HST-MMW-1 Vertical Computer Control

Universal Friction And Wear Testing Machine

1.Features:

The machine adopts process control principle, and combines industrial control computer with the configuration software technology and internet technology; Apply incorporate structure design, integrate embedded industry computer, configuration software, acquisition module and executor as a whole to control the test process, all test operation can be completed at the main interface of the Computer. It features flexible configuration control mode, multiple friction couplings, wide speed adjusting range, simulating high temperature circumstances, high automation and easy to use.

2.Application:

The machine can simulate rolling, sliding and rolling & sliding combined movement under the certain contact pressure to complete point, line and plane simulating tests. It can be used to evaluate the friction and wear performance of lubricant, metal, plastics, coating, rubber, ceramics etc. It can not only content with the needs of traditional petrochemical industry to research, develop and inspect the various kinds of intermediate & high

grade hydraulic oil, combustion engine oil and gear oil. Also it can be tested under dry condition, but also the needs of simulating evaluation to new material development and new technology research.

3.Conformed Standards:

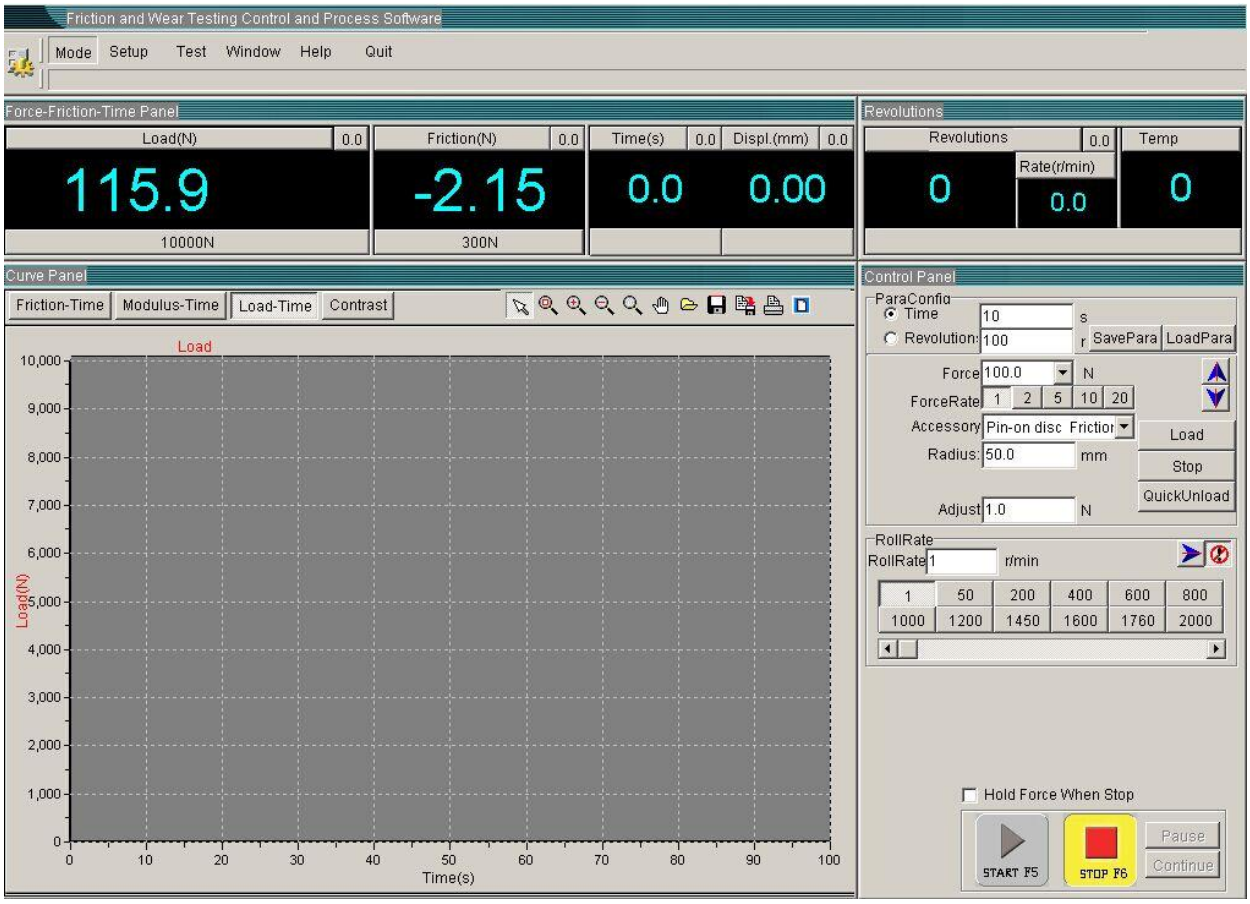
ASTM D-2266, D-3702, D-4172.

