

POLISH STUDIES ON SATURATION DIVING AND PRACTICAL APPLICATION OF THEIR FINDINGS. PART 3B

TECHNICAL AND ORGANISATIONAL ISSUES OF THE IMPLEMENTATION OF SATURATION DIVING IN POLAND FROM THE 1990S ONWARDS. PART 3C

Stanisław Skrzyński

Department of Underwater Works Technology, Polish Naval Academy

ABSTRACT

This article is another in a series of articles on the research and implementation of saturation diving technology in Poland. It discusses the specificities related to the implementation of this technology against the background of economic and historical conditions in our country. In Poland, the issue of saturation diving for the needs of the emerging offshore mining industry has been for over a dozen years dealt with by the Department of Diving Equipment and Technology of Underwater Works (Polish abbr. ZSNiTTP). In parallel, deep diving technologies were developed, in the first stage, as a basic diving technology and, since 1994, as complementary to ensure the full backup for saturation diving. Since 1995, saturation diving has become an everyday occurrence in the Polish economic zone of the Baltic Sea. This article shows the difficult path that the implementation of saturation diving took during a period of economic instability when the scale of the domestic offshore industry's facilities was small compared to global companies. Selected animators and participants in the implementation are recalled for two periods: one marked with the cooperation with the Italian underwater services company RANA and the other one, a period of implementation of long-term underwater works based on domestic capabilities. The article also considers the technical and organisational conditions for the implementation of saturation diving for the Polish mining industry. In 1990, the Oil and Gas Exploration and Production Company Petrobaltic (today LOTOS) played one of the key roles in the implementation of saturation diving in our country. The implementation of saturation diving in Poland was linked to the only operational diving system of Italian production, the Af-2, which enabled scientific research related to the application of new technical solutions and testing under operational conditions, as well as contributed to the development of scientific, engineering, and medical staff for the Polish offshore industry. The company played one of the main roles in the implementation of saturation diving in our country. The 1995 became a landmark year in the history of saturation diving in Poland, as well as in the Baltic Sea. Through this technology, the process of installing the first two underwater exploitation heads on production wells B3-7 and B3-10 was initiated. The saturation diving was possible thanks to the leasing of the Af-2 diving system by Petrobaltic and its subsequent purchase by the Naval Academy in 1998. This system, after a series of upgrades, is still in service today.

Keywords: saturation diving technology, decompression tables, saturation diving parameters, long-term underwater work, diving system, emergencies, technical and organisational backup for diving, medical issues of operational saturation diving, mobile diving system, saturation diving base, breathing mixtures.

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INTRODUCTION

TECHNICAL AND ORGANISATIONAL ISSUES IN SATURATION AND DEEP DIVES IN THE BALTIC SEA IN 1999 AND 2000.

PREPARATION AND MODERNISATION OF THE DIVING SYSTEM FOR THE SAKE OF CLASSIFICATION

In 1999 the Af-2 diving system was transported to ZSNiTTP. The Italian partners were asked to take care of the classification in RINA due for 2000. The Italian side maintained that a complete documentation of the Af-2 diving system was kept at RINA offices in Rotterdam. Yet, despite repeated requests, no documents were received over further two years while dives in 2000 could take place only if the system exploited for over 20 years were duly prepared and classified.

Plans were made to go through the classification procedure under the supervision of the Polish Register of Shipping (PRS). The idea failed as the PRS were excluded from the IACS (International Association of Classification Societies). Thus we were forced to apply for system classification at the Italian RINA Society.

The dives planned for 2000 by Petrobaltic were based on the diving contract of the Italian company RANA. As the Italians were no longer in charge of the diving system, in setting the terms and conditions RANA requested compliance with typical international procedures, including, of course, diving system classification documents, rather than the company's internal procedures as before. The classification was necessary for insurance purposes and to meet the requirements of international cooperation. The Italians also insisted that the system meet the current technical requirements for diving systems, based on the regulations of the classification society Det Norske Veritas and IMO resolutions.

In 2000 and 2001 the system was upgraded and adjusted to the requirements of the RANA company which delegated a safety engineer and a diving specialist for the purpose of supervision. On top of that, RINA society was asked to carry out the classification. An inspector representing the society responsible for classification approved the protocols of tests and performance trials of devices and components of the Af-2 system conducted at the Naval Academy. When it comes to incomplete technical and operating documentation he acknowledged that a complete documentation was kept at the offices of the society and will be delivered to Poland.

