

Type-4 CNG CYLINDER

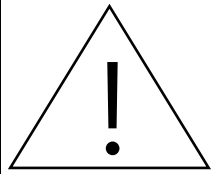
Operating and Maintenance Manual



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■ WARNING TAG



Read carefully this Operating Manual and use the product properly.
Following sign used to prevent risk toward the user and other Persons, and damage properly, from occurring. Be sure to use it an after confirming use and product specifications.

● Following sign indicates uncertain and general uncertain attention, warning and risk



DANGER

This sign indicates the event that risk of the user being killed or receiving serious wound is foreseeable if the user ignores and wrongly handles this sign.



WARNING

This sign indicates the event that risk of the user receiving serious wound is foreseeable if the user ignores and wrongly handles this sign.





CAUTION


This sign indicates the event that risk of the user being injured or physical damage occurring is foreseeable.

- ◆ Before using this product, please read carefully this Operating Manual for use.
- ◆ Also, always keep this Operating Manual in a conspicuous place

● Following sign indicates attention, prohibition/enforcement of and act specified risk note

 <p>Danger</p>	<p>Danger</p> <ul style="list-style-type: none">● DO NOT disassemble, repair or remodel this container at your need. Explosion and leakage may occur.● If this product requires repairing, contact the head office. Head office: 32, Hwajeongsandan 3-ro, Gangseo-gu, Busan, Korea Tel: +82-2-729-2899 Fax: +82-2-729-2363 E-mail: hpark1024@hanwha.com● DO NOT disassemble the valve from the container while it is operation.● Be sure that valve seat is tightened before providing working pressure. If the valve seat is tight it by hand wheel without fall.
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 <p>WARNING</p>	<p>Warning</p> <ul style="list-style-type: none">● DO NOT use this product outside the specification. Using the product outside the specifications may cause it to fail, stop functioning. It may also significantly reduce the service life of the product.● Be care not to be damaged to the container during handing or motor operation.● DO NOT use unapproved pressure relief device or valve. It may cause an explosion or serious damage to operator.● DO NOT use the valve beyond the scope of working temperature and working pressure. If the valve is used under high temperature and high pressure, it may cause failure or explosion.● Inside pressure of the container must be drained and be sure no pressure(zero). Before removal valve from container. It may cause an explosion or serious damage to operator.● In radius of 10 meters around the cylinder, smoking and fire is prohibited.
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 <p>CAUTION</p>	<p>Caution</p> <ul style="list-style-type: none">● The service life is provisionally limited to 20 years.● The containers shall be subjected to visual inspection of the outside surface at least every 3 years.
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1. CONTAINER TYPE

- CNG-4 container

Resin impregnated continuous filament with a non-metallic liner (all composite).

2. APPLICATION

- The container is specialty designed for the on-board storage of high pressure compressed natural gas as a fuel for automotive vehicles to which the containers are to be fixed.

3. SERVICE CONDITIONS

- Service life:

The service life is provisionally limited to 20 years.

- Temperature range:

Settled temperature of gas in containers may vary from a low of -40°C to a high of 57°C

The temperature of the container materials may vary from -40°C to 82°C

Use of fusible plugs is specified to rule out the bursting of the container in the event of the vehicle catching fire. Therefore, the fusible plugs in the valves and in the plugs shall not be replaced with solid plugs or other valves.

4. INSTALLATION AND MOUNTING INSPECTION

The container shall be mounted in a manner that adequately restrains the container but induce damage. Check for any signs of looseness in the mounting system and fuel and vent lines by grasping them firmly and attempting to displace them. In addition, look for signs of abrasion between components, which may be indicated by shiny or burnished spots on either the components or the vehicle.

Verify that lines connected to the container are installed in a manner that prevents damage to the plumbing when the vehicle flexes or when the container expands under pressurization.

- Installation of Valves


During assembly of valves, please follow, in accordance the points below.

1. Only authorized valves and relief devices are to be used.
2. Ensure that the thread of the valve and adapter is compatible to the cylinder threads.
Hanwha Solutions cylinders have a connecting thread of 1.125-12UNF.
3. Check all threads for damage and dirt. Remove dirt with a clean cloth. Damaged parts must be replaced.
4. Check that the valve and the supporting if there are no damages.
During the complete preparation, the cylinders need careful handling. Any impact, drop damage or other visible damage (e.g. scratches or notches $t > 0.5\text{mm}$ or surface damage) must be recorded and reported to Hanwha Solutions as soon as possible.
5. Tighten the valve with the matching specialty tool with a torque of 135Nm. Applying a torque of 135Nm +/- 5Nm to the adapter / cylinder is required.

VALVE TORQUE VALUE TABLE		
Thread	Min. N-m	Max. N-m
1.125-12UNF	130	140

6. Mark the transition from valve to the cylinder with a drop of sealing mark/paint.
7. Record the change of the valve in the documents.
8. Test the system cylinder / adapter / valve / for leaks.

5. Cylinder Inspection

 <p>WARNING</p>	<ul style="list-style-type: none">● an inspection shall be performed on a depressurized CNG container, prior to filling or returning it to service. If<ul style="list-style-type: none">- the fuel container or vehicle in which it is installed is involved in a fire- the fuel container is exposed to excessive heat- the fuel container is dropped or subjected to impact- the NGV is in a collision- the container is suspected to have damage from cargo, vehicle and / or environmental Conditions- the container is believed to have been damaged by and means- there is unusual behavior including (unexpected loss of gas pressure, indication of looseness, unusual snapping or hissing sounds)- the container is reinstalled after removal for the vehicle- the container installation is changed significantly- the fuel container is transferred to another vehicle- the container has been over-pressurized, not in accordance with the limits of its design.
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- General

The periodic re-qualification inspection and testing is performed on the gas container and its safety- related accessory equipment. During the periodic re-qualification inspection and testing, the technical inspectorate inspects and tests a container of deficiencies that are dangerous to the operating personnel or a third party.

Periodic requalification inspection and testing shall only be carried out at the manufacturer works or at an inspection and test house specifically approved by the technical inspectorate.

Repairs that are required to remove any deficiencies shall only be carried out by agreement with the container manufacturer and the technical inspectorate.

All containers and their equipment shall be visually inspected every 36 months. Guidelines are given in ISO 19078.

