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Replacing JB/T 3300-1992

Counterbalanced fork-lift trucks - Testing method for whole machines

平衡重式叉车 整机试验方法

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Foreword

This Standard replaces JB/T 3300-1992 *Counterbalanced fork-lift trucks - Testing method for whole machines*.

Compared with JB/T 3300-1992, the major changes of this Standard are as follows:

— The scope of application of the standard has been adjusted to the internal combustion counterbalanced fork-lift trucks with the rated lifting capacity of 500kg ~ 10,000kg and the battery-powered counterbalanced fork-lift trucks with the rated lifting capacity of 500kg ~ 5,000kg.

— ADD the foreword, Appendixes A and B, Chapter 3, Sections 4.2.1.4 and 19.3, Tables 3, 4 and 7, Figures 8, 9, 10 and 11.

— Modifications in this Standard: Sections 3.2.1.1, 3.2.1.2, 3.2.1.3, 3.2.2.3, 4.3.2, 4.3.3, 4.3.4, 4.3.6, 4.3.7, 4.3.8, 5.2.5, 5.3.2, 5.3.4, 5.3.5, 7.2, 7.4.1, 7.4.2, 7.4.3, 7.4.4, 7.4.5, 7.4.6, 7.4.7, 8.4.3, 8.4.4, 9.2, 9.4.5, 10.2, 10.4.1, 10.4.2.1, 10.4.3.1, 10.4.3.2, 10.4.4.2, 10.4.4.3, 11.4.1.1, 11.4.1.3, 11.4.2.1, 11.4.2.4, 12.4, 12.4.2, 12.4.3, 12.4.4, 16.5.1, 16.5.2, 16.5.3, 17.4.2, 18.2.1, 18.2.2, 18.2.2.1, 18.2.2.2, 18.3.1, 18.3.2 and 18.3.3.5, Chapters 11, 13, 14 and 15, Tables 4, 5, 6 and 7, Figures 4, 5, 6, 8, 9, 10, 11, 12 and 15.

— This Standard cancels the Chapter 19 “Tests for industrial use”, Appendix A “Table of test records”, Sections 3.3.2.4, 3.2.2.5, 4.3.1, 4.3.9, 4.3.10, 4.3.11, 5.1, 7.1, 7.3, 7.4.8b, 7.4.9, 8.1, 8.2, 8.3, 9.1, 9.3, 9.4.2, 10.1, 10.3, 10.4.4.1, 11.1, 11.2, 11.3, 12.1, 12.3, 16.1, 16.3, 16.4e, 17.1, 17.2, 17.3, 18.1, 18.2.3.4 and 18.2.3.5, Tables 3 and 4, Figures 8, 9, 13 and 14 in the original standard.

The Appendixes A and B of this Standard are normative.

This Standard was proposed by China Machinery Industry Federation.

This Standard shall be under the jurisdiction of the Beijing Hoisting and Conveying Machinery Research Institution (now known as “Beijing Materials Handling Research Institute”).

Responsible drafting organization of this Standard: Beijing Hoisting and Conveying Machinery Research Institution (now known as “Beijing Materials Handling Research Institute”).

Counterbalanced fork-lift trucks - Testing method for whole machines

1 Scope

This Standard specifies the test method for whole machines of the counterbalanced fork-lift trucks' preparations before test, test conditions, parameter determination and stability, loading and unloading performance, steering performance, operating performance, dynamic performance, energy consumption, braking performance, vibration, noise, etc.

This Standard is applicable to the internal combustion counterbalanced fork-lift trucks with the rated lifting capacity of 500kg ~ 10,000kg (referred to as "internal combustion fork-lift trucks" in particular to the internal combustion counterbalanced fork-lift trucks) and the battery-powered counterbalanced fork-lift trucks with the rated lifting capacity of 500kg ~ 5,000kg (referred to as "battery-powered fork-lift trucks" in particular to the battery-powered counterbalanced fork-lift trucks), which are hereinafter referred to as "fork-lift trucks". Other types of fork-lift trucks can use this Standard for reference.

2 Normative references

The provisions in the following documents become the provisions of this Standard through reference in this Standard. For dated references, the subsequent amendments (excluding corrections) or revisions do not apply to this Standard. However, parties who reach an agreement based on this Standard are encouraged to study if the latest editions of these documents are applicable. For undated references, the latest editions apply to this Standard.

GB/T 3785 *Electric, sonic properties and measuring methods for sound level meters*

GB/T 5141 *Counterbalanced fork-lift trucks - Stability test (GB/T 5141-2005, ISO 1074:1991, IDT)*

GB/T 5143 *Industrial trucks - Overhead guards - Specification and testing (GB/T 5143-2008, ISO 6055:2004, IDT)*

JB/T 2390 *Counter balanced fork lift trucks - Basic parameter*

ISO 5767 *Industrial trucks operating in special condition of stacking with mast tilted forward - Additional stability test*

b) Standard no-load operating status: OPERATE under standard no-load status and the condition of mast tilting backward to the greatest extent.

c) Standard load status: The fork-lift trucks shall be equipped with test loads. The masts shall be vertical. The upper surfaces of the forks shall be 300mm away from the ground.

d) Standard load operating status: OPERATE under standard load status and the condition of mast tilting backward to the greatest extent.

4 Preparations before test

4.1 Purpose of the preparations

Before the test, the fork-lift trucks shall have normal technical status, so as to ensure the correctness of the test results. In the meanwhile, ELIMINATE various hidden dangers to ensure the security and the smooth conduct of the test, and to avoid accidents.

4.2 Work items

4.2.1 Test forklift acceptance

4.2.1.1 REGISTER the product certificate, manufacturing plant's name, product model, product serial number or manufacturing date, and the original dimensions of the parts that need to be dismantled and inspected.