The upgrade was planned and carried out by the Department of Diving Equipment and Underwater Work Technology at the Naval Academy which received a substantial financial support and cooperation from PP Petrobaltic and a wide group of experts from domestic companies. Most works were performed by experts from the Department who had earlier (between 1988 and 1991) been involved in building diving complexes for the Szczecin Shipyard. While planning the refurbishment and upgrade of devices and sub-systems, three scopes of operations were identified.

SCOPE 1. Technical inspection when the system is in operation but before starting the dive:

- identification of technical condition of the devices and sub-systems;

- repair and maintenance as required by applicable regulations;
- replacement of exploitation materials in accordance with instruction manual;
- test run of equipment and installations;
- leakage tests;
- test runs of the system and identification of its main working parameters;
- provision of exploitation materials and spare parts;
- removal of damages to components caused during the maritime and road transport;
- replacement of damaged and over-used components and equipment.

Selected structural node joints had to be upgraded as parameters of available replacement components were very much different from those used in the period 1988-1991. Also, we had to meet the requirements specified by authorities that supervise the operation of diving complexes.

SCOPE 2. Works intended to improve the functionality of the system:

- replacement of outdated components and equipment (without the support from the servicing unit and spare parts),
- upgrade of structural node joints, sub-systems, installations, etc. that improve their performance.

SCOPE 3. Major renovation of the system with simultaneous upgrade which would enable:

- expanding the use of the system, increase the choice of mixtures and the use of the system for deep dives;
- changing the arrangement of sub-systems into more compact and versatile;
- improving safety, functionality, and ergonomics of the system;
- testing and trial runs of sub-systems, equipment, and installations after the overhaul and upgrade,
- testing the operation of the system at the site where it was renovated and upgraded,
- drafting necessary classification documentation.

Works related to the classification confirmed that following the overhaul and tests depth gauges and diving wireless communication meet classification requirements and received the required attestation. The cable and hose bundle of the diving bell (umbilical) was renovated, spigots were replaced and prepared for classification tests.

The heating system in the bell and diving suit heaters are among major equipment of the safety system. It was purchased by Petrobaltic from the French company COMANEX. To ensure safety, the diving system should include two independent heating devices. The scope of works lists all installations including over 200 valves. Preparatory works covered:

- refurbishment and upgrading of the chamber and bell system AF-2,
- renovation of the crane and lifting equipment,
- overhaul and upgrading of life support systems,
- renovation of the cylinder-gas storage sets,
- renovation of the diving suit and bell heaters,

- overhaul of diving gear and equipment,
- overhaul of compression and pumping equipment.

Moreover, Navy Staff were trained to carry out classification and handling. Research methodology was developed also for classification tests.



3 Fig. 3 Diving bell at the stand of ZSNiTPP Polish Naval Academy (2000).

The requirement of having an HRC (Hyperbaric Rescue Chamber) resulted from the newly adopted evacuation method as the previous ways of evacuation could not be applied for formal and organizational reasons. A rescue unit was built by adapting the chamber form the MOBNUR diving system of 1999. During the saturation dives, it is not possible to use conventional means to protect the lives of divers under positive pressure in emergency situations. The guide approved by the IMO's Life Support Scientific and Research Committee at its 22nd session (Resolution 692, para.17) outlines methods, construction requirements, and design principles for hyperbaric evacuation systems that can protect the evacuation of a diver during saturation dives in emergency and accident situations that necessitate leaving the platform or vessel. In addition, the design of the rescue chamber must meet the safety conditions as described in IMO (Resolution A.3536 and Resolution A 583). It means that a saturation dive in which divers need several or over a dozen days to return to atmospheric pressure cannot be interrupted. If forced to immediately abandon ship or platform, the divers would have no chance of surviving. The rescue chamber must be equipped with equipment and materials for the implementation of accelerated decompression performed from inside and outside the chamber, ensuring a minimum of 48 hours autonomy. Another important requirement is that the rescue chamber must be buoyant so that it can be picked up from the water by a rescue vessel after launching.

