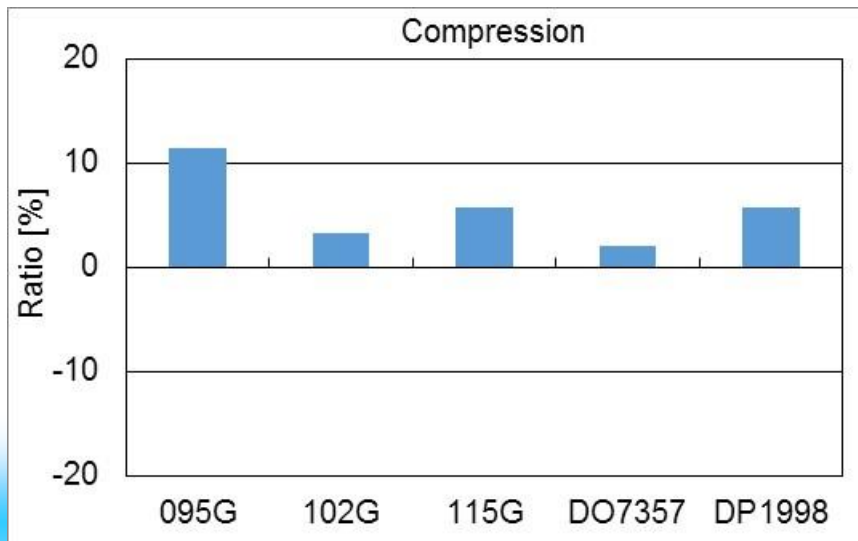
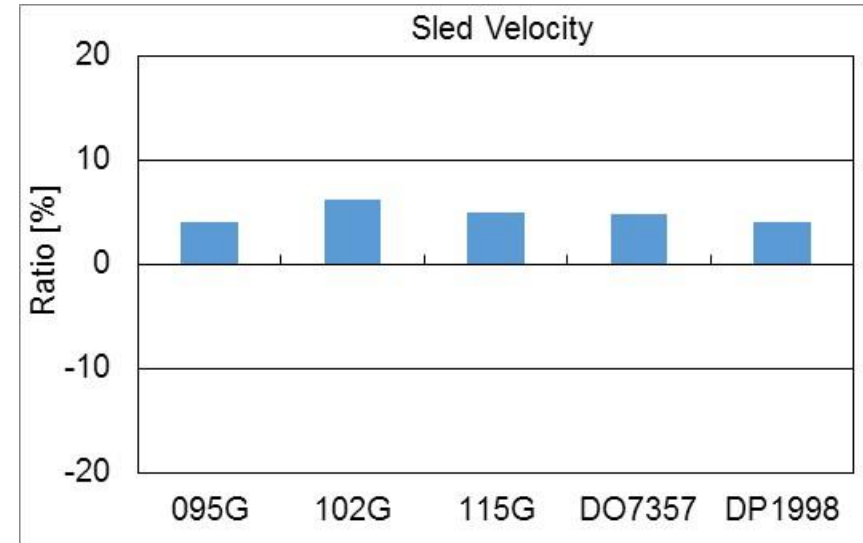
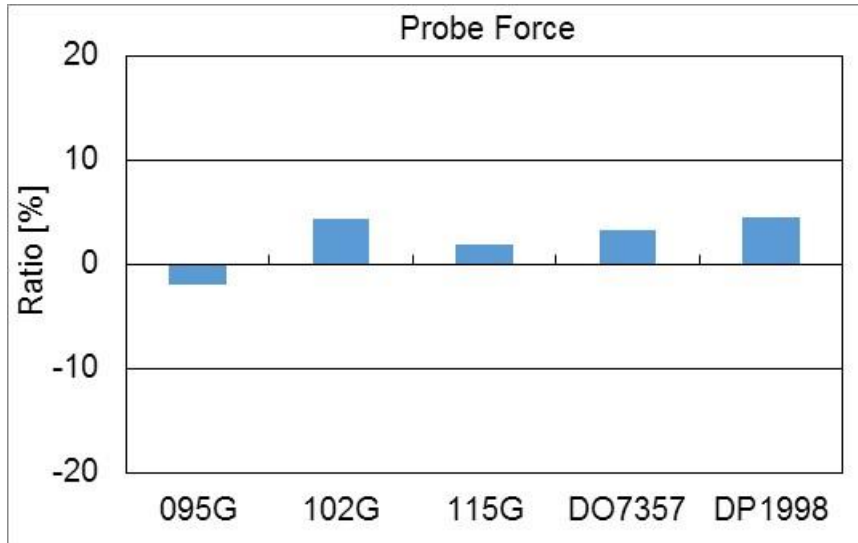
- The current corridors of the certification manual ($\pm 2\sigma$ ranges proposed by Humanetics) are narrower than the range of $\pm 1\sigma$ of the test results obtained in this study, for the compression in the Jacket test and the Pelvis-bottom test.

This make us difficult to have develop and compliance tests.

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① Jacket Test Results - Difference in the test facilities

