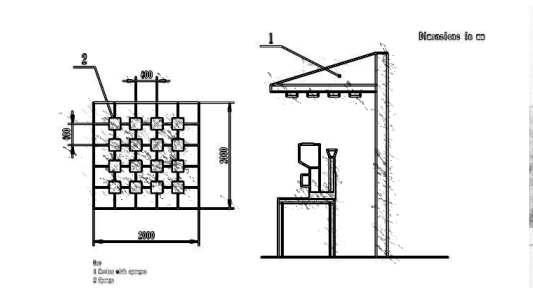
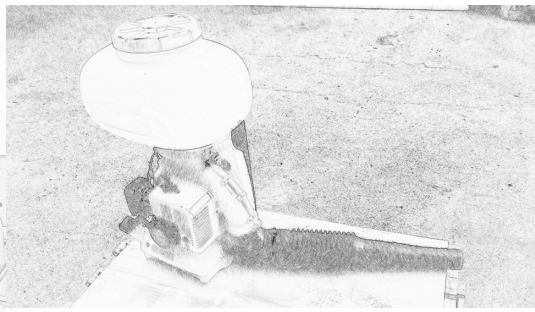
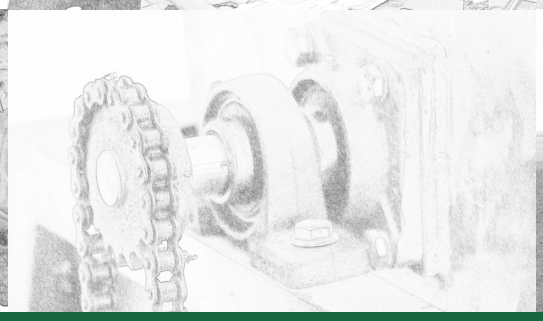
UNITED NATIONS
ESCAP
Economic and Social Commission for Asia and the Pacific

CSAM







TRAINING MANUAL FOR ANTAM STANDARD CODES FOR TESTING OF POWERED KNAPSACK MISTERS-CUM-DUSTERS

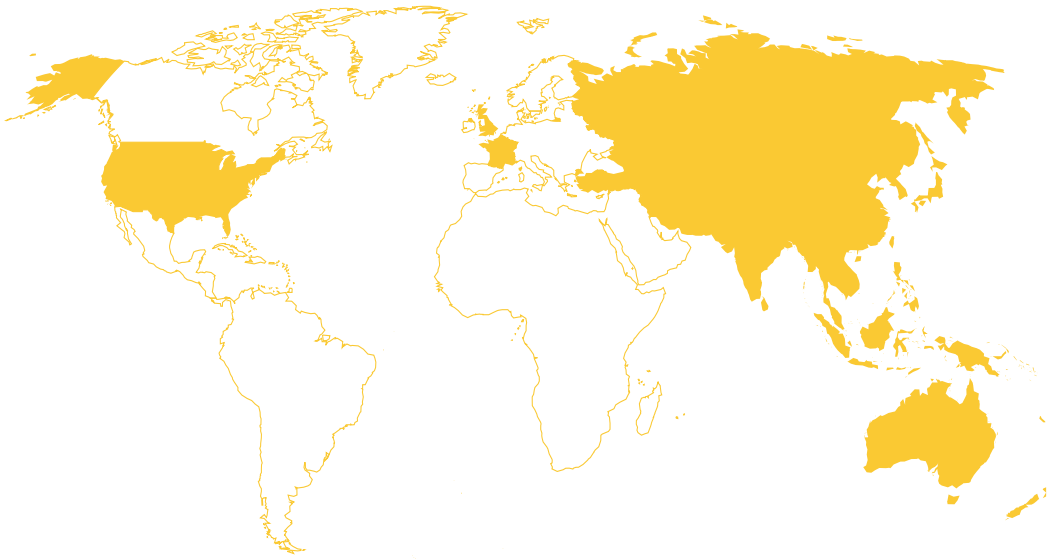
Centre for Sustainable Agricultural Mechanization
United Nations Economic and Social Commission for Asia and the Pacific

July 2015

The Centre for Sustainable Agricultural Mechanization (CSAM), is a regional institution of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), based in Beijing, China. CSAM started operations in 2004, building on the achievements of the Regional Network for Agricultural Machinery (RNAM) and the United Nations Asian and Pacific Centre for Agricultural Engineering and Machinery (UNAPCAEM). CSAM serves the 62 members and associate members of UNESCAP.

The vision of CSAM is to achieve production gains, improved rural livelihood and poverty alleviation through sustainable agricultural mechanization for a more resilient, inclusive and sustainable Asia and the Pacific.

The Secretariat of the Asian and Pacific Network for Testing of Agricultural Machinery (ANTAM) is based at CSAM. CSAM is the executing agency of ANTAM. The ANTAM Secretariat assists and coordinates the operation of the network, and provides necessary logistical and administrative support.



The shaded areas of the map indicate ESCAP members and associate members

Training Manual for ANTAM Standard Codes for Testing of Powered Knapsack Misters-Cum-Dusters

Centre for Sustainable Agricultural Mechanization

The United Nations Economic and Social Commission for Asia and the Pacific

This training manual was prepared by Dr. Chan Chee-Wan and Dr. Jean-Paul David Douzals, consultants contracted by the Centre for Sustainable Agricultural Mechanization (CSAM) and the China Agricultural Machinery Testing Centre (CAMTC), for the 1st Training of Trainers Programme on ANTAM Test Codes. Contents of the training manual were prepared as per *ANTAM Standard Codes for Testing of Powered Knapsack Misters-Cum-Dusters* (Version 2015, hereinafter referred to as "ANTAM Codes"), developed at the 1st Technical Working Group (TWG) meeting of ANTAM held from 4 to 6 May 2015 in Serpong, Indonesia.

This manual is the first attempt towards realizing the TOR of ANTAM with the intention for future review. The training manual is aimed to facilitate testing stations to implement ANTAM Codes. The ANTAM Codes are a dynamic process where regular updates and reviews will be made by the TWG of ANTAM at its annual meetings based on demands from participating countries. The current ANTAM Codes will be submitted to the 2nd Annual Meeting of ANTAM for review and adoption in December 2015.

Where testing equipment provided by the facilitating testing station for the training was not in supply, slight modifications of ANTAM standard testing methodologies were made in order to demonstrate the procedure.

The training manual was prepared under the substantive direction and guidance of Ms. AI Yuxin, Programme Officer of CSAM in charge of ANTAM project. Valuable comments and suggestions were received from Mr. ZHANG Xiaochen of CAMTC). Ms. Camilla Stelitano, individual contractor of CSAM, provided indispensible support to the editing, layout and coordination. Mr. WEI Zhen, IT Assistant of CSAM, contributed design of the cover page. Special thanks to Ms. HAN Xue and Ms. BAI Mengliang of CAMTC for facilitating communication.

The 1st Training of Trainers Programme on ANTAM Test Codes was jointly organized by CSAM and CAMTC in Najing, China from 23 to 27 June 2015. Profound appreciation and deep gratitude are given to CAMTC for its generous financial support, and the Nanjing Testing Station for sparing no efforts in providing testing facilities.

Table of Contents

GENERAL TEXTS

1.0 INTRODUCTION

1.1 Scope

This test code covers the terminology, general guidelines and tests to be conducted on powered knapsack mister cum duster fitted with a small < 4.5 kW gasoline engine coupled with a centrifugal fan. The code covers methodology for checking on machine specifications, materials, noise, vibration, safety and inspection of components and applications, labels, packing, transportation and storage. This code also prescribes the performance and other requirements of powered knapsack type pneumatic mister cum duster for spraying chemicals in liquid form and convertible into duster for dusting the chemicals in powder/micro granules form.

1.2 References

The Standards listed in Annex A contain provisions which through reference in this text, constitute provision of this draft standard incorporating existing international standards (ISO) and national standards practiced by China and India. The selection of publications, the editions indicated were provided by the various national representatives on test standards. Typical engine power for powered knapsack mister cum duster is 3 kW, current relevant standards for 3 kW and below small gasoline engines in the Chinese JB/T 5135.1.2.3-2013 (for engine less than 30 kW) and the Indian IS: 7347-1974 (for engine less than 20 kW) are referred. The ISO 8178-4:2007 standard is also referred. Specific references selected are the Chinese JB/T 7723-2014 and the Indian IS: 7593.1-1986. All selected standards are subjected to revision and considered recent as per documents provided. There is the possibility of applying the most recent editions of the standards indicated. All documents provided from the various national standards agency are copyrighted.

1.3 Specifications

1.3.1 Specification(s) - Manufacturer/applicant shall complete the specification sheet given in Annex B-1 for the power operated knapsack mister cum duster along with schematic drawing of the equipment and any other information required by the testing authority to carry out the tests. The manufacturer/applicant should also supply technical literature such as operation and maintenance manual, service manual and parts catalogue.