The transfer of divers under pressure (TUP) is a risky operation carried out during diving when the bell is being submerged and it is connected to and disconnected from the hyperbaric chamber. A similar operation must be performed when divers are evacuated. To make it feasible, a movable detachable coupling

ensuring a tight connection at a maximum pressure of to be added to the two chambers: the Af-2 chamber and the rescue chamber. The bursting force acting on the coupling at this pressure is 32.5T (325kN) with a chamber hatch diameter of 643mm. This device is the most likely to cause an implosion, which is why the first completed coupler, despite positive testing and pressure testing and approval by a RINA representative, was challenged by a RANA representative. The disqualifying argument was that the jaws of the coupling were welded to the coupling support ring. The coupler according to RANA should be made of a single block of deoxidized steel, so RANA proposed to purchase a typical coupler for DRASS chambers.

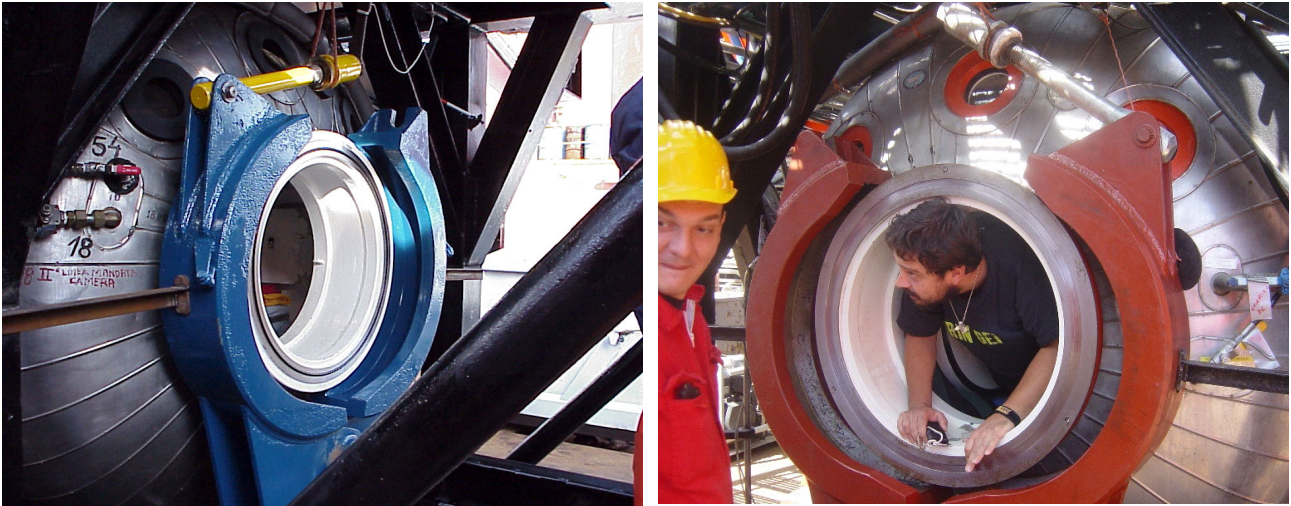


Fig. 4 Coupling between the Af-2 chamber and the rescue chamber for emergency under pressure evacuation of divers.

Following the aforementioned work, which required the shipowner to perform tests and trials, performance, functional and classification tests of the assembled system were carried out. Strength tests, component tests and parameter measurements were

carried out at the Department of Diving Equipment and Underwater Work Technology, while performance and functional tests were carried out at PP Petrobaltic and on the platform at sea.



Fig. 5 Tests of the rescue chamber (photos taken in 2007).

An additional challenge was the winter, when a complex prepared for Mediterranean conditions was adapted to the winter conditions in the Baltic Sea. All the work was carried out at an express pace, given the problems with supplies and purchasing problems in Poland and the small size of the implementation team. The work including classification studies took seven months. The first saturation dives in winter conditions were performed when the Af-2 dive system was mounted on the platform. The system was sheltered from the cooling effects of the wind, known as 'chilling', and in addition the platform had steam and hot water and a 'huge' reserve of electrical power, which allowed for the use of additional heaters. The platform offers the possibility of using additional sources to de-ice the so-called ice plugs that form in installations and hoses in which water or soggy gas flows, especially in areas of low-lying bends, siphons, bends and uncovered metal fittings

of disconnected installations in the diving process. To avoid heat loss, all of the above-mentioned piping and hose systems were, where possible, covered with high-quality polyethylene foam insulation lagging. The thickness of the cover matched the diameters of the pipes, and its installation required additional work from the preparation stage to the installation of the diving system. An important decision was the shielding of equipment where water vapour could condense, e.g., the exhaust regulators of the chamber's inhalers, as well as the hoses and sampling tubes for measuring oxygen and carbon dioxide (where, in addition to the possibility of 'flow clogging', low temperature introduces measurement error).

