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SAFE WORKING CONDITIONS FOR THE WATER JET TECHNOLOGY

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ABSTRACT: Water-jet cutting technology provides new possibility to shape cutting and various material cold cutting without heat influence of material on cutting edge. However, the power of the water jet overcomes expectation of a people that are not familiar with the technology. Work safety with water-jet in various production technologies must make provision for not only safety work with water-jet technology, but also safety work with all devices, which are on that workplace situated and also material manipulation. So, the paper is focused on some of the safety aspects at the water-jet workplaces.

KEYWORDS: Water-jet cutting technology, cold cut, safety

INTRODUCTION

Water-jet cutting technology represents unique, for the future oriented possibility of high automation introduction at high-speed cutting really all material types. In 30-thy year's American and Russian engineers first time tried to use water stream in mining, demarcating by high speed and that for coal, stone and rock mining. In the end of 60-thy year's one American airplane producer decided, that he use water jet cutting for processing of fleeced bonded textiles, plastic materials and materials folded from more layers. High-pressure cutting with water stream, which is named also Water jet-Cutting, was afterwards continuously developed. Important impulse for water jet using in production technique like tool has came from aircraft designing and astronautics.

TECHNOLOGY WATERJET - SAFETY WORK WITH WATER-JET

The water-jet cutting principle is visible on following Figure 1.

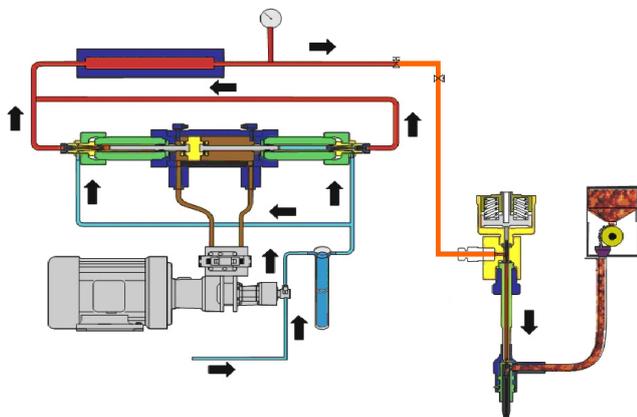


Figure 1. The principle of water-jet cutting - hydro-abrasive method

Safety processes and safety practices of water jet technology must be monitored during introducing to the operation, during lonely operation and maintenance of high pressure pumps. In this area has created tables and symbolic descriptions used in real practice, which is needed to follow at operation of workplaces for water jet material separation. The Table 1 shows the most important symbolic descriptions of water jet.

Table 1. Tables and abbreviations for safety at work with water-jet

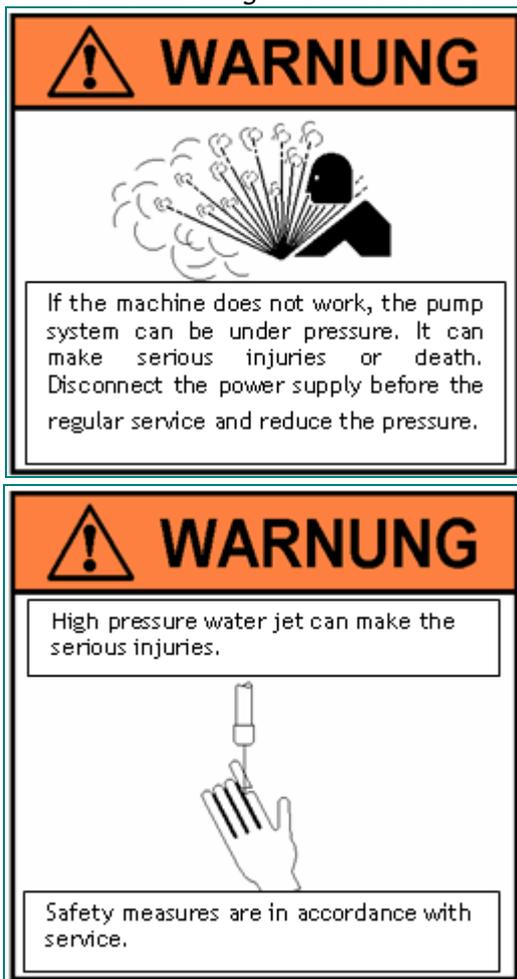
CAUTION	Show on dangerous, which can cause personal injuries or property damage, if care instructions are ignored.
WARNING	Show on dangerous, which can cause serious personal injuries, death or substantial property damage, if warning is ignored.
	High pressure of water stream can cause eyes injuries. Protect your eyes, when you work near the machine.
	Dangerous noise can cause hearing loss. Protect your ears, if you work near the machine.
	Dangerous electric tension can cause injury or death. Before opening the case unplug and disconnect main electric supply.
	Wrong function
	Hydraulic multipliers

Table 1. Tables and abbreviations for safety at work with water-jet (continue)

	Pressure control
	High pressure
	Low pressure
	Start/Initialization
	Stop
	Running

The Table 2 explains the warning label precautions at water jet operations. The great injuries can be made also when the machine does not work, but the pump system was not switch off. After following starting of work on machine, the high pressure of water jet can injure the person as cutting injuries.