The container may be damaged without showing significant damage on the surface. Therefore, this inspection must be performed carefully. Since the inspection depends primarily on visual observation, the surface of the container should be accessible, clean and well illuminated. Removal of paint or fiber for visual inspection is not permitted unless to determine accurate damage depth. However, an area of damage may require small amounts of material to be removed for an accurate evaluation of the damage.

In a case of damages on the surface, the container inspection shall be carried out by "Container Inspection elements."

● Container Inspection elements

▲ Container Service History Check

The inspector should review inspection/service records for the container prior to inspection. Knowledge of the service history and interviews of the vehicle owner/ operator may provide insight that will aid the inspection process.

▲ Outside Visual Examination

Visual examination of the composite container surface is the primary means of detecting container damage. Evidence of potential damage includes cuts, scuffs, scratches, surface distortions, material removal, discoloration of the container surface, and deterioration of the surface. If visual examination reveals damage, the area of damage must be carefully measured for depth using the gauge.

▲ Factory Inspection

Containers which are known or suspected to have been subjected to a potentially damaging incident, or which exhibit evidence of damage, should be removed and may be made by contacting Hanwha Solutions Customer Service.

● Marking composite containers

The date for the next periodic requalification inspection and testing shall be shown by a label pasted on the container. The pasted label shall be such that it cannot be removed from the container without being destructed.

5.1 Inspection and Maintenance

A trained inspector should inspect tanks at maximum intervals of 36 months. Tanks should also be inspected promptly if the tank, or vehicle in which it is installed, is involved in a motor vehicle accident or fire, is subjected to impact or believed to have been potentially damaged by any means. Moreover, the owner must maintain inspection records during the cylinder life.

The contents in this section can be used as a guide to determine whether the tank can be used continuously, can be put back after repair or must be removed from service, condemned, and destroyed.

THIS CONTAINER MUST BE VISUALLY INSPECTED AFTER A MOTOR VEHICLE ACCIDENT OR FIRE AND AT LEAST EVERY 36 MONTHS OR 58,000km (36,000 miles), WHICHEVER COMES FIRST, FOR DAMAGE AND DETERIORATION, IF THERE IS A QUESTION ABOUT THE PROPER USE, INSTALLATION, OR MAINTENANCE OF THIS CONTAINER, CONTACT MANUFACTURER.

Alternative fuel cylinders are designed and manufactured for a limited design life, which is indicated on the cylinder label. The label always need to be checked to ensure that the cylinder has not exceeded its expiration date.

TYPE 4 CYLINDER
DO NOT USE AFTER
01 / 2037
USE ONLY MANUFACTURER
SPECIFIED / APPROVED PRD
AND VALVE

5.2 Preparation for inspection

The surface of the cylinder should be clean and free of dirt or other debris that can impede the inspection of the external surface of the cylinder. Remove shields or covers, where possible, to ensure maximum access to the tank surface are for inspection.

Inspection Tools



- A portable microscope and a flashlight could be useful for inspecting the surface of the cylinder in detail.
 - Use a brush in order to make the clean surface of the cylinder before the inspection.
- Identify how to measure the depth of damage before the inspection.

Caution

Do not remove the cylinder from the vehicle for general inspections. Cylinder removal is only necessary if the following conditions

- The cylinder has been exposed to corrosive chemicals.
- Unusual or excessive corrosion is observed in the cylinder area.
- Obvious damage is observed in cylinder area.
- The cylinder straps are loose or damaged.
- The vehicle has been involved in a collision and damage is observed in the cylinder area.
- The vehicle has been involved in a fire

If the cylinder is replaced, perform the following steps:

- Obtain a new fill area, cylinder expiration label.
- Add the new cylinder's word of caution ' **DO NOT USE AFTER DATE** ' onto the label.

5.3 Composite Tank Inspection

The composite fuel tank may be damaged without showing significant damage on the surface.

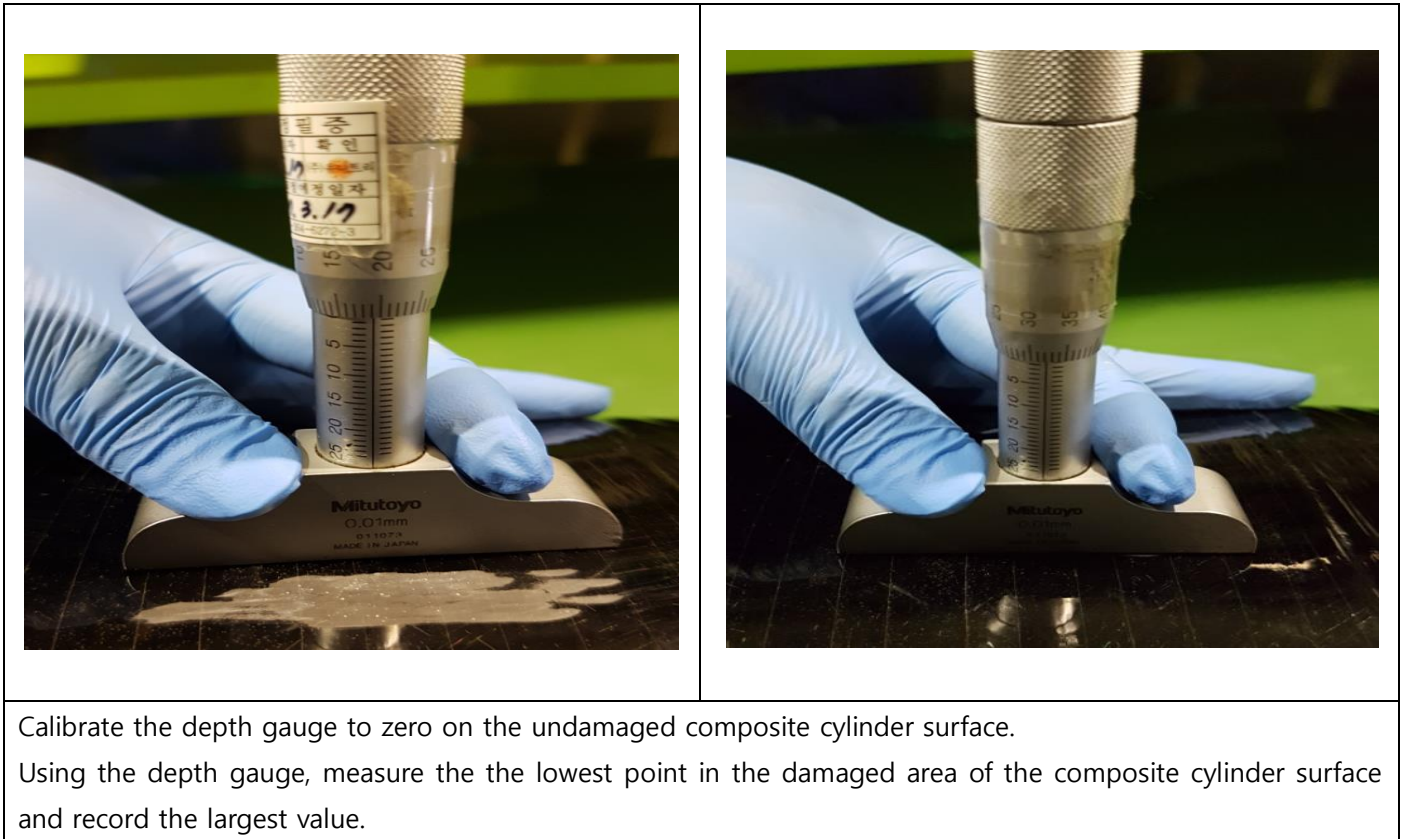
Therefore, this inspection must be performed carefully by using inspection tools mentioned above.