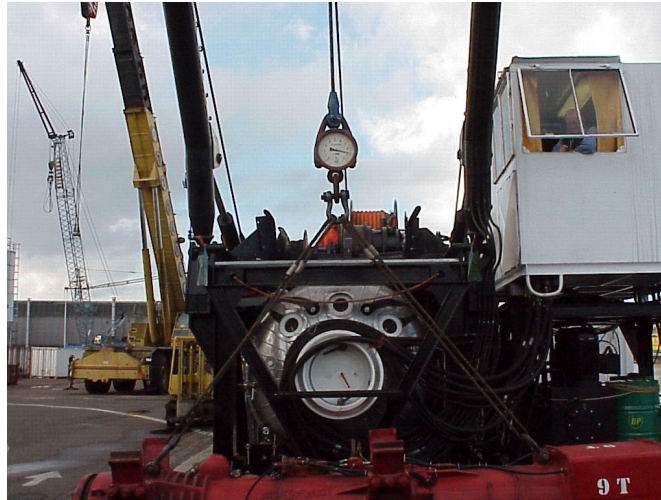


Fig. 6 Diving complex during classification tests of diving bell lifting-lowering system (2000).

In 2001, the effectiveness of electrical heating tapes and mats was tested, which were then successfully used during saturation dives on board the vessel, for which it was and is necessary to provide additional electrical installation.

On behalf of the ZSNiTPP this work was performed primarily by Bartłomiej Jakus, M. Sc, Eng., Marcin Palczewski, Eng., and technicians Janusz Pawlak, Stanisław Wiśniewski, and Ryszard Torchała. RANA delegated Vittorio de Boni to supervise the work. Cooperation with him was exemplary. The Petrobaltic team who drafted the documentation, manufactured components and durable details played the leading role in upgrading and refurbishment of the Af-2 and HRC chambers. On behalf of Petrobaltic the works were headed by the V-ce Technical Manager Jerzy Jernas, M. Sc., Eng. Also the contribution of the base workshop headed by the manager Bogdan Baranowski, M. Sc., Eng. and the Head of Maritime Technology Department Krzysztof Borowiec, M. Sc., Eng. with a team.

SATURATION DIVES IN 2000 AND 2001

For PP Petrobaltic, dives to a depth of 82m were carried out with the help of Polish equipment and Navy specialists, with the work of a team of divers from the Italian company RANA. The Polish side secured the dives logistically, technically and service-wise. Unlike in previous years, only Italian divers took part in the dives. The participation of Polish divers from the Navy was not possible due to official duties (performing other tasks for the Navy and Petrobaltic). The Polish side fielded a team of safety divers. The cooperation was flawless and, which should be stressed, experts from the Naval Academy won the sympathy and, what is important in diving, also gained the full trust of the Italian divers with their expertise and commitment. The AF-2 system operated smoothly although these were its first saturation dives in winter time (the Af-2 diving system worked in temperatures below zero, the lowest temperature measured at night was -7°C). An indicator of the preparedness of the diving system was the daily consumption of helium to secure the operation of the

chamber. Throughout the period this consumption was minimal, 3-6m³ per day of divers staying at the saturation plateau (in previous years there were dives where it was several times higher, reaching 60m³/day).

In 1995, a very important problem was to maintain the tightness of the bell-chamber system and the associated installations, even though the results of leak test showed normal values before the dive. Helium had to be replenished. Its losses resulted from: leaks (the need to maintain saturation plateau pressure), gas losses from the chamber for sluicing operations, bell connection and disconnection operations, hygiene procedures (bathing and toileting) and refilling the bell twice to repair its equipment. Approximately 60m³ of helium was consumed per day for these operations. In both dives in 1995, 8100m³ of helium was consumed, of which about 3300m³ was used for the divers' work at depth.

