



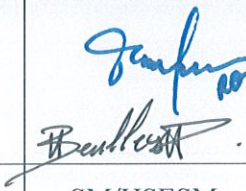

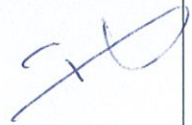
PETROCHEMICAL SHARED SERVICES (PSS) PROCEDURE

High Pressure Water Cleaning (HPWC) HSE Procedure




Procedure Number: PR-250-HSE-05

Document Classification: Internal

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  	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 2 of 27

Revision / Modification History:

Rev #	Date	Section No.	Reason for revision / modification
00	15/04/2016		New procedure
01	11/03/2019		<ul style="list-style-type: none"> • Updated Objective and Scope • Updated Procedure Summary • Added two levels of high pressure washing such as; • High pressure water cleaning • Ultra-high-pressure cleaning • Updated requirements for Safe Operation of HPWC, adding Stoppers and Centralizers for tube & pipe cleaning • Updated Personal Protective Equipment requirements • Updated work areas barricades system (Hard and Soft Barrier system) • Revised training needs and level of competency for different crafts involved • PR-250-HSE-05- CL-01 Pre Job Assessment Checklist revised to accommodate TGM Approval for Ultra High Pressure cleaning
02	17/08/2021	8.2.1 (h) Appendix	<ul style="list-style-type: none"> • Rearrange the procedure as per new document structure and align. • Add neck protection requirement for Hydrojetter • Update the LMRA and Pre- Mob equipment inspection • Remove the Pre-Job assessment


Review Team: (*Optional*. May be used when a team is used for reviewing the document)

Rev #	Job Title	Department	Remarks

  	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 3 of 27

Contents

1. OBJECTIVE	4
2. SCOPE	4
3. PROCEDURE SUMMARY	5
4. ABBREVIATIONS / DEFINITIONS	5
5. DOCUMENT REFERENCES	6
5.1 Risk Register Reference	7
6. IT SYSTEM REQUIREMENTS	7
7. RASCI SUMMARY	7
8. PROCEDURE METHOD	7
8.1 HAZARD IDENTIFICATION & RISK ASSESSMENT	9
8.1.1 Specific Risk Assessment (Rules to Reduce the Risk):	11
8.1.2 Execution of HPWC:	11
8.1.3 Work areas, barricades and signs (Hard and Soft Barrier system)	13
8.1.3.1 First line of defense (Hard Barricade System)	14
8.1.3.2 Second line of defense (Soft Barricade System)	14
8.1.4 HPWC equipment minimum requirements.	17
8.2 SAFE OPERATION OF HPWC	17
8.2.1 PERSONAL PROTECTIVE EQUIPMENT	19
8.2.1.1 PPE REQUIREMENT FOR HPWC ACTIVITIES > 1500 bar	19
8.2.1.2 PPE Requirement for less than 1500 PSI cleaning activities:	21
8.2.2 OPERATIONAL ROLES AND COMMUNICATION	22
8.3 MONITORING:	25
8.4 TRAININGS	25
8.4.1 Craft based Training Matrix:	26
9. RECORDS	27
10. APPENDIX	27
10.1 SERVICE LEVEL DEFINITION	27
10.2 PR-250-HSE-05- CL-01 - HPWC EQUIPMENT INSPECTION CHECK LIST	27
10.3 PR-250-HSE-05- CL-02 - HPWC LMRA	27
10.4 PR-250-HSE-05- F01 - SAMPLE JSA FOR HPWC TASK	27

	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 4 of 27

1. OBJECTIVE

The objective of this procedure is to outline the criteria for high pressure water cleaning (HPWC) activities and to minimize, control the high risks and hazards associated with it. It also describes the precautions required to protect personnel from the potential exposure to hazards associated with high pressure water cleaning (HPWC) operations.

This objective of this procedure is also to:

- Help identify the hazards involved with this type of activity at QAPCO.
- Help parties (QAPCO and contractors) to prevent accidents when cleaning with high or very high-pressure water jets.




2. SCOPE

This procedure applies to all high-pressure water cleaning activities carried within QAPCO facilities where the HPWC can generate a pressure of 1,500 psi or more.

This procedure will ensure that everyone who is involved in the HPWC High-Pressure Water Cleaning (Hydro Jetting) work activity is aware of the potential and residual risks that are involved with the task being performed and outline the roles and responsibilities of the parties involved in executing a job.

Note: *Pressure below one thousand five hundred (1,500) psi does not mean that it cannot cause injury or requires any less attention. An adequate precautions are required at all pressures.*

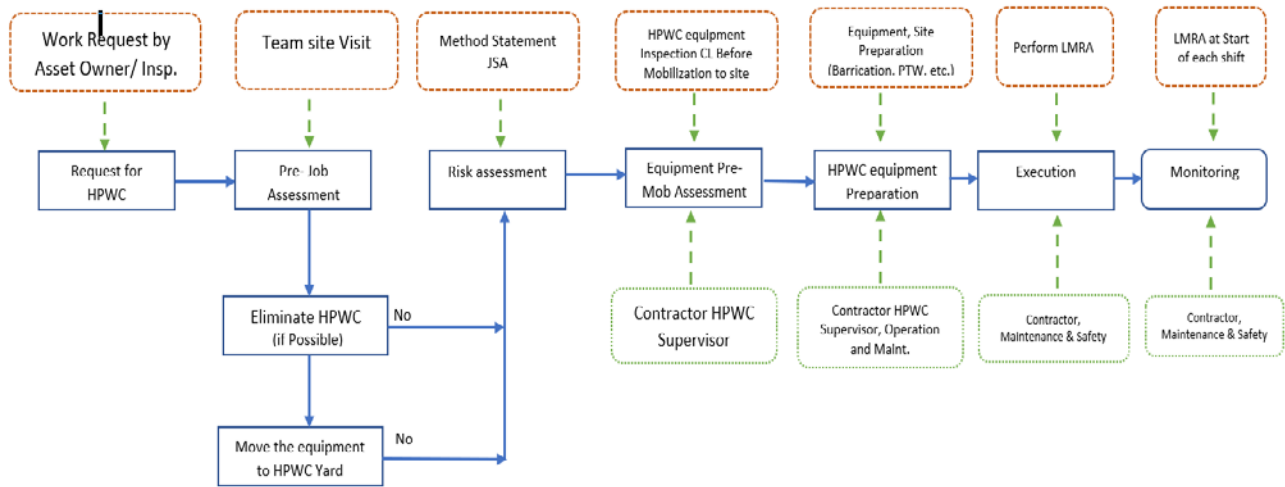
This procedure is not applicable for activities such as car wash.

  	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 5 of 27

3. PROCEDURE SUMMARY




High pressure water jet cleaning (hydro jetting) is a very efficient cleaning method. However, because of the very high pressures involved, it is also potentially dangerous if used incorrectly. It is, therefore, necessary that personnel required to operate high pressure water jet cleaning equipment are trained and competent in the correct use of the equipment, before using the equipment.

