

BioRID II R&R Comparison Series 2 vs. Series 1

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Test Series

- Series 1:
 - Dummies: D028, D068, D077, D100
 - Testing Site: BASt
 - Seat: TRL Seat Rig
 - Repeats: 5
- Series 2:
 - Dummies: D054, D068, D077, D100
 - Testing Site: BASt
 - Seat: TRL Seat Rig
 - Repeats: 6

Test Matrices

Test Order	Test #	Dummy	Date	Day	Week
1	M111216001	D100	12/16/2011	Friday	1
2	M111219001	D077	12/19/2011	Monday	2
3	M111220001	D077	12/20/2011	Tuesday	
4	M111220004	D100	12/20/2011	Tuesday	
5	M111221001	D100	12/21/2011	Wednesday	
6	M111221002	D077	12/21/2011	Wednesday	
7	M111222001	D068	12/22/2011	Thursday	
8	M111223001	D028	Unknown	Unknown	5
9	M120109002	D068	1/9/2012	Monday	
10	M120109007	D028	1/9/2012	Monday	
11	M120110002	D028	1/10/2012	Tuesday	
12	M120110003	D068	1/10/2012	Tuesday	
13	M120111001	D068	1/11/2012	Wednesday	
14	M120111002	D028	1/11/2012	Wednesday	
15	M120111003	D100	1/11/2012	Wednesday	
16	M120112001	D077	1/12/2012	Thursday	
17	M120112002	D077	1/12/2012	Thursday	
18	M120112003	D100	1/12/2012	Thursday	
19	M120113001	D068	1/13/2012	Friday	
20	M120113003	D028	Unknown	Unknown	

Test Order	Test #	Dummy	Date	Day	Week
1	M120917001	D068	9/17/2012	Monday	1
2	M120918001	D077	9/19/2012	Wednesday	
3	M120919001	D077	9/19/2012	Wednesday	
4	M120920001	D068	9/20/2012	Thursday	
5	M120920002	D054	9/20/2012	Thursday	2
6	M120924001	D054	9/24/2012	Monday	
7	M120924002	D100	9/24/2012	Monday	
8	M120924004	D100	9/24/2012	Monday	
9	M120925001	D100	9/25/2012	Tuesday	
10	M120925002	D054	9/25/2012	Tuesday	
11	M120925004	D068	9/25/2012	Tuesday	
12	M120926001	D077	9/26/2012	Wednesday	
13	M121010001	D054	10/10/2012	Wednesday	4
14	M121010002	D054	10/10/2012	Wednesday	
15	M121010003	D068	10/10/2012	Wednesday	
16	M121010004	D077	10/15/2012	Monday	5
17	M121015001	D100	10/15/2012	Monday	
18	M121015002	D054	10/15/2012	Monday	
19	M121017001	D068	10/17/2012	Wednesday	
20	M121017002	D100	10/17/2012	Wednesday	
21	M121017003	D077	10/17/2012	Wednesday	
22	M121017004	D077	10/17/2012	Wednesday	
23	M121018001	D100	10/18/2012	Thursday	
24	M121018002	D068	10/18/2012	Thursday	

Test Series #2 – Rebuilt Dummies

- Bumpers:
 - All new bumpers
 - Each bumper type from the same batch of material
- Jackets:
 - Three (3) new jackets for D054, D068, and D077
 - Kept original jacket for D100 (matched the other jackets)
- Pelvises:
 - New flesh/foam for all four (4) dummies

Comparison Results

Show result plots

- Head
- Neck
- Thorax
- Lumber
- Pelvis

Results Summary

- Reported score based on the average for each evaluation criteria
- Score values:

		Score
Good	$\geq 97.5\%$	3
Acceptable	$\geq 95.0\%$	2
Marginal	$\geq 90.0\%$	1
Poor	$< 90.0\%$	0

- Average score for each evaluation criteria is reported in column "All"