In 2000 between 05 November and 26 November one saturated diving took place which lasted 508 hrs., including 9 bell submersions, the total time of over 32 hrs.

In 2001 three saturation dives took place:

- 1st between 12 January and 05 February 2002, duration 580 hrs. - including 22 bell runs, the total time of over 136 hrs.
- 2nd between 07 February and 28 February 2001, duration 498 hrs. – including 18 bell runs the total time of over 82 hrs.
- 3rd between 17 March and 26 March 2001, duration 212 hrs. - including 5 bell runs the total time of over 17 hrs.

In total, 1,789 hours (77 days) of four divers staying in winter conditions under pressure between 0.7 – 0.73 MPa, including 267 hours of two divers' working in deep sea.



Fig. 7 The AF-2 complex on Petrobaltic platform in 2001. On the right flooding of platform components.

During the aforementioned saturation dives, the basic atmospheric parameters of the chamber and bell were measured continuously as a result of upgrades and additions to the measurement equipment in 1999 and 2000; saturation plateau - 70-73m, operating depth - 82m,

- $p_{O_2}=32\text{kPa}$, $p_{CO_2} = 0.25\text{kPa}$, $p_{He}=\text{exact}$
 $p_{N_2}=130\text{kPa}$, $t=27\text{-}28\text{oC}$, $\varphi=50\text{-}60\%$,
- working mixture heliox 10% O_2 , emergency mixture heliox 18% O_2 .

Decompression parameters:

time 74h 23min. (depending on the start time - with three breaks of 6 hrs. at night), (*depressurisation: up to 60m 1.8/hr, 60-30-1.5m/hr, 30m-15m - 1.2m/hr, 15-0m - 0.9m/hr, from 6m air*).

Consumption:

- $7,676\text{m}^3$ of He, $1,580\text{m}^3$ of O_2 , 560m^3 of air (the sum of gases used in mixtures of pure oxygen to secure operations in the chamber),
- Sorbents: 2,200kg of CO_2 sorbent, 20 kg of activated carbon, 15 kg of alumina, and 20kg of purafil.

The crew worked in the offshore system, i.e., in two 12-hour watches. On the Polish side, the team consisted of 8 people, a diving manager, a safety diver and 4 hyperbaric operators, a system mechanic and a system electrician.

The technical and logistical support was provided by ZSNiTPP Department of the Naval Academy.

The saturation dives performed in 2001 in the area of the mining platform confirmed the team's preparation for technically and organisationally complex underwater works, and provided the basis for further studies of saturation dives in the direction of technical and organisational execution and protection of underwater works taking into account domestic capabilities. These dives provided an answer to the question of how far our saturation diving meets international standards, and indicated directions for further modernisation, despite the fact that the system

was designed in the 1970s with technical norms differing from the requirements of the 1990s.

List of saturation dives in the Baltic Sea between 1995 and 2001.

No.	Year	Diver's working depth [m]	Duration [hour]	Diver's working time [hour;min]	Number of bell dives	Diving base	Team	Underwater works	
1	1995	70-78	562	58;00	14	Beta Platform	Polish-Italian team Italian divers	Assembly of underwater structures	
2	1995	70-79	713	93;10	19	Petrobaltic Platform	Polish-Italian team R.Kłos and G.Mączka + Italian divers	Assembly of underwater structures	
3	1997	72-80	503	62;16	16	ATHS Bazalt	Polish-Italian team R.Kłos and G.Mączka + Italian divers	Assembly of underwater structures	
4	1997*	72-80	820*	83;14	23	ATHS Bazalt	Polish-Italian team G.Mączka + Italian divers*	Assembly of underwater structures	
5	1997	72-81	122	14;20	2	ATHS Bazalt	Polish-Italian team	Assembly of underwater structures	
6	1997	72-84	194	37;55	8	ATHS Bazalt	Polish-Italian team G.Mączka + Italian divers*	Assembly of underwater structures	
7	1997	72-84	224	36;55	10	ATHS Bazalt	Polish-Italian team	Assembly of underwater structures	
8	2000	74-78	508	32;10	9	Petrobaltic Platform	Polish-Italian team	Assembly of underwater structures	
9	2001	75-80	136	58;15	22	Petrobaltic Platform	Polish-Italian team	Assembly of underwater structures	
10	2001	75-80	498	82;30	18	Petrobaltic Platform	Polish-Italian team	Assembly of underwater structures	
11	2001	75-80	212	17;20	5	Petrobaltic Platform	Polish-Italian team	Assembly of underwater structures	