High Pressure Water Cleaning (HPWC) Operation Flow Chart



4. ABBREVIATIONS / DEFINITIONS




#	Abbreviation / Key word	Definition summary
1.	HPWC	The term HPWC High-Pressure Water Cleaning covers all water cleaning; including the use of additives or abrasives at pressure indicatively above one thousand (1,500) pounds per square inch (psi)
2.	CHSEQO	Chief HSEQ Officer
3.	MGM	Manufacturing Group Manager
4.	TGM	Technical Group Manager
5.	COO	Chief Operations Officer
6.	Competent person	A person who has acquired through training, qualification or experience, or a combination of these, the knowledge and skills enabling that person to perform the task required
7.	HPWC Contractor Supervisor	A competent person assigned by contract (HPWC Company) to plan, prepare and execute the HPWC activities at QAPCO site.
8.	Responsible Executer	QAPCO maintenance/Engineering/operation responsible person organize, arrange and supervise the HPWC Job.
9.	Asset Owner Manager	Area/ equipment owner where HPWC job will be performed.

  	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 6 of 27

#	Abbreviation / Key word	Definition summary
10.	Flexible lance	A flexible tube used to feed a nozzle through an enclosed space such as a pipeline. The flexible lance is most commonly used where a tube contains one or more bends.
11.	Foot control valve	The operator's control valve may be arranged for actuation by the operator's foot if desired, either in place of, or in addition to, hand-control
12.	Jetting gun	A portable combination of operator's control valve, lance and nozzle, normally resembling a gun in arrangement.
13.	Flexible lancing	An application of a lance made up of reinforced tube but flexible enough to bend. It is primarily used manually and in rare cases, it could be automated.
14.	Mechanic Rigid Lancing	An application of a lance made of SS tubing and mounted on an automated feeder. Cleaning is affected by air driven lance inserted into, and retracted from exchanger tubes. It is propelled by air driven motors.
15.	Nozzle	A device with one or more openings (orifices) where the fluid discharges from the system. The nozzle restricts the area of flow of the fluid, accelerating the water to the required velocity and shaping it to the required flow pattern and distribution for a particular application. Combinations of forward and backward nozzles are often used to balance the thrust. Such nozzles are commonly referred to as tips, jets or orifices.
16.	Operator	A person who has been trained/certified by 3rd party and has demonstrated the competence necessary to perform an assigned water jetting related task.
17.	R	R = Responsible (the class of people who are ultimately responsible for getting the work done)
18.	A	A = Accountable (the position that is accountable to oversee that the work gets done)
19.	S	S = Support (the person who supports by providing information and suggest any deviations from the Procedure)
20.	C	C = Consulted (the person who can advise when needed)
21.	I	I = Informed (concerned persons who are required to be informed or communicate to)
22.	Contract Holder (Coordinator):	A person appointed within the Contract Sponsor Department/User Department who is responsible for managing & execution of contract.

5. DOCUMENT REFERENCES

#	Document ID	Document name	Summary of dependency or use
1	M-250-PSS-01	HSE Integrated Management System Manual	Detail information about health and safety Management system
2	PR-PSS-113	Contractor HSE Management	Detail contractor evaluation requirements
3	PR-PSS-114	Permit to Work Procedure	Work authorization guidelines and instructions
4	AS/NZS 4233.1 2013	High Pressure Water (Hydro) Jetting System	Reference for further information

  	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 7 of 27

5.1 Risk Register Reference

#	Risk ID	Risk Description	Remarks
1	QPO_HSEQ_20_003	Failure to ensure safety of work environment leading to fatalities, LTI, TRI, major process incidents and professional sickness	No

6. IT SYSTEM REQUIREMENTS

#	IT system module name	Summary of IT system module use
	N/A	N/A

7. RASCI SUMMARY

#	Procedure chapter	HPWC Contractor Supervisor	Asset owner	Concerned execution Manager	Responsible executor/ Contract	Contractor Manager	Safety representative
8.1	Hazard identification and Risk assessment	R	S	A	R	R	S
8.2	Safe Operation HPWC	R	S	A	R	R	S
8.3	Monitoring	R	S	A	R	R	S
8.4	Training	R	S	A	R	R	S

Legend:

R = Responsible (the class of people who are ultimately responsible for getting the work done)

A = Accountable (the position that is accountable to oversee that the work gets done)

S = Support (the person who supports by providing information and suggest any deviations from the Procedure)

C = Consulted (the person who can advise when needed)




I = Informed (concerned persons who are required to be informed or communicate to)

8. PROCEDURE METHOD

- a) The term “High pressure washing” refers to a high-pressure washing system capable of generating a pressure of 1,500 psi or more.

There are two levels of high pressure washing, based on water pressure used:

1. High pressure water cleaning – 1,500 to 40,000 psi

  	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 8 of 27

2. Ultra-high-pressure cleaning – greater than 40,000 psi

b) Ultra-high pressure cleaning – greater than 40,000 psi.

The usage of such pressure is strongly not recommended, in rare cases if it is required the concerned department managers (Ex; Production, Maintenance, ESD) including Safety Manager, Subject Matter Expert (SME) on Ultra High Pressure water cleaning* and Contractor Manager shall convene a meeting to discuss the hazards and special precautions required. Highly experienced and certified craftsmen shall be involved to handle such pressure after conducting risk assessment (JSA) and proper mitigations identified and implemented.

Note: *The approval to carry out Ultra-high pressure cleaning shall be obtained from Technical Group Manager (TGM). TGM shall review and endorse proper mitigations and protective measures.*

* Subject Matter Expert, also referred to as SME, is a person who has special skills or knowledge on Ultra High Pressure water cleaning. He could be within QAPCO, Contractor or Third Party Consultant.

c) The term “pressure washing” typically refers to a washing system capable of generating less than 1,500 psi. Such systems are used for car wash, or in the form of portable equipment designed for light commercial use. Pressure above 1,500 psi and up to 40,000 psi shall be considered as High-pressure water cleaning.

d) Conversion Table:

Pound force per square inch (psi)	Bar
01	0.07
14.5038 psi	01
1,500	68.94
40,000	2758
Pound force per square inch (psi)	Kilo Pascal (kPa)
1	6.894

Pound force per square inch to Bar formula

$$\text{Bar} = \text{psi} / 14.50$$

Bar to Pound force per square inch formula

$$\text{psi} = \text{bar} * 14.504$$


Psi to Pascal formula

$$1 \text{ psi} = 6894.76 \text{ Pa}$$

$$1 \text{ Pa} = 0.0001450377 \text{ psi}$$

Example: convert 15 psi to Pa:

$$15 \text{ psi} = 15 \times 6894.7572931783 \text{ Pa} = 103421.35939767 \text{ Pa}$$

	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 9 of 27

Bar to Pascal formula

1 bar = 100000 Pa

1 Pa = 1.0E-5 bar

Example: convert 15 bar to Pa:

15 bar = 15 × 100000 Pa = 1500000 Pa

8.1 HAZARD IDENTIFICATION & RISK ASSESSMENT

a. General Hazards:

High pressure water cleaning is a HIGHLY HAZARDOUS and complex operation and should only be used when other less hazardous methods have been considered and ruled out as ineffective or inefficient. High pressure water jet can travel at speed exceeding 3.330 Km/h, so it can cause serious injury or death:

- Perforation, cut or severing a part of the body,
- Body trauma,
- Electrocutation (when electrical source nearby),
- Hearing loss,
- Physiological fatigue,
- Asphyxiation, intoxication, or chemical burns when using chemicals or abrasive materials
- No portion of the body shall ever be placed in front of the water jet. Water jet can easily puncture and tear the skin or penetrate deeper causing infection or serious internal damage.


