

Test Lab

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 Report # **R2019-022.01**
 Quote # P19-32
 Project # 40-67

 Recoverable Signature



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Customer

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Job # N/A
 PO # N/A

METHOD:

The test setup included a universal receiver, a velocity gate and a blunt trauma torso rig (BTTR) to measure chest deflection/time history. Upon firing of the system, the projectile was accelerated down the barrel, through the velocity gate and out of the barrel toward the target. The BTTR was comprised of a flexible cylindrical membrane designed to reproduce the impact response (stiffness) of the human chest (sternum). A non-contact laser transducer located behind the target location was used to measure the dynamic deflection of the membrane as a result of a projectile impact.

The laser transducer signal was recorded by a data acquisition system sampling data at 10 kHz. The data was then post processed using a 1 kHz lowpass digital filter. During the impact, the membrane deflection was recorded with respect to time. The velocity at which the membrane deformed was derived from the deflection measurements. Both parameters (chest deflection and velocity) were used to calculate the viscous criterion (VC). VC is an indicator of injury severity. A higher VC value indicates a higher injury risk.

LIMITATIONS:

Testing was conducted in accordance with AEP-99 at four different impact velocities. AEP-99 is still in the research phase and not a published standard. The tolerances given in AEP-99 have been optimized for 37 mm rigid projectiles shot in the 20 to 60 m/s velocity range and scaling factors for other projectiles have yet to be developed. We have applied the latest scaling factor available¹, however this has not been adapted for the projectiles tested. Performance may be assessed **relative** to other similar projectiles currently on the market but the injury threshold value (VC = 0.8 m/s) may not be applicable.

[1] Cyril Robbe, Nestor Nsiampa, and Alexandre Papy, "Sensitivity studies of the BTTR surrogate and comparison" between NLW and BABT applications," PASS, 2018.

Cartridge		12 ga.		
Component	Qty	Mass (g)	Total (g)	Note
Balls	2	5.02	10.04	ø 18 mm
Wad	1	3.18	3.18	
Over powder card	1	1.09	1.09	
Over shot card	1	0.33	0.33	
Total impact mass			<u>14.64</u>	

Velocity	m	ft
Free Flight Dist.	2.84	9.3
Velocity Baseline Dist.	0.4	1.3

Data Acquisition

Sampl. Freq.	10 kHz
Filter	1 kHz low pass
Transducer	Micro-Epsilon
Mod.	optoNCDT 1627-200
Sensitivity (mm/V)	10.354

VC Corrections

$$VC_{max\ corr.} = ((VC_{max}/1.3)*(255/236))*0.432^1$$

[1] Cyril Robbe, Nestor Nsiampa, and Alexandre Papy, "Sensitivity studies of the BTTR surrogate and comparison".

Group	Shot	AOA (deg.)	Velocity		(VC) _{max}	(VC) _{max} corr. ¹
			(m/s)	ft/s	(m/s)	m/s
1 Propellant: 6 gr.	1	0	151	495	2.46	0.88
	2	0	165	541	1.34	0.48
	3	0	147	482	0.37	0.13
	4	0	149	489	0.46	0.17
	5	0	153	502	0.83	0.30
	6	0	142	466	0.47	0.17
	7	0	155	509	1.14	0.41
	8	0	150	492	0.95	0.34
	9	0	152	499	1.01	0.36
	10	0	185	607	2.27	0.82
2 Propellant: 7 gr.	1	0	172	564	2.23	0.80
	2	0	222	728	3.37	1.21
	3	0	202	663	2.21	0.79
	4	0	212	696	2.68	0.96
	5	0	214	702	2.78	1.00
	6	0	205	673	3.84	1.38
	7	0	211	692	2.11	0.76
	8	0	226	741	1.78	0.64
	9	0	227	745	2.91	1.04
	10	0	207	679	3.12	1.12
3 Propellant: 8 gr.	1	0	274	899	5.35	1.92
	2	0	278	912	4.53	1.63
	3	0	267	876	4.91	1.76
	4	0	276	906	3.23	1.16
	5	0	268	879	3.55	1.27
	6	0	245	804	5.42	1.95
	7	0	261	856	13.92	
	8	0	272	892	3.71	1.33
	9	0	269	883	2.75	0.99
	10	0	256	840	7.29	2.62
4 Propellant: 9 gr.	1	0	292	958	4.75	1.71
	2	0	323	1060	6.65	2.39
	3	0	305	1001	6.11	2.19
	4	0	280	919	6.26	2.25
	5	0	291	955	9.09	3.26
	6	0	297	974	3.71	1.33
	7	0	299	981	5.35	1.92
	8	0	294	965	9.62	3.45
	9	0	300	984	6.65	2.39
	10	0	323	1060	4.22	1.52

