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BEFORE CYBERTERRORISM BEGAN. THE COMMUNICATION SYSTEM AND EQUIPMENT OF THE FORCES FOR FRONTIER DEFENCE IN THE PROTECTION OF THE PRL MARITIME BORDER IN THE SECOND HALF OF THE 20TH CENTURY. SELECTED PROBLEMS. PART I

ZANIM POJAWIŁ SIĘ CYBERTERRORYZM. SYSTEM I SPRZĘT ŁĄCZNOŚCI WOJSK OCHRONY POGRANICZA W OCHRONIE GRANICY MORSKIEJ PRL W DRUGIEJ POŁOWIE XX WIEKU. WYBRANE PROBLEMY. CZ. II

Abstract: The article presents the role of communications in the protection of Poland's maritime border, which was guarded by personnel of the Border Protection Forces (WOP) in the second half of the 20th century. Part II of the article describes WOP communications along the coast from the 1970s until the dissolution of this unit in 1991. It discusses the organization of communications within the WOP's Independent Reconnaissance Aviation Squadron (SELR WOP), the coordination in this regard between WOP vessels and WOP outposts, and the role of duty and operations services in protecting the maritime border of the People's Republic of Poland. The appendices also discuss selected types of communications equipment

used at that time by soldiers of the formation's coastal brigades (radio sets: R-116, R-105, R-106, R-108, R-109, the FM-302 radio-telephone and the TAI-43MR telephone, as well as the authorized staffing of the communications unit of the Kashubian BWOP in Gdańsk Nowy Port until 1991).

Zarys treści: W artykule zaprezentowano funkcjonowanie łączności w ochronie polskiej granicy morskiej, którą w drugiej połowie XX w. ochraniał personel Wojsk Ochrony Pogranicza (WOP). W cz. II artykułu scharakteryzowano łączność WOP na Wybrzeżu od lat 70. XX w. do rozwiązania tej formacji w roku 1991. Omówiono organizację łączności w Samodzielnej Eskadrze Lotnictwa Rozpoznawczego WOP (SELR WOP), współdziałanie w tym zakresie okrętów WOP ze strażnicami WOP oraz rolę służb dyżurno-operacyjnych w ochronie granicy morskiej PRL. W załącznikach omówiono również wybrane typy sprzętu łączności wykorzystywane w tym czasie przez żołnierzy nadmorskich brygad tej formacji (radiostacje t.: R-116, R-105, R-106, R-108, R-109, radiotelefon t. FM-302, aparat telefoniczny t. TAI-43MR, a także obsadę etatową służby łączności Kaszubskiej BWOP w Gdańsku-Nowym Porcie do roku 1991).

Keywords: communications in the maritime border protection of the Polish People's Republic, communications equipment of the Border Protection Forces.

Słowa kluczowe: łączność w ochronie granicy morskiej PRL, sprzęt łączności Wojsk Ochrony Pogranicza.

Another organizational change was implemented along the maritime border on 1 October 1971. At that time, by a decision of the Presidium of the Government of the Polish People's Republic (dated 30 July 1971), the WOP was placed under the command of the Ministry of Internal Affairs, while in administrative terms this change took effect on 1 January 1972. At the same time the former WOP Headquarters was reorganized into the WOP Command (DWOP) in Warsaw.[1]

[1] Pursuant to Order No. 0214 of the Ministry of National Defence, dated 30 September 1971, the following officers were appointed to key positions in the DWOP:
- Commander of the WOP – Brig. Gen. Czesław Stopiński,
- Chief of Staff of the WOP – Col. Feliks Stramik,
- Deputy Commander for Political Affairs – Col. Izydor Koper, M.A.,
- Deputy Commander for Intelligence – Col. Edward Tarała, M.A.,
- Deputy Commander for Technical and Logistics Affairs – Col. Henryk Chmielak.

The Border Control Service (KRG), which had previously operated under the Ministry of Internal Affairs, was reintegrated into the formation. These changes also affected the Coastal Border Guard (BWOP). At the same time, the Mountain Border Guard (MBOP) was removed from this formation and remained within the Navy (MW).

