NAHAD HOSE SAFETY INSTITUTE.org

Committed to Hose Assembly Safety, Quality & Reliability

NAHAD Hose Safety Institute Whitepaper:
Safety First…the New Normal in High Pressure Hydroblasting

Industry Best Practices for Hydroblast Hose Assembly Applications

Abstract:

This whitepaper represents an on-going effort to document best practices for ensuring safety and reliability of Hydroblast hose assembly applications (5,000 – 55,000 psi). It is intended to represent the consensus of contributing companies and organizations as to the recommended best practices in the design, fabrication, and on-going maintenance of hose assemblies used in Hydroblasting applications, specifically Hydroblasting. (See the end of this document for a list of contributing companies.)

The Industrial cleaning industry operates some of the highest pressure equipment, in what are often the most diverse and time critical applications. Hydroblasting has the potential to be a high risk craft if not managed properly. This white paper is part of a comprehensive approach to ensure worker safety, one which requires equal effort in three critical areas: behavior based safety, standard equipment design and maintenance, and employee training to the standard.

While each area is of equal importance, this paper focuses on best practices in standard equipment design relating to hose assemblies based on input from hydroblasting contractors and hose and equipment manufacturers and distributors.

This whitepaper was developed under the auspices of the **Hose Safety Institute©**, operated by NAHAD, The Association for Hose and Accessories Distribution. The Institute provides a powerful forum for distributors, manufacturers, suppliers, end-users and industry organizations to support and promote hose assembly safety, quality and reliability, across all markets and industries.

The Institute's core deliverables are the ***NAHAD Hose Assembly Guidelines;*** performance standards for hose assembly specification, design, fabrication, handling and management as provided by qualified NAHAD Hose Safety Institute Members.

The Institute is managed by NAHAD's **Standards Committee** and supported by the end-users and industry experts serving on the **Hose Safety Institute Advisory Council.**

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Background:

Hydroblasting services have grown over the last 25 years. Hose management policy and procedures vary across services providers.

- Lack of a comprehensive hose management policy, including marking, inspection, and testing, can put lives at risk.
- Customers, such as major petrochemical companies, have elevated their expectations and now require proof of a hose management policy in order to perform work in their facilities
- Operational consistency across Hydroblast companies, their sites and divisions is required, but few programs offer a complete hose life cycle solution; therefore service provider's costs vary greatly
- No common industry standards exist for the hydroblasting hose, relating to inspection, testing, service life, or common definitions of terms

This paper addresses the need to improve the level of safety for the sourcing, fabrication, and service life issues of high pressure hose applications, largely industrial cleaning applications. Safety processes increase costs, but for these applications, they are critical.

Objective:

This paper delineates recommended best practices to provide guidance to end-users, distributors, and others involved in this business.

Business benefits:

- ***Strategic business model***
  High Pressure Hydroblast hoses are one of the most critical components of Hydroblast Operations. Hose reliability and safety directly affect a provider's ability to deliver safe, productive service. Following practices that increase reliability and safe performance of these components is essential for the continued health and vitality of the business.
- ***Top line impact***
  Clients are attracted to vendors who can provide service in the most safe and cost efficient manner. Providers who can demonstrate processes and strategies which insure the highest standards of safety and hose integrity will gain more business opportunities and consequently grow their top line revenue.
- ***Bottom Line Impact***
  Injuries and downtime due to hose failures lead to costly direct and indirect expenses which will erode any top line revenue gains. Hoses that are safer and have higher integrity protect profits.
- ***Human cost***
  Employees who work for companies with strong hose management programs enjoy higher confidence in their equipment which leads to higher morale and productivity. A

hydroblast injection injury is by nature a recordable injury under OSHA and carries significant treatment costs and lost or restricted workdays.

This whitepaper can be added to over time, may include sections on pre-sale considerations, post-sale in-service issues/recommendations, and whatever else the team deems appropriate.

Primary audience:

- Risk Management Managers
- EH&S Managers
- Senior Management at Hydroblast Services companies
- Client Maintenance Managers
- WJTA-IMCA members (Water Jet Technology Association – Industrial & Municipal Cleaning Association)
- Hose and Accessories Distributors

Call to action: This white paper is a first step towards documenting best practices for the hose and accessory industry. Should be used in conjunction with WJTA-IMCA Recommended Practices for the Use of High Pressure Water Jetting Equipment.

