Jetstream®
Subsidiary of Federal Signal Corporation

ROTOMAG™ X22/X22N

(PNs 63945, 65095)

PRODUCT INSTRUCTIONS

PI-078

The RotoMag is a 2-D self-rotating pipe cleaning tool. Spinning on a film of high pressure water, the tool has no ball bearings to replace, making field service simple. Operating pressure up to 22,500 psi (1550 bar).

Read these instructions thoroughly before installing, connecting, or using the RotoMag X22. 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 RotoMag X22 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.

11. Properly tighten all high pressure connections. All NPT connections must have a minimum engagement of four (4) threads. Pipe (NPT) connections should be made up hand tight plus two (2) full wrenched turns. Do not tighten NPT threads past two (2) wrenched turns.

⚠ 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.

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

13. 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.**

14. 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.

15. 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.

16. 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.

17. 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".

18. 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.

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

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

21. 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.

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

CONTROL GUNS AND DEVICES

1. **Read General Safety** section before connecting or using control guns or control devices.

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

⚠ WARNING As described in the Industry Best Practices for the Use of High Pressure Waterblasting Equipment published by the Waterjet Technology Association, the standard shotgun barrel length shall be a minimum length of 48" to minimize the risk of nozzle discharge accidentally striking the operator's feet, legs, or body. See Section 11.10.6. The WJTA has recognized that deviations or variances from these best practices may be acceptable under certain circumstances. See Section 2.7. If users believe deviation from this 48" standard is acceptable, they should follow procedures outlined in Section 2.7 to minimize risk to the operator. Among other things, users should ensure that other measures to perform the work have been considered and exhausted, senior safety management and customers have considered and approved the

deviation, operators have been properly trained and warned about any increased risk associated with the deviation, and operators are wearing all appropriate PPE, including body armor rated for the operating pressure.

3. Prior to use, thoroughly check control gun or control device for smooth and proper operation. Control guns and control devices should also be checked for proper operation before each operating shift. Do not use any control gun or control device that has not been checked before your operating shift.

4. A control gun operator using a hand-held gun should position and brace his body for the gun's rearward reaction force before depressing gun trigger. Gun's rearward reaction should be a maximum force of 40 to 50 lbs. (or 1/3 body weight of operator.) The control gun operator should maintain firm, solid footing to counter gun's rearward reaction.

5. The use of a Safety Shroud and a Safety Whip Hose with handheld control guns is strongly recommended for additional operator protection against a burst occurring in the high pressure hose connected to the gun. Use of Hand Grip and Shoulder Stock in hand-held control guns will provide greater operator comfort and safety.

6. Fall protection should be provided when blasting on scaffolding or sloping surface per OSHA guidelines. Do not operate a hand-held gun while standing on slippery surfaces.

7. The control gun operator should always start blasting with a low system pressure and slowly increase blasting pressure. Depress and release control gun trigger/pedal several times at operating pressure to check the control gun's operation before starting cleaning operations.

8. A dump type control gun should always open fully and reduce the system pressure to near zero immediately when its trigger/pedal is released. If this type of control gun does not relieve system pressure immediately or system pressure does not fall below 200 psi when trigger/pedal is released, do not use the control gun.

9. The control gun operator should never pass a control gun to another operator without first stopping the pump and water flow to the control gun. Passing off a control gun without first stopping system waterflow is dangerous because of possible accidental trigger actuation.

10. Do not use a control gun or control device that has malfunctioned or you suspect malfunctioned without having it repaired and/or

thoroughly checked for proper operation by a qualified high pressure maintenance mechanic or your supervisor.

11. Do not use a control gun that does not have a trigger guard.

12. Never tie, wedge or clamp a control gun's trigger in the closed position.

13. All electric throttle control cords should be rated for wet conditions. All cord connections and switches should be kept out of water.

14. Any hose used for transporting dump water back to pump should have a large enough diameter and short enough length so that potentially dangerous back pressure is kept low. Protect hose from traffic.

15. Hand-operated control guns should never be used as foot-operated devices.

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. Read the appropriate Safety Warning (i.e. Flexible Tube Cleaning Lances or Rigid Tube Cleaning Lances) prior to installing nozzle on lance.

2. Nozzle flow ratings must be compatible with pump discharge and pump pressure rating. (See Nozzle Flow Rating Chart on page 34.)

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. For 15,000 psi models - Apply 3 - 4 wraps of Teflon tape to male connection thread on the barrel. 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.
For 22,500 psi models - Apply anti-gall compound to the gland threads and male cone on control gun front barrel. DO NOT use Teflon tape. Check blast nozzle size before installing the nozzle. Make sure the nozzle orifices are not too small in order to prevent excessive system pressure when the gun's control valve trigger/pedal is depressed.

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. Special nozzles requiring a thread locking pin must have the pin installed prior to use or the nozzle may unscrew from the lance while in service and cause the lance to blow back toward the operator.

8. With nozzles requiring adjustment, always read applicable instructions.

9. 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.

10. 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

FLEXIBLE TUBE CLEANING LANCES

1. Read General Safety section and Nozzle Safety Warnings prior to connecting flex lances.

2. Do not use a flex lance with a burst rating less than 2.25 times the pressure at which it will operate. 10,000 psi operating pressure flex lances **must** have a **minimum** 22,000 psi burst rating. 8,000 psi operating pressure flex lances **must** have a **minimum** 18,000 psi burst rating.

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

4. Never use a lance which is kinked, worn, frayed or whose abilities to hold pressure is questionable.

5. Do not use a lance which has damaged or missing threads.

6. Clearance between lance and tube deposits **must be sufficient** to allow unrestricted backflow of water and debris. With tubes containing hard deposits this clearance should be 1/8" **minimum** on the diameter (or 1/16" per side) of the lance. With tubes containing soft, pliable deposits this clearance should be greater. **Insufficient side clearance may cause lance to blow back toward operator.**

7. ⚠ **WARNING** Serious injury may occur should a lance with live nozzle exit tube. Use anti-withdrawal device to prevent lance from exiting tube unexpectedly.

8. The following **JETSTREAM** lance accessories are **strongly recommended** for safer lance operation:

A. Lance Strain Relief --Helps prevent lance inlet end fitting failure.

B. Lance Stinger - Affords the operator greater control of nozzle. Establishes a "safety zone" so operator knows when nozzle is about to exit tube; will eliminate possibility of nozzle and lance "double back" toward operator within large diameter pipe.

C. Anti-withdrawal device prevents the lance from exiting the tube or pipe. Contact JETSTREAM for additional information regarding these products.

9. Use only nozzles designed for use with flex lances (i.e. nozzle drilled with sufficient rearward orifices so nozzle pulls lance through tube.)

10. If lance end fittings do not have wrench flats, use properly adjusted smooth jaw plier wrench (JS PN 64119) to connect lance to pressure source and nozzle onto lance. Apply wrench on lance and fitting **directly behind end fitting thread (not on fitting ferrule or collar)** when installing nozzle on lance. Do not clamp on the lance hose itself with vise when installing nozzle.

11. Avoid rough handling, stretching or straining of lance.

12. Never attempt to "ramrod" flex lance through blockages or to repair or recouple lances.

13. After use, drain, coil and store lance properly. Be sure safety tags remain intact.

RIGID TUBE CLEANING LANCES

1. Read General Safety section and Nozzle Safety Warnings prior to connecting rigid lances.

2. Do not use a rigid lance with a burst rating less that 3.0 times the pressure at which it will operate. 10,000 psi operating pressure rigid lances must have a minimum 30,000 psi burst rating. Do not use a rigid lance that has an unknown burst or unknown manufacturer's operating pressure rating.

