Biologische Bundesanstalt
für Land- und Forstwirtschaft

ENTAM
European Network for Testing Agricultural Machinery

ENTAM - Test Report

Equipment type:	mounted boom sprayer
Trade mark:	Amazone
Model:	UF 1501 and UF 1801 with Q-plus (15 m) and Super-S (15, 18, 21, 24, 28 m) boom

Manufacturer:
Amazonen-Werke
H. Dreyer GmbH & Co KG
D - 49202 HASBERGEN-GASTE

Test report: D - 1732

November 2005

Assessment table

No.	Contents	Assessment											
		UF1501						UF1801					
		15m QPlus	15m Super S	18m Super S	21m Super S	24m Super S	28 m Super S	15m QPlus	15m Super S	18m Super S	21m Super S	24m Super S	28 m Super S
1	Spray tank surface roughness	+						+					
2	Spray tank over volume	+++						++					
3	Volume of total residual (here max. allowed 37.5 l - 65 l)	++						++					
4	Spray tank contents gauge up to 20% Filling	+++						++					
5	Spray tank contents gauge from 20% Filling	+++						+++					
6	Agitation system (deviation of even solution)	++ *						++					
7	Width of nozzle bar section	+++	+++	++	+++	++	++	+++	+++	++	+++	++	++
8	Boom height adjustment range	++						++					
9	Deviation of pressure gauge	+						+					
10	Deviation of flow meter	++						++					
11	Regulation speed	++						++					
12	Transverse distribution	++	++	++	++	++	++	++	++	++	++	++	++
13	Rinsing water tank	++						+					
14	Deviation of volume/hectare adjustment device (spray computer) from desired value	++											
15	Repeatability of volume/hectare adjustment device (spray computer)	++											
16	Pressure drop between manometer and nozzle	++	++	+++	+++	+++	++	++	++	+++	+++	+++	++
17	Deviation of single nozzle output from table	++	++	++	+++	++	++	++	++	++	+++	++	++

*) measured at 1800 l tank

Table 1+2: Assessment table and assessment keys of important test results.

Note: The assessment keys are listed below. All detailed results are in the following test report.

No.	unit	+	++	+++	No.	unit	+	++	+++
1	µm	>70-100	30-70	<30	10	%	4-5	2-4	0-<2
2	%	5-8	>8-12	>12	11	%	>7-10	>3-7	0-3
3	of allow.value	>2/3-3/3	1/3-2/3	<1/3	12	CV	>7-9	4-7	<4
4	%	7.5-5.0	5.0-2.5	<2.5	13	% of tank vol.	10-12	>12-14	>14
5	%	5.0-4.0	<4.0-2.0	<2.0	14	%	>4-6	2-4	<2
6	%	>10-15	5-10	<5	15	%	>2-3	1-2	<1
7	m	>4.5-6	>3-4.5	3 or less	16	%	>7-10	3-7	<3
8	m	1-1.5	>1.5-2.0	>2.0	17	%	>7-10	3-7	<3
9	bar	>0.10-0.20	>0.05-0.10	0.00-0.05					

