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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 3B

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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. ZSNiTPP). 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

SATURATION DIVES IN 1997

After completion in 1995, the AF-2 diving system was stored at Petrobaltic in Poland. In 1996 it was upgraded and prepared for operation by ZSNiTPP according to the recommendations of RANA specialists.

During 1996 and 1997, the Department prepared for saturation diving operations. The AF-2 diving system was adapted for the classification requirements of the Italian classification society RINA. At the same time, the diving team and operating personnel were being trained. In 1997 the Af-2 system was installed on the service vessel Bazalt, (this option was repeated until 2018). Five saturation dives were carried out that year, two of which were performed by an Italian-Polish team. The execution of at least one dive by only a Polish team was not possible due to the tasks performed by the Navy (the Polish Navy team was involved in other service tasks at the same time) and the lack of experienced dive leaders. Another, perhaps the most important factor was pressure from the Italian divers' union representative at RANA. Formally, Petrobaltic had a contract with the Navy and the Naval Academy was a subcontractor. At the time, the team consisted of 2-3 people from the Navy units, with a permanent staff of the Department of 7 people and 4 shore security personnel.

Due to the installation of the Af-2 system on the Bazalt vessel, the proportion of Navy diving vessels performing tasks for Petrobaltic decreased.

SPECIFICITY OF AF-2 ASSEMBLY ON A VESSEL

Mounting on a ship implied additional requirements for which the technical and welfare provision for saturation diving had to be extended. These requirements included:

- social protection for the diving and underwater work team for 22 people. This was achieved by inserting two accommodation containers and assigning guest cabins. In the galley, the kitchen staff was reinforced to serve meals around the clock according to the rhythm of the watch. An additional washing machine for divers was also installed;
- anchorages were erected for stable positioning of the ship above the work site. An anchorage consisting of two anchors with buoys and two platform legs or a minimum of 3 anchors was required to secure and position TSV Bazalt and maintain her position;
- a 150kW emergency generator was borrowed from the Navy, providing an independent power source for the diving equipment;
- installation of an overboard water supply system for the bell heating units and divers' suits;
- a fender was installed at the bell diving station to protect the bell from striking the side;
- the arrangement plan for the diving system on deck was developed and the hoses and cables were fitted to the plan;
- a safety diving station was set up;
- medical precautions have been taken, including przed uderzeniami o burtę,
- an infirmary for the doctor in the cabin;
- lighting was installed at the diving bell diving station.

The location of the AF-2 complex on TSV Bazalt created a qualitatively new situation for underwater work, the characteristics of which are outlined below:

- underwater work depended on the weather, and in particular on side winds, as TSV Bazalt had very little opportunity to position herself in the 'wind bed' with the anchors so positioned;
- the positioning of the AF-2 provided opportunities to move around the entire operating area of the Polish shelf;
- TSV Bazalt's crew was involved in positioning the vessel over the work site. Upon the completion of the underwater work, TSV Bazalt would move to a waiting position,
- the diving service crew was 'cut off' from the work on the tower, which had a positive effect on the quality of the work;
- the living conditions of the service personnel were unfortunately inferior (they slept in deck containers) compared to the platform;
- Petrobaltic's underwater coordinators operating on the platform during the work of the vessel moored at the supports from a height of more than 20m were not able to accurately assess the sea state, which gave rise to discrepancies regarding the possibility of continuing the dive and when to stop the diver's work (permissible sea state is 3°, wave height 1.25m, wind up to 5° B). The conflict between the coordinators and the dive team was driven by economic considerations. The divers' fee depended on the number of days worked. Each delay generated additional costs, which the principal wanted to reduce;
- it was important to move from the ship's position at the right time before the oncoming storm (the system was mounted on the deck just over 2m above the water surface);
- escaping to the base or to a safe refuge resulted in stress for the divers staying in the chamber as well as for the deck crew. This was due to the ship's wave-induced movements as well as the operation of the propellers, which caused strong vibrations. The vibrations prevented measurements and caused sparks and shutdown of electrical equipment in the manoeuvring control room.
- the crew had to navigate through the water flowing on the deck.

The timing of leaving the position cannot be compromised and this is decided by the Captain and the Underwater Work Manager, who are responsible for safety. Interrupting the work does not interrupt the dive and the stay in the refuge is paid for in the same way as for the work at sea.