• Visual examination

This examination of the composite cylinder surface is the primary means of detecting tank damage. When performing this examination, removal of fiber or resin is not permitted for measuring accurate damage depth. However, In case that an area of damage may requires tiny debris to be removed for accurate evaluation of the damage, it is allowed.

• Measuring the depth of damage

1. Identify the damaged area
2. First calibrate the depth gauge to zero on the undamaged composite cylinder surface.
3. Using the depth gauge, measure the the lowest point in the damaged area of the composite cylinder surface and record the largest value.



The following categorization is about description of some types of damage that can occur with CNG cylinders. As it is not possible to describe all possible damages, these are the most common types of damage that the cylinder might be done from many situations

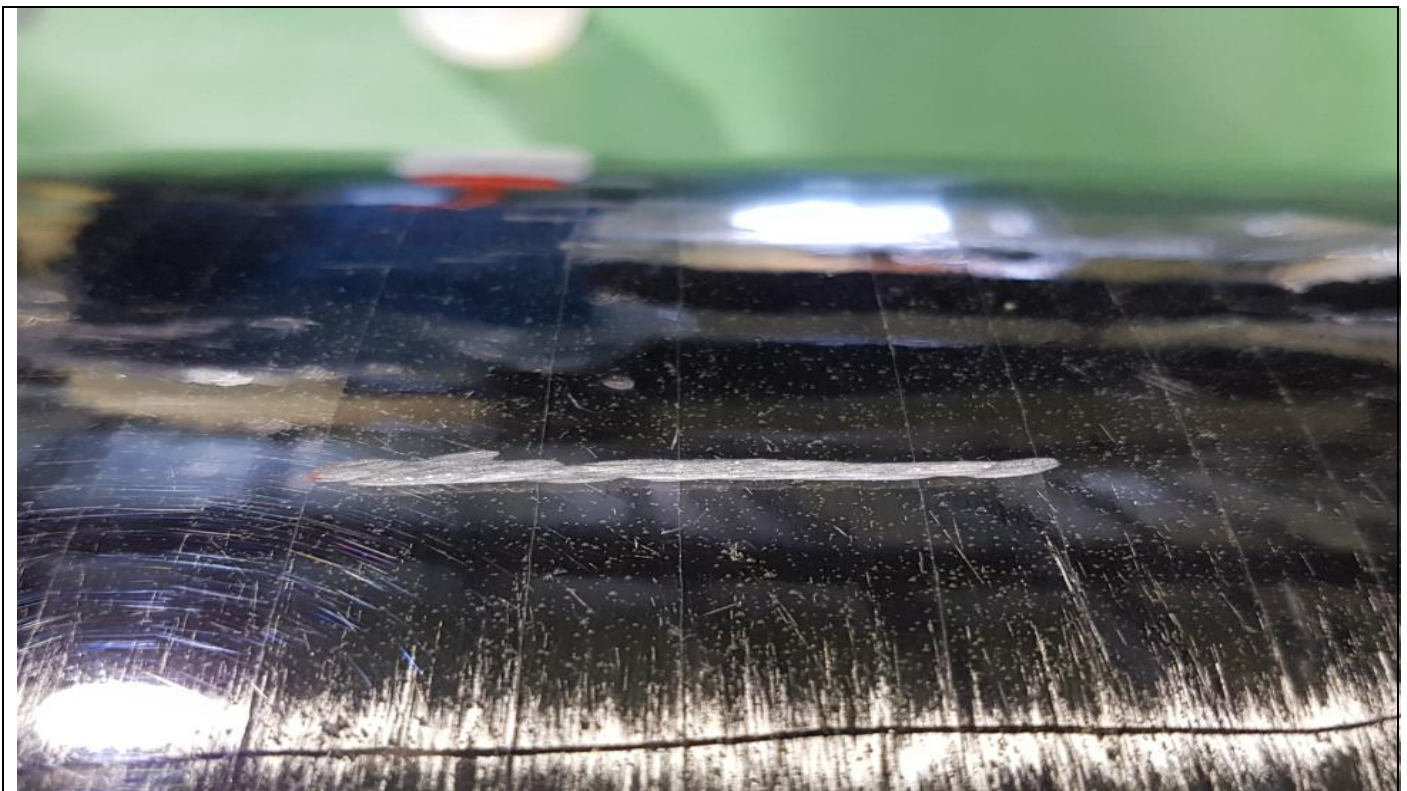
- Damage categorization**
1. Cut, scratches, abrasion and gouge
 2. Fire or Chemical damage
 3. Impact damage
 4. Delamination
 5. Weathering

5.3.1 Cut, scratches, abrasion and gouge

-Cut ,Gauge and Scratches damage: These damages are caused by a sharp object.

-Abrasion damage: This damage is caused by a wearing, grinding or rubbing away of the protective coating or the outer layers of fiber by friction.

