To: [redacted]

From: [redacted], Director of Marine Operations

Date: 1/19/18

Re: Cyclops 2 (Titan)

With Cyclops 2 (Titan) being handed off from Engineering to Operations in the coming weeks, now is the time to properly address items that may pose a safety risk to personnel. Verbal communication of the key items I have addressed in my attached document have been dismissed on several occasions, so I feel now I must make this report so there is an official record in place.

As the Director of Marine Operations, it is my professional opinion that the items noted in my report are significant in nature and must be addressed. I have also included my recommendation to how we should be addressing each issue in the attached Quality Inspection Report.
As stated in my employment contract and job description [redacted] is responsible for ensuring the safety of all crew and clients during submersible and surface operations". I feel we all have a duty of care as Management to all personnel whether it be staff or Mission Specialist. Therefore, it is my opinion that until suitable corrective actions are in place and closed out, Cyclops 2 (Titan) should not be manned during any of the upcoming trials.

My report and the relevant attachments are merely a clear stated record of what I feel should be addressed to allow for successful and safe operations within OceanGate Inc.

This report was prepared by myself as part of the pending handover of the asset from OceanGate Engineering team to the Operations department on the 18th January 2018.

OCEANGATE CYCLOPS 2 QUALITY CONTROL INSPECTION REPORT

PROJECT NAME:	CYCLOPS 2 (TITAN)	DOCUMENT VERSION NO:	1
PREPARED BY:	[redacted]	DOCUMENT DATE:	18th JANUARY 2018

COMPONENT/DELIVERABLE	INSP DATE	INSPECTION NOTES	CORRECTIVE ACTION/RECOMMENDATIONS	ATTACHMENTS	CLOSED OUT
Viewport, O-ring and fasteners	1/18/18	Viewport was installed by OG Engineering department prior to this inspection, no thorough inspection of acrylic or O-ring could be carried out on inspection date.	Documentation to be issued to Operations department showing completed pressure test results and associated documentation from Hydrospace Group. Engineering Director has denied my requests for these records to be produced		No
Forward Dome	1/18/18	Pitting and scoring evident on external face	None		Yes
Forward Dome sealing face	1/18/18	At the 12 o-clock position it must be noted that a plunge-hole is present. This will create the least path of resistance of sea water on this critical sealing face. A double dove tail O-ring groove has been machined to captivate the O-ring yet with the plunge hole this type of O-ring groove is out- with standard design parameters	Recommend re-machining of the sealing face too correct both the plunge-hole and the O-ring groove as they deviate from standard design parameters	Photos and PDF of O-ring groove are below this report	No
Segment 1 sealing face	1/18/18	Some marks seen at the 9 O-clock position, impact caused by hatch swing	None		Yes
Segment 1	1/18/18	Glued onto the Forward Carbon hull prior to delivery so unable to inspect the attachment face.	Director of Engineering to verify condition of the attachment face prior to gluing occurring Non Destructive Testing of the Bond Line should be carried out		No
Hatch Hinge	1/18/18	Ongoing work so final inspection will be required to be done on completion	Further inspection required upon completion		No