1.3.2 Material - The material for construction of different components of powered knapsack mister cum duster except gasoline engine is given in B-2 Annex B. All components coming in contact with the chemicals shall be of good quality chemical resistant materials.

Note: The specification data sheet for tests of powered knapsack mister cum duster for China JB/T 7723-2014, JB/T 7723.2-2005 and India IS 7593 (Part 1)-1986 has been referred.

1.3.3 Manual - Manufacturer can prepare operators and service manual separately or as a single document. But operational and maintenance manual should contain complete list of regular and optional parts, method of converting the mister into duster, instruction on adjustments, assembly and disassembly for cleaning and routine inspection and replacement of parts and safety precautions to be taken during operation and handling. Manuals shall comply with the ISO 3600: 1998 or IS 8132:1999 standards and contain information on: main technical details of engine, rated speed, tank capacity, misting/dusting rate at recommended pressure, recommended pressure range, horizontal spray range, starting and stopping instructions, safety, common faults and repairs, safe chemical handling, cleaning, maintenance, storage, forbidden chemical/liquid to be used, manufacturer and supplier contact details.

1.4 Submission of Test Samples

The powered knapsack mister cum duster, under production, should be selected by the manufacturer from the production line, complete with its standard accessories and in a condition as generally offered for sale. The power operated knapsack mister cum duster shall be new and should not be given any special treatment or preparation for test. At least 5 units of current year production, new and unused qualified machine are to be submitted. An additional unit of a similar machine with the engine removed is to be supplied.

1.5 Running-In*

1.5.1 The manufacturer/applicant shall run-in the powered knapsack mister cum duster before the test, under his responsibility and in accordance with his usual instructions. The running-in shall be carried out in collaboration with the testing authority. If this procedure is impracticable due to the powered knapsack mister cum duster being an imported model, the testing authority may itself run-in the powered knapsack mister cum duster in accordance with the procedure prescribed or agreed to with the manufacturer/applicant.

1.5.2 The place and duration of the running-in shall be reported in the pro-forma given in Annex C-2.

* A device for the suction and the evacuation of exhaust gases shall be used when a mister cum duster is tested inside the testing facility

1.6 Servicing and Preliminary Setting After Running-In

1.6.1 Servicing - After completion of running-in, servicing and preliminary settings should be done according to the printed literature supplied by the manufacturer/applicant. The following may be carried out, wherever applicable:

a) Change of the engine oil;

b) Change of oil and fuel filters (if required);

c) Greasing/oiling of all the lubricating points;

d) Tightening the nuts and bolts;

e) Checking and adjustment of safety devices, if any;

f) Any other checking or adjustment recommended by the manufacturer after the running-in period, and included in the printed literature of the powered knapsack mister cum duster.

1.6.2 Preliminary Setting - The manufacturer/applicant may make adjustments in any other adjustments during the period the powered knapsack mister cum duster is prepared for tests.

These adjustments should conform to the values specified by the manufacturer/applicant for agricultural use in the printed literature/specification sheet. No adjustment shall be made, unless it is recommended in the literature. All the parts replaced shall be reported in the test report.

1.7 Repairs and Adjustments during Tests

1.7.1 Repairs - All repairs made during the tests shall be reported, together with comments on any practical defects or shortcomings in Annex C-2. This shall not include those maintenance jobs and adjustments which are performed in conformity with the manufacturer's recommendations.

1.8 Definition and Vocabulary

A portable mister cum duster is commonly used to apply crop protection products or fertilizers under liquids, dust, powders or micro granules forms. Compared to a traditional knapsack sprayer, the misting and dusting is achieved with the help of air assistance provided by a blower.

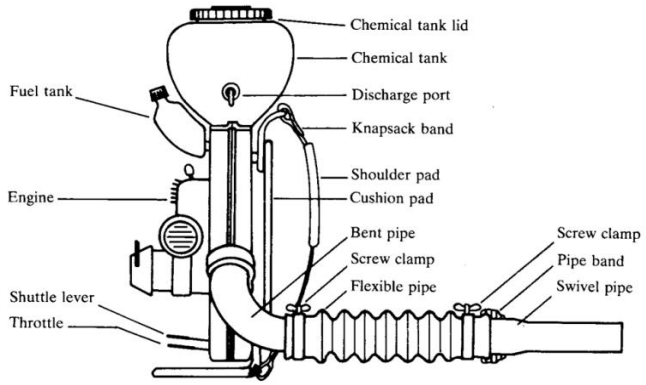


Figure 1a. A typical mister cum duster

CODES

1.0 SPECIFICATIONS

Refers to Annex B (B-1 and B-2) of the ANTAM Standard codes for testing powered knapsack mister cum duster.

Fill in the following table:

1.0	GENERAL	PLEASE INDICATE
1.1	Name & address of manufacturer *(If more than one give details of manufactures. Separate sheets may be used)*	
1.2	Name and address of the applicant for test	
1.3	Make/Type/Model	
1.4	Serial number	
1.5	Year of manufacture	
2.0	ENGINE *(No test necessary if a certified test report is provided by the manufacturer (according to either one of the following standard: IS 7374-1974, JB/T 5135.1 or ISO 8178.4-2007)* *If no engine test certification provided the equipment might be rejected)*	
2.1	Make/Type/Model/Country	
2.2	Serial number	
2.3	Engine (manufacturer's recommended settings) - Rated power, kW - Maximum torque, Nm - Speed at rated power, rpm - Speed at max. torque, rpm - Specific fuels consumption, g/ kWhr - Specific oil consumption, g/ kWhr (where relevant)	

2.4	Type of fuel used *(octane number)*	
2.5	Capacity of fuel tank, l	
2.6	Presence of strainer at engine tank inlet, yes/no	
2.7	Type of fuel filter	
2.8	Starting system: - Type - Aids for cold starting, if any - Any other device provided for easy starting	
2.9	Noise level at maximum speed, dB(A)	
3.0	FRAME	
	Material of construction	
	Size *(Width x height x length)*, mm	
4.0	TANK *(Please indicate each for misting and dusting in case of two separate tanks)*	
	Shape *(Trapezoidal/Cylindrical/ Any other)*	
	Size (*In case of Trapezoidal : Width x height x depth, In case of cylindrical: Diameter x length)*, mm	
	Capacity, litre	
	Material of construction	
	Size of liquid filling hole, mm	
	Strainer or filter mesh (< 2 mm)	
	Marking on the tank, if any	
5.0	BACK REST	
	Size *(Width x height x thickness)* , mm	
	Material	
6.0	STRAP	
	Material of strap	
	Material of strap buckle	

	Width and thickness of strap, mm	
	Minimum and maximum strap length can be used, mm	
7.0	MISTING DUCT	
	Type of misting duct	
	Misting duct internal diameter, mm	
	Misting duct discharge at recommended pressure, ml/min	
	Misting range (m)	
8.0	BLOWER	
	Fan type : Fully enclosed / partially enclosed	
	Fan blade type : Forward bent / radial / backward bent	
9.0	DUSTING or MICRO GRANULES	
	Dusting width, m	
	Dusting discharge rate (horizontal), kg/min	
10.0	TOTAL MASS *(without liquid/dust)*, kg	
11.0	DETAILS OF AGITATING DEVICE PROVIDED (if any)	
12.0	LIST OF STANDARD ACCESSORIES/PARTS PROVIDED WITH EQUIPMENT (provide as annex)	
13.0	PUBLICATIONS • Operator's manual • Service manual • Parts catalogue • Safety precautions	

2.0 MATERIALS

Refers to Annex B-2 of the ANTAM *Standard* **codes** *for testing powered knapsack mister cum duster*

No.	Component	Material	Please Indicate
1.	Tank	Fibre glass reinforced plastics Plastics HDPE	
2.	Lid or cap	Fibre glass reinforced plastics Plastics HDPE	
3.	Frame	Mild steel Engineering plastics	
4.	Impeller	Mild steel Galvanized plain steel Aluminum alloy Fibre glass reinforced plastics Plastics	
5.	Casing	Mild steel Galvanized plain steel Aluminum alloy Fibre glass reinforced plastics Plastics	
6.	Air bent outlet	Galvanized plain steel Plastics	
7.	Air hose	Rubber, fabric braided Rubber. synthetic Plastics	
8.	Strap	Leather, vegetable tanned Woven web cotton Yarn, synthetic	
9.	Strap buckle	Mild steel Galvanized plain steel Aluminum Engineering plastic	

10.	Cushion	Foam rubber Foam plastics	
11.	Gasket	Rubber, synthetic PVC Leather Fibre	
12.	Air pressure regulating device	Brass Plastics	
13.	Air pressure pipe	Plastics	
14.	Liquid or dust regulating device	Brass Plastics	
15.	Hose clip	Mild steel Galvanized plain steel	
16.	Air duct (misting or dusting)	Stainless steel Plastic	
17.	Valve assembly	Brass Stainless steel Plastic	
18.	Pipe for agitator	Galvanized iron Brass Polyvinyl chloride (PVC)	

