

**Vehicle Research and Test Center
FMVSS 213 Testing
CRABI 12 Month Old**

**Prepared By:
Transportation Research Center Inc.
10820 State Route 347
P. O. Box B-67
East Liberty, OH 43319**



Summary Report

March 2022

**Prepared For
Vehicle Research and Test Center
P. O. Box 37
East Liberty, OH 43319**

SECTION 1
PURPOSE AND SUMMARY FOR 12 MONTH OLD CRABI

The purpose of this test series was to evaluate the test bench and test procedures for the proposed FMVSS 213 frontal impact test.

SUMMARY

A CRABI 12 month old dummy (serial number 095) was secured in the left rear occupant position (position 4 or P4) in a rearward facing child restraint system (CRS). The CRABI 12 month old was instrumented with head, chest, and pelvic triaxial accelerometers, and upper neck, and lumbar force and moment load cells. During this test series the dummy was restrained with Lower Anchors (LA Only).

Section 2 contains testing performed using a rearward facing CRS. Section 3 contains the dummy certification information.

SECTION 2
REARWARD FACING CRS TEST SUMMARY

TEST DUMMY INFORMATION

Description	Position # 4 CRS
ATD Type/Serial No.	CRABI 12 Month Old/095
Restrain System	LA Only
CRS Direction	Rearward Facing
Foam Cushion	WB15

CAMERA POSITIONING FARO MEASUREMENTS

Description	Units	X	Y	Z
Origin	mm	0.00	0.00	0.00
N1 Driver Front	mm	--- ¹	--- ¹	--- ¹
Driver Side	mm	377.15	-893.72	-365.63

¹ Measurements not recorded

DUMMY POSITIONING

CRS: Chicco KeyFit 30 – Rearward Facing Infant – LA Only

TRC Test Number: S220307-1

VRTC Test Number: FR_BE_01



DUMMY POSITIONING FARO MEASUREMENTS

Description	Units	X	Y	Z
Z-Point	mm	-0.39	-0.10	0.44
Center of the seat frame bottom	mm	613.67	350.34	-105.48
CRS base center	mm	627.30	350.08	-270.53
CRS mid-height	mm	691.26	350.96	-460.72
Top of CRS	mm	696.28	351.65	-618.74
CRS handle center	mm	740.69	352.02	-640.72
CRS bottom strap center	mm	131.57	349.63	-363.99
Top of the head	mm	589.78	350.80	-633.63
Bridge of nose	Mm	498.31	350.89	-592.44
Head CG outboard	mm	573.95	286.57	-567.61
Chest Clip	mm	461.42	349.18	-485.64
Buckle	mm	332.77	349.93	-396.78
Knee pivot	mm	248.41	273.50	-368.49
CRS side handle	mm	433.96	137.40	-408.07
CRS 1	mm	610.28	207.95	-504.01
CRS 4	mm	497.21	156.85	-265.46
CRS 2	mm	382.06	187.98	-322.98
CRS 3	mm	134.65	170.34	-286.65
Center of seat frame back	mm	-120.39	350.01	-680.59

DUMMY INJURY

HIC (36 ms)	343
Chest Clip (3 ms)	43.2 g
Max Seat Back Angle (from vertical)	51.4°

SECTION 3
DUMMY CALIBRATION DATA

Transportation Research Center Inc. ATD Certification Report

Customer:

Vehicle Research and Test Center
10820 State Rout 347
East Liberty, Ohio 43319

Anthropomorphic Device:

CRABI (12) Month Old
Serial No. 095
Certification No. 11



**Transportation Research Center Inc.
P.O. Box B-67
10820 St. Rt. 347
East Liberty, OH 43319-0367**

Table of Contents

Introduction	Page 3
Appendix A – Incoming Inspection	Page 4
Findings	Page 5
Photographs	Page 6
Summary of Action Items	Page 7
Appendix B – Test Results	Page 8
Front Head Drop Certification	Page 9
Rear Head Drop Certification	Page 11
Neck Flexion Certification	Page 13
Neck Extension Certification	Page 17
Front Thorax Certification	Page 21
Appendix C – TRC Inc. Quality Assurance	Page 23

Introduction

Customer Name: VRTC
Customer Contact: Bryan Crabtree
Email: Bryan.Crabtree.CTR@dot.gov
Phone: (937) 666-2011
Date Received: February 23, 2022
Date Completed: February 24, 2022

Special Instruction: N/A

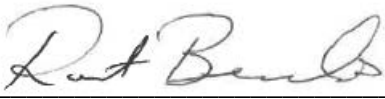
This Certification Report meets the requirements set forth by the ANSI National Accreditation Board ISO/IEC 17025:2017 accreditation under the scope of Mechanical Testing for Crash Test Dummy Certification Testing (ANAB Certificate #L2187). **This testing certification shall not be reproduced, except in full, without written approval of TRC Inc.**

The evidence measurements of this Certification Report are traceable by the Serial Number and Certification Number located at the top of the first section for each certification.

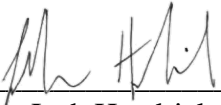
Each certification test was conducted by an authorized Transportation Research Center Inc. (TRC Inc.) employee within the requirements of the ISO/IEC 17025:2017 standards and adheres to CFR Part 572 Subparts B, E, N, O, P, R, T, U, V, SAE J2860, J2856, J2862; depending on ATD type. Any statements of conformity in this report are made using the shared risk method.

Each component of the ATD to be tested was contained in a temperature controlled environment for a period of at least 4 hours before the test. The temperature in the ATD Certification Laboratory was between 20.6°C and 22.2°C (69.08°F – 71.96°F). The relative humidity in the ATD Certification Laboratory was between 10% and 70%.

Date Received: 02/23/2022

Testing Conducted by: 
Robert Benavides

Date: 02/24/2022

Testing Approved by: 
Josh Hendricks

Date: 02/24/2022

Appendix A – Incoming Inspection



TRC ATD Laboratory As Received Inspection Report

Name: Robert Benavides

Date: 2/24/2022

Customer: VRTC

ATD S/N: 095

HEAD / NECK		
No.	Comments	Photo No.
1	None to report.	
2		
3		

THORAX / ABDOMEN		
No.	Comments	Photo No.
4	None to report.	
5		
6		

SHOULDERS / ARMS		
No.	Comments	Photo No.
7	None to report.	
8		
9		

PELVIS / LUMBAR		
No.	Comments	Photo No.
10	None to report.	
11		
12		

FEMUR / KNEES		
No.	Comments	Photo No.
13	None to report.	
14		
15		

LOWER LEGS / FEET		
No.	Comments	Photo No.
16	None to report.	
17		
18		





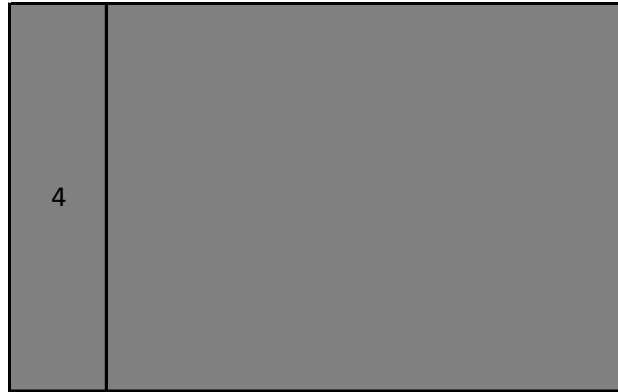
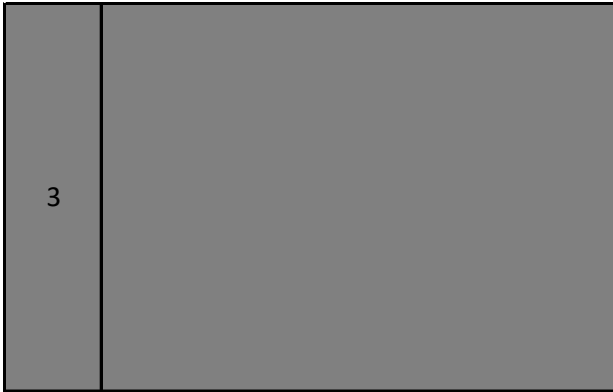
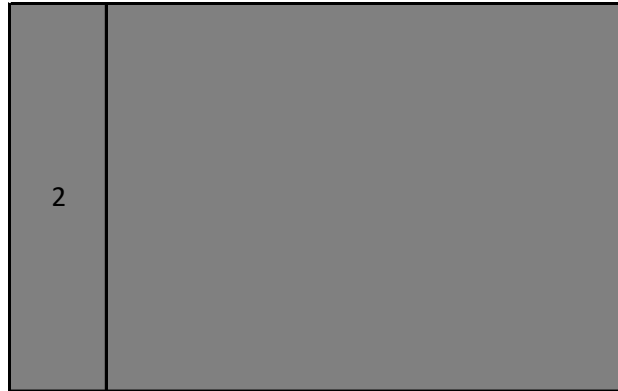
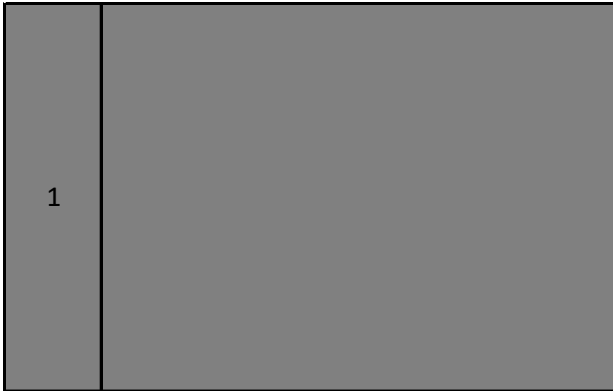
TRC ATD Laboratory As Received Inspection Photos

