

Stab Resistance Tester

*NIJ Standard – 0115.00 Stab Resistance of personal Body Armor
for KICTEX*

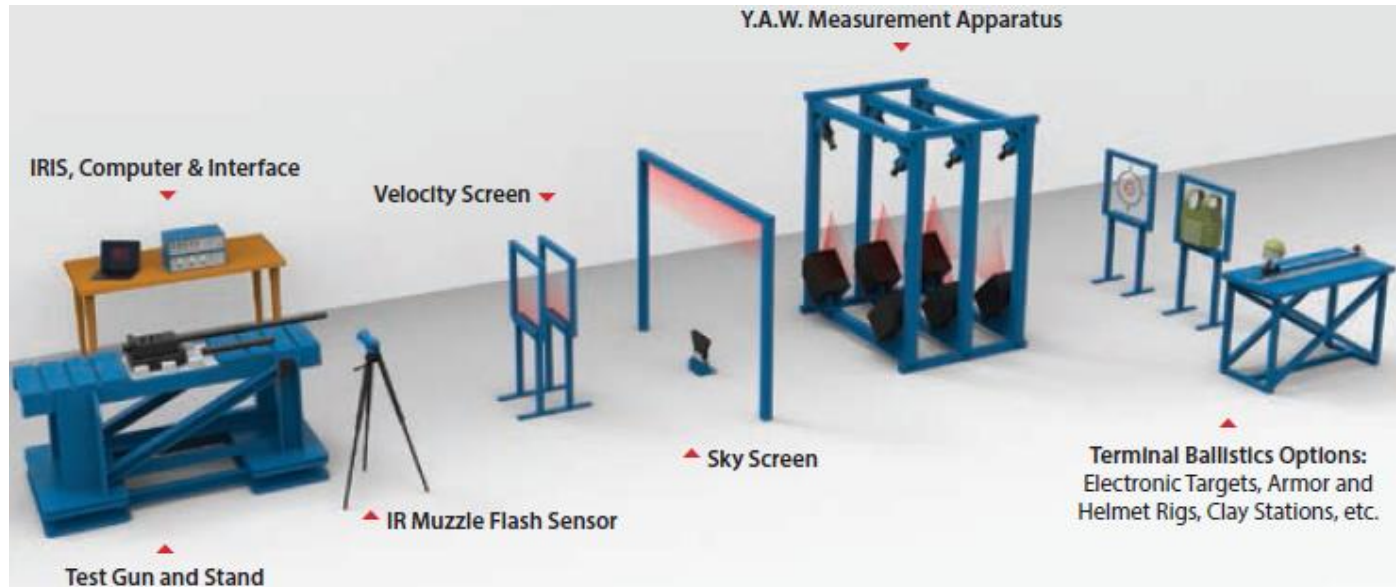


Company Introduction



About SYDOR Technologies

- Founded in 2014. (From Sydor Instruments LLC since 2004.)
- Fairport, New York, USA (Headquarter)
- Caterham, Surrey, CR3 5QX, U.K.
- Complex measurement solution & application
 - Defense, Energy, Ballistics, Security, Space, Research industries
- Homepage : <https://sydortechnologies.com>



NIJ Standard – 0115.00 Stab Resistance of Personal Body Armor

< 방검장비에 관한 국제 규격 >

- **NIJ (National Institute of Justice)**

- PSDB (Police Scientific Development Branch)

- CEN (European Committee for Standardization)

1. PURPOSE AND SCOPE

- To establish minimum performance requirements and methods of test for the stab resistance of personal body armor
- NIJ – 0115.00 is limited to stab resistance only
- Not cover ballistic threats. It is covered by NIJ standard – 0101.04

2. NIJ STAB RESISTANCE BODY ARMOR CLASSIFICATION

2.1 Protection Classes

“Edged Blades” class – high quality knife blades, commercially machined edged

“ Spike” class – lower quality knife blades and spike style weapons

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2.2 Protection Levels

3 levels of protection – 85%, 90%, 95% of normal male power

Table 1. Stab resistant protection level strike energies

Protection Level	“E1” Strike Energy		“E2” Overtest Strike Energy	
	J	ft· lbf	J	ft· lbf
1	24 ± 0.50	17.7 ± 0.36	36 ± 0.60	26.6 ± 0.44
2	33 ± 0.60	24.3 ± 0.44	50 ± 0.70	36.9 ± 0.51
3	43 ± 0.60	31.7 ± 0.44	65 ± 0.80	47.9 ± 0.59

Penetration limit : E1 – 7 mm, & E2 – 20 mm

50% higher energy condition = E2 (for safety factor of armor design)

