Jetstream®
Subsidiary of Federal Signal Corporation

MAGDART™ X40

(PN 66416)

PRODUCT INSTRUCTIONS

PI-192

The MAGDART™ is a self-powered rotating nozzle that offers a polisher or unplugger head for cleaning a variety of process lines. The MagDart comes equipped with an eddy-current braking system which controls rotation speed for maximum cleaning power and minimum wear. The MagDart rotary seal is housed in an innovative, patented cartridge design which allows quick replacement in the field. The MagDart is rated for 3,000 bar (43,511 psi) maximum working pressure.

Read these instructions thoroughly before installing, connecting, or using the MagDart X40. If any questions remain, call JETSTREAM at (800) 231-8192 or (832) 590-1300. Also read the yellow JETSTREAM SAFETY WARNING pamphlet included with the shipment of your new MagDart X40 and reproduced inside this publication. This product is sold with the understanding that the purchaser agrees to thoroughly train all operators and maintenance personnel in the correct and safe installation, operation and maintenance of the product and to provide adequate supervision of personnel at all times. Retain these instructions for future reference. If this product is resold or otherwise conveyed, purchaser must pass on the instructions to the new user.

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SECTION 1: SAFETY

⚠ DANGER

Incorrect Use of High Pressure Waterblast Equipment May Cause Serious Injury
Read these instructions in their entirety before using any JETSTREAM products.

This information was prepared to aid in the identification of potentially unsafe conditions when using high pressure waterblast equipment. It should be noted that other potential hazards may exist which might have not been mentioned in this brochure.

In all cases, JETSTREAM products are sold with the understanding that the purchaser agrees to thoroughly train all operating and maintenance personnel in the correct and safe installation, operation of maintenance of waterblast equipment and to provide adequate supervision of personnel at all times.

Read the following in its entirety before connecting, operating or repairing equipment. Purchasers and operators also should be familiar with the current version of the “Industry Best Practices for the Use of High Pressure Waterjetting Equipment” published by the Waterjet Technology Association, as well as any applicable OSHA regulations, standards and guidelines.

Should any questions arise concerning safe and proper procedure, contact JETSTREAM prior to the installation or use at (800) 231-8192 or (832) 590-1300.

GENERAL WATERBLAST

1. Use only clear, clean water in high pressure system.

2. Place barricades with warning signs or barricade tape around work area.

3. Outfit all operators with Personal Protective Equipment (PPE). Hard hat with plastic face shield, rainsuit, non-skid knee boots **with metatarsal protection,** gloves, ear protection and body armor rated for operating pressures are considered minimum safety equipment. Proper respiratory protection is required where dangerous fumes or dust is present or created by the waterblasting operation. Follow applicable OSHA regulations, standards and guidelines regarding the use of respiratory protection if harmful fumes or dust is present during, or created by the waterblasting operation.

4. Use products intended for high pressure waterblasting only.

5. No product should be altered without written consent of the manufacturer.

6. Read and follow all manufacturer's instructions prior to using any waterblast product. Contact manufacturer.

7. Thoroughly review alternative methods before initiating any potentially dangerous waterblasting operation. Fully automated, semi-automated, and/or mechanized methods should all be considered first. Contact the applicable waterblasting manufacturers for assistance and recommendations.

8. The operator handling the cleaning device (with nozzle) must always have control of water pressure. A surface cleaning operator should operate a trigger style control gun capable of instantaneously stopping pressure to nozzle. A tube cleaning lance operator should operate a foot gun capable of instantaneously stopping pressure to the lance.

9. Inspect the condition of all components prior to use. Use no items which are in questionable condition.

10. Check the condition of thread connections prior to the make-up of any high pressure connection. Use Teflon tape and anti-seize on male pipe (NPT) thread for sealing purposes. Do not let tape overlap the male pipe thread end. Tape fragments may enter system water stream and clog nozzle's orifices.

Do Not use a component with missing or damaged threads on the high pressure connections.

⚠ CAUTION Use wrench flats (when available) or a properly adjusted smooth jaw plier wrench (JS PN 64119) for tightening components. Avoid using pipe wrench as wrench marks will cause high pressure components to crack and fail.

11. All high pressure hose connections require a hose restraint (whip check), including connection at fluid end discharge.

12. Before attaching a nozzle to the control gun or tube cleaning lance, **operate the pump at low speed to purge** dirt and debris from system. **Dirt and debris can clog nozzle orifice(s) and cause excessive system pressure which could lead to a lance failure.**

13. With nozzle installed, **operate the pump at a low speed (low pressure) for test**. Should system repairs or adjustments be necessary, stop pump and relieve all pressure before making required repairs or adjustments. The pump operator should watch the nozzle operator at all times in case any difficulty arises and it becomes necessary to depressurize system. If the pump operator does not have a clear line of sight to the nozzle operator, it may be necessary to have another employee available to communicate between the nozzle and pump operators.

14. With the system operating properly, **increase pump speed slowly until operating pressure is reached**-and adjusted. Pressure adjustments should always be made slowly. The nozzle operator shall be warned before any pressure adjustment is made by the pump operator. A sudden change in reaction force may cause the nozzle operator to lose balance.

15. Use **minimum pressure required**-for cleaning. Do not exceed the operating pressure of the system's lowest pressure-rated component. All equipment pressure rating markers and warning tags should be left intact.

16. Waterblast operators must be made aware that the **cleaning nozzle's discharge jets(s) can inflict serious body wounds.** Supervisors should demonstrate the potential danger of discharge jet(s) by showing all new operators the effect of a waterjet by cutting a scrap piece of wood such as a 2" x 4".

17. If equipment malfunctions or a system malfunction is suspected, immediately stop cleaning activity and relieve the pressure in the system before attempting any repairs. Always follow the manufacturer's repair instructions.

18. Only trained persons should be authorized to perform any maintenance or repair.

19. Following any repairs, the system should be operated at low pressure for test. Bring equipment up to operating pressure slowly.

20.For shutdown in freezing conditions, even for brief periods, drain water from all components. Prior to starting operations in freezing conditions, the operation of all equipment components must be checked carefully to make sure components are not frozen and can be operated.

21. Store components properly by protecting them from damage when not in use. Be sure all safety warning tags and markers remain intact.

PRESSURE RELIEF DEVICES

1. Read General Safety section prior to installing Relief Valve and/or Pressure Relief Devices.

2. A waterblast system should include both primary and secondary pressure relief protection:

A. For primary protection a primary rupture disc assembly or spring-loaded relief set at 1.2 times, maximum operating pressure is recommended (i.e. relief valve is set at 12,000 psi if maximum operating pressure is 10,000 psi)

B. For secondary protection a rupture disc assembly containing a manufacturer's approved disc having a burst rating of 1.4 times maximum operating pressure is recommended.