Name: Robert Benavides

Date: 2/24/2022

Customer: VRTC

ATD S/N: 095





TRC ATD Laboratory Inspection Report Action Items

Name: Robert Benavides

Date: 2/24/2022

Customer: VRTC

ATD S/N: 095

Action #1	None to report.
Resolution #1	
Action #2	
Resolution #2	
Action #3	
Resolution #3	
Comments	



Appendix B – Test Results

Transportation Research Center Inc.

Front Head Drop

CRABI 12 MO Serial No. 095 Certification No. 11-1

Test Date: 2/24/2022

Test Parameter	Specification	Test Results	Pass
Temperature	18.9 - 25.6 °C	21.3 °C	Yes
Relative Humidity	10 - 70 %	30 %	Yes
Peak Head Resultant Acceleration	100 - 120 g	112.6 g	Yes
Peak Head Lateral Acceleration	(-15) - 15 g	2.2 g	Yes
Is Acceleration Curve Unimodal within 17% of Peak?	< 17 %	9.40 %	Yes

Test meets specifications.

Condition: Used

Comments:

Head Skin S/N: 1710001

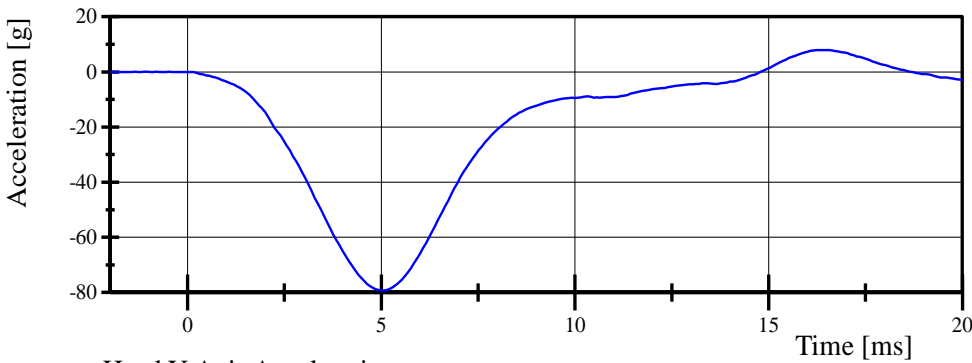
Transportation Research Center Inc.

Front Head Drop

CRABI 12 MO Serial No. 095 Certification No. 11-1

Test Date: 2/24/2022

Head X-Axis Acceleration

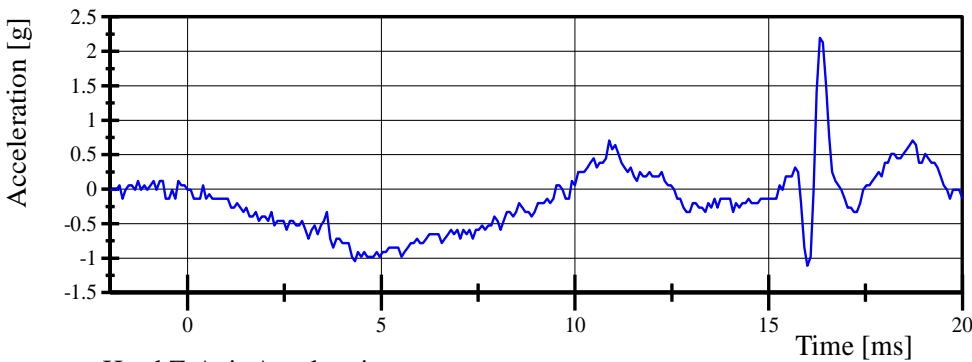


Filter Class: CFC_1000

Max: 8.0 g at 16.3 ms

Min: -79.3 g at 5.0 ms

Head Y-Axis Acceleration

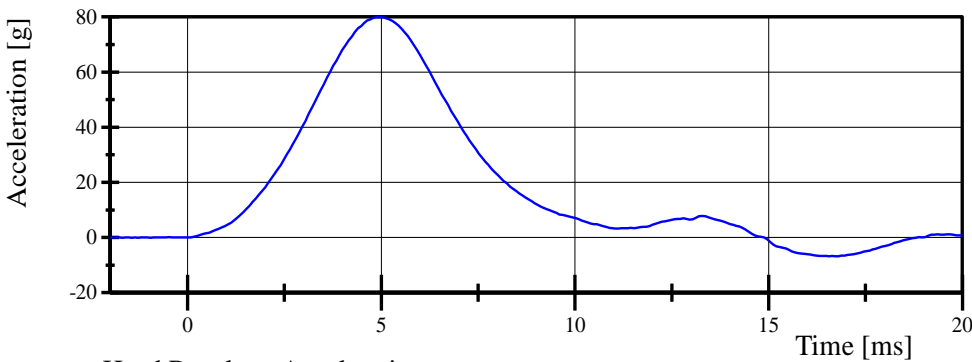


Filter Class: CFC_1000

Max: 2.2 g at 16.3 ms

Min: -1.1 g at 16.0 ms

Head Z-Axis Acceleration

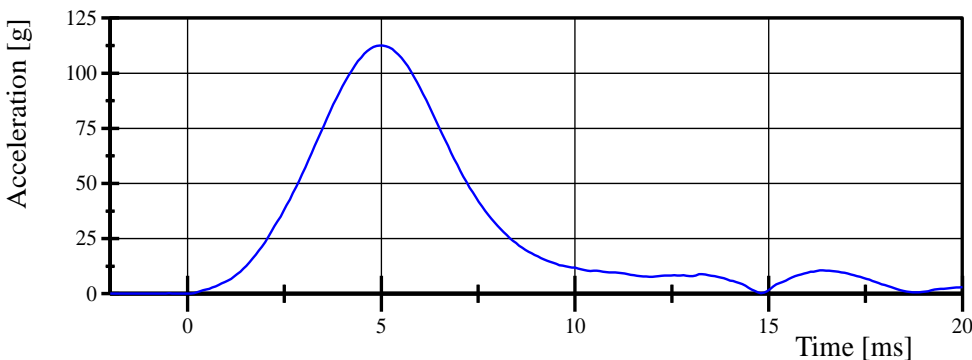


Filter Class: CFC_1000

Max: 80.0 g at 4.9 ms

Min: -6.8 g at 16.6 ms

Head Resultant Acceleration



Filter Class: CFC_1000

Max: 112.6 g at 5.0 ms

Min: 0.0 g at -1.9 ms

Transportation Research Center Inc.

Rear Head Drop

CRABI 12 MO Serial No. 095 Certification No. 11-1

Test Date: 2/24/2022

Test Parameter	Specification	Test Results	Pass
Temperature	18.9 - 25.6 °C	21.9 °C	Yes
Relative Humidity	10 - 70 %	34 %	Yes
Peak Head Resultant Acceleration	55 - 71 g	61.7 g	Yes
Peak Head Lateral Acceleration	(-15) - 15 g	-2.0 g	Yes
Is Acceleration Curve Unimodal within 17% of Peak?	< 17 %	13.48 %	Yes

Test meets specifications.

