

### Head Impact Response Requirements

Parameter	Units	AUG. 2016 Specification			SEPT. 2018 Specification		
		Min.	Max.	Corridor Width ±%	Min.	Max.	Corridor Width ±%
Impact Velocity	m/s	1.95	2.05		1.95	2.05	
Peak Probe Force	N	5362	5972	5.4%	5022	6138	10%
Peak Head CG Resultant Acceleration	g	109.6	124.2	6.2%	105.3	128.7	10%

### Face Rigid Disk Impact Response Requirements

Parameter	Units	AUG. 2016 Specification			SEPT. 2018 Specification		
		Min.	Max.	Corridor Width ±%	Min.	Max.	Corridor Width ±%
Impact Velocity	m/s	6.68	6.78		6.68	6.78	
Peak Probe Force	N	9117	11143	10%	6378	7796	10%
Peak Head CG Resultant Acceleration	g	219	267	9.9%	124	152	10%

### Neck Torsion Response Requirements

Parameter	Units	AUG. 2016 Specification			SEPT. 2018 Specification		
		Min.	Max.	Corridor Width ±%	Min.	Max.	Corridor Width ±%
* Pendulum velocity at 10 ms after T0	m/s	1.72	1.90	5.0%	1.71	2.09	10.0%
* Pendulum velocity at 15 ms after T0	m/s	2.65	2.93	5.0%	2.57	3.14	10.0%
* Pendulum velocity at 20 ms after T0	m/s	3.58	3.96	5.0%	3.46	4.23	10.0%
* Pendulum velocity at 25 ms after T0	m/s	4.44	4.91	5.0%	4.27	5.22	10.0%
Impact Velocity	m/s	4.95	5.05		4.95	5.05	
LEFT Peak Upper Neck $M_z$	N-m	36.1	39.0	3.9%	37.3	45.6	10.0%
LEFT Peak Neck Fixture Rotation	deg	-56.3	-46.0	10.1%	-52.7	-43.1	10.0%
LEFT Decay time to 0° from peak rotation	ms	50.9	62.2	10.0%			
* LEFT <b>First</b> Peak Upper Neck Angular Velocity $\omega_z$	deg/s	-1591	-1431	5.3%	-1529	-1251	10.0%
RIGHT Peak Upper Neck $M_z$	N-m	-39.0	-36.1	3.9%	-45.6	-37.3	10.0%
RIGHT Peak Neck Fixture Rotation	deg	46.0	56.3	10.1%	43.1	52.7	10.0%
RIGHT Decay time to 0° from peak rotation	ms	50.9	62.2	10.0%			
* RIGHT <b>First</b> Peak Upper Neck Angular Velocity $\omega_z$	deg/s	1431	1591	5.3%	1251	1529	10.0%

\* Indicates that the specification was revised after the AUG. 2016 manual

### Neck Flexion Response Requirements

Parameter	Units	AUG. 2016 Specification			SEPT. 2018 Specification		
		Min.	Max.	Corridor Width ±%	Min.	Max.	Corridor Width ±%
* Pendulum velocity at 8 ms after T0	m/s	1.57	1.79	6.5%	1.57	1.92	10.0%
* Pendulum velocity at 16 ms after T0	m/s	3.2	3.61	6.0%	3.13	3.82	10.0%
* Pendulum velocity at 24 ms after T0	m/s	4.53	5.06	5.5%	4.42	5.41	10.0%
Impact Velocity	m/s	4.95	5.05		4.95	5.05	
Peak Upper Neck $M_y$	N-m	26.2	30.5	7.6%	27.9	34.1	10.0%
Peak Upper Neck $F_x$	N	-1375	-1195	-7.0%			
<del>Maximum Upper Neck <math>F_z</math></del> * Upper Neck $F_z$ most positive value prior to 40 ms	N	835	1020	10.0%	774	946	10.0%
Posterior Neck Cable $F_z$ first peak before 60.0 ms	N	1157	1375	8.6%			
Peak Head Angular Velocity $\omega_y$ (relative to earth)	deg/s	-2017	-1828	4.9%	-2172	-1777	10.0%
Peak Head Rotation (relative to pendulum)	deg	-65.8	-61.5	3.4%	-71.0	-58.1	10.0%
Decay time to 0° from peak angle	ms	77.6	87.2	5.8%			

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### Neck Extension Response Requirements