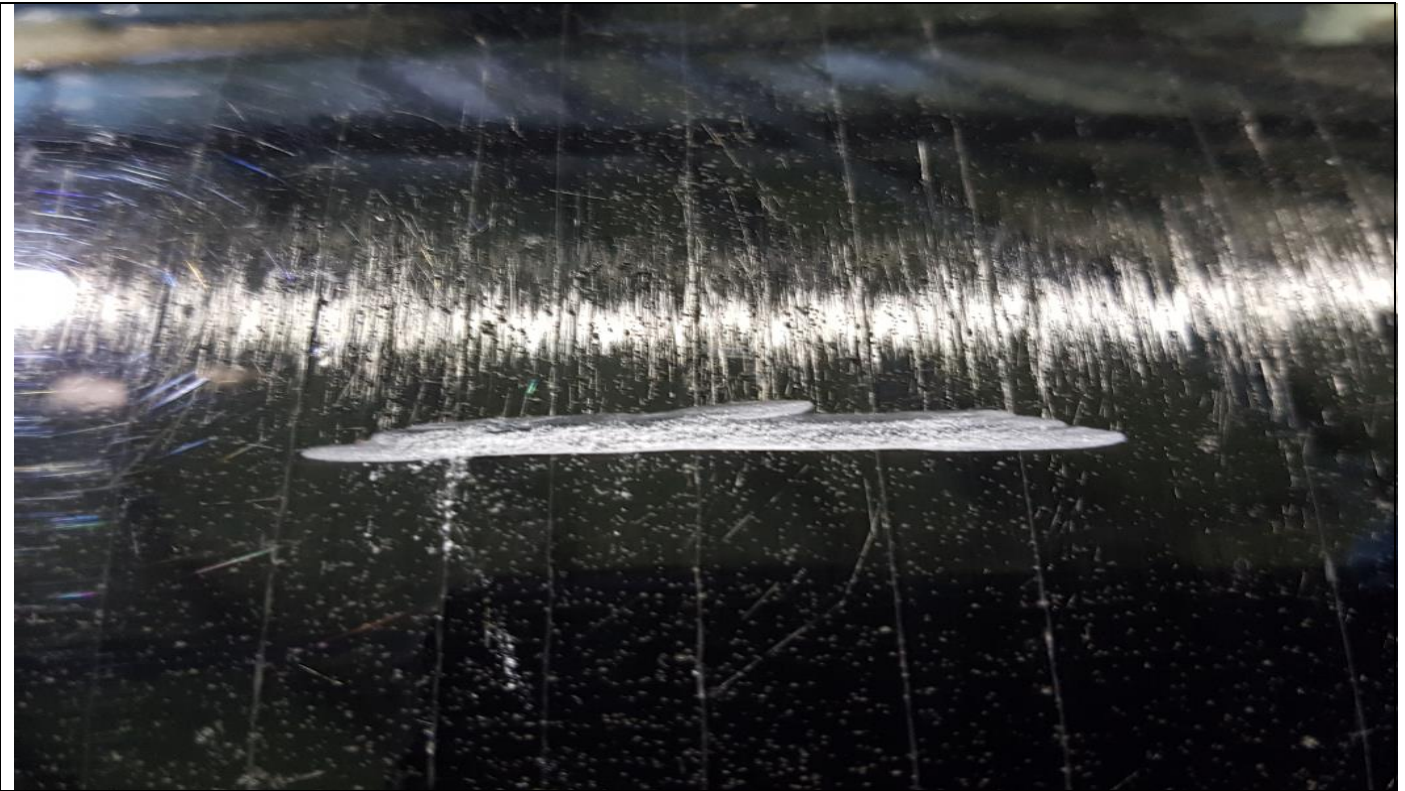
Damage Levels		
<u>Cut, scratches, abrasion and gouge</u>		
Damage levels	Depth (inches)	Depth (millimeter)
Level 1	$0 \leq 0.01$	$0 \leq 0.25$
Level 2a	$0.011 \leq 0.035$	$0.26 \leq 0.89$
Level 2b	$0.035 \leq 0.050$	$0.90 \leq 1.27$
Level 3	$0.05 <$	$1.27 <$



Level 1 cut

The depth of 'Level 1 cut' is between zero and less than or equal to 25 inches (0.25mm)

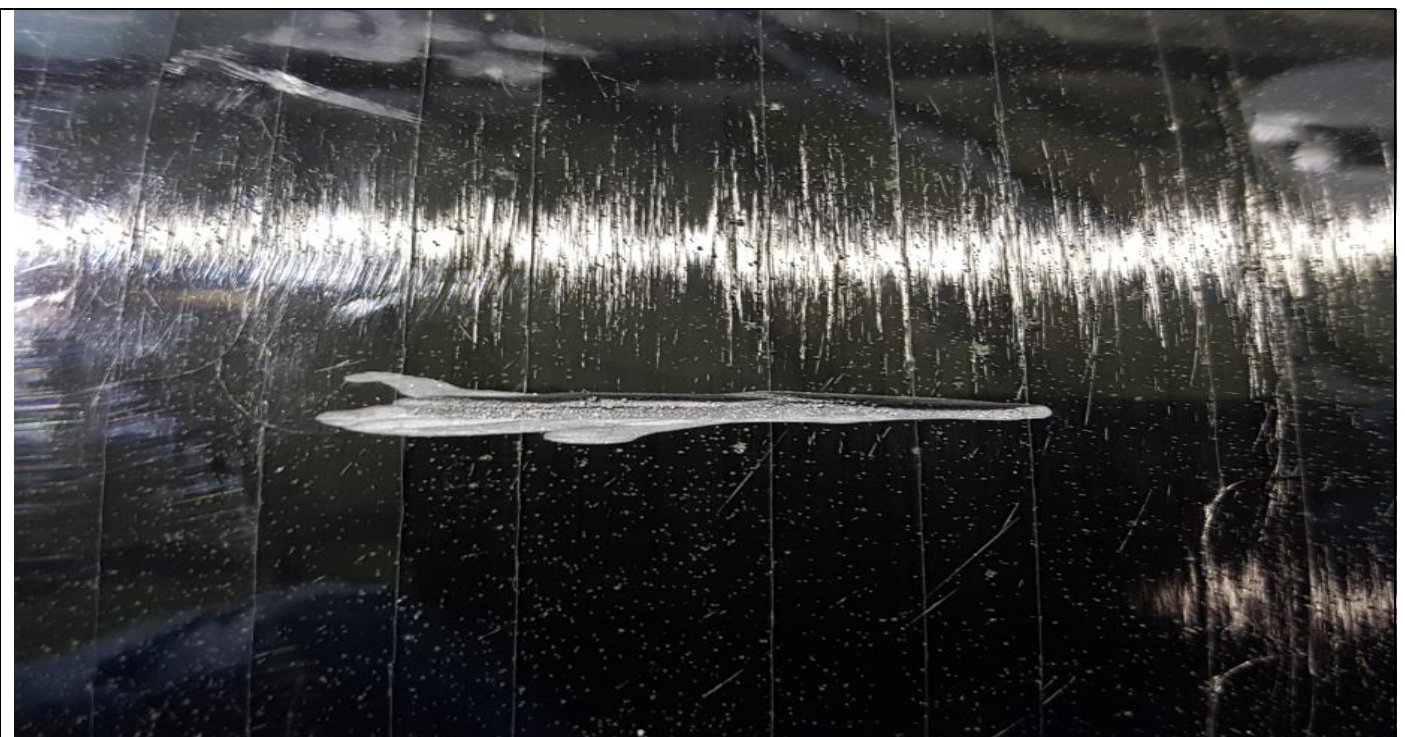
The depth of 'sample cut' : 0.0039 inches (0.1mm)