3. Clearance between lance and tube must be sufficient to permit the unrestricted backflow of water and debris. With tubes containing hard deposits this clearance should be 1/8" minimum on the diameter (or 1/16" per side) of the lance. With tubes containing soft, pliable deposits this clearance should be greater. Insufficient side clearance may cause lance to blow back toward operator.

4. Be sure nozzle, lance and adapter thread sizes are compatible before installing nozzle and adapter on lance. Do not use a rigid lance that has damaged or missing threads.

5. Use wrench flats (when available) or a properly adjusted smooth jaw plier wrench (JS PN 64119) to connect lance. Do not use pipe wrench as

wrench marks will cause high pressure components to crack and fail.

6. A rigid lance over 4 ft long requires two men for support and safe operation. Operator at tube should use a foot control gun so he can instantly relieve system pressure in case of emergency.

7. When using and moving lance, support it in a manner to avoid stress and possible breakage at inlet end connection.

8. Never ”ramrod” lance into tube blockage.

9. Transport and store lances in tubes or racks to avoid bending, corrosion or other damage. Damaged lances (bends, mars) should be removed from service.

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).

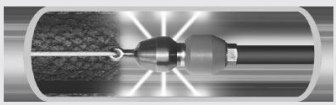
SECTION 2: PRODUCT DESCRIPTION

The RotoMag X22* is a self-powered rotating nozzle designed for cleaning stacks, sewer lines, drains, tanks, and other large diameter pipes.

- Two rotors available: ½”-28 UNEF ports (RotoMag X22) or ¼” NPT nozzle ports (RotoMag X22N)
- Uses up to 8 flush-mounted tungsten carbide RM or sapphire RMS nozzles (RotoMag X22) or 8 low profile tungsten carbide P4TC nozzles (RotoMag X22N)

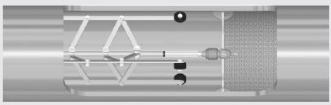
The RotoMag X22 has many features, including:

- Magnetic braking system (to control rotation speed)
- Completely field repairable (in less than 5 minutes)
- 90: radial, 45: forward, 45: rearward nozzle angles
- 2X radial low-speed nozzle ports, 2X radial high-speed nozzle ports
- Pipe cleaning range from 3 1/2 “ ID to 60” ID
- 3/4” MP female inlet connection (3/4” NPT 15K adapter available)
- Rated to 22,500 psi operating pressure



PIPE CLEANING WITHOUT CENTRALIZER

VESSEL CLEANING



PIPE CLEANING WITH CENTRALIZER

Figure A

Figure B

* **NOTE:** ‘RotoMag X22’ is used to describe both the RotoMag X22 (1/2”-28 UNEF nozzle ports) and RotoMag X22N (1/4” NPT nozzle ports) except in reference to nozzle ports. RotoMag X22N is called out when necessary.

Product Specifications

Model Name	RotoMag X22 (PN63945) RotoMag X22N (PN 65095)
Maximum Operating Pressure (psi)	22500
Minimum Operating Pressure (psi)	3000
Maximum Flow (gpm)	80
Maximum Operating Pressure (bar)	1550
Minimum Operating Pressure (bar)	200
Maximum Flow (l/min)	227
Inlet Connection	3/4"MP Female
Tube or Pipe I.D. (in)	3-1/2 to 60
Tube or Pipe I.D. (mm)	90 to 1525
Speed Range (RPM)	30-600
Number of Nozzle Ports	8
Nozzle Port Connections	X22: 1/2" - 28 UNEF (63954) X22N: ¼" NPT (65095)
Nozzle Pattern	2 @ 45°, 4 @ 90°, 2 @ 135°
Nozzle Types Accepted	X22: RM/RMS (63945), X22N: JS4F, P4TC (65095)
Diameter (in)	2.75
Length (in)	7.38
Weight (lbs)	6
Diameter (mm)	70
Length (mm)	187
Weight (kg)	2.7

SECTION 3: PREPARATION FOR USE

3.0 The RotoMag X22 is generally mounted to a rigid lance or a flexible hose for cleaning pipes. It can be used with a centralizer and can be fitted with nozzle extensions. See Appendix B for applicable accessories.

3.1 Before use, disassemble the RotoMag X22 and inspect the mandrel and bushing for wear, damage, o-ring condition, etc. and repair or rebuild as necessary. See Section 6 for disassembly and assembly details.

3.2 Clean the RotoMag X22 by wiping internal components using a soft cloth and a water dispersing lubricant like WD-40.

3.3 See nozzle charts in Appendix B to choose nozzle configuration, flow rate, and desired operating pressure. The RotoMag X22 is equipped with two forward facing ports at 45°, two low speed radial ports at 90°, two high speed radial ports at 90°, and two rearward facing ports at 135°. Choose nozzle size based on desired operating pressure and flow.

3.4 The two sets of radial ports are marked ‘LS’ and ‘HS’ for low speed and high speed, respectively. The high speed ports have a larger offset distance from the centerline than the low speed ports, which will cause the tool to spin faster. The high speed ports also allow the tool to be run at lower flows than the low speed ports due to the higher torque created by the offset distance.

SECTION 4: SETUP

4.0 CONNECTING ROTOMAG X22

Prior to installing the RotoMag X22 onto the rigid lance or hose, flush the system to clear any debris.

For 22,500 psi operation (9/16" MP FML Inlet)

1. Apply anti-seize compound to the threads and cone on the 3/4" MP male connection.

2. Install the RotoMag X22 and tighten to 90 lbs. ft.

For 15,000 psi operation (NPT FML Inlet)

Use a female NPT to male 3/4" MP adapter for 15,000 psi operation.

1. Apply 3-4 wraps of Teflon thread sealant tape to the male connection thread (NOT adapter).

2. Apply anti-seize compound over the sealant tape for protection against galling in connection threads.

3. Tighten the connection 1-1/2 to 2 turns past hand tight. All NPT pipe connections should have a minimum thread engagement of (4) threads.

4. Apply anti-seize compound to the threads and cone on the male end of the adapter.

   NOTE: Do not use Teflon tape.

5. Install the RotoMag X22 onto the adapter and tighten to 90 lbs. ft.

4.1 Prior to installing nozzles in the RotoMag X22, turn on pump and run at low pressure to flush debris from the system. Refer to nozzle charts in Appendix B for the proper flow rates for your application.

NOTE: It is strongly recommended the RotoMag X22 be used with a BALANCED (same size nozzles) combination of nozzles. Failing to do so may reduce the life of the tool. Configurations of 2, 4, 6, or 8 nozzles are available using the different combinations of nozzles and plugs. When nozzles are installed in both the 90 degree and 45 degree ports the RotoMag X22 will spin faster. There are two sets of radial ports marked 'HS' for high speed and 'LS' for low speed.

1. New RotoMag X22 comes with nozzle plugs installed. Determine nozzle configuration to be used and remove plugs (if needed) using a 3/16” hex key.

2. For RotoMag X22 (1/2”-28 UNEF): If plugs are to be used, apply anti-seize compound to male threads and install into correct ports using 3/16” hex key. Tighten to 50 lbs. in.
For RotoMag X22N (1/4” NPT): If plugs are to be used, apply 3-4 wraps of Teflon thread sealant tape to male connection thread. Apply anti-seize compound over the sealant tape and install into correct ports using 3/16” hex key. Tighten connection 1-1/2 to 2 turns past hand tight.