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3. DEFINITIONS

3.1 Angle of Incidence & 3.5 Backing Material

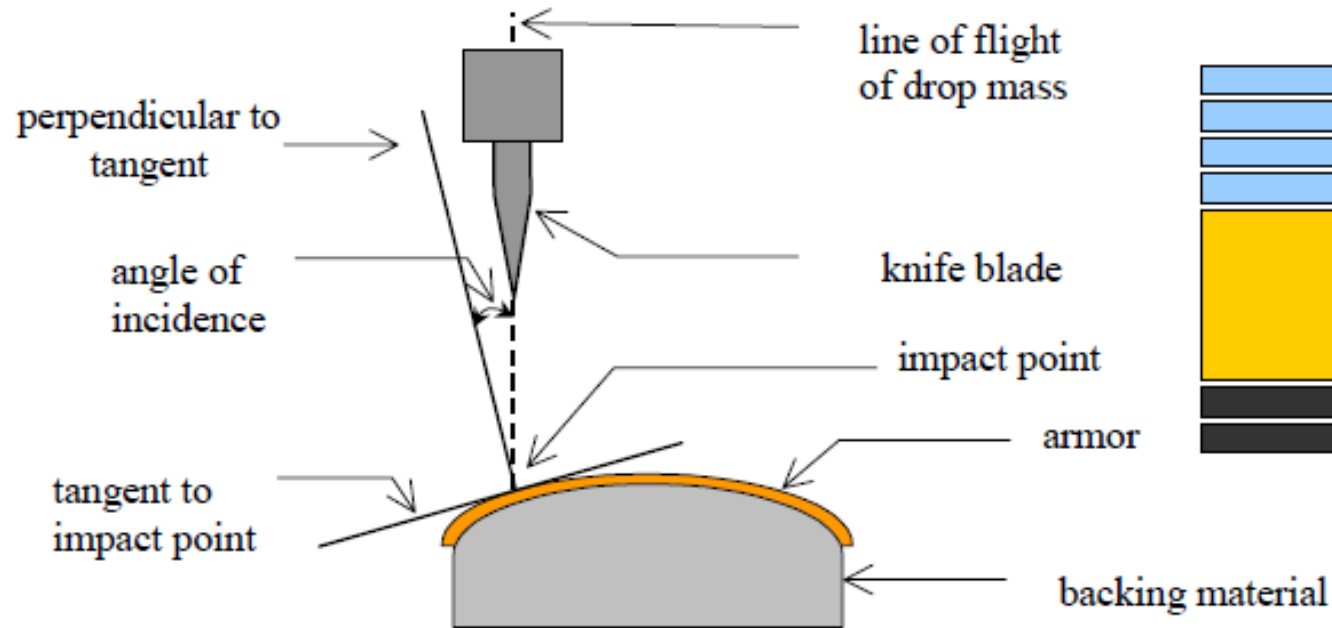


Figure 1. Schematic of armor and knife arrangement

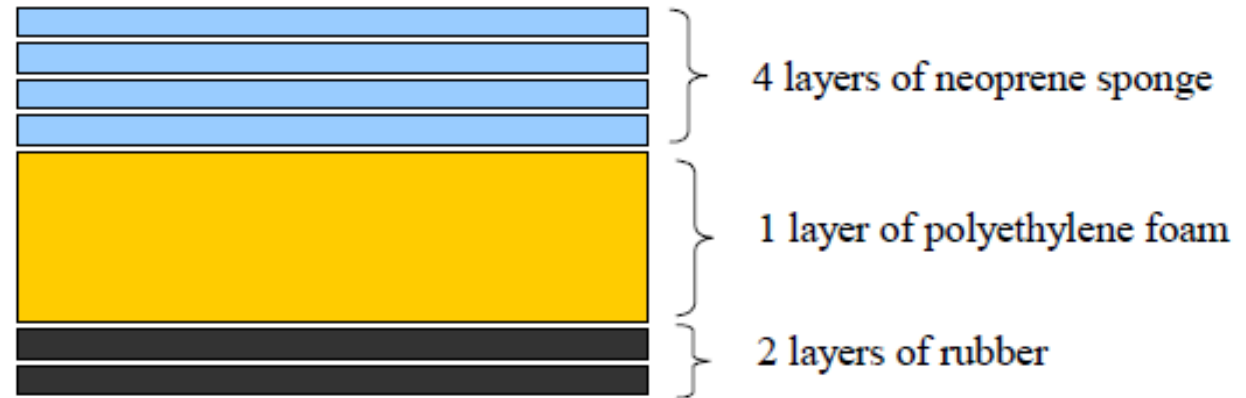
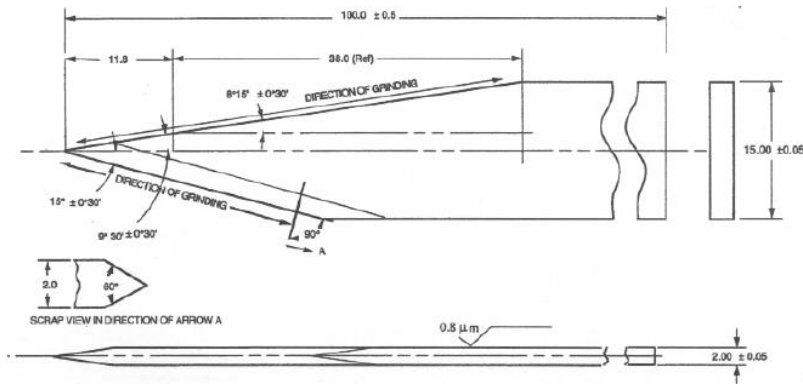


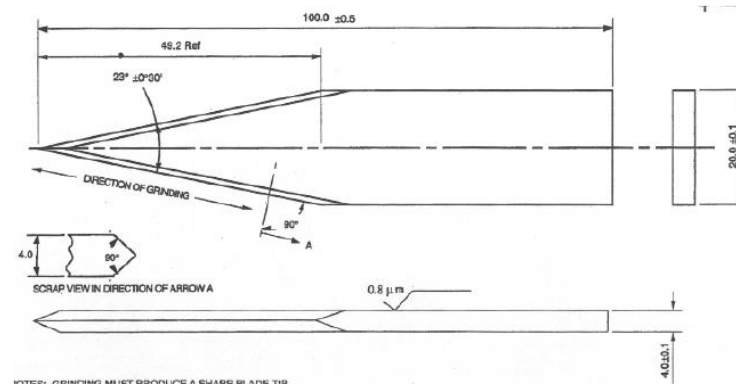
Figure 2. Composite backing material

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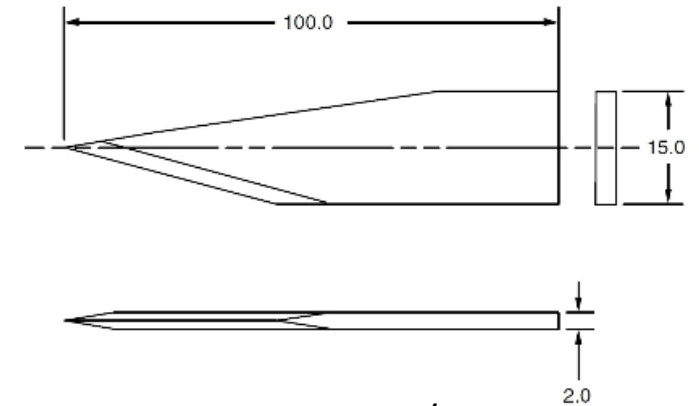
3.10 Engineered Knife Blades