⚠WARNING Only use a rupture disc holder which will NOT permit the use of coins or other objects in place of discs.

3. Relief devices should never be mounted so the discharge could strike personnel.

4. Never install a shut-off valve between the pump and relief device.

5. "Set pressure" must be prominently displayed on all relief devices. Never install or use a relief device unless its "set pressure" is known.

6. Do not attempt to correct a leaking relief valve by increasing spring tension as this will increase its set pressure.

7. Do not use a pressure relief valve as a combination relief and throttling device.

8. Keep relief valve dry during freezing conditions.

NOTE: Pressure relief devices are imperative for the protection of both operator and equipment from dangerous over-pressurization.

HIGH PRESSURE HOSE

1. Read General Safety section prior to connecting high pressure hose.

2. Do not use a high pressure hose with a burst rating less that 2.5 time the pressure at which it will operate. 10,000 psi operating pressure high pressure must have a minimum 25,000 psi burst rating. 8,000 psi operating hose must have a minimum 22,000 psi burst rating.

3. Do not use a high pressure hose that has an unknown burst rating or manufacturer's operating pressure rating.

4. Use of a Safety Shroud is strongly recommended for added safety where hose connects to control gun.

5. Use of hose restraint (whip check) is required at all hose connections, including connections at fluid end.

6. Always apply wrench to wrench flats when making threaded connections. Do not apply wrench on the end fitting ferrule (collar).

7. Remove hose from service if:

A. Cover is damaged and reinforcing wires are exposed to rust and corrosion;

B. Cover is loose, has blisters or bulges;

C. Hose has been crushed or kinked;

D. End fitting shows evidence of damage, slippage, or leakage.

E. Hose has been exposed to pressures greater than 50% of burst rating; or

F. Hose is three or more years old, regardless of condition.

8. Disconnect, drain, coil and store hose properly after use.

9. Never attempt to repair or recouple high pressure hoses in field. High pressure hose end fittings are the permanently crimped type and can only be properly installed with hydraulic crimping equipment.

NOZZLES

1. **Read General Safety** section.

2. Nozzle flow ratings must be compatible with pump discharge and pump pressure rating. (See Nozzle Flow Rating Chart on page 23.)

3. Use only nozzles with a manufacturer's pressure rating of at least the operating pressure or a burst rating or no less than 3.0 times the desired operating pressure.

4. Prior to installation, make sure the nozzle has no clogged orifices.

5. Apply 3 - 4 wraps of Teflon tape to male connection threads on the nozzle. Apply anti-seize compound over the sealant tape for additional protection against galling in connection threads. Wrench connection 1 1/2 - 2 turns past hand tight. A minimal thread engagement of four (4) threads should exist on all Jetstream NPT pipe connections.

6. ⚠ CAUTION Use wrench flats (when available) or a properly adjusted smooth jaw plier wrench (JS PN 64119) to tighten nozzle. Avoid using pipe wrench as wrench marks will cause nozzles to crack and fail.

7. Blocked orifice(s) can cause excessive system pressure and failure. If orifice(s) appear clogged or partially blocked with dirt or debris, remove nozzle from J-Force and clean immediately.

8. **Remove nozzle from service if:**

   A. Nozzle is split or damaged;

   B. Nozzle sidewall is worn by more than 25% at any point;

   C. Nozzle's ability to hold pressure is questionable

   D. Threads are missing or damaged

HIGH PRESSURE FITTINGS

1. **Read General Safety** section prior to installing fittings in system.

2. Use non-brass or non-cast iron fittings which are made for high pressure waterblast use.

3. Use only high pressure fittings which are clearly marked with the operating pressure.

4. High pressure fittings should have a known burst rating of not less than 3.0 times system operating pressure. Never use a damaged or corroded fitting or one with damaged or missing threads.

5. Use only high pressure rated fittings and hose in the waterblast system. For 10,000 psi waterblast service all fittings and hose should have a minimum burst rating of 25,000 psi; for 15,000 psi service they should have a minimum burst rating of 37,500 psi; for 20,000 psi service they should have a minimum burst rating of 50,000 psi.

6. Use wrench flats (when available) or a properly adjusted smooth jaw plier wrench (JS PN 64119) to tighten fittings. Avoid using pipe wrench as wrench marks will cause high pressure fittings to crack and fail.

REPLACEMENT PARTS

1. **Read General Safety** section prior to repairing equipment and installing replacement parts.

2. Only trained persons should be authorized to perform maintenance or repairs to equipment.

3. Read and follow all manufacturer's repair instructions. All tool, torque, clearance and lubrication recommendations should be followed.

4. During replacement of any part, inspect mating part for wear and replace if necessary.

5. Do not attempt to install or use a part whose dimensions, clearances, function or use are suspect.

6. Test repaired equipment carefully and thoroughly before putting it into service. Do not put any piece of repaired equipment into service if its performance is questionable. If repaired equipment performance is questionable, call manufacturer of repair parts for assistance.

This section concludes all the same information included in the yellow JETSTREAM SAFETY WARNING pamphlet (PI-082).

SECTION 2: PRODUCT DESCRIPTION

The MagDart™ is a self-powered rotating nozzle that offers a polisher or unplugger head for cleaning a variety of process lines.

The MagDart comes equipped with an eddy-current braking system which controls rotation speed for maximum cleaning power and minimum wear.

⚠ WARNING This system contains several high-energy, rare-earth magnets that produce a magnetic field. Persons with a pacemaker or other electronic medical device must use extreme caution when handling or in close proximity. It is recommended that a minimum distance of 6 inches (152mm) be maintained at all times between the MagDart and any electronic medical devices.

The MagDart is designed to be completely rebuilt in the field in less than five minutes. It has two available head options.

⚠ CAUTION The use of gloves is recommended when handling the tool after operation as the body may reach temperatures greater than 200:F.

