Jetstream®
Subsidiary of Federal Signal Corporation

TUBE SPINNER™

TUBE SPINNING NOZZLE

PRODUCT INSTRUCTIONS

PI-123

The Tube Spinning Nozzle is assembled from three components: the nozzle body, the sleeve, and the front nozzle (multiple types available). The sleeve spins at an ultra-high rpm to provide streak-free cleaning and polishing in a single pass. The front nozzle blasts free large deposits and provides propulsion. The nozzle is self-propelling and can be used on both rigid and flexible tube cleaning lances.

Read these instructions thoroughly before installing, connecting, or using the Tube Spinning Nozzle. 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 Tube Spinning Nozzle 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

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.

2. Nozzle flow ratings must be compatible with pump discharge and pump pressure rating. (See Nozzle Flow Rating Chart on page 25.)

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

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 Tube Spinning Nozzle is assembled from three components: the nozzle body, the sleeve, and the front nozzle (multiple types available). The sleeve spins at an ultra-high rpm to provide streak-free cleaning and polishing in a single pass. The front nozzle blasts free large deposits and provides propulsion. The nozzle is self-propelling and can be used on both rigid and flexible tube cleaning lances. Optional thrusters are available for NPT connection tube spinning nozzles to provide additional thrust for pulling through tubes. Depending on the connection type, the Tube Spinning Nozzle is rated to 15,000 psi (NPT, M7, and BSPP), 20,000 psi (5/16-24 x ¼ MP), or 22,000 psi (MP LH/RH).

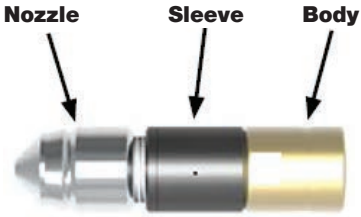
Product Specifications

Model Name	Tube Spinning Nozzle
Maximum Operating Pressure (psi)	15K / 20K / 22K
Minimum Operating Pressure (psi)	3000
Maximum Flow (gpm)	35
Maximum Operating Pressure (bar)	1000 / 1400 / 1500
Minimum Operating Pressure (bar)	200
Maximum Flow (l/min)	132
Inlet Connection	BSPP, M7, MP, NPT, 5/16-24
Cap Nozzles Accepted	FB, FM, FP, HPEL, HPER, HPFR, HPFL

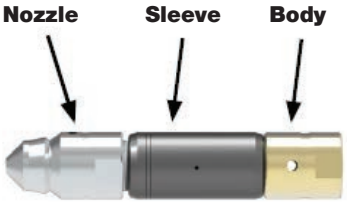
NOTE: See Appendix B for list of PNs and accessories.

SECTION 3: PREPARATION FOR USE

15K Tube Spinner with FP Nozzle



22K Tube Spinner with HPF Nozzle



3.0 BEFORE PUTTING TUBE SPINNING NOZZLE INTO SERVICE

NEW TUBE SPINNING NOZZLE

3.1 Check the Tube Spinning Nozzle carefully upon removal from its shipping container for damage.

PREVIOUSLY USED TUBE SPINNING NOZZLE

3.2 Inspect all components.

3.3 The Tube Spinning Nozzle body, sleeve, and front nozzle should be inspected and cleaned to ensure no debris has entered the orifice that could plug the nozzle and over-pressurize the system.

3.4 Remove the Tube Spinning Nozzle from service if the body, sleeve, thruster, or front nozzle show signs of cracking or excessive abrasion.

3.5 Review Flow Charts in Appendix B to decide on nozzle configuration and proper flows for application.

SECTION 4: SETUP

4.0 CONNECTING TUBE SPINNING NOZZLE

Prior to the start of any job, make sure that the use of only high pressure rated fittings and hoses are in the waterblasting system.

Connect the body to the system according the appropriate connection rating below. **DO NOT ASSEMBLE SLEEVE OR FRONT NOZZLE AT THIS STAGE.** Once body is connected, engage the pump and purge the lines for a minute to clear any possible debris. Disengage pump once lines are purged.

4.1 15K PSI RATED TUBE SPINNING NOZZLES

> **NOTE:** When using a thruster, follow the steps below, repeating twice, to assemble body to thruster then thruster to lance or stinger.

FOR NPT CONNECTIONS

1. Apply 3-4 wraps of Teflon thread sealant tape to the male threads on the mating lance or stinger.

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

3. Install the nozzle bodies by using appropriate open-end wrench on flats found on body and tighten 1-2 turns past hand-tight. All NPT pipe connections should have a minimum thread engagement of (4) threads.

FOR BSPP AND M7 FLAT SEAL CONNECTIONS

1. BSPP and M7 flat seal connections required a copper crush washer between the male and female connections.

2. Seat copper crush washer in female BSPP or M7 connection on tube spinning nozzle body.

3. Apply anti-seize compound to male threads of mating lance or stinger.

4. Install the nozzle bodies by using appropriate open-end wrench on flats found on body and tighten to 20 lb-ft.

4.2 22K PSI RATED TUBE SPINNING NOZZLES

1. Apply anti-seize compound to the male threads and cone of the mating lance or stinger.

> **NOTE:** DO NOT use Teflon tape on 22K PSI connections.

2. Install the nozzle bodies by using appropriate open end wrench on flats found on body and tighten until firmly snug.

NOTE: DO NOT OVERTIGHTEN; damage to coned sealing surface could result.

4.3 SLEEVE AND FRONT NOZZLE

Assemble the sleeve and the appropriate front nozzle to the previously connected body. Assemble front nozzle according to appropriate connection rating below.