NIJ – P1/A

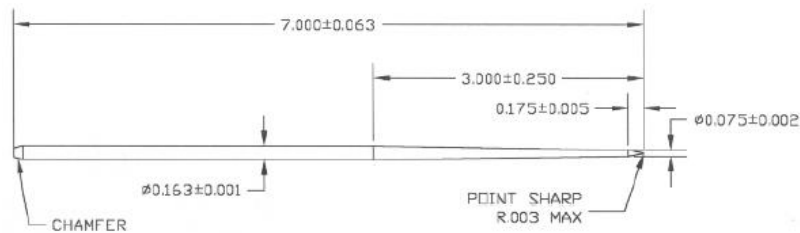


NIJ – S1/G

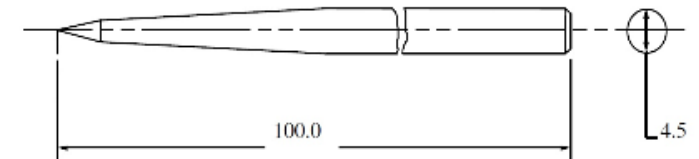


HOSDB – P1/B

3.11 Engineered Spike



NIJ – SP/A (long)



HOSDB – SP/B

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3.12 Fair Hit or Fair Strike

- (a) Strike energy meets to table 1.
- (b) No closer than 51 mm to the edge of the armor
- (c) No closer than 51 mm to the edge of the backing material
- (d) No closer than 51 mm to any prior strike
- (e) Incidence angle is within $\pm 5^\circ$

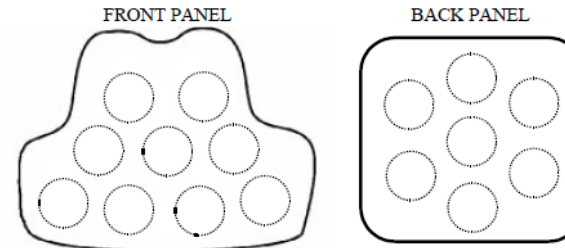
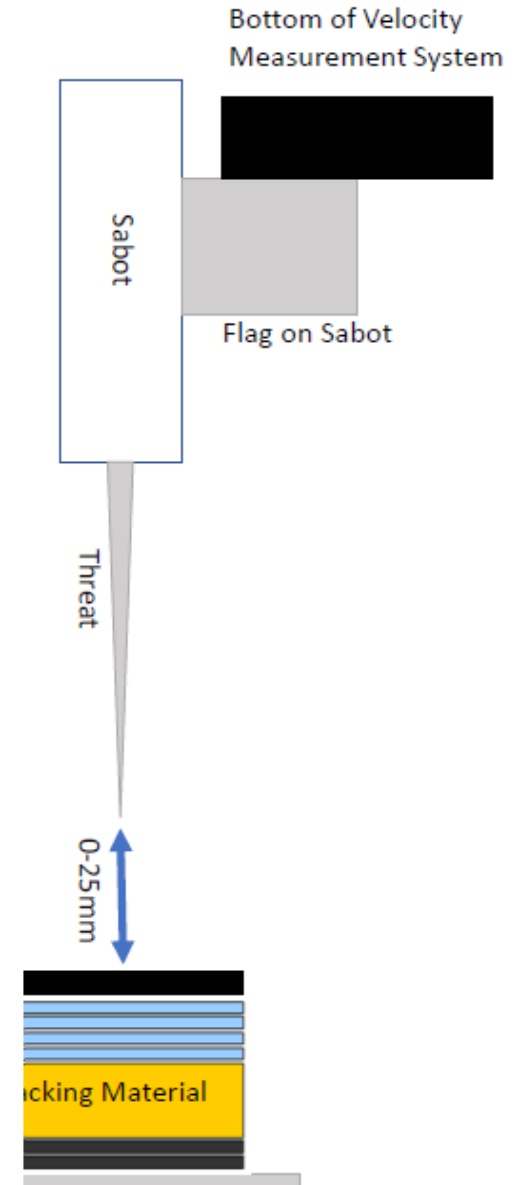


Figure 6. Template pattern for stab impact locations

3.22 Velocity Measurement Zone

A zone located above the impact point, within which the velocity of the drop mass is measured. The length of the velocity measurement zone is less than 51 mm (2.0 in).

When the drop mass crosses the lower edge of the velocity measurement zone, the tip of the knife blade or spike will be positioned between 0 mm (0.0 in) and 25 mm (1.0 in) above the impact point.



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4. REQUIREMENTS

4.6.1 Stab Resistance Drop Test Series for “Edged Blades” Protection Class

Table 2. Summary of drop tests for each test panel

Number of Drop Tests	Angle of Incidence	Threat Weapon	Energy Level
1	0°	P1 knife blade	E1
1	0°	P1 knife blade	E2
1	0°	S1 knife blade	E1
1	0°	S1 knife blade	E2
1	45°	P1 knife blade	E1
1	45°	S1 knife blade	E1

4.6.2 Stab Resistance Drop Test Series for “Spike” Protection Class

Table 3. Summary of spike drop tests for each test panel

Number of Drop Tests	Angle of Incidence	Threat Weapon	Energy Level
1	0°	Spike	E1
1	0°	Spike	E2
1	45°	Spike	E1

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5. TEST METHODS

5.1 Purpose

5.2 Test Sequence

- According to this standard section 4 and 5

5.3 Label Examination

- See section 4.4

5.4 Workmanship Examination

5.4.1 Carrier

- Visual inspection of sample status and record in the report if need.

5.4.2 Protective Panel

- Pretest – Checking the sample before testing
- Posttest – Checking the sample immediately after testing
- Inspection Notification – Notify sample status within 24 hours

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5.5 Description of Test Facilities and Equipment

5.5.1 Test Facility Environmental Conditions

- (a) Temperature : $21^{\circ}\text{C} \pm 6^{\circ}\text{C}$ ($70^{\circ}\text{F} \pm 10^{\circ}\text{F}$)
- (b) Relative humidity : $50\% \pm 20\%$
- (c) Record before and after a complete test series & every 4 hours

5.5.2 Drop Tube Test Apparatus

- Guided rail drop tube for free drop & predetermined point of impact
- Prevent the drop mass from rotating during drop & impact
- Reproducible drop velocities within $\pm 0.05 \text{ m/s}$ ($\pm 0.16 \text{ ft/s}$) of a nominal velocity

5.5.3 Drop Mass → next page

5.5.4 Velocity Measurement Equipment

- Velocity measurement accuracy : $\pm 0.05 \text{ m/s}$ ($\pm 0.16 \text{ ft/s}$) or better