The MagDart is rated up to 3000 bar (43,511 psi). The maximum working pressure is stamped on the main body of the nozzle

Product Specifications

Model Name	MAGDART X40 (PN 66416)
Maximum Operating Pressure (psi)	43,511
Minimum Operating Pressure (psi)	30,000
Maximum Flow (gpm)	12
Maximum Operating Pressure (bar)	3000
Minimum Operating Pressure (bar)	2070
Maximum Flow (l/min)	45
Inlet Connection	9/16" HP Female
Speed Range (rpm)	200 - 800
Nozzle Types Accepted	UHPX, UHPXI
Diameter (in)	2.00"
Length (in)	9.88
Weight (lbs)	6
Diameter (mm)	51
Length (mm)	251
Weight (kg)	13

SECTION 3: PREPARATION FOR USE

3.0 BEFORE PUTTING MAGDART X40 INTO SERVICE

NEW MAGDART X40

3.1 Check the MagDart X40 carefully upon removal from its shipping container for damage.

3.2 A new MagDart X40 is shipped assembled with exception of the nozzles. The tool is ready to use upon installation of nozzles per instructions in Section 4: Setup.

3.3 Review nozzle charts in the Appendix to determine proper flow rates for each application.

PREVIOUSLY USED MAGDART X40

3.4 Inspect all components. The MagDart X40 rotating nozzle head should turn by hand with minimal resistance.

3.5 The MagDart X40 should be inspected and cleaned to ensure that no debris has entered an orifice that could plug the nozzle and over-pressurize the system.

SECTION 4: SETUP

4.0 CONNECTING MAGDART X40

1. The MagDart X40 must be used with a operator control dump.

2. Flush out the high pressure hose before connecting MagDart to hose end or Stinger.

3. The MagDart X40 uses a 9/16" HP FML inlet connection. Apply anti-seize compound to the gland threads and cone on the male end of the adapter.

   NOTE: Do not use Teflon tape.

4. Install the MagDart X40 onto the hose and tighten to 50 ft-lbs.

5. When tube cleaning, a stinger is recommended.

4.1 NOZZLE INSTALLATION

Before installing the nozzles into the MagDart X40, verify each nozzle is the correct size, and inspect each nozzle to ensure the sapphire orifice is not damaged or missing. Refer to the charts in Appendix B for the proper flow rate and thrust for your application.

NOTE: The MagDart X40 may be configured with either four nozzles or two nozzles and two plugs. For a given flow, the larger streams obtained by using the two-nozzle configuration may be preferred for some cleaning applications.

1. Apply anti-seize compound to the male threads of the nozzle or plug (and cone if using UHPX nozzles).

2. Install using an adjustable or 5/16" wrench.

3. Tighten to 50 in-lbs.

SECTION 5: OPERATION

⚠ IMPORTANT Water cleanliness is very important. A filter no larger than 10 microns should be used on the water supply inlet.

5.1 Use only thoroughly trained operators to perform cleaning operations with the MagDart X40.

5.2 Make sure there is an operator controlled dump in the system.

5.3 The operator must be made aware that the MagDart X40 nozzle's discharge jet(s) can inflict serious body wounds.

5.4 Carefully inspect the tool for damage or missing parts. Make sure the head spins smoothly and freely.

5.5 Place barricades with warning signs or barricade tape around work area. This includes the waterblast unit and all high pressure hoses.

5.6 The operator must be outfitted with safety apparel. The minimum: hard hat with plastic face shield, rainsuit, steel toe non-skid boots, shin and foot guards and non-slip gloves.

5.7 Position the nozzle in a tube or the pipe while the pressure is being set. The high pressure seal may leak initially; it should stop when pressure is increased and rotation begins.

5.8 Close the dump and slowly bring up to pressure the first time to make sure no nozzles are plugged and that the jet thrust is correct. The swivel should begin to slowly rotate. Once operating pressure is reached, feed the tool into the tube or pipe to begin the cleaning job.

5.9 Once the work is complete and the tool is disconnected from the hose, blow out all water to prolong the life of the tool. A small amount of oil may also be blown into the inlet nut.

5.10 Protect the nozzle in freezing conditions. Stop using the tool if any low temperature operational problems occur. Drain the tool and remove its cartridge if it is not in use in freezing conditions.

SECTION 6: SERVICE

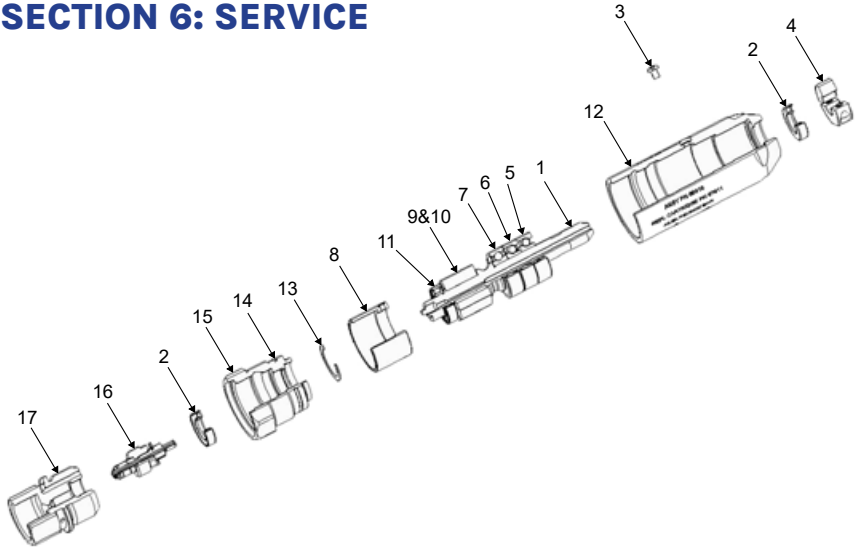


Figure A

Assembly PN 66416			
Item	**Qty**	**Part Number**	**Description**
1	1	57938	Shaft
2	2	57926	Oil Seal
3	1	64637	Screw
4	1	66778	Shaft Clamp
5	2	57933	Angular Contact Bearings
6	1	64992	Shim. Spring Steel
7	1	64991	Deep Groove Ball Bearing
8	1	66502	Current Sleeve
9	4	65005N	North Magnet
10	4	65005S	South Magnet
11	1	57928	Pilot Bearing
12	1	66417	Main Housing
13	1	57931	Wave Spring
14	1	57935	O-ring, 1-1/2 ID
15	1	57918	Pilot Bearing Retainer
16	1	57911	Seal Cartridge
17	1	57916	Seal Cartridge Housing

NOTE: Part numbers and descriptions are subject to change without notice.

6.0 MAGDART X40 MAINTENANCE

6.1 REPLACING THE SEAL CARTRIDGE (PN 57911)

⚠ CAUTION The use of gloves is recommended when handling the tool after operation as the body may reach temperatures greater than 200°F.