4.Main Specifications:

1.Test Force		
NO.	**Item**	**Specification**
1.1	Axial Test Force Working Range	1N~1000N (Stepless)
1.2	Relative Error Of Load Indicating Value	±1 %
1.3	Discriminability Of Test Force Indicated Value	±1.5 N
1.4	Test Force Automatic Loading Rate	400 N/min
1.5	Relative Error Of Test Force Automatic Hold Indicated Value In A Long Time	±1 %
2.Friction Moment		
2.1	Max. Testing Friction Moment	2.5 N.m
2.2	Relative Error Of Friction Moment Indicating Value	±2 %
2.3	Friction Force Weighing Transducer	50 N
2.4	Friction Force Arm Distance	50 mm
3.Spindle Stepless Speed Variation Range		
3.1	Stepless Speed Variation	5~2000 r/min
3.2	Error Of Spindle Speed	±1 %
4.Test Medium: Oil, Water, Slurry, Abrasive etc.		
5.Heating System		
5.1	Heater Working Range	Room Tempetature ~200℃ **(Can Be Customed 260℃)**
5.2	Disc heating plate	ϕ65, 220V, 250W
5.3	Jacketing Heater	Φ68*44, 220V, 300W
5.4	4φ3 dual-output platinum resistance thermometers:	RO=100±0.1Ω (one long and one short set)
5.5	Temperature Measuring Control Accuracy	±(0.3+0.005t)℃ (**"t"** Is Absolute Value Of Test Temperature)
6.Conicity Of Spindle Of Testing Machine: (1:7)		
7.Max. Distance Between Spindle And Lower Disc: ＞75mm		

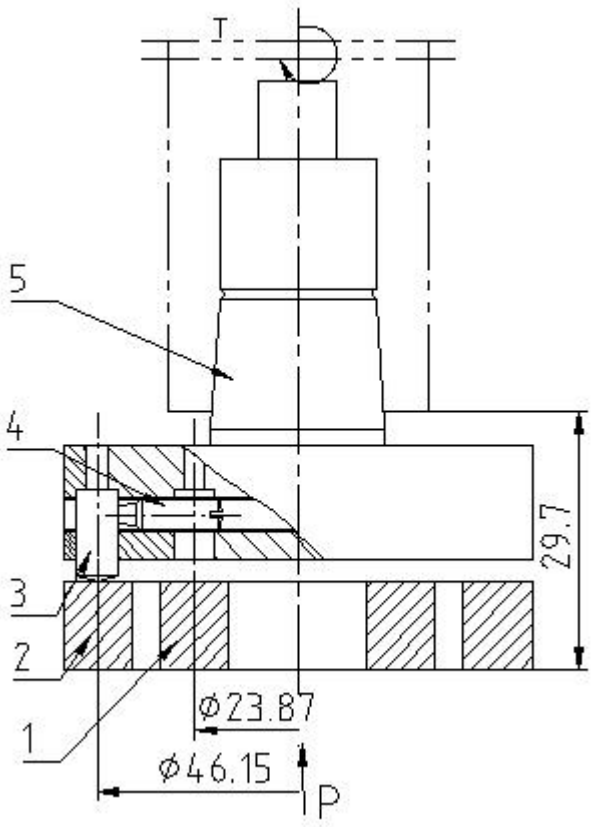
8.Testing Machine Spindle Control		
8.1	Manual Control	
8.2	Time Control	
8.3	Rotate Speed Control	
8.4	Friction Moment Control	
9	Time Display & Control Range	10 s~9999 min
10	Rotate Speed display & control Range	(1~99) * 105
11	Output Max. Moment Of Main Motor	5 N.m
12	Overall Dimension (L*W*H)	860*740*1560 mm
13	Net Weight	650 KG
14	Power Supply	380V, 50Hz.
15	**Computer & Data Processing Range:** Apply industrial control computer and configuration software to control the machine and test process, display different parameters in real time, record friction-time curve and temperature-time curve automatically. Control: Load, time, temperature, test duration. Curves: Temperature-Time, Friction- torque and Time etc. Data can be printed by Excel.	