Forward vertical legs	1/18/18	No action items noted	None		Yes
Forward Horizontal support	1/18/18	Where the support meets with the Segment 1 lower attachment bracket, 2 of the 4 bolts are missing, no nuts are present	Bolts and nuts to be secured prior to moving the vehicle		No
Top/Port/Stbd Horizontal beams	1/18/18	No action items noted	None		Yes
Carbon hull and coating	1/18/18	Hull could not be inspected externally due to Rhino-coating having been applied under the direction of OG Engineering department. It must be noted that visible voids and delamination's are present in the Carbon end cut off segments, highlighting the need to carry out Non Destructive Inspection to verify the hull integrity	Non Destructive Inspection is required to be undertaken and subsequent results provided to myself prior to any in water Manned Dives commencing. This testing will also provide a solid baseline of the hull condition prior my recommended unmanned pressure testing in the Bahamas April 2018	Photos of delamination's and porosity in Carbon end segments after this report	No
Ballast Bag and vent mechanism	1/18/18	Glue coming away from seams, no support on the base of the bag preventing air from exiting during thrusting of vehicle in water. Vent mechanism unproven. No vent mechanism seen on forward end of ballast bag	Glue to be reapplied, ballast bag design to be re-assessed.		No
Aft vertical legs	1/18/18	No action items noted	None		Yes
Aft Horizontal support	1/18/18	No action items noted	None		Yes
Stbd penetrators	1/18/18	No action items noted	None		Yes
Port penetrators	1/18/18	No action items noted	None		Yes
Segment 2	1/18/18	Glued onto the Aft Carbon hull prior to delivery so unable to inspect the attachment face	Director of Engineering to verify condition of the attachment face prior to gluing occurring Non Destructive Testing of the Bond Line should be carried out		No
Segment 2 sealing face	1/18/18	This sealing face could not been inspected as the aft dome was torqued in place by OG Engineering department prior to this inspection	Engineering Director to verify condition of the sealing face prior to sealing it up		No

Aft Dome	1/18/18	Aft dome torqued in place by engineering department prior to this inspection. Pitting and scoring evident on external face	Engineering Director to verify torque settings and witnessed		No
Aft Dome sealing face	1/18/18	This sealing face could not been seen as the aft dome had been torqued in place by OG Engineering department prior to this inspection. Yet prior to the dome being in its current configuration we noted that at the 6 o-clock position a plunge-hole is present on the O-ring groove. This will create the least path of resistance of sea water on this critical sealing face. A double dove tail O-ring groove has been machined to captivate the O-ring yet with the plunge hole this type of O-ring groove is out- with standard design parameters	Re machining of the sealing face too correct both the plunge-hole and the O-ring groove. Engineering Director to verify condition of the sealing face prior to sealing the dome	Photos and PDF of O-ring groove are below this report	No
Exo-structure	1/18/18	Dissimilar metals used throughout. Rubber spacers for top fairing need to be secured more effectively	Anodes required Rubber securement required, not zip ties		No
Electrical Pods	1/18/18	No Anodes on any of the cans	Anodes required to prevent corrosion		No
Electrical Pod tray	1/18/18	Dissimilar fasteners used	Fasteners should be assessed		No
Ictineu Battery	1/18/18	Securement in tray using ratchet straps, one strap is tensioned over the upper sealing bolts	Clamping method to secure battery to tray should be considered		No
Battery Tray	1/18/18	No action items noted	None		No
Fairings and thruster support brackets	1/18/18	Vertical Thruster mounting bracket bolts are deflecting off the ballast bag port and starboard. Thruster brackets have differing fasteners	Use of shorter bolts or protection to prevent rupturing the ballast bag. Fasteners should be assessed		No
Thrusters	1/18/18	Snagging hazards evident with the positioning of the oil filled cables	Angled adaptors required to allow for greater protection of cables and neater cable runs		No
Sonar/ Pan and Tilt	1/18/18	Pan and tilt not installed	None		Yes
Anodes	1/18/18	Other than the thruster motor anodes no Anodes were present on vehicle	Anode assessment required		No

HPA System	1/18/18	System is plumbed and charged, verification of leak test required No securement present for the HPA Cylinder	Leak test and system test required. Cylinder securement required		No
Novatech Iridium	1/18/18	Secured onto support bar with zip ties	Clamping arrangement suggested		No
Oxygen system	1/18/18	No access granted on day of inspection	Inspection required		No
House batteries	1/18/18	No access granted on day of inspection	Inspection required		No
HPA system, Blow Vent	1/18/18	No access granted on day of inspection	Inspection required		No
Control / computer systems	1/18/18	No access granted on day of inspection	Inspection required		No

The PDF image below shows the type of O-ring groove currently machined on both Forward and Aft Cyclops 2 (Titan) Dome sealing faces. This selection deviates from the standard design process for our application.