1. Unscrew and remove the Seal Cartridge Housing (PN 57916) from the Pilot Bearing Retainer (PN 57918).

2. Unscrew the Seal Cartridge Retainer (PN 57910) from the Seal Cartridge Housing (PN 57916).

3. When the Seal Cartridge Retainer (PN 57910) is fully unscrewed, pull it out of the Seal Cartridge Housing (PN 57916) to remove the Seal Cartridge Assembly (PN 57911).

4. Before installing the new Seal Cartridge Assembly (PN 57911), apply nickel anti-seize compound to the Seal Cartridge Retainer (PN 57910) thread and o-ring lubricant to the o-ring on the plastic seal of the Seal Cartridge Assembly (PN 57911).

5. Push the new Seal Cartridge Assembly (PN 57911) into the Seal Cartridge Housing (PN 57916) and begin threading the Seal Cartridge Retainer (PN 57910) into the Seal Cartridge Housing (PN 57916) by hand.

6. Tighten and torque the Seal Cartridge Retainer (PN 57910) to approximately 30 lbs. ft.

7. Thread the Seal Cartridge Housing (PN 57916) back into the Pilot Bearing Retainer (PN 57918) and tighten with a wrench. Rotate the head assembly as the Seal Cartridge Housing is being screwed into the Pilot Bearing Retainer to ensure that the anti-rotation pins in the mandrel of the seal cartridge do not bind with the anti-rotation tabs at the end of the shaft.

See YouTube for videos showing the MagDart X40.

YouTube https://www.youtube.com/user/JetstreamWaterblast

SECTION 7: TROUBLESHOOTING

7.0 MAGDART X40 TROUBLESHOOTING

Problem	Remedy
The nozzle leaks from all weep holes of the seal housing.	Pressure is required to push the seal cartridge mandrel into the shaft to create a seal, so some leakage at low pressure is normal and expected. During operation, some leakage from the bottom weep holes of the seal housing is normal during the life of the seal cartridge. If a stream of water is leaking continuously from the top hole of the seal housing, the seal cartridge should be replaced.
The nozzle head does not spin easily.	When the nozzle and seal cartridge are new, the initial friction in the bearings and seal cartridge may prevent the nozzle from beginning to spin. In this case, it is acceptable to gently brush the nozzle head from right to left along the ground or another flat surface to help the nozzle head to begin rotating.
The nozzle head will not spin at all.	Check to see that the head will rotate freely when the nozzle is not under pressure. If there is mechanical binding inside the nozzle, it will need to be disassembled and inspected.
	Ensure that the nozzle orifices are sized correctly. If the orifices are too small for a given operating pressure, the orifices may not generate enough torque to rotate the nozzle head.
The nozzle spins erratically.	Check to see that the head will rotate freely when the nozzle is not under pressure. If any scraping or mechanical interference is noted, the nozzle will need to be disassembled and inspected.

APPENDIX A

Exploded Views

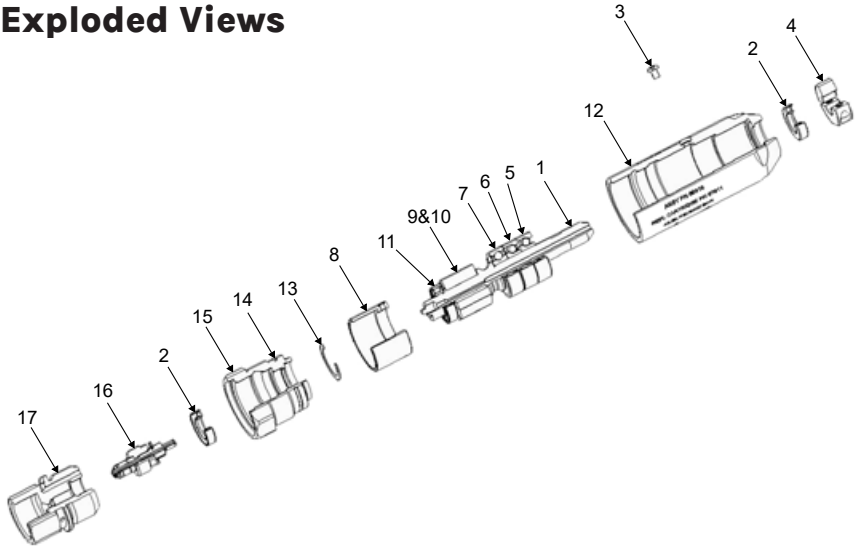
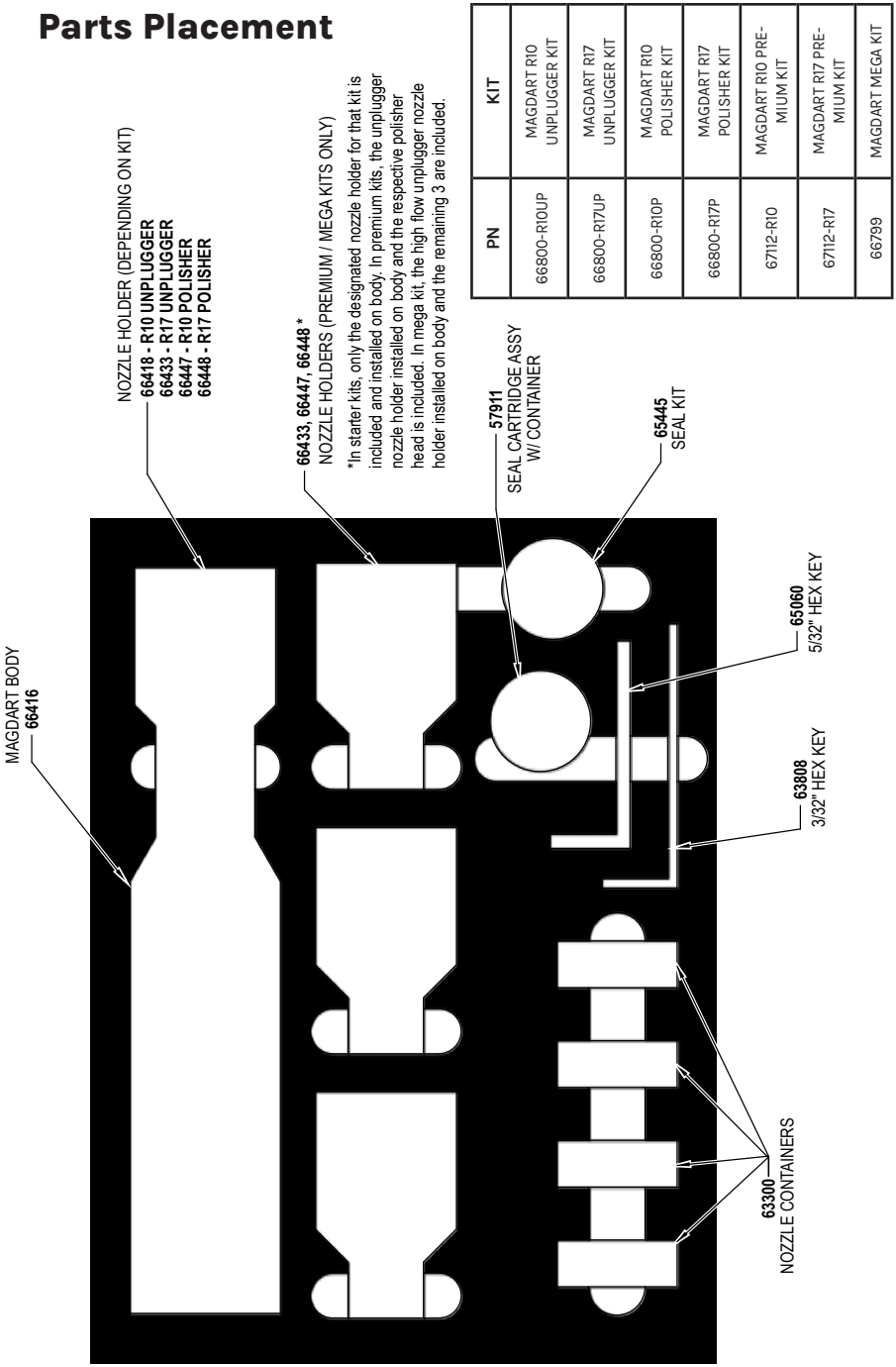