Level 2a cut

The depth of 'Level 2a cut' is between greater than equal to 0.011 inches (0.26mm) and less than or equal to 0.035 inches (0.89mm)

The depth of 'sample cut' : 0.028 inches (0.7mm)



Level 2b cut

The depth of 'Level 2b cut' is between greater than equal to 0.035 inches (0.90mm) and less than or equal to 0.050 inches (1.27mm)

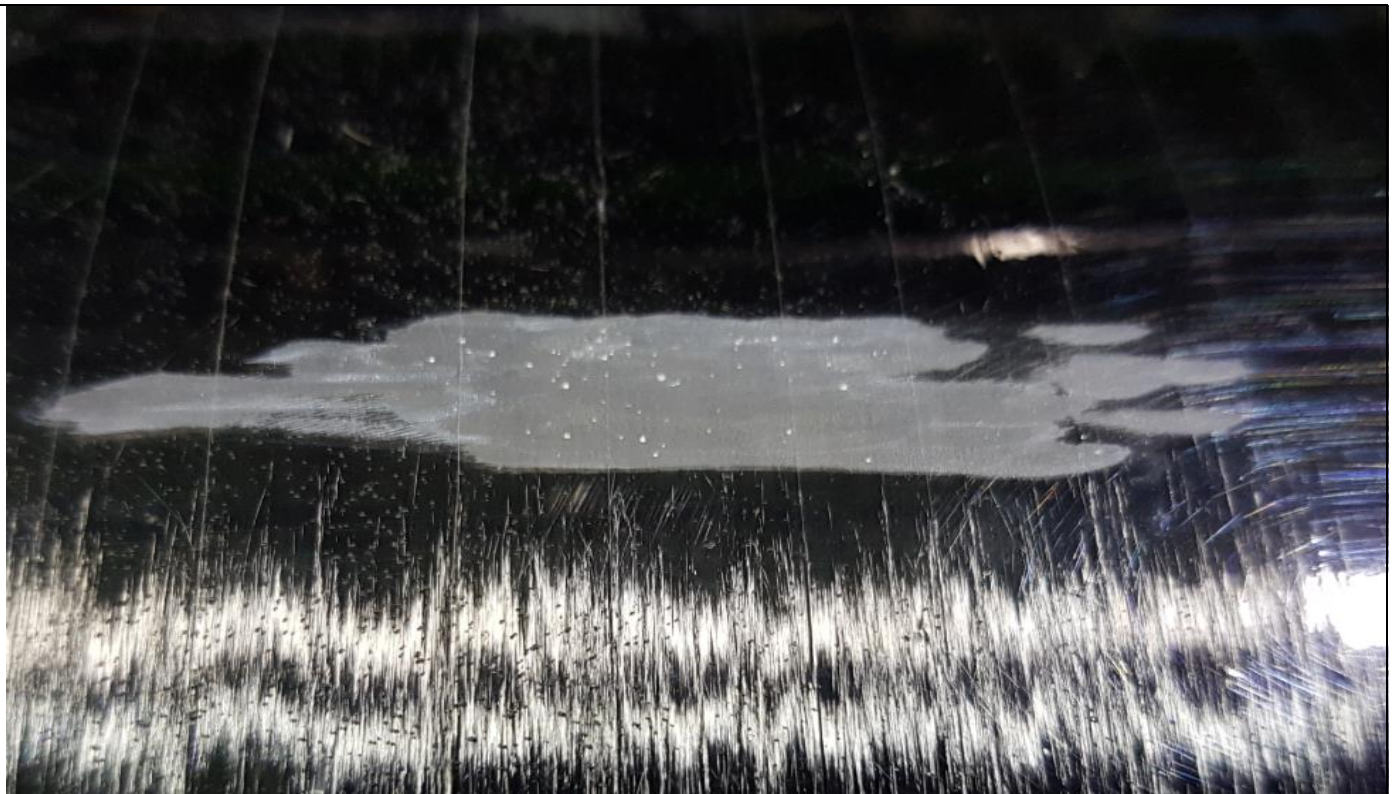
The depth of 'sample cut' : 0.04 inches (1.03mm)



Level 3 cut

The depth of 'Level 3 cut' is greater than 0.050 inches (1.27mm)