4.4 15K PSI MODELS

1. Slide sleeve over male end of body.

FOR NPT CONNECTIONS

2. Apply 3-4 wraps of Teflon thread sealant tape to the available male threads found on the body.

3. Apply anti-seize compound over the sealant tape for additional protection against galling.

4. Install appropriate FP front nozzle using smooth jaw plier wrench (PN 64119).

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

FOR BSPP AND M7 FLAT SEAL CONNECTIONS

2. Seat copper crush washer in female BSPP or M7 connection on appropriate FB or FM cap nozzle.

3. Apply anti-seize compound to male threads of tube spinning nozzle body.

4. Install the cap nozzle by using appropriate open-end wrench on flats found on cap nozzle and tighten to 20 lb-ft.

4.5 22K PSI MODELS

1. Slide sleeve over male end of body.

2. Apply anti-seize compound to the available male threads found on the body.

NOTE: DO NOT use Teflon tape on 22K PSI connections.

3. Install appropriate HPFR/HPFL/HPER/HPEL front nozzle by using appropriate open-end wrench on flats found on cap nozzle and tighten until firmly snug.

NOTE: DO NOT OVERTIGHTEN; damage to coned sealing surface could result.

NOTE: There should be approximately 1/16" to 1/8" clearance between the sleeve and the front nozzle. With a knife or other sharp object, clear any Teflon tape or exposed compound between the nozzle and sleeve. Confirm that sleeve spins freely.

SECTION 5: OPERATION

5.0 OPERATING TUBE SPINNING NOZZLES

As per the WJTA-IMCA Recommended 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 'Recommended Practices for the Use of High Pressure Waterjetting Equipment' Section 6, Protective Equipment For Personnel.

⚠ DANGER Operators and crew need to be clear of spray area as high water pressure is dangerous. The person controlling the cleaning nozzle must be the operator and must have control of the pressure. Do not allow a secondary or remote operator have control of pressure. Use only thoroughly trained operators.

5.1 The Tube Spinning Nozzle can now be used like any standard tube cleaning nozzle. Periodically inspect the nozzle for damage or excessive wear.

> **NOTE:** For improved reliability and longer life, it is recommended that a filter of at least 10 microns be used on the water supply inlet. A strainer (100 mesh minimum) must also be used in the water tank (if equipped with tank).

⚠ DANGER Failure to follow the following instructions will cause unsafe conditions, severe injury can result.

- DO NOT operate the Tube Spinning Nozzle above specified pressure rating.
- When used on a flex lance and in a tube much larger than the nozzle diameter, the Tube Spinning Nozzle must be used with a stinger to prevent the nozzle from "doubling back" for operator safety.
- Operator must wear ear protection due to the noise generated by the

spinning nozzle.

- Never stand in the plane of blasting.
- A Lance Safety Grip is recommended to minimize the risk of a live nozzle exiting the tube unexpectedly back at the lance operator.
- At high-pressure, the water can be hot. Wear gloves and use precaution to prevent scalding.
- DO NOT use Teflon tape on 22K PSI connections.
- DO NOT over tighten connections to prevent sealing surface damage.
- Place barricades with warning signs or barricade tape around work area. This includes the waterblast unit and all high-pressure hoses.
- Operator must be outfitted with proper safety apparel (refer to yellow JETSTREAM SAFETY WARNING pamphlet). Body armor is strongly recommended.

SECTION 6: SERVICE

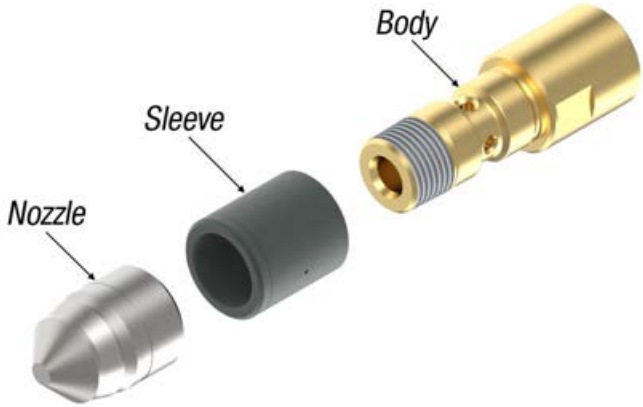


Figure A

NOTE: See Appendix B for list of PNs and accessories.

6.0 TUBE SPINNING NOZZLE MAINTENANCE

When not in use, store nozzle in a dry place. If nozzle is to be stored more than a few days, disassemble and apply WD-40® or other penetrating oil to nozzle body and sleeve. Reassemble Tube Spinning Nozzle per installation instructions.

See YouTube channel for videos on various Jetstream products.

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

⚠ WARNING Remove the nozzle from service if:

A. The body, sleeve, or front nozzle shows signs of cracking or other damage.

B. The wall thickness of these parts is reduced by 25% at any point.

C. The nozzle can no longer hold pressure at water flow rate for which it was sized.

SECTION 7: TROUBLESHOOTING

7.0 TUBE SPINNING NOZZLE TROUBLESHOOTING

Problem	Possible Cause	Remedy
Will not spin	Debris	Clean*
	Nozzles worn or wrong size	Replace nozzles
Weep hole leak	Fitting loose	Tighten fitting
	Sealing surfaces worn	Re-dress or replace
Excessive flow or pump will no longer come up to pressure	Debris	Clean*
	Nozzles worn	Replace nozzles
	Sleeve worn	Replace sleeve
	Nozzle body worn	Replace nozzle body

* Remove nozzle and sleeve, clean parts thoroughly. Inspect for wear, debris or damage to bearing surfaces.