4.2.1.2 CHECK the integrity of the fork-lift trucks' assemblies, components, accessories, accessory devices and attached tools, tightening degree of the fasteners in key positions, lubrication and sealing conditions of the assemblies' lubricating oil and points, sealing conditions of the hydraulic systems and oil pipe connectors, insulation resistance between batteries and bodies of the battery-powered fork-lift trucks, and firmness of the battery cells in the containers, battery containers in the frames and battery system wiring.

4.2.1.3 CHECK the assembly condition of the fork-lift trucks: For the fork-lift trucks in standard no-load operating status, CHECK whether the steering system, transmission system, braking system, operating system, electrical system and battery container sets are normal and reliable. For the fork-lift trucks in standard no-load status, CHECK whether the mast lifting system and hydraulic system are normal and reliable. There shall be no oil leakage.

4.2.1.4 CHECK whether the nameplates and load curve plates of the fork-lift trucks are correct, and whether their security identifications are integral.

4.2.2 Forklift running-in

5.5 Before the performance test, fully PREHEAT the fork-lift trucks.

5.6 During the test, CONFORM to the following conditions:

a) The ambient temperature shall be within the range of -5°C to +40°C;

b) The wind speed shall not exceed 5m/s;

c) The relative air humidity shall not be greater than 90%;

d) The altitude shall be less than 2,000m.

5.7 The test site surfaces shall be flat, dry and clean concrete ground. The slope shall not be greater than 0.5%. The area shall meet the fork-lift trucks' condition of making full circle rotation, or shall meet the specific test requirements of this item.

5.8 Straight test tracks shall be flat, dry and clean concrete ground. The slope shall not be greater than 0.5%. The track length and width shall not be less than 80m and 5m, respectively, or shall meet the specific test requirements of this item.

6 Determination of major structural parameters and technical characteristic parameters

6.1 External dimensions determination of the fork-lift trucks

6.1.1 Measurement method

The method for measuring the external dimensions of the fork-lift trucks is as follows:

a) PARK the fork-lift trucks on the test site. The load status (standard no-load or standard load status) shall be in accordance with the measurement requirements. The steering wheels shall be in the linear position for operation.

b) Besides direct measurement, the horizontal and height dimensions can be indirectly measured with the aid of appliances.

c) Besides direct measurement, the angle parameters can be obtained by determining the positions of the characteristic points via the graphing or calculation method.

6.1.2 Measuring items for the external dimensions of the fork-lift trucks

			driver's head after the driver sits down (not indicated in Figure 4)
Cover height of the engine (or battery container)		H_8	Not indicated in Figure 4
Height of the traction hook center		H_9	Not indicated in Figure 4
Minimum ground clearance	At the mast bottom	H_5	Standard no-load and standard load statuses
	At the wheelbase center	H_7	Standard no-load and standard load statuses
	At the lowest point of the frame	H_{10}	Standard no-load and standard load statuses (not indicated in Figure 4)
	At the lowest point of the drive axle	H_{11}	Standard no-load and standard load statuses (not indicated in Figure 4)
	At the lowest point of the steering axle	H_{12}	Standard no-load and standard load statuses (not indicated in Figure 4)
Fork	Length	L_4	Not indicated in Figure 4
	Maximum lateral spacing	W_5	
Breakover angle	Ramp breakover angle	δ	Minimum acute angle formed by the intersection of the two tangents led from the wheelbase center to the outer edges of front and rear tires
	Departure angle	γ_2	Angle BETWEEN the tangent led from the lower edge at the mast bottom to the outer edge of the front tire AND the ground
	Approach angle	γ_1	Angle BETWEEN the tangent led from the lower edge at the mast bottom to the outer edge of the front tire AND the ground
Channel width [b]	Minimum theoretical width of the right-angle channel	B_T	Standard load status (for given trays)
	Minimum. theoretical width of the right-angle stacking channel	B_{Td}	Standard load status (for given trays)
Minimum turning radius [b]	Outside	r	
	Inside	r'	
Wheel free radius	Front wheel	R_c	MEASURE when the fork-lift truck lifts up and the wheels are off the ground (not indicated in Figure 4)
	Rear wheel	R'_c	
Wheel static radius	Front wheel	R_f,	

6.2.5.2 The fork-lift truck is in standard no-load status. The method for measuring the vertical distance BETWEEN centroid AND parking ground H_0 (SEE Figure 5) is as follows:

PLACE the front wheels of the fork-lift truck on the scale platform first. LIFT up the rear wheels until the forward tilt angle of the fork-lift truck is respectively 10°, 12° and 15°. MAKE measurements respectively. After lifting up, CALCULATE the height of the gravity center H_0 based on the front axle load G_f' and the static radiuses of the front and rear wheels R_f' and R_t' according to the Equation (8). TAKE the mean value of three measured values (the relative error of three measured values shall not be greater than 5%).

$$H_0 = \frac{L_1(G_f' - G_l') + (R_f' - R_r')G_f' \times \tan\theta}{G_0 \times \tan\theta} + R_r' \quad \cdots\cdots (8)$$

Where:

H_0 - Centroid height, in unit of mm;

θ - Forward tilt angle of the fork-lift truck, in unit of °;

G_f' - Measured value of the front axle load when the forward tilt angle of the fork-lift truck is θ, in unit of kg;

G_l' - Measured value of the front axle load, in unit of kg;

R_f' - Measured value of the front wheel static radius after lifting up the fork-lift truck, in unit of mm;

R_r' - Measured value of the rear wheel static radius after lifting up the fork-lift truck, in unit of mm.

On the premise of meeting the measurement accuracy (the relative error BETWEEN the average measured value obtained by using other methods AND that obtained by using the weighing method shall be less than 5%), it is allowed to use other methods (such as lifting method and hanging method) for determining the centroid height.

a) The engine of the internal combustion fork-lift truck is in idle state;

b) The operating oil pump's motor of the battery-powered fork-lift truck is in off state.