The complete test report can be downloaded at:
www.ENTAM.com or www.BBA.de

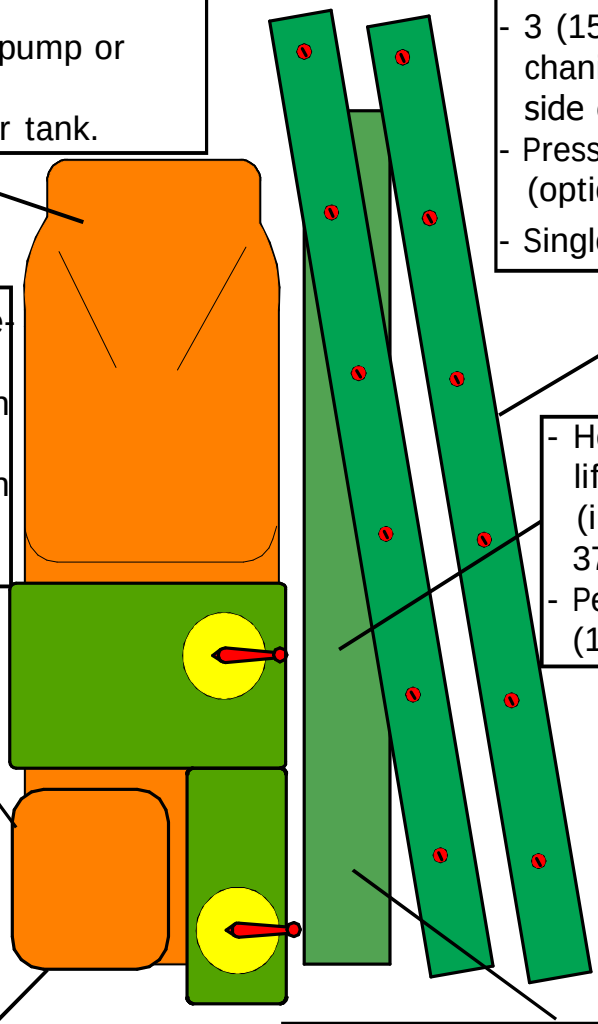
Technical data of sprayer

- 1500 or 1800 l tank.
- Level indicator with float.
- 1 rotating nozzle for cleaning inside of tank.
- Tank filled using pump or hydrant.
- 190 l clean water tank.

- „Q"-boom with folding boom on the back; „S"-boom with vertical folding.
- 3 (15 m) to 5 (28 m) mechanical segments on each side of „S"-boom.
- Pressure circulation system (optional).
- Single or three-nozzle holder.

- Max. load at three-point linkage: 2500 kg (1501 with 15 m Q-plus) up to 3600 kg (1801 with 28 m Super-S).

- Height adjustment using lifting frame with heights (infinitely variable) between 370 - 2170 mm.
- Pendulum range up to 14 ° (15 m Q-plus).



6-chamber diaphragm pump, model „Comet BP 235 K" or „Comet BP 280 DS" with 215 l/min and 236 l/min at 15 bar.

- Super-S boom with max. slope compensation of 14 % (28 m) to 18 % (15 m).
- damping system for horizontal and vertical vibrations.

Dimensions and weights:

Length:	1730 mm - 2300 mm
Height:	2480 mm - 2940 mm
Transport width:	2360 mm - 3050 mm
Net weight :	865 kg - 1240 kg (Q-plus / 28 m Super-S)

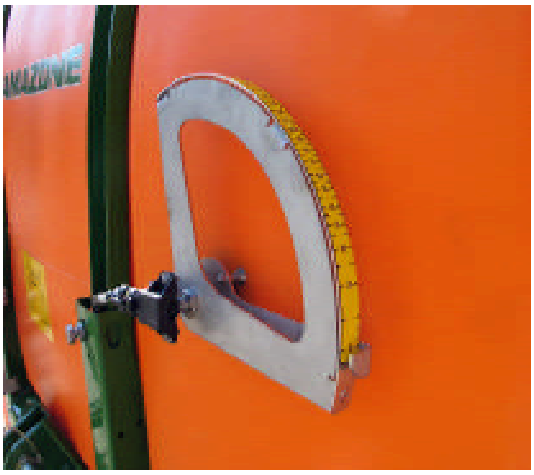
(detailed technical data to follow)

Fig. 1: summary of sprayer data

Description of sprayer

The support frame is made of angular metal profiles and standard profiles. There are three bore holes at different heights for the lower linkage. As an extra, Amazone offers a quick-coupling system with a coupling triangle. The sprayer is parked on castors. The frame also comprises extendable stands to prevent the parked sprayer from tipping over. The tanks with a nominal volume of 1500 l (UF 1501) and 1800 l (UF1801) are made of polyethylene.

Fig. 2+3 castors and clean water tank (underneath the spray tank). Level indicator on the left at the front.



The level indicator has an indirect scale (floating rod with indicator scale) on the front left (scale graduations of 50 l). The volume of liquid in the tank is also displayed by the on-board computer, AMATRON^{+}. The tank can be filled either using the filling opening (405 mm inner diameter) or otherwise, via an optional filling connection (Kam-lok coupling on the left side of the sprayer).