Figure B

Assembly PN 66416			
Item	**Qty**	**Part Number**	**Description**
1	1	57938	Shaft
2	2	57926	Oil Seal
3	1	64637	Screw
4	1	66778	Shaft Clamp
5	2	57933	Angular Contact Bearings
6	1	64992	Shim. Spring Steel
7	1	64991	Deep Groove Ball Bearing
8	1	66502	Current Sleeve
9	4	65005N	North Magnet
10	4	65005S	South Magnet
11	1	57928	Pilot Bearing
12	1	66417	Main Housing
13	1	57931	Wave Spring
14	1	57935	O-ring, 1-1/2 ID
15	1	57918	Pilot Bearing Retainer
16	1	57911	Seal Cartridge
17	1	57916	Seal Cartridge Housing

NOTE: Part numbers and descriptions are subject to change without notice.

Parts Placement



PN	KIT
66800-R10UP	MAGDART R10 UNPLUGGER KIT
66800-R17UP	MAGDART R17 UNPLUGGER KIT
66800-R10P	MAGDART R10 POLISHER KIT
66800-R17P	MAGDART R17 POLISHER KIT
67112-R10	MAGDART R10 PREMIUM KIT
67112-R17	MAGDART R17 PREMIUM KIT
66799	MAGDART MEGA KIT

Figure C

APPENDIX B

Accessories

UHPX Nozzle

Figure D

Premiere high-productivity sapphire nozzle.

Tapered orifice retainer reduces turbulence and provides a cohesive, aggressive waterjet.

UHPXI Nozzle/Plug

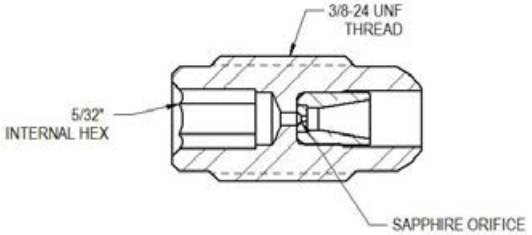


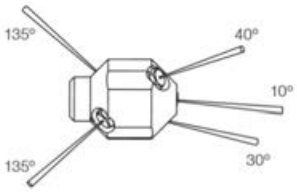
Figure E

- Economically designed replaceable sapphire nozzle.
- Installed using a special retainer (see Related Items below).

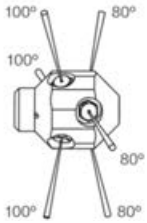
Related Items

- Plug, PN: UHPXI-PLUG

Nozzle Holders



UNPLUGGER
5 Ports:
1 @ 10°
1 @ 30°
1 @ 40°
2 @ 135°

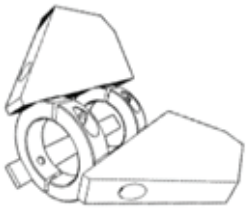


POLISHER
6 Ports:
3 @ 80°
3 @ 100°

- There are two standard nozzle holder types in either high-flow or low-flow configurations.
- The provided flow charts may be used to help determine which configuration is most appropriate for a given pressure and flow.

FLOW	UNPLUGGER	POLISHER	OFFSET
4-8 GPM (15-30 L/MIN)	66433	66448	R17
8-12 GPM (30-45 L/MIN)	66418	66447	R10

Centralizers



- Balances jet standoff distance for more consistent cleaning.
- Prevents tool from turning around in pipe sizes greater than 1.5x the tool diameter.

PIPE SIZE	CENTRALIZER
4 in. (100 mm)	63842-DART-4
5 in. (127 mm)	63842-DART-5
6 in. (152 mm)	63842-DART-6
8 in. (203 mm)	63842-DART-8
12 in. (305 mm)	63842-DART-12

Backout Preventers

- Mount to pipe flanges to prevent backing out of pipe cleaning nozzles.
- Important during events of unexpected and sudden shift in thrust.
- Prevent operator injury.
- Fits around hoses from 1/4” to 1” I.D.

	Flange Bolt Circle Diameter Range	
Part Number	in.	cm.
29124	5-15	13-38
54805	5-36	13-91
61447*	4-19	10-48

*Style different than image above

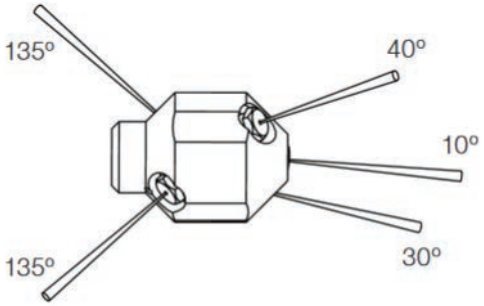
Seal Cartridge

- The patented seal cartridge (PN 57911) is designed to facilitate quick seal changes without special tools or small parts that are easy to lose.

