

# New regimes to follow up pressure chamber and diving bells

The Bergen International Diving Seminar 2017

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## Fatigue design

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- Until the last Rule update July 2017, one of DNVGLs requirements have been that the Pressure Vessels (PV) in a diving system shall be designed for a fatigue life of 5000 full load cycles
- The design standards normally allows utilisation of 20% of the fatigue design life before the first inspection. This means that the first in-service inspection to be carried out when the system has experienced 1000 cycles
- In the last Rule update, it is left to the PV designer to define the design fatigue life. This may implice that for future systems the first in-service inspection may be required at another "milestone"!

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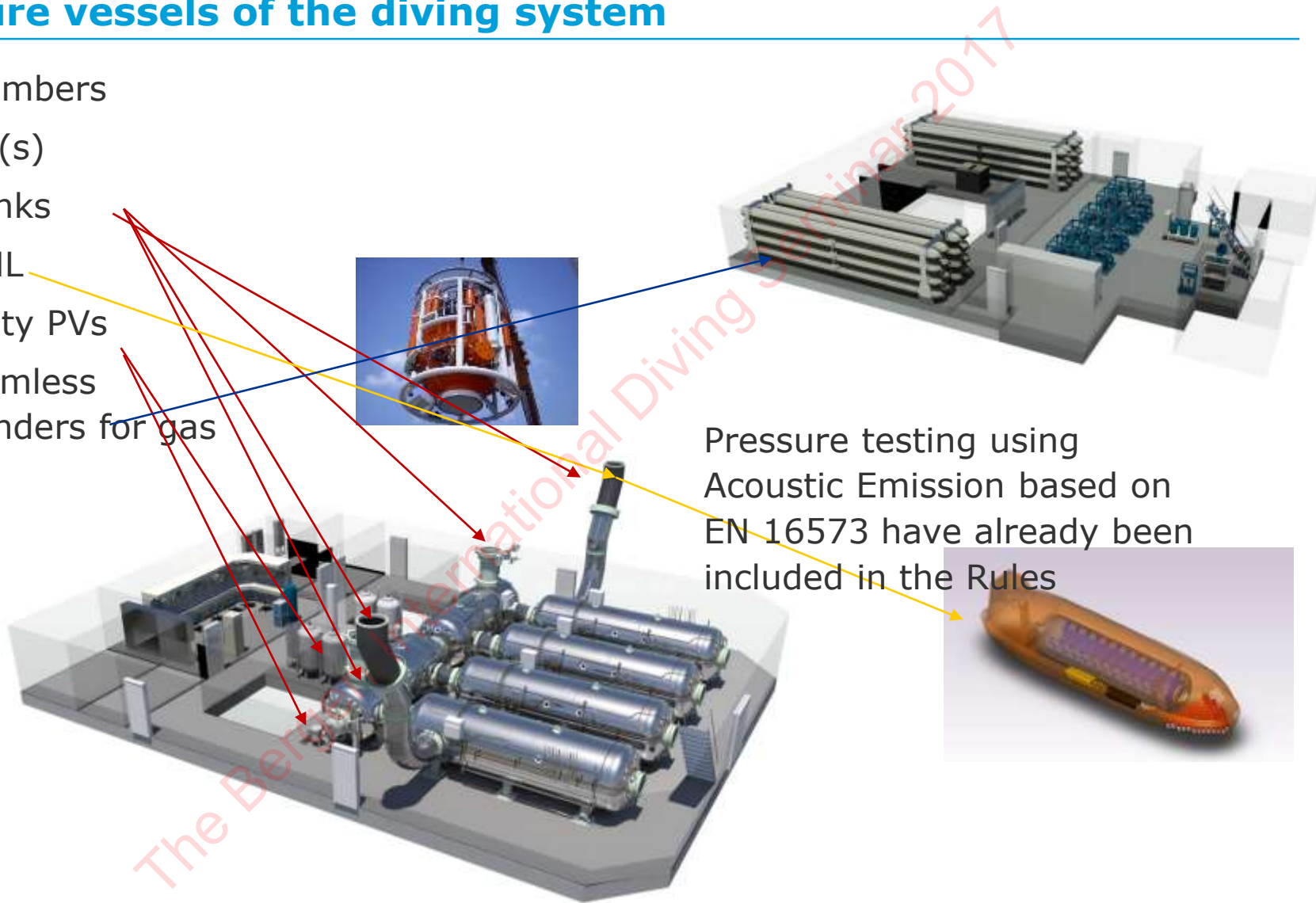
## Testing regimes