8.2.4 Partial load test for masts

The fork-lift truck is in standard load status. CONDUCT parking braking. The provisions on the partial load distance are as follows:

500kg ≤ Q < 1,000kg, 80mm;

1,000kg ≤ Q ≤ 3,500kg, 100mm;

3,500kg < Q ≤ 5,000kg, 125mm;

5,000kg < Q ≤ 10,000kg, 150mm.

The fork lifts up to the highest position at bearable maximum load (Q_1 or Q_2) and full speed, and then descends to 500mm from the ground at maximum descent speed. Respectively REPEAT the above procedures three times on the left and right sides. TAKE the mean value.

Note 1: Q_1 refers to the maximum load at the standard load center distance and standard lifting height.

Note 2: Q_2 refers to the maximum load at the maximum lifting height indicated on the nameplate of the carrying capacity.

8.2.5 Determination of the inclined hydraulic cylinder's oil pressure and mast's maximum tilt speed:

The fork-lift truck is in standard load status. FIX the test load on the fork carriage. CONDUCT parking braking. When the hydraulic distribution valve is fully open, DETERMINE the mast's forward and backward tilt time spent in tilting from maximum backward tilt position to maximum forward tilt position, and in operating in the opposite direction. In the meantime, DETERMINE the maximum operating oil pressure of the inclined hydraulic cylinder when the mast is tilting from maximum forward tilt position to maximum backward tilt position. PERFORM each determination three times. TAKE the mean value.

8.2.6 Determination of the fork's natural gliding range and the mast tilt angle's natural variation:

The fork-lift truck is in standard load status. The mast shall be vertical. CONDUCT parking braking. LIFT the load up to 2,500mm from the ground (for the fork-lift truck with the lifting height of less than 2,500mm, TAKE its maximum lifting height instead). SHUT down the engine or motor. START the timekeeping

while closing the hydraulic distribution valve. LET stand for 10min. Respectively MEASURE the fork's natural gliding range and the mast tilt angle's natural variation. PERFORM each measurement twice. TAKE the mean value.

8.2.7 Joint operation test

The fork-lift truck forks the test load. The mast moves from vertical position to maximum backward tilt position. PERFORM joint operation of running while lifting at a moderate speed. The lifting height shall be within the range of 300mm to 1,500mm. Respectively GO forward and backward three times. OBSERVE whether there is oil leakage and other abnormalities in the lifting system and hydraulic system of the mast.

For the battery-powered fork-lift trucks, USE the ones with large-capacity battery packs that can meet the energy demand of the joint operation. Do NOT conduct this test.

8.2.8 Overload test

8.2.8.1 The fork-lift truck forks 1.1Q test load. Respectively PERFORM lifting, tilt and operation at a moderate speed. The lifting height shall be within the range of 300mm to 1,500mm. PERFORM each operation three times. OBSERVE whether there is oil leakage and other abnormalities in the lifting system and hydraulic system of the mast.

8.2.8.2 At the maximum lifting height, the loads that can be born within 15min are 1.33Q_1 or 1.33Q_2. When the fork-lift truck is tested, steadily PLACE the loads on the fork that has been lifting up to the maximum height. PLACE the fork-lift truck on the solid and flat ground. The mast shall be vertical. In view of the security, the fork-lift truck to be tested shall be fixed, and the wheels can be removed on the premise of not affecting the test.

9 Steering performance test

9.1 Determination of the steering wheel's idle angle

The fork-lift truck is in standard no-load status. Slowly ROTATE the steering wheel until the running clearance is eliminated. Do NOT rotate the steering wheel. Respectively DETERMINE the idle angles in the left and right directions.

9.2 Determination of the steering wheel's orientation angle

The fork-lift truck is in standard no-load status. USE a steering wheel locator to respectively determine the camber angles of the left and right steering wheels and the kingpin inclination angle. Do NOT conduct this test to the three-wheel fork-lift trucks.

9.6.3 Minimum theoretical width of the right-angle channel

9.6.3.1 Four-wheel fork-lift trucks (narrow loads)

When the transverse dimensions of the fork-lift trucks with narrow loads meet the condition of ($b_{12}/2 \leq b_{13}$), DETERMINE and CALCULATE according to the Equation (14) and r. SEE Figure 8.

$$R = \sqrt{(a_{12} + L_2)^2 + \left(\frac{b_{12}}{2}\right)^2} \quad \cdots\cdots (14)$$

Where:

R - Turning radius of the transverse distance between instantaneous center of turning to tray or goods ($b_{12}/2$), in unit of mm;

L_2 - Front suspension wheelbase, in unit of mm;

a_{12} - Longitudinal dimensions of the trays or goods, in unit of mm;

b_{12} - Transverse dimensions of the trays or goods, in unit of mm.

For the minimum theoretical width B_T of the right-angle channel, TAKE the greater numerical value from the Equation (14) and the minimum external turning radius r, in unit of mm.

9.6.3.2 Four-wheel fork-lift trucks (wide loads)

When the transverse dimensions of the fork-lift trucks with wide loads meet the condition of ($b_{12}/2 \geq b_{13}$), DETERMINE and CALCULATE according to the Equation (15) and r. SEE Figure 9.

$$R = \sqrt{(a_{12} + L_2)^2 + \left(\frac{b_{12}}{2} - b_{13}\right)^2} \quad \cdots\cdots (15)$$

Where:

R - Turning radius of the transverse distance between instantaneous center of turning to tray or goods ($b_{12}/2$ - b_{13}), in unit of mm;

L_2 - Front suspension wheelbase, in unit of mm;

a_{12} - Longitudinal dimensions of the trays or goods, in unit of mm;

b_{12} - Transverse dimensions of the trays or goods, in unit of mm;

The fork-lift truck is respectively in standard no-load and standard load operating statuses. The tire pressure shall conform to the provisions.