**The longest dives in the history of saturation diving in Poland lasting 35 days.

CHANGE OF THE OWNER OF THE AF-2 DIVING SYSTEM

Since the completion of the work in August 2001, due to the lack of storage space at the ZSNiTPP Department of the Naval Academy and the high cost of transport from Gdansk to Gdynia, the complex was stored mainly at the Petrobaltic onshore base. The ZSNiTPP team had limited access, due to the distance and the lack of finances to operate this system. In view of this situation, the then manager of the ZSNiTPP made efforts to resell or transfer the Af-2 system to Petrobaltic. For more than 18 month there was no response. The impulse regarding the ownership of the Af-2 system came when the Italian company RANA wanted to rent the system in mid-2003. According to the Academy administration, at that time there was no direct procedural possibility of renting the

Af-2 system on a commercial basis. Even the use of a rental cascade, i.e., the Academy makes it available to Petrobaltic and Petrobaltic lends to the Italian company RANA, was not accepted.

The ZSNiTPP planned full implementation of these standards for the Af-2 diving system, but it was suspended in 2002 and 2003. This was determined by the lack of support from the Navy and the Academy, due to personnel and organisational changes, as well as changes in the management team and the lack of needs and plans for the use of saturation diving by PP Petrobaltic. Despite the fact that the ZSNiTPP team sought funding to maintain the Af-2 system, analyses made by policy makers and research reviewers suggested that it was not advisable. For example, in the justification of the lack of funding for the Naval Academy command and beyond, the most important arguments were the campaigning nature of saturation diving with breaks of more than 3 years, and



the establishment of a land-based centre at IMMiT in Gdynia, which was to take over the research of underwater work for the benefit of the national economy. Reality showed that the aforementioned issue of interruptions in saturation diving was a real one, as the next saturation dives took place in 2007. During this long break, the ZSNiTPP team developed the technology for deep trimix diving, while at the same time building a diving system for these dives (MOBNUR) classified by the Polish Register of Shipping. On the other hand, the 'land centre' at IMMiT did not undertake any activity in this direction, as it had no technical team at all and the medical team had no experience in saturation diving; it only had the knowledge obtained from doctors at the Department of Maritime and Tropical Medicine of the Military Medical Academy.

Due to structural and personnel changes, Petrobaltic participated in its maintenance to a minimal extent (be ensuring storage). The formal explanation for Petrobaltic's lack of investment in the AF-2 diving complex was that the company cannot pay for the maintenance of the system and invest in a piece of equipment not owned by them. A cost-effectiveness analysis indicated that the maintenance and repair expenditure required to keep the dive system operational pays for itself in full after two dives of 14 days' duration.



In addition, maintaining the system in working order is very expensive and with this in mind, the Department's team carried out the necessary maintenance resulting from technical supervision reviews and classification regulations. Funds for this purpose were set aside from the work carried out by the Department in 2002 and 2003. The cost of maintaining the system after classification on an annual basis is approximately PLN 80,000 (excluding classification supervision fees).

After intensive use between 2000 and 2001, the system needed to be overhauled and repaired, as well as replacing parts due to surveillance regulations. No funds were obtained for this purpose between 2001 and 2003. This was due to the lack of investment and the need to plan the overhaul of Petrobaltic's underwater oil production structures, and the lack of support from the Ministry of Defence and the Ministry of Higher Education (under grants).

The Af-2 system stored 'in the open air' without systematic maintenance work got decapitalised at an alarming rate. By the end of 2003, its technical condition was alarming, especially due to the condition of rubber joints and portholes, seals and corrosion of equipment stored outdoors.



Fig. 8 The condition of the Af-2 system components of the chamber and bell lifting and lowering device in August 2003.

With regard to this, the Rector of the Naval Academy sent a letter in October 2003, which was met with a positive response from Petrobaltic's Board of Directors, on condition that they agreed to the following conditions:

- Petrobaltic will refurbish the complex when it owns it,
- The investment will be a joint venture, with the Naval Academy providing the operation and act as the main contractor,
- In addition, Naval Academy will supervise the condition of the system and keep it operational.
- It will be Naval Academy's responsibility to train the diving service personnel.