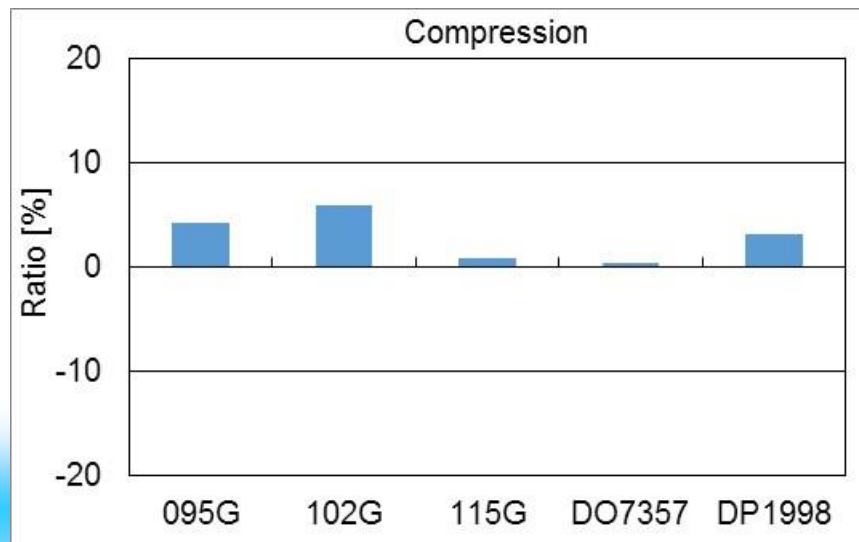
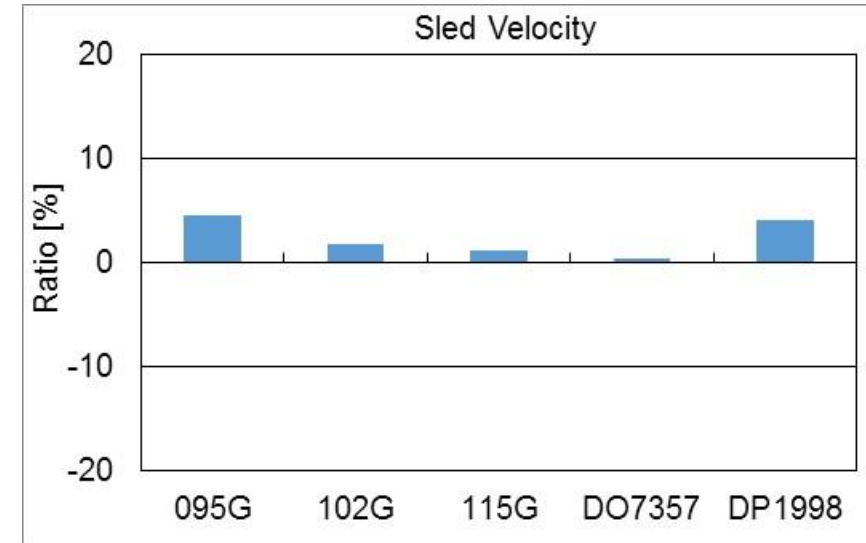
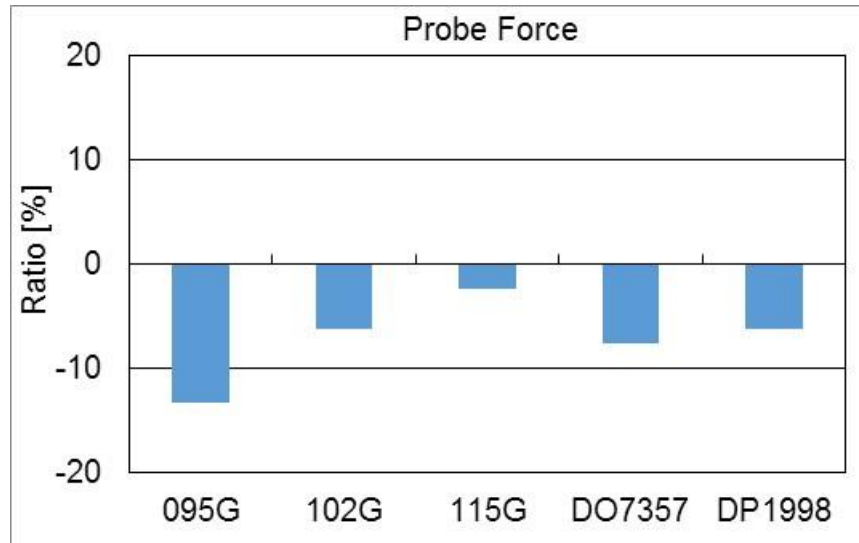


The difference of each parameter between the two test facilities is calculated for each individual dummy, using the following equation;

$$\text{Variation} = \frac{(\text{Ave.HIS-J}_{\text{dummy}} - \text{Ave.NTSEL}_{\text{dummy}})}{\text{Ave. AllData}_{\text{dummy}}}$$

- For the compression, the 095G dummy demonstrated more than 10% difference ratio.

② Pelvis-Bottom Test Results - Difference in the test facilities



The difference of each parameter between the two test facilities is calculated for each individual dummy, using the following equation;

$$\text{Variation} = \frac{(\text{Ave.HIS-J}_{\text{dummy}} - \text{Ave.NTSEL}_{\text{dummy}})}{\text{Ave. AllData}_{\text{dummy}}}$$

- For the Probe force , the 095G dummy demonstrated more than 10% difference ratio.

- The jacket tests conducted in this study demonstrated good repeatability and reproducibility in two different test facilities. On the other hand, the repeatability and reproducibility were acceptable for the Pelvis-bottom tests in both the test facilities.