Condition: Used

Comments:

Head Skin S/N: 1710001

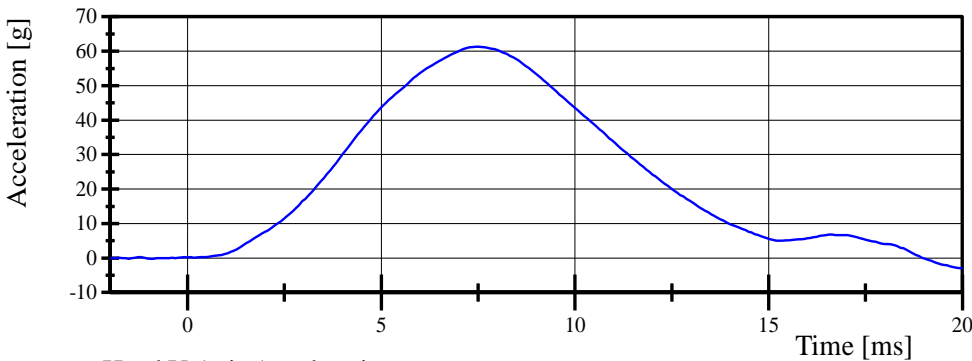
Transportation Research Center Inc.

Rear Head Drop

CRABI 12 MO Serial No. 095 Certification No. 11-1

Test Date: 2/24/2022

Head X-Axis Acceleration

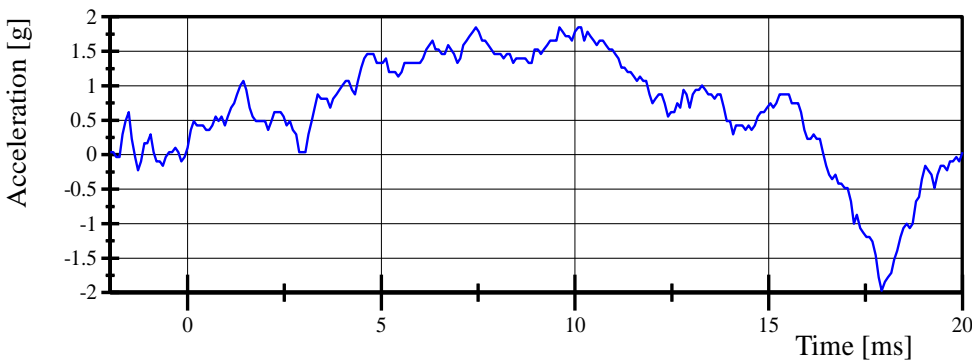


Filter Class: CFC_1000

Max: 61.3 g at 7.4 ms

Min: -3.0 g at 20.0 ms

Head Y-Axis Acceleration

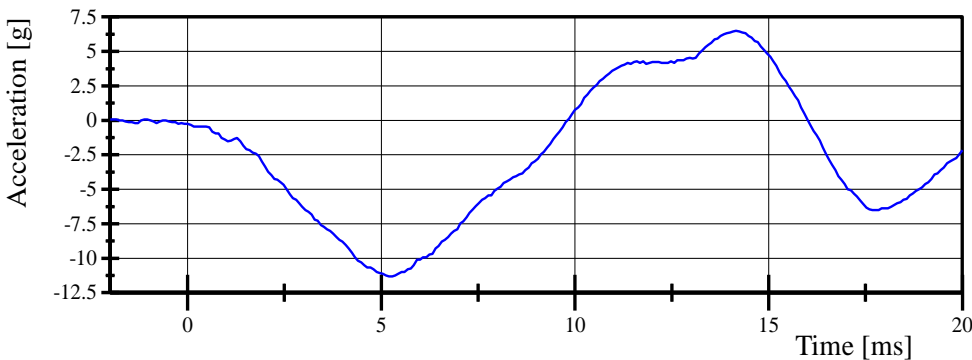


Filter Class: CFC_1000

Max: 1.8 g at 7.4 ms

Min: -2.0 g at 17.9 ms

Head Z-Axis Acceleration

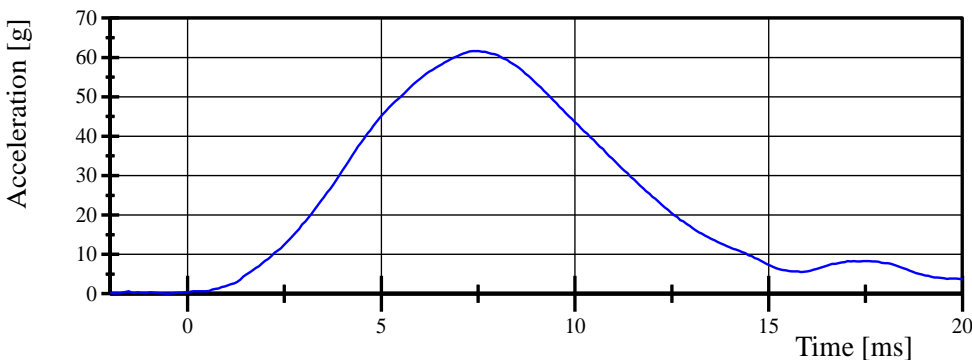


Filter Class: CFC_1000

Max: 6.5 g at 14.2 ms

Min: -11.3 g at 5.2 ms

Head Resultant Acceleration



Filter Class: CFC_1000

Max: 61.7 g at 7.4 ms

Min: 0.0 g at -0.6 ms

Transportation Research Center Inc.

Neck Flexion

CRABI 12 MO Serial No. 095 Certification No. 11-4

Test Date: 2/24/2022

Test Parameter	Specification	Test Results	Pass
Temperature	20.6 - 22.2 °C	21.9 °C	Yes
Relative Humidity	10 - 70 %	33 %	Yes
Pendulum Velocity	5.1 - 5.3 m/s	5.30 m/s	Yes
Pendulum Integrated Velocity Change at 10ms	(-1.6) - (-2.3) m/s	-1.90 m/s	Yes
Pendulum Integrated Velocity Change at 20ms	(-3.4) - (-4.2) m/s	-3.83 m/s	Yes
Pendulum Integrated Velocity Change at 25ms	(-4.3) - (-5.2) m/s	-4.68 m/s	Yes
Total Head D-Plane Rotation	(-75) - (-86) °	-75.2 °	Yes
Total Neck Occipital Condyles Moment	36 - 45 N·m	37.6 N·m	Yes
Total Neck Occipital Condyles Moment Decay to 5 Nm	60 - 80 ms	71.0 ms	Yes

Test meets specifications.

Condition: Used

Comments:

Neck S/N: 310

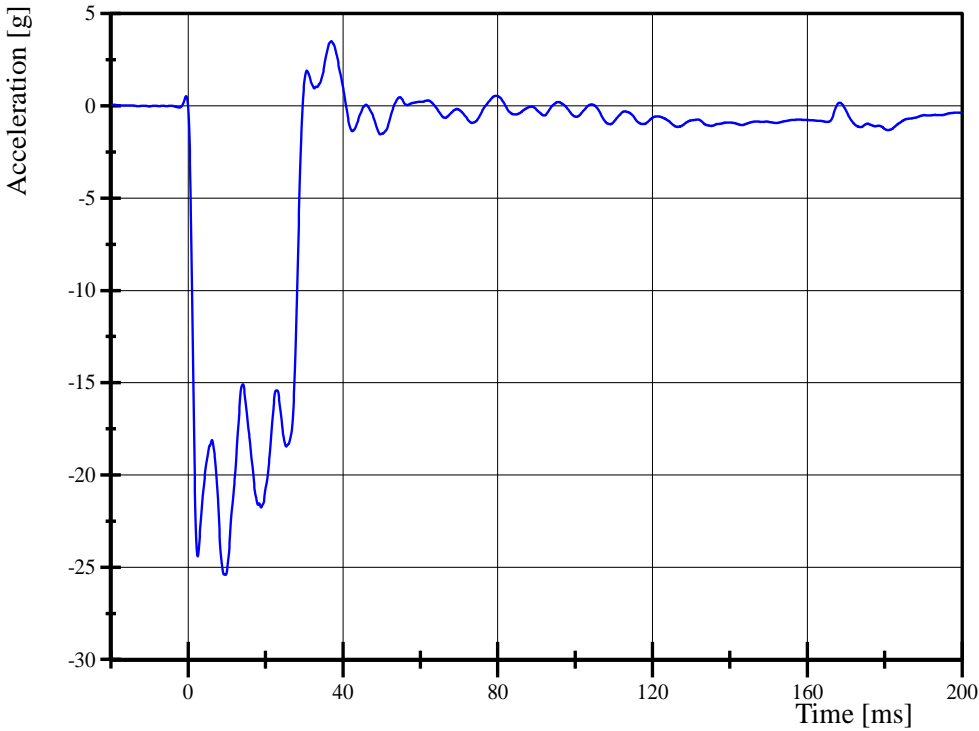
Transportation Research Center Inc.