Unfortunately, the meteorological problem, i.e., the inability of the diver to work due to the weather, was not solved, which went against the decisions of the work coordinators aiming to complete the work as soon as possible and the underwater work managers upholding the safety of the work in the following situations:

- Should saturation dive be aborted based on a long-term weather forecast ? The Baltic is a very capricious sea and forecasts are not always accurate
- How long should divers be kept on a saturation plateau without working? The standard 28-day saturation dive period, including decompression, already introduces some limitations. Optimally, there will be 2-3 days between the dives and after decompression the divers will start working 24 hours later.

In practice, decisions were made 'on the spur of the moment', lacking the principle to apply the decision in the optimum way, especially in terms of cost-effectiveness.

SATURATION DIVES CARRIED OUT IN 1997

In 1997, five saturation dives were carried out in the 75 - 80 m depth range for installation work on the B-3 deposit. The work was carried out jointly with the RANA company. The Polish team was led, as before, by Stanislaw Skrzynski on the part of the Naval Academy, while the entire underwater work was led by Vittorio de Boni of the 'RANA' company. The work lasted from February to November and was carried out from ATHS Basalt and the Petrobaltic platform. The third saturation dive was the longest ever and lasted 35 days. Among the divers taking part in this historic event was Polish diver Grzegorz Mączka. The participation of Polish divers in these dives was: twice Grzegorz Mączka and once Ryszard Kłos. In the final phase of the work, after a quick upgrade, the Polish team performed a deep dive from the AF-2 system using semi-closed circuit apparatus for inspection purposes, which was the implementation of deep dives from the system into saturation dives. They were led by ZSNiTPP representatives Stanislaw Wisniewski, Janusz Pawlak, and Bartłomiej Jakus. To their credit, a number of technical innovations were introduced in the configuration of the diving system and the installation on the ship and adaptation of the diving bell for deep dives using semi-closed circuit breathing equipment. In addition, specialists from the Navy's rescue vessels and the Polish Army's Diver and Frogman Training Centre took part in securing the work. In parallel, development work was carried out on the design of the MOBNUR mobile diving system for deep diving, which was and is used to secure the operation of the Af-2 system.

THE COURSE OF THE 1ST SATURATION DIVE FROM 26 APRIL 1997 AT 12:00 HRS TO 17 MAY 1997 AT 12:00 HRS

The departure to sea on 18 April 1997 with the AF-2 complex was interrupted due to the weather. As the emergency generator was giving low voltage, the departure to work on 26 April 1997 took place after the voltage regulator of the generator had been replaced. Two pairs of divers, Polish and Italian, dived. On 28 April 1997 the first dive took place. The divers worked at a depth of 80m, a saturation plateau of 73m. In total, the divers performed 13 dives. The times of their work are given in table 2.

Table 2

Divers' working time during the 1st saturation.

No.	Name and surname	Hours in saturation	Hours spent in water	Hours spent in the bell	Bell dives
1	2	3	4	5	6
1.	R. KŁOS	503	16.45	25.18	6
2.	G. MĄCZKA	503	16.48	25.15	6
3.	C. FACCIA	503	12.00	21.49	7
4.	S. BURATINI	503	16.41	15.08	7

During the dive, they had to leave the work site twice and take refuge in the harbour (once the fog was an obstacle). Due to the fact that the AF-2 complex was mounted on TSV Basalt the divers worked on both Petrobaltic and Beta platforms dismantling heads and switching underwater pipelines (flow line). During this operation, the divers performed, among other things, underwater thermal cutting of two wells.

This was the first and unfortunately the last dive in which a physician was directly involved. The medical examination of the Italian divers beforehand caused a great deal of surprise and slight resistance.

On 17 May 1997 the TSV Basalt stood at the Naval Shipyard. The AF-2 diving complex was specially protected during dock work. At the same time, the COMANEX heating unit, on loan from the Navy, which could not withstand the hardships of working on the ship, was being overhauled. There was a need to replace the bell heater as the temperature in the bell was at or below the thermal comfort required by the classification regulations.

THE COURSE OF THE 2ND SATURATION DIVE FROM 03 JUNE 1997 AT 12:00 HRS UNTIL 07 JULY 1997 AT 18:00 HRS

This was a very long dive of 35 days. Long downtimes were due to platform work and bad weather. Divers' working time is given in Table 3.

Table 3

Divers' working time during the 2nd saturation.