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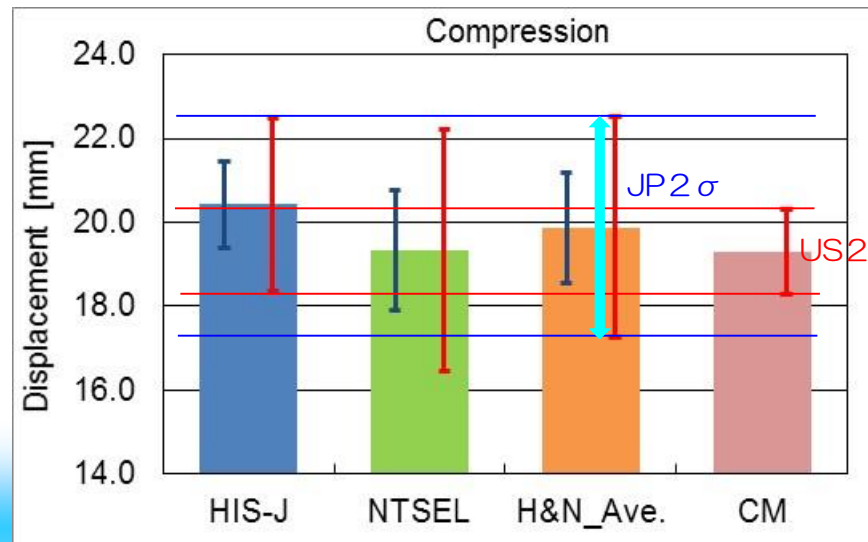
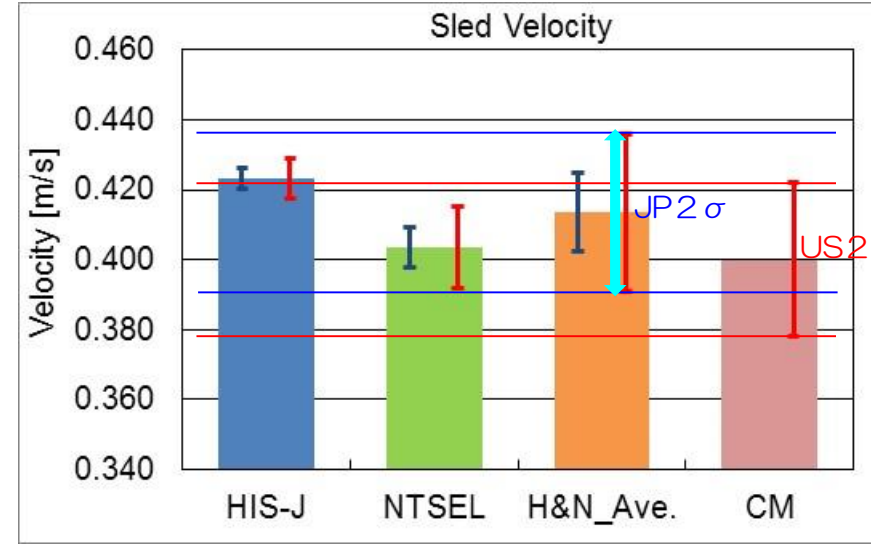
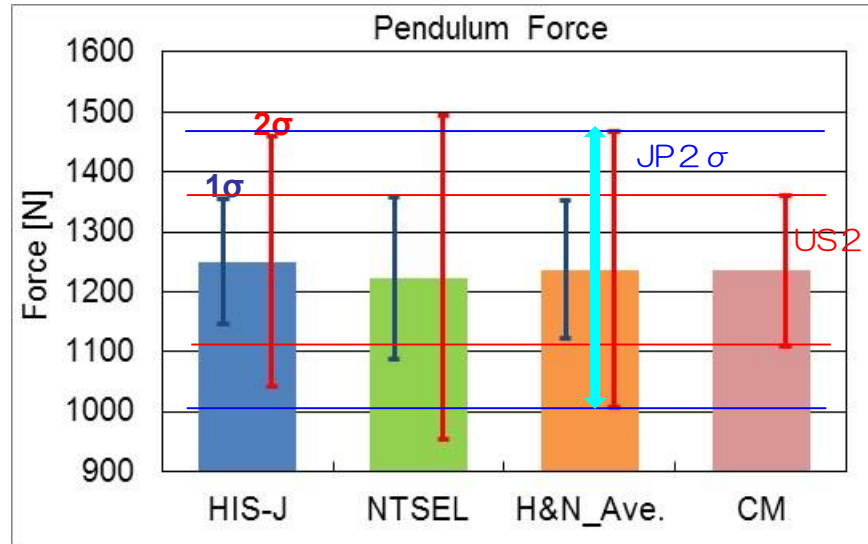
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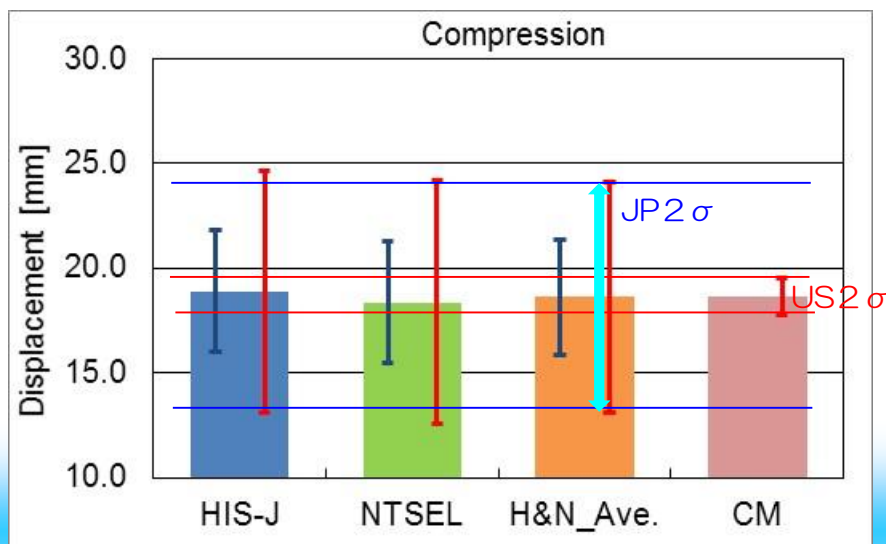
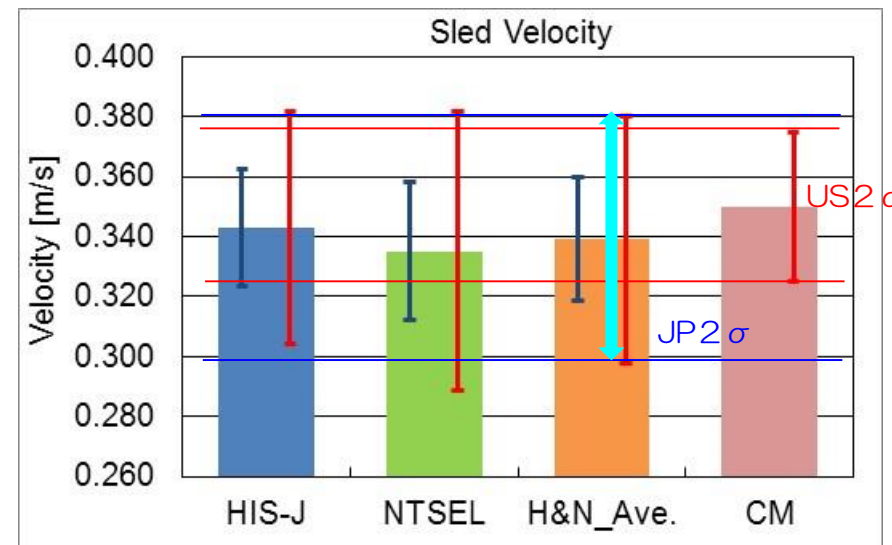
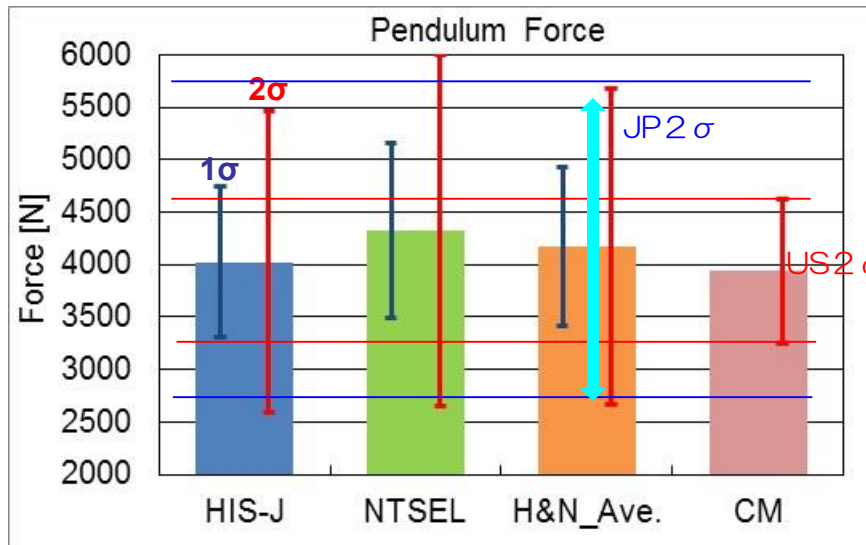
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① Jacket Test Results - Corridors



- The average pendulum force is similar in both the test facilities. However, there are differences of the average sled velocity and the average compression between the two test facilities.
- For the compression, the current corridor indicated in the certification manual (+/- 2σ range proposed by Humanetics) is narrower than the range of +/- 1σ obtained from the test results in this study.

② Pelvis-Bottom Test Results - Consideration of Corridor



- The average compression is similar in both the test facilities. However, there are differences of the average pendulum force and the average sled velocity between the two test facilities.
- For the compression, the current corridor indicated in the certification manual (+/- 2σ range proposed by Humanetics) is narrower than the range of +/- 1σ obtained from the test results in this study.

- The jacket tests conducted in this study demonstrated good repeatability and reproducibility in two different test facilities. On the other hand, the repeatability and reproducibility were acceptable for the Pelvis-bottom tests in both the test facilities.