Note: Any person struck on the skin by the high-pressure water jet shall be medically assessed. The injury may be more severe than apparent.

b. Operational Hazards:

There is a high risk of puncture, cutting and severing if part of the body is exposed to the high pressure jet from the nozzle or to a leak in the high pressure circuit either directly or indirectly after deflection by an obstacle.

The resulting injuries are always very serious, sometimes fatal. Accidents are mainly due to the following:

- Use of safety extension inappropriate to the diameter of the duct to be cleaned (nozzle with backward jet: risk of flipping)
- Obstructions near the inlet (nozzle ejection)
- The “rocket” effect (nozzles with forward jets: nozzle propelled backwards by the jet’s thrust). See below figure # 1
- Material projected throughout the opposite end of the tube being cleaned
- The nozzle exiting from the opposite end of the tube being cleaned
- A rupture in the hose connection (in the absence of a coupling protection sheath)

	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 10 of 27

- The loosening of the nozzle
- Unwanted system starts up
- Using a shot gun that enables the jet to flip over against a part of the body. The gun length must never be less than 1.5m (between the nozzle outlet and the trigger protection ring)
Note: In some circumstances (operating in confined spaces) it may be necessary to use a length < 75cm (29 inches). The risk of injury in this case is much higher than in normal condition.
- The absence or inoperability of the gun's hold-to-run control(s) available
- Flying debris from the cleaning operations.
- Release of hazardous materials into the atmosphere from dislodged deposits,
- Noise of the cleaning operation that may damage hearing or drown out the sound of an emergency alarm
- Difficulty in breathing in confined space due to the high water vapor content in the air
- Electrostatic charging of nozzles and lances
- Reactive force generated by the discharge of water, creating a backward thrust against the nozzle holder.
- The piston effect (water and Material flashback)

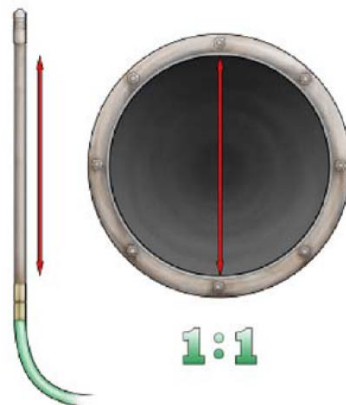


Figure # 1


Rocket Effect

a stinger with a length equal to the maximum inside diameter of the pipe will prevent the nozzle from turning back on itself inside the pipe (line reversal).

c. Danger of setting mobile parts in motion

Due to pressure, some parts of objects may hit an individual and cause direct bodily trauma or be the indirect cause of the fall. These are:

- A split hose (in the absence of an anti-whip device) - See below figure # 2
- A poorly controlled or broken-off nozzle
- Debris or poorly secured objects by the force of the jet

	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 11 of 27

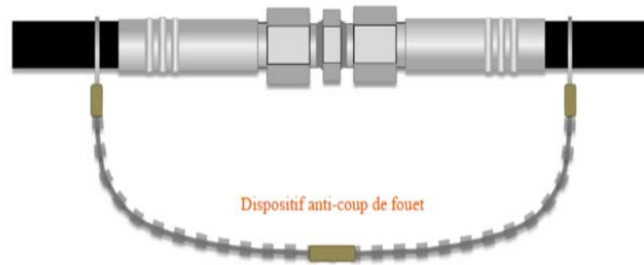


Figure # 2

Anti-whip device

8.1.1 Specific Risk Assessment (Rules to Reduce the Risk):

Before starting high pressure water jetting operations, a risk assessment (JSA) shall be done by QAPCO/contractor to identify the inherent risk and assessing the risks involved in conducting the HPWC work. It will help both QAPCO and the contractor in developing good work practices to protect the personnel, assets, environment, and reputation.

Each HPWC site shall be visited by a team (HPWC Contractor supervisor, Responsible Executor, Operation & Safety).

***Note:** The team should assess the requirements of HPWC at site and consider other safer cleaning methods (Remove equipment and conduct HPWC at safe location, etc.).*

Following but not limited are key requirements for Risk Assessment:




- a) Based on site visit and equipment information, method statement and JSA shall be prepared.
- b) Any Simultaneous HPWC operation is planned, associate hazards and precautions shall be addressed in individual JSAs.
- c) Maximum pressure to be used for cleaning shall be recorded in the JSA.
- d) Any deviation from the recommended maximum pressure shall be avoided.
- e) QAPCO inspection dept shall recommend for the maximum pressure to be applied for Hydro Jetting.
- f) Effective communication between HPWC operator and pump operator shall be established. This shall be identified in detail during JSA preparation.

Once JSA is completed, a Pre-Mob equipment inspection shall be performed to ensure the available HPWC equipment are safe to perform planned activity. (PR-250-HSE-05- CL-01)




8.1.2 Execution of HPWC:

Hydrojetting job shall not be started in QAPCO until site visit with all concerned parties completed and below applicable requirements are confirmed:

- a) Equipment/ Pipelines shall be isolated and ready for cleaning.
- b) All required Work Permits and associate documents shall be approved.
- c) Hydrojetting LMRA shall be performed before commencing of activity.
- d) Only the pump operator shall be allowed nearby the pump to adjust pressure settings.
- e) Pump operator/ hydrojetter shall not overlap hoses while system is operating.