3. For RotoMag X22: Apply anti-seize compound to male threads of nozzles and install using 3/16” hex key. Tighten to 50 lbs. in.
For RotoMag X22N: Apply 3-4 wraps of Teflon thread sealant tape to male connection thread. Apply anti-seize compound over the sealant tape install using 3/16” hex key. Tighten connection 1-1/2 to 2 turns past hand tight.

4.2 An anti-withdrawal device (backout preventer) should be used to prevent the tool from accidently exiting the pipe under high pressure. Hose restraints (whip checks) should be used at all high pressure hose connections including the fluid end discharge. See Appendix B for a list of backout preventers.

4.3 Contact Jetstream representative for assistance.

SECTION 5: OPERATION

5.0 OPERATING ROTOMAG X22

As per the WJTA-IMCA Industry Best Practices, all operators shall follow the OSHA regulations for personal protective equipment. (OSHA guidelines for Personal Protective Equipment are available in document number 3151-12R 2004, which can be obtained from www.osha.gov.) All operators shall be issued suitable head protection, eye protection, hearing protection, body protection, hand and foot protection and respiratory protection (if needed). For detailed specifications on all protections required, refer to the WJTA-IMCA 'Industry Best Practices for the Use of High Pressure Waterjetting Equipment' Section 6, Protective Equipment For Personnel.

⚠ CAUTION A centralizing device is strongly recommended when using nozzle extensions to prevent damage to the extensions or the RotoMag X22.

⚠ CAUTION The RotoMag X22 can be used for minimum service temperature of -20°C (-4°F) and a maximum service temperature of 115°C (240°F). Use of lower or higher than recommended temperatures will result in o-ring seal failure.

5.1 Start by slowly increasing pressure to 500 psi and check entire system including all connections for leaks. Increase pressure in increments, pausing at each to inspect system for leaks, proper rotation of tool, temperature, and other operational anomalies. If any problems are discovered, lower pressure back to zero and turn off source of power before making any adjustments.

5.2 During operation, it is normal for water to leak out the front of the rotor from around the tow ring and between the rotor and body. This leak-by water comes from the water bearing that the tool operates on.

SECTION 6: SERVICE

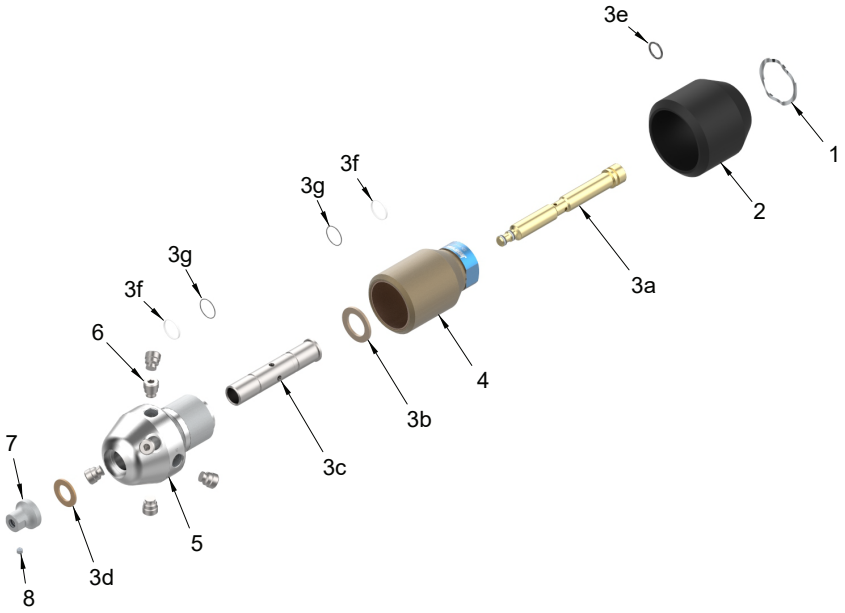


Figure C

*Tow ring with eye is PN 52386 and is included in Premium Kits only. 66170 comes standard with RotoMag assembly.

NOTE: Part numbers in parenthesis are used in RotoMag X22N assembly. Part numbers and descriptions are subject to change without notice

RotoMag X22 Assembly PN 63945 (RotoMag X22N PN 65095)			
Item	**Qty**	**Part Number**	**Description**
1	1	27072	Retaining Ring
2	1	52803	Shroud
3a-3g	1	54535	Rebuild Kit
3a	1	54449	Mandrel
3b	1	52351	Thrust Washer
3c	1	54448	Bushing
3d	1	52384	Thrust Bearing
3e	1	25193	O-ring, Mandrel
3f	2	52636	Backup Ring, Bushing
3g	2	26870	O-ring, Bushing
4	1	54452	Body
5	1	63944 (65094)	Rotor
6	6	RM-PLUG (64682) (JS4F-PLUG)	Plug, ½"-28 UNEF Plug, ¼" NPT internal hex Plug, ¼" NPT external hex
7	1	66170	Tow Ring, No Eye
8	1	26869	Setscrew

6.0 ROTOMAG X22 MAINTENANCE

When not in use, the RotoMag X22 should be cleaned (to remove any debris, deposits, or contaminants that could impede rotation) and sprayed with water dispersing lubricant (like WD-40) for storage until next use.

See YouTube for videos showing the RotoMag X22.

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

6.1 DISASSEMBLY

1. Remove the RotoMag X22 from the rigid lance or hose using open-ended or adjustable wrench on both lance/hose connection and RotoMag X22 body (4) and turning counter-clockwise.
2. Remove set screw (8) from tow ring (7) using 3/32" hex key.
3. Insert a 1/4" hex key through the back of the body (4) into the rear of the mandrel (3a).
4. Hold the hex key stationary while unscrewing tow ring (7).
5. Remove tow ring (7) and thrust bearing (3d) beneath.
6. Slide the rotor (5) off the mandrel (3a).
7. If a new mandrel o-ring (3e) is needed, carefully remove the old o-ring using a hook pick.
8. Remove the mandrel (3a) from the body (4) by pushing the mandrel (3a) towards the inlet connection.
9. To remove the bushing (3c) from the rotor (5), use the mandrel (3a) as a pusher tool and place the o-ring end of mandrel (3a) inside the front of the rotor (5) against the bushing end and push bushing (3c)out of rotor (5).
10. If new bushing o-rings (3f, 3g) are needed, carefully remove the old o-rings using a hook pick.
11. Remove nozzles if they need to be replaced.
12. Shroud (2) does not need to be removed during rebuild. In the event it needs to be replaced, shroud (2) can be detached by removing retaining ring (1) from groove on body (54452) and sliding shroud (2) off of body (4).
13. Clean and inspect all parts being reused.

6.2 ASSEMBLY

1. Ensure the new mandrel (3a), flange bushing (3c), and rotor (5) are clean.

2. Apply a light coat of o-ring lube to o-rings to reduce friction and ease installation. Install new o-rings (3f, 3g) onto the flange bushing (3c). See Figure D for proper orientation of o-rings when installed.

NOTE: O-ring (3g) color subject to change.

Figure D

3. Wet o-rings (3f,3g) on the flange bushing (3c) very lightly with water or grease. Slide the flange bushing (3c) into the rotor (5). The head of the flange bushing (3c) should now be flush up against the back of the rotor (5) with no gap between them.

4. Place the thrust washer (3b) over the flange bushing (3c) on the bottom surface of the rotor (5).

5. Install the new mandrel o-ring (3e) onto the mandrel (3a).

6. Insert the mandrel (3a) completely into the body (4). It may require a twisting motion.

7. Install the rotor (5) into the mandrel/body assembly. To ensure thrust washer (3b) stays in proper location, install with nozzle ports facing downward and sliding mandrel/body into rotor (5).