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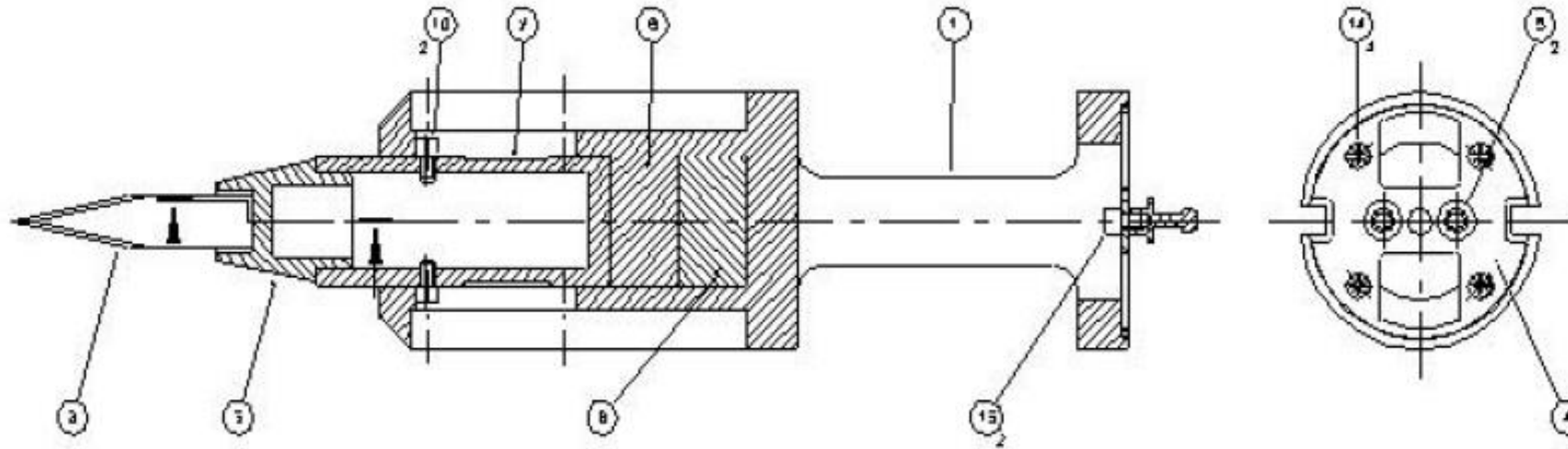


Figure 5. Drop mass

5.5.3 Drop Mass

- Consists of 4 basic parts

(a) A threat weapon

(b) A steel and aluminum alloy bottom mass $650 \text{ g} \pm 7 \text{ g}$ ($1.43 \text{ lb} \pm 0.02 \text{ lb}$) with a threat weapon installed.

(c) A nylon upper mass, $1250 \text{ g} \pm 13 \text{ g}$ ($2.76 \text{ lb} \pm 0.03 \text{ lb}$), 97 mm (3.82 in) and 400 mm (15.75 in) length

(d) Two closed cell polyethylene foam discs, 30 mm (1.18 in) thick and 50 mm (1.97 in) diameter.

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5.5.5 Test Knife Blades and Spike Specifications

- Tip sharpness test : Rockwell C scale between -50 and -150

Table 4. Conversion of HRC values to indentation depths

HRC	D (mm)	HRC	D (mm)	HRC	D (mm)	HRC	D (mm)	HRC	D (mm)
-160	0.52	-130	0.46	-100	0.40	-70	0.34	-40	0.28
-150	0.50	-120	0.44	-90	0.38	-60	0.32	-30	0.26
-140	0.48	-110	0.42	-80	0.36	-50	0.30	-20	0.24

5.5.6 Composite Backing Material Specification

- At least 381 mm (15.0 in) length and 305 mm (12.0 in) width
- 4 layers x 5.8 mm (0.23 in) neoprene
- 1 layer x 31 mm (1.22 in) & 33 kg/m³ (2.06 lb/ft³) closed-cell polyethylene foam
- 2 layers x 6.4 mm (0.25 in) natural rubber
- For all flat and flexible armor samples.

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5.5.7 Composite Backing Material Acceptance Criteria

- Conditioning for min. 12 hours before being used
- Meet a restitution test. Drop spherical steel ball 1.042 kg (2.297 lb) at 1500 mm \pm 15 mm (59 in \pm 0.59 in)
The height of rebound (2 drops) 450 mm \pm 102 mm (17.7 in \pm 4.0 in)

5.5.8 Damping Disks

- Diameter 50 mm \pm 1 mm (1.97 in \pm 0.04 in)

5.5.9 Polyart™ Witness Paper

- Basis weight of 140 g/m² (0.46 oz/ft²) and thickness 0.178 mm (7 mil)

5.6 Conducting the Stab Tests

5.6.1 Calibration Trials to Confirm Strike Energies

- Pretest to check the correct velocities correspond to the specified impact energies.

5.6.2 Temperature/Humidity Conditioning

- Conditioning in min. 12 hours.

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5.6.3 Stab Location Marking

- Refer to section 3.12

5.6.4 Preparation of Backing Material and Mounting of Armor

- Polyart paper is between body armor and backing material
- Body armor is fixed by straps and the distance between straps is greater than 51 mm.

5.6.5 Assembly of Drop Mass

- 2 x damping disks installed in the nylon body of the upper mass
- In case of drop tests at less than 65 J, no more than 12 drop tests
- In case of drop tests at 65 J or higher, no more than 4 drop tests
- To allow the damping discs to return to their original volume, a period of 5 minutes shall elapse between each test strike.

5.6.6 Installation of Knife Blade or Spike into Drop Mass and Drop Test Procedure

- **A new knife blade or spike, tested for sharpness, shall be used for each test strike.**
- Mass measurement method shall have an accuracy of ± 1 g (± 0.002 lb) or less

5.6.7 Determination of Hit Fairness

- Record strike, impact velocity and strike location on the test data sheet.

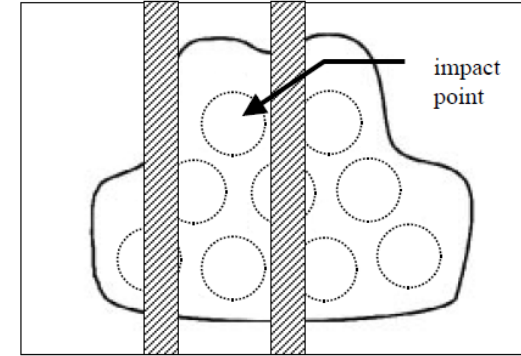


Figure 7. Acceptable strapping method

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5.6.8 Measurement of Penetration

- Appendix C : Conversion Tables for Penetration Depth.