3.0 OPERATOR AND SERVICE MANUAL

	Yes	No
Operator manual		
Service manual		
Main technical details of the engine		
Engine rated speed		
Tank capacity		
Misting and dusting rate adjustment		
Misting and dusting range		
Starting and stopping instructions		
Safety during operation		
Common defaults and repairs		
Safe chemical handling		
Cleaning		
Maintenance		
Storage		
Forbidden chemical/liquids		
Manufacturer/supplier contact details		
List of regular and optional parts		
Method to convert mister into duster		
Remarks:		

4.0 SUBMISSION OF SAMPLES

Pro-forma For Submission, Running-In and Repairs

1. Name of the manufacturer:
2. Address:
3. Submitted for test by :
4. Sample model and serial number:

   Sample 1:
   Sample 2:
   Sample 3:
   Sample 4:
   Sample 5:
   Sample 6 (additional unit without engine):

5. Date of manufacture:
6. Place of running-in:
7. Duration and schedule of running in (6 hrs each for 4 times):
8. Repairs and adjustments made during running-In:

9. Received by: date:

10. Signatures and chop (manufacturer)

11. Signature and chop (test center):

12. List of spare parts provided :

5.0 INSTRUMENTATION, MEASURING TOLERANCES AND TEST RIGS

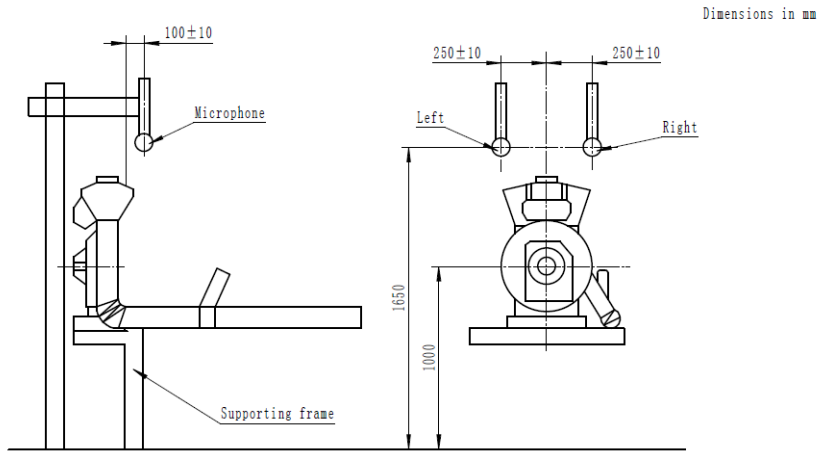
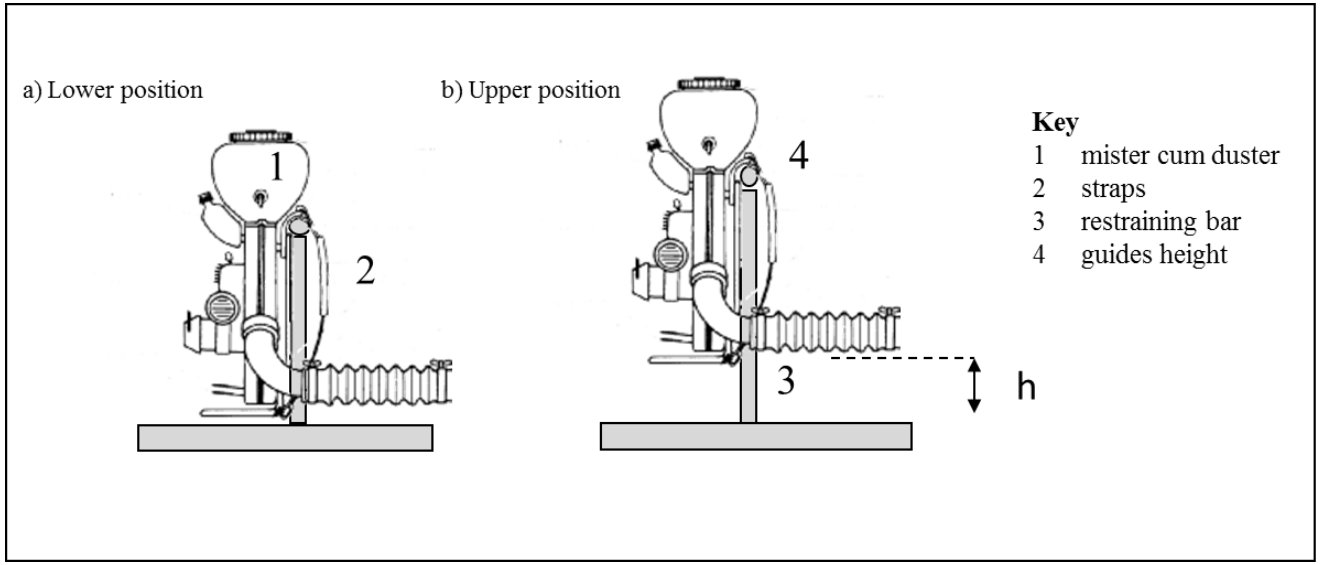
No	Parameters	Measuring device (example)	Accuracy	Notes
1	Rotational speed, rev/min		± 0.5	Tachometer
2	Air velocity		+5% FS	Anemometer (hot wire or vane type) capable of measuring air velocity at 1 Hz during 15 s

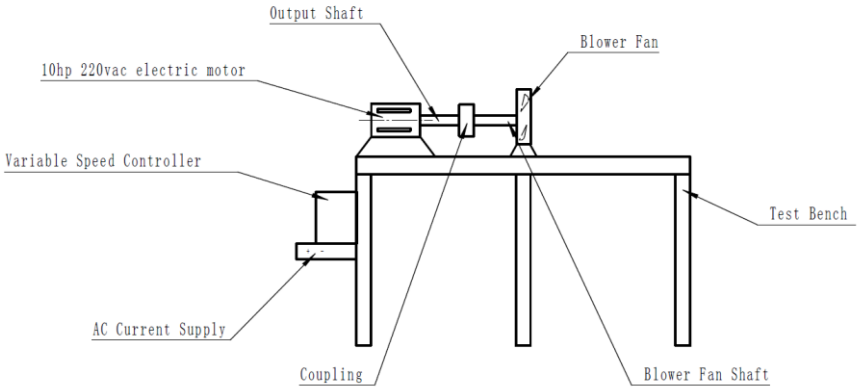
3	Time variation, s		±1	Digital stopwatch
4	Noise variation, dB (A)		±0.5	Sound level meter
5	Vibration, % FS		± 10	Accelerometer

6	Weight variation, kg		±0.05	Weighing balance of sufficient accuracy
7	Weight variation, g		±0.05	Weighing balance of sufficient accuracy
8	Pressure, % FS		+ 1 (< 10 kPa)	Pressure, % FS

9	Temperature, ^{0} C		± 1 ^{0}C	Thermometer
10	Relative Humidity, % FS		± 1%	Hygrometer
11	Paint layer thickness		2 µm ± 3%	Digital coating thickness gauge
12	Distance, mm		0.1 mm	Vernier caliper,

13	Distance, m		0.01m	Measuring tape, 0.01m
14	Tensile strength		1N	Tensile strength test bench

15	Test rig used to fix the mister cum duster for blower test, misting or dusting range and noise test	
16	Test rig used for the strap test	

17	Test rig for fan overspeed test	 Figure Test rig for over-speed mister-cum-duster test		
18	Aging box		±1℃	Stove

6.0 MARKING AND PACKING

Each mister-cum-duster shall be marked with the following particulars:

Marking	**Comment**	**Present (Yes/No)**
Manufacturer's name or registered trade-mark		
Tank capacity		
Production code and serial number		
Engine certification label		
Type of fuel used		
Maximum blower speed (RPM)		
Safety labels *(The mister-cum-duster shall have safety label which reminds the operator to pay attention to safety while operating. There shall be warning sign near the entrance of fan, high-temperature components of muffler. The pattern and content of the safety label shall comply with the terms of ISO 11684:1995. The safety label shall be pasted firmly).*		
Control device labels *(In the control device or nearby location, there shall have clear labels[1], its contents should reflect the basic characteristics of the control device).*		
Any other ANTAM approved Asia Pacific member countries national certification label *(The use of the certification label is governed by the approval of the ANTAM secretariat).*		

[1] Signs or engraved letters or signs are also accepted

Packing ***(****Each unit shall be first packed in a polyethylene bag and then in a wooden case or carton package of sufficient strength to avoid damage in transit.* *Spare Parts - Spare parts separately packed for each mister-cum duster according to the number required shall be provided).*		

7.0 WORKMANSHIP AND FINISHING

All the components of the unit shall be free from burrs, pits and other visual defects which may be detrimental for their use. The exposed metallic parts shall have a protective coating to prevent surface deterioration. The paint quality shall comply with the following: (Source: Chinese JB/T 5673-1991.)