APPENDIX A

Exploded View

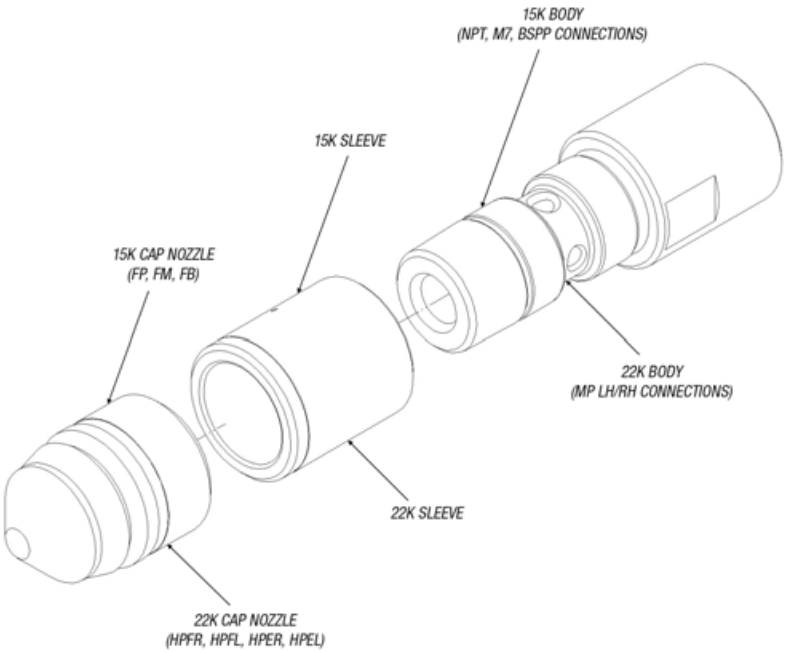


Figure C

APPENDIX B

Tube Spinning Nozzle Options

15K PSI

ASSEMBLY PART NO.	CONNECTION TYPE FEMALE INLET X MALE OUTLET	FLOW RATE	OUTSIDE DIAMETER		LENGTH W/ CAP NOZZLE*		SLEEVE PART NO.	BODY PART NO.
			in	mm	in	mm		
52146	1/16" NPT	1	0.375	9.5	2.72	69	52141	52143
52147		2	0.375	9.5	2.72	69	52142	52143
51997	1/8" NPT	1	0.500	12.7	2.66	68	51992	51996
51998		2	0.500	12.7	2.66	68	51993	51996
52002	1/4" NPT	1	0.665	16.9	3.14	80	51922	52001
52003		2	0.665	16.9	3.14	80	51923	52001
52007	3/8" NPT	1	0.875	22.2	3.30	84	51926	52006
52008		2	0.875	22.2	3.30	84	51927	52006
64104		3	0.875	22.2	3.30	84	64088	52006
64105		4	0.875	22.2	3.30	84	64089	52006
52012	1/2" NPT	1	1.040	26.4	3.92	100	51941	52011
52013		2	1.040	26.4	3.92	100	51942	52011
64106		3	1.040	26.4	3.92	100	64090	52011
64107		4	1.040	26.4	3.92	100	64091	52011
59900	M7 x 1	1	0.375	9.5	2.28	58	52141	59906
59901		2	0.375	9.5	2.28	58	52142	59906
59902	1/8" BSPP	1	0.500	12.7	2.38	61	51992	59907
59903		2	0.500	12.7	2.38	61	51993	59907
59904	1/4" BSPP	1	0.665	16.9	2.68	68	51922	59908
59905		2	0.665	16.9	2.68	68	51923	59908

* NPT connection uses FP cap nozzle, M7 connection uses PM cap nozzle, and BSPP connection uses FB cap nozzle. SOLD SEPARATELY.

22K PSI

ASSEMBLY PART NO.	CONNECTION TYPE FEMALE INLET X MALE OUTLET	FLOW RATE	OUTSIDE DIAMETER		LENGTH W/ CAP NOZZLE*		SLEEVE PART NO.	BODY PART NO.
			in	mm	in	mm		
64199	1/4" MP LH	1	0.375	9.5	2.22/2.57	55/65	51956	64193
64200	1/4" MP RH	1	0.375	9.5	2.22/2.57	55/65	51956	64194
64201	3/8" MP LH	1	0.500	12.7	2.57/2.99	65/76	51958	64195
64202	3/8" MP RH	1	0.500	12.7	2.57/2.99	65/76	51958	64196
64203	9/16" MP LH	1	0.750	19.1	3.55/4.02	90/102	52551	64197
64204	9/16" MP RH	1	0.750	19.1	3.55/4.02	90/102	52551	64198
64205	9/16" MP LH	2	0.750	19.1	3.55/4.02	90/102	54256	64197
64206	9/16" MP RH	2	0.750	19.1	3.55/4.02	90/102	54256	64198

* MP connection uses HPFR/HPFL/HPER/HPEL cap nozzle. Lengths are HPFR and HPFL/HPER and HPEL respectively. SOLD SEPARATELY.