Neck Flexion

CRABI 12 MO Serial No. 095 Certification No. 11-4

Test Date: 2/24/2022

Pendulum Acceleration

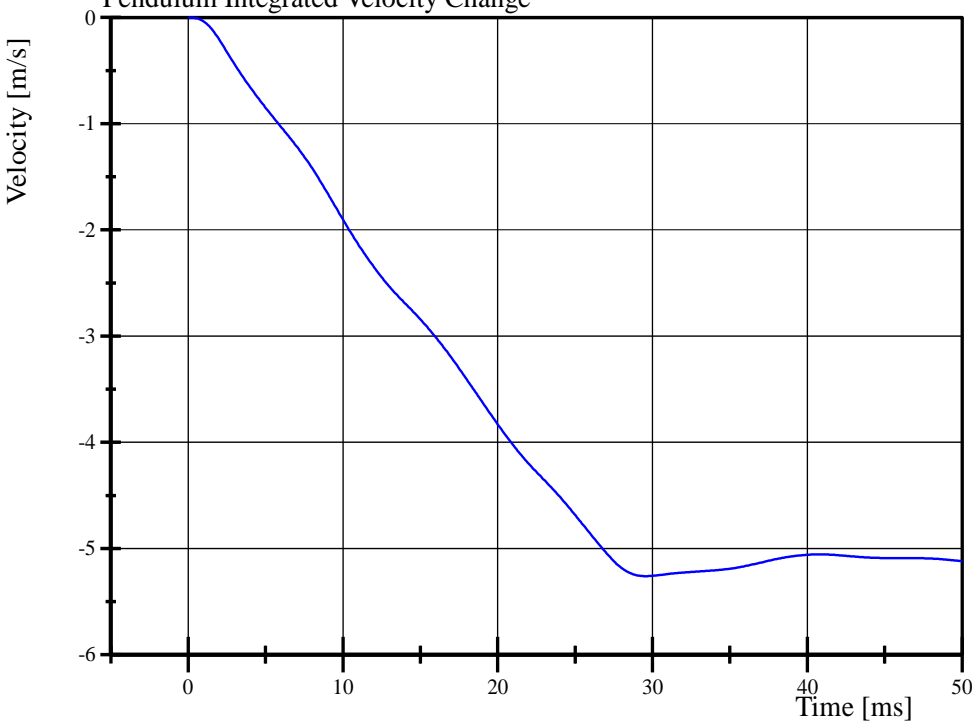


Filter Class: CFC_180

Max: 3.5 g at 37.0 ms

Min: -25.4 g at 9.8 ms

Pendulum Integrated Velocity Change



Filter Class: CFC_180

Max: 0.0 m/s at 0.0 ms

Min: -5.3 m/s at 29.6 ms

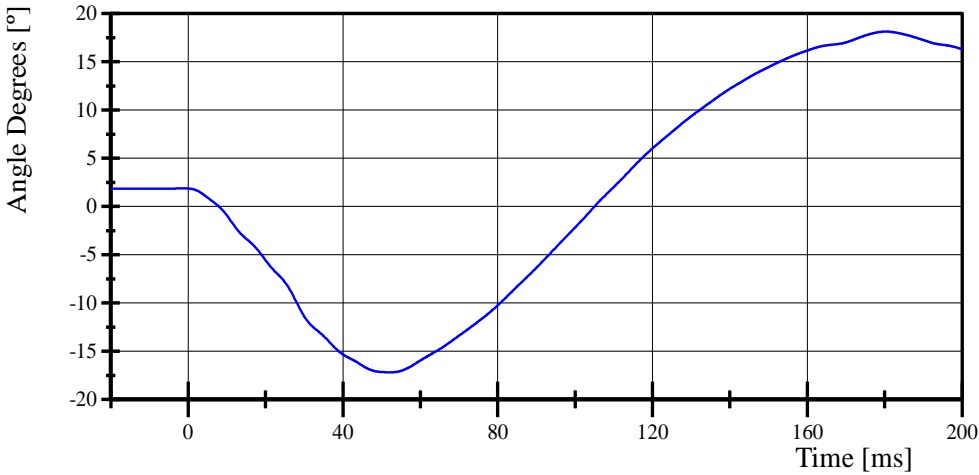
Transportation Research Center Inc.

Neck Flexion

CRABI 12 MO Serial No. 095 Certification No. 11-4

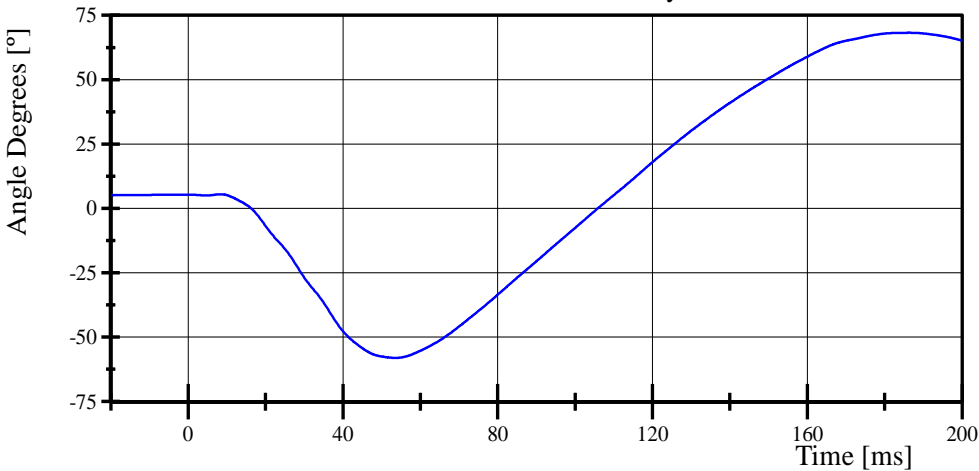
Test Date: 2/24/2022

Forward Pot Rotation at Base of Pendulum



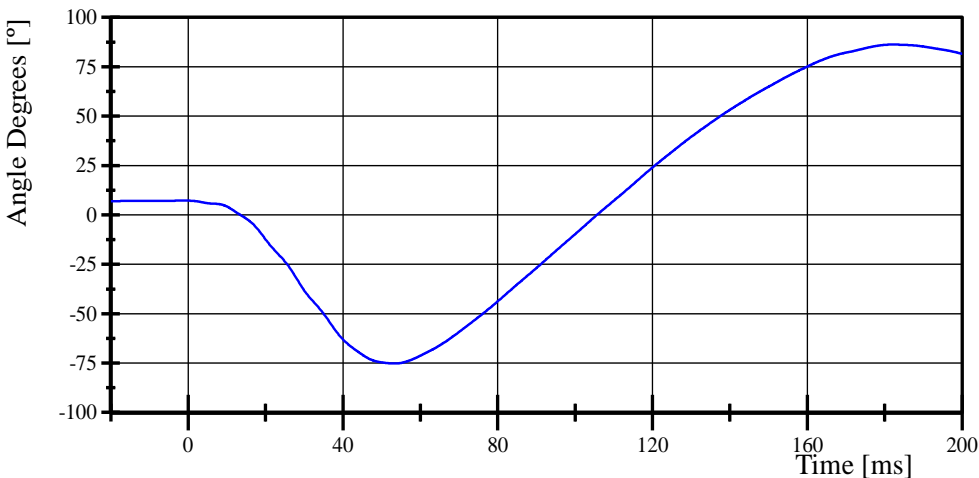
Filter Class: CFC_60
Max: 18.1 ° at 180.3 ms
Min: -17.2 ° at 52.3 ms