8. Install thrust bearing (3d) into groove on front of rotor (5).

9. Screw tow ring (7) onto the threaded end of mandrel (3a). While holding the mandrel (3a) in place with a ¼" hex key, tighten tow ring (7) to 25 lbs. ft.

10. Apply Vibra-Tite VC-3 (or similar removable threadlocker) to set screw (8) and install into threaded hole on side of tow ring (7) using 3/32" hex key.

11. Install the nozzles and plugs in the ports on rotor (5) using a 3/16"

hex key and tighten to 50 lbs. in.

NOTE: Excessive torquing of nozzles will not enhance seal

12. If shroud (2) has been removed, replace by sliding shroud (2) over body (4) and installing retaining ring (1) in groove on body (4). See Figure E for proper installation.

⚠ CAUTION Failure to tighten the tow ring setscrew could result in the rotor sliding off the mandrel during use.

Figure E

SECTION 7: TROUBLESHOOTING

7.0 ROTOMAG X22 TROUBLESHOOTING

Problem	Possible Cause	Remedy
Will not spin	Nozzles worn or wrong size	Replace nozzles
	Kit worn	Replace kit
	Thrust washer moved	Re-install correctly; may need replacement
	Debris	Clean*
Spins slowly	Incorrect nozzle size or worn nozzles	Replace nozzles
	Debris	Clean*
Pressure too low	Nozzle worn or wrong size	Replace nozzles
	Kit worn	Replace kit
	Connections not tight, leak	Correct

* To clean the RotoMag X22 follow 6.1 DISASSEMBLY, clean all components, and then reassemble according to 6.2 ASSEMBLY.

APPENDIX A

Exploded View

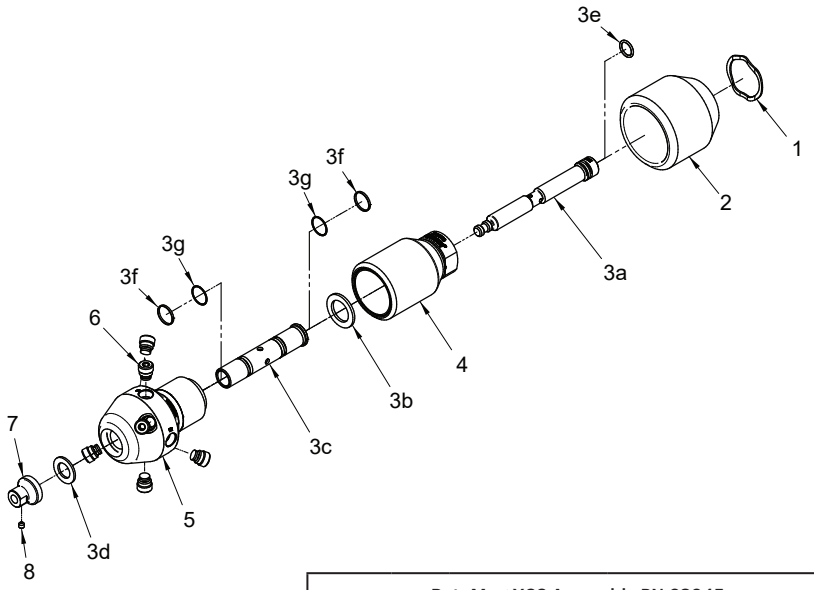


Figure F

*Tow ring with eye is PN 52386 and is included in Premium Kits only. 66170 comes standard with RotoMag assembly.

NOTE: Part numbers in parenthesis are used in RotoMag X22N assembly. Part numbers and descriptions are subject to change without notice

RotoMag X22 Assembly PN 63945 (RotoMag X22N PN 65095)			
Item	**Qty**	**Part Number**	**Description**
1	1	27072	Retaining Ring
2	1	52803	Shroud
3a-3g	1	54535	Rebuild Kit
3a	1	54449	Mandrel
3b	1	52351	Thrust Washer
3c	1	54448	Bushing
3d	1	52384	Thrust Bearing
3e	1	25193	O-ring, Mandrel
3f	2	52636	Backup Ring, Bushing
3g	2	26870	O-ring, Bushing
4	1	54452	Body
5	1	63944 (65094)	Rotor
6	6	RM-PLUG (64682) (JS4F-PLUG)	Plug, ½"-28 UNEF Plug, ¼" NPT internal hex Plug, ¼" NPT external hex
7	1	66170	Tow Ring, No Eye
8	1	26869	Setscrew

Parts Placement

RotoMag X22 (1/2”-28 UNEF Ports) available in hard case kit form:

- PN 63813 Premium Kit
- PN 63811 Starter Kit

RotoMag X22N (1/4” NPT Ports) available in hard case kit form:

- PN 65130 Premium Kit
- PN 65129 Starter Kit

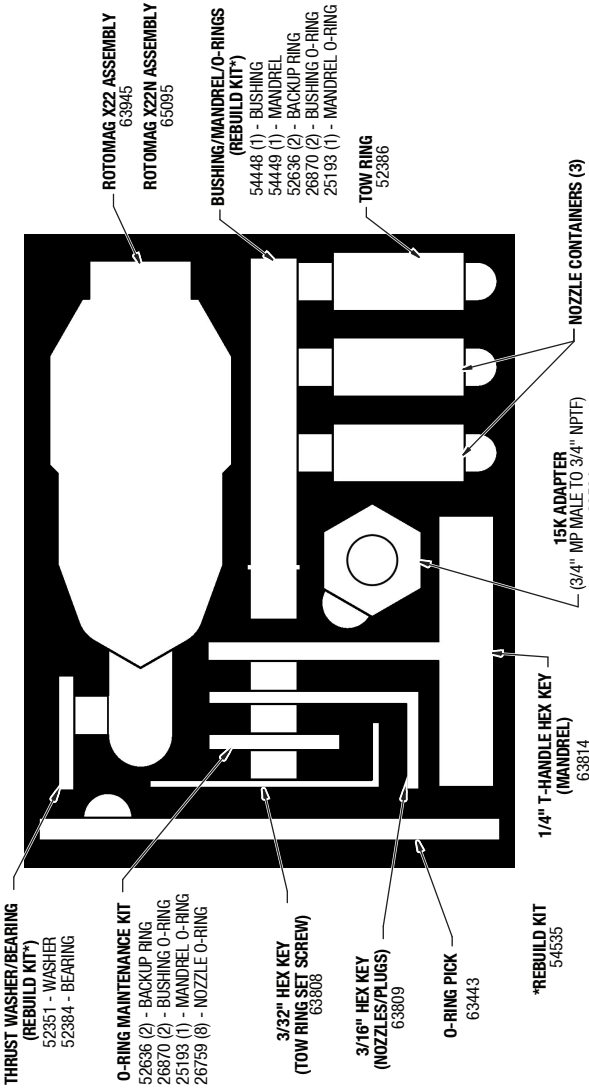


Figure G

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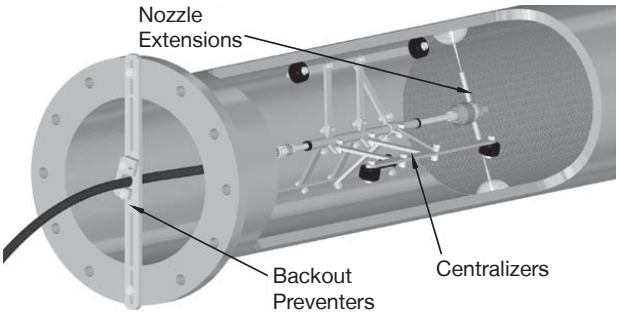
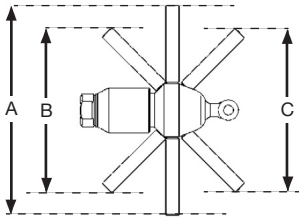
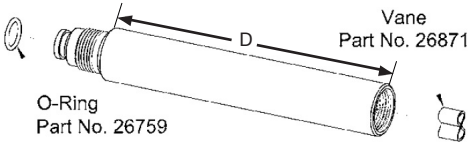
APPENDIX B