  	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 12 of 27

- f) An anti-whip lash shall be attached at all connections after the pump connection to prevent disconnection.
- g) The lance always be pointed at the work area while operating.
- h) The operator shall stand on a firm support surface.
- i) The operator may need an assistant to aid in moving the hose to different areas and backing up the operator. During this movement the HPWC pump shall be switched off.
- j) The weakest part of the HPWC assembly is where the hose hooks into the lance, if this assembly fails the operator is at risk of water cut. To eliminate this hazard, the assembly must be covered with a safety shroud that protects the operator.
- k) Any modification or change in nozzle or hose connections shall be verified for its integrity by HPWC supervisor.
- l) The operating pressure should never exceed the manufacturer's guidelines for the equipment. The HPWC supervisor of the work is responsible for monitoring this.
- m) No unauthorized attachment to be made to the unit. **THE TRIGGER SHALL NEVER BE TIED DOWN.**
- n) The Operator should be changed at frequent intervals to avoid fatigue.
- o) Equipment should be cleaned often to avoid oil or dirt build-up, especially around the trigger and guard area.
- p) While operating, the Operator and his assistant shall be safely positioned and if any unauthorized person enters the working area, HPWC should be stopped.
- q) The work area in which HPWC will take place shall be barricaded to prevent entry by anyone other than the person operating the HPWC system. HPWC must stop before additional personnel are allowed to enter, unless the person entering the area has been assigned to assist the HPWC operator and he is aware of his presence.
- r) Do not perform HPWC while standing on unstable surfaces such as ladders, step stools, benches, etc. Use only approved scaffolding or platforms that are job specific.
- s) Before starting a HPWC operation, crew members should agree on hand signals to be used during the operation of the equipment
- t) HPWC equipment shall never be left pressurized and unattended.
- u) **DO NOT** start the unit with the gun engaged.
- v) Ensure that environmental protection and waste disposal requirements are understood and appropriately arranged.
- w) Ensure that all other personnel stay away from the area barricaded for high pressure washing operations.

  	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 13 of 27

- x) The area shall be inspected frequently, remove small objects that could be picked up by the Jet stream and the plugs used in exchanger tubes shall be removed prior to HPWC this will be launched as high speed projectiles.
- y) When potential for HOT temperatures exists, precautions should be taken against the risk of Heat Stress.
- z) Never modify, deactivate or block a safety component or shutdown control system.
- aa) Objects to be cleaned shall not be held manually. This may end up in serious injury to hand.
- bb) Water jets shall not be directed on any electrical equipment, conduit, tubing, or vessels energized or under pressure.
- cc) When working at heights or scaffolding a special consideration must be given to restrict areas below the work area.
- dd) For all the HPWC Hydro jetting activities executed outside from specified QAPCO Hydro Jetting area, the affected area shall be displayed with appropriate signs and shall be barricaded as described in this procedure, so that nobody can enter the area at any time.
- ee) In case of an accident OR damage, the HPWC equipment shall be re- inspected by 3rd party.
- ff) Any homemade / fabricated nozzles or any other component for HPWC shall not be used.
- gg) “Change in hydrojetting scope or addition of equipment, a mandatory site visit shall be done by team (Operations, safety and execution) and ensure all required controls are discussed and comply before start of activity.




Note: The manufacturer of the HPWC equipment must approve of any modifications to the equipment deviating from its design.

Note: Horseplay with HPWC equipment shall be considered as same as an act of crime and therefore treated accordingly. Violation of this procedure will result in disciplinary action, up to and including termination

8.1.3 Work areas, barricades and signs (Hard and Soft Barrier system)

A safe area shall be established around the planned hydrojetting operations. The limits of this area should be clearly defined by using a physical barrier to protect people from the impact of a high pressure jet and prevent them entering the area.

- a) Hard barricades provide a safety barrier system capable of physical protection of workers.
- b) Appropriate warning signage shall be clearly displayed informing of the danger and forbidding access to any person not involved in the HPWC activities conducted in this area, this area is known as the safety zone. Visibility between the two operators must be ensured.

  	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 14 of 27

- c) Barriers shall also stop people encountering other hazards associated with the jetting operation like flying debris falling from above.
- d) Entry into the safety zone shall be restricted to authorized people through a designated safe entry point.
- e) The barriers shall be highly visible and give an effective warning. At all times, when high pressure water jetting equipment is in use, signs indicating **DANGER: HIGH PRESSURE WATER JETTING EQUIPMENT IS IN USE** shall be displayed so as to be clearly visible and legible to all persons who are in or near the restricted area where the equipment is being used.
- f) Danger / Caution signs should be placed at least every 4-6 meters in the entire barricade boundary. Possible stairways, ladders in the barricaded area shall be considered and signs shall be placed.

Note: To support 06 meter radius area barricade, an actual test was carried out at 38000 psi to check the pressure impact. This test was carried out using both shotgun and lance. In the first test, flexible lance and nozzle combination were inserted into the tube of exchanger bundle at 38000 psi. Once the tube came out from the other side of the bundle the jet was aimed on a concrete wall, the damage on the wall was obvious when the nozzle was close to half a meter from the wall. Slowly the nozzle was retracted, at 2 meters from the tip of the nozzle the pressure dropped significantly and there was no damage or impact visible on the wall, also an empty water bottle was used to see the pressure impact but no impairment was found on the bottle.

In the second test, a shotgun was used at 38000 psi on a scrap metallic structure. The result was very clear as the paint and other residuals were cleaned immensely when the shotgun was held close to half a meter away from the structure. Slowly the Operator moved back aiming at the same structure and with same pressure. At 2 meters from the tip of the nozzle the pressure dropped significantly and there was no damage or impact visible on the structure.

Based on this practical test it is concluded that a radius of 06 meters is sufficient while the hydro-jetting in progress.

8.1.3.1 First line of defense (Hard Barricade System)

This type of barricade is intended to protect personnel from

- a. Direct impact or fatal injury from high pressure water jet.


Type: A cubicle or a tent type with one side open for better vision with assistant operator or helper shall be prepared using PVC sheets (tarpaulins) to protect from high pressure water jets. This type of barrier is considered as First line of defense.

8.1.3.2 Second line of defense (Soft Barricade System)

This type of barricade is intended to protect personnel from entering the high risk area.

The risks involved are;

- a. Direct impact from jet causing puncture wounds or fatal injuries.
- b. Contaminated water
- c. Debris under pressure causing puncture wounds or fatal injuries.
- d. Being inside a high risk area.