Pre-Sale Considerations

Definitions:

- High Pressure Supply Hose
  Hoses – usually 50' - which supply water from the pump to the accessory hoses or pressure relieving devices. Supply Hose is usually purchased as an independent item.
- Flexible Lance
  A flexible tube (known as lance) or flexible hose (known as a line mole) that carries water to the nozzle located between the foot control valve and the nozzle.
- Shotgun Whip Hose
  A hose – usually between 6-10' - specifically designed to connect to a shotgun (aka hand lance). Usually covered with a protective shroud. Shotgun whip hoses allow for easier disassembly and transport than when a Supply Hose is connected directly to the gun and covered with a protective shroud. Can be purchased independent of a Shotgun or as part of a shotgun kit.
- Jetting Gun/Shotgun
  The hand-operated device that is often used in manual waterjetting. It is normally connected to the high pressure system by a high pressure hose assembly. The gun is made up of a control valve, mounted within a guard, a lance section, and then a nozzle assembly, which may include one or more nozzles. The gun may also include a support bracket and shoulder pad and/or one or more support handles.
- Pump Hose
  High Pressure Hose which is connected on pump between High Pressure block and Supply hose block. Note: Does not include water volume bypass hose.
- Hose Safety Shroud
  A protective covering over a high pressure hose, which is designed to protect the worker from a high pressure water burst should a hose failure occur, or prevent leakage from a threaded connection or weep hole impacting a worker. The shroud should be constructed to prevent the burst from exiting the shroud. The shroud should be designed in a manner as to cover nearby threaded connections and weep holes and be removable to facilitate high pressure hose inspections. Typical shroud length, at minimum, should be six (6) feet. Longer shrouds are acceptable and, in certain situations, should be considered. Hose shrouds should be tagged with both an identification number, unique to each shroud, and a manufacturing date. Due to the sensitive protective position of the shroud, they should be visually inspected before each use.

  Hose shrouds should be used whenever it is likely that the high pressure hose will come into close contact with the worker. Typical applications are shotgun whips and rigid lancing. Typically the two areas of contact are next to the body and near the pump. The hydroblast pump, depending on design, is another area to be considered for high

pressure hose shrouding. Often workers come in close contact with high pressure hoses during normal pump operations.

If any hose failure or burst occurs inside the safety shroud, the safety shroud **shall** be removed from service.

Mark hose assembly with applicable color code per the WJTA-IMCA recommendations.

- 10K Pressure Rating – Yellow
- 15K Pressure Rating – Green
- 20K Pressure Rating – Blue
- 30K Pressure Rating - Silver
- 40K Pressure Rating - Orange
- 55K Pressure Rating - Red

Specification and Design – STAMPED

An effective way to identify application factors that need reviewing prior to defining the proper specifications of a hose assembly is to remember the simple acronym STAMPED.

The STAMPED acronym stands for the 7 major information areas required to provide a quality hose assembly for the customer, as follows:

S stands for **SIZE**; I.D. and length; any O.D. constraints

- overall length should be specified to include fittings
- tolerances need to be specified if special requirements exist

I.D., O.D. and overall length of the assembly

- To determine the replacement hose I.D., read the layline printing on the side of the original hose. If the original hose layline is painted over or worn off, the original hose must be cut and inside diameter measured for size.
- The inside diameter of the hose must be adequate to keep pressure loss to a minimum, maintain adequate flow, and avoid damage to the hose due to heat generation or excessive turbulence.
- Length tolerances should be considered for all types of hose assemblies.
- **Pressure Loss -** The flow rate of the system in conjunction with the inside diameter of the hose will dictate the pressure loss through the hose. Please consult your hose supplier for specific recommended flow rates.

T stands for **TEMPERATURE** of the material conveyed and environmental conditions

- Are there factors such as heat sources in the environment in which the hose will be used
- Continuous (average) and minimum and maximum temperatures have to be specified for the environment
- Care must be taken when routing hoses near hot manifolds and in extreme cases a heat shield may be necessary.
- In subfreezing temperatures, care must be taken to keep water flowing through hoses. All hoses must be drained on completion of the project. In starting in subfreezing conditions, hoses must be flushed to remove ice crystals prior to installing the tip.
- Other things to consider: maximum intermittent ambient temperature, fluid temperature, ambient temperature and maximum temperature.