Parameter	Units	AUG. 2016 Specification			SEPT. 2018 Specification		
		Min.	Max.	Corridor Width ± %	Min.	Max.	Corridor Width ± %
* Pendulum velocity at 10 ms after T0	m/s	1.73	1.96	6.2%	1.74	2.12	10.0%
* Pendulum velocity at 20 ms after T0	m/s	3.38	3.74	5.1%	3.30	4.04	10.0%
* Pendulum velocity at 30 ms after T0	m/s	4.66	5.15	5.0%	4.53	5.54	10.0%
Impact Velocity	m/s	4.95	5.05		4.95	5.05	
Peak Upper Neck $M_y$	N-m	-32.5	-26.6	10.0%	-25.3	-20.7	10.0%
Peak Upper Neck $F_x$	N	699	854	10.0%			
Peak Upper Neck $F_z$	N	-3115	-2549	10.0%	-3210	-2626	10.0%
Peak Anterior Neck Cable $F_z$	N	2074	2535	10.0%			
Peak Head Angular Velocity $\omega_y$ (relative to earth)	deg/s	2084	2247	3.8%	1855	2267	10.0%
Peak Head Rotation (relative to pendulum)	deg	64.5	70.9	4.7%	58.5	71.5	10.0%
Decay time to 0° from peak angle	ms	74.2	78.7	2.9%			

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### Neck Lateral Flexion Response Requirements

Parameter	Units	AUG. 2016 Specification			SEPT. 2018 Specification		
		Min.	Max.	Corridor Width ±%	Min.	Max.	Corridor Width ±%
* Pendulum velocity at 4 ms after T0	m/s	0.96	1.08	5.9%	1.06	1.30	10.0%
* Pendulum velocity at 8 ms after T0	m/s	2.07	2.32	5.7%	2.09	2.55	10.0%
* Pendulum velocity at 12 ms after T0	m/s	3.10	3.43	5.1%	3.16	3.86	10.0%
Impact Velocity	m/s	3.35	3.45		3.35	3.45	
Upper Neck $M_x$ first peak after 40.0 ms	N-m	43.2	52.2	9.4%	44.8	54.7	10.0%
* LEFT First Peak Head Angular Velocity $\omega_x$ (relative to earth)	deg/s	-1434	-1300	4.9%	-1498	-1226	10.0%
LEFT Peak Head Rotation (relative to pendulum)	deg	-47.0	-40.9	6.9%	-45.9	-37.6	10.0%
LEFT Decay time to 0° from peak angle	ms	78.0	83.4	3.3%			
RIGHT Upper Neck $M_x$ first peak after 40.0 ms	N-m	-52.2	-43.2	9.4%	-54.7	-44.8	10.0%
* RIGHT First Peak Head Angular Velocity $\omega_x$ (relative to earth)	deg/s	1300	1434	4.9%	1226	1498	10.0%
RIGHT Peak Head Rotation (relative to pendulum)	deg	40.9	47.0	6.9%	37.6	45.9	10.0%
Decay time to 0° from peak angle	ms	78.0	83.4	3.3%			

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### Upper Thorax Qualification Response Requirements

Parameter	Units	AUG. 2016 Specification			SEPT2018 Specification		
		Min.	Max.	Corridor Width ±%	Min.	Max.	Corridor Width ±%
Impact Velocity	m/s	4.25	4.35		4.25	4.35	
Peak Probe Force	N	2449	2855	7.7%		3039	10%
Peak Upper Left X-axis Rib Deflection	mm	-46.4	-38.0	10%			
Peak Upper Right X-axis Rib Deflection	mm						
Peak Upper Left Resultant Deflection	mm				48.3	59.0	10%
Peak Upper Right Resultant Deflection	mm						
Difference Between Peak Left & Right X-axis Deflections	mm	N/A	< 7.00				
Difference Between Peak Left & Right Resultant Deflections	mm				N/A	< 5	
Peak Upper Left Z-axis Rib Deflection	mm	25.6	31.2	9.9%			
Peak Upper Right Z-axis Rib Deflection	mm						
Difference Between Peak Left & Right Z-axis Deflections	mm	N/A	< 7.00				
Force at Left & Right Peak Resultant Deflection	N				2409	2944	10%

### Lower Thorax Qualification Response Requirements

Parameter	Units	AUG. 2016 Specification			SEPT. 2018 Specification		
		Min.	Max.	Corridor Width ±%	Min.	Max.	Corridor Width ±%
Impact Velocity	m/s	4.25	4.35		4.25	4.35	
Peak X-axis Deflection	mm	-55.3	-45.4	9.8%			
Peak Probe Force	N				3136	3832	10%
Probe Force at time of Peak X-axis Deflection	N	3058	3680	9.2%			
Left or Right Resultant Deflection at Peak Force	mm				45.8	56.0	10%

**Lower Abdomen Qualification Response Requirements**

Parameter	Units	AUG. 2016 Specification			SEPT. 2018 Specification		
		Min.	Max.	Corridor Width ±%	Min.	Max.	Corridor Width ±%
Impact Velocity	m/s	3.25	3.35		3.25	3.35	
Peak Force	N	2746	3078	5.7%	2626	3210	10%
Lower left abdomen X-axis deflection at time of Peak Force	mm	-92.9	-70.1	14%	-91.3	-74.7	10%
Lower right abdomen X-axis deflection at time of Peak Force							
Difference Between Peak Left & Right X-axis Deflections	mm	_	< 12.00		_	< 8	

