

**CLOSED-CIRCUIT COMPRESSED OXYGEN  
BREATHING APPARATUS FOR USE UNDER ELEVATED AMBIENT PRESSURE**

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**INTRODUCTION**

A Problem which had remained unsolved for some time was that of respiratory protection in underground installations which have to be kept under overpressure to prevent the infiltration of water.

Anyone entering or working in such areas must enter and leave through an air-lock system, a method which is called "Caisson Method". At present, the overpressure necessary for such projects lies between 0,8 and 4 bar. In case of a fire safe protection is necessary.

For protection compressed-air or closed-circuit mixed gas breathing apparatus can be used. However compressed air breathing apparatus have the distinct disadvantage that duration of use drops with increasing ambient pressure. Therefore, the problem posed can be solved by using mixed gas closed-circuit breathing apparatus only.

**SELECTION OF BREATHING APPARATUS**

Oxygen is essential to life, but it is highly dangerous under some circumstances. It can damage the lung. As is known, a human being can breathe oxygen with the requisite safety only up to a pressure of around 1,8 bar (and above for a very short time) for a period limited to a few hours without detrimental effects. When selecting apparatus for "Caisson Areas" this fact must be taken under close consideration.

Filter apparatus are unsuitable. since in the case of a caisson it is a matter of an enclosed area, so that while respiratory protection is necessary, the danger of oxygen deficiency cannot be excluded. Moreover, in the case of rescue work, the inhalation resistance would become uncomfortably high because of the higher air density.

As it was stated, the limit of the admissible oxygen partial pressure lies at 1,8 bar. Since, however, the oxygen content in the circulation of normal oxygen protection apparatus with a constant flow of 15 L/min plus lung-controlled addition supply rises up to 100 %, the admissible oxygen partial pressure of 1,8 bar is only reached with a elevated over pressure of 0,8 bar. For applications having a higher ambient pressure than 0,8 bar 100 % oxygen protection apparatus are unsuitable.

Physiologically speaking, there are no problems connected with the use of compressed-air breathing apparatus. The phenomena of "depth intoxication", known from diving experience as a result of the increasing nitrogen partial pressure, only arise at a pressure of around 4 bar.

However, for "Caisson Areas" compressed air breathing apparatus have the distinct disadvantage that the duration of use drops proportionally with increasing ambient pressure. Hence at caisson construction sites, compressed *air* breathing apparatus **may be** used only as an escape apparatus, but not as a working or rescue apparatus.

It can, therefore, be seen that caisson-application cannot be solved with normal breathing apparatus.

#### SOLUTION AND RESULTS

Because of the problems listed above, the development of a special breathing apparatus became acute. The BG 174 was the basis for the new apparatus. Theoretical calculations **and** men tests were object to modify the BG 174 as follows:

- mixed gas (60 Vol.% O<sub>2</sub>, 40 Vol.% N<sub>2</sub>) 800 L instead pure oxygen
- constant flow 6,4 L/min only
- duration 2 h
- weight 17,2 kg
- length 620 mm
- max. ambient over pressure 2 1/2 bar

Practical trials were carried out with kind support of the Main Rescue Office in Essen. The test results obtained confirmed that the design was correct.