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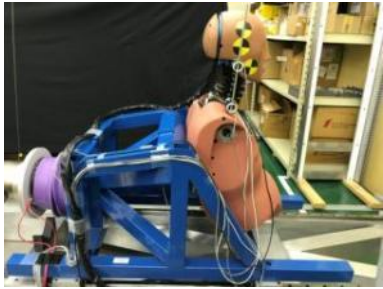
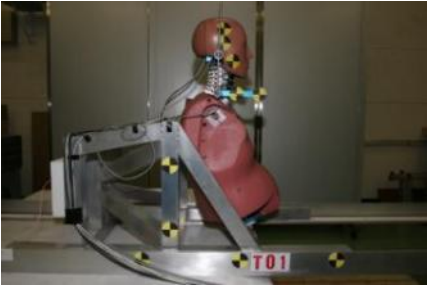
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Certification Test of the Without Headrest

- Test facilities
 - HIS-J ; Humanetics Innovative Solutions - Japan
 - NTSEL ; National Traffic Safety and Environment Laboratory
- Dummies
 - Five individual BioRID-II dummies (produced between 2008 to 2014)

Purpose of this investigation is to:

- look at repeatability & reproducibility of the five individual BioRID-II dummies.
- investigate the effect of test facilities on repeatability & reproducibility of the BioRID-II dummies.

	Without Headrest	Without Headrest (Denton)
Test Condition		
Probe mass	37.68kg	33.55 kg
Impact Velocity	4.70~4.80 m/s	4.70~4.80 m/s

- ※ In order to set up the same initial condition of the BioRID-II dummy, the certification test specified by the Denton method was conducted before the BioRID-II certification tests without headrest for each dummy.

- In the BioRID-II certification tests without headrest, All dummies met the requirements specified in the Denton method but some dummies failed to meet the requirements specified in the certification manual.

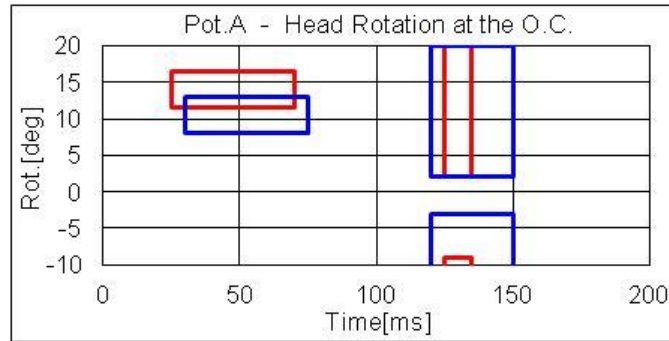
- Characteristics of the dummies can be classified into two groups, 095G and 102G dummies (old dummies) and other dummies (new dummies) based on a difference. This make Pot.A CV Value be large .These is a probability to large influence for value for Upper Neck My.
Page 21 Denton&HIS Requirements ,22 Pot.A shape ,23 R&R
Page 24-26 influence possibility.

- The purpose of the certification test with headrest is to increase flexion behavior of the dummy. However, peak values of flexion for Pot.A and UpperNeck-MY in the tests with headrest were similar to those in the tests without headrest.
Page 28-29.

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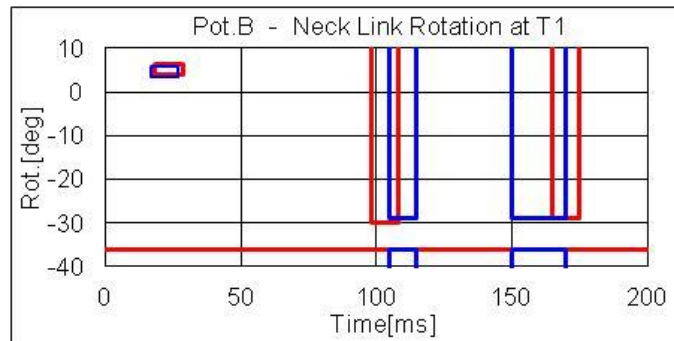
Requirements (Without Headrest) : ②

Head Rotation at the O.C. (Pot.A)

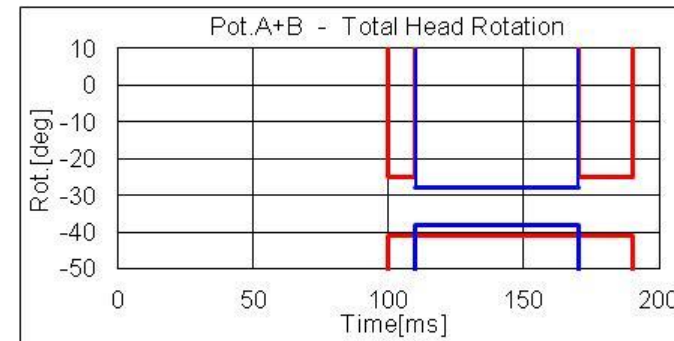


Red Line: Certification Manual
Blue Line: Denton method

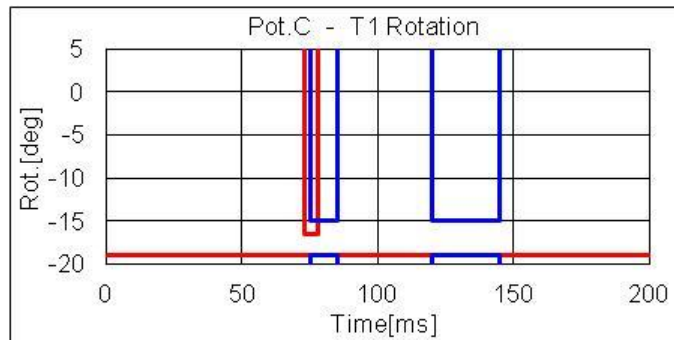
Neck Link Rotation (Pot.B)



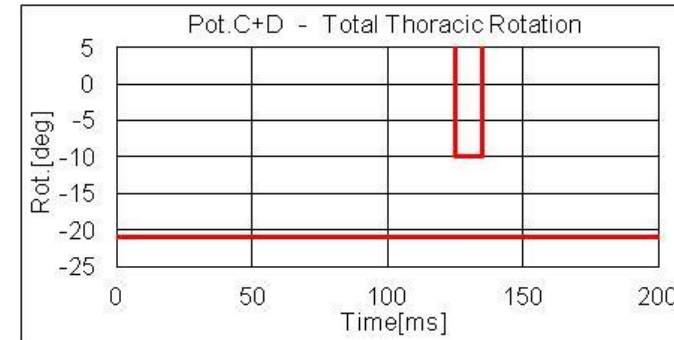
Total Head Rotation (Pot.A+Pot.B)