Instrumentation: See Section 5 item 12, Paint layer thickness meter

Method: Randomly select 5 spots and measure, compute the average of the 5 spots

Criteria	**Yes**	**No**
The paint coating surface shall be flat, smooth, uniform, without pinhole, pitting, there shall not have any painting defects.		
The total thickness of the paint coating shall not be less than 40 μ m		
Remarks :		

8.0 SPECIFICATIONS FOR PERFORMANCE

Verification of the information provided in Annex B-1 of the ANTAM test code.

Instrumentation: Please refer to items listed in Section 5

Criteria	Performance level	Method	Compliance (Yes/No)
Tank	Filling hole of min. 90 mm	Measure	
	Cap or lid covering the tank hole and water tight	Check	
	Tank of minimum 10 L capacity	Measure	
	Easy interchangeable tank from misting to dusting	Check	
	Less than 5% variation between measured and declared tank volume	Measure	
	No leakage/buckle when the tank is filled at full capacity	Check	
Strainer	Mesh size shall be between 0.5 mm to 2 mm	Measure	
Leakages	No leakage/buckle shall occur on connected hoses air pressure hose when the tank is filled at full capacity	Check	
Impeller	The impeller of the fan shall be dynamically balanced at its rated speed. The impeller shall not touch casing at any point.	Check	
Blower housing	The internal and external blower housing surface shall be smooth, without dents or depressions, cracks and defects. Testing is by observation and manual hand feeling method.	Check	
Air bent outlet	An air bent outlet may be provided. If provided, shall be connected with fan casing outlet, air hose and air pressure regulating device.	Check	
Flow regulator	A device to regulate the flow of the liquid or dusting powder shall be provided.	Check	
Straps	2 straps shall be provided	Check	
	Not less than 800 mm length, 38 mm width	Measure	
	Strap cushion of min 40 mm width and 20 mm thick	Measure	
	Back rest with cushion of 200 x 200 x 20 mm	Measure	
	Cushions made of cotton, canvas, resin, or plastic coated parts	Check	
	1 adjustable single strap provided to carry the mister cum duster	Check	
	1 double shoulder strap shall be designed so that pressure is evenly distributed on both shoulders of the operator. The design of the double shoulder strap shall prevent slipping in any direction.	Check	

	All double shoulder straps shall be equipped with a quick-release mechanism positioned either at the connection between the mister cum duster and strap or between the strap and operator. Either the strap or the use of the quick-release mechanism shall ensure that the mister cum duster can be released quickly from the operator in the event of emergency. If a quick-release mechanism is provided, it shall be possible to open it under load and release the machine using only one hand.	Check	
	Each shoulder strap shall have a load bearing part of at least 200 ±10 mm of a minimum comfort width of 50 mm. The load shall be distributed over the whole width	Measure	
	If the load bearing area is formed by a pad, this shall not slip from its position unintentionally.	Check	
Engine	The gasoline engine used should comply with JB/T 5135.1, IS:7347-1974 or ISO 8178-4:2007. (Without governor)	Check	
	The gasoline engine should follow the starting procedures as listed in the operation manual under normal temperature conditions	Check	
	Recoil rope starting used for starting gasoline engine should be able to start the engine at least once in three attempts within 30 s.	Check	
	All engine control components shall be normal without restriction, easy to control with the maximum rated engine achieved at the highest setting. It shall also allow the engine shut off at the lowest level setting.	Check	
	A separate manual button/switch for stopping the engine shall be provided for hand lever operated idle speed set at the lowest level position. The fuel and chemical discharge controls shall be in easy access of the operator	Check	
	The exhaust outlet of the engine shall be so positioned that the smoke does not directly affect the operator or crop, At the option of the purchaser, a guard shall be provided on or near the exhaust pipe for the protection of the operator.	Check	
	Dangerous parts of the gasoline engine: recoil rope starter, exhaust (silencer), inlet of blower shall be fitted with protective cover. The rotating parts such as the entrance of fan, starting wheel, etc. shall be equipped	Check	

	with protective cover with proper strength. The muffler and other high-temperature components shall be equipped with protective device to avoid empyrosis. If dimensions shall be are not available because of structure, warning signs shall be set up, and note it in the manual.		
	Engine speed	Check if information is available (refer engine certificate provided by the manufacturer)	
	Engine power at the crankshaft		
	Indicated horse power		
	Fuel consumption		
	Specific fuel consumption		
	Full throttle		
	Gasoline engine		

9.0 HOSE ACCELERATED AGEING TEST

9.1 Materials and Instrumentation

Equipment	
Stove	Traction for test bench and sensor
	

a. This test is destructive and the availability of 2 spare hoses shall be verified prior to testing.

b. It requires an elongation test bench with according dimensions and strength such that a rubber hose sample can be tested.

c. Attention shall be paid to safety when operating the test

9.2 Test Procedure

a. Prepare two identical samples from rubber hoses provided with spare parts. Samples shall have a dimension adapted to the tensile test device (ex : 20 cm x 3cm).

b. Measure the maximum tensile strength (Sf1) and the maximum elongation at breakage for sample 1 (E1).

c. Place the sample 2 in a stove at 70 ℃ ± 1 for a period of 72 hours (3 days) for accelerated ageing.

d. Measure the maximum tensile strength (Sf2) and the maximum elongation at breakage for the sample 2 (E2).

Calculations and criteria:
Variation in maximal tensile strength: S= 100 x (Sf2-Sf1)/Sf1 max. ± 25%
Variation in maximal elongation: E = 100 x (E2-E1)/E1 min -10%; max + 30%

9.3 Report

Samples		Data	Material or reference if present
Before test	Length, cm		
	Hose 1, Li1		
	Hose 2, Li2		
After test	Elongation, cm		
	Hose 1, E1		
	Hose 2, E2		
	Tensile strength, N		
	Hose 1, Sf1		
	Hose 2, Sf2		
Variation	Elongation, %		
	Tensile strength, %		

Record result in the main summary test report

10.0 CHEMICAL TANK ASSEMBLY TEST

10.1 Materials and Instrumentation

a. This test is non-destructive and is operated on one complete mister.

b. Attention shall be paid to safety when operating the test

Equipment
Test bench for tank assembly test


10.2 Test Procedure

a. Select 2 misters, conceal the end of the pressure hose,

b. Place the mister cum duster upside down and immerse at the first half of the tank level (Figure 10a).

c. Apply an air pressure of 0.01 MPa (0.1 bar) at the liquid discharge hose into the chemical tank for 1 minute. (Figure 10b).

d. The tank, connected hoses and air pressure hose shall not show any sign of leakage and shall not buckle.

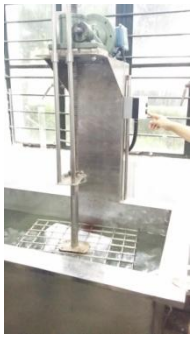
 Figure 10a

 Figure 10b

10.3 Report

Record result in the main summary test report

11.0 STRAP DROP TEST

11.1 Materials and Instrumentation

Equipment	
Strap drop test bench and sensor	
 An example strap drop test set up with manual lifting mechanism	   An example strap drop test set up with a pneumatic lifting mechanism

This test is normally non-destructive. It requires a support for strap drop test as proposed on Figure 11a.

WARNING: This test has an element of risk. All personnel shall either be kept out of the test area or otherwise protected from hazards such as parts displaced from the mister cum duster on test.

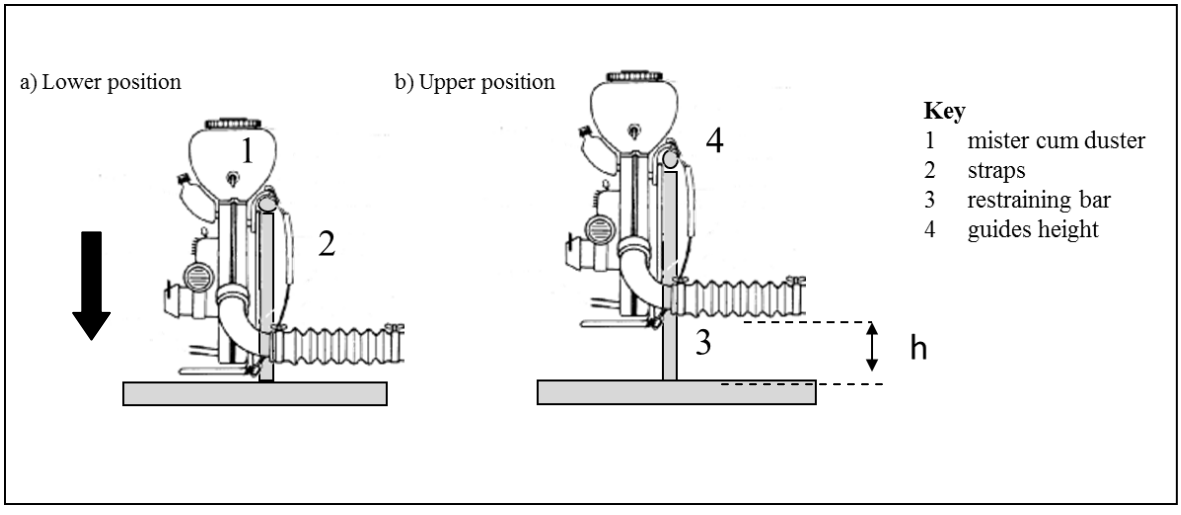


Figure 11a. Strap drop test with test applied to the load carrying straps

11.2 Test Procedure

The straps and their assembly shall withstand the test follows:

a. The tank shall be filled with clean water to its full capacity.
b. The mister cum duster (without discharge line) shall be hung from a solid support by its strap(s) simulating its carriage or to the shoulder of an operator.
c. Raise the tank vertically to a height of 300 mm and allow to drop freely while hang by the strap (s). Repeat the operation 24 times.
d. The assembly shall be deemed to have passed this test if none of its parts (straps, brackets, etc) break.