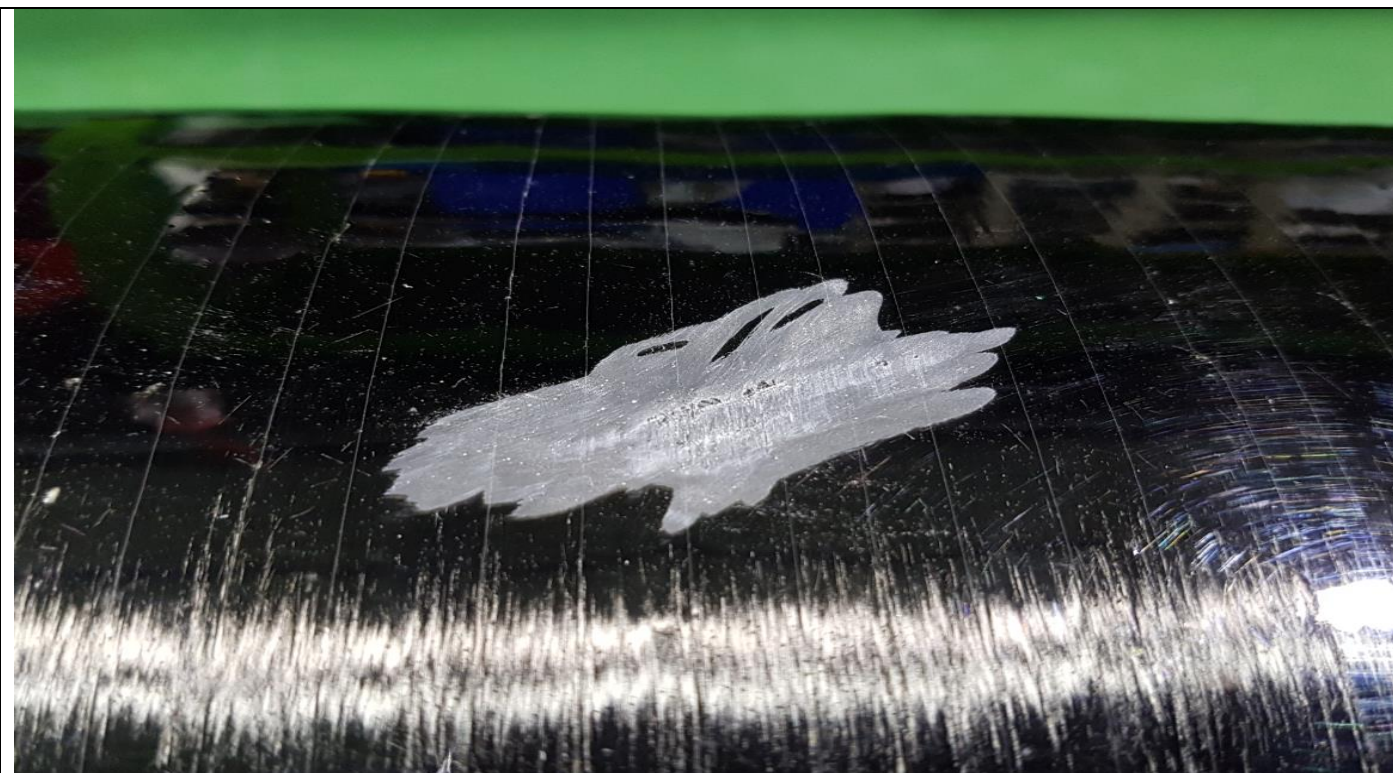
The depth of 'sample cut' : 0.093 inches (2.35mm)



Level 1 abrasion

The depth of 'Level 1 abrasion' is between zero and less than or equal to 25 inches (0.04mm)

The depth of 'sample abrasion' : 0.0016 inches (0.1mm)



Level 2a abrasion

The depth of 'Level 2a abrasion ' is between greater than equal to 0.011 inches (0.26mm) and less than or equal to 0.035 inches (0.89mm)

The depth of 'sample abrasion ' : 0.034 inches (0.88mm)



Level 2b abrasion

The depth of 'Level 2b abrasion' is between greater than equal to 0.035 inches (0.90mm) and less than or equal to 0.050 inches (1.27mm)

The depth of 'sample abrasion' : 0.044 inches (1.13mm)



Level 3 abrasion

The depth of 'Level 3 abrasion' is greater than 0.050 inches (1.27mm)

The depth of 'sample abrasion' : 0.088 inches (2.35mm)

5.3.2 Fire or Chemical damage

The careful examination of the cylinder is required after elevated heat exposure or chemical damage caused from an accident.

Fire damage

Evidence of heat damage is darkening, charring, sooting or melting of the composite material. These damages can be easily found on the cylinder surface and result in resin removal and loose fibers.

(Note. These damages are considered as Level 3 damage.)

Therefore, cylinders suspected of being damaged by elevated heat exposure should be depressurized and removed from the service as soon as possible.

Chemical damage

TKF Type4 cylinders are resistant to most chemicals. However, cylinders should be maintained in a clean state and should not be exposed to prolonged automotive fluids , corrosive fluids or moisture.

Chemicals can dissolve, soften, corrode cylinder materials. In extreme cases, composite may exhibit fractures and delamination. Resin removal, delamination, blistering, swelling, fracture belong to Level 3 damages. Therefore, the cylinders must be condemned, removed from service and destroyed.



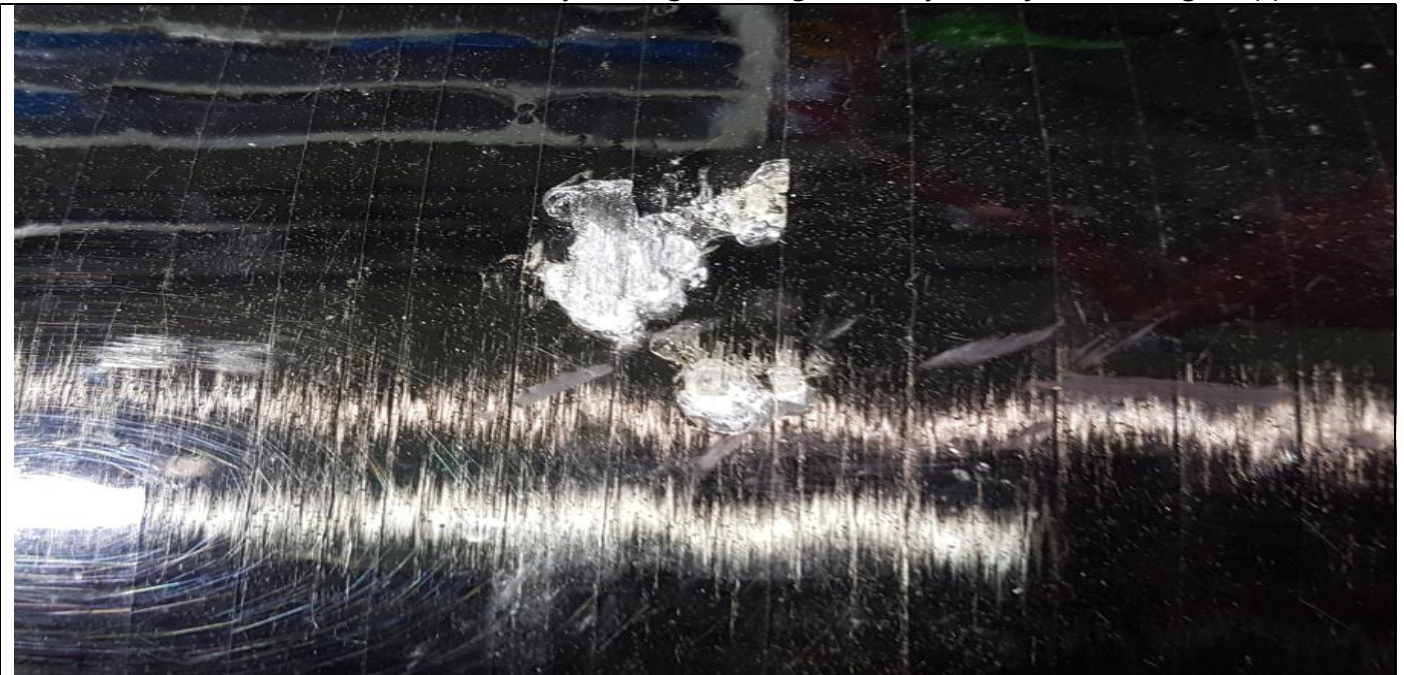
Fire damage can be evident on exposed cylinder surface as you can see the picture.