USE the imprinting method to determine the wheel rolling radius: The fork-lift truck operates at a lower and constant speed. When the fork-lift truck drives away, the tires leave imprints behind. MEASURE the total length of the three perimeters of the driving wheels S_r based on the imprinting center. CALCULATE the rolling radius of the driving wheel r_a. CALCULATE in accordance with the Equation (17):

$$r_a = \frac{S_r}{6\pi} \quad (17)$$

Where:

r_a - Rolling radius of the driving wheel, in unit of mm;

S_r - Total length of the three perimeters of the driving wheels, in unit of mm.

10.3 Fretting property determination

The fork-lift truck is in standard load status. The transmission is configured at low-speed forward gear. STEP on the inching pedal to the final position. STEP down the accelerator pedal, until the engine's rotating speed comes up to about 2/3 of the rated rotating speed. Slowly LIFT up the inching pedal. Slowly STEP down the inching pedal after the combination of the clutch. DETERMINE the inching oil pressure *p* and the pedal stroke *s*. DRAW the curve of inching oil pressure and pedal stroke (*p*-*s*). It is unnecessary to conduct this test to the mechanical, static pressure and battery-powered fork-lift trucks.

10.4 Neutral impact test and impact test in gear

10.4.1 Neutral test: The fork-lift truck is in standard no-load status. The transmission is configured at neutral gear. STEP down the accelerator pedal, until the engine's rotating speed comes up to about 2/3 of the rated rotating speed. LET stand for a while.

10.4.2 Impact test in gear: The fork-lift truck is in standard no-load status. The engine's rotating speed is about 2/3 of the rated rotating speed. Suddenly CHANGE from neutral gear to forward gear first. Suddenly CHANGE from neutral gear to backward gear afterwards. Respectively DETERMINE and RECORD the oil pressure in gear and the acceleration process of the fork-lift truck. DRAW the curve of time and forklift acceleration. It is unnecessary to conduct this test to the mechanical, static pressure and battery-powered fork-lift trucks.

CONDUCT the test back and forth twice. TAKE the mean value of the time respectively spent in passing through the measuring section for four times.

CALCULATE the minimum stable speed according to the Equation (19):

$$v_{min} = \frac{3.6L_0}{1/4(t_1 + t_2 + t_3 + t_4)} \quad \cdots\cdots (19)$$

Where:

v_{min} - Minimum stable speed, in unit of km/h;

L_0 - Distance of the measuring section, in unit of m;

t_1 - Time spent in passing through the measuring section for the first time, in unit of s;

t_2 - Time spent in passing through the measuring section for the second time, in unit of s;

t_3 - Time spent in passing through the measuring section for the third time, in unit of s;

t_4 - Time spent in passing through the measuring section for the fourth time, in unit of s.

It is unnecessary to conduct this test to the battery-powered, hydraulic transmission and static pressure fork-lift trucks.

11.3 Acceleration performance test

11.3.1 Determination of the fork-lift truck's acceleration performance in various gears

The fork-lift truck is in standard load operating status. PASS through the 30m long section for measuring the initial speed at a constant speed of minimum stable speed. After arriving at the starting point of the acceleration test, rapidly STEP down the accelerator pedal. ACCELERATE to maximum operating speed. For the hydraulic, static pressure and battery-powered fork-lift trucks, the accelerator pedal can be rapidly stepped down when the fork-lift truck is at rest, until it accelerates to maximum operating speed. For the battery-powered fork-lift truck, MEASURE the operating voltage and current variations of the operating motor. The operating current shall not exceed the maximum allowable current value of the motor. DRAW the curve of starting and accelerating current (the curve of speed-current and voltage).

instrument to record the entire traction test process. DRAW the speed-hook traction characteristic curve.

The maximum hook traction refers to the numerical value obtained after stabilizing for 3s before the engine is stalled or when the driving wheels are fully slid, and the one obtained after stabilizing for 3s when the motor comes up to the maximum allowable current under the working system of S_2 = 5min. For the hydraulic transmission fork-lift trucks, the maximum hook traction refers to the numerical value obtained when the torque converters are under stall conditions. CONDUCT the test back and forth twice.

11.5 Gradeability performance test

11.5.1 Gradeability test conforming to the provisions

The test ramps shall be flat and dry concrete ramps with consistent gradient. TAKE skid resistant measures on the ramp surfaces.

The fork-lift truck is in standard load operating status. STOP at the flat road section at the ramp bottom first. The front wheel center shall be 1m away from the ramp bottom line. The fork-lift trucks climbs up in a straight line at the operating speed of the lowest gear. FLOOR the engine's accelerator pedal. After passing through a 3m long preparatory section, ENTER into the speed measuring section in the middle of the ramp. For the hydraulic and hydrostatic transmission fork-lift trucks, the speed shall not be less than 2km/h.

In the climbing process of the battery-powered fork-lift truck's operating motor, DETERMINE according to the maximum allowable current value under the working system of S_2 = 5min. MEASURE the operating voltage, current and temperature rise in the climbing process.

11.5.2 Maximum gradeability conversion in accordance with the maximum traction

It is recommended to convert the maximum gradeability according to the traction. It is unnecessary to use test ramps to conduct the gradeability performance test.

According to the maximum hook traction determined in accordance with the traction performance test (the maximum traction of the hydraulic and static pressure fork-lift trucks shall be determined under the condition of v = 2km/h; the maximum traction of the battery-powered fork-lift truck shall be determined under the operating motor's working system of S_2 = 5min; the maximum traction of the mechanical fork-lift truck shall be determined at minimum stable speed), CONDUCT approximate calculation of the maximum gradeability according to the Equation (20):

During the test, the cycle running sequence of the fork-lift truck is as follows:

a) The fork-lift truck loads the test load *Q* at *A*. REGRESS along the route 1 in standard load operating status. TURN to *X*.

b) MOVE forward along the route 2 from *X*. TURN to *B*.

c) The mast returns to vertical state from backward tilt state at *B*. LIFT up 2,000mm. DESCEND to 300mm from the ground. The mast tilts backwards. The fork-lift truck is in standard load operating status.

d) REGRESS along the route 3 from *B*. TURN to *Y*.

e) MOVE forward along the route 4 from *Y*. TURN to *A*.

f) The mast returns to vertical state from backward tilt state at *A*. LIFT up 2,000mm. DESCEND to 300mm from the ground. The mast tilts backwards. The fork-lift truck is in standard load operating status.

a) ~ f) refers to one cycle. The turning radius shall adapt to the turning requirements of the test fork-lift truck. OPERATE and RUN uninterruptedly, until it meets the test requirement of 60 cycles within 1h.