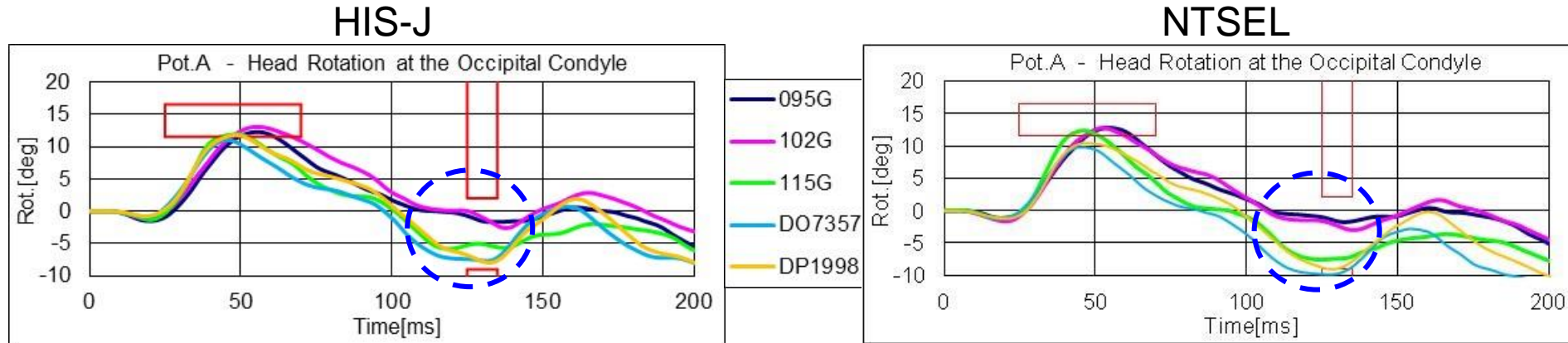
T1 Rotation (Pot.C)



Total Thoracic Rotation (Pot.C+Pot.D)

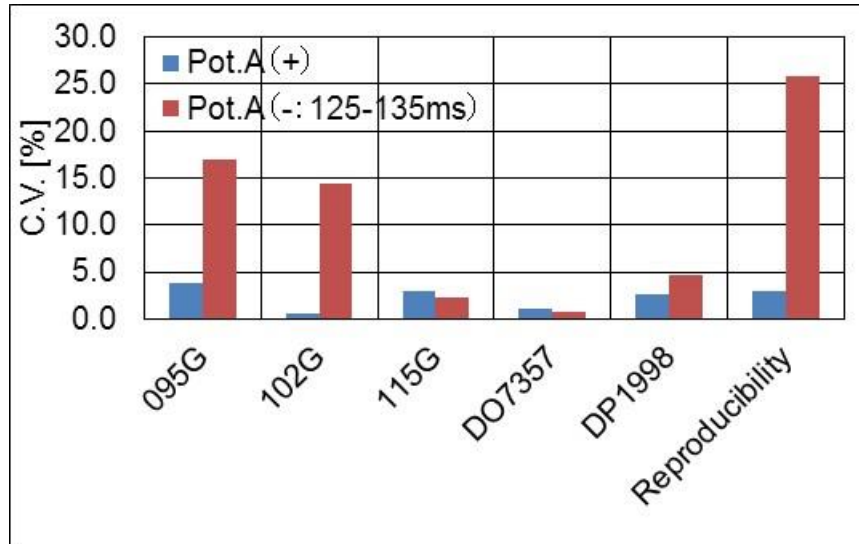


Pot.A(Head Rotation)

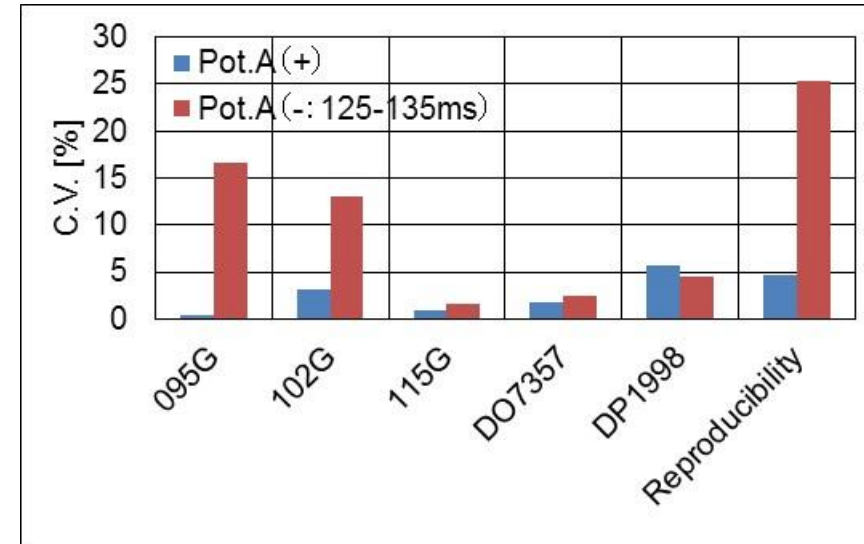


- All dummies met the requirement provided by the Denton method. However, some dummies did not meet the requirement for the Pot.A specified in the certification manual.
- Characteristics of the dummies can be classified into two groups, 095G and 102G dummies (old dummies) and other dummies (new dummies) based on a difference indicated in the blue circle areas.
- These difference is might influence injury value especially.

HIS-J



NTSEL



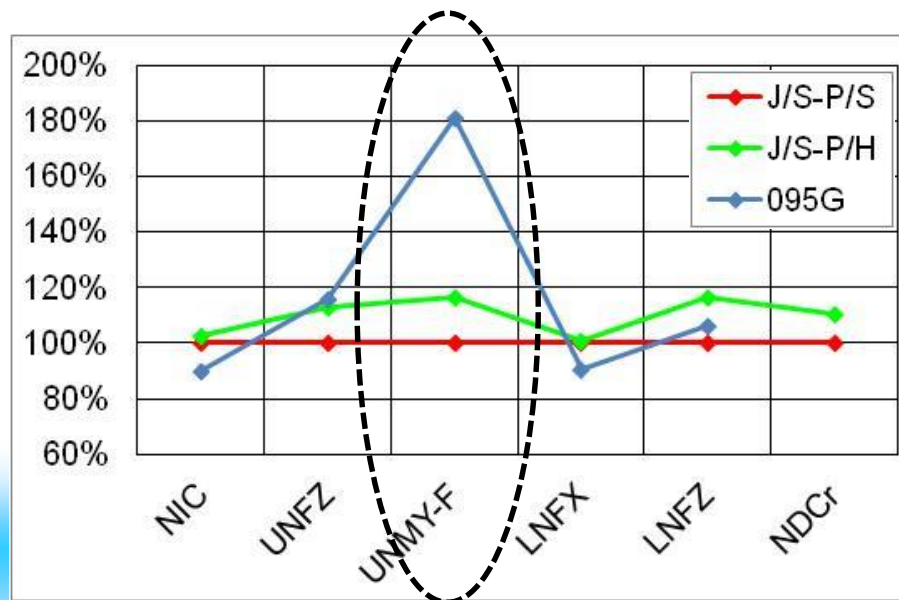
- As for the Repeatability of 125-135ms , C.V. of 095G and 102G exceeded 10%. However, the variation in the peak value of +Pot.A was within 1 ° .
- As for the Reproducibility of 125-135ms , C.V. was exceeded 10%, and the variation in the peak value of +Pot.A was about 5 ° .