However, in accordance with the order of the Chief of Staff of the Border Guard (WOP), Col. Feliks Stramik, (No. 012 of 28 December 1971) regarding the organization of communications within the WOP as part of the Ministry of Internal Affairs' unified communications system, as of 00:01 on 4 January 1972, the WOP communications system was integrated into the Ministry of Internal Affairs' unified communications system.[2] To do this:

- at the DWOP in Warsaw (100 Al. Niepodległości), an encryption station and a military post office were put into operation,
- until the telephone exchange at the DWOP in Warsaw was built, long-distance telephone communication between DWOP and WOP units was maintained through the Ministry of National Defence's garrison communications system, as well as through the Ministry of Internal Affairs' communications system, via the Provincial Citizens' Militia Commands (KWMO), and subscribers with terminal equipment connected to the Ministry of Internal Affairs' exchanges.

Government long-distance communications were maintained at that time under the existing rules. In KF (short-wave) radio communications, orders were issued to switch to operating on the Ministry of Internal Affairs' (MSW) radio networks and frequencies. At the same time, command communications via the radio networks and frequencies of the General Staff and individual Military Districts (OW) were discontinued.

At the same time, instructions were issued to organize and conduct telephone and radio communications (both encrypted and in plain text) between the BWOP Headquarters, WOP Units (OWOP) and the WOP-DWOP Training Centre.

Meanwhile, the head of the Communications and Technical Surveillance Division (OŁiOT) of the WOP Headquarters (in Warsaw – Col. Stanisław Łuczyński) was instructed to organize, in consultation with the heads of the KWMO Communications Departments, the transfer of telephone and telegraph lines previously leased

Archiwum Straży Granicznej (hereafter ASG) w Szczecinie, Akta Szefostwa WOP, ref. no. 1841, vol. 4, Rozkaz dcy WOP gen. bryg. Cz. Stopińskiego nr 01 z 11.10.1971 r. w sprawie sformowania DWOP, p. 1.

[2] ASG w Szczecinie, Akta DWOP, ref. no. 1841, vol. 4, Zarządzenie szefa sztabu WOP płk dypl. F. Stramika nr 012 z 28.12.1971 r. w sprawie organizacji łączności w WOP w jednolitym systemie łączności resortu spraw wewnętrznych, p. 1.

by the Ministry of National Defence (MON) and to establish new connections between KWMO and WOP units.

WOP units were also ordered to take over the lines previously leased by the Ministry of National Defence for their own needs, as well as the lines connected within the Ministry of National Defence's cable networks.[3]

In mid-1972, the MBOP (which was already operating within the Navy) assessed that the state of radio communications generally ensured command and control over subordinate units. However, in the units' day-to-day operations, the installed FM equipment had too short a range. This severely limited the ability to maintain communications over longer distances on the VHF network.[4]

The FM-325 radio-telephones, installed on an experimental basis, significantly improved the range of audibility; however, upon the transition to MW, these devices were dismantled and handed over to the Kashubian BWOP in Gdańsk, in accordance with orders from the MW Signal Corps Command.

Similarly, the R-609 VHF radios, as a result of long-term operation (on average about 10 years), had worn-out components, which effectively reduced their output power. According to MW plans, this equipment was to be gradually replaced with R-609 radios starting in 1973.

Maintaining coordination via the UKF FM network with the WOP's Air Defence Command (POWT) also posed no difficulties. However, coastal WOP outposts were ordered to remain on constant listening watch during border operations and to relay information to one another regarding any WOP vessel (MBOP) within their line of sight.

Cooperation in the area of communications between WOP vessels and WOP aircraft – which were already in service with the Navy – was also evaluated positively, in accordance with the current communications organization. Due to the low power of the R-609 radio, it was deemed necessary for the aircraft to climb to a higher altitude (800 m) in order to establish communication over longer distances.

At that time, on third-class MBOP ships (t. 902, t. 912, t. 912M, t. 205, t. 206P)[5] the RFT 1414 radio sets – which the Navy Repair Workshops refused to repair due to a lack of spare parts – were dismantled. The Navy Signal Corps Headquarters

[3] Ibidem, p. 2.

[4] Archiwum Marynarki Wojennej (hereafter AMW) w Gdyni, Akta DMBOP, ref. no. 3541/73, vol. 234, Pismo nr pf 665 z 24.04.1974 r. o aktualnym stanie łączności i obserwacji technicznej w MBOP flagowego oficera łączności i obserwacji MBOP kmdr. por. W. Babraja, p. 1.