12.1.3 Data arrangement

The test data arrangement is as follows:

a) CALCULATE the unit cycle oil consumption according to the Equation (21):

$$F_c = K\frac{q}{n} \qquad (21)$$

Where:

F_c - Unit cycle oil consumption, in unit of L;

K - Correction factor of the flowmeter;

n - Cycle times;

q - Fuel oil consumption, in unit of L.

b) CALCULATE the hourly oil consumption during operation according to the Equation (22):

$$F_h = \frac{q}{t} \qquad (22)$$

$$t_m = n'T / 3\,600 \quad \cdots\cdots (24)$$

e) Available operating time of the battery capacity t_1, in unit of h. CALCULATE according to the Equation (25):

$$t_1 = K \times t_m \quad \cdots\cdots (25)$$

f) Hourly energy consumption during operation (kWh), CALCULATE according to the Equation (26):

$$\text{kWh} = W \times U \times n / 1\,000 \quad \cdots\cdots (26)$$

Where:

W - Power consumption in the unit cycle process, in unit of A • h;

U - Battery voltage, in unit of V;

n - Specified cycle times, *n* = 60.

Note: The working system for the operations of the forklift users *K* = 2.0~3.0. *K* = 2.5 is recommended under the working system for the general operations of the forklift users, which can be used for estimating the available operating time after the batteries are fully charged at a time.

13 Braking performance test

13.1 Test conditions

CONFORM to the provisions of Chapter 5. FIX the test loads. USE new or relatively new tires.

13.2 Test methods

13.2.1 Brake running-in

Besides the operating running-in during the running-in driving of the entire truck, CONDUCT strong braking running-in for 10 times before the test. The fork-lift truck is in standard no-load operating status. The braking deceleration is 3m/s^2 or so. Each interval shall be above 2min.

13.2.2 Determination of the forklift braking capacity (pulling force of the drawbars)

The fork-lift truck is in standard load status. INSTALL a tension sensor between forklift traction hook and tractor. KEEP the drawbar basically level. INSTALL it

$$S = S' \frac{v_0^2}{v_0'^2} \quad \cdots\cdots (28)$$

Where:

S - Corrected braking distance, in unit of m;

S' - Actual braking distance, in unit of m;

v_0 - Specified initial speed, in unit of km/h;

v_0' - Measured initial speed, in unit of km/h.

13.2.4 Ramp parking brake test

The fork-lift truck is in standard load operating status. The transmission is in neutral gear, the engine is stalled, or the operating motor shuts down. USE the force of not greater than 500N to tighten the hand brake. PARK on the dry, clean and flat ramp with specified slope. The drivers shall have no auxiliary operational motions. After the fork-lift truck stops, OBSERVE for 5min. ROTATE the fork-lift truck 180° away from the ramp parking direction. CONDUCT the ramp parking brake test again.

14 Vibration test

CONDUCT the vibration test according to the Appendix A.

15 Noise test

CONDUCT the noise test according to the Appendix B.

16 Security performance test for overhead guards

CONDUCT the security performance test for overhead guards according to GB/T 5143.

17 Thermal balance test

17.1 Test conditions

According to the provisions of Chapter 5, CHECK the tension of the fan's driving belt. In the meantime, CHECK whether there is any oil and water leakage. The engine's oil supply system shall conform to relevant provisions. The gasoline

18 Operating force determination

18.1 Operating force determination of handles

The fork-lift truck is in standard no-load status. DETERMINE the idle stroke, effective stroke and operating force of the handles.

18.2 Operating force determination of pedals

The fork-lift truck is in standard no-load status. The determination for the idle stroke, effective stroke and pedal force of the pedals is as follows:

a) DETERMINE the accelerator pedal when starting the engine or operating the motor.

b) For the clutch pedal determination of the mechanical transmission fork-lift truck, DETERMINE the breaking point and contact of the clutch pedal in operating status or when the driving axle lifts up.

19 Strengthening test

19.1 Strengthening test for the internal combustion fork-lift trucks

19.1.1 Test conditions

According to the provisions of Chapter 5, SEE Figure 12 for the site layout.

"*X*" high goods allocation - The goods stacking height equals to 150mm subtracted from the maximum lifting height.

"*Y*" medium goods allocation - The goods stacking height equals to half the maximum lifting height.

"*Z*" low goods allocation - The goods stacking height equals to zero, which is to place goods on the ground.

Curves - SET two curves on the track among high, medium and low goods allocations, so as to assess the turning performance of the fork-lift truck.

Test ramp - There is a ramp section composed of up-grade and down-grade slopes and a horizontal section on the opposite side of high, medium and low goods allocations, so as to assess the climbing and braking performances of the fork-lift truck. The slope is configured as 10%.

through the track with obstacles at a speed of not less than 4km/h: Left wheels cross the obstacles on the left first. Right wheels cross the obstacles on the right afterwards. In the process of crossing the obstacles, parking, stalled engine and severe deviation are not allowed.

The fork-lift truck keeps driving forward to enter into the climbing section: Before climbing, SHIFT the fork-lift truck to low speed. CONDUCT parking brake when climbing up to the middle of the up-grade section. STOP for 3s to 5s. After starting, KEEP climbing to the horizontal section of the slope. DRIVE downhill at a safe speed. STOP, BRAKE and STALL when driving to the starting point. The first cycle completes.