P1 Knife Blade Penetration Depths from Witness Paper Cut Length
for 0° Angle of Incidence

Length (mm)	Depth (mm)	Length (mm)	Depth (mm)	Length (mm)	Depth (mm)	Length (mm)	Depth (mm)
0.42	1	6.04	14	11.41	27	13.56	40
0.85	2	6.46	15	11.82	28	13.71	41
1.29	3	6.87	16	11.97	29	13.85	42
1.72	4	7.28	17	12.11	30	14.00	43
2.16	5	7.69	18	12.26	31	14.14	44
2.60	6	8.11	19	12.40	32	14.29	45
3.03	7	8.52	20	12.55	33	14.43	46
3.46	8	8.93	21	12.69	34	14.58	47
3.90	9	9.35	22	12.84	35	14.72	48
4.33	10	9.76	23	12.98	36	14.87	49
4.77	11	10.17	24	13.13	37	15.00	50
5.22	12	10.58	25	13.27	38		
5.63	13	11.00	26	13.42	39		

S1 Knife Blade Penetration Depths from Witness Paper Cut Length
for 0° Angle of Incidence

Length (mm)	Depth (mm)	Length (mm)	Depth (mm)	Length (mm)	Depth (mm)	Length (mm)	Depth (mm)
0.41	1	5.70	14	10.98	27	16.27	40
0.81	2	6.10	15	11.38	28	16.67	41
1.22	3	6.51	16	11.79	29	17.08	42
1.63	4	6.92	17	12.20	30	17.49	43
2.03	5	7.32	18	12.60	31	17.89	44
2.44	6	7.73	19	13.00	32	18.30	45
2.85	7	8.13	20	13.42	33	18.71	46
3.25	8	8.64	21	13.82	34	19.11	47
3.66	9	8.90	22	14.23	35	19.52	48
4.07	10	9.31	23	14.64	36	20.00	49
4.47	11	9.76	24	15.05	37		
4.88	12	10.16	25	15.45	38		
5.29	13	10.57	26	15.86	39		

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5.7 Drop Test Series for “Edged Blade” Protection Class

- Total of 24 fair hit drop tests.
- Requires a total of 4 test panels

5.7.1 0° Angle Test Strikes

Angle	E Level	Threat	Panel
0°	E1	P1	Panel 1
			Panel 2
	E2	S1	Panel 3
			Panel 4

5.7.2 45° Angle Test Strikes

Angle	E Level	Threat	Panel
45°	E1	P1	Panel 1
			Panel 2
		S1	Panel 3
			Panel 4

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5.8 Drop Test Series for “Spike” Protection Class

- Total of 12 fair hit drop tests.
- Requires a total of 4 test panels

5.8.1 0° Angle Test Strikes

Angle	E Level	Threat	Panel
0°	E1	Spike	Panel 1
	E2		Panel 2
			Panel 3
			Panel 4

5.8.2 45° Angle Test Strikes

Angle	E Level	Threat	Panel
45°	E1	Spike	Panel 1
			Panel 2
			Panel 3
			Panel 4

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5.9 Test Surveillance

6. DATA COLLECTION AND REPORTING

6.1 Test Documentation

6.1.1 Data Storage

- Minimum 5 year storage.

6.1.2 Data Recording

- The results of each armor test shall be recorded on the Compliance Test Report form.

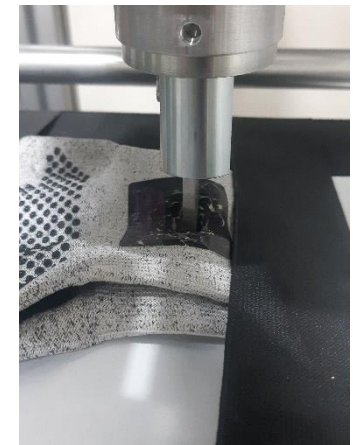
6.2 Test Report

6.2.1 Requirements

- (a) Submission letter stating the outcome of the testing
- (b) Compliance Test Report
- (c) Pass/Fail Statement
- (d) Failure Documentation if applicable
- (e) Photographs of each armor panel before and after testing with scale and identification sign.

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5.9 Test Surveillance



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Drop Height Calculator

NIJ_Drop Height Calculator - Excel

Kim Andrea

H39

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Drop mass Weight =	1920 g			Stab resistant protection level strike energies								
2				Protection level	E1 Strike Energy(J) Allowable penetration : 7 mm	Calculated Velocity (m/s)	Calculated Height (m)	E2 Overtest Strike Energy(J) Allowable penetration : 7 mm	Calculated Velocity (m/s)	Calculated Height (m)			
3				1	24± 0.50	5.00	1.27	36± 0.60	6.12	1.91			
4					Upper Limit	5.03	1.29	Upper Limit	6.15	1.93			
5					Lower Limit	4.97	1.26	Lower Limit	6.10	1.90			
6				2	33± 0.60	5.86	1.75	50± 0.70	7.22	2.66			
7					Upper Limit	5.89	1.77	Upper Limit	7.24	2.67			
8					Lower Limit	5.84	1.74	Lower Limit	7.19	2.64			
9				3	43± 0.60	6.69	2.28	65± 0.80	8.23	3.45			
10					Upper Limit	6.67	2.27	Upper Limit	8.25	3.47			
11					Lower Limit	6.72	2.30	Lower Limit	8.21	3.43			
12													
13	Engineered Knife blades												
14	P1 : Thinner and one cutting edge												
15	S1 : Thicker and two cutting edge												
16													
17	Engineered Spike												
18	One spike threat specified in this standard												
19													
20													
21	Damping Disk Replacement schedule												
22	Less than 65 J : 12 drop												
23	Over 65 J : 4 drop												
24													

Strikes the armor at an angle of incidence within ± 5° from the intended angle of incidence.