Injury Measures in $\Delta V=20.0\text{km/h}$

(Comparison between T-5, T-6 and Test 095G)

Test.No	Jacket	Pelvis	ΔV	NIC (m^2/s^2)	UpperNeck				LowerNeck				NDCr (deg)
					FX (N)	FZ (N)	MY-Flx. (Nm)	MY-Ext. (Nm)	FX (N)	FZ (N)	MY-Flx. (Nm)	MY-Ext. (Nm)	
T-05	Soft	Soft	20.0	15.0	14.7	398.3	11.3	0.0	221.4	189.3	1.9	-4.4	13.6
T-06	Soft	Hard		15.3	0.6	449.0	13.2	0.0	222.7	220.0	1.7	-4.9	15.0
095G	Hard	Hard		11.7	23.4	430.4	20.9	-6.8	188.2	196.8	1.4	-6.7	-

T05&06 Spine is DP1998. 095G spine is 095G.

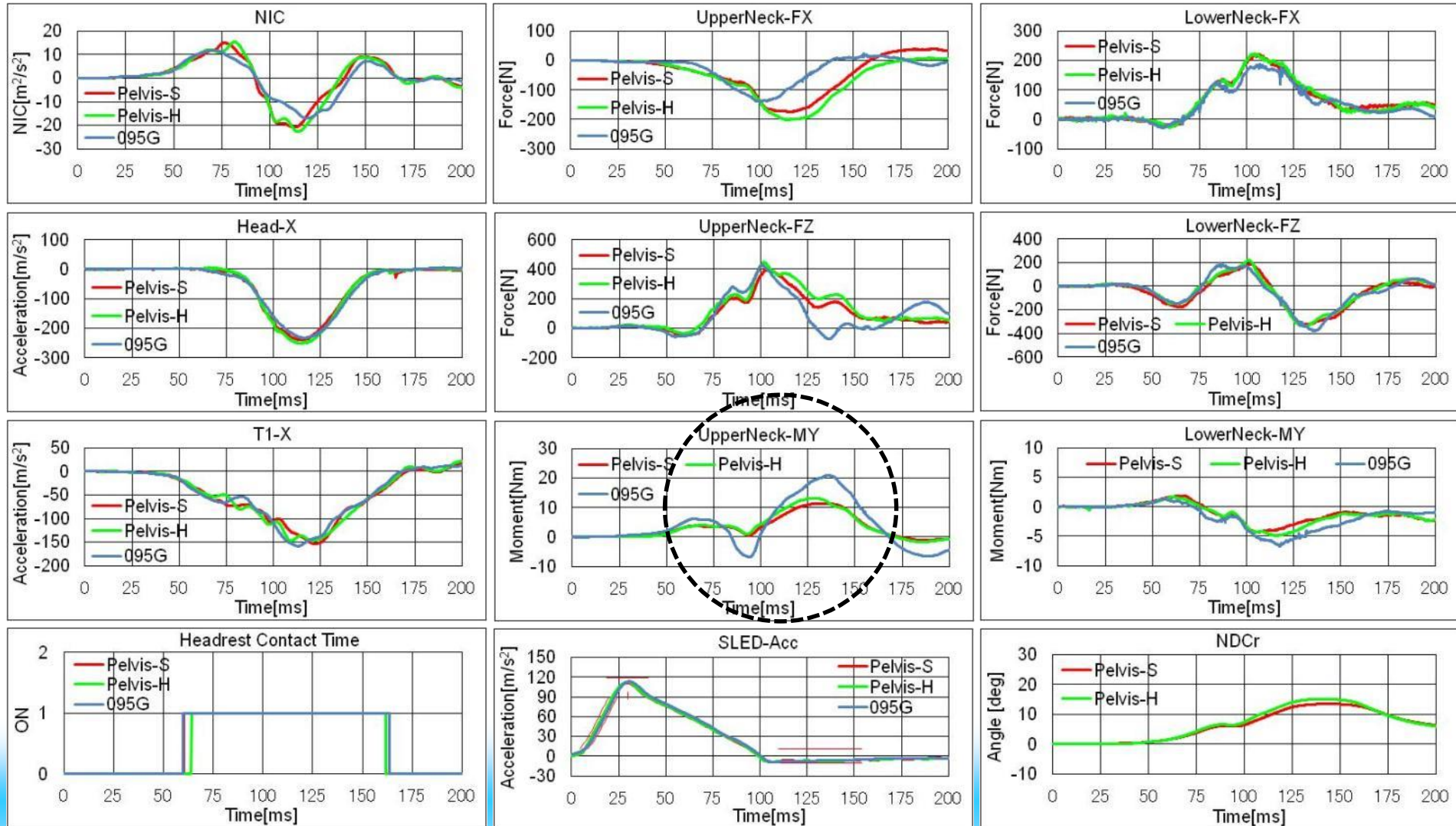


		J	
		H	S
P	H	095G	T-06
	S		T-05

		J	
		H	S
P	H	095G	T-06
	S		T-05

Response Time Histories in $\Delta V=20.0\text{km/h}$

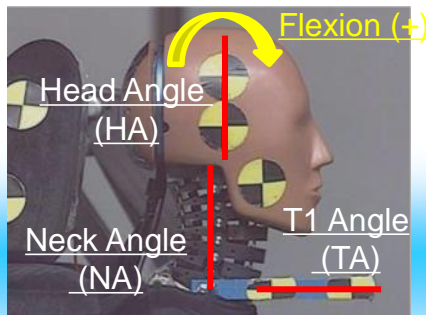
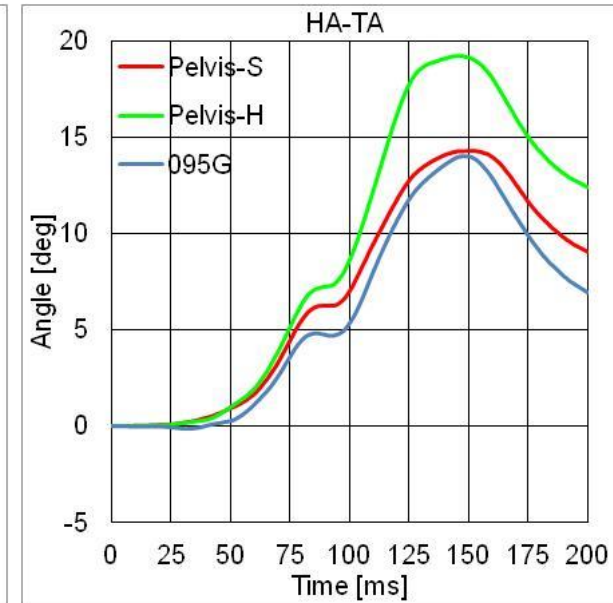
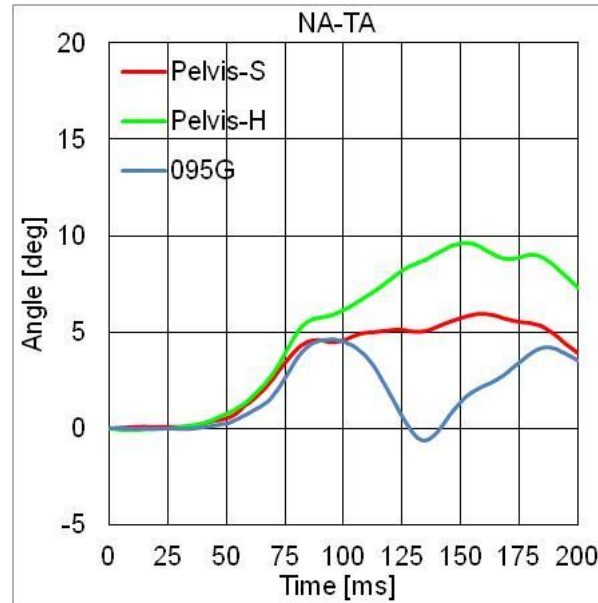
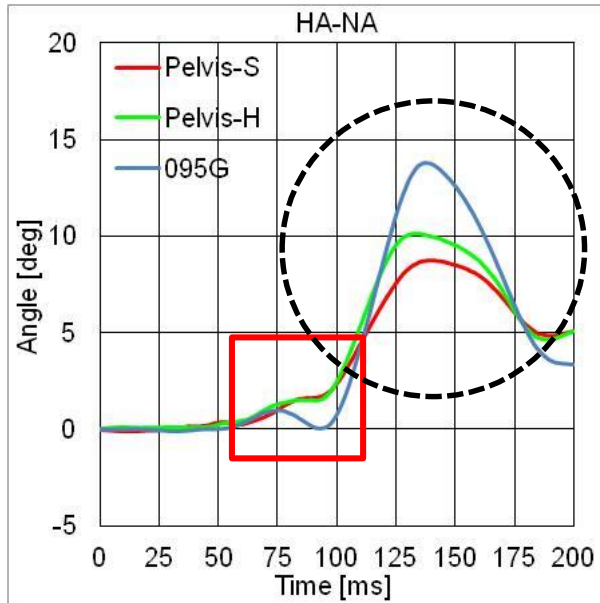
(Comparison between T-5, T-6 and Test 095G)



Dummy Behavior in $\Delta V=20.0\text{km/h}$ - Angular Disp.


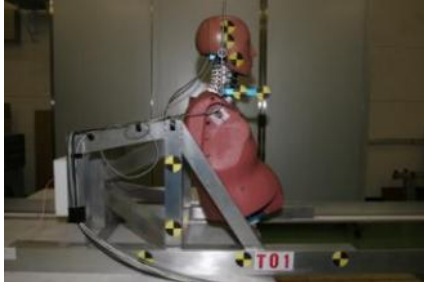
(Comparison between T-5, T-6 and Test 095G)

		J	
		H	S
P	H	095G	T-06
	S		T-05



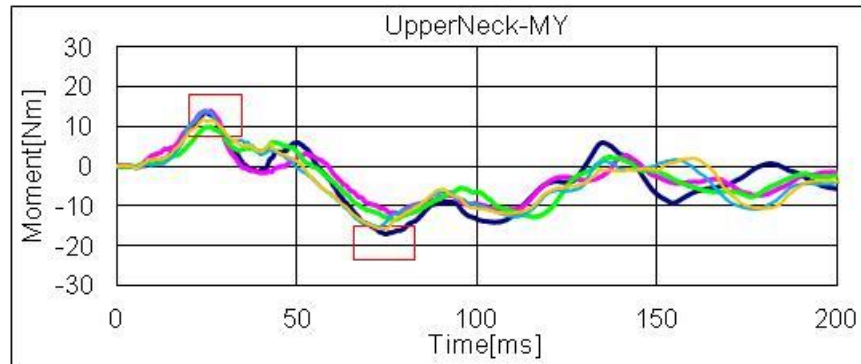
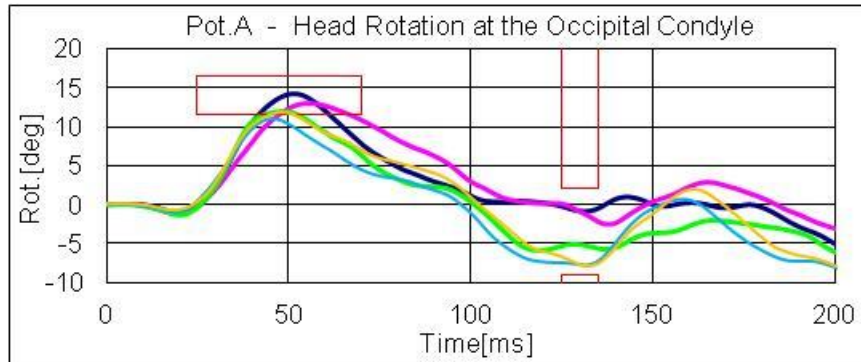