START again for the second test cycle. Besides exchanging the test load's "removing" and "placing" positions as well as full load and no-load sections, other operations are the same with those in the first cycle. Alternately CONDUCT the test. When the number of cycles comes up to half the total number of times, DRIVE along the clockwise direction instead of the counter-clockwise direction of the track. It is unnecessary to rearrange the track.

19.1.3 Test requirements

19.1.3.1 The fork-lift truck to be tested shall run along the center line of the test track at maximum safe speed. When the fork-lift truck arrives at the 90° corner, MAKE a turn via the minimum turning radius.

19.1.3.2 MAKE continuous operations for not less than 8h each day.

19.1.3.3 For the fork-lift trucks with the rated lifting capacities of less than 5,000kg, CYCLE for at least 20 loops per hour. For the fork-lift trucks with the rated lifting capacities of greater than or equal to 5,000kg, CYCLE for at least 15 loops per hour. During the test, it is allowed to add fuels to the fork-lift trucks.

19.1.3.4 After the test, CONDUCT performance retesting and disassembly inspection to the whole machines.

19.2 Strengthening test for the battery-powered fork-lift trucks

19.2.1 Test conditions

According to the provisions of Chapter 5, SEE Figure 15 and Table 7 for the test site layout and running routes of the fork-lift trucks.

Respectively PLACE the empty tray, auxiliary test load 0.7Q and test load Q at X_1, X_2 and X_3 in the site. The load distribution in the test process respectively accounts for 20%, 50% and 30%.

c) Vertically LIFT up the load at full speed from Y_1 to H from the ground. DESCEND to 150mm from the ground afterwards. The mast tilts backward.

d) DRIVE backward at full speed from Y_1 to B_1 along the route 3. CONDUCT braking afterwards. DRIVE forward at full speed from B_1 to X_1 along the route 4. CONDUCT braking afterwards.

e) The above-mentioned procedures of a) to d) refer to “first cycle (forward) process”. UNLOAD the load at X_1. CONDUCT 2nd and 3rd circulations according to the above-mentioned procedures.

f) After the 3rd circulation, UNLOAD the load at X_1. DRIVE backward at full speed to A_1 along the route 5. CONDUCT braking afterwards. DRIVE forward at full speed to X_2 along the route 6. CONDUCT braking afterwards. This procedure refers to the “transition procedure” for load transfer.

g) The tested fork-lift truck continues the 4th to 8th circulations from X_2 to A_2 to Y_2 to B_2 to X_2 according to the above-mentioned procedures of a) to d).

h) After the 8th circulation, CONDUCT the “transition procedure” for load transfer from X_2 to A_2 to X_3 according to the above-mentioned procedure of f).

i) The tested fork-lift truck continues the 9th and 10th circulations from X_3 to A_3 to Y_3 to B_3 to X_3 according to the above-mentioned procedures of a) to d).

j) After the 10th circulation, CONDUCT the “transition procedure” for load transfer from X_3 to A_1 to X_1 according to the above-mentioned procedure of f).

k) The above-mentioned 10 (the number of times is not included in the transition procedure) circulations refer to the “forward circulation group”. CONTINUE the backward operation afterwards. MAKE 10 circulations, which are considered as “backward circulation group”. In the process of backward circulation, the test route (① to ④) is $X \rightarrow B \rightarrow Y \rightarrow A \rightarrow X$. Other test procedures are the same with the above-mentioned procedures of a) to j).

l) During the test, 20 (the number of times is not included in the transition procedure) circulations refer to a “circulation group”, including the “forward circulation group” of 10 forward operating cycles and the “backward circulation group” of 10 backward operating cycles.

19.2.3 Test requirements

19.2.3.1 In the test cycles, all the operating time has to be effective (including the fork-lift truck’s operation, braking, load lifting and descent, mast tilt and required operating time). During each circulation, the non-dynamic operating

time (including the required operating time and inevitable artificial rest time) shall not exceed 20s. In the “transition procedure” of each load transfer, the non-dynamic operating time shall not exceed 8s.

19.2.3.2 The tester uses an instrument to record 20 circulations in one test circulation group and the “transition procedure” thereof. DRAW the current-voltage-time curve. CALCULATE the time consumption of the test circulation group according to the Equation (29):

$$T = \frac{\Sigma t_1 + 20 \times 20 + 8 \times 3}{3600} \quad \cdots\cdots (29)$$

Where:

$\sum t_1$ - Total dynamic operating time consumption in the circulation group, in unit of s.

19.2.3.3 According to the above-mentioned determined circulation group’s “current-voltage-time curve” and Section 12.2.3, CALCULATE the average power consumption of a circulation group W (in unit of A • h) and the number of tests for the available circulation group of the battery capacity n'.

19.2.3.4 After the test, CONDUCT performance retesting and disassembly inspection to the whole machines.

19.3 Forklift maintenance and parts replacement during the strengthening test

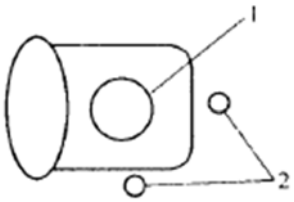
19.3.1 Forklift maintenance during the strengthening test

During the strengthening test, the fork-lift trucks to be tested shall not add other maintenance items, except the ones listed in the product instruction manual.

19.3.2 Parts replacement during the strengthening test

During the strengthening test, if main parts (such as half axles, half axle casings, chain breaks, gear damages of the transmissions’ driving axles, etc.) are damaged, RECORD the operating condition during damage in details. KEEP the damaged parts. If necessary, TAKE photos for future inspection.

After replacing the damaged major parts, it is allowed to go on with the test. However, the time spent in conducting the strengthening test shall be recounted from zero.



1 - Forward riding; 2 - Lateral riding.