Center Headform Pot Rotation at Center of Gravity



Filter Class: CFC_60
Max: 68.2 ° at 186.3 ms
Min: -58.1 ° at 53.5 ms

Total Head D-Plane Rotation



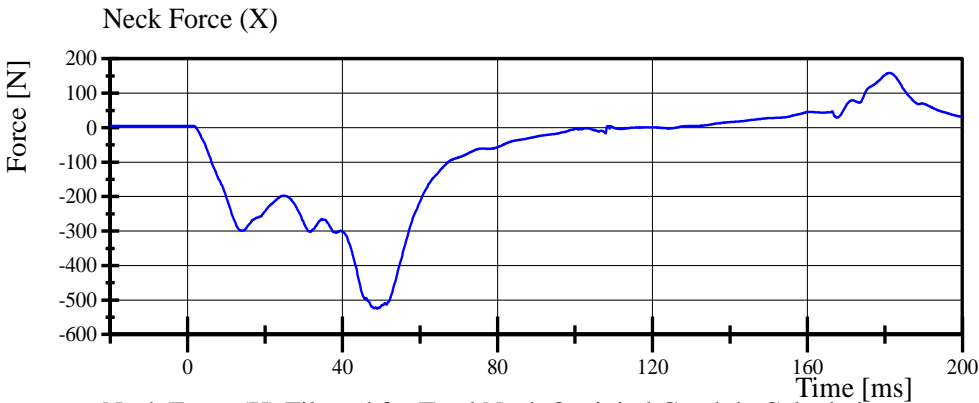
Filter Class: CFC_60
Max: 86.2 ° at 182.0 ms
Min: -75.2 ° at 53.3 ms

Transportation Research Center Inc.

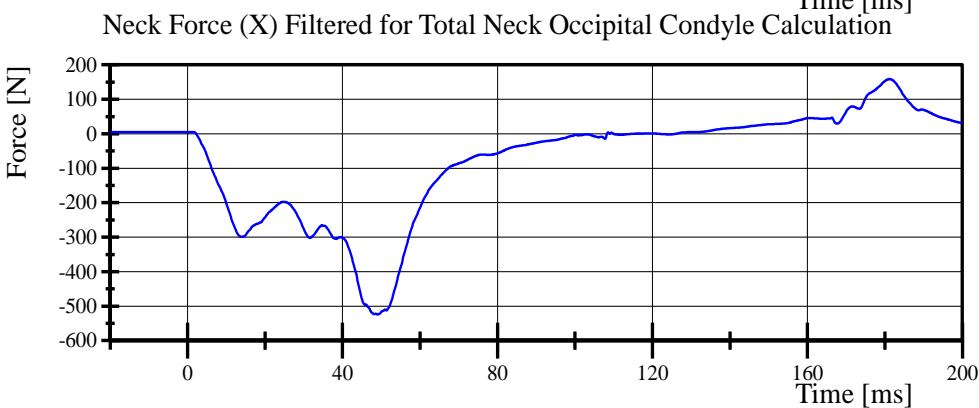
Neck Flexion

CRABI 12 MO Serial No. 095 Certification No. 11-4

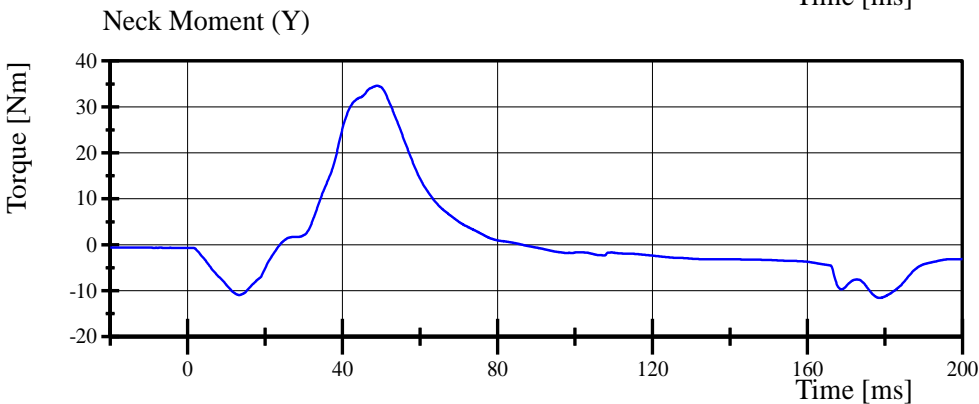
Test Date: 2/24/2022



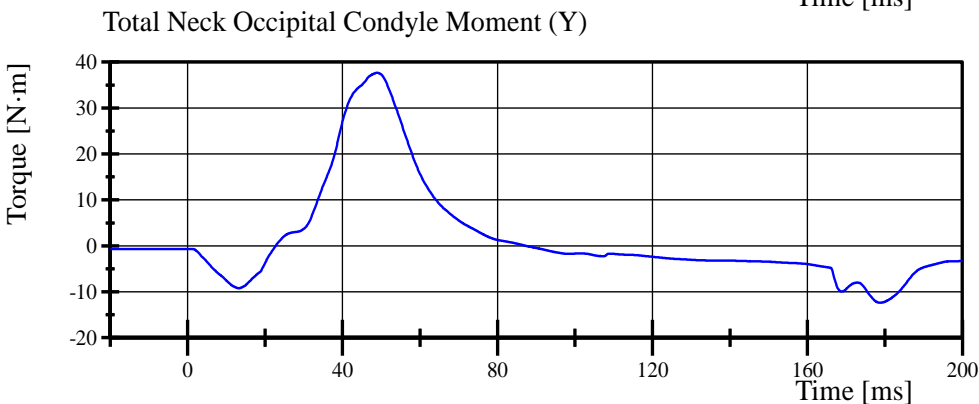
Filter Class: CFC_1000
Max: 158.5 N at 181.1 ms
Min: -524.9 N at 49.0 ms



Filter Class: CFC_600
Max: 158.4 N at 181.1 ms
Min: -524.1 N at 49.0 ms



Filter Class: CFC_600
Max: 34.6 Nm at 48.8 ms
Min: -11.6 Nm at 178.6 ms



Filter Class: Without_(Constar
Max: 37.6 N·m at 48.8 ms
Min: -12.4 N·m at 178.8 ms

Transportation Research Center Inc.

Neck Extension

CRABI 12 MO Serial No. 095 Certification No. 11-1

Test Date: 2/24/2022

Test Parameter	Specification	Test Results	Pass
Temperature	20.6 - 22.2 °C	21.7 °C	Yes
Relative Humidity	10 - 70 %	32 %	Yes
Pendulum Velocity	(-2.4) - (-2.6) m/s	-2.52 m/s	Yes
Pendulum Integrated Velocity Change at 6ms	0.8 - 1.2 m/s	0.85 m/s	Yes
Pendulum Integrated Velocity Change at 10ms	1.5 - 2.1 m/s	1.63 m/s	Yes
Pendulum Integrated Velocity Change at 14ms	2.2 - 2.9 m/s	2.41 m/s	Yes
Total Head D-Plane Rotation	80 - 92 °	84.5 °	Yes
Total Neck Occipital Condyles Moment	(-12) - (-23) N·m	-16.0 N·m	Yes
Total Neck Occipital Condyles Moment Decay to -5 Nm	76 - 90 ms	81.6 ms	Yes

Test meets specifications.