[5] I. Bieniecki, *Wojska Ochrony Pogranicza w systemie ochrony i obrony granicy morskiej w latach 1965–1991*, Wydawnictwo Naukowe Akademii Pomorskiej w Słupsku, Słupsk 2015, p. 146.

made efforts to acquire short-wave (KF) equipment to replace the dismantled radio sets or, alternatively, to temporarily equip the ships with short-wave receivers.

In MW Alarm Network No. 715, communication reliability improved significantly following organizational changes (the introduction of duty shifts for professional non-commissioned officers). However, it was determined that the worn-out KF receivers (which had been in service for 12 years) were unsuitable for use in a network where communications took place without callsigns or code names.

At that time, VHF communications between ships and the control group (from the ships) were maintained using R-6411 radio-telephones, with which the OP squadrons were equipped (two sets each). However, it was determined that this equipment was not suitable for this type of operation due to its battery power supply (risk of burns to operators, the need for frequent recharging and its large size). It was still considered essential to install FM-331 radio sets at the DOP, necessary for cooperation with fishing bases and fishing vessels.

Regarding wired communications within the MBOP at that time (1972), it was assessed that the condition of the lines between the MBOP headquarters (Gdańsk Nowy Port) and the Pomeranian DOP (Świnoujście) and the Baltic DOP (Kołobrzeg) had recently improved and reception on the aforementioned circuits was good. The in-house installation of a new internal system and the installation of two dispatch centres at the MBOP headquarters radically improved the technical condition of wired communications.

The establishment of communication links between the duty operations officer (ODO) of the MBOP and the ODO of the Kashubian BWOP (Gdańsk Nowy Port) and the ODO of the Kashubian DOP (Gdańsk Westerplatte) also significantly accelerated the flow of information. However, at the Kashubian DOP the state of wired communications remained unsatisfactory.

At that time, work began on laying an underground cable (15 pairs) between the MBOP headquarters (Gdańsk Nowy Port) and the Kashubian BWOP headquarters (Gdańsk Nowy Port), which was expected to improve audio quality to some extent. It was estimated, however, that new circuits (improved communications within the KDOP) could only be established after soldiers of the Kashubian BWOP had laid the underground cable and a new telephone exchange had been installed in that brigade. It was also deemed necessary to install dispatch centres in individual squadrons, which was expected to significantly improve audio clarity.

The Ministry of Internal Affairs' wired communications to the duty stations of the border patrol vessels in the ports of Władysławowo, Hel, Mikoszowo and Ustka were operational. However, according to a statement by a representative of

the Navy's Communications Command, at that time the Navy could provide wired connections to these locations only for a short period. When a Navy vessel was docked at any of these four locations, that circuit (there was only one) was used primarily by the Navy vessel, which automatically deprived the MBOP vessel of its wired communications.[6]

In the 1970s, radio communications within the WOP continued to rely on two main types of equipment:

- military equipment, type "R" at higher levels of command (from BWOP and above) and in typically military subunits (WOP battalions and reserve companies, etc.);
- special equipment, using FM radios for border service and operations, as well as other purposes.[7]

The WOP communications system, organized using this equipment, remained integrated in terms of operating frequencies. Despite this, the entire radio communications system was significantly modernized and expanded.

After 1975 significant changes took place in the military communications equipment. Single-band HF radios were introduced into the Border Guard's inventory to replace the R-118 radios, along with the VHF R-107 and R-111 radios,[8] covering the 20–60 MHz band, replacing the previous standards: R-105, R-108 and R-109.

In addition, between 1971 and 1975, K-1 radio-telephones – a type of military equipment – were introduced for use by all WOP units,[9] whose network covered the entire country. These radio-telephones operated in duplex mode[10] and enabled connections to telephone networks from locations up to 30 km away from a telephone exchange. These radio-telephones made it possible to establish immediate communication in all networks and to all landline destinations from field command posts.

In the field of specialized radio equipment, the "MORS" plant in Gdynia ceased production of FM radio-telephones based on vacuum-tube technology in 1970.

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[6] AMW w Gdyni, Akta DMBOP, ref. no. 3541/73, vol. 234, Pismo nr pf 665 z 24.04.1974 r. o aktualnym stanie…, op. cit., p. 2–3.

[7] ASG w Szczecinie, Akta DWOP, ref. no. 1841, vol. 9, Pismo dotyczące ogólnych kierunków rozwoju WOP do roku 1980 z 12.05.1969 r., p. 22–24.