Results Summary – Test Series #1

		Shape													Magnitude CVs - Reproducibility														
		Repeatability					Reproducibility								Taxicab					Euclidian					Infinity				
							D028	D028	D028	D066	D066	D077		D028						D066	D077	D100	All	D028	D066	D077	D100	All	D028
		D028	D066	D077	D100	All	D066	D077	D100	D077	D100	D100	All	D028	D066	D077	D100	All	D028	D066	D077	D100	All	D028	D066	D077	D100	All	
Head	Ax	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	2.75	2	2	3	2	2.25	1	2	3	2	2	
	Az	2	3	3	2	2.5	1	2	1	0	2	0	1	3	1	0	2	1.5	3	1	0	1	1.25	3	2	1	0	1.5	
Neck	Upper	Fx	3	3	3	3	3	2	3	2	2	3	2	2.333	3	2	3	3	2.75	3	3	1	2	2.25	0	1	2	3	1.5
		Fz	3	3	3	3	3	2	3	3	1	3	2	2.333	3	0	0	3	1.5	1	0	0	3	1	0	0	0	2	0.5
		My	3	3	3	3	3	1	1	2	0	1	1	1	1	1	0	0	1	0.5	1	0	0	1	0.5	0	0	0	1
	Lower	C4 Ax	3	3	3	2	2.75	3	3	2	2	3	2	2.5	2	3	3	2	2.5	1	1	2	3	1.75	0	0	3	3	1.5
		C4 Az	3	3	3	2	2.75	2	2	1	2	2	1	1.667	3	1	2	2	2	2	1	2	1	1.5	1	2	1	1	1.25
		Fz	2	2	2	1	1.75	0	1	0	0	0	0	0.167	1	1	3	3	2	1	0	2	3	1.5	0	0	0	0	0
		My	3	3	3	1	2.5	1	1	0	0	1	0	0.5	3	3	1	1	2	3	3	1	1	2	0	1	3	0	1
Thorax	T1 Ax	3	3	3	3	3	2	3	2	2	3	2	2.333	3	3	3	3	3	2	3	3	3	2.75	0	0	1	1	0.5	
	T1 Az	NA	3	3	2	2.667	NA	NA	NA	0	1	0	0.333	NA	1	0	2	1	NA	0	0	1	0.333	NA	0	0	0	0	
	T8 Ax	3	3	3	3	3	2	3	2	2	3	2	2.333	2	3	3	3	2.75	3	3	3	3	3	1	3	2	2	2	
	T8 Az	NA	2	2	2	2	NA	NA	NA	0	1	0	0.333	NA	3	1	2	2	NA	2	0	2	1.333	NA	2	0	1	1	
Lumbar	L1 Ax	3	3	3	3	3	2	2	2	2	3	2	2.167	3	3	3	3	3	3	3	3	3	3	1	2	3	3	2.25	
	L1 Az	3	3	3	3	3	1	2	2	1	2	2	1.667	1	1	2	2	1.5	1	1	1	2	1.25	0	0	2	1	0.75	
Pelvis	Ax	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	2	2	2	1.75	0	1	3	1	1.25	
	Az	2	3	3	2	2.5	0	2	1	0	1	2	1	3	0	0	3	1.5	2	0	0	3	1.25	0	0	0	1	0.25	
Counts	Good	>= 97.5 %	71%	88%	88%	53%	75%	18%	41%	18%	12%	47%	12%	15%	59%	47%	41%	53%	50%	29%	29%	24%	41%	31%	6%	6%	29%	18%	15%
	Acceptabl	>= 95.0 %	18%	12%	12%	35%	19%	35%	29%	41%	35%	18%	47%	24%	12%	6%	18%	35%	18%	24%	18%	24%	29%	24%	0%	29%	18%	18%	16%
	Marginal	>= 90.0 %	0%	0%	0%	12%	3%	24%	18%	18%	12%	29%	12%	12%	18%	29%	12%	12%	18%	35%	24%	18%	29%	26%	24%	18%	18%	41%	25%
	Poor	< 90.0 %	0%	0%	0%	0%	0%	12%	0%	12%	41%	6%	29%	15%	0%	18%	29%	0%	12%	0%	29%	35%	0%	16%	59%	47%	35%	24%	41%
		Individual																											
		Dummy	Averaged Results																										
Good		>= 97.5 %	3	2.5 =< v =< 3.0																									
Acceptabl		>= 95.0 %	2	1.5 =< v < 2.5																									
Marginal		>= 90.0 %	1	0.5 =< v < 1.5																									
Poor		< 90.0 %	0	0.0 =< v < 0.5																									