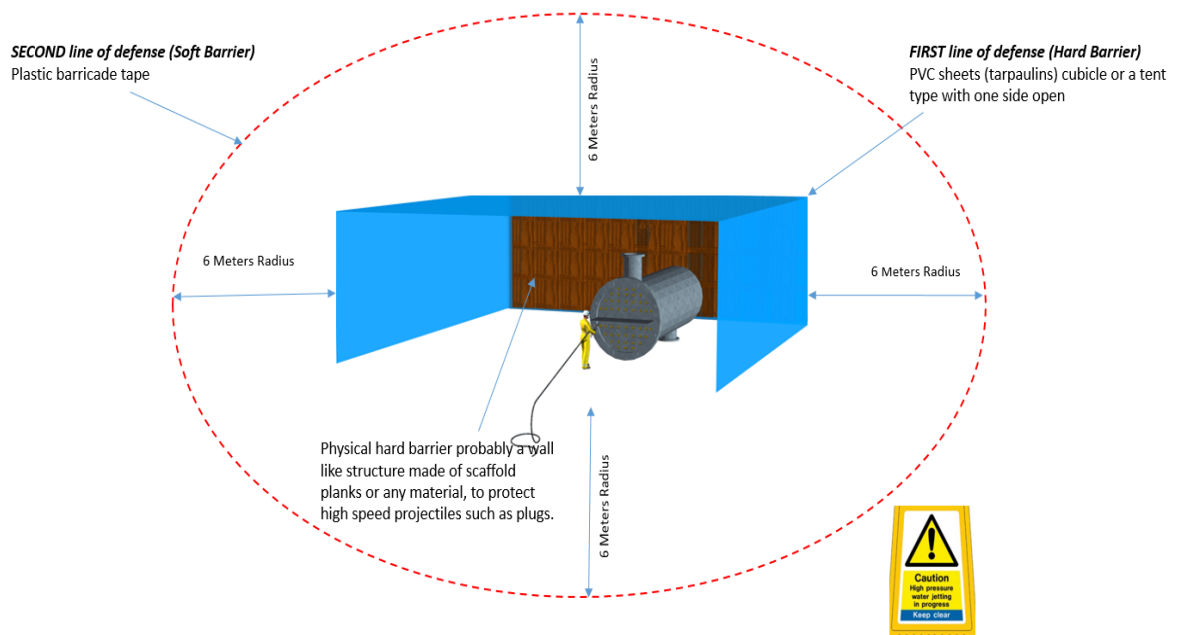
	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 15 of 27

Type: A continuous marking of 06 meters radius from the hydro jetting location shall be barricaded with nylon warning tape with Danger / Caution signs placed at least every 4-6 meters in the entire barricade boundary. This type of barrier is considered as Second line of defense

See the below illustrations for more details;

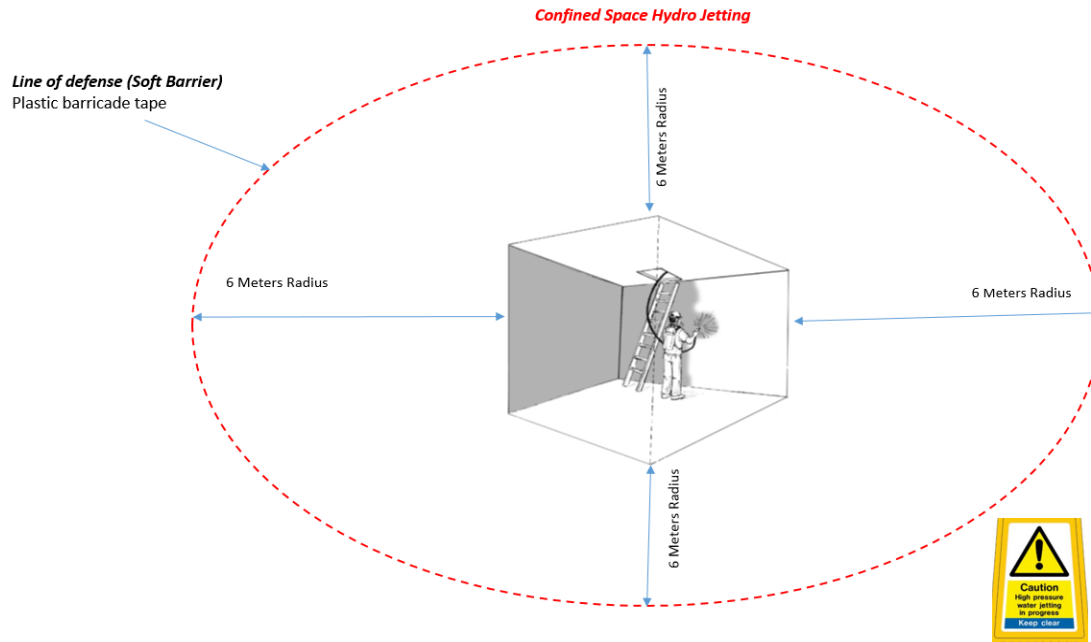
Note: If the equipment is not a heat exchanger but a tank or any vessel, then the physical hard barrier made of scaffold planks is not required as high speed projectiles are not present. PVC (tarpaulin sheet) is sufficient.

Example # 1 Single equipment hydro jetting (Heat Exchanger)



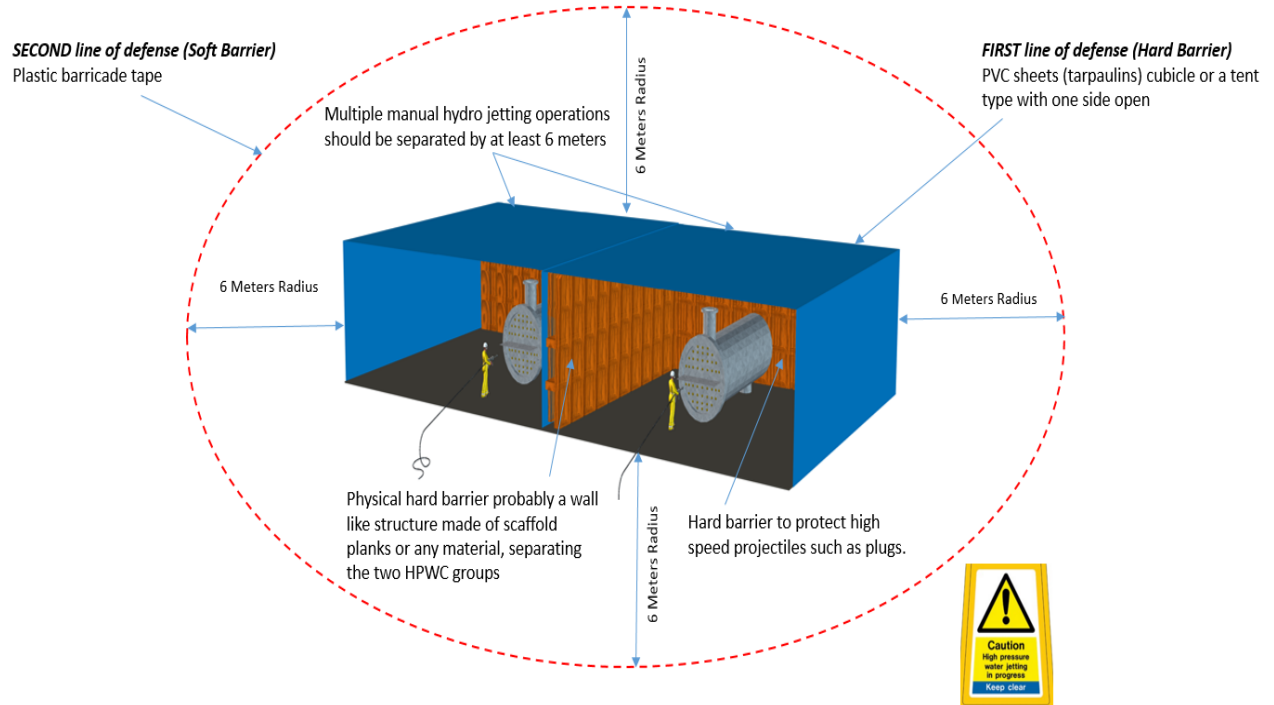
Signs should be placed at least every 4-6 meters in the entire soft barricade boundary