Table 2. Warning Label Precautions



In the Table 3 is shown the important symbols from the point of view of maintenance and service.

Table 3. Warning Label Precautions

	<p>The electrical enclosure and motor junction box can present an electrical shock hazard. Always disconnect and lockout the main power before opening the enclosure. You must always disconnect and lockout the main power and the circuit disconnect on the electrical enclosure door before performing any type of maintenance.</p>
	<p>The surface of high pressure water and hydraulic components becomes hot during normal operation. Failed or failing components can become extremely hot during operation.</p>
	<p>Ensure that all protective guards, shields or covers are in place on the equipment at all times. Never operate the pump with the guards removed.</p>
	<p>High pressure water and/or hydraulic pressure can remain in the system even when the pump has been shut off. All pressure can be safely bled from the system by opening the high pressure cutting water valve for a few seconds after shutting off the pump. Pressing the EMERGENCY STOP button turns the control power to the intensifier off, stops the pump and bleeds the high pressure water through the safety dump valve. Depressurization of the high pressure system creates a loud hissing sound when the dump valve opens. The sound fades quickly as the pressure drops.</p>
	<p>All personnel involved in the installation, operation and/or service of the intensifier must carefully read, understand and follow the procedures in this manual to avoid creating unsafe conditions, risking damage to the equipment, or personal injury.</p>

SAFETY PROCESSES

Safety procedures must be following while it is worked with high pressure pump, with some its high pressure part. Such pump can operate only by qualified person. It is concerned at following safety procedures:

- High pressure of water from 3800 to 4150 bar (55 to 60 000 psi) at water-jet cutting systems should not be reason for disconcertment. User must have respect before that pressure and use current safety processes and safety working practices.
- Everyone, who is connected with water-jet cutting system must realize, that power of water-jet

cutting stream can penetrate into many hard and strong materials.

- Not qualified personal must not move in water-jet cutting area.
- In water-jet cutting area must be all time used safety glasses and earmuffs.
- All emergency STOP buttons must be regularly checked. During normal operation are pulled out.
- Check of buttons: Turn on electric supply and activate emergency STOP button so, that are pushed, you must see, if energy exploding. Every device should be checked according special table. All the time, when device is checked, must function or must be returned into the original status before the start of operation.
- Use high clean lubricating wax for all threaded high-pressure connections. All piping, assembled and screwed connections should be tightened into the recommended moment values. If the circuit is under high pressure, do not try tight or install any high pressure parts, see safety of high pressure tubing.
- All high pressure leakages must be immediately repaired.
- Check all equipment according tables.
- Before maintenance starting, turn off the main stop and ensure that high pressure is released.

SAFETY OF THE HIGH PRESSURE TUBING

Tubing with high pressure must be installed without stress in torsion. Suitable support and direction must be ensured. 9/16" external diameter of high pressure pipes and armatures are recommended between the pump and the cutting head.

Tubes of these big dimensions will decrease vibration, tension and bend between pump tubing and cutting area. Bigger tubing diameter also decreases the pressure and pressure pulsation.

GENERAL MAINTENANCE FROM POINT OF VIEW OF WORK SAFETY

Suitable maintenance is important for reliable and rigorous performance. Preventive maintenance reduces stoppage time for repairing, provides bigger operating life of parts and increases work safety.

High-pressure water will cut almost all what reaches. Every infiltration must be immediately repaired to prevent damage or serious personal injury.

Maintenance directions are following:

- Regular equipment checking is recommended,
- Keep equipment and surroundings clear,
- Check pressures, temperatures and seal tightness,
- Immediately execute repairing,
- Maintenance record should be saved.

Working environment at water jet operations:

- Keep clear working environment for repair and maintenance waterjet pump.
- Use clear working table for repairs and clear working environment.
- Use not woolen materials for wiping.
- If parts with compressed air are released, use only clear, dry air. If parts are wash solvent, use only clear filtrated liquid.
- Always use original spare parts from producer for original version, reliability, safety and guarantee protection.

Safety recommendations for working persons:

- Carefully read the safety instructions.
- Turn off all electric power.
- Shut all incoming delivery valves and open all unwatering valves.
- Shut injection and transfer valves, if energy is closed, safety exiting valve will open and release water high pressure hidden in releasing tubing.
- Ensure suitable drawer, bowl, tanks, etc. For fixation and detention liquid to avoid of hazardous working environment.
- Abide double control for ensuring, that all pressure is removed from system before you continue in work.
- Especially medical treatment is required always at treatment of wounding by waterjet according to card for emergency rescue. This card is part of technology delivery.
- Avoid of leaking, sharpen abrasions or bend loads, if work with expensive technology parts.
- Ensure, that all parts are clean, without sharpen edges, particulates, dirt, etc.
- Use high clean lubricant wax, if assemble some high pressure part or set.
- After repair any high-pressure part, check all high pressure connections for releasing of pressure.

CONCLUSIONS

Work safety with water-jet in various production technologies must make provision for not only safety work with water-jet technology, but also safety work with all devices, which are on that workplace situated and also material manipulation.

In case of other workplace devices, manipulation with material, interoperable transport, storage, control and overall work environment, i.e. production logistic, safety regulations valid for technology operation are applied and followed, in accordance with law, in terms of Inspectorate of work safety and State health authority.

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