Petrobaltic was the only company that was planned to be engaged in sea rescue and dive team training at the Naval Academy. Interest in the Af-2 system was minimal as there was a misconception in Petrobaltic's Board of Directors that it might be better to hire a service company from Western countries. *(The cost of a unit with a dive complex is between £160,000 and*

£180,000 per day of operation. (2001 figures) excluding the so-called consumable, i.e., the cost of materials and provisions during the dive. This unit needs to be ordered well in advance. Having a diving system resulted in a lower price for the underwater service and accelerated mobilisation for the work. Familiarity with the realities of the Baltic Sea and a well-trained team improved the efficiency of underwater work).

One needs to bear in mind that the AF-2 system is a small and very flexible complex for onboard assembly on platforms and floating vessels. The majority of available mobile diving systems for saturation dives would not fit the size of rigs and vessels of the company.

TERMS ON WHICH THE SYSTEM WAS TRANSFERRED

In 2002 and 2003 the Department was restructured and 10 people (35% of the Department's staff) left it leading to the shortage of skilled personnel capable of maintaining in good shape all the assets

accumulated for over 29 years, including the complex for saturation dives. These assets had to be under constant surveillance monitored by the Technical and Metrological Inspection or the supervision of classification societies and the labour inspection. Constant training of the staff was necessary which implied financial resources which were very limited. Because the Department dealt with research and experimental studies with the involvement of divers, a fraction of payment for each work was earmarked for keeping up high level of security and technical performance of the Department's base. Aside from this workload, the Department staff had to work on their research, publish papers, deal with marketing and attract new orders. In addition, the rates for research work and especially markups at the Naval Academy deprived the Department of the inflow of funds earned from research work, which could have been used to keep the diving system operational at its own cost.

The handover of the AF-2 diving system freed the Naval Academy from the concern to keep it operational from other work, while concluding a contract with Petrobaltic. It is fair to say that the Naval Academy recovered many times the money spent on the purchase of the Af-2 system, even without taking into account the financing of its upgrade in 2000. However, about half of the funds recovered were 'eaten up' by surcharges and profit. This, unfortunately, is the rule at Polish state universities.

Although the AF-2 system was left in the hands of the Naval Academy, they have to continue using the services of Petrobaltic, because the heavies components of the system are stored there. With the transfer of ownership this arrangement may change. Already in 2002 voices were heard to charge the Naval Academy for storage space.

The transfer of the AF-2 diving system should also take into account the fact that keeping it operational is a problem of vital importance to the defence of the State. Saturation dives are the basis for rescuing submarine crews (as was painfully discovered during the 'Kursk' submarine disaster), methods of treating severe cases of pressure sickness and performing complex underwater work of a large scope. The Polish Navy is one of the few NATO fleets with the ability to conduct saturation dives, which still caused astonishment among foreign specialists in the field of underwater work.

The transfer of the diving system - resale on special terms, was linked to the conclusion of a long-term cooperation agreement. The scope of the agreement included benefits for both parties. The Naval Academy handed over the hardware part of Af-2, while the measurement part, the gas storage safety equipment, and the life support system for research purposes were left at the Naval Academy due to the operational supervision, which could not be carried out at Petrobaltic as they lack specialists.

A long-term agreement was concluded between the parties on research, scientific and implementation cooperation for underwater work technology where the use of the Af-2 diving system was agreed for the rescue needs of the Navy. Below we quote the provisions of the Agreement:

§ 1 -

- *In view of their long-standing cooperation in the field of underwater work and the resulting benefits for national defence, in particular the Navy's rescue tasks, anti-terrorist defence, the maintenance of the national rescue potential and the ecological protection of the Baltic waters of the Polish maritime economic zone and the development of Poland's underwater service potential, the Contracting Parties agreed to:*
- *co-operate in underwater work technologies with the involvement of divers and bring these technologies forward through providing mutual support in the field of technical service, training, and the provision of services focused principally on saturation diving,*
- *use their research and technical potentials in underwater works in the Polish shelf and rescue operations in the Baltic Sea region,*
- *conduct joint rescue, experimental, and emergency underwater work,*
- *exchange specialist knowledge in the field of underwater work,*
- *conduct training on new technologies, underwater work, and diving,*
- *carry out joint research projects.*
- *Whenever this Agreement refers to the making available of the AF-2 core system to the ACADEMY, it shall be understood to mean the provision on a loan basis. It does not apply to AF-2 system 'carrier' vessels.*