No.	Name and surname	Hours in saturation	Hours spent in water	Hours spent in the bell	Bell dives
1	2	3	4	5	6
1.	G. MĄCZKA	820	20.07	25.13	10
2.	S. BURATINI	820	20.33	41.41	12
3.	S. PUTZU	820	27.23	33.12	19
4.	A. CAMPANALE	820	15.11	37.04	9

efficiency factor in this dive was lower than in the short deep dive, i.e., between 0.02 - 0.03, as it can be seen from the relationship of time spent in the bell to working time that there were two stops during the divers' stay at the work site. It was necessary to extend it by 7 days in relation to the divers' normative working time. The underwater work was complicated by the laying of the flow-line from the head control cable. By the end of the dive, the divers were very tired.

The decision to extend the dive was made jointly by V. de Boni and S. Skrzynski after discussions with the divers, consultation with the Polish medical doctor and telephone consultation with Italian doctors. During the dive there was a medical incident in the bell, Putzu, a diver, vomited probably as a result of food poisoning. Throughout the dive, the divers experienced thermal discomfort in the bell due to a malfunctioning water heater. The divers work was also interrupted four times due to crosswinds and stormy weather. At the end of the dive, the divers were interrupted for seven days during the laying of the pipeline. During the operation, there were several power cuts and multiple shutdowns of the Comanex heating unit, forcing a quicker return to the bell. The switchover to the emergency Kinergetic genset lasted 3 min. The Italian-Polish Buratini-Mączka pair were very efficient, doing most of the heavy lifting in connecting the pipeline and jumpers (flexible hoses 5 inches in diameter) to the head. It should be noted that mentally the divers very well coped with the long stay. There were minor altercations, especially between the Italian divers (southern temper) but the Mączka-Buratini pair worked in an exemplary manner.

In the second dive, there were problems with injuries, an eye abrasion, skin (on the feet between the toes) and stomach problems. In all cases, qualified medical assistance was given to the divers. None of the above ailments put the divers out of action.

The bell hatch 'failed to hold pressure' on several occasions, which was a dangerous situation. In this case, divers could not return to the chamber under plateau pressure conditions. Several dozen hours of decompression in the bell is technically possible, but impossible from the point of view of the divers' medical and psychological endurance, even if a shorter emergency decompression with a high probability of pressure sickness would have been applied. This malfunction was removed by the divers without problems by changing the gasket twice. Dramatic situations also included lubrication of the bell and diving equipment with the grease used for the head assembly, and a leak in the head system. In the latter case, a certain amount of gas from the bed got into the bell; it had to be intensively ventilated. All these situations were under the control of the staff.

THE COURSE OF THE 3RD SATURATION DIVE FROM 13 JULY 1997 AT 10:00 HRS UNTIL 18 JULY 1997 AT 12:00 HRS

This short dive involved all four Italian divers and Polish technical crew. The decompression, which started at 06.00 on 15.07.1997 included two sleep breaks. Two dives took place during the two working days.

The first one on 13.07.1997 from 19.30 to 03.30 h. During the second one on 14.07.1997 from 09.20 to 16.00 h, the divers connected the '*umbilical*' (control cable) heads and the pipeline flanges. At the end of the second dive there were again problems with the heating unit (electrical puncture - loss of 50 kW of power).

While conducting decompression, ATHS Bazalt manoeuvred between the turret and the tanker. The chamber was located on the stern and any manoeuvring might lead to a hazardous condition. Traditionally, the last few days of decompression were spent in port and from the morning of 17.07.1997 the partial dismantling from the AF-2 complex of those items that were not necessary for decompression began. On 19 July 1997 in 6 hours the AF-2 complex was dismantled from TSV Bazalt. The team from the ZSNiTPP Department of the Naval Academy acted very efficiently. Diver protection was organised in the hyperbaric complex of the ZSNiTPP Department of the Naval Academy.

DIVES FROM THE PETROBALTIC PLATFORM 1997

From 20 July to 05 August 1997, repair and maintenance work was carried out on AF-2, including the repair of the hatches and the Comanex water heater. In addition, all diving equipment underwent maintenance and overhaul. On 07 August 1997 the transport of AF-2 to the P.P.PETROBALTIC platform took place. From 11 August 1997 to 14 August 1997 the complex was assembled and on 19 and 20 August 1997 after the tests, the fourth saturation dive of 1997 started.