[8] *Nadajniki demobilowe*, "Świat Radio", April 2015, p. 32.

[9] Ibidem, p. 33.

[10] Duplex – a type of transmission in which information is transmitted simultaneously in both directions of a link. In telegraphy, duplex transmission was achieved through line translation on inter-exchange lines. The system enabling this type of transmission on a single line was called differential duplex. See the entry *duplex*, in: J. Modrzewski et al. (eds.), *Encyklopedia techniki wojskowej*, Wydawnictwo MON, Warszawa 1978, p. 144.

New prototypes of portable, stationary, automotive and marine radio-telephones were based on transistor technology and printed circuits. Their main advantages were a significant increase in operational reliability and a reduction in weight and size (for example, a portable radio-telephone with a range of 12 km weighed about 1 kg).

Between 1970 and 1975, this equipment replaced the existing FM radio-telephones after their service life had expired.

In the organization of the WOP's wired communications system during the 1970s along the western and southern borders, no major changes were anticipated, except for those dictated by organizational changes within the unit. The unit retained its own communications system, which was modernized by replacing worn-out telecommunications lines and terminal equipment.

Along the maritime border as well the Border Guard retained its own wired communications system; however, in connection with the expansion of the cable system along the entire coast (carried out by the Ministry of National Defence's Signal Corps Headquarters), the WOP gradually transitioned from its existing overhead lines to dedicated cable links in individual routes, reserved exclusively for the WOP's use. It was estimated that by 1980, 80% of the existing landlines on the coast would be replaced by cable connections owned by the Ministry of National Defence.

On the eastern border, as the responsibilities of Border Guard (WOP) posts continued to expand and they were further developed – both in terms of border protection and combat readiness – it became necessary to re-establish the Border Guard's own wired communications system. This was achieved in two ways: by leasing lines from the Ministry of Communications (MŁ) and, where the MŁ was unable to provide them, by constructing the WOP's own lines.

By 1973, it was planned to complete the installation of a unified alarm system for telephone subscribers at various levels of command, extending all the way to WOP guard posts and outposts.

Furthermore, between 1970 and 1980, the introduction of encryption devices was planned for both radio and wired communications, which significantly facilitated command and control through the use of technical communication means.[11]

[11] ASG w Szczecinie, Akta DWOP, ref. no. 1841, vol. 9, Pismo dotyczące ogólnych kierunków rozwoju WOP…, op. cit., pp. 22–24.

Communications and their organization in the Independent Reconnaissance Aviation Squadron (SELR) of the Border Guard (WOP)

The formation of the WOP squadron – which was the only aviation unit in that formation – did not begin until November 1958. This unit was formed on 30 December 1958.[12] Initially, Yak-12 aircraft and SM-2 helicopters were used to protect the maritime border.[13] While carrying out tasks related to maritime border protection they generally flew at low altitudes and, relatively often, at a considerable distance from the shore. For this reason, maintaining constant communication with them using the single VHF radio on board the aircraft was difficult for technical reasons. As is well known, the range of VHF radio communication depended, among other things, on the height at which the correspondents' antennas were positioned. Therefore, if an aircraft was flying at a low altitude several dozen kilometres away from a ground station, its crew might not be able to establish communication. An additional factor hindering the establishment of communication may have been the fact that the ground station was partially obscured by terrain obstacles. Attempts made in 1960 to establish communication with SELR WOP aircraft via radio stations installed at DOP headquarters (Świnoujście, Kołobrzeg and Gdańsk Westerplatte) did not yield satisfactory results for various reasons. This applied both to notifying the squadrons of the need to turn on their radios and to transmitting messages via the duty-operations service and several telephone stations. The difficulties in this regard were caused by the great distances involved in these communications.

Furthermore, the inconsistent manner in which radio communications were conducted between WOP aircraft pilots and ground station personnel at the DOP, as well as the lack of adequate training and coordination among duty and operations personnel at various levels (BWOP, DOP and WOP watchtower), often prevented the aircraft crew from communicating with their home airfield. Even greater difficulties arose in maintaining coordination between aircraft, ships and watchtowers. In this case, the cause of this situation was the variety of communications equipment they were equipped with and the lack of standardized crystals.[14]

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[12] Wojskowe Biuro Historyczne – Centralne Archiwum Wojskowe (hereafter WBH-CAW) w Warszawie, *Dzieło II*, vol. 15, p. 30.