- HA-NA of 095G showed little bit different behavior from other tests, i.e. it is increase once until 75 msec and then decrease between 80-100 msec, and increase again after 100 msec
- It possibly influenced to the injury measures

- In the BioRID-II certification tests without headrest, All dummies met the requirements specified in the Denton method but some dummies failed to meet the requirements specified in the certification manual.
 - Characteristics of the dummies can be classified into two groups, 095G and 102G dummies (old dummies) and other dummies (new dummies) based on a difference. This make Pot.A CV Value be large .These is a probability to large influence for value for Upper Neck My.
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 - The purpose of the certification test with headrest is to increase flexion behavior of the dummy. However, peak values of flexion for Pot.A and UpperNeck-MY in the tests with headrest were similar to those in the tests without headrest.
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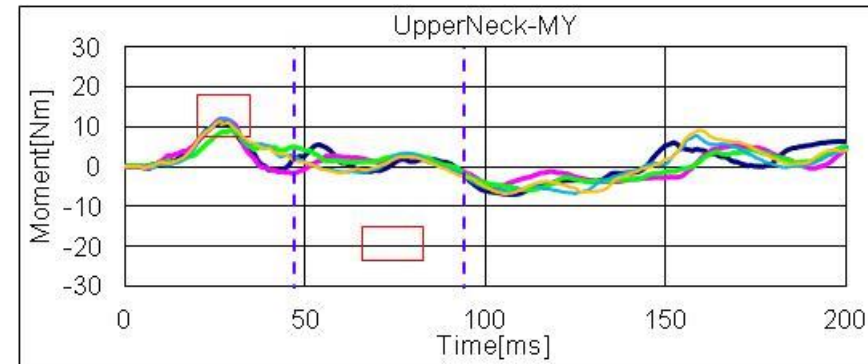
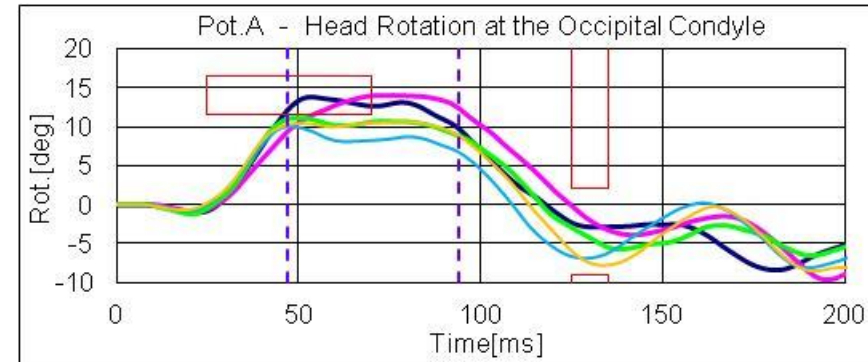
	With Headrest (Backset: 70mm)	Without Headrest (Denton)
Test Condition		
Probe mass	37.68kg (Same as without Headrest)	33.55 kg
Impact Velocity	4.70~4.80 m/s	4.70~4.80 m/s