Example # 2 Hydro jetting inside confined space (The equipment is considered as first line of defense)






Signs should be placed at least every 4-6 meters in the entire soft barricade boundary

Example # 3 Multiple Hydro jetting operations in close vicinity



Signs should be placed at least every 4-6 meters in the entire soft barricade boundary


  	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 17 of 27

8.1.4 HPWC equipment minimum requirements.


- a. All high pressure water jetting (hydro jetting) cleaning equipment including pump, hoses, fittings etc. shall be tested by third party. Records of tests shall be maintained by the execution team.
- b. All safety (hand and foot operated) actuators and safety valves on high pressure side shall be tested once every six (6) months by third party or after each pop-up or repair. Records of tests shall be maintained by the concerned contractor's administrator.
- c. All high pressure water jetting (hydro jetting) cleaning equipment shall be fitted with actuating devices that require positive effort by the operator, (hand or foot) to keep the supply valve open
- d. A water pump with relief system that is set so that the Maximum Allowable Working Pressure is maintained in order to protect the weakest component.
- e. Hoses shall be tagged to indicate working pressure, date brought into service and predicted life expectancy.
- f. High pressure hose shall not have kinks, cuts or chipping on outer rubber. High pressure hoses shall be pressure tested, once every year by third party. Records of all such test shall be kept by the concerned contractor's administrator.
- g. The system shall have a dead-man valve which, when released, shall drop the system pressure to a safe level of 200 psi within one second. The actuating device shall be protected to prevent inadvertent operation.
- h. Hoses with exposed reinforcing wire shall be disposed of or repaired immediately.
- i. Hammering and tightening of unions or connections while under pressure shall not be done.
- j. All unions or connections shall be tightened without using medium such as Teflon tape.
- k. Damaged or faulty equipment shall not be used. It shall be tagged OUT OF SERVICE and repairs organized.
- l. Care shall be taken when laying out hydro jet hoses on the ground to avoid constant pulsation damage, especially from corners.
- m. Couplings shall be of such a design that they are unable to loosen or be accidentally dislodged during operation.

8.2 SAFE OPERATION OF HPWC

- a. Only trained personnel shall be allowed to operate the HPWC machine, as per the training matrix.
- b. Appropriate Work permit shall be obtained and thorough JSA shall be prepared for carrying out High Pressure Water Cleaning.

	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 18 of 27

- c. JSA & PTW requirements shall be discussed in detail by HPWC Supervisor with all crew involved to discuss specific safety issues as they arise.
- d. If higher pressure (above JSA defined) is required for cleaning, concerned Ops, Maint, HSE, Insp and contractor representatives shall reconvene and associated risks shall be thoroughly discussed and JSA shall be amended accordingly.
- e. The High Pressure Water Jetting work shall be done on buddy system, i.e., operator and Asst operator to assist at all times.
- f. All high pressure equipment shall be earthed before work starts and during operation, to prevent the development of electrostatic charges between the lance and the workplace.
- g. While cleaning of heat exchanger tubes, a clamp should be fixed on the HP flexible lance 1 meter from the nozzle tip, to alert the operator to release pressure before completely withdrawing the flexible lance from the tube on return path.
- h. During the shift handover the outgoing HPWC supervisor shall discuss with the in-coming supervisor any difficulties or hazards associated with the job or any adjacent activities during previous shift and appropriate mitigations taken.
- i. Adjacent equipment that require protection from the high pressure jet stream or water spray shall be guarded with appropriate material or scaffold planks.
- j. Multiple manual hydro jetting operations should be separated by at least 6 meters and by an adequate physical hard barrier probably a wall like structure separating the two HPWC groups. Each operation shall be supplied by a separate pump. If 6 meters distance condition is not met, JSAs shall consider hazards from both simultaneous operations. If the area doesn't help in erecting a physical hard barrier, then HPWC activity shall be done at one location only.
- k. While working at height, if the HPWC hose drop exceed 3 meters, the hose shall be securely tied off to a rigid support to limit the pull due to the weight of the hose.
- l. Operator or his assistance shall not modify any parts of the HPWC assembly.
- m. Assistant operator / Standby man shall have a clear line of sight with the operator, in places where it is not possible an extra standby man shall be assigned to establish clear sightline.

	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 19 of 27

- n. Back out preventers (Stoppers) shall be used on all High Pressure water cleaning methods for cleaning pipes, heat exchangers tubes etc. using flexible hoses. The Back out preventers (Stoppers) increase operator safety by keeping the tool/hose from backing out of the pipe. Several options are available including fixtures for small diameter pipes, pipes with various flange bolt circle diameters, and adapters for pipes with no-flange entry. See below Figure 3

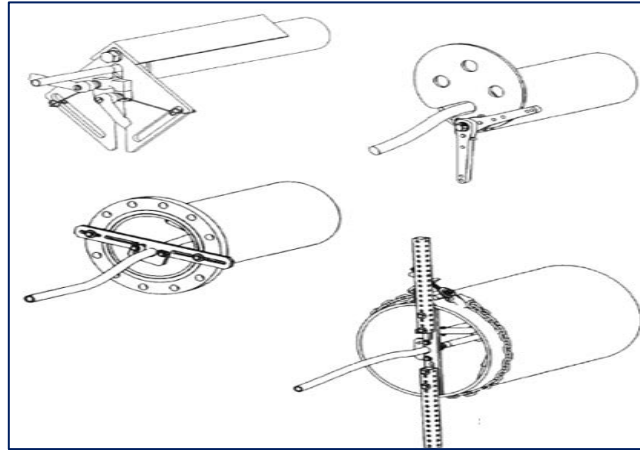


Figure 3

- o. A centralizer should be used which helps to protect the tool as it passes through the pipe and balances jet standoff distance for more consistent cleaning. In cases where pipe size is more than 1.5 times the diameter of the tool, a centralizer is an important safety device, preventing the tool from turning around and thrusting backwards out of the pipe.

8.2.1 PERSONAL PROTECTIVE EQUIPMENT

The following additional Special Hydro Jetting Personal Protective Equipment shall be worn by personnel involved in HPWC operations

8.2.1.1 PPE REQUIREMENT FOR HPWC ACTIVITIES > 1500 bar




- a. **Head protection** with visor and hearing protectors (all parts are tested and certified for protection against liquids with pressure up to 3000 bar/43500 psi) shall be used when performing hydrojetting activities. Head protection shall meet the below requirement.