[13] A. Morgała, *Polskie samoloty wojskowe 1945–1980*, Wydawnictwo MON, Warszawa 1981, pp. 223–227.

[14] See the entry *kwarc*, in: J. Modrzewski et al. (eds.), *Encyklopedia techniki wojskowej*, op. cit., pp. 299–300.

The aforementioned shortcomings were discussed in detail at a meeting held in January 1962 at the Baltic BWOP in Koszalin, devoted to issues of cooperation among the units protecting the maritime border of the People's Republic of Poland. The conclusions drawn at that meeting pointed to the need to organize a radio communications system along the coast that would allow for the command and control of aircraft in flight, regardless of the area of operations, as well as the transmission of messages and the exchange of information between aircraft, ships and guard posts, while ensuring flight safety. At that time, it was determined that this system could be based solely on VHF radio stations and radio-telephones.

Taking into account the technical capabilities (range) of the VHF equipment available at the time, the WOP developed the following model of radio communications for the formation's aviation units. According to this model, radio communications along the coast could be organized by establishing a so-called radio link. This line was to consist of radio stations, adapted to work with both aviation radio stations and ships, deployed along the entire coast at distances of 35–50 km from one another and interconnected via FM-252 or FM-302 station radio-telephones.[15] The distances between the radio stations depended on the overlap of their coverage areas as viewed from an aircraft flying at an altitude of 100–150 m above sea level. The radio stations comprising the radio link were to maintain communication with aircraft and helicopters within their range. In contrast, radio-telephones (FM-252 and FM-302 – see Appendix 1), which had significantly greater power and a longer range, were intended for communication between radio stations and for relaying messages between aircraft and the airport, or between aircraft and headquarters in support of which the aircraft crew was conducting operations. In addition, other units interested in the aircraft's operations could tune their radio-telephones to monitor the frequency and thus stay informed about the current situation.

To establish the radio link, the plan was to use RSK-type radio stations installed at airports, R-609-type radio stations (see Appendix 1) at DOP headquarters, as well as additional radio stations of one of the aforementioned types installed at watchtowers at those locations where the coverage areas of the two fixed stations did not overlap. Deploying additional radio stations at the watchtowers was intended to avoid a number of organizational difficulties, such as housing and feeding the operating personnel and supplying the stations with electricity, etc. Furthermore, the watchtowers' radio-telephones could be used simultaneously for the needs of the radio link. All radio stations comprising the radio link were to operate on the same (specially

[15] S. Łuczyński, *Organizacja łączności w pododdziałach ochraniających granicę morską*, "Biuletyn Wojsk Ochrony Pogranicza" 1962, no. 1/18, p. 185.

allocated) frequency used by the crews of WOP aircraft and ships. This solution was intended to facilitate establishing communication and transmitting messages. However, due to the large number of radio units operating on a single frequency, it was deemed necessary to impose certain restrictions on communications.[16] The established rule was that the staff at all ground stations were to remain on listen-only mode and were to respond only when called by the crew of an aircraft or a WOP vessel. They were permitted to initiate transmissions only in exceptional circumstances and only upon the orders of their superiors.

The radio link along the route where the aircraft was to carry out its mission was to be activated before the aircraft's takeoff and remain on standby until its landing. The radio link could be activated using radio-telephones installed at the radio stations or via wired connections. In either case, the SELR WOP flight controller was required to verify that the stations had been activated before issuing takeoff clearance; the aircraft would then establish contact with the nearest radio station (in this case, the station located at the airport) and maintain contact with it until reaching the range limit. However, before crossing the range boundary, the pilot was required to establish contact with the next station and continue the flight only after contact had been established. At the same time, the stations that the aircraft had already flown out of continued to monitor the airwaves until they received permission from the airport to switch off. The communications system organized in this way was intended to ensure communication with WOP close-range reconnaissance aircraft and helicopters.

Maintaining radio communication with long-range reconnaissance aircraft was considered less complicated (An-2[17] and Li-2[18]), which were also part of the SELR WOP's equipment. This was due to the fact that, in addition to VHF radios, these aircraft were equipped with HF radios. Therefore, an aircraft in flight had unlimited capabilities for maintaining good, direct radio communication with its home airfield via the KF network. In this case, VHF radios were used only during takeoff and landing, as well as for communicating with ships and other aircraft in the air.[19] The KF network may also have included receivers at the headquarters of the BWOP, DOP and battalions – primarily those for which the aircraft was carrying out missions. This arrangement made it possible to minimize the time required to transmit messages from the aircraft to the relevant headquarters.