Sheet1

준비

100 %

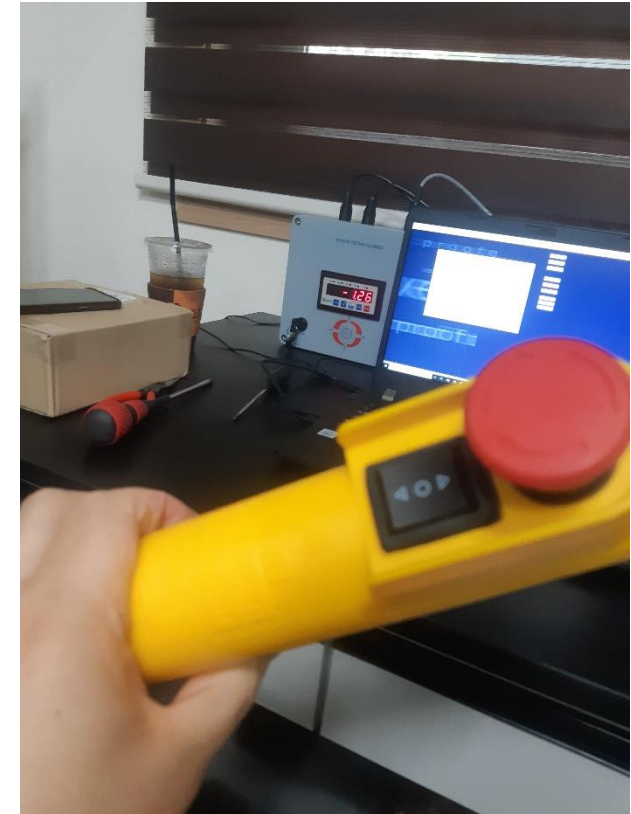
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Force Measurement Amp.

DAQ (Data Acquisition System)
- Transfer the data to PC

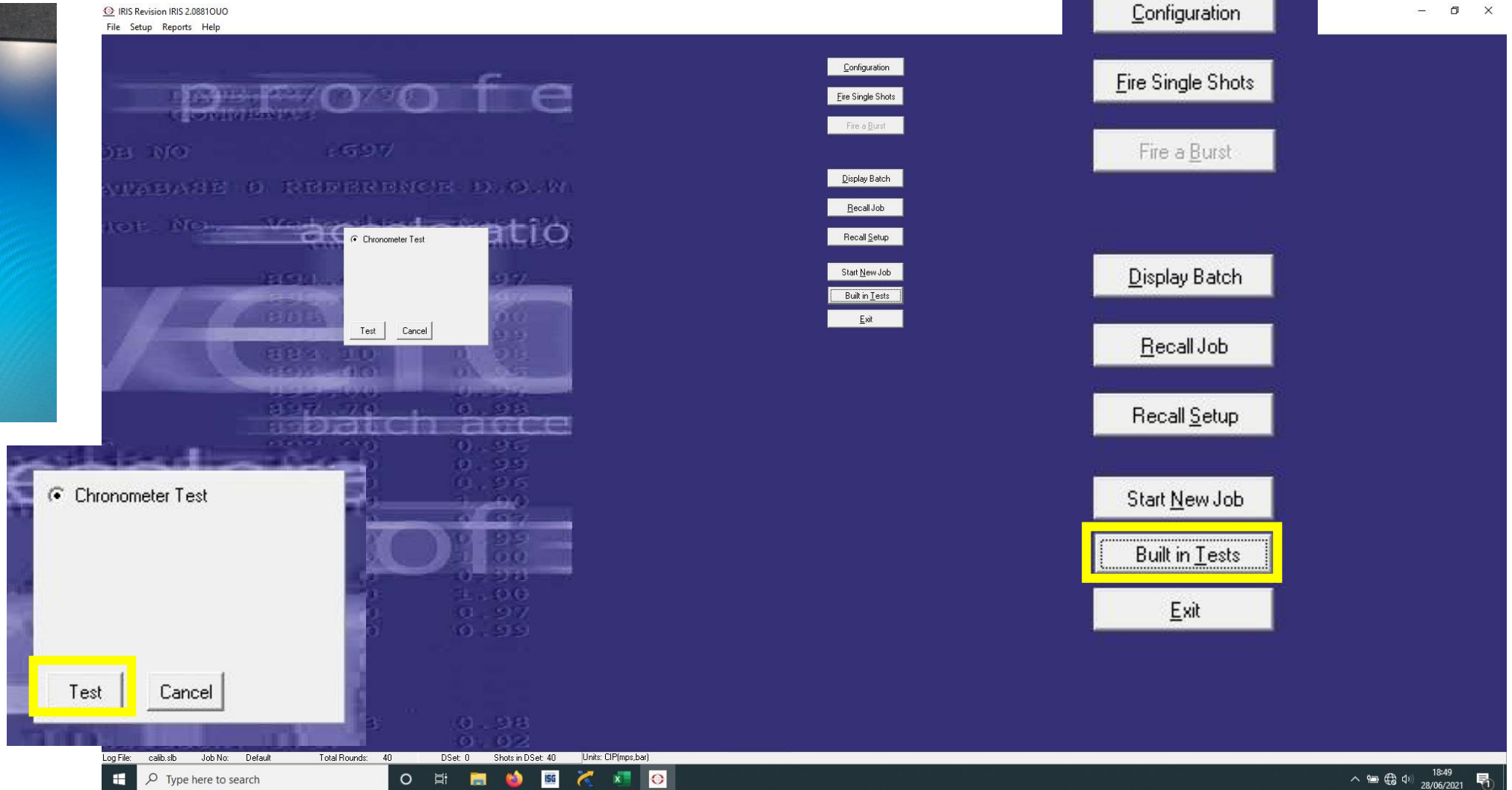
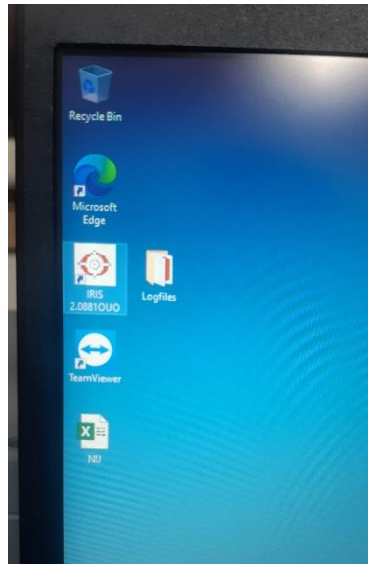
IRIS Velocity Measurement