A stands for the **APPLICATION**, the conditions of use

- Configuration/routing (add a sketch or drawing if applicable)
    - is the hose hanging, laying horizontally, supported, unsupported (orientation and aspect of the hose)
    - what else is attached to the hose, any external load on the hose
    - bend radius requirements, flexibility
- Quantify anticipated movement and geometry of use requirements
- Intermittent or continuous service

- Indoor and outdoor use
- Unusual mechanical loads
- Excessive abrasion
- External conditions – abrasion, oil (specify type), solvents (specify type), acid (specify type and concentration), ozone, salt water, ultraviolet (UV) radiation (sunlight)
- Hose now in use
    - Type of hose
    - Service life being obtained and description of failure or source of customer dissatisfaction
- strength and frequency of impulsing or pressure spikes
- non-flexing applications (static), flexing applications (dynamic)

M stands for the **MATERIAL or MEDIA** being conveyed, type and concentration

- Are there special requirements for this hose tube
- Media velocity, flow rate

P stands for the **PRESSURE** to which the assembly will be exposed

- System pressure, including pressure spikes. Hose assembly working pressures must be equal to or greater than the system pressure. Pressure spikes greater than the maximum working pressure will shorten hose life and must be taken into consideration.
- Temperature implications
- **Maximum Operating Pressure -** This is the maximum pressure that the system should be exposed to in normal operating conditions. This pressure should be dictated by the relief setting of the system. Both the hose and hose end should not be rated to a pressure less than the maximum operating pressure of the system.
  Pressure Spikes - When a system is subjected to a large load in a short period of time, the system pressure can overshoot the relief setting and exceed the maximum operating pressure. Frequent pressure spikes can reduce the life of hose assemblies.

E stands for **ENDS**; style, type, orientation, attachment methods, etc.

- Specify end style
- Materials and dimensions (steel, stainless, etc.)

D stands for **DELIVERY**

- Specific to customer requirements
- Testing and certification requirements
- Any special packaging requirements
- Any special shipping requirements
- Tagging requirements

Hose Assembly Fabrication Considerations

Fabrication of hose assemblies should be done in accordance with industry best practices supplemented by specific manufacturer instructions. Locations where assemblies are fabricated should be certified by the appropriate manufacturer.

Fabrication of hose assemblies shall be done in accordance to the specific manufacturer instructions supplemented by industry best practices. Locations where assemblies are fabricated should be certified by the appropriate manufacturer.

As part of the fabrication process, assemblies should be proof tested to ensure the integrity of the product when first made. Inspection and re-testing of in-service assemblies should be conducted annually. Field inspection should be conducted prior to each use as well as end of job use.

For assembly handling, storage and shipping best practices, please refer to the appropriate sections found in NAHAD's Hose Safety Institute Handbook©.

Documentation of assemblies should be thorough and trackable in conformance with a formal hose management program including tagging of assemblies through a formal marking scheme, and a formal tracking process. See *In-Service Considerations* for more details.

Specific remediation of hoses which have been taken out of service is beyond the scope of this document. Repair and Remediation of hoses should be done in accordance with industry best practices.

In-Service Considerations

Background - As of 2013 Hydroblast Hoses are typically managed as a consumable item. They are run until failure or significant hose degradation and then discarded and replaced. Hose life guidelines either do not exist or are not widely known or published. Visual inspection and periodic testing varies between End User companies, Distributors and Manufacturers. Many manufacturer recommendations are vague. Standards should be written which give clear instruction to workers on proper use, inspection and handling of Hydroblast hoses.

General –Workers and non-expert observers should be able to easily identify Hydroblast hose characteristics on the job site. Hydroblast End Users should understand and follow established guidelines and written recommendations regarding Hydroblast hose use and inspection. End User companies should ensure that employees working with Hydroblast hose are trained and competent in these recommendations.