The tank is emptied via a 5-way ball valve on the left beneath the

Fig. 4 operator panel with 5-way ball valve and filling connection on the left of the sprayer.

tank and also a separate pump connection (Kamlok, 45 mm inner diameter). A rotating cleaning nozzle in the centre cleans the inside of the tank (rotating nozzle made of plastic). The sprayer comprises a pressurised agitation system which is fed by the flow from the self-cleaning pressure filter, consisting of two injector nozzles positioned in the middle above the tank. The injector nozzles spray in the direction of the side walls. Agitation speed can be set to one of five different settings.

The plant protection product is introduced either via the tank opening for filling on the top of the sprayer or the induction bowl on the left. The induction bowl is made of polyethylene with a circular rinsing pipe and three flat fan nozzles for introducing the product and also for rinsing off any product residues on the sides of the bowl.
The induction bowl is equipped with a spring-loaded rotating rinsing nozzle for cleaning the product cans. For cleaning the outside of the sprayer, a special cleaning set is available as an extra, consisting of a hose drum with 1/2" hose and a spray gun. The hose drum is situated behind the sprayer on the boom support. It is activated by a 5-way ball valve at the operating controls.

Fig. 5: swivelling induction bowl.

This model has decentralised controls comprising electromotive section valves on the boom support, pressure regulation valve (flow distribution regulator with fixed settings for cross-distribution) on the left of the sprayer and two flow meters in the pressure and reflux pipe, and the operator terminal, AMATRON^{+}, with a job counter (on the boom frame). The entire sprayer is controlled by the operator terminal (hydraulics and spray functions).

Fig.6: AMATRON^{+} terminal.

The tractor must be equipped with a connection for hydraulic pressure and a free reflux.
In addition, the AMATRON⁺ Terminal gathers specific data on the respective application and processes these. It also has access to other special functions. AMATRON⁺ calculates the current speed, application rate (l/ha), the remaining distance until the tank is empty, the actual contents level, the spray pressure and the power take-off shaft speed (optional). The spray pressure is displayed both manually using a larger pressure gauge at the front of the sprayer and electronically via a pressure sensor. This takes away the pressure directly in front of the section valves. A large graphic-compatible display makes entering the data for the operator easier with its four menus („job", „machine data", „set-up" and „operation") before beginning work or operating the sprayer in the spray setting.

The functions of the sprayer are controlled in the menus by so-called „soft keys" (switches with varying functions).

Spray booms for UF sprayers.
Q-plus series: this boom folds at the back and is available in the operating width dimensions 12 m, 12.5 m and 15 m. It is only possible to adjust the standard version of the Q-plus boom to different terrains via the boom suspension.

Fig.7+8: 15 m Q-plus boom which folds at the back, hydraulic on-off valves, hydraulic pendulum locking and spring-damping system.

Fig. 9: folded 15 m Super-S boom.

There is no slope compensation system included; this is however optional and can be ordered. Springs and shock absorbers contribute to an effective pendulum suspension behaviour. Alternatively, a boom from the Super-S series can be used. These booms are folded vertically and are available in the operating widths 15, 18, 20, 21, 24, 27 and 28 m. The Super-S boom has a central pendulum suspension.

Slope compensation is effected either by electro-spindle drive or hydraulically and activated by a switch on the AMATRON+. The position of the boom (horizontal or at an angle) can be seen on the graphic display. The Super-S boom is connected to the support frame using springs and dampers which compensate for horizontal and vertical movements of the boom.

Both series have in common that the boom construction is made of welded steel plate profiles.

The boom is folded and unfolded via the operator terminal AMATRON+ from the tractor cab. Once the boom has been released from its transport position and the appropriate folding function has been selected, the boom is unfolded and folded by a series of hydraulic functions which are automatically triggered.

The Q-plus booms have single nozzle bodies which are clamped to the boom. The Super-S booms are equipped with single and multi-nozzle bodies which are fixed to the boom with stainless steel screws.

All nozzle bodies have diaphragm reflux valves and bayonet caps (TeeJet system). Alternatively, the operator can order the boom with a pressure circulation system. The circulation pipe is activated by closed boom sections and ensures that the spray liquid is distributed evenly.