APPENDIX C

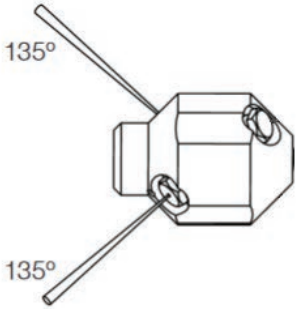
Flow Charts

NOTE: Select nozzles from the following charts by choosing operating pressure, desired flow, and two or four-nozzle operation.



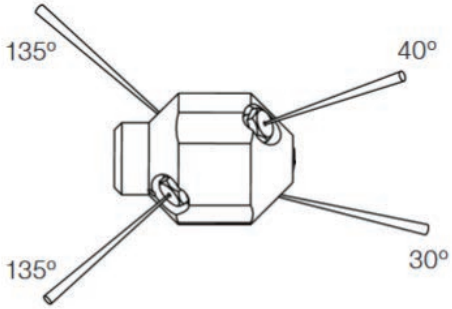
10°, 30°& 40° PORT Orifice Size (in.)	2x 135° PORT Orifice Size (in.)	R17 Unplugger Head (PN 66433) 5 UHPx Nozzles					
		30000 psi	2068 bar	40000 psi	2757 bar	43511 psi	3000 bar
		gpm	lpm	gpm	lpm	gpm	lpm
0.010	0.019			4.0	15.1	4.3	16.3
0.011	0.020			4.6	17.4	4.9	18.5
0.012	0.022	4.8	18.1	5.6	21.2	5.8	21.9
0.013	0.023	5.4	20.4	6.3	23.8	6.5	24.6
0.014	0.024	6.0	22.7	7.0	26.5		
0.015	0.025	6.7	25.3				
0.016	0.026	7.3	27.6				

10°, 30°& 40° PORT Orifice Size (in.)	2x 135° PORT Orifice Size (in.)	R10 Unplugger Head (PN 66418) 5 UHPx Nozzles					
		30000 psi	2068 bar	40000 psi	2757 bar	43511 psi	3000 bar
		gpm	lpm	gpm	lpm	gpm	lpm
0.014	0.024					7.3	27.6
0.015	0.025			7.7	29.1	8.0	30.2
0.016	0.026			8.5	32.1	8.8	33.3
0.017	0.027	8.1	30.6	9.3	35.2	9.7	36.7
0.018	0.028	8.8	33.3	10.2	38.6	10.6	40.1
0.019	0.029	9.6	36.3	11.1	42.0	11.5	43.5
0.020	0.031	10.8	40.8				
0.021	0.032	11.6	43.8				



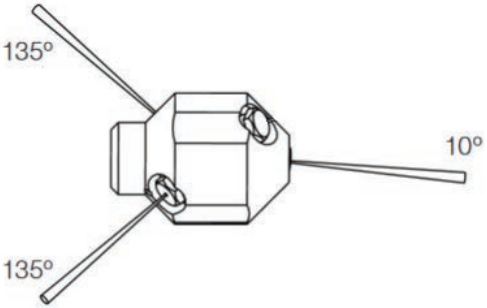
10°, 30°& 40° PORT Orifice Size (in.)	2x 135° PORT Orifice Size (in.)	R17 Unplugger Head (PN 66433) 2 UHPx Nozzles & 3 PLUGS					
		30000 psi	2068 bar	40000 psi	2757 bar	43511 psi	3000 bar
		gpm	lpm	gpm	lpm	gpm	lpm
PLUG	0.021					3.7	14.0
PLUG	0.022			3.8	14.4	4.0	15.1
PLUG	0.023			4.2	15.9	4.4	16.6
PLUG	0.024	4.0	15.1	4.6	17.4	4.8	18.1
PLUG	0.025	4.3	16.3	5.0	18.9	5.2	19.7
PLUG	0.026	4.6	17.4	5.4	20.4		
PLUG	0.027	5.0	18.9				
PLUG	0.028	5.4	20.4				
PLUG	0.029	5.8	21.9				
PLUG	0.030	6.2	23.4				

10°, 30°& 40° PORT Orifice Size (in.)	2x 135° PORT Orifice Size (in.)	R10 Unplugger Head (PN 66418) 2 UHPx Nozzles & 3 PLUGS					
		30000 psi	2068 bar	40000 psi	2757 bar	43511 psi	3000 bar
		gpm	lpm	gpm	lpm	gpm	lpm
PLUG	0.028			6.3	23.8	6.5	24.6
PLUG	0.029			6.7	25.3	7.0	26.5
PLUG	0.030			7.2	27.2	7.5	28.4
PLUG	0.031			7.7	29.1	8.0	30.2
PLUG	0.032	7.0	26.5	8.2	31.0	8.5	32.1
PLUG	0.033	7.5	28.4	8.7	32.9	9.0	34.0
PLUG	0.034	8.0	30.2	9.2	34.8	9.6	36.3
PLUG	0.035	8.5	32.1	10	37.8		
PLUG	0.036	9.0	34.0	10.4	39.3		
PLUG	0.037	9.5	35.9				
PLUG	0.038	10.0	37.8				
PLUG	0.039	10.5	39.7				
PLUG	0.040	11.0	41.6				
PLUG	0.041	11.6	43.8				



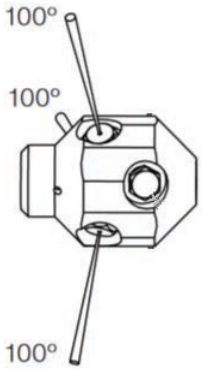
10° Orifice Size (in.)	30°& 40° PORT Orifice Size (in.)	2x 135° PORT Orifice Size (in.)	R17 Unplugger Head (PN 66433) 4 UHPx Nozzles & 1 PLUGS					
			30000 psi	2068 bar	40000 psi	2757 bar	43511 psi	3000 bar
			gpm	lpm	gpm	lpm	gpm	lpm
PLUG	0.011	0.017			3.3	12.5	3.4	12.9
PLUG	0.012	0.018			3.7	14.0	3.9	14.7
PLUG	0.013	0.019			4.2	15.9	4.4	16.6
PLUG	0.014	0.020	4.1	15.5	4.8	18.1	5.0	18.9
PLUG	0.015	0.021	4.6	17.4	5.3	20.0	5.6	21.2
PLUG	0.016	0.022	5.1	19.3	5.9	22.3		
PLUG	0.017	0.023	5.7	21.5				
PLUG	0.018	0.024	6.2	23.4				