The addition of the unnecessary plunge hole on both our O-ring grooves also deviates from standard design process.

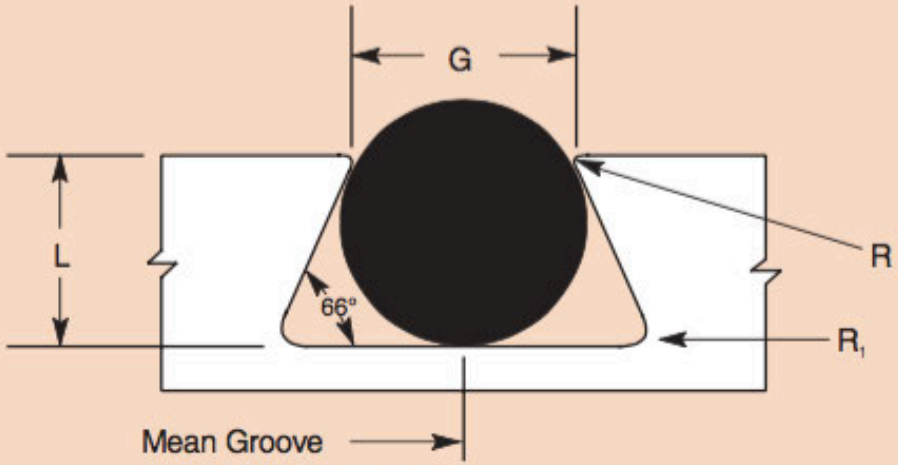
As can be seen on both the images on the next page the O-rings are not fully captivated due to the plunge hole, and this void on either side creates the potential for the least path of resistance of seawater. In my experience the potential for this issue will be exacerbated if we see any sort of buckling of the materials during the immense pressure changes as we go deeper.

Parker O-Ring Handbook

Dovetail Grooves

It is often necessary to provide some mechanical means for holding an O-ring in a face seal groove during assembly and maintenance of equipment. An undercut or dovetail groove has proven beneficial in many applications to keep the O-ring in place. This is an expensive groove to machine, however, and thus should be used only when absolutely necessary.

It should be noted that although this method has been used successfully, it is not generally recommended. The inherent characteristics of the groove design limit the amount of void area. Normally acceptable tolerance extremes, wide service temperature ranges, and fluid media that cause high swell of the elastomer are conditions that cannot be tolerated in this type of groove design.