TECHNICAL DESCRIPTION

- Helmet is made of fiberglass reinforced polyamide
 - Temperature range -30° to +150°
 - Recommended life span 3-5 years
- CE-marking, approved according to:**
- Industrial safety helmets: SS-EN397:2012
 - Eye protection: SS-EN166:2001
 - Hearing Protection: SS-EN 352-3:2002



  	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 20 of 27

Note: The Visor shall meet the requirements for Eye protection, it will be replaceable and can be set in folded up position whereas, hearing protectors shall be adjustable and can be set in different position against the head.


- b. **Hearing protection** shall be worn because HPWC will generate noise more than 85 decibel.
- c. **Turtle Suit**, long/full waterproof coat of sufficient mechanical strength and shall meet the directive (EU) 2016/625 TST Gamma suit should be used. See details below:

2. GAMMA KIT

Gamma Kit includes:

- Trousers and Jacket with integrated Hand Protections
- Ventilation is an option.

SIZES		ART. NO. OPT. VENTILATION	
S/M-2XL/3XL		5198000 5030	



Single/Rotor*	Size	Art. No.	Model No.
10/28	S/M-2XL/3XL	51K3047	5000
20/30	S/M-2XL/3XL	51K3068	5085






Gamma suit

Note: This indicates protection up to 2000 bar/30000 psi pin jet and 3000 bar/43500 psi rotor jet –(20/30). This Trousers and Jacket with integrated Hand Protections.

- d. **Neck Protection:** full waterproof coat of enough mechanical strength and shall meet the directive (EU) 2016/625 with protection 20/30 up to 2000 bar/30000 psi pin jet and 3000 bar/43500 psi rotor jet shall be used.
- e. **Hand protection:** Pressure resistance / waterproof gloves made of leather / PVC or other high pressure water cut resistance material of sufficient mechanical strength. Gloves shall provide best grip and used with inner nylon gloves. See below detail

PROTECTION LEVEL 5/5/2

-  ROTOR 500 bar/7500 psi
-  FLAT 500 bar/7500 psi
-  SINGLE 200 bar/3000 psi

CE Regulation (EU) 2016/425




Waterproof Gloves

- f. Gum boots with built-in metatarsal / steel toe caps protection or boots that shall protect against high-pressure water jet at the front side, the inside and at the heel of the foot. Has to comply to 20/30 protection level



Gum Boots

	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 21 of 27




- g. Boots that withstands “everything” within water-jetting on account of its fixed aluminum gaiters. The gaiters are moulded and jointed, which gives both excellent comfort and mobility. The Boots shall conform to the requirements of BGR-191
- h. Operating crew and workers within <6 meters radius shall wear all special PPE as stated above including remote operated rigid lance operations.
- h. No part such as neck, head, hands shall be exposed directly to hazard (ex; high pressure water jet)
- i. Respiratory protection may be required, depending on the hazards associated with the materials being removed. The selection of respirator type depends on the severity of the hazard. Water does suppress dust, so the need for respiratory protection is reduced, however toxic vapors pose a hazard. HSE representative should be involved in risk assessment and selection of respirator type.



Note: Be aware that filter cartridge respirators can become saturated with water for anyone close to the water jetting, especially the operator. Breathing becomes more laboured when the cartridges are saturated. Because of this, supplied-air respirators are recommended for HPWC if respiratory protection is needed

8.2.1.2 PPE Requirement for less than 1500 PSI cleaning activities:

Cleaning operations using less than 1,500 psi, if not performed safely, can put workers at risk for injury. Workers are to be aware of the pressure being used and all possible hazards that maybe present in the surroundings.

PROTECTION LEVEL 5/5/2	
	ROTOR 500 bar/7500 psi
	FLAT 500 bar/7500 psi
	SINGLE 200 bar/3000 psi
CE Regulation (EU) 2016/425	

Following Special PPE to be used while cleaning using less than 1,500 psi for activities such as equipment or floor cleanings etc.


- a. Body Protection: use high visibility Jacket with hood & trouser for body protection OR overall, with hood. The jacket shall provide protection up to 7500 PSI (500 bar) CE certified
- b. Head Protection: helmet equipped with with visor and hearing protection provides protection up to 7500 PSI (500 bar) CE certified.

Jacket & trouser



Helmet with face shield



	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 22 of 27

- c. Foot protection: waterproof long boots provides protection from high pressure jet up to 7500 PSI (500 bar) and fixed with steel toecap, CE certified



Long Boots



- d. Hand protection: the gloves provide protection for abrasion, tear, and puncture. The gloves shall be rough, sand patterned surface and provides the best grip. A separate inner glove in nylon shall be used. Shelf life of gloves shall not be more than 3 years. CE certified

Hand gloves






8.2.2 OPERATIONAL ROLES AND COMMUNICATION

- a. Each worker within the work team should have a defined role, for example the operator or assistant operator.
- b. Effective communication between members of the work team during jetting operations is very important. A mechanism, for example radio headphones which allow the nozzle operator to convey their requirements to the pump operator or observer will make the jetting operations safer and more efficient.
- c. The most common way of communicating is by using hand signals. If hand signals are used, workers should agree on a set of signals before starting jetting operations. Every worker should always understand and be alert to the signals.
- d. Hand signals should not be used as the communication method where the nozzle operator requires two hands to safely hold the device. In these circumstances the nozzle operator shall shutdown the operations to convey the communication, such as increase or decrease pressure.
- e. The hydro jetting team consists of at least 3 crew members:

i. Operator (Hydrojetter):

HPWC Operator shall have at least one (1) year on-the-job experience as high-pressure water cleaning operator. His key responsibilities are:

- a) Understand the scope of cleaning activities.
- b) Ensure the area is properly barricaded and signs installed
- c) Wear all special PPE as required.
- d) Inspect all equipment such as shut gun, safety switches, foot dumper etc.
- e) Communicate to assistant operator to adjust system pressure or starting /shutting down the pump.

  	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 23 of 27

ii. Assistant Operator (Assistant Hydro jetter)

Assistant HPWC Operator (assistant) shall have at least six (6) months on-the-job experience in high pressure water cleaning. His key responsibilities are:

- a) Ensure the area is properly barricaded and safety signs installed
- b) Wear the all special PPE and observing the jetting operations
- c) Maintain clear vision/contact with the Operator.
- d) Communicating to the pump operator to adjust system pressure as requested by the jetting operator, or to start or shutdown the pump.

iii. Pump Operator (Helper)

Pump Operator (Helper) shall have at least six (6) months on-the-job experience on:

- Pump operation, including emergency shutdown system and signals.
- Safety devices and precautions.
- Hazard Identification and risk controls

His key responsibilities are:

- a) Ensure the pump area is properly barricaded and signs installed
- b) Shutting down the system in an emergency or if the system malfunctions
- c) Follow instruction from Assistant operator adjust system pressure as requested by the jetting operator, or starting /shutting down the pump as requested by the jetting operator
- d) Controlling access of people into the barricaded area.




f. Other Responsibilities:

i. Contract / Concerned execution Managers:

- a) Shall ensure that HPWC High-Pressure Water Cleaning is done according to this procedure.
- b) Shall ensure QAPCO medical fitness requirements are met.

ii. High Pressure Water Cleaning Contractor Supervisor

- a) Ensure that only properly trained, qualified, valid third party certified, and experienced personnel operate High Pressure Water Cleaning equipment.
- b) HPWC Supervisor shall verify any modification or change in nozzle or hose connections for its integrity prior to its use.
- c) Ensure all crew workers shall possess medical fitness certificate as required by QAPCO.