§ 2

- *The ACADEMY will transfer to PETROBALTIC the basic set of the AF-2 saturation diving system on the basis of a separate civil-legal agreement.*
- *The basic diving system set, hereinafter referred to as the 'basic AF-2 complex' referred to in Section 1, does not include the following equipment that the Academy has purchased or upgraded from the complex and which remains in its possession:*
 - ✓ *Life support system,*
 - ✓ *Diving equipment and individual emergency equipment,*
 - ✓ *Measuring equipment,*
 - ✓ *Four cylinder bundles.*
- *The taking over of the basic AF-2 complex by PETROBALTIC shall be governed by the conditions stipulated by the Parties in a working mode.*
- *The Contracting Parties shall not, during the term of the Agreement, resell their equipment comprising the AF-2 diving system without the consent of the other Party.*
- *The Contracting Parties undertake to maintain, at their expense, the AF-2 diving system permanently technically ready for use, each to the extent of those pieces of equipment that they have in their respective possession.*

§ 3

PETROBALTIC shall be obliged to:

- operate the AF-2 system with the participation and supervision of the ACADEMY specialists,
- prepare and implement the AF-2 basic system into the national saturation diving system, resulting in the classification of the AF-2 system in a selected classification society under the supervision and participation of the ACADEMY team,
- make the AF-2 basic system available to the ACADEMY on a fully privileged basis free of charge and to provide a 'carrier' unit of the system at its own cost, except for the rescue operations referred to in 'e' below,
- secure the execution of saturation and deep dives during underwater work carried out with the AF-2 diving system, carried out for PETROBALTIC and by PETROBALTIC on behalf of third parties,
- make the AF-2 basic system of the ACADEMY available free of charge for a specified period of time with a 'carrier' vessel in the event of the Polish Navy conducting rescue exercises in the field of saving the life of a submarine crew,
- make the AF-2 basic system available to the ACADEMY once every two years with a 'carrier' vessel for conducting the planned rescue exercises of the Polish Navy in saving the life of a submarine crew,
- make the basic AF-2 system available to the ACADEMY for conducting cyclic training of the diving teams and maintenance personnel of the Polish Navy in the field of maintaining the AF-2 system technically operational and ready for use for underwater work within the framework of rescue actions, referred to in § 2 pt. 'e',
- make the AF-2 basic system available to the ACADEMY for scientific and research work allowing for the development of deep and saturation diving.

§ 4

The ACADEMY shall be obliged to:

- maintain an ACADEMY team prepared to operate and service the AF-2 system,
- prepare its part of the AF-2 system equipment for saturation dives, which will result in the

classification of the AF-2 in a selected classification society in cooperation with the team from PETROBALTIC,

- make its part of the AF-2 system equipment available to PETROBALTIC or the Navy without rental costs and on a full preference basis,
- carry out diving and underwater work training for PETROBALTIC against payment, according to separate orders,
- prepare and carry out training of divers and service crews for work for PETROBALTIC according to separate orders,
- maintain a stockpile of consumables and breathing agents for the AF-2 diving system to secure 14 days of saturation diving with a minimum of 6 hours of divers per day.

§ 5

- The Agreement is concluded for an indefinite period.
- The Agreement may be terminated at the justified written request of one of the Parties with 6 months' notice. During the period of notice, the Parties undertake to agree on optimum terms and conditions to enable the continued use of AF-2 to the Party requesting it.
- The Agreement may also be terminated at any other time upon the written agreement of both Contracting Parties.

§ 6

The scope of works performed within the framework of this Agreement by the ACADEMY for the benefit of PETROBALTIC shall be decided in the working mode. A cost estimate will be prepared by the Parties for each job, confirmed by the Annex to the Agreement. Approval of the completed work shall take place on the basis of a handover report.

The handover of the diving system took place formally and practically at the beginning of 2004 and was an organisationally simple operation, as practically all components were stored on Petrobaltic's land base.

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dr inż. Stanisław Skrzyński
Katedra Technologii Prac Podwodnych
Akademii Marynarki Wojennej
s.skrzynski@amw.gdynia.pl