The 15 m boom from the Q-plus series was tested. Like all the other booms in this series, it is hydraulic and folded at the back. The hydraulic control valves are positioned on the boom. The boom is attached to the pendulum frame of the sprayer- via a lifting frame. The pendulum frame has a pendulum range of up to 14 ° to the horizontal. It is not possible to adjust the pendulum effect to sloping terrain (centrally pivoted suspension system). Springs on the sides of the pendulum frame keep the boom parallel to the sprayer. Horizontal shocks are compensated for and absorbed by springs and rubber elements and vertical shocks via the height adjustment springs and shock absorbers. For this type of boom, plastic hoses with fabric ply and an interior diameter of 15 mm and a wall thickness of 3.5 mm are used for the pressurised pipe system.

Fig. 10 : folded 28 m Super-S boom with section valve unit underneath stainless steel cover and tool box.

Fig. 11: 18 m Super-S boom whilst folding, in its highest position.

Amongst other parts, the 15 m boom was tested for the Super-S series. It folds vertically and hydraulically as all booms in the series do. The hydraulic control valves are situated on the boom frame. The boom is attached to the pendulum frame via a lifting frame. The pendulum frame has a pendulum range of up to 8 ° to the horizontal. The electric slope compensation via

Fig. 12: non-buckling hose system leading to the boom.

Fig.13: outer boom segment made of aluminium with protection bar on the 24 m Super-S boom.

spindle drive is activated using a switch on the on-board computer and ensures slope compensation up to a gradient of 18 %. On the contrary, the 18 m Super-S boom has hydraulic slope compensation (up to 18 %). The 24 m, 27 m and 28 m Super-S booms have a pendulum range of 10 ° due to their larger operating widths and can compensate for gradients of up to 14 %.

Result table

version	unloaded weight (kg)	allowed weight (kg)	width (mm)	length (mm)	height (mm)	horizontal distance from centre of gravity ("d") to coupling point of lower hitch arms (m)
UF 1501 - 15m Q-plus	861	2361	3050	1730	2480	0.708
UF 1801 - 15m Q-plus	890	2690	3050	-	-	
UF 1501 - 15m Super-S	1020	2520	2365	1700	2930	0.71
UF 1801 - 15m Super-S	1050	2850	2365	1700	2930	
UF 1501 - 18m Super-S	1050	2550	2400	1900	2900	
UF 1801 - 18m Super-S	1080	2880	2400	1900	2900	
UF 1501 - 21m Super-S	1150	2650	2360	2100	3160	
UF 1801 - 21m Super-S	1180	2980	2360	2100	3160	
UF 1501 - 24m Super-S	1180	2680	2380	2300	3160	0.695
UF 1801 - 24m Super-S	1210	3010	2380	2300	3160	
UF 1501 - 28m Super-S	1220	2720	2380	2300	3280	
UF 1801 - 28m Super-S	1240	3040	2380	2300	3280	0.724

					volume of total residual (l)					
tank	tank over volume	agitation test	rinsing water tank	deviation of "AMATRON" contents gauge	Q-plus 15 m	Super-S 15 m	Super-S 18 m	Super-S 21 m	Super-S 24 m	Super-S 28 m
UF 1501	15.07%	max. 8.8%	190 l	2.2 % (< 300 l) 1.3% (> 300 l)	17.11	19.35	27.83	28.77	25.02	30.47
UF 1801	8.33%		190 l	5.1% (< 360 l) 2.5% (> 360 l)						

volume/hectare adjustement device								
			change of driving speed by changing gears					
	switching on / off	switching of single sections	from 1.5 m/s to 2.0 m/s	from 2.0 m/s to 2.5 m/s	from 2.5 m/s to 2.0 m/s	from 2.0 m/s to 1.5 m/s	repeatability of adjustment	CV of repeatability
regulation time (s) with deviation > 10 % to adjusted value	2.7 s	2.7 s	2.6 s	2.3 s	2.3 s	2.6 s	-	-
mean deviation from adjusted value (210l/ha)	-	-	-	-	-	-	3.0%	0.61%
mean deviation from adjusted value (300l/ha)	-	-	-	-	-	-	2.4%	0.29%
mean deviation from adjusted value (390l/ha)	-	-	-	-	-	-	2.2%	0.37%