5.Software Interface:



6.Overview of the friction pairs of the testing machine

Pin-plate friction pair: (Figure 5 Pin-plate friction pair <single needle and three needles>)



1—Small test ring 2—Large test ring 3—Sample pin 4—Screw 5—Pin chuck

Figure 5. Pin-plate friction pair <Single needle and three needles>

coefficient of friction

1.1 Single-needle small loop

Because f = μP ……（1）

T=fr……(2)

Therefore, μ = $\frac{T}{P \cdot r}$ = 0.0837 $\frac{T}{P}$ ……（3）

Where: f—friction force N

μ—coefficient of friction

P—Axial testing force of the testing machine (N)

T—Frictional torque of the testing machine (N/mm)

r—Radius of the contact point between the small test ring and the sample pin, 23.873/2 mm

1.2 Three-needle small ring

Because f = μ $\frac{P}{3}$ ……（4）

T=3fr……(5)

μ= $\frac{T}{P \cdot r}$ =0.0837 $\frac{T}{P}$ ……(6)

1.3 single-needle large loop and three-needle large loop

μ= $\frac{T}{P \cdot R}$ =0.04332 $\frac{T}{P}$ ……(7)

In the formula, R is the radius of the trajectory of the contact point between the large test ring and the sample pin, which is 46.155/2 mm.

1.4 Small ring and pin sample velocity Vs

Vs = πdn = 75n mm/min

Large ring and pin sample speed Vs

VL=πDn=145n mm/min

Where: n—spindle speed of the testing machine (rhm)

d—Diameter of the contact point between the small test ring and the sample pin, d = 23.873 m

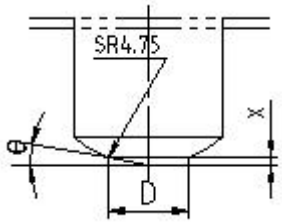
D—Diameter of the contact point between the large test ring and the sample pin, D=46.155mm

3102 Sample Pin Axial Wear Amount and Wear Contact Diameter

Table 2 Comparison of Axial Wear and Wear Contact Diameter of Pin-Disc Friction Pair

Table 3. Conversion Table of Axial Wear Amount and Wear Contact Diameter for Pin-Disc Friction Pair (Metric and Imperial Units)

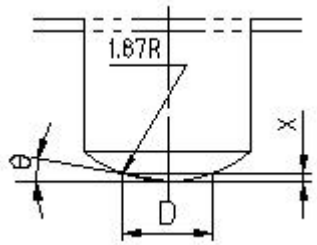
Table 2 Comparison of Axial Wear and Wear Contact Diameter of Pin-Disc Friction Pair



Axial wear mm(x)	wear angle °(θ)	Wear contact diameter mm (D)	Single contact area mm2(A)	Three contact areas mm2 (B)
0.02	5.26	0.8709	0.5956455	1.786937
0.04	7.44	1.2303	1.188778	3.566333
0.06	9.12	1.5052	1.779396	5.338189
0.08	10.53	1.7362	2.367502	7.102507
0.10	11.78	1.9391	2.953095	8.859284
0.12	12.91	2.1219	3.536173	10.60852
0.14	13.95	2.2895	4.116739	12.35022
0.16	14.91	2.4449	4.694792	14.08438
0.18	15.82	2.5904	5.27033	15.81099
0.20	16.69	2.7276	5.843358	17.53007
0.22	17.51	2.8577	6.41387	19.24161
0.24	18.29	2.9815	6.981869	20.94561
0.26	19.04	3.0999	7.547354	22.64206
0.28	19.77	3.2135	8.110328	24.33098
0.30	20.47	3.3227	8.670788	26.01236
0.32	21.15	3.4279	9.228735	27.68621
0.34	21.81	3.5295	9.78416	29.35251
0.36	22.45	3.6279	10.33709	31.01126
0.38	23.07	3.7232	10.8875	32.66249
0.40	23.68	3.8158	11.43539	34.30617
0.42	24.28	3.9057	11.98077	35.94231
0.44	24.86	3.9932	12.5236	37.57091