10° Orifice Size (in.)	30°& 40° PORT Orifice Size (in.)	2x 135° PORT Orifice Size (in.)	R10 Unplugger Head (PN 66418) 4 UHPx Nozzles & 1 PLUGS					
			30000 psi	2068 bar	40000 psi	2757 bar	43511 psi	3000 bar
			gpm	lpm	gpm	lpm	gpm	lpm
PLUG	0.016	0.022			6.0	22.7	6.2	23.4
PLUG	0.017	0.023			6.5	24.6	6.8	25.7
PLUG	0.018	0.024			7.2	27.2	7.5	28.4
PLUG	0.019	0.025	6.8	25.7	7.9	29.9	8.2	31.0
PLUG	0.020	0.026	7.5	28.4	8.7	32.9	8.9	33.6
PLUG	0.020	0.027	7.8	29.5	9.4	35.5	9.4	35.5
PLUG	0.021	0.028	8.5	32.1	9.8	37.0		
PLUG	0.022	0.029	9.2	34.8	10.6	40.1		
PLUG	0.023	0.030	9.9	37.4				
PLUG	0.024	0.031	10.6	40.1				
PLUG	0.025	0.032	11.4	43.1				



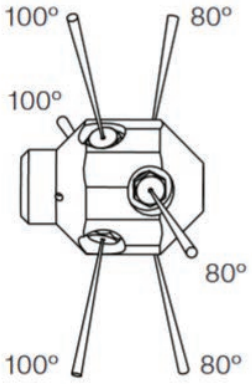
10° Orifice Size (in.)	30°& 40° PORT Orifice Size (in.)	2x 135° PORT Orifice Size (in.)	R17 Unplugger Head (PN 66433) 3 UHPx Nozzles & 2 PLUGS					
			30000 psi	2068 bar	40000 psi	2757 bar	43511 psi	3000 bar
			gpm	lpm	gpm	lpm	gpm	lpm
0.007	PLUG	0.021			3.7	14.1	3.8	14.4
0.008	PLUG	0.022			4.1	15.5	4.3	16.3
0.009	PLUG	0.023	3.9	14.7	4.5	17.0	4.8	18.1
0.010	PLUG	0.024	4.3	16.3	5.0	18.9	5.2	19.7
0.011	PLUG	0.025	4.7	17.8	5.5	20.8	5.7	21.5
0.012	PLUG	0.026	5.2	19.7	6.0	22.7		
0.013	PLUG	0.027	5.6	21.2				
0.014	PLUG	0.028	6.1	23.1				
0.015	PLUG	0.029	6.6	24.9				
0.016	PLUG	0.030	7.1	26.8				

10° Orifice Size (in.)	30°& 40° PORT Orifice Size (in.)	2x 135° PORT Orifice Size (in.)	R10 Unplugger Head (PN 66418) 3 UHPx Nozzles & 2 PLUGS					
			30000 psi	2068 bar	40000 psi	2757 bar	43511 psi	3000 bar
			gpm	lpm	gpm	lpm	gpm	lpm
0.012	PLUG	0.026					6.2	23.4
0.013	PLUG	0.027			6.5	24.6	6.8	25.7
0.014	PLUG	0.028			7.1	26.8	7.4	28.0
0.015	PLUG	0.029			7.6	28.7	8.0	30.2
0.016	PLUG	0.030			8.2	31.0	8.6	32.5
0.017	PLUG	0.031	7.6	28.7	8.8	33.3	9.2	34.8
0.018	PLUG	0.032	8.2	31.0	9.5	35.9	9.9	37.4
0.019	PLUG	0.033	8.8	33.3	10.2	38.6	10.6	40.1
0.020	PLUG	0.034	9.4	35.5	10.8	40.8	11.3	42.7
0.021	PLUG	0.035	10.0	37.8	11.6	43.8		
0.022	PLUG	0.036	10.7	40.4				
0.023	PLUG	0.037	11.3	42.7				



80° PORT Orifice Size (in.)	100° PORT Orifice Size (in.)	R17 Polisher Head (PN 66448) 3 UHPx Nozzles, 3 Plugs in 80° ports					
		30000 psi	2068 bar	40000 psi	2757 bar	43511 psi	3000 bar
		gpm	lpm	gpm	lpm	gpm	lpm
PLUG	0.016					3.2	12.1
PLUG	0.017			3.5	13.2	3.6	13.6
PLUG	0.018			3.9	14.7	4.0	15.1
PLUG	0.019			4.3	16.3	4.5	17.0
PLUG	0.020	4.2	15.9	4.8	18.1	5.0	18.9
PLUG	0.021	4.6	17.4	5.3	20.0	5.5	20.8
PLUG	0.022	5.0	18.9	5.8	21.9		
PLUG	0.023	5.5	20.8				
PLUG	0.024	6.0	22.7				
PLUG	0.025	6.5	24.6				

80° PORT Orifice Size (in.)	100° PORT Orifice Size (in.)	R10 Polisher Head (PN 66447) 3 UHPx Nozzles, 3 Plugs in 80° ports					
		30000 psi	2068 bar	40000 psi	2757 bar	43511 psi	3000 bar
		gpm	lpm	gpm	lpm	gpm	lpm
PLUG	0.022			5.8	21.9	6.1	23.1
PLUG	0.023			6.3	23.8	6.6	24.9
PLUG	0.024			6.9	26.1	7.2	27.3
PLUG	0.025			7.5	28.4	7.8	29.5
PLUG	0.026	7.0	26.5	8.1	30.6	8.5	32.1
PLUG	0.027	7.5	28.4	8.8	33.1	9.1	34.4
PLUG	0.028	8.1	30.6	9.4	35.5	9.8	37.0
PLUG	0.029	8.7	32.9	10.1	38.2		
PLUG	0.030	9.4	35.5				
PLUG	0.031	10.0	37.8				
PLUG	0.032	10.6	40.1				
PLUG	0.033	11.3	42.7				
PLUG	0.034	12.0	45.4				



80° PORT Orifice Size (in.)	100° PORT Orifice Size (in.)	R17 Polisher Head (PN 66448) 6 UHPx Nozzles					
		30000 psi	2068 bar	40000 psi	2757 bar	43511 psi	3000 bar
		gpm	lpm	gpm	lpm	gpm	lpm
0.011	0.013			3.5	13.2	3.6	13.6
0.012	0.014			4.0	15.1	4.2	15.9
0.013	0.015	4.1	15.5	4.7	17.8	4.9	18.5
0.014	0.016	4.7	17.8	5.4	20.4	5.7	21.5
0.015	0.017	5.3	20.0	6.2	23.4		
0.016	0.018	6.0	22.7				
0.017	0.019	6.8	25.7				