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[16] Ibidem, p. 186.

[17] A. Morgała, *Polskie samoloty wojskowe*…, op. cit., pp. 160–176; and *Ilustrowana encyklopedia dla wszystkich. Lotnictwo*, Wydawnictwa Naukowo-Techniczne, Warszawa 1979, pp. 5–6.

[18] See the entry *Douglas DC-3*, in: *Ilustrowana encyklopedia*…, op. cit., pp. 34–35.

[19] S. Łuczyński, *Organizacja łączności*…, op. cit., p. 187.

Communications between WOP vessels and WOP outposts

In the first half of the 1960s, following a series of tests, the deployment of radar stations began[20] to equip the Border Guard posts that protected the maritime border. As a result, the role of radio communications in inter-agency coordination increased significantly[21] between the ships in this formation, other vessels and coastal watchtowers. The tasks of the vessels included, among other things, identifying any suspicious targets detected by radar and locator stations and conducting border pursuits[22] behind detected targets and, if necessary, supplement the coastal radar/location system with stations installed on WOP ships.

This created a need to maintain radio communication between vessels on duty at sea – within the area covered by a given WOP coastal outpost – and that outpost. Attempts to use the radio stations installed in the Navy's POWTiŁ did not yield the desired results, due to technical and organizational reasons. Therefore, it became necessary to establish a dedicated communication system for coordination between coastal stations and WOP vessels. The simplest and most cost-effective solution to this problem was deemed to be the additional installation of FM-252 or FM-302 radio-telephones on all vessels of this formation (see Appendix 1). With direct radio communication WOP outpost commanders could guide vessels to a target using data received from the WOP radio/location-motorboat station at their disposal and could also relay this data to a WOP vessel, provided that such a vessel was on duty in their sector. Furthermore, if suspicious objects were detected at sea, the outpost commander could proceed with a portable radio to a WOP POWT under his command and, from there, transmit radar readings directly to the crews of WOP vessels on duty in that area.[23]

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[20] See the entry *stacja radiolokacyjna*, in: J. Modrzewski et al. (eds.), *Encyklopedia techniki wojskowej*, op. cit., p. 670.

[21] Coordination communications are organized in accordance with the Chief of Staff's guidelines to facilitate the exchange of information between units, formations, subunits and elements of a combat group, as well as between different branches of the military and the armed forces. Coordination communications are maintained using all means of communication available at a given command level. See the entry *łączność współdziałania*, in: J. Modrzewski et al. (eds.), *Encyklopedia techniki wojskowej*, op. cit., p. 342.

[22] A border pursuit is an operation conducted by Border Guard forces and cooperating units (agencies) deployed as needed, aimed at apprehending individuals who have illegally crossed the state border or attempted to cross it but were not apprehended while doing so. See the entry *pościg graniczny*, in: Laprus M. et al. (eds.), *Leksykon wiedzy wojskowej*, Wydawnictwo MON, Warszawa 1979, p. 324.

[23] S. Łuczyński, *Organizacja łączności*…, op. cit., p. 188.

On-duty and operational service in maritime border security

In his memoirs Col. Jan Nikiforow, an officer in this unit who was quoted above, wrote the following about the role of the duty and operations service in the early 1950s.

"(…) Throughout the entire 24-hour period, the "dispatch" service was directly responsible for managing and overseeing the timely dispatch of units (WOP-I.B. and I.S. groups) to the blocking (physical – I.B. and I.S.) and escort services, as well as inspection teams for vessel inspections (…) later renamed the "duty-operations" service. The dispatcher maintained constant contact with the duty officers at the Port Authority, the Maritime Agency, the Customs Office and other cooperating port enterprises and institutions. This ensured that the agency's own border security units were promptly notified of ship traffic and planned port operations (…)."[24]

However, the heads of the communications services of units and subunits bore full responsibility for the proper organization and maintenance of communications regardless of the situation. The actual activation and operation of communications, on the other hand, depended to a large extent on the duty and operations service as well as on the commanders of aircraft, ships and WOP guard posts. The duty and operations staff at each level of command (BWOP – port; WOP – WOP outpost) were required to maintain a constant and accurate understanding of the operational situation, know the locations of technical assets (ships and aircraft) and maintain communication with them. Furthermore, due to the close coordination and joint execution of tasks by various subunits, the duty officers of these subunits maintained constant contact with one another. To this end, they had to be thoroughly familiar with the communications system, its operating principles and activation procedures, and monitor its operation. For example, the flight duty officer at the airport had to constantly know the location of aircraft in the air and was required to maintain direct radio contact with them, either directly or through relay stations.