  	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 24 of 27


- d) Ensure that all High Pressure Water Cleaning equipment such as HPWC pump, hoses, pressure gauges, flexible and rigid lances along with safety equipment (i.e. foot pedal valves, dump valves, etc.) possess valid third party certificate and inspected prior to initial use and found to be in good condition
- e) Ensure that their employees follow this procedure.
- f) Perform site visit for High Pressure Water Cleaning equipment / area and understand the job requirements.
- g) Perform equipment inspection (**PR-250-HSE-05- CL-01**) before mobilization of equipment to site.
- h) Perform a LMRA “Check list For High Pressure Cleaning Operations” prior to the start of job at each shift.
- i) Exercise their responsibility and authority to take action necessary to correct hazard(s) or remove workers from the hazardous exposure if the hazard(s) cannot be immediately corrected.
- j) Ensure that personnel involved in HPWC activity equipped with all appropriate special PPE in addition to the minimum basic PPE required.

iii. Maintenance Supervisor:

- a) Ensure requirement defined in this procedure shall communicate to HPWC contractor.
- b) Coordinate with operation, HPWC contractor and arrange site visit for HPWC equipment arrangements.
- c) Responsible to ensure method statement is prepared after visiting equipment area and inspection is consulted for cleaning pressure.
- d) Lead JSA exercise and ensure that JSA include cleaning pressure, hazards & precaution.
- e) Will coordinate the operation /equipment owner for equipment preparation including PTW arrangements.
- f) Verify the LMRA is completed by contractor supervisor and sign on Non-technical part of checklist.

iv. Safety Agent / Outdoor operator

- a) To check and verify that all precautions are taken as per JSA and work is being performed with valid work permit
- b) Perform Check Non-technical checklist for LMRA PR-250-HSE-05- CL-02 (Safety Agent)
- c) Issue work permit and participate in LMRA. (Outdoor Operator)




	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 25 of 27

8.3 MONITORING:

- a) Regular inspection must be done by HPWC supervisor to ensure that safe work practices are being followed, including the proper use of protective equipment, devices, and clothing provided.
- b) Before starting a job and at the beginning of each shift, the HPWC supervisor shall check out the condition of the hydro jetting equipment, including its accessories. He shall also examine the equipment to be cleaned to see if there is any potential hazard from debris, corrosive or toxic chemicals, flammable liquids or vapors, etc.
- c) A specialized HPWC safety Checklist LMRA (PR-250-HSE-05- CL-02) shall be completed each shift prior to conducting HPWC work.
- d) Any equipment damage, personnel injury shall be reported and investigation as per QAPCO procedure.

8.4 TRAININGS

- a) HPWC technicians are trained and certified in all aspects of the hydro jetting / cleaning process by a third party and all necessary training records shall be maintained by contractor & available. The training shall be included as minimum:
 - i. Cutting action of high pressure water and correct selection of nozzles, other fittings, and water pressure.
 - ii. Personal protective equipment requirements.
 - iii. Inspecting hydro jetting equipment.
 - iv. Purpose of primary equipment.
 - v. System operation, including lance handling and emergency shutdown procedures and signals.
 - vi. Safety devices and precautions.
 - vii. Hazard Identification and risk controls
 - viii. General safe work practices for high pressure washing
 - ix. Basic Principles of the high pressure pumps
 - x. Description of water supply factors, electrical hazards, electrical grounding, and wastewater control.
- b) All employees that work with HPWC equipment either as an operator or assistant will be required to show their knowledge and competence with minimum following:
 - i. HPWC Operator with at least one (1) year on-the-job experience as high pressure water cleaning operator.




  	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 26 of 27

- ii. Assistant HPWC Operator (assistant) shall have at least six (6) months on-the-job experience as high pressure water cleaning.
- iii. Water jetting operator must have completed an initial theoretical and practical training
- c) QAPCO retains the right to refuse HPWC operators who fails to demonstrate their knowledge and skills in identifying HPWC hazards.
- d) Training Validity: The validity of the training shall be according to the third party training provider. If no validity mentioned on the third party certificate, the HPWC technicians shall undergo refresher training every three (3) years.

8.4.1 Craft based Training Matrix:

Craft	Required competency/ Awareness		
	Basic training (safe practice of hydro-jetting)	Advance training (practical training)	HPWC procedure awareness
Hydro-Jetter	Applicable	Applicable	Applicable
Hydro-Jetter Foreman / Supervisor / Standby Man	Applicable	Applicable	Applicable
Hydro jetting helper	Applicable	NA	Applicable
Others; Safety Agent; Sr. Safety Officer, Inspection member, and Maintenance coordinator / Supervisor	NA	NA	Applicable
Operations Area Operator and Shift Supervisors	NA	NA	Applicable

ID	Activity	Document reference	Responsible org. position
8.1	Hazard identification and Risk assessment	JSA/ MS	Responsible Executor
8.1.1	Pre- mobilization Checkpoints	PR-250-HSE-05- CL-01	Responsible Executor
8.1.2	Preparation (Barrication, safety sign)	NA	Responsible executor
8.2	HPWC Operation	NA	Responsible Executor
8.3	Monitoring	PR-250-HSE-05- CL-02	Responsible Executor / maint.
8.4	Training	NA	Contractor Manager

  	High Pressure Water Cleaning (HPWC) HSE Procedure	Procedure No.	PR-250-HSE-05
		Revision	02
		Date	17- Aug-2021
		Page No.	Page 27 of 27

9. RECORDS

The owner / executor of change shall maintain the following, but not limited to, records / documents for reference:

#	Document / Record ID	Document / Record name	Responsible department or section
1	Pre-Mob equipment inspection	PR-250-HSE-05- CL-01	HPWC Contractor supervisor
2	JSA, Method Statement	NA	Responsible executor
3	Equipment certificates	Na	Responsible executor
4	HPWC Personnel certificates	NA	Responsible executor

10. APPENDIX

10.1 SERVICE LEVEL DEFINITION

The key services and service levels listed below are required to complete the activities contained within this procedure

#	Service	Service level	Service provider	Service customer
1	NA	NA	NA	NA

10.2 PR-250-HSE-05- CL-01 - HPWC EQUIPMENT INSPECTION CHECK LIST

10.3 PR-250-HSE-05- CL-02 - HPWC LMRA

10.4 PR-250-HSE-05- F01 - SAMPLE JSA FOR HPWC TASK