80° PORT Orifice Size (in.)	100° PORT Orifice Size (in.)	R10 Polisher Head (PN 66447) 6 UHPx Nozzles					
		30000 psi	2068 bar	40000 psi	2757 bar	43511 psi	3000 bar
		gpm	lpm	gpm	lpm	gpm	lpm
0.014	0.016					5.6	21.2
0.015	0.017			6.2	23.4	6.4	24.2
0.016	0.018			7.0	26.5	7.3	27.6
0.017	0.019	6.8	25.7	7.8	29.5	8.1	30.6
0.018	0.020	7.5	28.4	8.7	32.9	9.1	34.4
0.019	0.021	8.3	31.4	9.6	36.3	10.0	37.8
0.019	0.022	8.8	33.3	10.1	38.2	10.5	39.7
0.020	0.022	9.2	34.8	10.6	40.1		
0.021	0.023	10.0	37.8				
0.021	0.024	10.6	40.1				
0.022	0.024	11.0	41.6				
0.022	0.025	11.5	43.5				
0.022	0.026	12.0	45.4				

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WARRANTY

Limited Warranty. Each Waterblast Unit, Bareshaft Pump, and Fluid End manufactured by Jetstream is warranted against defects in material and workmanship for a period of 12 months or 1,000 hours, provided it is used in a normal and reasonable manner and in accordance with all operating instructions. If sold to an end user, the applicable warranty period commences from the date of delivery to the end user. If used for rental purposes, the applicable warranty period commences from the date of delivery to the party holding the equipment available for rent. This limited warranty may be enforced by any subsequent transferee during the warranty period. This limited warranty is the sole and exclusive warranty given by Jetstream.

Exclusive Remedy. Should any warranted product fail during the warranty period, Jetstream will cause to be repaired or replaced, as Jetstream may elect, any part or parts of such Waterblast Unit, Bareshaft Pump, or Fluid End that the examination discloses in Jetstream's sole judgment to be defective in material or factory workmanship. Repairs or replacements are to be made at Jetstream in Houston, Jetstream FS Solutions Rental Center, the customer's location, or at other locations approved by Jetstream. Labor is furnished only when the unit or part is returned to the factory or when travel and expenses are paid by the purchaser. Freight, travel and expenses incurred in connection with repair or warranty are excluded from this warranty and shall be paid by the purchaser. The foregoing remedies shall be the sole and exclusive remedies of any party making a valid warranty claim.

The Jetstream Limited Warranty shall NOT apply to (and Jetstream shall NOT be responsible for):

1. Major components or trade accessories that have a separate warranty from their original manufacturer, such as, but not limited to: diesel engines, electric motors, electronic soft starter and/or across the line starter panels, axles, PTO's, clutch packs, high pressure gauges, high pressure hoses, flex lances, etc.

2. Normal adjustments and maintenance services.

3. Normal wear parts such as, but not limited to: oil, clutches, belts, filters, packing, cartridges, univalves, face seals, diffusers, gland nut bushings, plungers, nozzles, rupture disks, etc.

4. Failures resulting from the machine being operated in a

manner or for a purpose not recommended by Jetstream including failures or malfunctions resulting from corrosion, misapplication, overpressurization, inadequate pump suction conditions, improper water quality, improper maintenance, or misuse.

5. Repairs, modifications or alterations which in Jetstream's sole judgment, have adversely affected the machine's stability, operation or reliability as originally designed and manufactured.

6. Items subject to misuse, negligence, accident or improper maintenance.

NOTE The use of any part other than ones approved by Jetstream may invalidate this warranty. Jetstream reserves the right to determine, in its sole discretion, if the use of non-approved parts invalidates the warranty. Nothing contained in this warranty shall make Jetstream liable for loss, injury, or damage of any kind to any person or entity resulting from any defect or failure in the machine or part.

THIS WARRANTY IS, AND SHALL BE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ALL OF WHICH ARE DISCLAIMED. THIS DISCLAIMER AND EXCLUSION SHALL APPLY EVEN IF ANY WARRANTY POSSIBLY ASSERTED FAILS OF ITS ESSENTIAL PURPOSE.

This warranty is in lieu of all other obligations or liabilities, contractual and otherwise, on the part of Jetstream. For the avoidance of doubt, Jetstream shall not be liable for any indirect, special, incidental or consequential damages, including, but not limited to, loss of use or lost profits. Jetstream makes no representation that the unit has the capacity to perform any functions other than as contained in Jetstream's written literature, catalogs or specifications accompanying delivery of the machine. No person or affiliated company representative is authorized to alter the terms of this warranty, to give any other warranties or to assume any other liability on behalf of Jetstream in connection with the sale, servicing or repair of any machine manufactured by Jetstream. Any legal action based hereon must be commenced within eighteen (18) months of the event or facts giving rise to such action.

Jetstream reserves the right to make design changes or improvements in its products without imposing any obligation upon itself to change or improve previously manufactured products.

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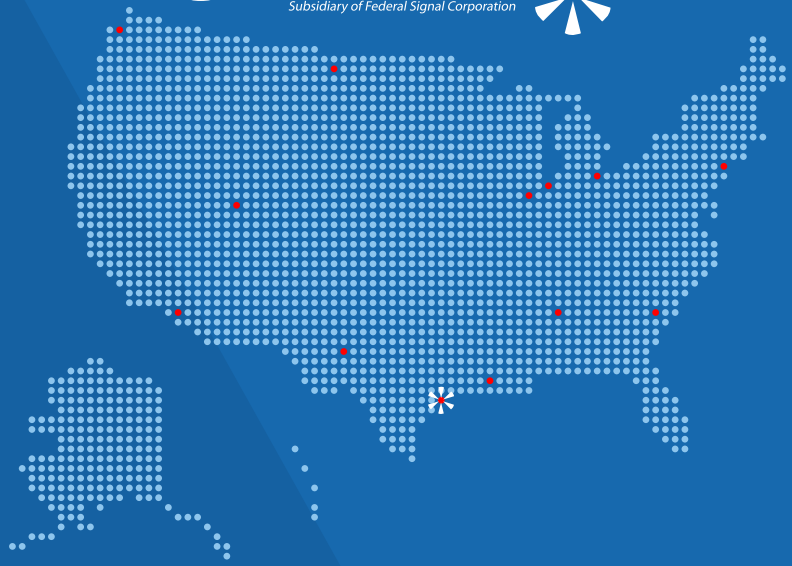

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Capacity ratings, features, and specifications vary depending upon the model and type of service. Application approvals must be obtained from Jetstream; contact your representative for application approval. We reserve the right to change or modify our product specifications, configurations, or dimensions at any time without notice.