Tube Spinning Nozzle Flow Chart

ASSEMBLY PART NO.	CONNECTION TYPE FEMALE INLET X MALE OUTLET	FLOW RATE	SLEEVE PART NO.	BODY PART NO.	OUTSIDE DIAMETER		LENGTH W/ CAP NOZZLE		FLOW (GPM) AT SPECIFIED PRESSURE (PSI)*											
					in	mm	in	mm	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000	12,500	15,000	17,500	20,000
52146	1/16" NPT	1	52141	52143	0.375				1.9	2.3	2.6	2.9	3.2	3.5	3.7	4.0	4.6	5.1	-	-
52147		2	52142	52143	0.375				3.0	3.5	4.0	4.4	4.8	5.2	5.6	5.9	6.8	7.5	-	-
51997	1/8" NPT	1	51992	51996	0.500				2.6	3.1	3.5	3.9	4.3	4.7	5.0	5.4	6.2	7.0	-	-
51998		2	51993	51996	0.500				5.0	5.9	6.7	7.4	8.0	8.7	9.3	9.9	11.3	12.5	-	-
52002	1/4" NPT	1	51922	52001	0.665				2.4	2.9	3.4	3.8	4.2	4.6	5.0	5.4	6.3	7.2	-	-
52003		2	51923	52001	0.665				5.2	6.2	7.0	7.8	8.5	9.2	9.9	10.6	12.1	13.5	-	-
52007	3/8" NPT	1	51926	52006	0.875				3.6	4.3	4.9	5.5	6.1	6.6	7.2	7.7	9.0	10.1	-	-
52008		2	51927	52006	0.875				7.0	8.2	9.3	10.4	11.3	12.2	13.1	14.0	15.9	17.8	-	-
64104		3	64088	52006	0.875				10.0	11.7	13.3	14.7	16.0	17.2	18.4	19.6	22.1	24.6	-	-
64105		4	64089	52006	0.875				13.7	15.9	18.0	19.9	21.5	23.1	24.7	26.2	29.5	32.7	-	-
52012	1/2" NPT	1	51941	52011	1.040				3.0	3.7	4.3	4.9	5.5	6.1	6.6	7.1	8.5	9.7	-	-
52013		2	51942	52011	1.040				6.7	7.9	9.0	10.0	11.0	12.0	12.9	13.7	15.8	17.8	-	-
64106		3	64090	52011	1.040				10.3	12.2	13.8	15.2	16.7	18.1	19.3	20.5	23.4	26.1	-	-
64107		4	64091	52011	1.040				14.0	16.4	18.5	20.4	22.2	24.0	25.6	27.1	30.8	34.2	-	-
59900	M7 x 1	1	52141	59906	0.375				1.9	2.3	2.6	2.9	3.2	3.5	3.7	4.0	4.6	5.1	-	-
59901		2	52142	59906	0.375				3.0	3.5	4.0	4.4	4.8	5.2	5.6	5.9	6.8	7.5	-	-
59902	1/8" BSPP	1	51992	59907	0.500				2.6	3.1	3.5	3.9	4.3	4.7	5.0	5.4	6.2	7.0	-	-
59903		2	51993	59907	0.500				5.0	5.9	6.7	7.4	8.0	8.7	9.3	9.9	11.3	12.5	-	-
59904	1/4" BSPP	1	51922	59908	0.665				2.4	2.9	3.4	3.8	4.2	4.6	5.0	5.4	6.3	7.2	-	-
59905		2	51923	59908	0.665				5.2	6.2	7.0	7.8	8.5	9.2	9.9	10.6	12.1	13.5	-	-
64199	1/4" MP LH	1	51956	64193					-	-	-	-	-	-	-	2.3	2.7	3.0	3.4	3.8
64200	1/4" MP RH	1	51956	64194					-	-	-	-	-	-	-	2.3	2.7	3.0	3.4	3.8
64201	3/8" MP LH	1	51958	64195					-	-	-	-	-	-	-	3.3	3.9	4.5	5.1	5.7
64202	3/8" MP RH	1	51958	64196					-	-	-	-	-	-	-	3.3	3.9	4.5	5.1	5.7
64203	9/16" MP LH	1	52551	64197					-	-	-	-	-	-	-	4.5	5.5	6.4	7.4	8.5
64204	9/16" MP RH	1	52551	64198					-	-	-	-	-	-	-	4.5	5.5	6.4	7.4	8.5
64205	9/16" MP LH	2	54256	64197					-	-	-	-	-	-	-	8.8	10.3	11.7	13.1	14.6
64206	9/16" MP RH	2	54256	64198					-	-	-	-	-	-	-	8.8	10.3	11.7	13.1	14.6

**Flow rates do not include additional flow if a drilled cap nozzle is used.

Cap Nozzle Flow Chart

FP, FM, FB Nozzle, and TP Thruster

Flow Rate No.	Flow (gpm) at Specified Pressure (psi)																									
	2,000		3,000		4,000		5,000		6,000		7,000		8,000		9,000		10,000		11,000		12,000		13,000		14,000		15,000	
	gpm	lpm	gpm	lpm	gpm	lpm	gpm	lpm	gpm	lpm	gpm	lpm	gpm	lpm	gpm	lpm	gpm	lpm	gpm	lpm	gpm	lpm	gpm	lpm	gpm	lpm	gpm	lpm
2	1.2	4.5	1.5	5.7	1.7	6.4	1.9	7.2	2.1	7.9	2.3	8.7	2.4	9.1	2.6	9.8	2.7	10.2	2.9	11.0	3.0	11.4	3.1	11.7	3.2	12.1	3.3	12.5
3	1.5	5.7	1.8	6.8	2.1	7.9	2.4	9.1	2.6	9.8	2.8	10.6	3.0	11.4	3.2	12.1	3.3	12.5	3.5	13.2	3.7	14.0	3.8	14.4	4.0	15.1	4.1	15.5
4	1.8	6.8	2.2	8.3	2.6	9.8	2.9	11.0	3.2	12.1	3.4	12.9	3.7	14.0	3.9	14.8	4.1	15.5	4.3	16.3	4.5	17.0	4.7	17.8	4.8	18.2	5.0	18.9
5	2.6	9.8	3.1	11.7	3.6	13.6	4.0	15.1	4.4	16.7	4.8	18.2	5.1	19.3	5.4	20.4	5.7	21.6	6.0	22.7	6.3	23.8	6.5	24.6	6.8	25.7	7.0	26.5
6	3.3	12.5	4.1	15.5	4.7	17.8	5.2	19.7	5.7	21.6	6.2	23.5	6.6	25.0	7.0	26.5	7.4	28.0	7.8	29.5	8.1	30.7	8.4	31.8	8.7	32.9	9.1	34.4
7	3.8	14.4	4.7	17.8	5.4	20.4	6.0	22.7	6.6	25.0	7.1	26.9	7.6	28.8	8.1	30.7	8.5	32.2	8.9	33.7	9.3	35.2	9.7	36.7	10.1	38.2	10.4	39.4
8	4.1	15.5	5.1	19.3	5.9	22.3	6.6	25.0	7.2	27.3	7.8	29.5	8.3	31.4	8.8	33.3	9.3	35.2	9.7	36.7	10.2	38.6	10.6	40.1	11.0	41.6	11.4	43.1
9	4.5	17.0	5.5	20.8	6.4	24.2	7.1	26.9	7.8	29.5	8.4	31.8	9.0	34.1	9.6	36.3	10.1	38.2	10.6	40.1	11.1	42.0	11.5	43.5	11.9	45.0	12.4	46.9
10	5.2	19.7	6.3	23.8	7.3	27.6	8.1	30.7	8.9	33.7	9.6	36.3	10.3	39.0	10.9	41.3	11.5	43.5	12.1	45.8	12.6	47.7	13.1	49.6	13.6	51.5	14.1	53.4
12	5.6	21.2	6.8	25.7	7.9	29.9	8.8	33.3	9.6	36.3	10.4	39.4	11.1	42.0	11.8	44.7	12.4	46.9	13.0	49.2	13.6	51.5	14.2	53.7	14.7	55.6	15.2	57.5
14	6.7	25.4	8.2	31.0	9.5	36.0	10.6	40.1	11.6	43.9	12.5	47.3	13.4	50.7	14.2	53.7	15.0	56.8	15.7	59.4	16.4	62.1	17.1	64.7	17.7	67.0	18.4	69.6
15	7.3	27.6	9.0	34.1	10.4	39.4	11.6	43.9	12.7	48.1	13.7	51.9	14.6	55.3	15.5	58.7	16.4	62.1	17.2	65.1	17.9	67.8	18.7	70.8	19.4	73.4	20.1	76.1
20	10.2	38.6	12.5	47.3	14.5	54.9	16.2	61.3	17.7	67.0	19.2	72.7	20.5	77.6	21.7	82.1	22.9	86.7	24.0	90.8	25.1	95.0	26.1	98.8	27.1	102.6	28.1	106.4
40	13.2	50.0	16.2	61.3	18.7	70.8	20.9	79.1	22.9	86.7	24.7	93.5	26.5	100.3	28.1	106.4	29.6	112.0	31.0	117.3	32.4	122.6	33.7	127.6	35.0	132.5	36.2	137.0