Condition: Used

Comments:

Neck S/N: 310

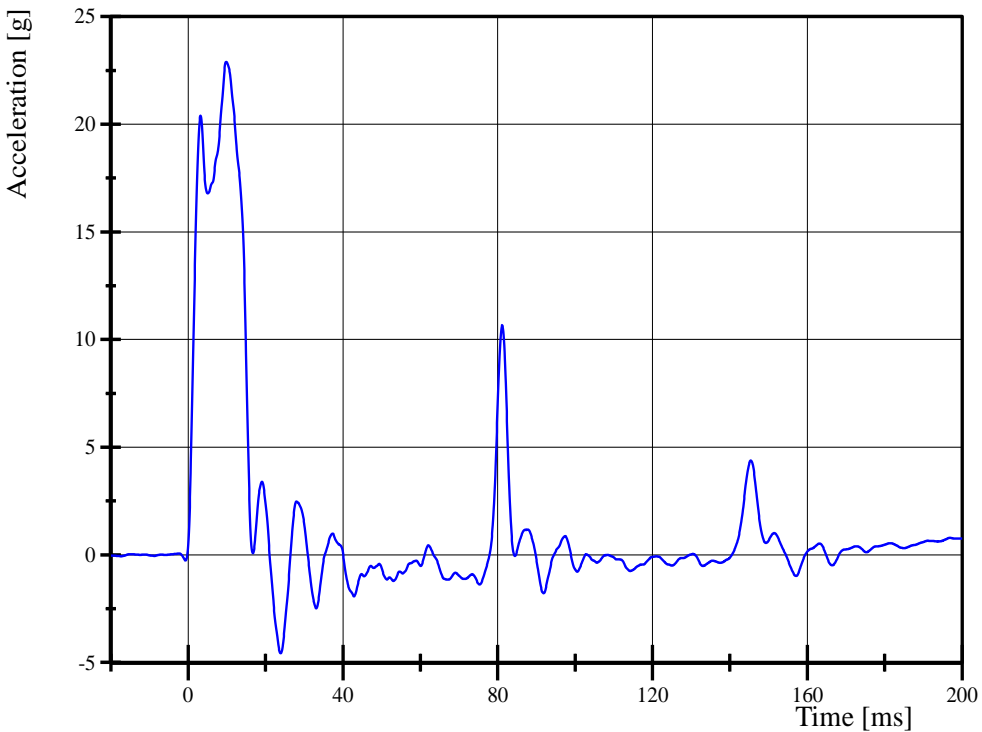
Transportation Research Center Inc.

Neck Extension

CRABI 12 MO Serial No. 095 Certification No. 11-1

Test Date: 2/24/2022

Pendulum Acceleration

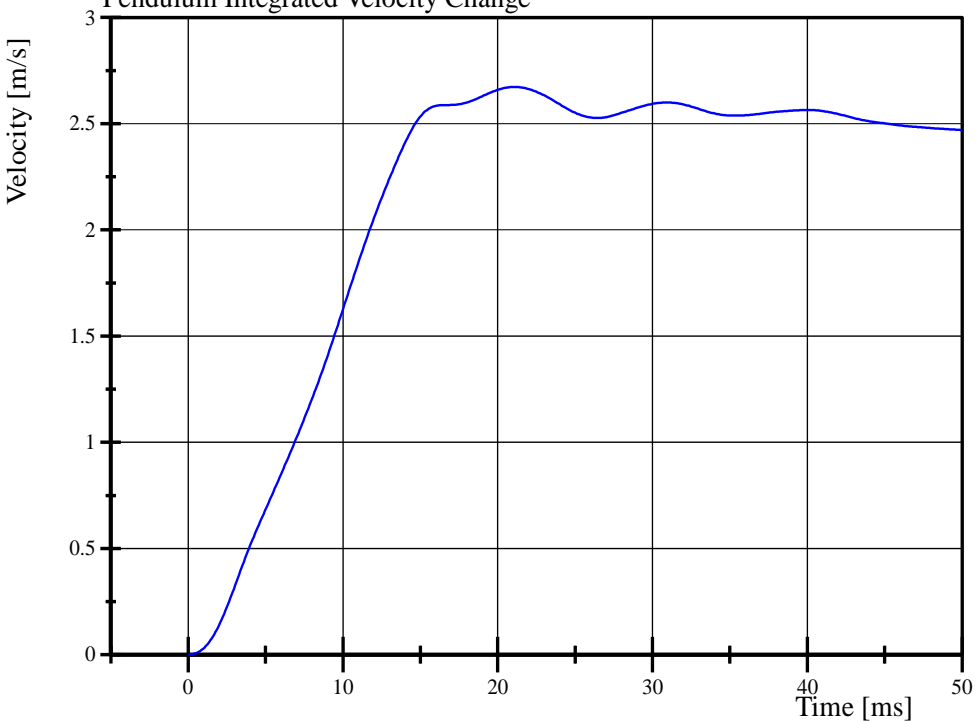


Filter Class: CFC_180

Max: 22.9 g at 9.8 ms

Min: -4.6 g at 23.9 ms

Pendulum Integrated Velocity Change



Filter Class: CFC_180

Max: 2.7 m/s at 21.0 ms

Min: 0.0 m/s at 0.0 ms

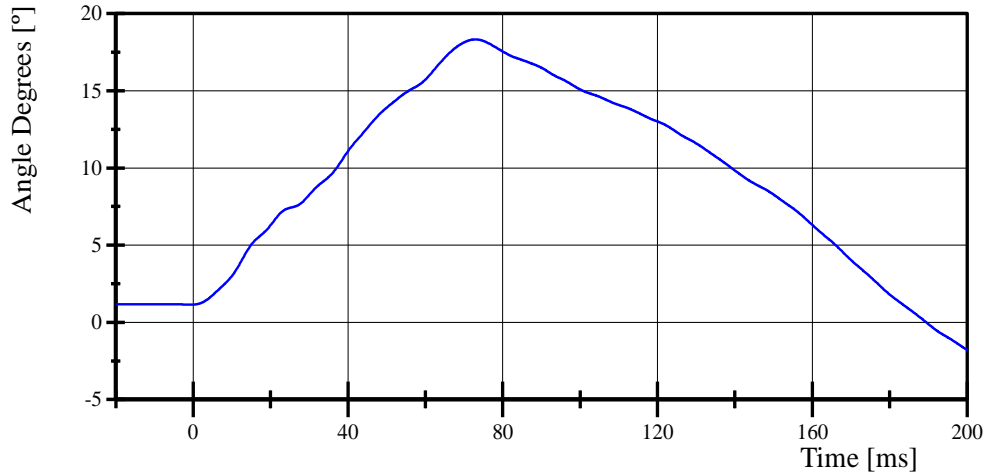
Transportation Research Center Inc.

Neck Extension

CRABI 12 MO Serial No. 095 Certification No. 11-1

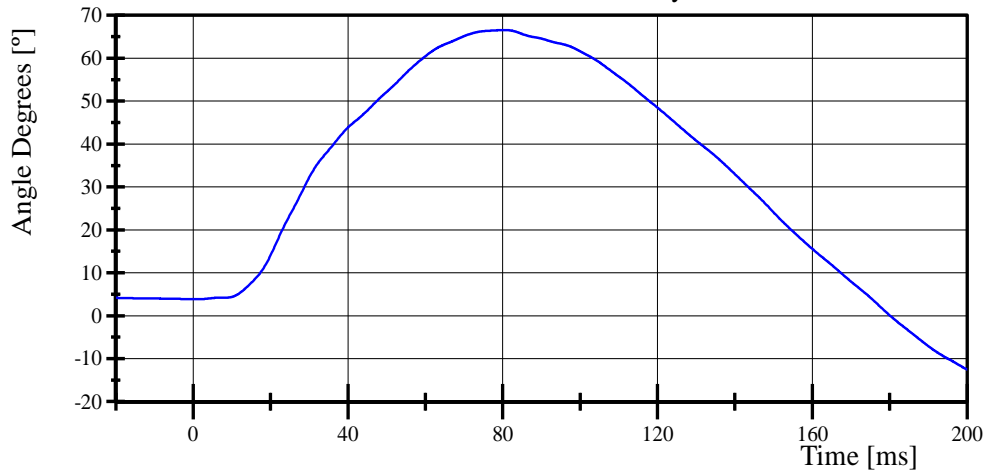
Test Date: 2/24/2022

Forward Pot Rotation at Base of Pendulum



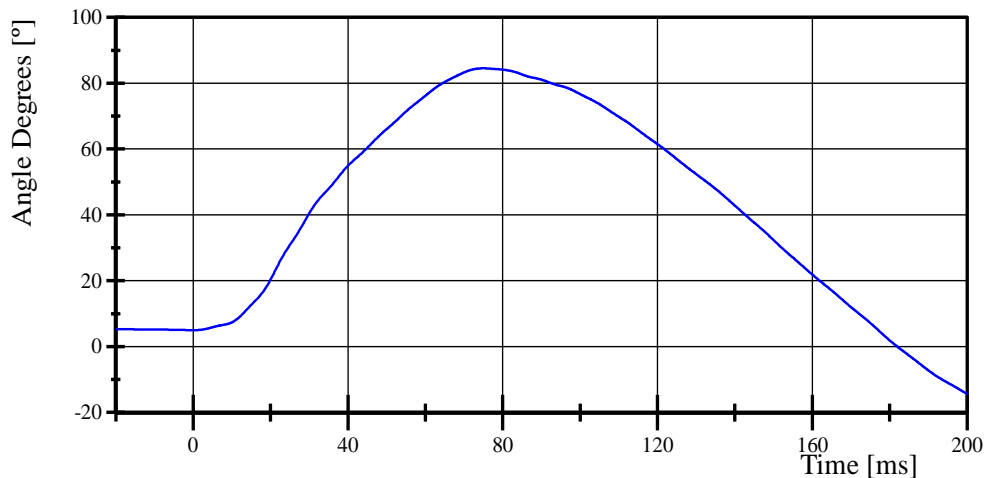
Filter Class: CFC_60
Max: 18.3 ° at 72.9 ms
Min: -1.8 ° at 200.0 ms