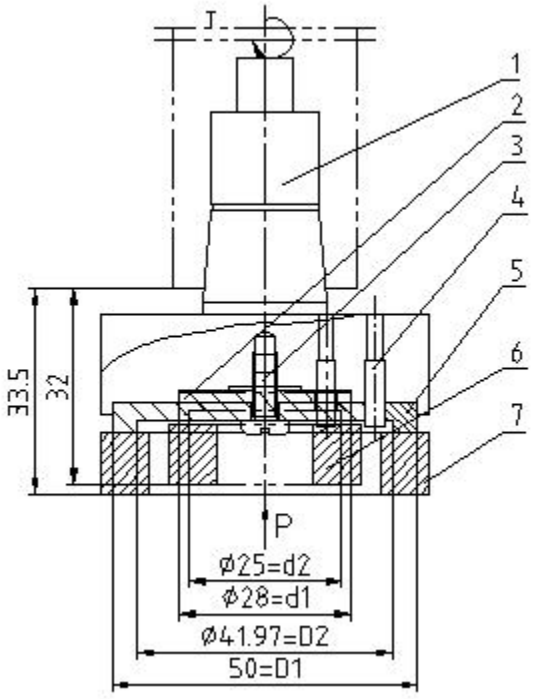
0.46	25.42	4.0784	13.06399	39.19197
0.48	25.98	4.1615	13.60183	40.40548
0.50	26.53	4.2426	14.13716	42.41147
0.52	27.06	4.3219	14.66997	44.00992
0.54	27.59	4.3993	15.20027	45.60081
0.56	28.10	4.4750	15.72806	47.18417
0.58	28.61	4.5491	16.25333	48.75999
0.60	29.11	4.6217	16.77609	50.32827
0.62	29.60	4.6928	17.29633	51.889
0.64	30.09	4.7625	17.81407	53.44221
0.66	30.57	4.8309	18.32929	54.98787

Table 3. Conversion between metric and imperial units for axial wear and wear contact diameter of pin-disc friction pair.



Axial wear amount X mm (in)	Wear angle θ°	Wear contact diameter D mm (in)	Single contact area A mm2 (in2)	Three contact areas B mm2 (in2)
0.0254 (0.001)	5.93	0.9811 (0.0386)	0.756007 (0.00117108)	2.268021 (0.003515)
0.0508 (0.002)	8.39	1.3856 (0.0545)	1.50796 (0.0023373)	4.523881 (0.007012)
0.0762 (0.003)	10.28	1.6948（0.0667）	2.5586（0.0034966）	6.767581（0.010489）
0.1016（0.004）	11.87	1.9542（0.0769）	2.99706（0.0046495）	8.999119（0.013949）
0.127（0.005）	3.28	2.1820（0.0859）	3.73948（0.0057962）	11.2185（0.017887）
0.1524（0.006）	14.55	2.38706（0.0939）	4.475238（0.0069366）	13.42571（0.02181）
0.1778（0.007）	15.72	2.5748（0.1014）	5.206923（0.0080707）	15.62077（0.024212）
0.2032（0.008）	16.82	2.7488（0.1082）	5.934553（0.0091985）	17.80366（0.027595）
0.2286（0.009）	17.85	2.9116（0.1146）	6.658131（0.0103201）	19.97439（0.030960）
0.254（0.010）	18.82	3.0649（0.1207）	7.377655（0.0114354）	22.13297（0.034306）
0.2794（0.011）	19.75	3.2101（0.1264）	8.093126（0.0125444）	24.27938（0.037633）
0.3048（0.012）	20.64	3.3482（0.1318）	8.804542（0.0136470）	26.41363（0.040741）
0.3302（0.013）	21.49	3.4801（0.1370）	9.511906（0.0147435）	28.53572（0.044230）
0.3556（0.014）	22.31	3.6064（0.1420）	10.21522（0.0158336）	30.64565（0.047501）
0.381（0.015）	23.11	3.7278（0.1468）	10.91447（0.0169175）	32.74342（0.050752）
0.508（0.020）	26.74	4.2745（0.1683）	14.34994（0.0224225）	43.04983（0.066727）
0.635（0.025）	29.97	4.7451 (0.1868)	17.68408 (0.0274104)	53.05223 (0.082231)