Results Summary – Test Series #2

		Shape													Magnitude CVs - Reproducibility														
		Repeatability					Reproducibility								Taxicab					Euclidian					Infinity				
		D054	D066	D077	D100	All	D066	D077	D100	D077	D100	D100	All	D054	D066	D077	D100	All	D054	D066	D077	D100	All	D054	D066	D077	D100	All	
Head	Ax	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	2.75
	Az	3	3	3	3	3	2	3	3	2	2	3	2.5	3	2	3	2	2.5	3	2	2	2	2.25	3	1	2	1	1.75	
Neck	Upper	Fx	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	2	2.5	3	2	3	3	2.75	3	3	3	3	3
		Fz	3	3	3	3	3	3	3	3	3	3	3	3	2	2	3	3	2.5	2	2	3	3	2.5	3	2	3	3	2.75
		My	3	3	3	3	3	3	3	3	3	3	3	3	1	1	3	3	2	1	1	3	3	2	3	1	3	1	2
	Lower	C4 Ax	3	3	3	3	3	3	3	3	3	3	3	3	2	2	3	3	2.5	3	3	3	3	3	3	2	1	2	2
		C4 Az	3	3	3	3	3	2	2	3	2	2	3	2.333	3	1	1	3	2	3	1	1	3	2	1	1	0	3	1.25
		Fz	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	3	1.5	0	3	0	3	1.5	2	0	0	3
My	2	2	3	2	2.25	1	2	2	2	2	3	2	2	2	1	3	2	2	3	1	3	2.25	2	3	1	2	2		
Thorax	T1 Ax	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	3	2.5	3	2	3	3	2.75	3	2	3	2	2.5	
	T1 Az	2	2	2	3	2.25	1	1	1	1	1	2	1.167	3	2	1	3	2.25	3	2	2	3	2.5	1	1	1	1	1	
	T8 Ax	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3		
	T8 Az	2	1	2	2	1.75	1	1	1	0	1	1	0.833	2	1	3	1	1.75	2	2	3	1	2	1	3	3	2	2.25	
Lumbar	L1 Ax	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	3	2	1.75	
	L1 Az	3	3	3	3	3	2	2	3	2	2	2	2.167	3	3	2	3	2.75	3	3	2	3	2.75	3	0	1	1	1.25	
Pelvis	Ax	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	2.75	3	2	3	2	2.5	2	1	2	0	1.25	
	Az	3	1	2	3	2.25	1	2	2	1	1	2	1.5	2	0	1	3	1.5	2	0	1	3	1.5	1	0	2	1	1	
Counts	Good	>= 97.5 %	76%	71%	76%	82%	76%	53%	59%	71%	53%	53%	71%	41%	59%	24%	59%	82%	56%	65%	41%	59%	82%	62%	53%	24%	47%	35%	40%
	Acceptabl	>= 95.0 %	24%	18%	24%	18%	21%	18%	24%	12%	24%	24%	18%	13%	29%	47%	12%	12%	25%	24%	41%	18%	12%	24%	18%	24%	18%	29%	22%
	Marginal	>= 90.0 %	0%	12%	0%	0%	3%	29%	18%	18%	18%	24%	12%	12%	12%	24%	29%	6%	18%	6%	12%	18%	6%	10%	29%	35%	24%	29%	29%
	Poor	< 90.0 %	0%	0%	0%	0%	0%	0%	0%	0%	6%	0%	0%	1%	0%	6%	0%	0%	1%	6%	6%	6%	0%	4%	0%	18%	12%	6%	9%
		Individual																											
		Dummy																											
		Averaged Results																											
		Good	>= 97.5 %	3	2.5 =< v =< 3.0																								
		Acceptabl	>= 95.0 %	2	1.5 =< v < 2.5																								
		Marginal	>= 90.0 %	1	0.5 =< v < 1.5																								
		Poor	< 90.0 %	0	0.0 =< v < 0.5																								

Comparison – Series #2 vs. Series #1

- Compared average values from columns “All”
- Highlighted **BLACK BOLD** values are improved in test series #2
- Highlighted **RED BOLD** values deteriorated in test series #2
- Overall score is based on 10 point scale:
 - 2 points for repeatability
 - 4 points for reproducibility
 - 4 points for magnitude (used traditional CV)
 - The points, for each of the above, are scaled linearly
- An overall score higher than 8 points is deemed acceptable