While maintaining radio communication, he oversaw the operations of individual radio stations (assigning them tasks, verifying their completion, etc.), either personally or through the duty officers to whom these stations were subordinate. The situation was similar with regard to the DOP, as well as the port battalions of the WOP and the coastal headquarters of the BWOP. Situations could not be allowed to arise in which an operations duty officer relayed an order via a third party to turn on a radio station and failed to verify its execution, resulting in the radio station not being

[24] J. Nikiforow, *W granicznym kalejdoskopie – wspomnienia 1945–2005*, Wydawnictwo DJ Drukarnia, Gdańsk 2007, p. 37.

turned on. In these matters, it was recommended to strictly adhere to the rules for issuing orders and reporting on their execution, as set forth in the regulations. Every order issued to turn on a radio, establish communication or terminate it should be acknowledged by the recipient, reported as executed and recorded in the appropriate official documents.[25]

In the second half of the 1960s, however, Col. J. Nikiforow, M.A., wrote the following about the tasks carried out by this unit's duty and operations staff along the maritime border;

"(…) In the brigade (WOP-I.B. and I. S.), the operations duty officer continuously monitored the movement of vessels, whose bearings were plotted on the operations table. This was done by soldiers (zsw-I.B. and I.S.) from the operations duty teams (which were part of the communications company). The duty operations officer (one of four in each BWOP-I.B. and I.S.) monitored the situation in real time but, in case of doubt, contacted a command staff officer who was part of the Field Staff Detachment (appointed for each 24-hour period). These officers were required to be reachable by telephone while on duty. In particularly important and uncertain situations, the duty and operations officer reported to the brigade commander (…)."[26]

The above discussion of how communications functioned in the maritime border defence of the Polish People's Republic reveals that, prior to the era of cyberterrorism, the primary threat to the functioning of this system within the military was posed by people (specialists) performing specific official duties in accordance with the "Regulations on Correspondence in Radio Communications of the Polish Army"[27] until the early 1990s.

"(…) It is prohibited to engage in conversations unrelated to ensuring communications or to transmit other information in plain text. It is also prohibited to engage in private conversations between operators. Official radio communications should be concise, brief and conducted in accordance with the guidelines set forth in these regulations (…) Persons who violate the regulations governing radio communications within the Polish Armed Forces shall be subject to disciplinary action (…)."[28]

Unfortunately, such situations also occurred in various Border Guard (WOP) units using communication equipment along the maritime border. This was confirmed, among other things, by recordings of conversations conducted on the VHF network

[25] S. Łuczyński, *Organizacja łączności*…, op. cit., pp. 188–189.
[26] J. Nikiforow, *W granicznym kalejdoskopie*…, op. cit., p. 55.
[27] *Przepisy korespondencji w relacjach radiowych Wojska Polskiego*, Wydawnictwo MON, Warszawa 1987, pp. 1–200.
[28] Ibidem, pp. 9, 13. The underlining in the document was added by the authors of this study.

within the area of operations of the Świnoujście Border Battalion (bg), made by personnel of the Military Internal Service (WSW) at the time. The most common violations of radio discipline in this region during the summer of 1987 included:

- the unauthorized use of the call sign "Krokus," which signalled a switch to wired communication,
- operating according to the old rules of radio correspondence,
- the use by POWT personnel of the call sign "Monitor" to make calls on the civilian network,
- the use of profanity.

In light of the above, the Chief of Staff of the Pomeranian BWOP in Szczecin ordered that disciplinary measures be taken against those responsible for negligence in this regard and that the aforementioned cases be discussed with the unit's personnel (in groups consisting of staff and ZSW soldiers) by 15 September 1987.[29]

To summarize the findings so far, it must be noted that the communications system in operation within the WOP – and thus also within its coastal brigades – depended on the ministry under which the formation was currently operating. Since the WOP changed its administrative affiliation several times during its existence (1945–1991) – shifting between the Ministry of Internal Affairs (MSW) and the Ministry of National Defence (MON) – this had specific consequences for the operation of the communications system, including both radio and wired communications. In each instance of a change in administrative control (subordination to the Ministry of National Defence or the Ministry of Internal Affairs), the coastal communications subsystem of the Border Guard (BWOP) also came under the new administrative control.