11.3 Report

Record result in the main summary test report

12.0 STRAPS ABSORBANCE TEST

12.1 Materials and Instrumentation

a. This test is non-destructive and straps shall be removed from a mister/duster.

b. A bucket or tank of water.

c. A weighing balance of sufficient accuracy (g) (Section 5 item 7).

12.2 Test Procedure

a. Any padding, metal or plastic parts attached to the straps are to be removed before immersion (in order to minimize, as far as possible, the dry mass of the straps).
b. Weigh the straps using a weighing device (m_b).
c. Completely immerse the straps in water for 2 min.
d. Remove the straps from the water, shake off surplus liquid and hang freely to drain for 10 min,
e. Re-weigh straps (m_a).

	Weight (g) (to 2 decimal places)
Straps before test (m_b)	
Straps after test (m_a)	

Calculations and criteria:

Variation in mass $\Delta m = 100 \times (m_a - m_b) / m_b$ **max. +30%**

12.3 Report

Report the variation in the test report

13.0 BLOWER AIR VELOCITY AND AIR VOLUME TEST

13.1 Materials and Instrumentation

a. This test is non-destructive and operated on a complete mister/duster.

b. Mount the mister cum duster onto a test bench.

Equipment		
Test bench for mounting mister cum duster	Anemometer	Tachometer
		

13.2 Test Procedure

a. A device for the suction and the evacuation of exhaust gases shall be used when a mister cum duster is tested inside the testing facility

b. Place the mister cum duster in an operational position. Lock the machine as per position in Figure 13a. Position air duct pipe in a horizontal position such as the height of the mister cum duster outlet pipe center is 1000 ± 20 mm from the ground.

c. Prepare a sampling grid as in figure below by using thin nylon wires, strings or a net on a frame or with a motorized/wheeled 2D or 3D structure supporting the anemometer.

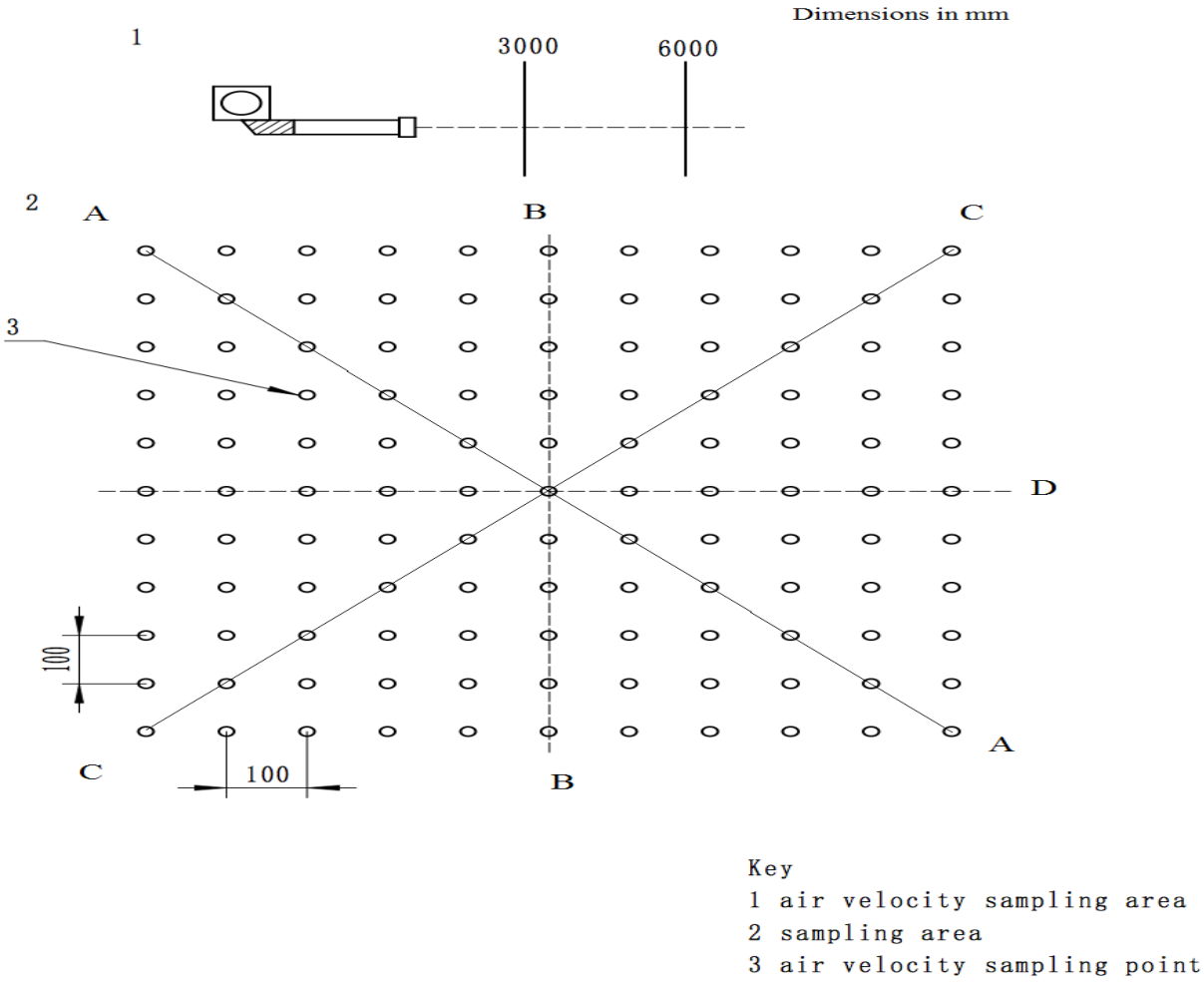


Figure 13a. Air velocity grid sampling

d. Set the engine speed according to the rated engine speed defined by the manufacturer.

e. Place an anemometer at the point (0, 0) correspond to the vertical and horizontal axis where (0, 0) is along the axis of the blower outlet air duct pipe.

f. Measure the air velocity during 15 seconds interval at distances of 3 000 ± 20 mm and 6 000 ± 20 mm from the air duct pipe outlet based on sampling grid of 100 x 100 mm ± 5 mm as per Figure 13a. Sample air velocities along the four lines A-A, B-B, C-C and D-D.

g. Measure at each grid point (Figure 13b and c)

h. Stop measuring when an air velocity lower than 2 m/s is detected.

Figure 13b. and Figure 13c. Set up for air velocities measurement

13.3 Report

Fill in the following tables where the central column and line correspond to the vertical and horizontal axis and the point (0,0) is in the axis of the blower outlet.

Table 13a. Air velocity profile at 3000 ± 20 mm distance

	-500	-400	-300	-200	-100	0 mm	100	200	300	400	500
500											
400											
300											
200											
100											
0 mm											
100											
200											
300											
400											
500											

Table 13b. Air velocity profile at 6000 ± 20 mm distance

	-500	-400	-300	-200	-100	0 mm	100	200	300	400	500
500											
400											
300											
200											
100											
0 mm											
100											
200											
300											
400											
500											

Determination of the effective air volume at 3000 mm distance:

Consider the area where the air velocity is > 2 m/s (A in m^2) and position its centroid. Calculate the mean value of velocity (V in m/s) along the air velocity profile from the centroid to the mean radius (assuming a linear variation of air velocity along the radius distance).

The effective air volume $_{3000}$ = A x V in $m^3.s^{-1}$

14.0 FAN IMPELLER OVER-SPEED TEST

14.1 Materials and Instrumentation

a. This test is non-destructive but required the use of a complete mister/duster fan impeller and housing (without engine).

b. Attention shall be paid to safety when operating the test.

c. Mount a unit of the mister cum duster (without engine) onto the overspeed test rig.