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- Since DNV launched its first rules for diving systems, it has been required to carry out pressure testing at every Renewal survey which means a 5-year cycle
- An alternative by downgrading the Maximum Allowable Working Pressure (MAWP) based on the safety factor that was the basis for the design, was launched as the regime with pressure testing proved to be difficult
- Most of the systems made during 1970 and 1980 was designed for 450 – 500 meters which meant that downgrading did mean a MAWP in the range 300 – 385 meters, which hardly gives any practical limitations
- In the latest revision issued this summer, an alternative using Eddy Current testing of chosen welds was launched and several owners have chosen to follow this
- However, the 5-year cycles remains and DNV GL have started to question if something can be done to base these intervals on actual utilisation of the systems!

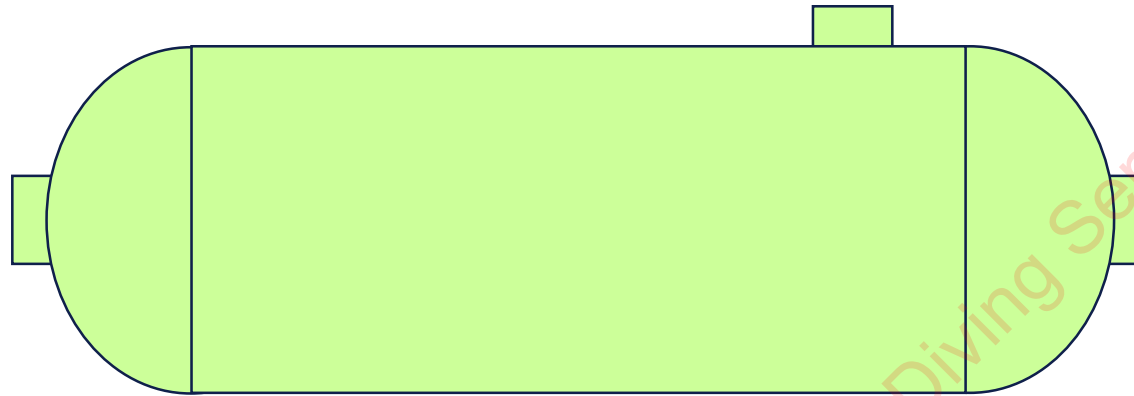
# Pressure vessels of the diving system

- Chambers
- Bell(s)
- Trunks
- SPHL
- Utility PVs
- Seamless cylinders for gas

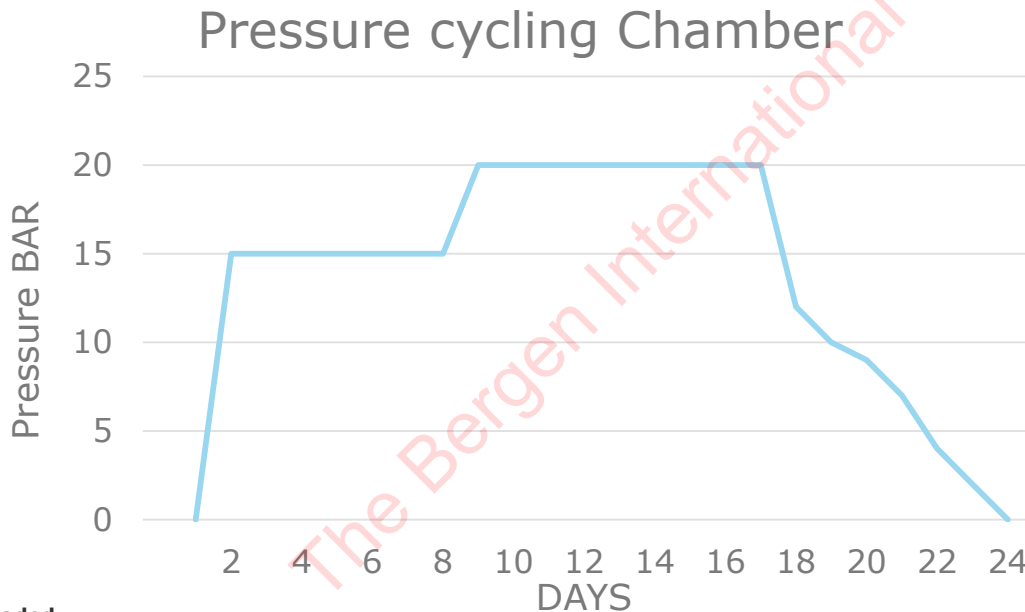


Pressure testing using Acoustic Emission based on EN 16573 have already been included in the Rules