Test Date 2019-06-14

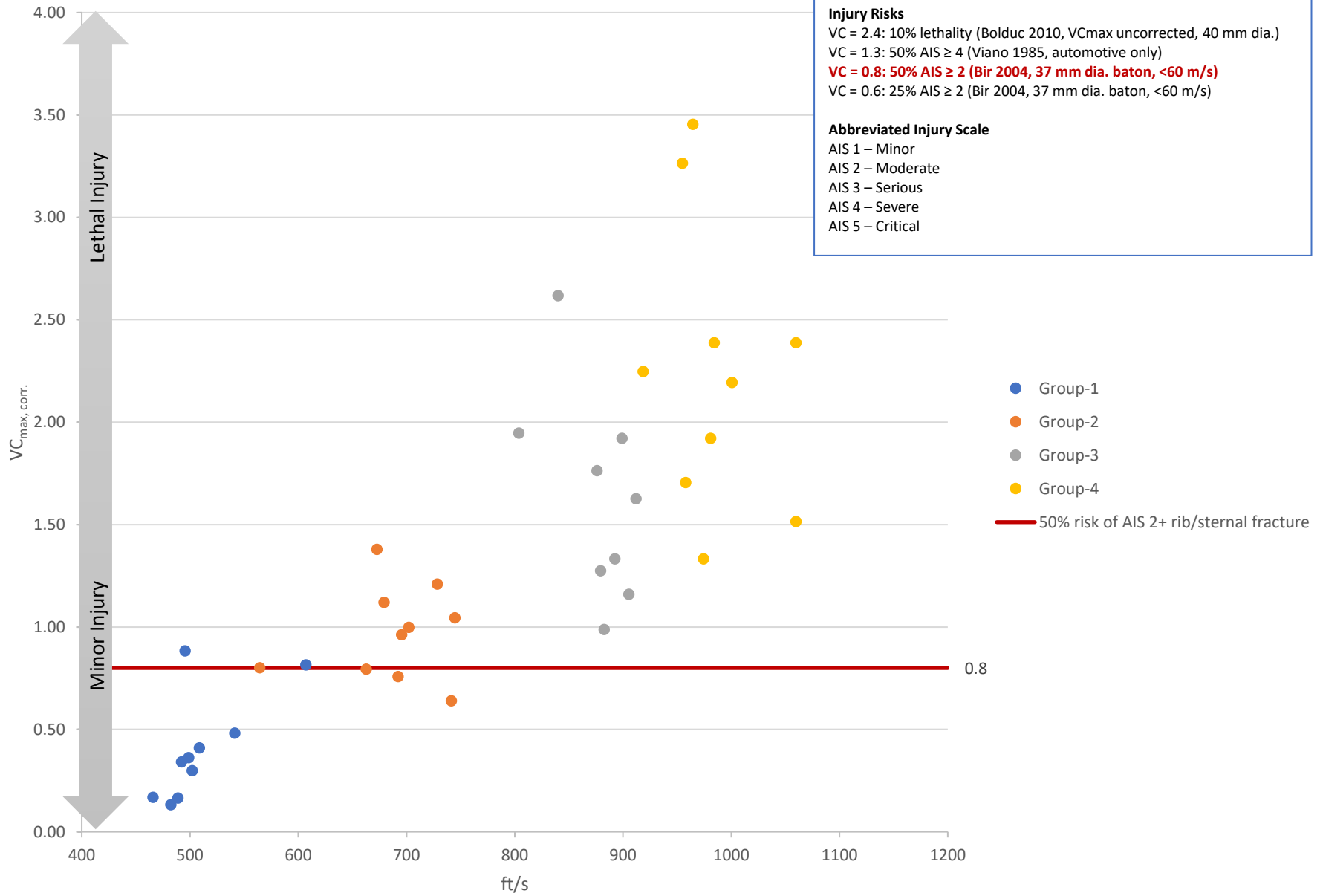
Technician MP

outlier removed

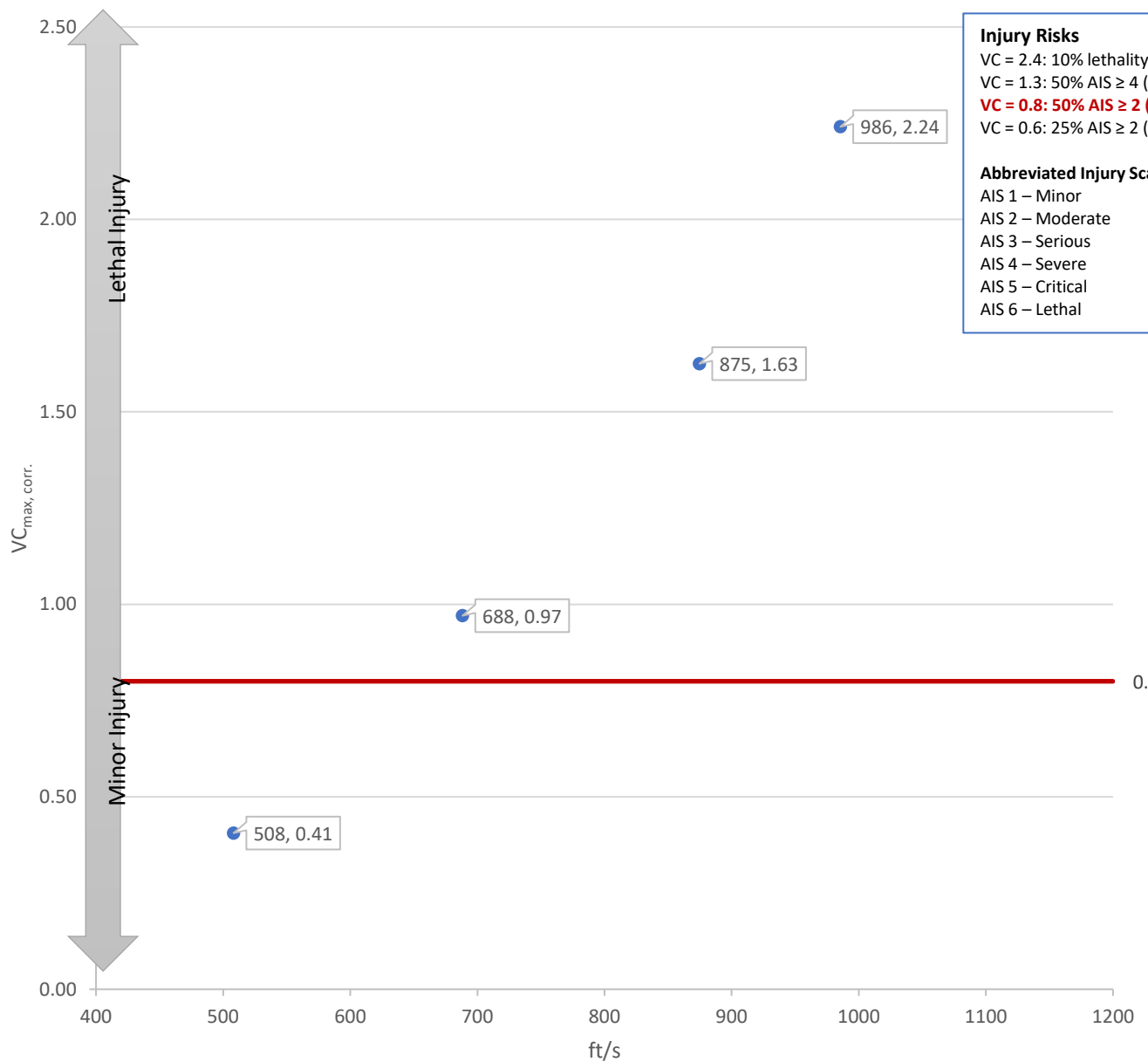
VC Corrections:

$$[1] (VC)_{max\ corr.} = ((VC_{max}/1.3)*(255/236))*0.432$$

VC_{max corr.} vs Velocity



Group Averages of $VC_{max\ corr.}$



Injury Risks
VC = 2.4: 10% lethality (Bolduc 2010, VCmax uncorrected, 40 mm dia.)
VC = 1.3: 50% AIS ≥ 4 (Viano 1985, automotive only)
VC = 0.8: 50% AIS ≥ 2 (Bir 2004, 37 mm dia. baton, <60 m/s)
VC = 0.6: 25% AIS ≥ 2 (Bir 2004, 37 mm dia. baton, <60 m/s)

Abbreviated Injury Scale
AIS 1 – Minor
AIS 2 – Moderate
AIS 3 – Serious
AIS 4 – Severe
AIS 5 – Critical
AIS 6 – Lethal

● Average
— 50% risk of AIS 2+ rib/sternal fracture