2. Thrust ring friction pair (Figure 6)



1. Thrust ring collet 2. Thrust ring test plate 3. Screw 4. Cylindrical pin 5. Thrust ring large test plate 6. Small test ring 7. Large test ring

Figure 6. Friction pair of thrust ring

AS—Contact area of the thrust ring small test plate (mm2)

AS = π(d1² - d2²) / 4 ≈ 125 mm²

Al—Contact area of the thrust ring test plate (mm2)

Al = π (D12 - D22) / 4 ≈ 580 mm2

P—Axial testing force of the testing machine (N)

n—Spindle speed of the testing machine (rpm)

T—Frictional torque of the testing machine (N/mm)

Ps—Contact pressure of the thrust ring small test plate (Pa)

$$Ps=\frac{P}{A3}=\frac{P}{125}=8\cdot P\cdot 10^{3}$$

Pl—Thrust ring large test plate contact pressure (Pa)

$$Pl=\frac{P}{Al}=\frac{P}{580}=1.724\cdot P\cdot 10^{3}$$

Rs—The average radius of the thrust ring test plate Rs = (d1 + d2) / 4 = 13.25 mm

Rl—The average radius of the thrust ring test plate Rl = (D1 + D2) / 4 = 22.3 mm

Vs—Thrust ring small test plate test speed

Vs = 2π.Rs.n = 83.25n mm/min

Vl—Thrust ring large test plate speed

Vl = 2π.Rl.n = 144.47n mm/min

μ3—the coefficient of friction of the small thrust ring friction pair

$$\mu 3=\frac{\frac{T}{Rs}}{P}=7.55\frac{T}{P}10^{2} \quad \text{.....（1）}$$

μl — Coefficient of friction of the large thrust ring friction pair

μl= $\frac{\frac{T}{Rl}}{P} = 4.35\frac{T}{P}10^2$ .....(2)

Pv3—Speed factor N for small thrust ring friction pair · $\frac{mm}{\min}$

Pv3=Ps.Vs= $\frac{P}{As}$ 2πRs n=0.666Pn.....(3)

Pvl—Speed factor N of the large thrust ring friction pair · $\frac{mm}{\min}$

Pvl=Pl.Vl= $\frac{P}{Al}$ 2πRl n=0.249Pn.....(4)

Kt—Wear factor of thrust ring friction pair (mm²/N)

Kt= $\frac{X}{P \cdot V \cdot t}$ .....(5)

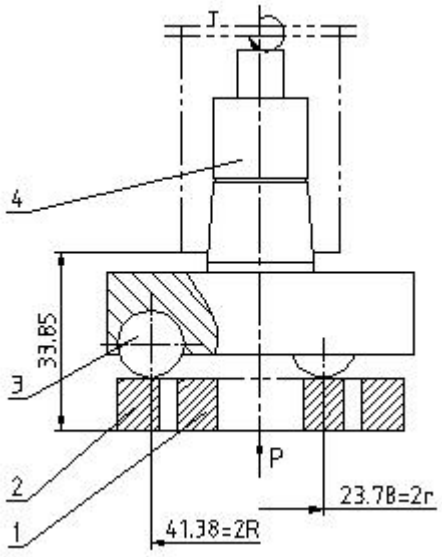
In the formula: X—axial wear of the thrust ring friction pair (mm)

P—Contact pressure of thrust ring friction pair Ps type pl Pa

V—Test speed of thrust ring friction pair Vs type Vl (mm/min)

t—Test time (min) of thrust ring friction pair

3.Friction Pair of Ball and Disc (Single Ball vs Three Balls) Figure 7



1.Small test ring 2.Large test ring 3. ϕ 12.7 steel ball 4.Ball-on-disc fixture

Figure 7 Ball-on-Disc Friction Pair (Single Ball and Three Balls)

Calculation of Friction Coefficient

3.1 The friction pairs of single ball/three balls with small ring are consistent with those of single pin/three pins for pin-on-disc configuration

μ= $\frac{T}{P.r} = 0.0837\frac{T}{P}$ .....（1）

3.2 Large ring friction pair with single ball and three balls (the calculation formula is the same as that of pin-on-disc friction pair)

$$\mu=\frac{T}{P.r}=\frac{1}{20.69}\frac{T}{P}=0.0483\frac{T}{P} \quad \text{.....(2)}$$

T — friction torque of tester, N·mm

P — axial test force of tester, N

R — track radius at contact point between large test ring and specimen ball, R=$\frac{41.38}{2}mm$