Fire damage inspection

Visually inspect the entire surface of the cylinder and all attachments (valves, PRD,, etc) for evidence of fire damage

5.3.3 Impact damage

-An indication of impact usually appears as a white frosted area in the composite material. Impact indications such as these can be caused by striking or being struck by an object or being dropped.



Level 1 impact

Level 1 impact is light impact damage and usually get frosted.
In this case, the cylinders can usually be returned to service.



Level 3 impact

Level 3 impact are severe damages and suspected to have got the liner denting or major structure damage in the cylinders. In this case, the cylinders must be condemned, removed from service and destroyed.

5.3.4 Delamination



This photo shows the carbon fiber delaminating from the cylinder surface.

Delamination

Delamination can be identified when the carbon fiber wrap lifts from the surface of the cylinder surface.

5.3.5 Weathering damage

Weathering is a change on the surface of composite material resulting from environmental exposure to sunlight and weathering. This condition is considered as Level 1 damage and only visual damage. Sometimes, damaged areas require repair by sanding or painting with a polyurethane paint.

5.3.6 Gas leakage

Hanwha Solutions recommends customers to remove cylinders that exhibit apparent gas leakage from service.

Procedure of the leak test

Leak test can be conducted by using leak detection spray or soapsuds. Cylinders shall be pressurized to the working pressure and rest for at least 1hour in order to make a stable pressure condition of the cylinders.

If it is impossible to conduct the leak test, contact Hanwha Solutions to check and report the condition regarding additional cylinder testing. Cylinders failed in leak test must be destroyed.

Note

Bubbles could be typically observed on the composite surface for several hours after pressurization, commonly after the initial pressurization following cylinder installation or similar conditions (cylinders are empty or nearly empty). These bubbles are caused from the air gap of nozzle parts or composite layers. If these bubbles are created steadily more than a day, leakage could be suspected.

Cut Scratches Abrasion Gouge	Level 1	Any size of damage less than 0.01 inches(0.25mm)
	Level 2	Any size of damage between 0.011 and 0.05 inches (0.26mm and 1.27mm)
	Level 3	Any size of damage greater than 0.05 inches (1.27 mm)

Fire / Chemical	Level 1	Light discoloration
	Level 2	N/A
	Level 3	Evidence of burning / Evidence of bubbling, extreme dulling of the resin, deterioration of the resin

Impact	Level 1	A white frosted area
	Level 2	N/A
	Level 3	Any severer damage than level 1 (Delaminated/peeling bands of fiber, liner indentation as noted by internal inspection, cut in excess of level 2 acceptability)

Delamination	Level 1	N/A
	Level 2	Delamination from the outer fiber layer only.
	Level 3	Any delamination exceeding level 2

Weathering	Level 1	Light discoloration
	Level 2	N/A
	Level 3	Mild discoloration, craze-cracking of the surface resin

6. REPAIR



- sandpaper, 2-part epoxy resin for repair, brush, etc .. are needed to repair damages except Level 3 damage

Caution

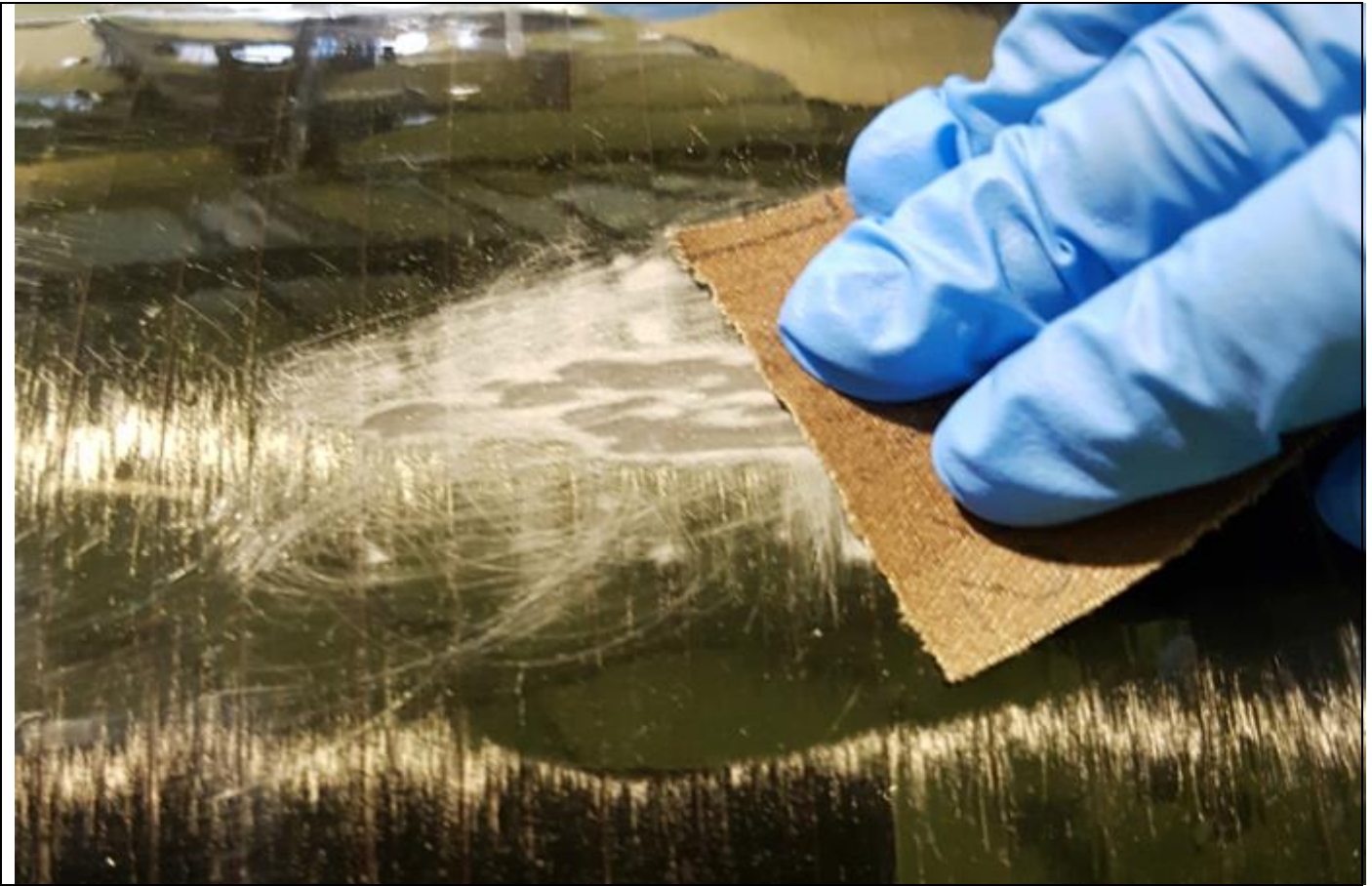
-Any rework to the overwrap shall be conducted with a commercial room temperature cure two-component epoxy resin system.