Accessories



Nozzle Extensions





- Available in two connections and three lengths:
  52320-XX part numbers for ½"-28 UNEF ports (RotoMag X22)
  65166-XX part numbers for ¼" NPT ports (RotoMag X22N)
- Extensions can be stacked to reach larger diameter pipes. See chart below for extension dimensions.
- Puts nozzles closer to the inner surface of large pipes for more effective cleaning.
- Replacement o-ring - Part number 26759
- Replacement vane - Part number 26871

Part Number	Diameter							
	"A"		"B"		"C"		Individual Length "D"	
	in	mm	in	mm	in	mm	in	mm
52320-05/ 65166-05	5.0	127	4.3	109	4.3	109	1.25	32
52320-10/ 65166-10	10.0	254	7.9	201	7.8	198	3.75	95
52320-15/ 65166-15	15.0	381	11.4	290	11.3	287	6.25	159

NOTE: Diameter includes two extensions plus rotor diameter. Individual length is the length of single extension when installed. When stacking extensions, add individual lengths to "A" dimension

to reach desired diameter. New diameter = A + 2*D. Contact Jetstream representative for assistance.

Nozzle Plugs

- Used to close unused RotoMag X22 nozzle ports.
- Part number RM-PLUG – ½"-28 UNEF (RotoMag X22)
- Part number 64682 – ¼" NPT internal hex (RotoMag X22N, standard)
- Part number JS4F-PLUG – ¼" NPT external hex (RotoMag X22N)
- Replacement o-ring - Part number 26759

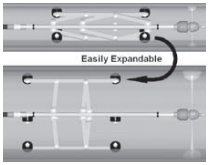
Backout Preventers

- 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

Centralizers



- Several models are available for a variety of applications.
- Required for use of extensions in horizontal pipe runs.
- Used with the RotoMag X22 to provide even, thorough cleaning and ease of movement.

Cage Style:

- Recommended for navigating complex piping arrangments to clean built-up debris.

Part No	Diameter	
	in	mm
63843-ROTO	18.75	475

NOTE: Does not include nipple or fittings.

FOR 15K RELATED ITEMS

Part No	Description
55450-7	7" long 1/2" NPT Male Nipple
28903	1/2" NPTF x 3/4" MP Male Adapter (Nipple to Tool)
27722 (4)	Capscrew, .25 F x 1.0"

NOTE: 3/4" NPT nipple **WILL NOT** fit in cage centralizer because OD is too large. If 1/2" NPT nipple is used, 4 pieces of capscrew 27722 must be used for the clamps to fit. Hose to nipple adapter may be needed based on end fitting.

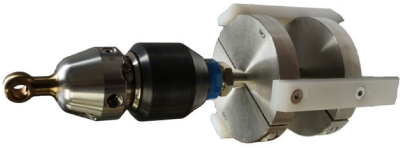
Scissor Style:

FOR 20K RELATED ITEMS

Part No	Description
29108-08	8" long 3/4" MP LH Tube Nipple
28383	3/4" MP Gland
28384	3/4" MP Collar

- Designed for straight pipe runs only.
- Adjustable frames allow for an effective pipe clean anywhere from 9-60 inches (230-1500 mm) in diameter, depending on the centralizer size chosen.
- Compatible with any tool using proper fittings.
- Comes with central lance for mounting tools.

Skid Style:



- Used in pipes with and without elbows up to 10” (250 mm) in diameter.

Part No	Diameter	
	in	mm
63842-ROTO-6	6.0	150
63842-ROTO-8	8.0	200
63842-ROTO-10	10.0	250

Note: Does not include nipple or fittings.

RELATED ITEMS
Use 20K fittings listed below and adapt to 15K hose using proper fittings.

Part No	Description
29108-08	3/4” MP LH Tube Nipple
28383 (2)	3/4” MP Gland
28384 (2)	3/4” MP Collar

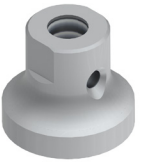
REPLACEMENT RUNNERS
Three plastic runners and six screws.

Part No	Diameter	
	in	mm
66104-06	6.0	150
66104-08	8.0	200
66104-10	10.0	250

Tow Rings

- Eye-less tow ring (PN 66170) comes standard with all RotoMag assemblies
- Tow ring with eye for towing (PN 52386) is an optional item but is included in all Premium Kits

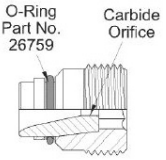
52386



66170

RM Carbide Nozzles

- High productivity carbide nozzles.
- Precision honed carbide orifices.
- Low-profile design mounts flush with the outside diameter of RotoMag X22.
- 1/2”-28 UNEF male connection
- Select nozzles using the charts by choosing operating pressure, desired flow, and two, four, six, or eight nozzle operation.

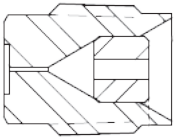


RMS Sapphire Nozzles

- High productivity sapphire nozzles.
- More durable than tungsten carbide for longer service life and lower operating cost.
- Low-profile design mounts flush with the outside diameter of RotoMag X22.
- 1/2”-28 UNEF male connection
- Select nozzles using the charts by choosing operating pressure, desired flow, and two, four, six, or eight nozzle operation.

JS4F Nozzles

- Flush mount design.
- Stainless steel.
- Precision drilled orifice.
- Tapered geometry provides highly cohesive, distortion-free waterjets for concentrated work-saving, cleaning, and cutting power.
- Straight (0°) patterns.
- 1/4” NPT Male connection

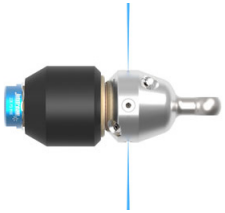


P4TC Carbide Nozzles

- High productivity tungsten carbide nozzles.
- Tapered geometry provides highly cohesive, distortion-free waterjets.
- Low profile design for unobstructed pipe cleaning.
- 1/4” NPT male connection.
- Select nozzles using the charts by choosing operating pressure, desired flow, and two, four, six, or eight nozzle operation.