Table 3: Test result table, part 1

Result table

		liquid pressure (bar)						
		1.0	1.5	2.0	3.0	5.0	6.0	8.0
Q-plus 15 m [1]	flow rate (l/min)				1.529	1.944		2.387
	deviation from table (%)				-1.33	-3.77		-5.64
	single nozzle: max. deviation from table (%)				-3.61	-5.77		-7.24
	CV of transverse distribution (%)				5.74	4.19		4.44
	at working height (cm)				50	50		50
Super-S 15 m [2]	flow rate (l/min)		0.893		1.211		1.676	
	deviation from table (%)		6.28		3.48		2.18	
	single nozzle: max. deviation from table (%)		8.57		5.57		6.54	
	CV of transverse distribution (%)		5.18		3.98		3.95	
	at working height (cm)		50		50		50	
Super-S 18 m [3]	flow rate (l/min)				1.19	1.51		1.93
	deviation from table (%)				1.88	-0.95		1.07
	single nozzle: max. deviation from table (%)				4.96	3.83		8.41
	CV of transverse distribution (%)				3.89	4.4		3.8
	at working height (cm)				50	50		50
Super-S 21 m [4]	flow rate (l/min)			0.846		1.268		1.611
	deviation from table (%)			4.5		-0.97		-0.57
	single nozzle: max. deviation from table (%)			6.06		-2.1		-1.41
	CV of transverse distribution (%)			5.81	3.77	2.9		3.05
	at working height (cm)			50	50	50		50
Super-S 24 m [5]	flow rate (l/min)				1.028	1.319		
	deviation from table (%)				2.81	2.13		
	single nozzle: max. deviation from table (%)				4.56	3.87		
	CV of transverse distribution (%)		6.21		5.28	4.01		
	at working height (cm)		50		50	50		
Q-plus 28 m [6]	flow rate (l/min)	1.251			2.019	2.519		
	deviation from table (%)	7.9			1.00	-2.40		
	single nozzle: max. deviation from table (%)	10			-4.20	-4.30		
	CV of transverse distribution (%)	5.74			3.33	3.05		
	at working height (cm)	50			50	50		

used type of nozzle: 1) Lechler ID 120 04 POM
2) Lechler IDK 120 03 POM
3) Lechler ID 120 03 POM
4) Lechler IDN 120 025 POM
5) Agrotop AirMix 110 025
6) Agrotop AirMix 110 05

Table 4: Test result table, part 2

Assessment

The conclusion of the test was that all ENTAM test requirements are fulfilled.

There are three bore holes of various sizes for assembling the lower links. This makes it possible to adjust the position for mounting the sprayer to the respective tractor. Alternatively, Amazone can offer a quick coupling system with a coupling triangle. The sprayer has wheels for transport. However, due to the weight and dimensions of the sprayer, it is difficult for one person alone to move it, and it can only be moved on even and hard surfaces. Care must be taken due to the weight of the sprayer when the tank is full that the front of the tractor is sufficiently ballasted and that the axles and tyres are able to cope with the load.

The spray tank is made of polyethylene. It is sufficiently smooth on the inside and outside and is rounded off well in general. Both the sump area and the bottom of the tank have an adequate cant so that the tank can be used until it is completely empty. The filling hole is adequate in size and the tank lid seals properly. For filling, in addition to a kamlok clutch on the left side - for a suction hose - the sprayer has a swivelling induction bowl with lid, circular pipe system and container rinsing nozzle. After swivelling out the induction bowl it is easily accessible and can (when the sprayer is semi-mounted in normal transport position) be filled comfortably at an opening height of approx. 85 cm. If the filling connection on the side is used, the sprayer can be filled with a pump capacity of up to 265 l/min. Care must be taken that only filling hoses with reflux valves are used. Alternatively, the manufacturer can also offer filling connections with a Storz clutch for filling via hydrants.

Thanks to its favourable shape, the tank has no protruding recesses and can be cleaned well on the inside due to the standard rotating cleaning nozzle. Both the tank volume indicator scales and the electronic display are sufficiently accurate. With an oversize of 15.1 % (UF 1501) / 8.3 % (UF 1801), the tanks have sufficient reserves for any foam which may occur. The mounted injection agitator is effective. The agitator capacity can be set to various speeds via a valve (return flow from the self-cleaning pressure filter). To avoid large amounts of residues, both the agitator and the return flow to the tank can be switched off.