Figure A.4

A.4.2 Measuring location

When measuring the vibration on the seat surface, PLACE the acceleration measuring instrument installed in a semi-rigid disc on the seat surface (SEE Figure 4). ENSURE that it is between the driver's ischial joints. In order to feel comfortable during driving, it is allowed to install the disc center a little forward (50mm at most), so as to avoid the joints.

When measuring the vibration on the seat base, firmly INSTALL the acceleration measuring instrument in the base center. If it is impossible, it is allowed to install it on the rigid part with the same height outside the base. The acceleration measuring instrument shall be vertical to the running direction, and shall connect with the seat center as far as possible.

Note: If the fork-lift truck is required to be equipped with a low-frequency resonant suspension cab (below 10Hz), it is recommended to arrange the frame's upper measuring point at a vertical point beneath the seat center.

A.5 Forklift installations and conditions

A.5.1 Fork-lift trucks

MAKE measurements on new and intact fork-lift trucks under good maintenance and debugging conditions. The installations equipped on the fork-lift trucks to be tested shall conform to the contents in the accompanying documents (such as lifting equipment, batteries, etc.).

A.5.2 Forklift load

The forklift test load used in the load center shall be 0.6*Q*. The relative error shall be within the range of 0% to 10%.

A.5.3 Forklift tires

The fork-lift trucks shall be equipped with new tires. The inflation pressure of the pneumatic tires shall conform to ± 10% of the manufacturing plant's

specified value. Respectively MEASURE the tire pressure before and after the vibration test. If the tire pressure difference before and after the vibration test is greater than 10%, it is necessary to conduct the vibration test again. If the fork-lift trucks are allowed to install different types of tires, CONDUCT the test to each type of tires.

A.5.4 Fork-lift trucks with cabs

Regardless of whether the fork-lift trucks are equipped with suspension cabs or not, MAKE the vibration measurement. If the cabs can move horizontally, MAKE measurements at the ends of the moving cabs. LIST the maximum vibration value into the report. If the cabs can move vertically, MAKE measurements in the lowest position.

A.5.5 Sitting type fork-lift trucks

ADJUST the seats to the positions where the drivers can comfortably touch the required control devices. If the fork-lift trucks are equipped with suspension seats, ADJUST the suspension to the weight applicable to the drivers. PREVENT the suspension regulating parts of the seats from touching the top or bottom. If the fork-lift trucks are allowed to install different types of seats, CONDUCT the test to each type of seats.

A.5.6 Drivers

A.5.6.1 Drivers of the station type fork-lift trucks

USE the driver with the mass of 75^{0}_{-10}kg for testing.

A.5.6.2 Drivers of the sitting type fork-lift trucks

If the driver seats pass the testing of the laboratory test criteria for seats (EN 13490), it will be allowed to use the driver with the mass of 75^{0}_{-10}kg for testing. If the seats fail to pass the testing of the laboratory test criteria for seats, respectively USE two drivers with the masses of 55^{0}_{-5}kg and 98^{0}_{-8}kg for testing.

A.6 Measuring procedures and effectiveness

A.6.1 Speed

The average operating speed of the fork-lift truck on the test track shall conform to the provisions of Table A.1. The tolerance shall be ± 10%. It is suggested to make measurements at different speeds within the specified speed tolerance, so as to select the reasonable speed that can eliminate any resonance effect or reduce it to the minimum.

A.6.2 Test procedures

Where:

s_{N-1} - Standard deviation, $s_{N-1}=\sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(a_{w,zi}-\bar{a}_{w,z})^2}$.

A.6.5 Report on vibration values

A.6.5.1 Station type fork-lift trucks

For the station type fork-lift trucks, the reported value of the whole body vibration is $\bar{a}_{w,zF}$, which is the mean RMS value of the frequency-weighted acceleration in *N* vertical directions measured on the floors where the drivers stand via a series of effective tests.

A.6.5.2 Sitting type fork-lift trucks

If the installed seats pass the testing of the laboratory test criteria for seats, the reported value of the whole body vibration $\bar{a}_{w,zS}$ refers to the mean value of the mean RMS value of the frequency-weighted acceleration in *N* vertical directions measured on the driver seat surfaces in a series of effective tests conducted by one driver.

If the installed seats fail to pass the testing of the laboratory test criteria for seats, the reported value of the whole body vibration $\bar{a}_{w,zS}$ refers to the mean value of $\bar{a}_{w,zS1}$ and $\bar{a}_{w,zS2}$ measured on the driver seat surfaces for *N* times in a series of effective tests conducted by two drivers with different weights. CALCULATE according to the Equation (A.3):

$$\bar{a}_{w,zS}=\frac{1}{2}(\bar{a}_{w,zS1}+\bar{a}_{w,zS2}) \quad \text{(A.3)}$$

A.6.5.3 Station/sitting type dual-purpose fork-lift trucks

For the station/sitting type dual-purpose fork-lift trucks, the reported values of the whole body vibration are respectively $\bar{a}_{w,zF}$ and $\bar{a}_{w,zS}$. SEE Section A.6.5.1 for the reported value $\bar{a}_{w,zF}$. SEE Section A.6.5.2 for the reported value $\bar{a}_{w,zS}$.

A.6.5.4 Reported values of the vibration values

The reported values of the vibration values shall be rounded off to the values that are approximate to 0.1m/s^2.

A.6.5.5 Uncertainty of the vibration values

The uncertainty of the vibration values is fixed at $K = 0.3\bar{a}_{w,z}$.

B.1.1.3 There shall be no bigger sound reflectors within the range using the test site center "*O*" as base point and with the radius of 3 times the hemisphere radius *r*.

B.1.1.4 In the case of raining, snowing, hailing and snow accumulation on the ground, or when the wind speed is greater than 5m/s, do NOT conduct this test.

B.1.1.5 Other relevant test conditions shall conform to the requirements of Chapter 5.