Center Headform Pot Rotation at Center of Gravity



Filter Class: CFC_60
Max: 66.6 ° at 80.4 ms
Min: -12.6 ° at 200.0 ms

Total Head D-Plane Rotation



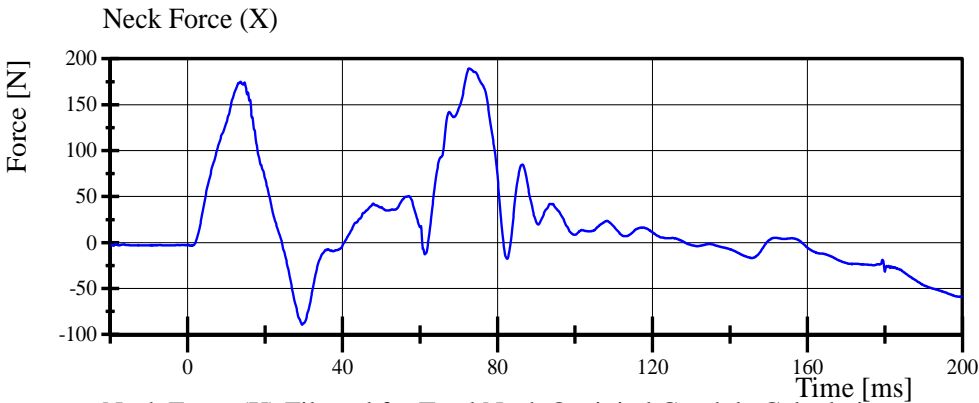
Filter Class: CFC_60
Max: 84.5 ° at 75.0 ms
Min: -14.4 ° at 200.0 ms

Transportation Research Center Inc.

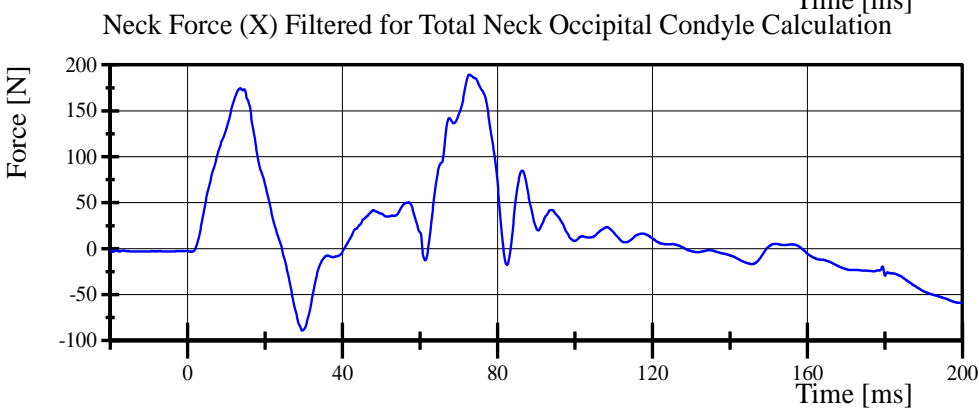
Neck Extension

CRABI 12 MO Serial No. 095 Certification No. 11-1

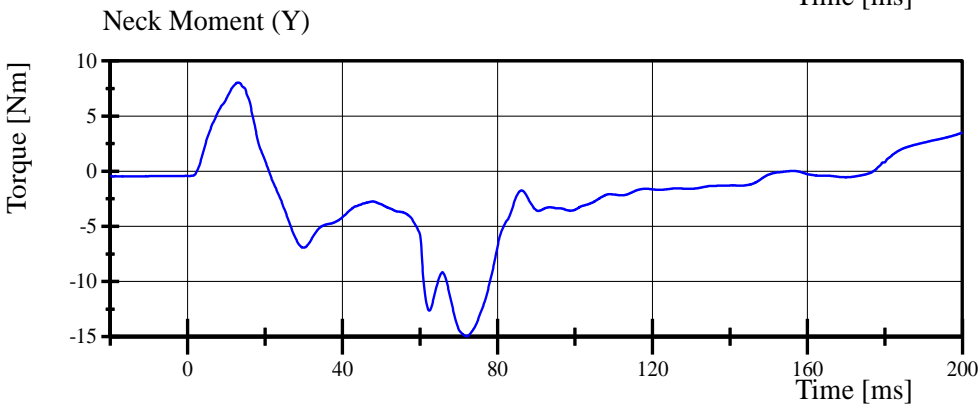
Test Date: 2/24/2022



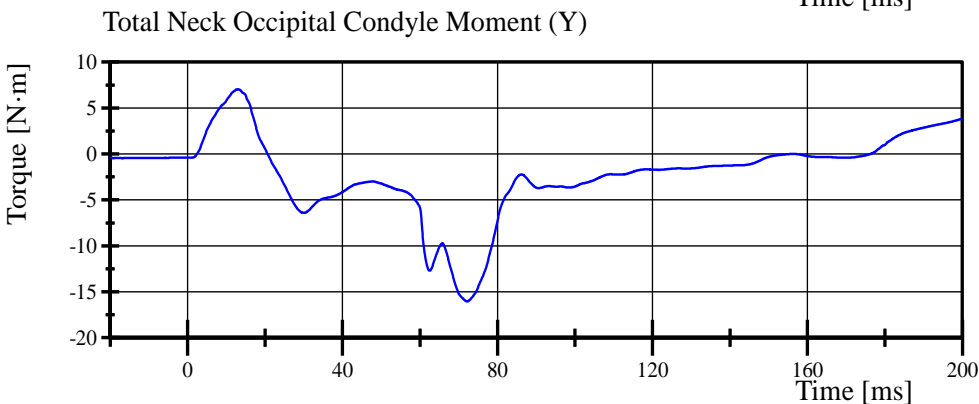
Filter Class: CFC_1000
Max: 189.4 N at 72.7 ms
Min: -89.3 N at 29.6 ms



Filter Class: CFC_600
Max: 189.4 N at 72.7 ms
Min: -89.1 N at 29.6 ms



Filter Class: CFC_600
Max: 8.0 Nm at 13.0 ms
Min: -15.0 Nm at 72.1 ms



Filter Class: Without_(Constar
Max: 7.0 N·m at 13.0 ms
Min: -16.0 N·m at 72.2 ms

Transportation Research Center Inc.

Front Thorax

CRABI 12 MO Serial No. 095 Certification No. 11-1

Test Date: 2/24/2022

Test Parameter	Specification	Test Results	Pass
Temperature	20.6 - 22.2 °C	21.4 °C	Yes
Relative Humidity	10 - 70 %	30 %	Yes
Impactor Velocity	4.9 - 5.1 m/s	4.92 m/s	Yes
Impactor Force	(-1,514) - (-1,796) N	-1,616.3 N	Yes

Test meets specifications.