HPFR/HPFL/ HPER/HPEL Nozzle

Flow Rate No.	Flow (gpm) at Specified Pressure (psi)													
	10,000		12,000		14,000		16,000		18,000		20,000		22,000	
	gpm	lpm	gpm	lpm	gpm	lpm	gpm	lpm	gpm	lpm	gpm	lpm	gpm	lpm
2	2.7	10.3	3.0	11.3	3.2	12.2	3.5	13.1	3.7	13.9	3.9	14.6	4.0	15.2
3	3.3	12.6	3.7	13.8	3.9	14.9	4.2	16.0	4.5	16.9	4.7	17.8	4.9	18.5
4	4.1	15.5	4.5	16.9	4.8	18.3	5.2	19.6	5.5	20.8	5.8	21.9	6.1	23.0
5	5.7	21.6	6.3	23.7	6.8	25.6	7.2	27.4	7.7	29.0	8.1	30.6	8.5	32.0
6	7.4	27.9	8.1	30.6	8.7	33.1	9.3	35.3	9.9	37.5	10.4	39.5	11.0	41.5
7	8.5	32.1	9.3	35.2	10.0	38.0	10.7	40.6	11.4	43.1	12.0	45.4	12.6	47.7
8	9.3	35.1	10.1	38.4	11.0	41.5	11.7	44.3	12.4	47.0	13.1	49.6	13.8	52.2
9	10.1	38.1	11.0	41.8	11.9	45.1	12.7	48.2	13.5	51.1	14.2	53.9	15.0	56.7
10	11.5	43.5	12.6	47.7	13.6	51.5	14.5	55.1	15.4	58.4	16.3	61.6	17.1	64.6
12	12.4	46.9	13.6	51.4	14.7	55.5	15.7	59.4	16.6	63.0	17.5	66.4	18.4	69.6
14	15.0	56.7	16.4	62.1	17.7	67.0	18.9	71.7	20.1	76.0	21.2	80.1	22.2	84.2
15	16.3	61.9	17.9	67.8	19.3	73.2	20.7	78.3	21.9	83.0	23.1	87.5	24.2	91.5
20	22.9	86.6	25.1	94.8	27.1	102.4	28.9	109.5	30.7	116.1	32.3	122.4	34.0	128.6
40	29.5	111.8	32.3	122.4	34.9	132.3	37.4	141.4	39.6	150.0	41.8	158.1	43.8	165.6

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APPENDIX C

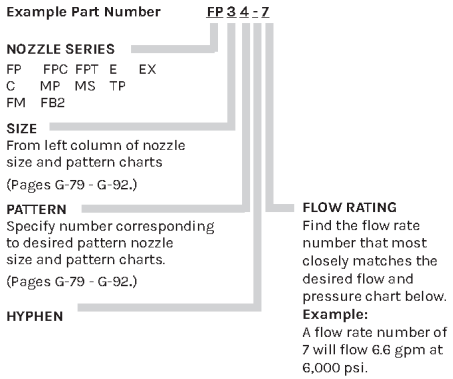
Accessories

Cap Nozzle

SELECTION & PART NUMBERING

Use the part numbering instructions given below for ordering tube nozzles.

NOZZLE PART NUMBERING



- For use with flex or rigid lances that have male pipe threads (NPT Male)
- Recessed orifices for protection from surface abrasion or damage by wrenches
- Double-tapered nose for fast, unrestricted travel through plugged tubes
- Machined from heat-treated stainless steel
- Maximum working pressure: 15,000 psi (1000 bar)
- Five sizes, seven standard patterns, and fourteen flow ratings (see the following page)
- Custom patterns available