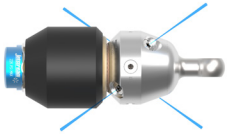
APPENDIX C

Flow Charts



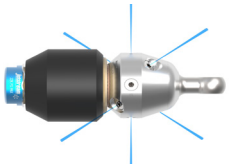
Rotomag X-22 Flow for 2-RM/P4TC/JS4F Carbide Nozzles											
RM Nozzle Part Number	P4TC Nozzle Part Number	Dia. In.	Blasting Pressure (PSI)								
			3000	5000	7000	10000	12500	15000	17500	20000	22500
RM-018	P4TC-018	0.018	-	-	-	3.7	4.2	4.6	5.0	5.3	5.6
RM-020	P4TC-020	0.020	-	-	3.5	4.2	4.7	5.1	5.5	5.9	6.2
RM-022	P4TC-022	0.022	-	3.3	3.9	4.6	5.2	5.7	6.1	6.5	6.9
RM-024	P4TC-024	0.024	-	3.6	4.3	5.1	5.7	6.3	6.8	7.2	7.7
RM-026	P4TC-026	0.026	-	4.0	4.7	5.7	6.3	6.9	7.5	8.0	8.5
RM-029	P4TC-029	0.029	3.6	4.6	5.5	6.5	7.3	8.0	8.7	9.3	9.8
RM-032	P4TC-032	0.032	4.1	5.3	6.3	7.5	8.4	9.2	10.0	10.6	11.3
RM-035	P4TC-035	0.035	4.7	6.1	7.2	8.6	9.6	10.6	11.4	12.2	12.9
RM-038	P4TC-038	0.038	5.4	6.9	8.2	9.8	11.0	12.0	13.0	13.9	14.7
RM-042	P4TC-042	0.042	6.3	8.1	9.6	11.5	12.9	14.1	15.2	16.3	17.3
RM-047	P4TC-047	0.047	7.6	9.8	11.7	13.9	15.6	17.1	18.4	19.7	20.9
RM-052	P4TC-052	0.052	9.1	11.7	13.9	16.6	18.6	20.3	22.0	23.5	24.9
RM-057	P4TC-057	0.057	10.7	13.8	16.4	19.5	21.9	23.9	25.9	27.6	29.3
RM-063	P4TC-063	0.063	12.8	16.6	19.6	23.4	26.2	28.7	31.0	33.1	35.1
RM-067	P4TC-067	0.067	14.4	18.6	22.0	26.2	29.3	32.1	34.7	37.1	39.4
RM-069	P4TC-069	0.069	15.2	19.6	23.2	27.7	31.0	33.9	36.7	39.2	41.6
RM-073	P4TC-073	0.073	16.9	21.8	25.7	30.8	34.4	37.7	40.7	43.5	46.2
RM-075	P4TC-075	0.075	17.7	22.9	27.1	32.4	36.2	39.7	42.8	45.8	48.6
RM-078	P4TC-078	0.078	19.1	24.6	29.2	34.9	39.0	42.7	46.1	49.3	52.3
RM-082	P4TC-082	0.082	21.0	27.1	32.1	38.3	42.8	46.9	50.7	54.2	57.5
RM-090	P4TC-090	0.090	25.1	32.3	38.3	45.7	51.1	56.0	60.5	64.7	68.6
RM-093	P4TC-093	0.093	26.7	34.4	40.7	48.7	54.5	59.7	64.4	68.9	73.1
RM-098	P4TC-098	0.098	29.5	38.1	45.1	53.9	60.2	66.0	71.3	76.2	-
RM-106	P4TC-106	0.106	34.3	44.3	52.4	62.7	70.1	76.8	-	-	-
RM-110	P4TC-110	0.110	36.9	47.6	56.3	67.3	75.3	-	-	-	-
RM-115	P4TC-115	0.115	40.2	51.9	61.4	73.4	-	-	-	-	-
RM-125	P4TC-125	0.125	47.3	61.1	72.3	-	-	-	-	-	-
RM-135	P4TC-135	0.135	55.0	71.0	-	-	-	-	-	-	-
RM-145	P4TC-145	0.145	63.3	-	-	-	-	-	-	-	-
RM-155	P4TC-155	0.155	72.2	-	-	-	-	-	-	-	-
RM-165	P4TC-165	0.165	-	-	-	-	-	-	-	-	-
LEAK-BY GPM			1.1	1.4	1.7	2.0	2.2	2.4	2.6	2.8	3.0

*FLOW VALUES INCLUDE LEAK-BY GPM



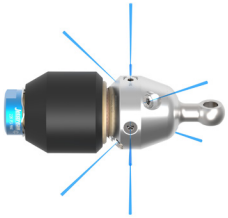
Rotomag X-22 Flow for 4-RM/P4TC/JS4F Carbide Nozzles										
RM Nozzle Part Number	P4TC Nozzle Part Number	Dia. In.	Blasting Pressure (PSI)							
			3000	5000	7000	10000	12500	15000	17500	20000	22500
RM-018	P4TC-018	0.018	-	-	-	5.5	6.1	6.7	7.3	7.8	8.2
RM-020	P4TC-020	0.020	-	-	5.3	6.3	7.1	7.7	8.4	8.9	9.5
RM-022	P4TC-022	0.022	-	5.1	6.0	7.2	8.1	8.9	9.6	10.2	10.8
RM-024	P4TC-024	0.024	-	5.8	6.9	8.2	9.2	10.1	10.9	11.6	12.3
RM-026	P4TC-026	0.026	-	6.6	7.8	9.3	10.4	11.4	12.3	13.2	14.0
RM-029	P4TC-029	0.029	6.1	7.8	9.3	11.1	12.4	13.6	14.7	15.7	16.6
RM-032	P4TC-032	0.032	7.2	9.2	10.9	13.1	14.6	16.0	17.3	18.5	19.6
RM-035	P4TC-035	0.035	8.3	10.8	12.7	15.2	17.0	18.7	20.1	21.5	22.8
RM-038	P4TC-038	0.038	9.6	12.4	14.7	17.6	19.7	21.5	23.3	24.9	26.4
RM-042	P4TC-042	0.042	11.5	14.9	17.6	21.1	23.5	25.8	27.8	29.8	31.6
RM-047	P4TC-047	0.047	14.2	18.3	21.6	25.9	28.9	31.7	34.2	36.6	38.8
RM-052	P4TC-052	0.052	17.1	22.1	26.1	31.2	34.9	38.2	41.3	44.1	46.8
RM-057	P4TC-057	0.057	20.3	26.2	31.0	37.1	41.5	45.4	49.1	52.5	55.6
RM-063	P4TC-063	0.063	24.6	31.7	37.5	44.9	50.2	54.9	59.4	63.4	67.3
RM-067	P4TC-067	0.067	27.6	35.7	42.2	50.5	56.4	61.8	66.8	71.4	75.7
RM-069	P4TC-069	0.069	29.3	37.8	44.7	53.4	59.7	65.4	70.7	75.5	-
RM-073	P4TC-073	0.073	32.6	42.1	49.8	59.6	66.6	72.9	78.8	-	-
RM-075	P4TC-075	0.075	34.4	44.4	52.5	62.8	70.2	76.9	-	-	-
RM-078	P4TC-078	0.078	37.1	47.9	56.6	67.7	75.7	-	-	-	-
RM-082	P4TC-082	0.082	40.9	52.8	62.4	74.6	-	-	-	-	-
RM-090	P4TC-090	0.090	49.0	63.3	74.9	-	-	-	-	-	-
RM-093	P4TC-093	0.093	52.3	67.5	79.8	-	-	-	-	-	-
RM-098	P4TC-098	0.098	57.9	74.8	-	-	-	-	-	-	-
RM-106	P4TC-106	0.106	67.6	-	-	-	-	-	-	-	-
RM-110	P4TC-110	0.110	72.7	-	-	-	-	-	-	-	-
RM-115	P4TC-115	0.115	79.3	-	-	-	-	-	-	-	-
RM-125	P4TC-125	0.125	-	-	-	-	-	-	-	-	-
RM-135	P4TC-135	0.135	-	-	-	-	-	-	-	-	-
RM-145	P4TC-145	0.145	-	-	-	-	-	-	-	-	-
RM-155	P4TC-155	0.155	-	-	-	-	-	-	-	-	-
RM-165	P4TC-165	0.165	-	-	-	-	-	-	-	-	-
LEAK-BY GPM			1.1	1.4	1.7	2.0	2.2	2.4	2.6	2.8	3.0