Condition: Used

Comments:

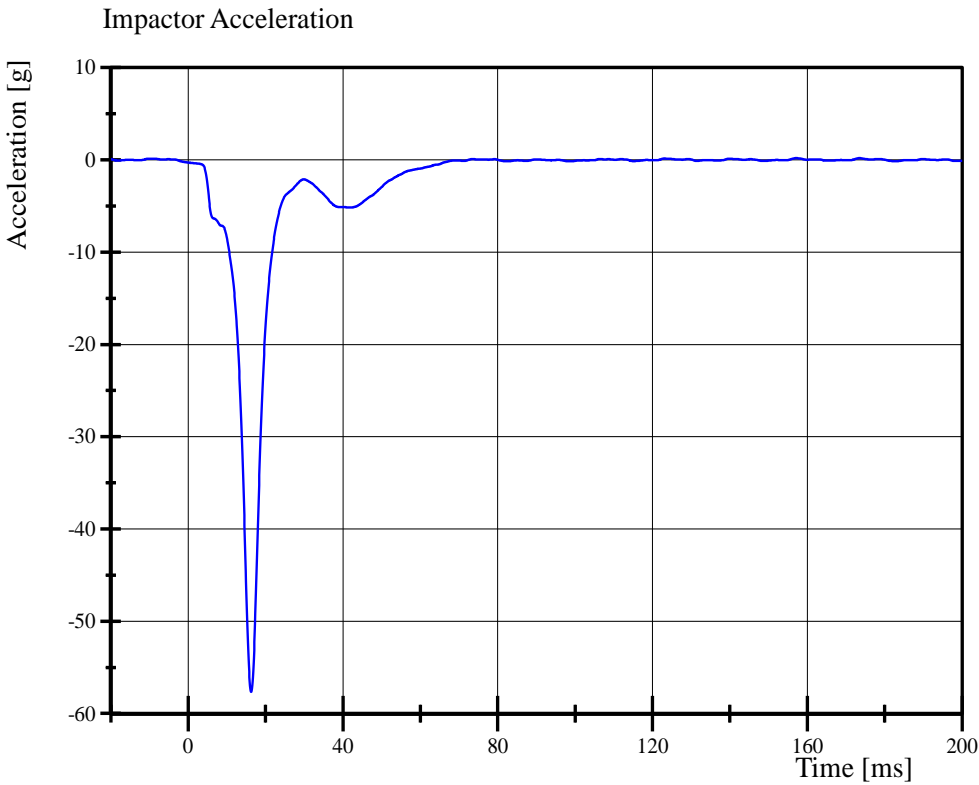
Jacket S/N: N/A

Transportation Research Center Inc.

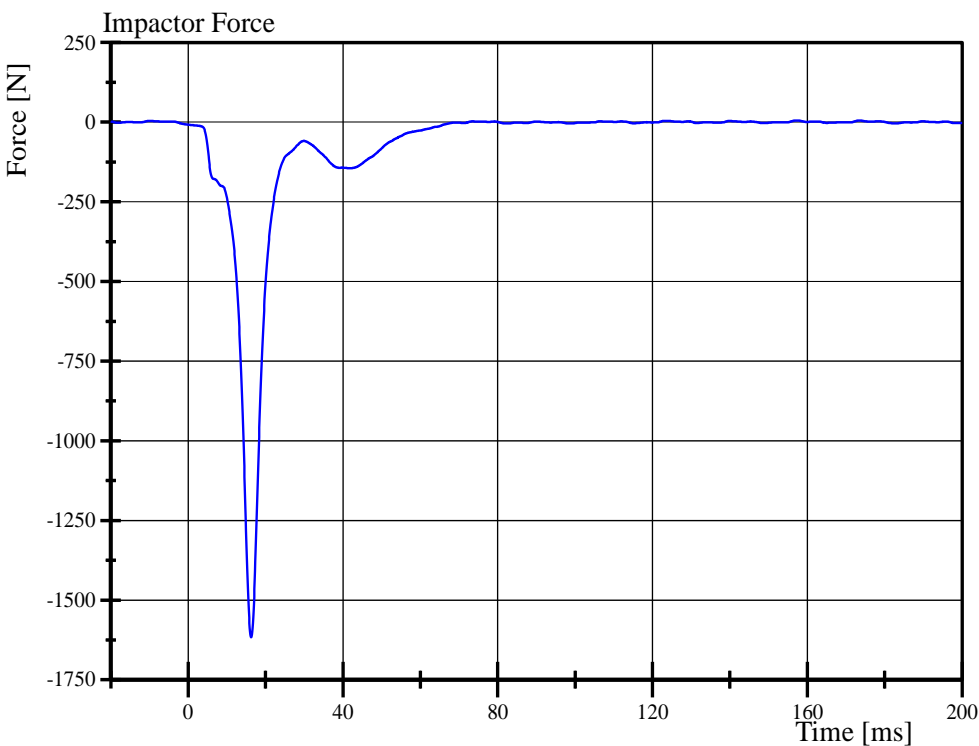
Front Thorax

CRABI 12 MO Serial No. 095 Certification No. 11-1

Test Date: 2/24/2022



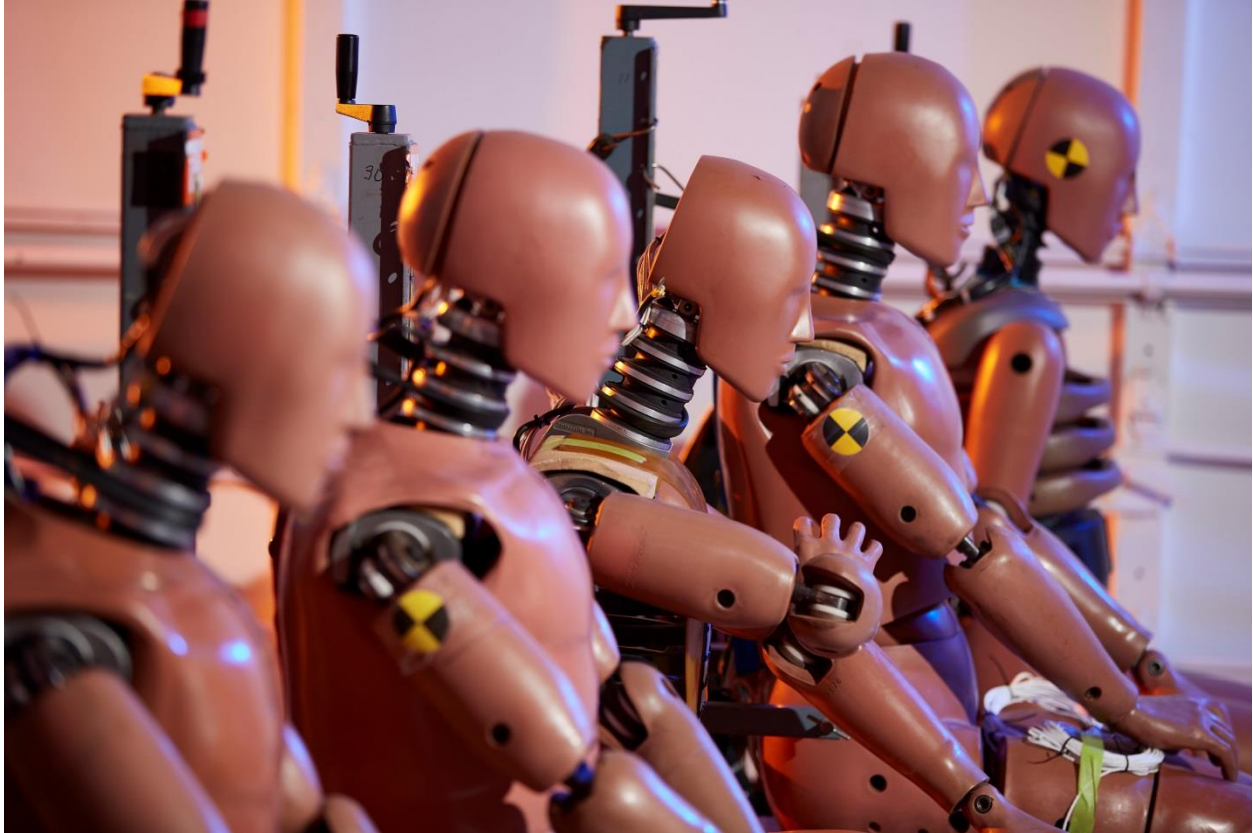
Filter Class: CFC_180
Max: 0.2 g at 173.5 ms
Min: -57.6 g at 16.2 ms



Filter Class: CFC_180
Max: 5.1 N at 173.5 ms
Min: -1,616.3 N at 16.2 ms

Appendix C – Quality Assurance

Quality Assurance



ATD Assembly & Final Inspection

ATD Type: CRABI (12) Month Old

ATD Serial Number: 095

Assembled by: *Dot Benda*

Date Inspected: 02/24/2022