The clean water tank which is positioned underneath the spray tank is easily accessible for filling (on the right) and the 190 l volume is adequate. The clean water tank is connected so that the pipes, pump and boom can also be rinsed when the spray tank is full. Clean water can also be fed through the optional exterior cleaning system, including the spray gun and hose reel.

The spray boom is extended and folded using Amatron$^+$ via a hydraulic sequence function which is controlled by corresponding hydraulic valves on the boom. The operator merely has to extend the boom from its transport position and select the folding function.

The Q-plus booms are somewhat simpler as far as the construction of the pendulum frame is concerned. The centrally pivoted suspension system can only be adjusted to a limited extent to different use conditions. Slope compensation is not included as a standard but is available as an extra. However, springs and shock absorbers make for an adequate pendulum suspension system.

The Super-S booms have a centrally pivoted suspension system. Slope compensation is achieved either by electric spindle drive or hydraulically driven and activated by a switch on the Amatron$^+$. The position of the boom (horizontal or inclined) can be seen very clearly on the graphic display. The Super-S booms are connected to the support frame by springs aind dampers which compensate effectively for horizontal and vertical shocks. Alternatively, the boom is available with a pressure circulation system (DUS). This circulation system is activated when the valve sections are closed and ensures an even distribution of the spray liquid. This means that the full concentration of spray fluid is immediately available to the nozzles before they are even switched on.

The continuous circulation means that sedimentation is avoided and it is much easier to clean the sprayer following operation. The circulation system can be switched off if necessary.
Pressure build-up and release is relatively fast. Up to a width of 20 m the booms have 5 spray sections each. The 21 m Super-S boom is available either with 5 or 7 boom sections. The 24 m boom always has 7 sections and the 27 or 28 m booms have either 7 or 9 sections. The boom sections are never wider than 4.5 m (the Super-S 21 m boom has 5 sections and the Super-S 27 has 7 sections). The nozzles are protected against damage by the boom construction which is made of angular sheet steel. An aluminium pipe on the end element of the boom offers the nozzles extra protection from touching the ground. The end element is also flexible and is built to avoid obstacles to the front and the back. The nozzles can be exchanged quickly and without the need for additional adjustment aids through the use of multi-nozzle bodies with bayonet caps.

Apart from the control valve functions such as switching on the boom section valves and pressure adjustment, the Amatron^{+} terminal can also be used to regulate all hydraulic functions such as lifting and lowering, extending and folding and slope compensation. An oil circulation system is needed for the hydraulics including a pressure connection and free return flow.

Using the terminal, both the flow of liquid can be switched off quickly and the pressure adjusted rapidly. The integrated control unit also makes it possible to apply the spray depending on the respective speed. Changes such as opening and closing section valves, speed changes within the same gear or changing gears are compensated for rapidly by the control unit. The description of the control unit, the on-board computer and their calibration is clear and detailed. Before using for the first time, and also several times during the season, the accuracy of the flow meter should be checked and calibrated anew if necessary.

Safety Tests

The sprayer is equipped with safety pictograms (stickers) on the sprayer and operating instructions in the operator's native language, which include further safety information. The sprayer carries a CE-mark and a vehicle identification plate.

The CE-mark shows that the product fulfils the requirements defined for the respective EC-directives and that the supplier has carried out the appropriate procedures to achieve conformity. The CE-mark is placed on the equipment by the manufacturer. The manufacturer confirms by doing so that the sprayer has been designed and built in accordance with harmonised EC Directive 98/37/EEC and that standard EN 907 has been met.