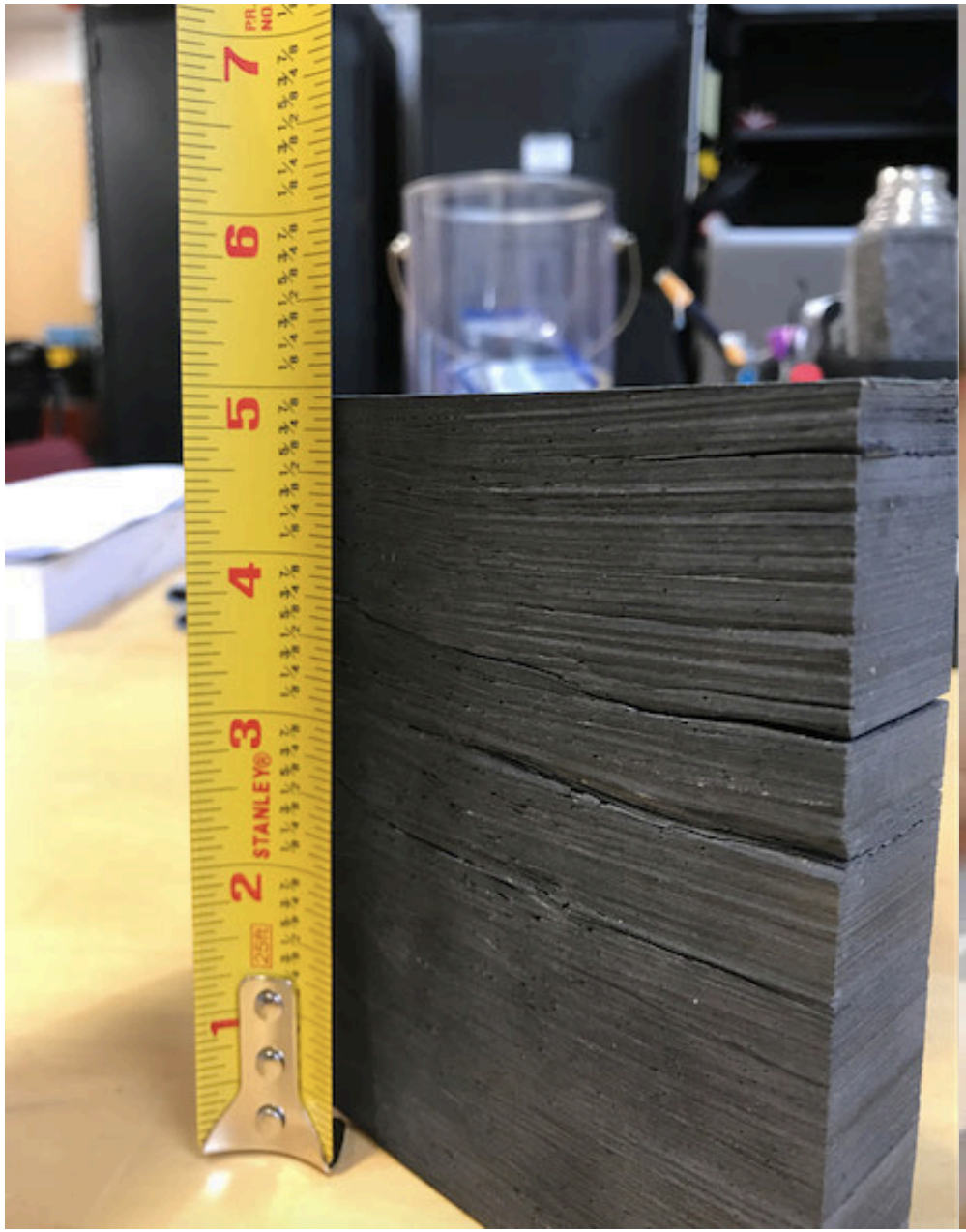
As we have all seen the Carbon hull end sections that were machined off after the completion of the winding show very visible signs of delamination and porosity within the Carbon.

I understand that most Carbon manufacturers expect some but not an excess of porosity (voids) from their end sections hence why they too machine off the ends after winding. With our application of the hull seeing such immense pressures not yet experienced on any known carbon hulled vehicle we run the risk of potential inter-laminar fatigue due to pressure cycling, this especially if we do have imperfections in the hull itself.

We should fully endorse what the company initially set out to do and carry out a full Non Destructive Inspection of both the hull and also the Bond line between the Carbon hull and both Segment 1 and 2. The results will provide us all with the knowledge that either the hull is indeed intact or there may be deficiencies. This also applies to the Bond line to verify the adhesion process. The images on the following page show examples of the delamination's and porosity within our hull cut off sections.

Image 1 shows a section of the hull end segment cut off with visible delamination's and porosity

Image 2 shows another piece of the hull end segment cut off with intense light shined onto it from behind, this method shows how prevalent the porosity actually is throughout.



The flooring of the cabin within Cyclops 2 (Titan) is currently made from a material called HDPE.

A sample of the flooring material was set alight for approximately 3 seconds outside of the OceanGate facility and the material continued to burn after removing the ignition source, the burning material released toxic fumes and the resultant melted remains continued to burn as they dropped to the asphalt below. It should also be noted a sample of the vinyl tape wrapped internally within Cyclops 2 (Titan) emits highly toxic gasses upon ignition.

The following image shows the test material used. Video footage of the test can be provided to show the continued burn.

Cheers David