Comparison – Series #2 vs. Series #1

			Shape				Magnitude CVs - Reproducibility						Overall Score		
			Repeatability		Reproducibility		Taxicab		Euclidian		Infinity				
			Series #1	Series #2	Series #1	Series #2	Series #1	Series #2	Series #1	Series #2	Series #1	Series #2	Series #1	Series #2	
Head	Ax		3.00	3.00	3.00	3.00	2.75	3.00	2.25	3.00	2.00	2.75	8.67	9.67	
	Az		2.50	3.00	1.00	2.50	1.50	2.50	1.25	2.25	1.50	1.75	5.00	7.67	
Neck	Upper	Fx	3.00	3.00	2.33	3.00	2.75	2.50	2.25	2.75	1.50	3.00	7.11	10.00	
		Fz	3.00	3.00	2.33	3.00	1.50	2.50	1.00	2.50	0.50	2.75	5.78	9.67	
		My	3.00	3.00	1.00	3.00	0.50	2.00	0.50	2.00	0.25	2.00	3.67	8.67	
	Lower	C4 Ax	2.75	3.00	2.50	3.00	2.50	2.50	1.75	3.00	1.50	2.00	7.17	8.67	
		C4 Az	2.75	3.00	1.67	2.33	2.00	2.00	1.50	2.00	1.25	1.25	5.72	6.78	
		Fz	1.75	2.00	0.17	1.00	2.00	1.50	1.50	1.50	0.00	1.25	1.39	4.33	
Thorax		My	2.50	2.25	0.50	2.00	2.00	2.00	2.00	2.25	1.00	2.00	3.67	6.83	
		T1 Ax	3.00	3.00	2.33	3.00	3.00	2.50	2.75	2.75	0.50	2.50	5.78	9.33	
		T1 Az	2.67	2.25	0.33	1.17	1.00	2.25	0.33	2.50	0.00	1.00	2.22	4.39	
		T8 Ax	3.00	3.00	2.33	3.00	2.75	3.00	3.00	3.00	2.00	3.00	7.78	10.00	
Lumbar		T8 Az	2.00	1.75	0.33	0.83	2.00	1.75	1.33	2.00	1.00	2.25	3.11	5.28	
		L1 Ax	3.00	3.00	2.17	3.00	3.00	3.00	3.00	3.00	2.25	1.75	7.89	8.33	
Pelvis		L1 Az	3.00	3.00	1.67	2.17	1.50	2.75	1.25	2.75	0.75	1.25	5.22	6.56	
		Ax	3.00	3.00	3.00	3.00	3.00	2.75	1.75	2.50	1.25	1.25	7.67	7.67	
Counts		Az	2.50	2.25	1.00	1.50	1.50	1.50	1.25	1.50	0.25	1.00	3.33	4.83	
		Good >= 97.5 %	75%	76%	15%	41%	50%	56%	31%	62%	15%	40%	27%	48%	
		Acceptabl >= 95.0 %	19%	21%	24%	13%	18%	25%	24%	24%	16%	22%	20%	18%	
		Marginal >= 90.0 %	3%	3%	12%	12%	18%	18%	26%	10%	25%	29%	15%	17%	
Poor < 90.0 %	0%	0%	15%	1%	12%	1%	16%	4%	41%	9%	22%	4%			
			Averaged Results												
			Good >= 97.5 %	2.5 =< v =< 3.0											
			Acceptabl >= 95.0 %	1.5 =< v < 2.5											
			Marginal >= 90.0 %	0.5 =< v < 1.5											
			Poor < 90.0 %	0.0 =< v < 0.5											

Comparison – Series #2 vs. Series #1

			Overall Score	
			Series #1	Series #2
Head	Ax		8.67	9.67
	Az		5.00	7.67
Neck	Upper	Fx	7.11	10.00
		Fz	5.78	9.67
		My	3.67	8.67
		C4 Ax	7.17	8.67
		C4 Az	5.72	6.78
	Lower	Fz	1.39	4.33
		My	3.67	6.83
	Thorax	T1 Ax		5.78
T1 Az		2.22	4.39	
T8 Ax		7.78	10.00	
T8 Az		3.11	5.28	
Lumbar	L1 Ax		7.89	8.33
	L1 Az		5.22	6.56
Pelvis	Ax		7.67	7.67
	Az		3.33	4.83

Comparison – Series #2 vs. Series #1

Need Improvement In order

Lower Neck	Fz
Thorax T1	Fz
Pelvis	Fz
Thorax T8	Fz
Lumbar L1	Fz
Neck C4	Az
Lower Neck	My
Pelvis	Ax
Head	Az

Best Improved In order

Upper Neck	My
Upper Neck	Fz
Thorax T1	Ax
Lower Neck*	My
Lower Neck*	Fz
Upper Neck	Fx

*Need further
improvements

Concluding Remarks

- Conservative analysis based on average values
- Dummy needs further improvements
- How to maintain the same level of material for the bumpers, jackets, and pelvises? Is that even possible?
- Results and conclusions would have been much more dramatic if the analysis was based on worst values of the Confidence Intervals (CI)
- Need to access the “durability” of the foams, especially the bumpers

Concluding Remarks

- Need to verify that these results hold for more square-ish pulse such as SRA16 (Euro NCAP, PDB) versus the triangular pulse used in both of these series