THE COURSE OF THE 4TH SATURATION DIVE FROM 20 AUGUST 1997 AT 17:00HRS UNTIL 28 AUGUST 1997 AT 18:00 HRS

Four Italian divers and a mixed technical team from the Polish ZSNiTPP Department of the Naval Academy and the Italian RANA company participated in the dive. Within this saturation, six dives took place:

- on 21.08.1997 from 15.50 until 23.15 - 7h35'

- on 22.08.1997 from 08.00 until 15.30 - 7h30' - from 23.00 until 04.00 - 7h00'
- on 23.08.1997 from 11.40 until 14.15 - 2h25'
- on 24.08.1997 from 05.15 until 13.45 - 8h30 - from 15.30 until 20.30 - 5h00'

This dive followed the classic rules of saturation diving, i.e., in 24 hours a diver works 4 hours and for

THE COURSE OF THE 5TH SATURATION DIVE FROM 25 SEPTEMBER 1997 AT 08:30HRS UNTIL 04 OCTOBER 1997 AT 16:00 HRS

This saturation dive engaged three Italian divers and one Polish diver. Table 4 shows how divers worked during this dive.

Table 4

Divers' working time during the 5th saturation.

No.	Name and surname	Hours in saturation	Hours spent in water	Hours spent in the bell	Dives
1	2	3	4	5	6
1.	G. MĄCZKA	224	9h09'	12h15'	4
2.	F. FACCIA	224	5h44'	12h44'	4
3.	A. KRAINC	224	8h14'	18h30'	3
4.	S. BURATINI	224	12h55'	14h20'	3

The work took place with the second head closed, similar to the 4th saturation. While the divers were working, the tower triggered the intake that the deposit, which was not consulted with the dive manager beforehand. The rig manager also did not notify anyone about the 'gas hazard' to the dive team, which caused a lot of tension in the team's work. A decision was taken to abort the dive, which was cancelled once the deposit was closed. Such a stressful situation was caused by the overzealousness of the rig crew to meet the expectations of the company's management, who, looking at the increasing costs of the dive team and interested in the production results, were impatiently waiting for the work to be completed. The dive was completed as planned. The on-board crew on the platform are prepared to work in conditions of gas emergency. There is an explosimeter in the shunting control room and the crew on board is equipped with escape isolation devices.

CHANGE OF THE OWNER OF THE AF-2 DIVING SYSTEM

After the end of operations in October 1997, the AF-2 complex remained in Gdańsk at the PP Petrobaltic base. On the other hand, the diving equipment was transported to ZSNiTPP Department of the Naval Academy in Gdynia. Until the end of the first quarter of 1998, on the part of ZSNiTPP, only periodic inspections of the condition of individual components and their protection against atmospheric influences were carried out.

After completion in 1997, the Af-2 system was dismantled and left on the Petrobaltic base. In 1998, the system still remained in the country. The Italians, knowing that the system's condition did not meet IMCA recommendations and its technical condition did not meet current classification regulations, having encountered financial difficulties, offered to sell the system to Petrobaltic. The sale was based on leasing terms, i.e., part of the rental payment was included in the lease. In view of the fact that Petrobaltic had retrofitted the system with diving equipment and the Naval Academy had installed its own equipment and facilities (left over from the Szczecin Shipyard) during the dives, not having a maintenance team and having a plan for further work, it was proposed to sell the system to the Naval Academy for the price of the last lease instalment. The decisive factor was the financial standing of Petrobaltic, which could be described as dramatic. The Italians estimated the cost of the system at USD 700K (excluding the diving equipment). To sell the system, RANA asked for USD 98K to be paid as the last lease instalment. In November 1998 after six months of analyses, the Commander of the Naval Academy gave his permission for the purchase of the AF-2 system for the above amount, two weeks before the expiry of the offer. Thus we could acquire the Af-2 diving system for 14% of its value.

Solving the problem of ownership of the complex meant that the main burden of future operation of the system would be transferred to ZSNiTPP Department of the Naval Academy. Based on the experience of the 3-year operation of the complex to date, it was assumed that in order to be used for the next few years, most of the equipment would require repairs of varying scope, some would need to be attested by relevant classification authority, and others would need to be upgraded. Therefore, a technical verification of the complex's equipment and an analysis of repair needs were carried out to determine the scope, cost and time consumption of the work.

During the rapid takeover of the diving system by the Academy, it was agreed that the full documentation for the Af-2 system would be delivered in January 1999. The Italians handed over only the documentation that was stored with the equipment. The analysis was based on DNV's 1985 requirements for documentation of diving complexes. Upon examination of the documentation contained in the AF-2 system, the following was found (quote from the original document sent to Italy):

- Outdated and incomplete documentation, including:
  - ✓ partially outdated plan of the complex,
  - ✓ partially outdated documentation of the gas, water, and electrical installations of the complex,

- ✓ partially outdated list of electrical devices,
- ✓ outdated certificates for cylinders and portholes,
- ✓ incomplete documentation on tests and examinations of components of the complex.