**Upper Leg Qualification Response Requirements**

Parameter	Units	AUG. 2016 Specification			SEPT. 2018 Specification		
		Min.	Max.	Corridor Width ±%	Min.	Max.	Corridor Width ±%
Impact Velocity	m/s	2.55	2.65		2.55	2.65	
Peak Probe Force	N	4278	5093	8.7%	4221	5158	10%
Peak Femur Force, $F_z$	N	-3314	-2712	10%	-3314	-2712	10%
Peak Resultant Acetabulum Force	N	1478	1806	10%	1478	1806	10%

**Knee Qualification Response Requirements**

Parameter	Units	AUG. 2016 Specification			SEPT. 2018 Specification		
		Min.	Max.	Corridor Width ±%	Min.	Max.	Corridor Width ±%
Impact Velocity	m/s	2.15	2.25		2.15	2.25	
Peak Femur Z-axis Force	N	-7170	-5866	10%	-7156	-5855	10%
Knee Deflection at Peak Femur Force	mm	-20.9	-19.5	3.5%	-22.2	-18.2	10%

**Left Ankle Inversion Qualification Response Requirements**

Parameter	Units	AUG. 2016 Specification			SEPT. 2018 Specification		
		Min.	Max.	Corridor Width ±%	Min.	Max.	Corridor Width ±%
Impact Velocity	m/s	1.90	2.10		1.95	2.05	
Peak Lower Tibia $F_z$	N	-560	-458	10%	-555	-454	10%
Peak Ankle Resistive Moment	Nm	-43.4	-35.5	10%	-43.0	-35.2	10%
Peak Ankle X-axis Rotation	deg	-35.6	-33.3	3.3%	-37.9	-31.0	10%

**Right Ankle Inversion Qualification Response Requirements**

Parameter	Units	AUG. 2016 Specification			SEPT. 2018 Specification		
		Min.	Max.	Corridor Width ±%	Min.	Max.	Corridor Width ±%
Impact Velocity	m/s	1.90	2.10		1.95	2.05	
Peak Lower Tibia $F_z$	N	-560	-458	10%	-555	-454	10%
Peak Ankle Resistive Moment	Nm	35.5	43.4	10%	35.2	43.0	10%
Peak Ankle X-axis Rotation	deg	33.3	35.6	3.3%	31.0	37.9	10%

**Left Ankle Eversion Qualification Response Requirements**

Parameter	Units	AUG. 2016 Specification			SEPT. 2018 Specification		
		Min.	Max.	Corridor Width ±%	Min.	Max.	Corridor Width ±%
Impact Velocity	m/s	1.90	2.10		1.95	2.05	
Peak Lower Tibia $F_z$	N	-629	-515	10%	-629	-514	10%
Peak Ankle Resistive Moment	Nm	38.8	47.3	9.9%	38.7	47.3	10%
Peak Ankle X-axis Rotation	deg	27.5	31.5	6.8%	26.6	32.5	10%



**Right Ankle Eversion Qualification Response Requirements**

Parameter	Units	AUG. 2016 Specification			SEPT. 2018 Specification		
		Min.	Max.	Corridor Width ±%	Min.	Max.	Corridor Width ±%
Impact Velocity	m/s	1.90	2.10		1.95	2.05	
Peak Lower Tibia $F_z$	N	515	629	10%	-629	-514	10%
Peak Ankle Resistive Moment	Nm	-47.3	-38.8	9.9%	-47.3	-38.7	10%
Peak Ankle X-axis Rotation	deg	-31.5	-27.5	6.8%	-32.5	-26.6	10%

**Ball of Foot Qualification Response Requirements**

Parameter	Units	AUG. 2016 Specification			SEPT. 2018 Specification		
		Min.	Max.	Corridor Width ±%	Min.	Max.	Corridor Width ±%
Impact Velocity	m/s	4.90	5.10		4.95	5.05	
Peak Lower Tibia $F_z$	N	-3437	-2897	8.5%	-3487	-2853	10%
Peak Ankle Resistive Moment	Nm	50.2	61.3	10%	49.8	60.8	10%
Peak Ankle Y-axis Rotation (in dorsiflexion)	deg	32.5	35.1	3.8%	30.4	37.2	10%

**Heel Qualification Response Requirements**

Parameter	Units	AUG. 2016 Specification			SEPT. 2018 Specification		
		Min.	Max.	Corridor Width %	Min.	Max.	Corridor Width %
Impact Velocity	m/s	3.90	4.10		3.95	4.05	
Peak Lower Tibia $F_z$	N	-3477	-2845	10%	-3478	-2846	10%