# Typical pressure cycling chamber

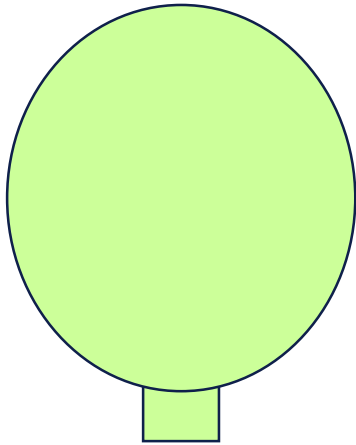


- This is just an invented “part cycle” for one chamber
- These cycles are dependant on:
  - the regularity with respect to continuously SAT operations
  - Water depth for the missions
  - Is the chamber used for Compression/decompression or kept at the living depth



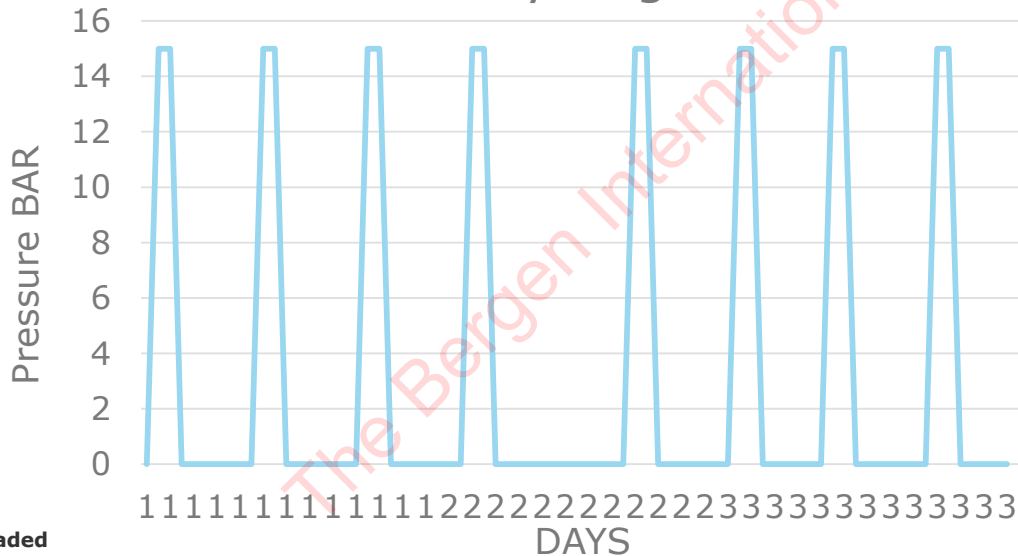
Ungraded

# Typical pressure cycling bell



The bell and the bell trunk together with the medical/food locks are probably seeing the most "part cycles" of the pressure vessels in the diving system

Pressure cycling Bell



Ungraded

## Acknowledgements

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- None of the systems do see complete pressure cycles during normal operations
- The number of partly carried out pressure cycles do vary between various systems which also is a product of the areas the systems are operating in
- DNV GL does not have any information with respect to the utilisation of the fatigue life for any diving system in Class as all testing have been based on a sequence of 5 years.
- Since the first systems that was classed back in 1975 until 2017, DNV GL do not have any experience that fatigue has been an issue for any system
- The various chambers, bell(s), medical/food/material locks see different numbers of “part cycles”
- Based on this acknowledgement, DNV GL have started to search for more relevant criteria to utilise the capacity with respect to fatigue and still ensure adequate level of safety for the systems

## Pressure cycle measurements

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- Most of the recently classed systems and many of the older systems have installed equipment using digital pressure readings
- This enables storage of the present pressure for each chamber during the part pressure cycles the various PV do see during each saturation profile
- This information can be converted into a “damage” caused by each “part of a pressure cycle” and based on this, the part cycles can be added into total pressure cycles and used as a basis to invoke inspection/testing
- The first step to establish such criteria is to collect the actual utilisation of the fatigue from some of the systems in operation do see
- This means that DNV GL need actual pressure data from some of the operating systems collected may be up to 1 year
- Data from all of the pressure vessels will enable quantification with respect to utilisation and from this specific criteria can be defined

