

# HAZARD AND OPERABILITY STUDY (HAZOP) REPORT

## CONCLUSIONS AND ACTIONS

**Subject:** **O-rings**  
Project: Provision of diver rebreather (RB) and monitoring system NR0006357.  
Site: St.Petersburg Design Centre  
Date: 19 January 2007, 3d part.  
Time: 10:00 -18:00  
Participants: Statoil team: Yngve Bergflodt  
Technip team: Jim Holborn , Jon Are Hvalbye , John Nortcliffe, Stein Olberg,  
NUI team: Kare Segadal  
Deep Life team: Alex Deas, Marat Evtuhov, Alexey Bogachev, Alexander Kudyashov, Sergei Maluytin, Vladimir Davidov, Pavel Kamochkin.  
Study leader: Vladimir Komarov .

### General summary:

Terms of reference and scope of the study are rebreather O-rings used in the project document Green Book GreenB\_ORTONOR\_070105.pdf and Agenda of HAZOP Study of 19.01.2007.

Each of the following O-ring positions was reviewed:

1. Hoses, Breathing. Dual O Rings, Ambient to Surface to Ambient pressure
2. Hoses, Electrical, Dual O Rings, Ambient to Surface pressure
3. Hoses, Gas Intermediate Pressure, Dual, Ambient to Surface to Ambient + 10 bar
4. Scrubber canister seal, Single thick, Ambient to Ambient
5. Scrubber cartridge seal, Dual, Auto Air Filter type seal, Ambient to Surface to Ambient
6. Pressure sensors (Gas contents), single, Ambient to High Pressure
7. Thermal expansion oil piston seals, single, Ambient to Ambient
8. Gas injector, dual, Ambient to Surface pressure
9. Counter Lung retaining ring, single + seal rings, Ambient to Ambient.

Specific O-rings were chosen for detailed scrutiny.

The reliability of O rings was reviewed, with comparison to hydraulic pistons such as on excavators. It was noted that the dual Ambient to Ambient seals provide Ambient to Surface and Surface to Ambient, so the sealing pressure is high as well as reliable.

The discussion on the scrubber canister seal concurred with the design decision that one thick O-ring was safer than two thin O Rings in this application.

The O-Rings are all black EPDM, which has good chemical resistance, good UV and ozone resistance, and is strong mechanically with good wear properties.

A detailed MSDS for Black EPDM was considered.

### The keywords combinations:

#### Primarily keywords:

Pressure; Temperature; Corrode;  
Absence.

#### Secondary keywords:

No; Under; Over; Reverse;  
Other.

During the HAZOP study sessions all the combinations of primarily and secondary keywords were considered. Action worksheets have been filled out (attached).

Recommended Actions: \_

1. Include in a checks when fitting a scrubber cartridge a visual check of scrubber O-rings. Damage to the end of the scrubber cartridge could act as a cutting tool on the O-ring. **Action:** Add risk to FEMCA Vol 4 for O-ring and scrubber canister.
2. Include in the mushroom valve check a visual check of the port O rings.
3. Replicate the pre-dive check results to the supervisor.
4. It is very important that only approved O2 compatible grease is used to prevent releasing potentially anesthetic or toxic chemicals into the breathing loop.
5. **Action:** Simulate the effect of omission of the scrubber O-ring and determine the survivability of such a complete ring failure. The onus is to either prove the O ring is not critical by showing that if it is omitted, then the water ingress is low enough that the dump valves can discharge it, or remedy it by fitting a second O ring.
6. It is very important that the rebreather does positive and negative pre-dive checks to identify any sources of leakage from O-ring failure.
7. Include in operational procedure a requirement to check physical presence of the O-rings when disassembled.
8. Underlines a strong necessity of proper training for all personal working with the RB.

Enclosure: HAZOP Action worksheets – 2 pages.

HAZOP Study leader:

V. Komarov