μ — friction coefficient between ball and large test ring

Testing speed:

3.3 Velocity of ball and small test ring (Vs), velocity of 3103 large test ring (Vl)

Vs=π.d.n=75n mm/min .....(3)

Vl=π.D.n=130n mm/min.....(4)

n — spindle speed of tester, r.p.m

d — track diameter at contact point between small test ring and specimen ball, d=23.873 mm

D — track diameter at contact point between large test ring and specimen ball, D=41.380 mm

Hertz Contact Stress

3.4 Maximum Hertz Contact Stress σmax of Ball-on-Disc Friction Pair

When the friction pair materials are identical and Poisson's ratio μ = 0.3

Single Ball-on-Disc Friction Pair σmax=0.388 $3\sqrt{pe^2\frac{1}{R^2}}=394\cdot p^{\frac{1}{3}}$ N/mm2

Three-Ball-on-Disc Friction Pair σ max=0.388 $3\sqrt{pe^2\frac{1}{R^2}}=274\cdot p^{\frac{1}{3}}$ N/mm2

P — axial test force of the tester, N

E — elastic modulus of alloy steel, 2.1×10^6 kgf/cm² = 2.06×10^5 N/mm²

R — radius of specimen ball, 6.35 mm

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Authentication Certificate of Quality Management Systems

Registration No.19924Q01775R1S

This is to certify that

JINAN HENSGRAND INSTRUMENT CO., LTD.

Unified Social Credit Code：91370104684680659H

Registered/Office/Production Address：No. 4915, Jingshi West Road, Huaiyin District, Jinan City, Shandong Province

Is in conformity with:

GB/T 19001-2016/ISO 9001:2015

The certificate is valid for the following scope:

Trial assembly and sales of equipment

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Date of Issue：2024-12-31
Date of Expiry：2027-12-30
Date of Initial Certification：2021-12-31
Date of Change：2024-12-31

General Manager

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MACHINERY DIRECTIVE ATTESTATION OF CONFORMITY

Technical file of the company mentioned below has been inspected and audit has been completed successfully.

2006/42/EC Machinery Directive Annex VIII has been taken as references for these processes.

Company Name	: **JINAN HENSGRAND INSTRUMENT CO., LTD.**
Company Address	: NO.4915, WEST JINGSHI ROAD, JINAN, CHINA
Related Directives and Annex	: **2006/42/EC Machinery Directive/Annex VIII**
Related Standards	: **EN ISO 12100:2010, EN 60204-1:2018**
Product Name	: **TESTING MACHINE**
Report No and Date	: TCF-JHIC230128-MD
Product Brand/Model/Type	: WDS-1, WDS-2, WDS-3, WDS-5, WDS-10, WDS-20, WDS-30, WDS-50, WDS-100,WDS- 200, WDS-300, WDS-500, WDW-1, WDW-2, WDW-3, WDW-5, WDW-10, WDW-20, WDW-30, WDW-50, WDW-100, WDW-200, WDW-300, WDW-500, WDW-600, WDW- 1000, WE-300, WE-600, WE-1000, WE-2000, WEW-300, WEW-600, WEW-1000, WEW- 2000, WAW-300, WAW-600, WAW-1000, WAW-2000, WAW-3000, WAW-5000, WAW- 6000, LAW-1000, JB-300B, JBS-300, JBW-300, JB-500B, JBS-500, JBW-500, JBW-750, CST-50, VU-2Y, VU-1S, DWC-40, DWC-60, DWC-80, DWC-100, DWC-196, YES-2000, YES- 300, YAW-1000, YAW-300, YAW-2000, YAW-3000, YAW-5000, NDS-200, NDS-500, NDS- 1000, NDS-2000, NDW-200, NDW-500, NDW-1000, NDW-2000, NDW-3000, NDW- 5000,NDW-10000, HEZ-3, HEZ-6, HEZ-10, JWJ-10, TLS, TLW, HST-P50, HST-P100, HST- P200, HST-P300, RDJ, NDT, DWTT, GBW-60, GW-50, HST, XNR-400

Certificate Number	: **M.2023.206.C81366**
Initial Assessment Date	: 31.01.2023
Registration Date	: 01.02.2023
Reissue Date/No	: -
Expiry Date	: **31.01.2028**

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