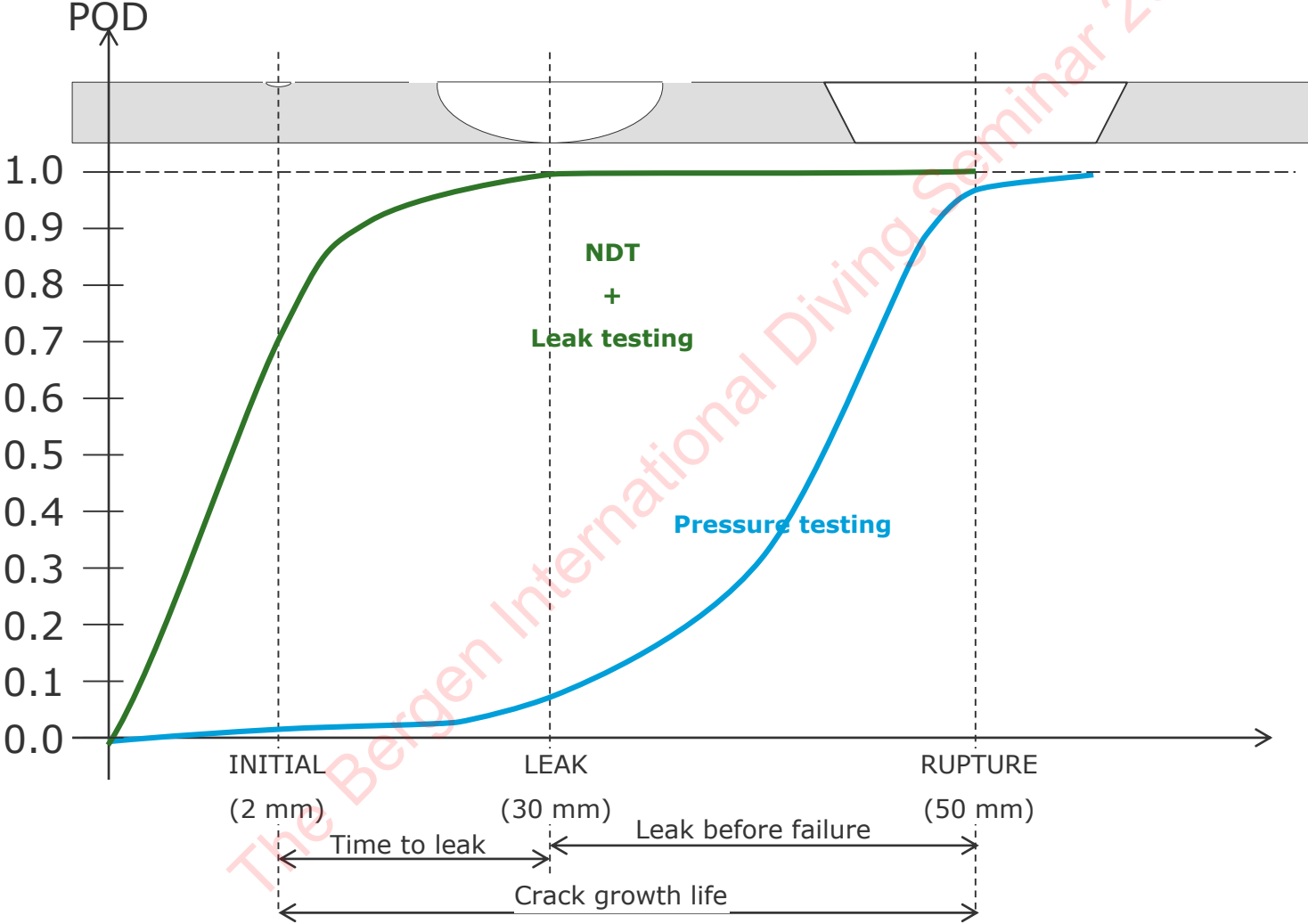


## Develop more relevant test requirements

- This will be the first attempt carried out by DNV GL to establish the actual utilisation of the fatigue capacity the pressure vessels in a diving system do see, based on actual data
- It is an ambition to use the data as the basis to change the Rules towards something more relevant than the 5 year cyclus which has been the basis since 1975
- **An important topic will be how such a new regime may be utilised!**
  - Shall the basis to invoke inspection/testing of the whole system be based on the pressure vessel seing the most total cycles or is it practical to base this on the utilisation on each of the pressure vessels in each system?
  - DNV GL do also need to establish a "Rule way" to convert the part cycles into complete cycles which shall be the basis to invoke required action such as NDT.

This is something DNV GL will work on and also discuss with owners of systems in Class with DNV GL and also providers of the digital systems for pressure registration

# POD for NDT versus Pressure testing



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