Diagram of the liquid system

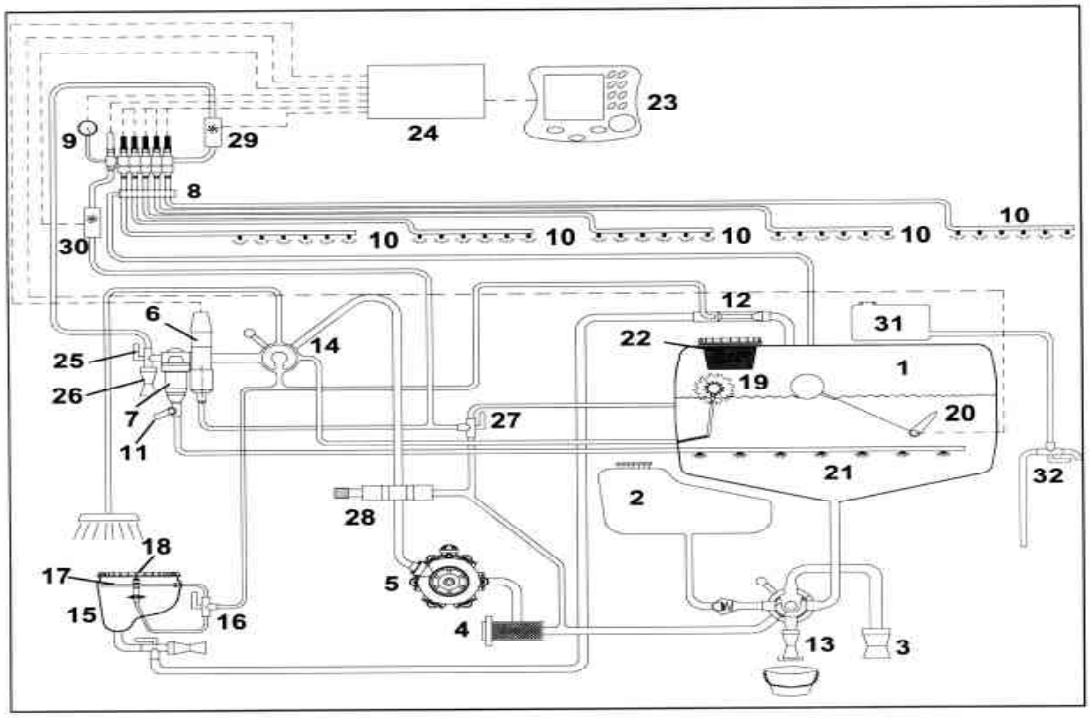


Fig. 14: spray/hose system

suction filter(4), 5-way valve (13), filling connection (3), clean water tank (2), regulation device (6), switch-over valve (to prevent large amounts of technical resuidues from entering the pump suction pipe from the spray tank (27)), pump (5), 5-way valve (14), control valves (8), cleaning nozzle (19), induction bowl (15), pressure regulator (6), return flow (27), section valves (8), initial flow meter (29), second flow meter (30), self-cleaning pressure filter (7), five-stage agitation system which can be switched off (21).

Explanation on testing:

Testing takes place according to the Technical Instructions for ENTAM-Tests of Filed crop sprayers. This procedure was developed by the competent testing authorities of the European countries participating in ENTAM and is based on the CEN standard EN 12761 „Agricultural and forestry machinery – Plant protection equipment for the application of plant protection products and liquid fertilisers". This test is only a technical performance test which takes place without an accompanying field test. The test results apply only to the tested appurtenances of the sprayer. Statements on the behaviour of the sprayer with different appurtenances cannot be derived from these results.

Responsibility and recognition

Performing competent authority:
Federal Biological Research Centre for Agriculture and Forestry (BBA) (Germany)
Application Techniques Division; Messeweg 11-12; D-38104 Braunschweig

This test is recognized by the ENTAM members:

HBLuFA FRANCISCO JOSEPHINUM WIESELBURG (Austria)	BLT-Prot.-Nr. 002/06
NAGREF National Agricultural Research Foundation (Greece)	LE/65/01/ZZ
PIMR - Przemyslowy Instytut Maszyn Rolniczych Industrial Institute of Agricultural Engineering (Poland)	PIMR - 01/ENTAM/06
D.I.A.S. - Danish Institute of Agricultural Sciences (Denmark)	DIAS recognition 954
CMA Generalitat de Catalunya Centre de Mecanització Agrària (CMA) (Spain)	EPH001/06
HIAE Hungarian Institute of Agricultural Engineering (Hungary)	D-1/2006
ENAMA Ente Nazionale per la Meccanizzazione Agricola (Italy)	ENTAM „Rapporto di prova prestazionale" 01/2006
CRA-W Centre de Recherches Agronomiques de Gembloux; Département de Génie rural (Belgium)	D-1732