Drop height lift up/down

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Velocity Measurement - IRIS

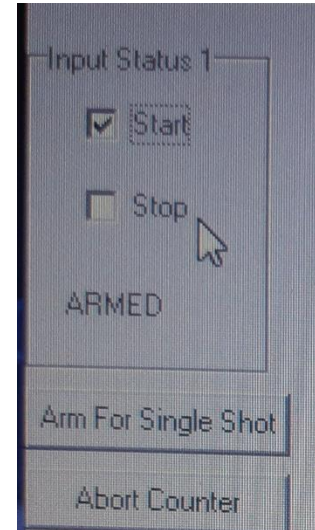
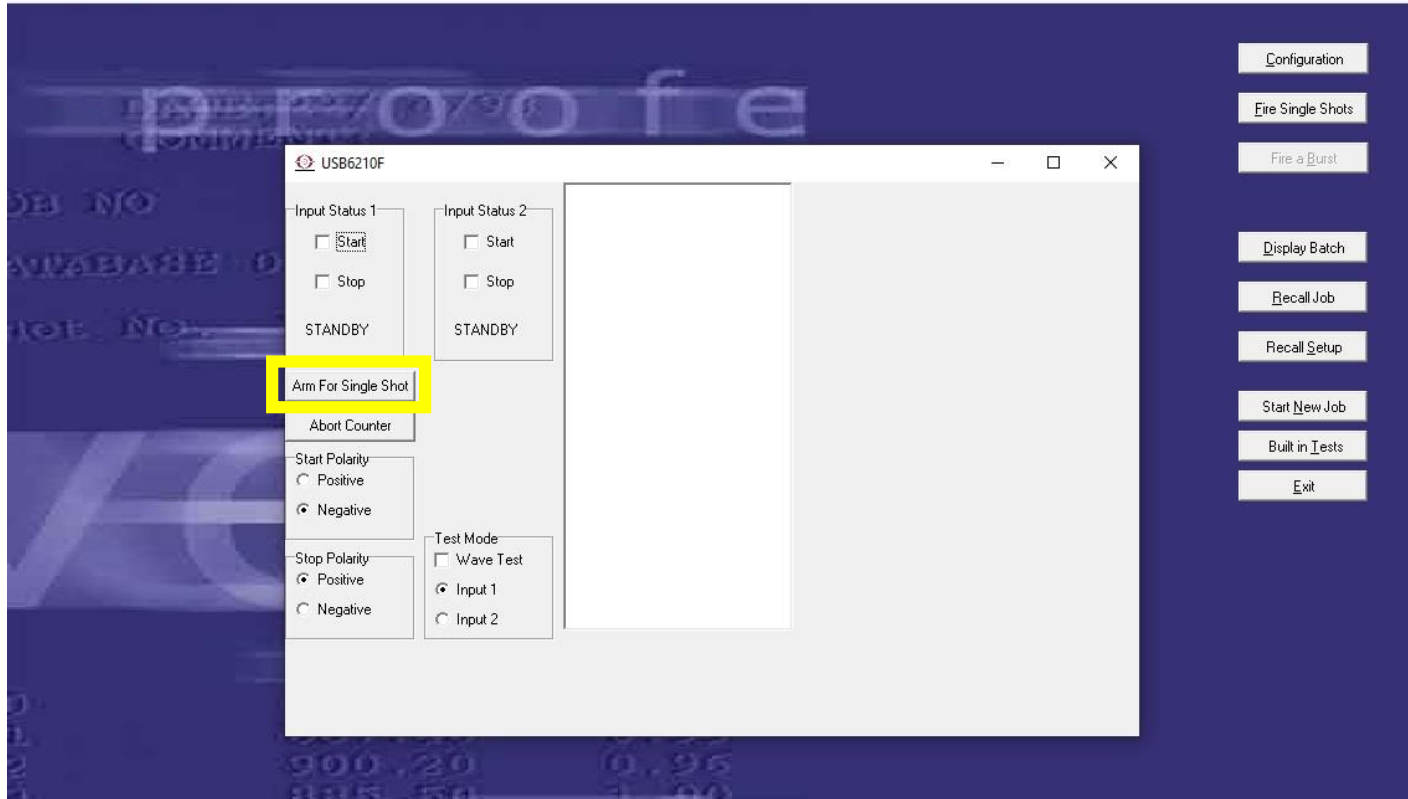


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Velocity Measurement - IRIS

IRIS Revision IRIS 2.08810UO

File Setup Reports Help



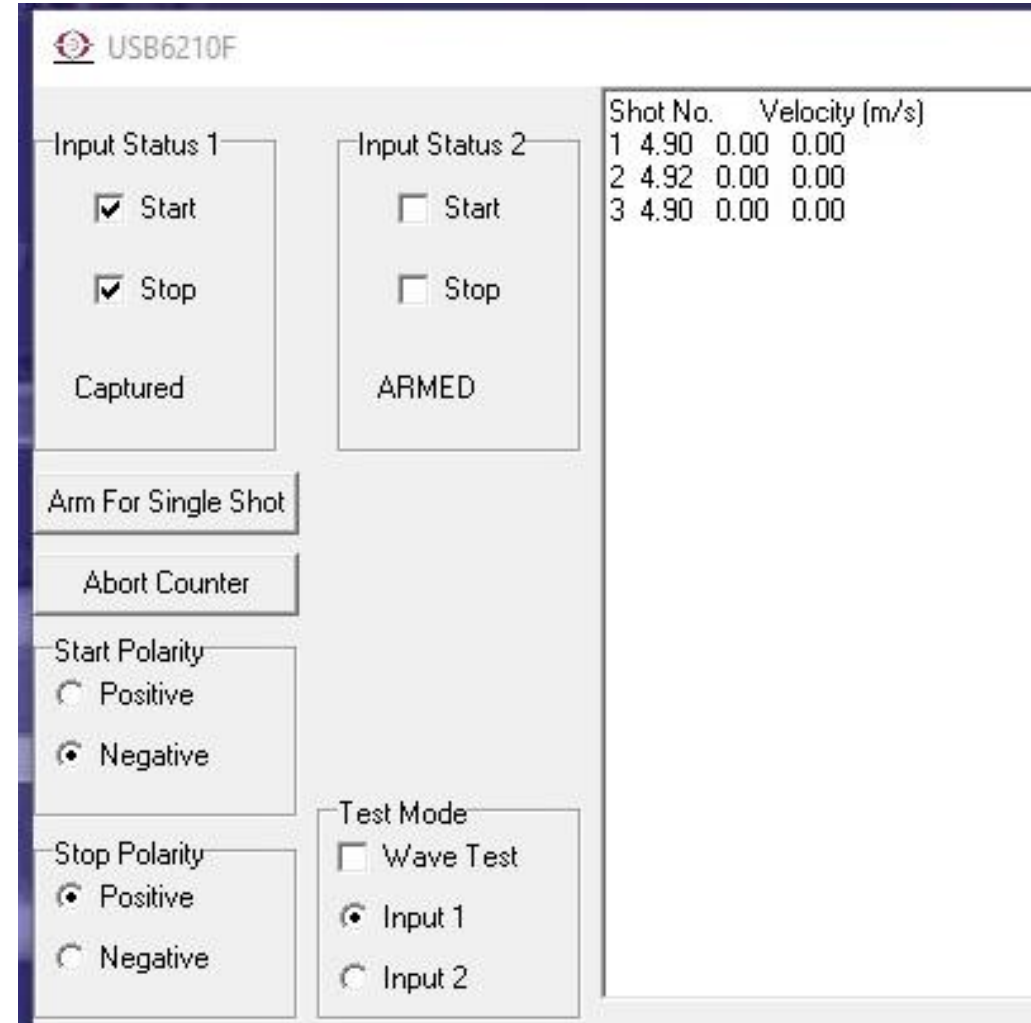
1. STANDBY
2. Click 'Arm For Single Shot'
3. ARMED
4. Check 'Start'