- Missing documentation for:

  - ✓ the chamber, bell, panels, regeneration systems, the system for lifting and lowering the bell, л
  - ✓ files to be approved by the Classification Authority (for devices subject to technical supervision): - chamber;- tanks for non-potable water;- tanks for regeneration systems;- bell lifting and lowering system;- gas and water supply installations,
  - ✓ electrical installation approved by the Classification Authority,
  - ✓ durability performance calculations to be approved by the Classification Authority for pressurized tanks and the system of bell lifting and lowering,
  - ✓ attestation for materials in sub-systems and installations,
  - ✓ documentation and attestation of pressure hoses,
  - ✓ material specification and safety devices in bell lifting and lowering system,
  - ✓ technical and operating documentation for regeneration systems, control panels, heaters, cooling gensets, bell lifting and lowering system, lifts in personnel lifting hydraulic winches, hydraulic genset, air compressor filters, and sets of cylinders,
  - ✓ instruction manuals for the assembly of the complex on the rig or ship together with load calculations, mass distribution, and the location of centres of gravity of the components,
  - ✓ list of measuring devices,
  - ✓ validation documentation for manometers,
  - ✓ fire monitoring and alarm system installation for the complex,
  - ✓ the calculations of buoyancy and stability of the bell while working.

The RINA Classification Authority regulations were also requested to be sent. In addition, for the continued operation of the complex, the Italian side was asked to provide spare parts for non-standard system components, e.g.: manhole seals, components of hydraulic winches, hydraulic pump and fittings components, gas regulator components, regeneration system components, etc.

REFERENCES

1. Skrzyński S., Pachut M., Olszański R.: „Helioksowe nurkowania saturowane w Morzu Bałtyckim", V Konferencja Naukowo-szkoleniowa „Problemy medycyny oraz Nurkowanie – problemy techniczne" 1998.
2. Skrzyński S. „Wybrane problemy techniczno-organizacyjne wdrożenia nurkowań saturowanych". Praca pk „ SATURN" AMW 1998.
3. Doboszyński T., Łokuciejewski B: „Tabele dekompresyjne dla trimiksowych nurkowań saturowanych do 120 m. wraz z zasadami rekompresji leczniczej", CPBR-9.5. „Techniczne, medyczne i prawne problemy długotrwałego przebywania człowieka pod wodą", Katedra Medycyny Morskiej WAM, Gdynia 1990.
4. Doboszyński T., J.Kot, Z Sicko „System Nurkowań Saturowanych z użyciem Trimiksu w Strefie Głębokości 80 metrów dla Platformy Wiertniczej Petrobaltic" DSK – 95 Akademia Marynarki Wojennej 1995
5. Skrzyński S., J.Pawlak, S. Wiśniewski Technologia Nurkowania Saturowanego w Kompleksie Nurkowym Af-2 LOTOS Petrobaltic S.A. Gdańsk 2011.
6. Normative Operative Requisiti di Sicurarzza RANA 1987. Rana" "Working and Safety Regulation
7. Skrzyński S., Dokumentacja pracy pk. NURSAT Nurkowania saturowane dla potrzeb Petrobaltic i LOTOS Petrobaltic z lat 1995-2000.
8. Skrzyński S. i zespół „Technologia nurkowań głębokowodnych z użyciem aparatów o obiegu otwartym" Punkt 6 harmonogramu pracy pk. POSEJDON Projekt celowy nr 11/BO umowa nr 148 308/C-T00/2001: „Nurkowania głębokie dla potrzeb Ratownictwa Morskiego" Akademia Marynarki Wojennej Gdynia 2002.
9. „Diving systems" Offshore Standards DNVGL-OS-E402 EditionJanuary 2017,
10. DET NORSKE VERITAS DNV-DSS-105 Rules for Classification of Diving Systems July 2012,
11. Polski Rejestr Statków „Przepisy Klasyfikacji i Budowy Urządzeń i Systemów Techniki Podwodnej Instalowanych Na Statkach oraz Innych Obiektach" Tymczasowe Gdańsk2020,
12. J.Kurek, J.Bokiniec, P.Jaworski „Rola przedsiębiorstwa Petrobaltic w rozwoju komercyjnych nurkowań płytkich i głębokich w Polsce „ Problemy Medycyny i Techniki Nurkowej" Okrętownictwo i Żegluga sp.o.o.str. 366 -373 Gdańsk 1997.
13. https://marine-offshore.bureauveritas.com/nr610-rules-classification-diving-systems.
14. Normative Operative Requisiti di Sicurarzza RANA 1987. Rana" "Working and Safety Regulation

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