*FLOW VALUES INCLUDE LEAK-BY GPM



Rotomag X-22 Flow for 6-RM/P4TC/JS4F Carbide Nozzles										
RM Nozzle Part Number	P4TC Nozzle Part Number	Dia. In.	Blasting Pressure (PSI)							
			3000	5000	7000	10000	12500	15000	17500	20000	22500
RM-018	P4TC-018	0.018	-	5.1	6.1	7.2	8.1	8.9	9.6	10.3	10.9
RM-020	P4TC-020	0.020	4.6	6.0	7.1	8.5	9.5	10.4	11.2	12.0	12.7
RM-022	P4TC-022	0.022	5.4	7.0	8.2	9.8	11.0	12.1	13.0	13.9	14.8
RM-024	P4TC-024	0.024	6.2	8.0	9.5	11.3	12.7	13.9	15.0	16.0	17.0
RM-026	P4TC-026	0.026	7.1	9.2	10.8	13.0	14.5	15.9	17.1	18.3	19.4
RM-029	P4TC-029	0.029	8.6	11.0	13.1	15.6	17.5	19.1	20.7	22.1	23.4
RM-032	P4TC-032	0.032	10.2	13.1	15.6	18.6	20.8	22.8	24.6	26.3	27.9
RM-035	P4TC-035	0.035	12.0	15.4	18.3	21.8	24.4	26.8	28.9	30.9	32.8
RM-038	P4TC-038	0.038	13.9	18.0	21.2	25.4	28.4	31.1	33.6	35.9	38.1
RM-042	P4TC-042	0.042	16.7	21.6	25.6	30.6	34.2	37.4	40.4	43.2	45.9
RM-047	P4TC-047	0.047	20.7	26.7	31.6	37.8	42.2	46.3	50.0	53.4	56.7
RM-052	P4TC-052	0.052	25.1	32.4	38.3	45.8	51.2	56.1	60.6	64.8	68.7
RM-057	P4TC-057	0.057	29.9	38.6	45.7	54.6	61.1	66.9	72.3	77.3	-
RM-063	P4TC-063	0.063	36.3	46.9	55.5	66.3	74.1	-	-	-	-
RM-067	P4TC-067	0.067	40.9	52.8	62.5	74.7	-	-	-	-	-
RM-069	P4TC-069	0.069	43.3	56.0	66.2	79.1	-	-	-	-	-
RM-073	P4TC-073	0.073	48.4	62.5	73.9	-	-	-	-	-	-
RM-075	P4TC-075	0.075	51.0	65.8	77.9	-	-	-	-	-	-
RM-078	P4TC-078	0.078	55.1	71.1	-	-	-	-	-	-	-
RM-082	P4TC-082	0.082	60.8	78.4	-	-	-	-	-	-	-
RM-090	P4TC-090	0.090	73.0	-	-	-	-	-	-	-	-
RM-093	P4TC-093	0.093	77.8	-	-	-	-	-	-	-	-
RM-098	P4TC-098	0.098	-	-	-	-	-	-	-	-	-
RM-106	P4TC-106	0.106	-	-	-	-	-	-	-	-	-
RM-110	P4TC-110	0.110	-	-	-	-	-	-	-	-	-
RM-115	P4TC-115	0.115	-	-	-	-	-	-	-	-	-
RM-125	P4TC-125	0.125	-	-	-	-	-	-	-	-	-
RM-135	P4TC-135	0.135	-	-	-	-	-	-	-	-	-
RM-145	P4TC-145	0.145	-	-	-	-	-	-	-	-	-
RM-155	P4TC-155	0.155	-	-	-	-	-	-	-	-	-
RM-165	P4TC-165	0.165	-	-	-	-	-	-	-	-	-
LEAK-BY GPM			1.1	1.4	1.7	2.0	2.2	2.4	2.6	2.8	3.0

*FLOW VALUES INCLUDE LEAK-BY GPM

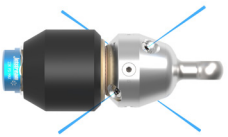


Rotomag X-22 Flow for 8-RM/P4TC/JS4F Carbide Nozzles										
RM Nozzle Part Number	P4TC Nozzle Part Number	Dia. In.	Blasting Pressure (PSI)							
			3000	5000	7000	10000	12500	15000	17500	20000	22500
RM-018	P4TC-018	0.018	4.9	6.4	7.5	9.0	10.1	11.0	11.9	12.7	13.5
RM-020	P4TC-020	0.020	5.8	7.5	8.9	10.6	11.9	13.0	14.1	15.0	16.0
RM-022	P4TC-022	0.022	6.8	8.8	10.4	12.5	13.9	15.3	16.5	17.6	18.7
RM-024	P4TC-024	0.024	7.9	10.2	12.1	14.4	16.1	17.7	19.1	20.4	21.7
RM-026	P4TC-026	0.026	9.1	11.7	13.9	16.6	18.6	20.3	22.0	23.5	24.9
RM-029	P4TC-029	0.029	11.0	14.3	16.9	20.2	22.5	24.7	26.7	28.5	30.2
RM-032	P4TC-032	0.032	13.2	17.1	20.2	24.1	27.0	29.5	31.9	34.1	36.2
RM-035	P4TC-035	0.035	15.6	20.1	23.8	28.5	31.8	34.9	37.6	40.2	42.7
RM-038	P4TC-038	0.038	18.2	23.5	27.8	33.2	37.1	40.6	43.9	46.9	49.8
RM-042	P4TC-042	0.042	22.0	28.4	33.6	40.1	44.8	49.1	53.1	56.7	60.2
RM-047	P4TC-047	0.047	27.2	35.2	41.6	49.7	55.6	60.9	65.8	70.3	74.6
RM-052	P4TC-052	0.052	33.1	42.7	50.5	60.4	67.5	74.0	79.9	-	-
RM-057	P4TC-057	0.057	39.5	51.0	60.4	72.2	-	-	-	-	-
RM-063	P4TC-063	0.063	48.1	62.0	73.4	-	-	-	-	-	-
RM-067	P4TC-067	0.067	54.2	70.0	-	-	-	-	-	-	-
RM-069	P4TC-069	0.069	57.4	74.1	-	-	-	-	-	-	-
RM-073	P4TC-073	0.073	64.1	-	-	-	-	-	-	-	-
RM-075	P4TC-075	0.075	67.6	-	-	-	-	-	-	-	-
RM-078	P4TC-078	0.078	73.1	-	-	-	-	-	-	-	-
RM-082	P4TC-082	0.082	-	-	-	-	-	-	-	-	-
RM-090	P4TC-090	0.090	-	-	-	-	-	-	-	-	-
RM-093	P4TC-093	0.093	-	-	-	-	-	-	-	-	-
RM-098	P4TC-098	0.098	-	-	-	-	-	-	-	-	-
RM-106	P4TC-106	0.106	-	-	-	-	-	-	-	-	-
RM-110	P4TC-110	0.110	-	-	-	-	-	-	-	-	-
RM-115	P4TC-115	0.115	-	-	-	-	-	-	-	-	-
RM-125	P4TC-125	0.125	-	-	-	-	-	-	-	-	-
RM-135	P4TC-135	0.135	-	-	-	-	-	-	-	-	-
RM-145	P4TC-145	0.145	-	-	-	-	-	-	-	-	-
RM-155	P4TC-155	0.155	-	-	-	-	-	-	-	-	-
RM-165	P4TC-165	0.165	-	-	-	-	-	-	-	-	-
LEAK-BY GPM			1.1	1.4	1.7	2.0	2.2	2.4	2.6	2.8	3.0