- ❌ In order to set up the same initial condition of the BioRID-II dummy, the certification test specified by the Denton method was conducted before the BioRID-II certification tests without headrest for each dummy.
- ❌ The certification tests with headrest were conducted with the same test condition as that for the certification test without headrest.

Without Headrest



With Headrest



- The purpose of the certification test with headrest is to increase flexion behavior of the dummy. However, peak values of flexion for Pot.A and UpperNeck-MY in the tests with headrest were similar to those in the tests without headrest.

- In the BioRID-II certification tests without headrest, All dummies met the requirements specified in the Denton method but some dummies failed to meet the requirements specified in the certification manual.
- Characteristics of the dummies can be classified into two groups, 095G and 102G dummies (old dummies) and other dummies (new dummies) based on a difference. This make Pot.A CV Value be large .These is a probability to large influence for value for Upper Neck My.
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Thank you

Appendix

		HIS-J (Nagoya Technical Center)		NTSEL (Kumagaya Test Center)	
Dummy S/N (owner)	Production Year	Jacket	Pelvis - Bottom	Jacket	Pelvis - Bottom
095G (JARI)	2008	3	3	3	3
102G (JARI)	2009	3	3	3	3
115G (HIS-J)	2010	3	3	3	3
DO7357 (NTSEL)	2014	3	3	3	3
DP1998 (NTSEL)	2014	3	3	3	3

- HIS-J ; Humanetics Innovative Solutions - Japan
- NTSEL ; National Traffic Safety and Environment Laboratory

Component Weight - Requirements and Measurement Results -

		Jacket Weight		Pelvis Weight	
Requirements in Certification Manual		21.610~ 22.130 kg	Pass or Fail	7.860~ 7.950 kg	Pass or Fail
Measurement Results	095G (JARI)	21.689	P	7.876	P
	102G (JARI)	21.827	P	7.860	P
	115G (HIS-J)	21.626	P	7.864	P
	DO7357 (NTSEL)	21.971	P	7.882	P
	DP1998 (NTSEL)	21.895	P	7.874	P

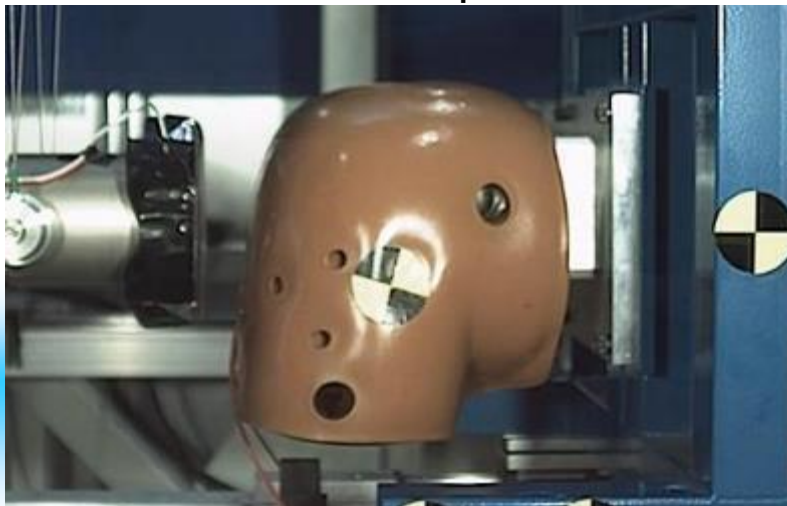
In the latest certification manual (BioRID-II Dummy Certification Manual: ARA-9901 [Rev.D]), the definition of time zero is clearly described in the calculation procedure for compression. However, when the certification tests were conducted for this study in 2016, time zero was not clearly defined in the certification manual Rev.A (Rev.A was the latest version at that time). Therefore, data obtained in this study was calculated based on time zero defined as follows.

Time zero = at the time when the probe acceleration reached at the 0.98m/s^2

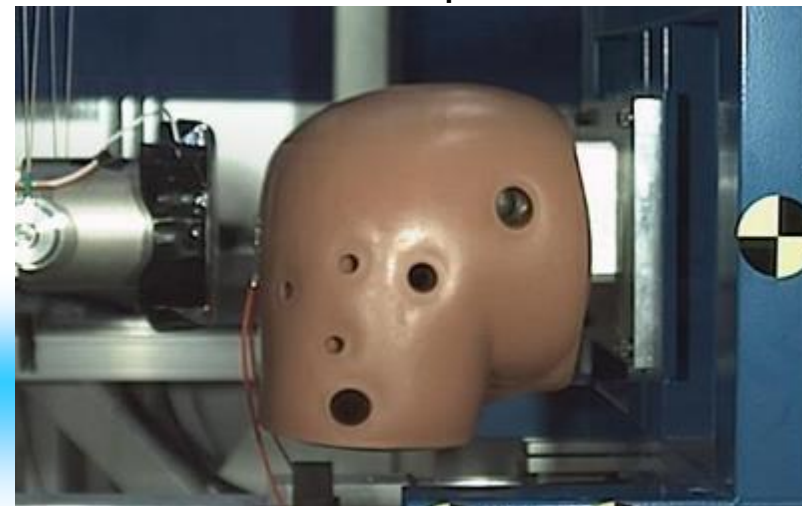
Due to a lack of data before Time zero, we did not recalculate the data according to the time zero definition described in "Rev.D".

(In addition, there is a difference of the pelvis shape between 095G and DP1998, as shown in following photos. It is also necessary to clarify the definition of time zero from the point of view of the difference in the pelvis shape.)

Pelvis-Bottom Impact - 095G



Pelvis-Bottom Impact - DP1998



Findings in the Response Time History

- The "time zero" is very important in the calculation process of the compression and sled velocity, and which defined in certification manual as follows,
 - Time zero is defined as the time of contact between the impact probe and the anterior surface the Jacket or Pelvis.
- Contact timing and point varies test-by-test by small difference of dummy setting, and results inaccurate responses, so the more reasonable definition should be considered
- As an example, following "time zero" definition is used to re-calculate the compression and sled velocity
 - the time at which the pendulum acceleration response crosses the 0.98m/s^2 (0.1G) level (ref. "time-zero definition of full-body certifications of ES-2 user manual)