-Loose fibers should be trimmed away before coating with resin

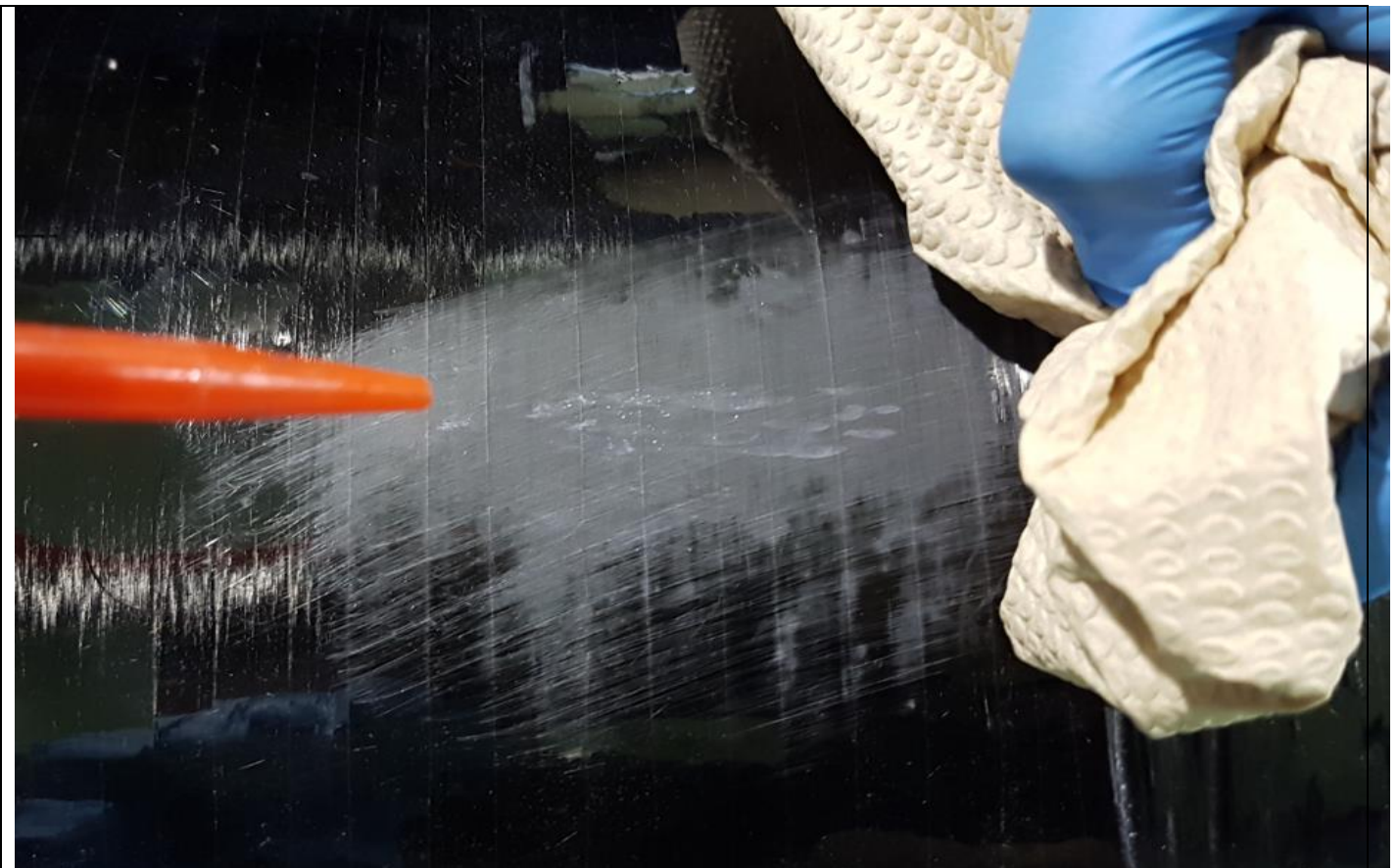
-All reworked cylinders shall be subjected to hydrostatic testing before being returned to service

-Flaw sites shall be observed for lifting or peeling of the overwrap that can have occurred during hydrostatic testing

-Any cylinder which got level 3 damaged cannot be repaired. So, these cylinders should be condemned and destroyed.



Sand damaged area with a sandpaper



Clean the damaged area after sanding



Resin application



After cure

7. INSPECTION RECORD

INFORMATION FORM	
Serial number	
Model number	
Inspection date	
Expiration date	
Vehicle mileage	
Vehicle identification number:	Inspector name:

P=Pass F=Fail

INSPECTION FORM				
Cylinder Inspection Features	1	2	3	4
Cylinder and mounting bracket are clean				
Bracket condition				
Mounting pads in good condition				
Labels in place				
Cylinder expiration date have not exceeded service life				
Valve condition				
PRD condition				
Inspect the cylinder leakage				
Inspect the cut, abrasion damage				
Inspect the chemical damage				
Inspect the Fire damage				
Inspect the impact damage				
Inspect the delamination				

Inspection results

Cylinder returned to service	<input type="checkbox"/>
Cylinder must be removed from service	<input type="checkbox"/>