*FLOW VALUES INCLUDE LEAK-BY GPM

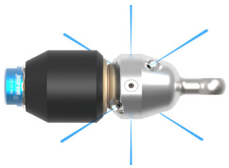
Rotomag X-22 Flow for 2-RMS Carbide Nozzles										
RMS Nozzle Part Number	Dia. In.	Blasting Pressure (PSI)								
		3000	5000	7000	10000	12500	15000	17500	20000	22500
RMS-018	0.018	-	-	-	3.3	3.7	4.0	4.4	4.7	4.9
RMS-025	0.025	-	-	3.8	4.5	5.0	5.5	6.0	6.4	6.8
RMS-029	0.029	-	3.8	4.5	5.4	6.0	6.6	7.1	7.6	8.0
RMS-033	0.033	3.5	4.5	5.3	6.4	7.1	7.8	8.4	9.0	9.5
RMS-038	0.038	4.3	5.5	6.5	7.8	8.7	9.5	10.3	11.0	11.7
RMS-042	0.042	5.0	6.4	7.6	9.1	10.1	11.1	12.0	12.8	13.6
RMS-046	0.046	5.7	7.4	8.8	10.5	11.7	12.8	13.8	14.8	15.7
RMS-052	0.052	7.0	9.1	10.7	12.8	14.3	15.7	17.0	18.1	19.2
LEAK-BY GPM		1.1	1.4	1.7	2.0	2.2	2.4	2.6	2.8	3.0

*FLOW VALUES INCLUDE LEAK-BY GPM



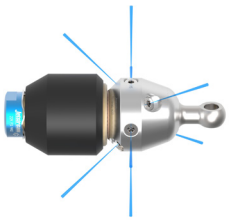
Rotomag X-22 Flow for 4-RMS Carbide Nozzles										
RMS Nozzle Part Number	Dia. In.	Blasting Pressure (PSI)								
		3000	5000	7000	10000	12500	15000	17500	20000	22500
RMS-018	0.018	-	-	-	4.6	5.1	5.6	6.1	6.5	6.9
RMS-025	0.025	-	-	5.9	7.0	7.8	8.6	9.3	9.9	10.5
RMS-029	0.029	-	6.2	7.3	8.7	9.8	10.7	11.5	12.3	13.1
RMS-033	0.033	5.9	7.6	9.0	10.7	12.0	13.1	14.2	15.1	16.1
RMS-038	0.038	7.4	9.6	11.3	13.6	15.2	16.6	17.9	19.2	20.3
RMS-042	0.042	8.8	11.4	13.5	16.1	18.0	19.7	21.3	22.8	24.2
RMS-046	0.046	10.4	13.4	15.8	18.9	21.2	23.2	25.0	26.8	28.4
RMS-052	0.052	12.9	16.7	19.8	23.6	26.4	28.9	31.3	33.4	35.4
LEAK-BY GPM		1.1	1.4	1.7	2.0	2.2	2.4	2.6	2.8	3.0

*FLOW VALUES INCLUDE LEAK-BY GPM



Rotomag X-22 Flow for 6-RMS Carbide Nozzles										
RMS Nozzle Part Number	Dia. In.	Blasting Pressure (PSI)								
		3000	5000	7000	10000	12500	15000	17500	20000	22500
RMS-018	0.018	-	4.2	4.9	5.9	6.6	7.2	7.8	8.3	8.8
RMS-025	0.025	5.2	6.7	7.9	9.5	10.6	11.6	12.6	13.4	14.3
RMS-029	0.029	6.6	8.6	10.1	12.1	13.5	14.8	16.0	17.1	18.1
RMS-033	0.033	8.3	10.7	12.6	15.1	16.8	18.5	19.9	21.3	22.6
RMS-038	0.038	10.6	13.7	16.2	19.3	21.6	23.7	25.6	27.3	29.0
RMS-042	0.042	12.7	16.4	19.4	23.2	25.9	28.4	30.6	32.8	34.8
RMS-046	0.046	15.0	19.4	22.9	27.4	30.6	33.5	36.2	38.7	41.1
RMS-052	0.052	18.9	24.4	28.8	34.4	38.5	42.2	45.6	48.7	51.7
LEAK-BY GPM		1.1	1.4	1.7	2.0	2.2	2.4	2.6	2.8	3.0

*FLOW VALUES INCLUDE LEAK-BY GPM



Rotomag X-22 Flow for 8-RMS Carbide Nozzles										
RMS Nozzle Part Number	Dia. In.	Blasting Pressure (PSI)								
		3000	5000	7000	10000	12500	15000	17500	20000	22500
RMS-018	0.018	-	5.1	6.0	7.2	8.0	8.8	9.5	10.2	10.8
RMS-025	0.025	6.6	8.5	10.0	12.0	13.4	14.7	15.9	17.0	18.0
RMS-029	0.029	8.5	10.9	12.9	15.5	17.3	18.9	20.4	21.9	23.2
RMS-033	0.033	10.6	13.7	16.3	19.4	21.7	23.8	25.7	27.5	29.1
RMS-038	0.038	13.8	17.8	21.0	25.1	28.1	30.7	33.2	35.5	37.7
RMS-042	0.042	16.6	21.4	25.3	30.2	33.8	37.0	40.0	42.7	45.3
RMS-046	0.046	19.6	25.4	30.0	35.9	40.1	43.9	47.4	50.7	53.8
RMS-052	0.052	24.8	32.0	37.9	45.3	50.6	55.4	59.9	64.0	67.9
LEAK-BY GPM		1.1	1.4	1.7	2.0	2.2	2.4	2.6	2.8	3.0

*FLOW VALUES INCLUDE LEAK-BY GPM

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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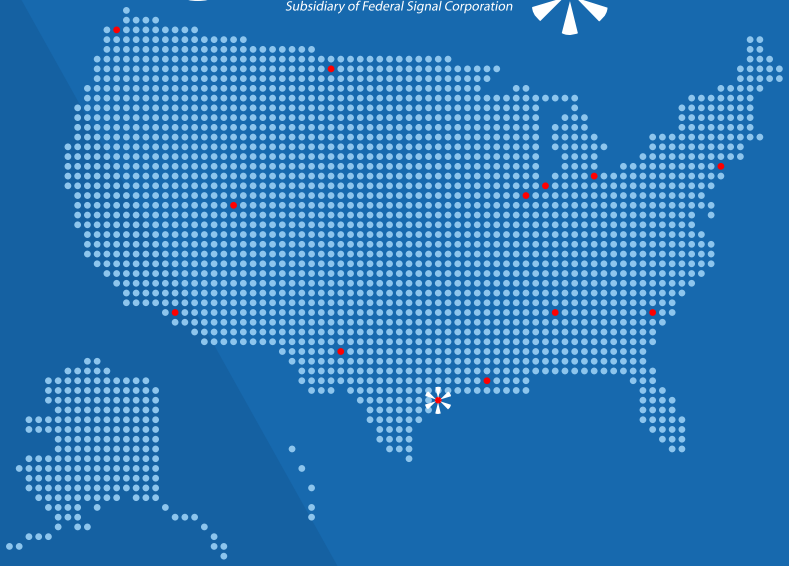

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Application Policy
Capacity ratings, features, and specifications vary depending upon the model and type of service. Application approvals must be obtained from Jetstream; contact your representative for application approval. We reserve the right to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