Hose Management Program

Hoses should be managed as an individual asset from fabrication of hose until end of useful life. Such management should include the following:

- An asset management program should include the following
    - Methods to track hose from initial fabrication until end of hose life
    - Methods to alert end user companies of scheduled inspections
    - Methods to alert end user of end of life so hose can be removed from service
    - A policy of hose life expectancy
    - Records confirming results of inspection program and asset certification
    - Techniques for proper marking of assets (e.g., mechanically etched ferrules)
- A proper use and care program should include the following
    - Manufacturer and Distributor recommendations
    - Proper handling of hose
    - Proper storage of hose
    - Do's and Don'ts for hose handling while in service.
- An inspection program should contain
    - Field visual inspection criteria
    - Periodic pressure test and integrity protocols
- A failure inspection program should contain
    - Definition and Types of hose failures
    - Methods for reporting hose failures
    - Methods for investigation hose failures
    - Methods for implementing lessons learned across the organization
- A training program should contain
    - All of the above programs
    - Documented hands on competency verification

Program Considerations

Service life

The recommended service life of Hydroblast hose is dependent on the care it receives, the application it is being used in, and a thorough inspection program. The maximum recommended service life of a Hydroblast hose is as follows:

- High Pressure Supply Hose: Four years from receipt
- Lance Hose: Two years from receipt
- Shotgun Whip Hose: Two years from receipt
- Pump Hose: Four years from fabrication

Inspections

A hose and fitting maintenance program can reduce equipment down time and maintain peak operating performance. Hoses should be inspected and pressure tested in house or by a third party prior to placement into service and whenever a defect is suspected or at a minimum of annually. A visual inspection should be conducted prior to each use as well as end of job use.

Inspections should include

- Visual inspection
- Pressure testing
    - New hoses and hoses for re-certification should be pressure tested at between 1.2 and 1.5 times maximum allowable working pressure for a minimum of 30 seconds; consult manufacturer for specific requirements.
- Inspection Results Documentation

Visual Inspections

The hose and fittings shall be visually inspected for:

A. Leaks at the hose fittings or in the hose.
B. Damaged, separated or pulled back covers
C. Cracked, damaged, deformed or badly corroded fittings.
D. Other signs of significant deterioration such as blisters.
E. Compromised reinforcement where the wires are exposed and show signs such as unwrapped, broken or corroded.
F. Dents, twists, or kinks
G. Discoloration of color coded hose cover
H. Verify test date and pressure are in conformity with requirements for the application.
I. Fitting Thread and seat condition

In addition to the above conditions, do not place any High Pressure Supply Hose in service that has visible or exposed reinforcing wires and immediately remove from service if there are compromised reinforcing wires.

Visual Inspection Checklist

Visually inspect hose before each use. Immediately remove Hoses from service upon finding any of the following conditions:

- ☐ Leaks at the hose fittings or in the hose.
- ☐ Damaged, separated or pulled back covers
- ☐ Cracked, damaged, deformed or badly corroded fittings.
- ☐ Other signs of significant deterioration such as blisters.
- ☐ Compromised reinforcing wires.
- ☐ Dents, twists, or kinks
- ☐ Discoloration of color coded hose cover
- ☐ Verify test date and pressure are in conformity with requirements for the application.
- ☐ Check thread and seat connections

In addition to the above conditions, do not place any High Pressure Supply Hose in service that has visible or exposed reinforcing wires and immediately remove from service if there are compromised reinforcing wires.

Note: pressure should reflect:
(Applicable color code per the WJTA-IMCA recommendations)

- 10K Pressure Rating – Yellow
- 15K Pressure Rating – Green
- 20K Pressure Rating – Blue
- 30K Pressure Rating - Silver
- 40K Pressure Rating - Orange
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Symptoms and Causes of hose failures

1. Symptom: The hose is cracked or cut externally showing wires but the elastomeric materials are soft and flexible at room temperature.

Hose starting to show cracking:

Cause: The probable reason is intense cold ambient conditions while the hose was flexed. Generally most hoses are rated to –40°F (–40°C). Some specialty hoses are rated at –57°F (–49°C). Ozone may cause rubber hose to get brittle.

2. Symptom: The hose has ruptured and examination of the wire reinforcement after stripping back the cover reveals random broken wires the entire length of the hose.

Cause: This would indicate a high frequency pressure impulse condition.

3. Symptom: The hose has ruptured, but there is no indication of multiple broken wires the entire length of the hose. The hose may have burst in more than one place.