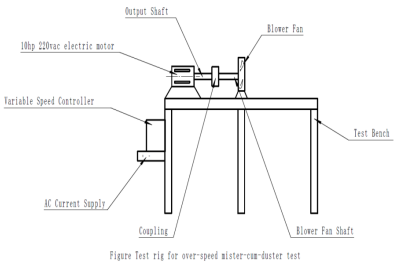
<table>
<tr><td colspan="2">Equipment</td></tr>
<tr><td>Test bench for fan overspeed test</td><td>Tachometer</td></tr>
<tr><td> 


Figure Test rig for over-speed mister-cum-duster test</td><td> 
</td></tr>
</table>

14.2 Test Procedure

a. Mount the test sample (without the engine) onto a test rig with a variable speed controlled electric motor.

b. The impeller shall be tested at 1.3 times the rated speed for 5 minutes on the occasion of full load. Check with a tachometer.

c. Stop and check that the following phenomena shall not occur to the impeller: get injured, get loose or be out of shape, etc.

d. Replicate step (b) and step (c) three times.

15.0 MISTING DISCHARGE RATE (FULL TANK, VARIOUS TANK VOLUMES) AND RESIDUES

15.1 Materials and Instrumentation

a. This test is non-destructive and required the use of a complete mister.

b. Weighing device and a measuring cylinder of 1 liter capacity

c. Mount the machine as shown

Equipment		
Test bench for mounting mister cum duster	Stopwatch	Balance
		

15.2 Test Procedure (Full Tank)

a. A device for the suction and the evacuation of exhaust gases shall be used when a mister cum duster is tested inside the testing facility

b. Fill the tank of the mister with clean water up to its full tank capacity.

c. Firmly place the knapsack mister on a weighing scale (or hang it),

d. Set the flow regulator at a desired setting (Figure 15a)

e. The mister should be run idle for some time before commencing the test to avoid initial variation in discharge

f. Divide the starting and stopping of misting into 5 to 7 segments of full tank capacity (stopping is defined as irregular continuous misting).

g. Measure the time and respective misting rate by weighting the mister between each segments. Conduct the horizontal and vertical misting.

h. Residue - weigh or measure the residual clean water remained in the chemical tank after each test and record it in Table 15a.

i. Repeat three times.

Figure 15a. Mister is placed on a weighting scale

Calculations and criteria:

$$Q_i = \frac{\Delta g_i}{\Delta t_i}$$

where Q_i = Average discharge rate at measure segment, kg / min

Δg_i = Amount discharged at measured segments, kg

Δt_i = Average time for discharge at measured segments, min

$$Q = \frac{1}{n}\sum_{i=1}^{n} Q_i$$

where Q = Average discharge rate, kg / min and n = Number of segment

$$S = \sqrt{\left[\frac{1}{n-1}\sum_{i=1}^{n}(Q_i - Q)^2\right]}$$

where S = Standard deviation

$$V = \frac{S}{Q} \times 100$$

where V = Coefficient of variation, %

15.3 Report

Report all data in Table 15a

Table 15a. Misting volume, evenness and residue test

Machine model		Rated RPM		Rated power, kW	
Instrument type and model		Environment Temperature/ Humidity		Test date	
Test site		Misting pipe condition:			
Inspector					

Test No.	Discharge segment		1	2	3	4	5	6	7
	Reduction in test materials (kg)								
Record	spray time (s)	1							
		2							
		3							
Computation	spray time (s)	1							
		2							
		3							
		Average							
	Sprayed rate, kg/min								
	Average sprayed rate, kg/min								
	Standard deviation								
	Coefficient of variation (%)								
	Residue (kg) test 1								
	Residue (kg) test 2								
	Residue (kg) test 3								
	Residue (kg) - average								

15.4 Test Procedure - Tank Filling Variation Discharge - Liquid

Obtain the tank filling variation discharge with data from section 15.3. The variation in discharge due "to tank filling at the various segments defined in section 15.3 shall not exceed 15% of the discharge at full capacity of the tank as obtained in 15.3.

16.0 DUSTING DISCHARGE RATE (FULL TANK, VARIOUS TANK VOLUMES) AND RESIDUES

16.1 Materials and Instrumentation

This test is non-destructive and required the use of a complete duster.

a. Weigh device

b. Mount the machine on a test rig

c. Use micro granules (eg. millet of bulk density of 0.83 kg l^{-1}).

Equipment		
Test bench for mounting mister cum duster	Stopwatch	Balance
		

16.2 Test Procedure (Full Tank)

a. A device for the suction and the evacuation of exhaust gases shall be used when a mister cum duster is tested inside the testing facility

b. Fill the tank of the duster with dust/micro granule material up to its full tank capacity.

c. Firmly place the knapsack duster on a weighing scale (or hang it) (Figure 16a)

d. The duster should be run idle for some time before commencing the test to avoid initial variation in discharge

e. Set the flow regulator at a full discharge setting

Figure 16a. Micro granules being filled while the duster is placed on a weighing scale

f. Measure the time and respective dusting rate by weighting the duster between segments. Conduct the horizontal and vertical dusting.

g. Repeat three times and obtain the average discharge per minute. The data shall be recorded in Table 16a

h. Residue - weigh or measure the residual dust remained in the chemical tank and hose after the test and record it in Table 16a.

Calculations and criteria:

$$Q_i = \frac{\Delta g_i}{\Delta t_i}$$

where Q_i = Average discharge rate at measure segment, kg / min

Δg_i = Amount discharged at measured segments, kg

Δt_i = Average time for discharge at measured segments, min

$$Q = \frac{1}{n}\sum_{i=1}^{n} Q_i$$

where Q = Average discharge rate, kg / min and n = Number of segment

$$S = \sqrt{\left[\frac{1}{n-1}\sum_{i=1}^{n}(Q_i - Q)^2\right]}$$

where S = Standard deviation

$$V = \frac{S}{Q} \times 100$$

where V = Coefficient of variation, %

16.3 Report

Report all data in the following Table 16a

Table 16a. Dusting volume, evenness and residue test

Machine model			Rated RPM		Rated power, kW		
Instrument type and model			Environment Temperature/ Humidity		Test date		
Test site				Dusting pipe condition:			
Inspector							
Test No.	Tank level		1/4	1/2	3/4	4/4	
	Reduction in test materials (kg)						
Record	Continuous dusting time (s)	1					
		2					
		3					
Computation	Continuous dusting time (s)	1					
		2					
		3					
		Average					
	Dusting rate, kg/min						
	Average dusting rate, kg/min						
	standard deviation						
	Coefficient of variation (%)						
	Residue (kg) 1						
	Residue (kg) 2						
	Residue (kg) 3						
	Residue (kg) Average						

16.4 Test Procedure (Intermediate Levels of the Tank – Maximum Discharge Rate)

a. A device for the suction and the evacuation of exhaust gases shall be used when a mister cum duster is tested inside the testing facility

b. Fill the tank with dust up to one-fourth of its full tank capacity. Operate the duster at its rated speed and set the flow regulator to maximum discharge. The variation in speed, if any, shall be not more than 5 percent.

c. Run the engine until the dust/micro granule in tank is emptied. Record the starting and stopping time accurately. Calculate the discharge rate per minute.

d. Repeat the above test for a minimum of three times and calculate the average discharge rate.

e. Conduct the above test at one-half and three-fourths of the full tank capacity.

f. The provision for graduations showing 1/4, 1/2, 3/4 and full opening positions shall be made. The data shall be recorded in Table 16a.

g. The variation in discharge due "to tank filling at one-fourth, one-half and three-fourths of total capacity shall not exceed 15 percent of the discharge at full tank capacity of the tank as obtained in 16.2.

h. Residue - weigh or measure the residual dust remained in the chemical tank and hose after the test and record it in Table 16a.

17.0 MISTING OR DUSTING RANGE AND WIDTH DURING GROUND DEPOSITION TEST

17.1 Objective

Determine the misting/dusting range and width as in Figure 17a.

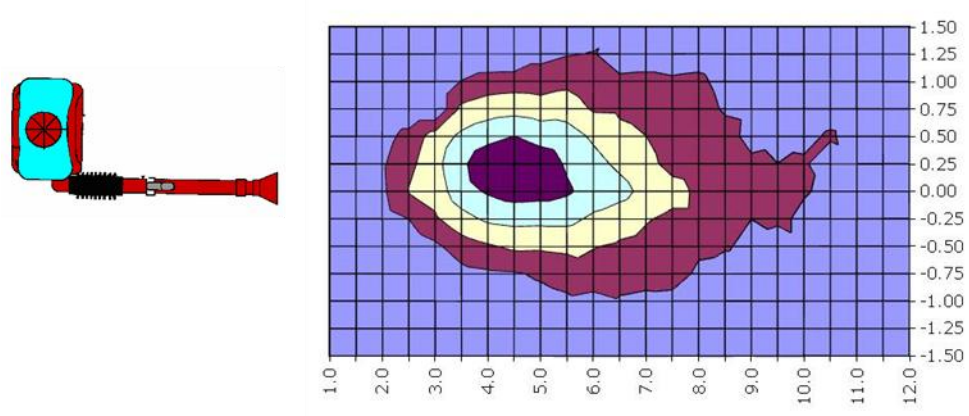


Figure 17a. Misting/Dusting range and width (source JKI)

17.2 Materials and Instrumentation

a. Conduct this test in an enclosed space without interferences due to wind.

b. Place the mister cum duster in an upright position.

c. Lock the machine on the test bench.