PATTERNS / SIZES Shown Actual Size	1  For FLEX or RIGID Lance	2  For FLEX or RIGID Lance	3  For FLEX or RIGID Lance	4  For FLEX or RIGID Lance	5  For FLEX or RIGID Lance	6  For RIGID Lance ONLY	7  For RIGID Lance ONLY
FP1 — 1/16" NPT Fml*  **Diameter** .375" (9.5 mm) **Length** .85" (21.6 mm)	1 Front 6 Back 30° **7 Jets Total** **Min Flow #2**	1 Front 12 Back 30° **13 Jets Total** **Min Flow #5**	1 Front 3 Forward 45° 6 Back 30° **10 Jets Total** **Min Flow #4**	1 Front 3 Forward 45° 8 Back 30° **12 Jets Total** **Min Flow #5**	1 Front 3 Forward 45° 6 Radial 6 Back 30° **16 Jets Total** **Min Flow #6**	1 Front 6 Radial **7 Jets Total** **Min Flow #2**	1 Front 12 Radial **13 Jets Total** **Min Flow #5**
FP3 — 1/8" NPT Fml*  **Diameter** .500" (12.7 mm) **Length** .88" (22.4 mm)	1 Front 6 Back 30° **7 Jets Total** **Min Flow #2**	1 Front 12 Back 30° **13 Jets Total** **Min Flow #5**	1 Front 3 Forward 45° 6 Back 30° **10 Jets Total** **Min Flow #4**	1 Front 3 Forward 45° 8 Back 30° **12 Jets Total** **Min Flow #5**	1 Front 3 Forward 45° 6 Radial 6 Back 30° **16 Jets Total** **Min Flow #6**	1 Front 6 Radial **7 Jets Total** **Min Flow #2**	1 Front 12 Radial **13 Jets Total** **Min Flow #5**
FP4 — 1/4" NPT Fml*  **Diameter** .665" (16.9 mm) **Length** 1.16" (29.5 mm)	1 Front 8 Back 30° **9 Jets Total** **Min Flow #4**	1 Front 16 Back 30° **17 Jets Total** **Min Flow #6**	1 Front 3 Forward 45° 8 Back 30° **12 Jets Total** **Min Flow #5**	1 Front 3 Forward 45° 12 Back 30° **16 Jets Total** **Min Flow #6**	1 Front 3 Forward 45° 8 Radial 8 Back 30° **20 Jets Total** **Min Flow #7**	1 Front 8 Radial **9 Jets Total** **Min Flow #4**	1 Front 16 Radial **17 Jets Total** **Min Flow #6**
FP5 — 3/8" NPT Fml*  **Diameter** .875" (22.2 mm) **Length** 1.20" (30.5 mm)	1 Front 8 Back 30° **9 Jets Total** **Min Flow #4**	1 Front 16 Back 30° **17 Jets Total** **Min Flow #6**	1 Front 3 Forward 45° 8 Back 30° **12 Jets Total** **Min Flow #5**	1 Front 3 Forward 45° 12 Back 30° **16 Jets Total** **Min Flow #6**	1 Front 3 Forward 45° 8 Radial 8 Back 30° **20 Jets Total** **Min Flow #7**	1 Front 8 Radial **9 Jets Total** **Min Flow #4**	1 Front 16 Radial **17 Jets Total** **Min Flow #6**
FP6 — 1/2" NPT Fml*  **Diameter** 1.040" (26.4 mm) **Length** 1.47" (37.3 mm)	1 Front 8 Back 30° **9 Jets Total** **Min Flow #4**	1 Front 16 Back 30° **17 Jets Total** **Min Flow #6**	1 Front 3 Forward 45° 8 Back 30° **12 Jets Total** **Min Flow #5**	1 Front 3 Forward 45° 12 Back 30° **16 Jets Total** **Min Flow #6**	1 Front 3 Forward 45° 8 Radial 8 Back 30° **20 Jets Total** **Min Flow #7**	1 Front 8 Radial **9 Jets Total** **Min Flow #4**	1 Front 16 Radial **17 Jets Total** **Min Flow #6**

FM7 SERIES TUBE CLEANING NOZZLES

- For use with Jetstream flex lances that have male M7 Flat Seal end fittings
- Heat-treated stainless steel
- Copper Crush Washer must be installed for seal connection between the nozzle and lance
- Maximum working pressure: 15,000 psi (1034 bar)
- Seven standard patterns and fourteen flow ratings
- Custom patterns available

FB SERIES TUBE CLEANING NOZZLES

- For use with Jetstream flex lances that have male BSPP Flat Seal end fittings
- Heat-treated stainless steel
- Copper Crush Washer must be installed for seal connection between the nozzle and lance
- Maximum working pressure: 15,000 psi (1034 bar)
- Seven standard patterns and 14 flow ratings
- Custom patterns available

FM / FB SERIES TUBE CLEANING NOZZLES

PART NO.	FM7	FB2	FB4
NOZZLES SHOWN AS ACTUAL SIZE			
INLET CONNECTION*	M7 FLAT SEAL	1/8" BSPP FLAT SEAL	1/4" BSPP FLAT SEAL
OUTSIDE DIAMETER	.375 | 9.5 mm	.500 | 12.7 mm	.665 | 16.9 mm
OVERALL LENGTH	.85" | 21.6 mm	.88" | 22.4 mm	1.16" | 29.5 mm
	PATTERNS - NUMBER OF JETS BY LOCATION		
PATTERN 1 FLEX OR RIGID LANCES 	1 Front 6 Back 30° 7 Jets Total **Min Flow #2**	1 Front 6 Back 30° 7 Jets Total **Min Flow #2**	1 Front 8 Back 30° 9 Jets Total **Min Flow #4**
PATTERN 2 FLEX OR RIGID LANCES 	1 Front 12 Back 30° 13 Jets Total **Min Flow #5**	1 Front 12 Back 30° 13 Jets Total **Min Flow #5**	1 Front 16 Back 30° 17 Jets Total **Min Flow #6**
PATTERN 3 FLEX OR RIGID LANCES 	1 Front 3 Forward 45° 6 Back 30° 10 Jets Total **Min Flow #4**	1 Front 3 Forward 45° 6 Back 30° 10 Jets Total **Min Flow #4**	1 Front 3 Forward 45° 8 Back 30° 12 Jets Total **Min Flow #5**
PATTERN 4 FLEX OR RIGID LANCES 	1 Front 3 Forward 45° 8 Back 30° 12 Jets Total **Min Flow #5**	1 Front 3 Forward 45° 8 Back 30° 12 Jets Total **Min Flow #5**	1 Front 3 Forward 45° 12 Back 30° 16 Jets Total **Min Flow #6**
PATTERN 5 FLEX OR RIGID LANCES 	1 Front 3 Forward 45° 6 Radial 6 Back 30° 16 Jets Total **Min Flow #6**	1 Front 3 Forward 45° 6 Radial 6 Back 30° 16 Jets Total **Min Flow #6**	1 Front 3 Forward 45° 8 Radial 8 Back 30° 20 Jets Total **Min Flow #7**
PATTERN 6 RIGID LANCE ONLY 	1 Front 6 Radial 7 Jets Total **Min Flow #2**	1 Front 6 Radial 7 Jets Total **Min Flow #2**	1 Front 8 Radial 9 Jets Total **Min Flow #4**
PATTERN 7 RIGID LANCE ONLY 	1 Front 12 Radial 13 Jets Total **Min Flow #5**	1 Front 12 Radial 13 Jets Total **Min Flow #5**	1 Front 16 Radial 17 Jets Total **Min Flow #6**