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Velocity Measurement - IRIS



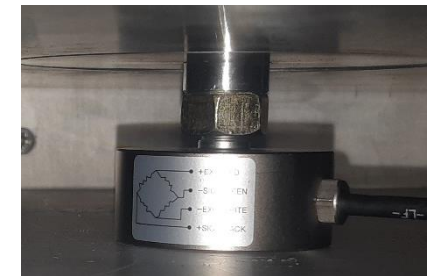
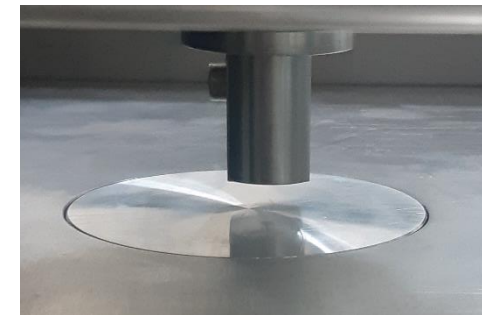
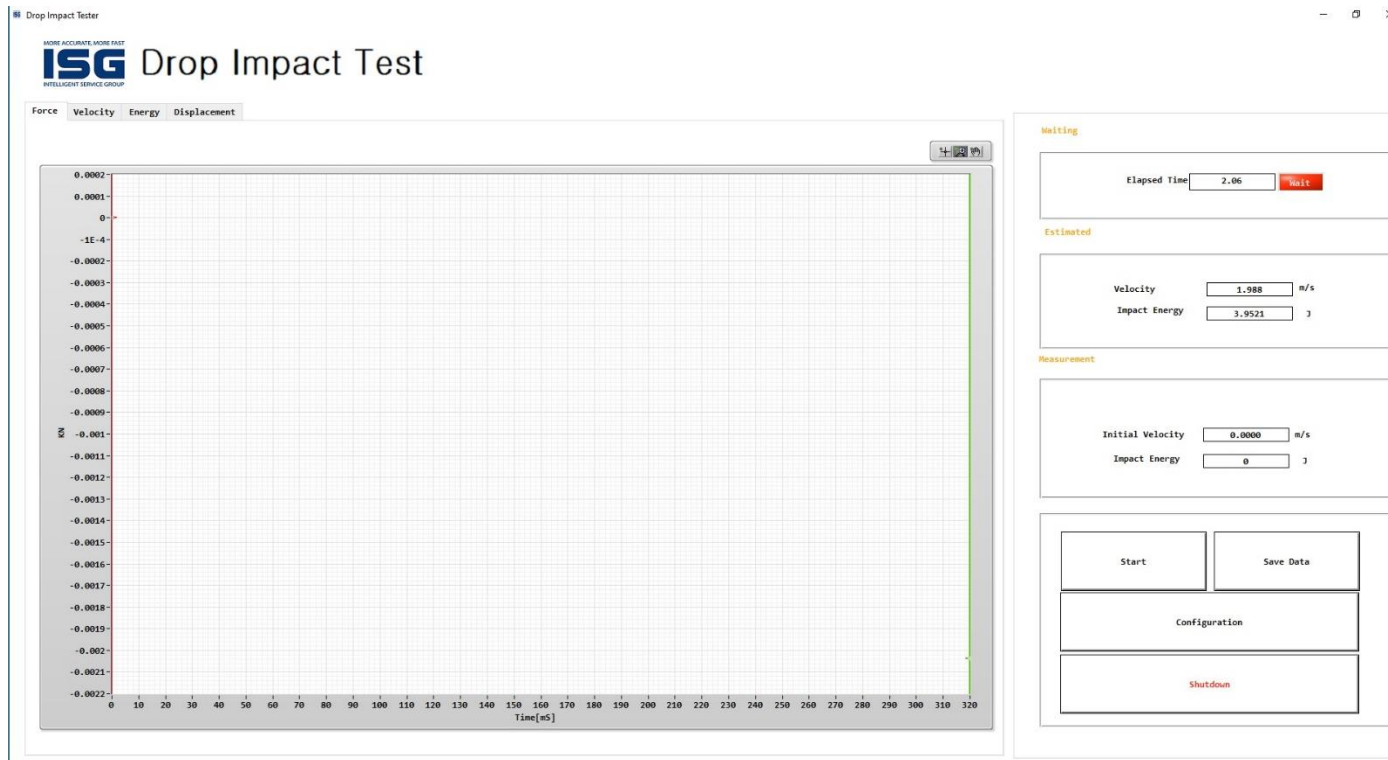
5. Turing to release drop mass
6. Automatically checked 'Stop'
7. Record velocity
8. Reset the next test



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Force Measurement

- Only for 0° Angle Test
- Under the support table



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