Equipment
Test bench for mounting mister cum duster 

17.3 Test Procedure (Full Tank)

a. A device for the suction and the evacuation of exhaust gases shall be used when a mister cum duster is tested inside the testing facility.

b. Position air duct pipe in a horizontal position such as the height of the mister cum duster outlet center is 1000 ±20 mm from the ground.

Initial trial:

c. Fill the chemical tank with clean water and set engine at rated speed. Operate the misting at full throttle for 3 min.

d. Visually observe the coverage of misting that will define the sample zone. (Figure 17b).

Figure 17b. Visually observe the coverage of misting zone

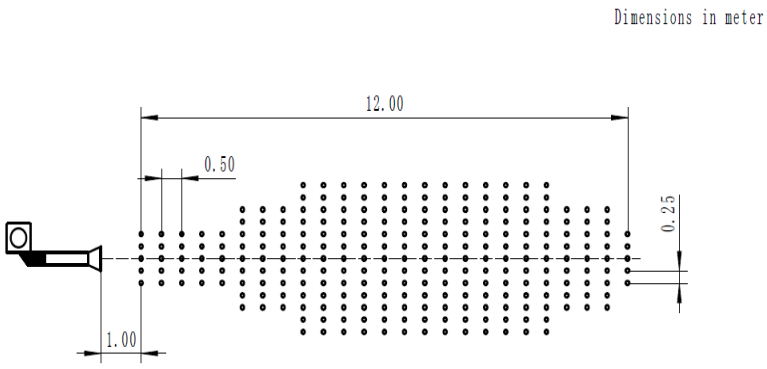


Figure 17c. Sprayer and Petri dishes layout

Test preparation:

a. Use rows of 60 mm diameter Petri dishes to sample water droplets. Each sidewall of the indoor enclosure shall have a minimum distance of 500 ±20 mm from the outermost Petri dishes (Figure 17c).

b. Weigh and identify each Petri dish. Position the center row of Petri dishes corresponding with the symmetric axis of the air duct pipe. The first Petri dish is placed at 1000 ± 20 mm from the air duct pipe outlet. The following Petri dishes shall be placed at 500 ± 20 mm from one to another. Additional number of Petri dishes is placed as according to the dimension and shape of the zone defined in section 17.3 c.

c. Set the engine speed according to the rated engine speed defined by the manufacturer. This test is conducted with the shutter outlet set at the minimum and the maximum misting/dusting flow rate. Fill the mister tank to the full tank level. Conduct the test while observing the water level of each of the Petri dishes. Stop the test when one of the Petri dishes is almost full with water or the tank is empty. (Figure 17 d).

d. Number and collect all Petri dishes and weigh the mass of water taking into

e. Repeat similar procedure (1 to 4) for dusters considering water is replaced by dust/micro granules. (use preferably collectors with height of at least 100 mm).

17.4 Report

Table 17a. Fill in the following tables

	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000…
-2500	Dish1	dish2	dish3	…							
-2000											
-1500											
-1000											
-500											
0											
500											
1000											
1500											
2000											
2500…											

Dish #	Initial mass, g	Mass after misting/dusting, g	Net mass , g
1			
2			
3…			

Report the maximal misting/dusting distance and width.

18.0 VERTICAL DEPOSITION TEST (MISTER ONLY)

18.1 Materials and Instrumentation

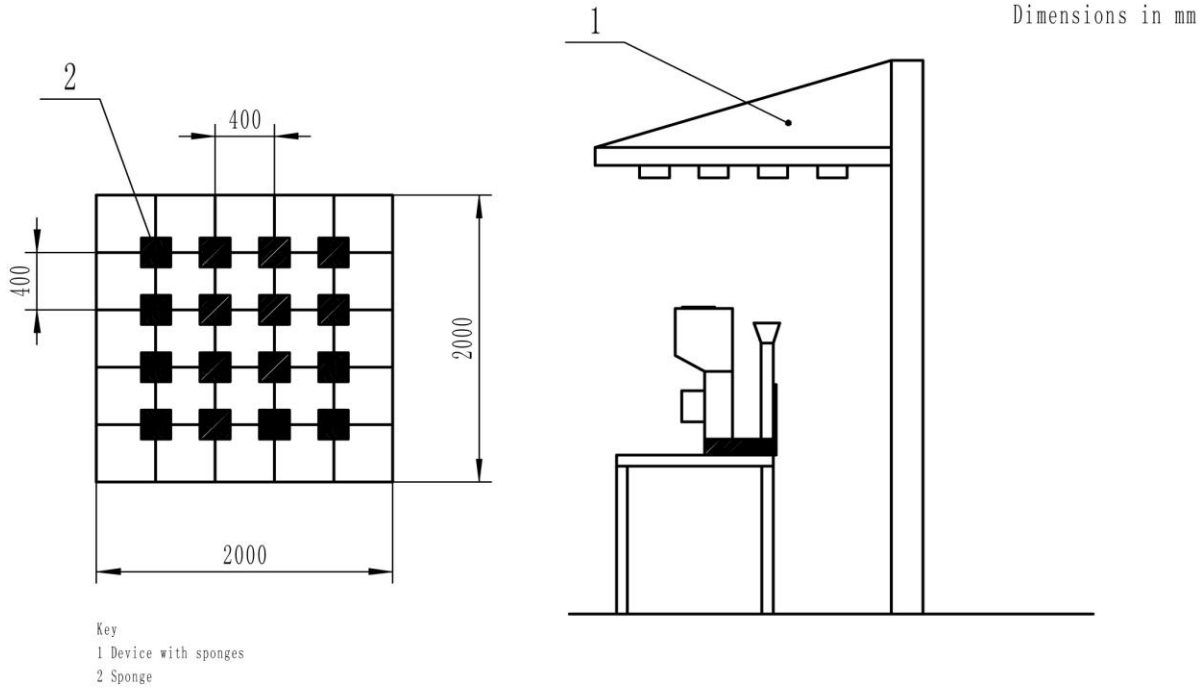
a. Conduct this test in an enclosed space without interferences due to wind.

b. Place the mister cum duster in an upright position.

c. Lock the machine as per figure below. Position air duct pipe in a vertical position such as the height of the mister cum duster outlet center is about 100 mm to 1000 ±20 mm from the ground.

d. Place a set of sponges tight to the support

Equipment
Vertical deposition test set up for mister cum duster



18.2 Test Procedure (Full Tank)

a. A device for the suction and the evacuation of exhaust gases shall be used when a mister cum duster is tested inside the testing facility

b. A pre-test can be conducted in order to define the sampling area with sponges

c. Use rows of sponges to sample water droplets. Identify each sponge, verify it is dry before the test and weigh.

d. Position the center row of sponges corresponding with the symmetric axis of the air duct pipe. The sponges sampling grid is placed at a height of 3000 ±20 mm from the air duct pipe outlet.
e. Set the engine speed according to the rated engine speed defined by the manufacturer. This test is conducted with the shutter outlet set at the minimum and the maximum misting flow rate. Fill the mister tank to the full tank level. Conduct the test until the sponges almost get saturated.

f. Number and collect all sponges and weigh the mass of water taking into consideration the initial mass of each sponge.

Figure 18a. Set up for vertical deposition test

18.3 Report

Fill in the following tables

	400	800	1200	1600…
400	Sponge 1	Sponge 2	Sponge 3	Sponge 4
800	Sponge 5	Sponge 6	Sponge 7	Sponge 8
1200	Sponge 9	Sponge 10	Sponge 11	Sponge 12
1600…	Sponge 13	Sponge 14	Sponge 15	Sponge 16

Sponge #	Dry mass (g) DM	Wet mass (g) WM	Water collected (g) W W= WM - DM
1			
2			
3…			

19.0 MEASUREMENT OF DROPLET SIZE AND DROPLET DENSITY (MISTER)

19.1 Materials and Instrumentation

a. Conduct this test in an enclosed space without interferences due to wind.

b. Place the mister cum duster in an upright position.

c. Position air duct pipe in a horizontal position such as the height of the mister cum duster outlet center is 1000 ±20 mm from the ground.

d. Plan scanner

e. Paper cards or water sensitive papers and Petri dishes (Figure 19a).