* Copper crush washer required for flat seal connections. See table below.

SIZE	PART NO.
M7	59932
1/8” BSPP	59933
1/4” BSPP	59934

TP SERIES THRUSTERS TUBE CLEANING NOZZLES

- Used in combination with Tube Spinners or other nozzles that do not have rear jets to provide thrust for pulling through tubes.
- Rear orifices recessed for protection from surface abrasion or damage by wrenches.
- Female pipe threads at inlet (NPT Fml) and male pipe threads at outlet (NPT Male).
- Machined from heat-treated stainless steel.
- Maximum working pressure: 15,000 psi (1000 bar).
- Three sizes, two standard patterns and thirteen flow ratings.
- Custom patterns available

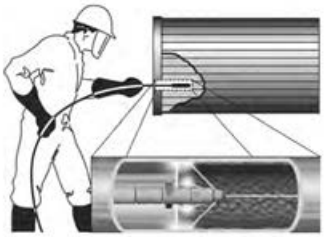
TP SERIES THRUSTERS TUBE CLEANING NOZZLES

PART NO.	TP4	TP5	TP6
NOZZLES SHOWN AS ACTUAL SIZE			
BLANK PART NO.	54709	52138	52151
INLET CONNECTION*	1/4" NPT Female	3/8" NPT Female	1/2" NPT Female
OUTLET CONNECTION*	1/4" NPT Male	3/8" NPT Male	1/2" NPT Male
OUTSIDE DIAMETER	.665" | 16.9 mm	.875" | 22.2 mm	1.040" | 26.4 mm
OVERALL LENGTH	1.63" | 41.4 mm	1.65" | 41.9 mm	2.03" | 51.6 mm
PATTERNS - NUMBER OF JETS BY LOCATION			
PATTERN 1 	8 Back 30° Min Flow #3	8 Back 30° Min Flow #3	8 Back 30° Min Flow #3
PATTERN 2 	16 Back 30° Min Flow #6	16 Back 30° Min Flow #6	16 Back 30° Min Flow #6

ORDERING HPFR/HPFL • HPER/HPEL • HPM NOZZLES

HPX L 3 4-7

1	**NOZZLE SERIES**	HPX
2	**THREADS** L = Left hand medium pressure threads. Omit for right hand Jetstream lance threads.	L
3	**SIZE** 1 = 1/4" Threads 2 = 3/8" Threads 3 = 9/16" Threads	3
4	**PATTERN** Specify number corresponding to desired pattern from chart above	4
5	**FLOW RATING** See flow rating chart. **Example:** a flow rating number of 7 will flow 10.7 gpm (40.6 lpm) at 16,000 psi (1,103 bar).	7



HPFR1 & HPFL1

HPFR2 & HPFL2

HPFR3 & HPFL3

HPFR/HPFL TUBE CLEANING NOZZLES

- Designed for use with flex or rigid lances.
- HPFR nozzles feature right-hand female medium pressure tube connections.
- HPFL nozzles feature left-hand female medium pressure tube connections.
- Recessed orifices provide protection from surface abrasion that could distort waterjets.
- Both series have three sizes with six patterns each and fourteen flow ratings to choose.
- Custom patterns and flows available.

HPER1 & HPEL1

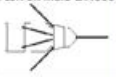
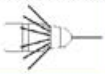
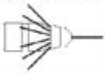
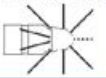
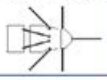
HPER2 & HPEL2

HPER3 & HPEL3

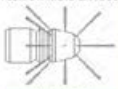
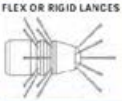
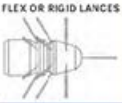
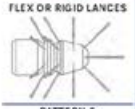
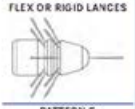
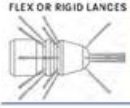
HPER/HPEL TUBE CLEANING NOZZLES

- Designed for use with flex or rigid lances.
- HPER nozzles feature right-hand female medium pressure tube connections.
- HPEL nozzles feature left-hand female medium pressure tube connections.
- Two rows for rearward jets provide extra flushing power while special nose design allows for a greater number and optimal positioning of forward jets for unplugging.
- Both series have three sizes with six patterns each and fourteen flow ratings to choose.
- Custom patterns and flows available.