Hose has burst. An examination indicates the wire reinforcement is rusted and the cover has been cut, abraded or deteriorated badly

Cause: This would indicate that the pressure has exceeded the minimum burst strength of the hose. The primary function of the cover is to protect the reinforcement. Elements that may destroy or remove the hose covers are:

1. Abrasion
2. Cutting
3. Battery Acid
4. Steam Cleaners
5. Chemical Cleaning Solutions
6. Muriatic Acid (for cement clean-up)
7. Salt Water
8. Heat
9. Extreme Cold
10. Ozone

Once the cover protection is gone the wire reinforcement is susceptible to attack from moisture or other corrosive matter.

4. Symptom: Hose appears to be flattened out in one or two areas and appears to be kinked. It has burst in this area and also appears to be twisted.

Cause: Torque on a hose will tear loose the reinforcement layers and allow the hose to burst through the enlarged gaps between the wire strands.

5. Symptom: Hose has ruptured about six to eight inches away from the end fitting. The wire reinforcement is rusted. There are no cuts or abrasions of the outer cover.

Cause: Improper assembly of the hose end fitting allowing moisture to enter around the edge of the fitting socket. The moisture will wick through the reinforcement. The heat generated by the system will drive it out around the fitting area but six to eight inches away it will be entrapped between the inner lining and outer cover causing corrosion of the wire reinforcement.

6. Symptom: Fitting ejected from the end of the hose.

Cause: It may be that the wrong fitting has been put on the hose. Recheck manufacturer's specifications and part numbers. In the case of a crimped fitting the wrong machine setting may have been used resulting in over or under crimping. This could also be caused from end fitting damage.

7. Symptom: Hose has burst. The hose cover is badly deteriorated and the surface of the rubber is crazed.

Cause: This could be simply old age. The crazed appearance is the effect of weathering and ozone over a period of time. Try to determine the age of the hose. Some manufacturers print or emboss the cure date on the outside of the hose. As an example, "1Q08" would mean that the hose was manufactured during the first quarter (January, February or March) of 2008.

8. Symptom: A hose has ruptured and literally split open with the reinforcement wire integrity destroyed.

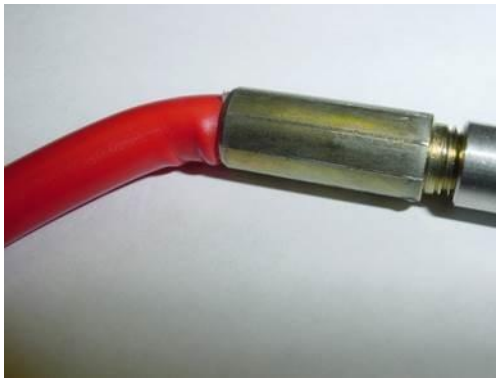
Cause: Over-pressurization, external damage, wear of the cover. The hose is too short to accommodate the change in length occurring while it is pressurized.

9. Symptom: The hose cover looks flattened.

Cause: Flattening of the cover could be a potential failure to the hose tube. Running over a hose will cause inner tube damage. A heavy object could fall on the hose also causing a tube failure. A kinked or flattened wire reinforced hose may be subject to premature failure.

10. Symptom: The hose has not burst but it is leaking profusely. An examination of the hose indicates that it was twisted and kinked close to the end fitting. Analysis of the hose reveals that the tube has ruptured inwardly.

Kinked at end fitting:



Cause: Hoses are not designed to be twisted or kinked. The inner tube can be damaged without visibility. A kinked or flattened wire reinforced hose may be subject to premature failure.

11. Symptom: Loss of pressure occurred during operation.

Cause: Cut to the outer cover which could have occurred during operation.

12. Symptom: Potential cause for imminent failure: cover removed to find that the hose wires are showing. .

Cause: Cover worn through to the hose cover.

13. Symptom: hose fitting blew from the hose end

Cause: Corroded and damaged end fitting

14. Symptom: Hose pressure loss

Cause: Cover pulled from beneath crimp sleeve.

Participating Companies:

Clean Harbors

GHX Industrial, LLC

NAHAD – the Association for Hose and Accessories Distribution

Parker Hannifin

PSC

SpirStar

WJTA-IMCA (Water Jet Technology Association – Industrial & Municipal Cleaning Association)

References:

WJTA-IMCA Recommended Practices for the Use of High Pressure Water Jetting Equipment

NAHAD's Hose Safety Institute Handbook©