Equipment
Test bench for mounting mister cum duster


Dimensions in meter

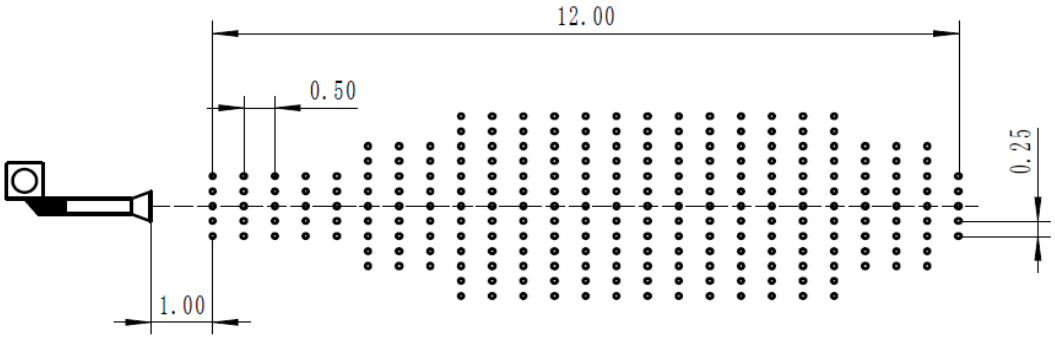


Figure 19a. Layout of Petri dish sampling

19.2 Test Procedure (Full Tank)

a. A device for the suction and the evacuation of exhaust gases shall be used when a mister cum duster is tested inside the testing facility

b. Fill the tank either with clean water (in case Water Sensitive Papers are used) or coloured water when a dye is used to contrast with artificial collectors such as filter papers, papers cards, etc placed in each Petri dish.

c. During a short misting time (of about 3s) the duct is moved laterally to avoid collector saturation. Cover the 1st half of the Petri dishes sprayed zone with a plastic canvas. Repeat the short misting time (of about 10s). All collectors described in the following are analyzed. After digitalization with a plan scanner, droplet sizes are directly calculated from the impact distribution by using an image analysis software[2]. At least 3 repetitions of the test are to be achieved (Figure 19 b and c).

[2] http://www.ars.usda.gov/services/software/download.htm?softwareid=247

Figure 19b. First half of droplet size sampling

Figure 19c. Second half of droplet size sampling

a. For each sample image, determine the number of droplets per class of drop size with 10 µm interval.

b. Set a table to compile all results

c. Calculate the average value for each class and determine the D10, D50 and D90 values.

d. D10 : 10 % of impacts have a diameter lower than this value.

e. D50 : median value of impact diameter

f. D90 : 10 % of impacts have a diameter higher than this value

g. % coverage: indicate the average value of coverage

19.3 Data Report

Table 19a. Number of droplets per classes of diameter (µm)

	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
S1																				
S2 …																				

20.0 GENERAL NOISE AND EAR LEVEL NOISE TESTS

20.1 Materials and Instrumentation

a. Test equipment set up for ear side noise measurement

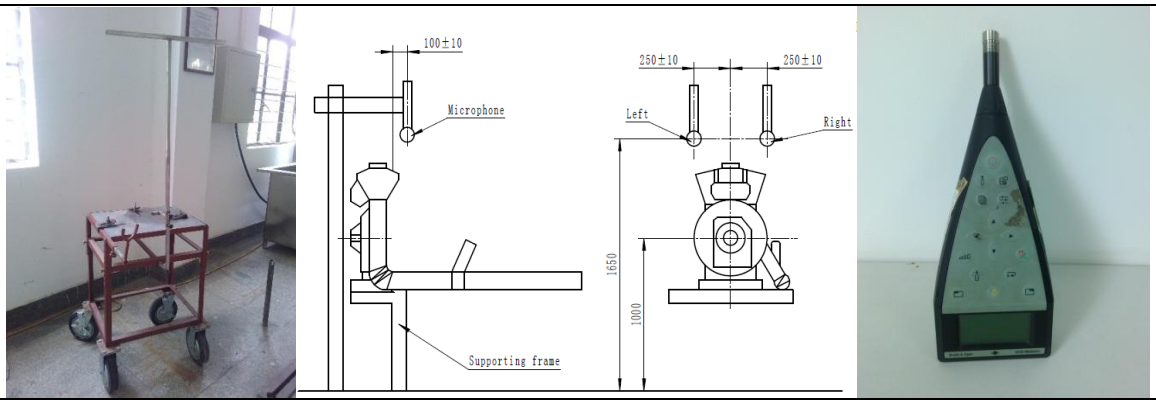
Equipment
Test bench for ear side noise measurement


Figure 20a. Setup for noise measurement. (Dimensions are in mm)

20.2 Test Procedure

a. The test of the noise of powered knapsack mister-cum-duster shall be conducted in a flat open field of radius > 20 m.

b. There shall not be any obstacles or reflective surfaces.

c. The level of the background noise and the sound pressure level of the wind shall be at least 10 dB (A) below the sound level measured during the test.

d. The natural wind speed shall be less than 5 m/s otherwise a windbreaker shall be used.

e. The mister-cum-duster shall be misting normally at its rated speed, at the highest misting rate, and it shall be standing on a stationary platform with the shaft of the engine 1000 mm height above the ground (see figure). The platform shall not resonate or reverberate with the mister-cum-duster.

20.3 Operator Ear Level Noise Measurement

a. During measurement, the microphone is placed vertically left and right at a distance of 250 ±10 mm, horizontally in front of the operator backpack cushion 100 mm ±10mm and 1650 mm above the ground level.

b. Measure the noise level. Repeat 3 times at each point.

c. Variations between two successive measurements shall not exceed 3 dB(A). Record the max value.

d. Compute the average, record readings in Table 20a.

Table 20a. Results of noise measurement

	Right	Left	Remarks
Background			
Test 1			
Test 2			
Test 3			

The noise level measured at the ear side shall conform to the specifications as listed in Table 20b.

Table 20b. Noise level limits at ear side, dB (A)

Gasoline engine rated power (kW)	Noise level at various rated engine speed, dB (A)		
	≤ 5500 rpm	> 5500 - 7000 rpm	> 7000 rpm
≤ 1.5	≤ 97	≤ 98	≤ 99
> 1.5 - ≤2.3	≤ 99	≤ 100	≤ 101
> 2.3 - ≤3.1	≤ 101	≤ 102	≤ 103
>3.1 – ≤3.8	≤ 103	≤104	≤ 105
>3.8 - ≤ 4.5	≤ 105	≤ 106	≤ 107
>4.5	≤ 107	≤ 108	≤ 109

21.0 VIBRATION TEST

21.1 Materials and Instrumentation

a. Use a vibration accelerometers.

b. See section 5, item 5 for instrumentation.

Equipment
Accelerometer


21.2 Test Procedure

a. Fill the chemical tank with ½ tank of clean water. Fit the knapsack with 6 to 9 pieces of metal washers tapped to the backpack cushion.

b. Operate at normal misting conditions.

c. Measure the vibration at each of the 6 to 9 spots as in (b).

d. Repeat the test three times.

21.3 Report

Location	1	2	3	4	5	6	7	8	9
Test1									
Test2									
Test3									
Average									

a. Compute the average record results in the table 21a.

b. Average vibration acceleration at the back rest shall not exceed 15 m s^{-2}.

Table 21a: Noise and vibration test

Machine model		Rated RPM		Rated power, kW	
Instrument type and model		Environment Temperature/ Humidity		Test date	
Test site			Note:		
Inspector					

Test No.	Noise level at ear, dB (A)		Vibration acceleration, ms $^{-2}$								
	Left	Left	1	2	3	4	5	6	7	8	9
1											
2											
3											
Average											

22.0 RELIABILITY AND ENDURANCE TEST

22.1 Materials and Instrumentation

a. Select five (5) misters cum dusters.

b. Stopwatch.

22.2 Test procedure Time to First Failure Test

Operate the misters cum duster under normal conditions, rated speed at maximum throttle during 100h (example 15 periods of 6 hours).

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	
Cycle 1						
Cycle 2						
Cycle 3						
Cycle 4						
Cycle 5						
Cycle 6						
Time of 1st failure						

Calculation and criteria

$$MTTFF = \frac{1}{n}\left(\sum_{i=1}^{r} t_i + \sum_{j=1}^{n-r} t_j\right)$$

where: MTTFF = Average operating time before 1st failure, h
n = total number of machines
r = no. of machine having 1st failure (when r =0 hr, n =1)
t_i = Cumulative operating hour of the i th unit of machine first failure
t_j = Cumulative operating hour of the j th machine (not having failure) at the end of 100 hr cumulative operation.

Average operation time to the first failure (exclude minor failure) shall not be less than 50 hrs.

Ex : TFF Sample 1: 58 h; Sample 2: 98 h, Sample 3 to 5 no failure during 100h
n = 5; r = 2; t1 = 58h; t2 = 98h; t3, t4, t5 = 100 h

MTTFF =1/5(58+98+300) = 91.2 h

Note: Minor failure refers to failure which can be easily repaired by farmer such as loose parts, loose wire and unimportant parts.

UNITED NATIONS
ESCAP CSAM
Economic and Social Commission for Asia and the Pacific

United Nations
Centre for Sustainable Agricultural Mechanization

A-7/F, China International Science and
Technology Convention Centre
No.12, Yumin Road, Chaoyang District
Beijing 100029, P.R.China

Tel: (86-10) 8225 3581
Fax: (86-10) 8225 3584
info@un-csam.org
www.un-csam.org