HPFR/HPFL TUBE CLEANING NOZZLES

NOZZLES SHOWN AS ACTUAL SIZE						
PART NO.	HPFR1	HPFL1	HPFR2	HPFL2	HPFR3	HPFL3
HPF BLANK PART NO.	64259	54242	64260	54243	64261	54244
INLET CONNECTION*	1/4" MP Tube RH Female	1/4" MP Tube LH Female	3/8" MP Tube RH Female	3/8" MP Tube LH Female	9/16" MP Tube RH Female	9/16" MP Tube LH Female
OVERALL LENGTH	.71 in | 18.0 mm	.71 in | 18.0 mm	.87 in | 22.1 mm	.87 in | 22.1 mm	1.15in | 29.2 mm	1.15in | 29.2 mm
OUTSIDE DIAMETER	.375 in | 9.5 mm		.50 in | 12.7 mm		.75 in | 19.1 mm	
PATTERNS - NUMBER OF JETS BY LOCATION						
PATTERN 1 FLEX OR RIGID LANCES 	1 Front 6 Back **Min Flow #3**		1 Front 6 Back **Min Flow #3**		1 Front 8 Back **Min Flow #4**	
PATTERN 2 FLEX OR RIGID LANCES 	1 Front 8 Back **Min Flow #4**		1 Front 8 Back **Min Flow #4**		1 Front 12 Back **Min Flow #5**	
PATTERN 3 FLEX OR RIGID LANCES 	1 Front 3 Forward 6 Back **Min Flow #4**		1 Front 3 Forward 6 Back **Min Flow #4**		1 Front 3 Forward 8 Back **Min Flow #5**	
PATTERN 4 FLEX OR RIGID LANCES 	1 Front 3 Forward 8 Back **Min Flow #5**		1 Front 3 Forward 8 Back **Min Flow #5**		1 Front 3 Forward 12 Back **Min Flow #6**	
PATTERN 5 FLEX OR RIGID LANCES 	3 Forward 3 Radial 6 Back **Min Flow #5**		4 Forward 4 Radial 6 Back **Min Flow #5**		4 Forward 4 Radial 8 Back **Min Flow #6**	
PATTERN 6 FLEX OR RIGID LANCES 	1 Front 3 Radial 6 Back **Min Flow #4**		1 Front 4 Radial 6 Back **Min Flow #5**		1 Front 4 Radial 8 Back **Min Flow #5**	

HPER/HPEL TUBE CLEANING NOZZLES

NOZZLES SHOWN AS ACTUAL SIZE						
PART NO.	HPER1	HPEL1	HPER2	HPEL2	HPER3	HPEL3
HPE BLANK PART NO.	64262	54249	64263	54251	64264	54252
INLET CONNECTION*	1/4" MP Tube RH Female	1/4" MP Tube LH Female	3/8" MP Tube RH Female	3/8" MP Tube LH Female	9/16" MP Tube RH Female	9/16" MP Tube LH Female
OVERALL LENGTH	1.06 in | 26.9 mm	1.06 in | 26.9 mm	1.28 in | 32.5 mm	1.28 in | 32.5 mm	1.62 in | 41.1 mm	1.62 in | 41.1 mm
OUTSIDE DIAMETER	.375 in | 9.5 mm		.50 in | 12.7 mm		.75 in | 19.1 mm	
PATTERNS - NUMBER OF JETS BY LOCATION						
PATTERN 1 FLEX OR RIGID LANCES 	1 Front 2 Forward 2 Radial 6 Back (45°) **Min Flow #5**		1 Front 3 Forward 3 Radial 8 Back (45°) **Min Flow #5**		1 Front 4 Forward 4 Radial 8 Back (45°) **Min Flow #6**	
PATTERN 2 FLEX OR RIGID LANCES 	1 Front 3 Forward 8 Back (30°) **Min Flow #5**		1 Front 4 Forward 12 Back (30°) **Min Flow #6**		1 Front 6 Forward 16 Back (30°) **Min Flow #8**	
PATTERN 3 FLEX OR RIGID LANCES 	1 Front 3 Radial 8 Back (30°) **Min Flow #5**		1 Front 4 Radial 8 Back (30°) **Min Flow #5**		1 Front 6 Radial 12 Back (30°) **Min Flow #7**	
PATTERN 4 FLEX OR RIGID LANCES 	1 Front 2 Forward 3 Radial 6 Back (30°) **Min Flow #5**		1 Front 3 Forward 3 Radial 8 Back (30°) **Min Flow #6**		1 Front 4 Forward 6 Radial 12 Back (30°) **Min Flow #8**	
PATTERN 5 FLEX OR RIGID LANCES 	1 Front 12 Back (30°) **Min Flow #5**		1 Front 12 Back (30°) **Min Flow #5**		1 Front 16 Back (30°) **Min Flow #6**	
PATTERN 6 FLEX OR RIGID LANCES 	2 Front 3 Forward 8 Back (45°) **Min Flow #5**		3 Front 3 Forward 10 Back (45°) **Min Flow #6**		3 Front 4 Forward 8 Back (30°) 8 Back (45°) **Min Flow #8**	

*See details on all connection types in Section I.

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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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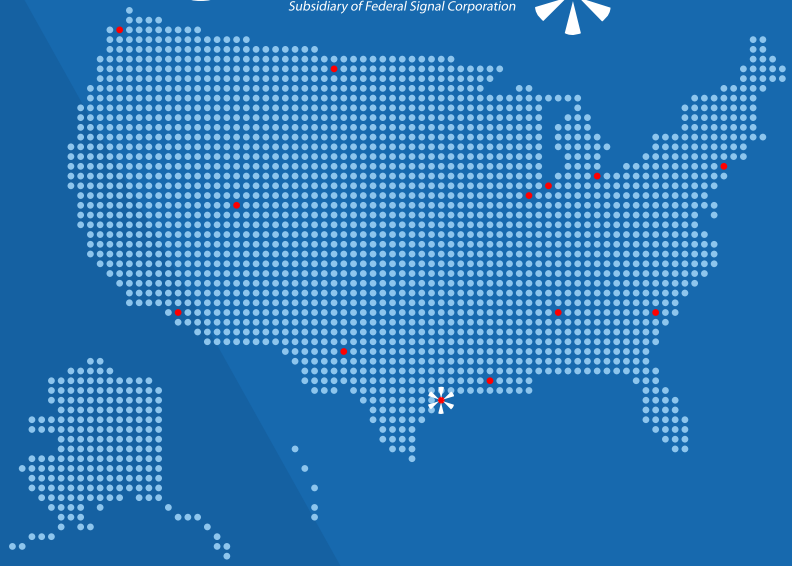

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Capacity ratings, features, and specifications vary depending upon the model and type of service. Application approvals must be obtained from Jetstream; contact your representative for application approval. We reserve the right to change or modify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