B.1.2 Background noise

When the background noise (including the wind noise) at each measuring point of the test site is at least 15dB lower than the radiation noise of the fork-lift truck, TAKE the background noise's corrected value as K_1 = 0, which indicates that it is forbidden to conduct the background noise correction. During the testing, if the background noise difference at each measuring point is greater than 15dB, it will be considered as invalid measurement.

B.1.3 Forklift status during testing

For the determined length of the test prototype *l*, SEE Figure B.2.

B.1.3.1 Lifting and idling conditions: PLACE the fork-lift truck's longitudinal axis on the *C*-*C* axle. PLACE the center *l* / 2 at the point "*O*" (SEE Figures B.1 and B.2).

B.1.3.2 Operation condition: KEEP the fork-lift truck's longitudinal axis on the *C*-*C* axle as far as possible (SEE Figure B.1).

B.1.4 Preheating of the test prototype

The relevant components of the test prototype shall be preheated to normal operation condition.

and starts its accessories (such as power steering, engine's cooling fan, air conditioner or ventilation system in the cab, forced ventilation system, etc.); while the motor runs in idling status.

B.3.2.3 Operation condition

During the measurements in operating status, the fork-lift truck runs at full acceleration from the stop position under no-load condition. ARRIVE at *A-A* after passing through 3 times the length of the main forklift body *l*. KEEP on running at maximum acceleration. ARRIVE at and PASS through *B-B* afterwards. The measuring section is from *A-A* to *B-B* (SEE Figure B.1).

For the transmission cases with multiple gears, SELECT the gear with maximum possible speed to pass through this measuring section.

B.3.3 Provisions on the cabs

B.3.3.1 Cabs with air conditioners and/or pressurized ventilation system:

MAKE measurements when the doors and windows are closed. If the air conditioner or forced ventilation system has two and more operating speeds. RUN at medium speed. If there are only two operating speeds, RUN at low speed. If the air conditioner or forced ventilation system has internal and external circulations, USE the external circulation for air control.

B.3.3.2 Cabs without air conditioners and/or pressurized ventilation system:

MAKE measurements when the doors and windows are closed. MEASURE again after opening the doors and windows. TAKE the greater values of the two groups of data as reported values.

B.4 Drivers' dressing and microphone locations during testing

B.4.1 Drivers' dressing

During the measurement, the drivers shall be in the driving position. The observers cannot be too close to or in the cabs. The drivers cannot wear sound-absorbing clothes, hats or scarfs (excluding the protective caps and helmets for security).

B.4.2 Microphone locations

B.4.2.1 Microphone location during the determination of the sound pressure level in the driver location

If there are no drivers sitting on the fork-lift truck, PLACE the microphone in the position which is 0.80m ± 0.05m above the middle of the seat surface.

The determination results are as follows:

$\overline{L_{pAfa}}$: A-weighted surface sound pressure level under the lifting condition;

$\overline{L_{pAfb}}$: A-weighted surface sound pressure level under the idling condition;

$\overline{L_{pAfc}}$: A-weighted surface sound pressure level under the operation condition.

B.6.4 Calculation of the sound power level under the operation condition

For the A-weighted sound power level under each operation condition, USE the A-weighted radiation sound pressure level on the measuring surface for calculation.

A-weighted sound power level equals to the sum of A-weighted surface sound pressure level and measuring surface ratio. CALCULATE according to the Equation (B.2):

$$L_{WA} = \overline{L_{pAf}} + 10\lg\frac{S}{S_0} \quad \text{(B.2)}$$

Where:

$\overline{L_{pAf}}$ - A-weighted surface sound pressure level, in unit of dB;

$10\lg\frac{S}{S_0}$ - Measuring surface ratio, this ratio is 20 when the spherical radius r = 4m; this ratio is 28 when the spherical radius r = 10m; this ratio is 32 when the spherical radius r = 16m.

The calculation results are as follows:

L_{WAa} - A-weighted sound power level under the lifting condition;

L_{WAb} - A-weighted sound power level under the idling condition;

L_{WAc} - A-weighted sound power level under the operation condition.

B.6.5 Calculation of the sound power level in one operating cycle

CALCULATE the A-weighted sound power level according to the Equation (B.3), in unit of dB:

$$L_{WAZ} = 10\lg\left[1/(a+b+c)\times(a\times10^{0.1L_{WAa}} + b\times10^{0.1L_{WAb}} + c\times10^{0.1L_{WAc}})\right] \cdots\cdots\cdots\cdots \text{(B.3)}$$

Where:

a - Operating time factor under the lifting condition, 0.18 for counterbalanced fork-lift trucks;

b - Operating time factor under the idling condition, 0.58 for counterbalanced fork-lift trucks;

c - Operating time factor under the operation condition, 0.24 for counterbalanced fork-lift trucks;

L_{WAa} - A-weighted sound power level under the lifting condition, in unit of dB (A);

L_{WAb} - A-weighted sound power level under the idling condition, in unit of dB (A);

L_{WAc} - A-weighted sound power level under the operation condition, in unit of dB (A).

B.7 Expression of the noise measuring level values

The noise measuring level values shall be clearly expressed as follows:

a) At the driver location, the A-weighted radiation sound pressure level under each relevant operation condition and in one operating cycle shall be determined according to the Section B.5, and shall be calculated according to the Section B.5.3. The calculation results shall be rounded off to the most approximate integral dB values. The uncertainty of the measurement results, which is the uncertainty of the radiation sound pressure level at the driver location, is as follows: δ_R = 2.5dB.

b) At the whole fork-lift truck, the A-weighted sound power level under each relevant operation condition and in one operating cycle shall be determined according to the Section B.6, and shall be calculated according to the Section B.6.5. The calculation results shall be rounded off to the most approximate integral dB values. The uncertainty of the measurement results, which is the uncertainty of the fork-lift truck's sound power level, is as follows: δ_R = 1.5dB.

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