Furthermore, the operation of communications within this unit was positively influenced by new technology in the production of communications equipment and the transition from vacuum-tube to transistor technology in the 1960s. In the coastal Border Guard Units (BWOP), the situation regarding radio communications was further complicated by the fact that, in the second half of the 20th century, specialized units operated specifically along the coast within the formations protecting the maritime border – units that were not found in other BWOP units. These included three DOPs equipped with vessels (ships and cutters), the WOP Reconnaissance Aviation Squadron (ELR WOP) equipped with airplanes and helicopters, technical outposts equipped with POWTs, as well as port outposts and battalions. These specialized

[29] ASG w Szczecinie, Akta PB WOP, ref. no. 2624, vol. 9, Pismo nr pf. 1456/Łącz. szefa sztabu Pomorskiej BWOP do dowódcy batalionu granicznego Świnoujście z 26.08.1987 r., p. 1; nr pf 1425/Łącz. z 19.08.1987 r., pp. 1–2.

subunits had to possess communication systems enabling them to coordinate with one another and ensuring the effective execution of their official duties in protecting Poland's maritime border.

APPENDIX 1

Selected military wireless communications equipment

R-116 radio

The R-116 radio was a portable, two-way radio capable of voice communication. It was an FM radio with amplitude modulation, designed to provide communication without the need to search for a correspondent within company networks. The radio's frequency range was from 48.65 to 51.35 MHz (6.17–5.84 m). Ten operating frequencies were allocated within this range. Interoperability between the R-116 radio and the R-106 radio was ensured on a single shared channel (channel "0" on the R-116 radio and channel "18" on the R-106 radio).

The transmitter's antenna power was 0.06 W. The receiver's sensitivity was no less than 6 μV. The radio was equipped with a Kulikov-type rod antenna, with a wire extension, having a total length of 145 cm. With this antenna the radio, in moderately covered terrain, provided two-way communication with a radio of the same type (or on the same frequency as the R-106 radio) at a distance of 1 km. This range was achieved at any time of year or day and regardless of the operator's position (while marching, lying down or standing, etc.). The best reception of the correspondent – and thus the radio's maximum range – was achieved when the antenna was tilted in the direction opposite to the correspondent.

The radio ensured that communication could be established and maintained (without having to search for a correspondent or fine-tune the frequency) over a distance of 1 km, even when the temperature difference between the operating environments of the radios was 30 ºC.

To prevent mutual interference, radios operating on adjacent frequencies in the same location had to be spaced at least 80 m apart and when receiving on a single operating frequency, at least 100 m apart.

The radio was powered by a BANSS-18 dry anode-incandescent-grid battery. This ensured continuous operation of the radio for 12–20 hours, with a reception-to--transmission time ratio of 3:1. The weight of the radio, including the power supply,

was 4.2 kg. The radio set included: a transceiver, a rod antenna, a headset and microphone set and a dry anode-incandescent-grid battery.[30]

R-106 radio

The R-106 radio was a portable, two-way radio capable of voice communication. It was an AM VHF radio designed to provide communication within battalion networks without the need to search for a correspondent. The radio's frequency range was from 46.1 to 48.65 MHz (6.5–6.7 m). Eighteen operating frequencies were allocated within this range. The R-106 radio could operate in conjunction with the R-116 and R-105 radios. To establish communication between the R-106 and R-116 radios, the R-106 had to be set to channel "18," while the R-116 had to be set to channel "0." To establish communication between the R-106 and R-105 radios, the R-106 radio had to be tuned to band "1," and the R-105 radio to band "461."

The transmitter's antenna power was 0.5 W and its sensitivity was no less than 6 μV. The radio used a 145-cm-long Kulikov-system rod antenna. When operating with this antenna in moderately covered terrain, it provided two-way communication with a radio of the same type at a distance of 1.6 km, at any time of the year or day. Communication on this type of radio was established and maintained without the need to search for a correspondent or fine-tune the frequency. The radio was powered by a type 2 NKN-24 battery. A vibrator converter was used to power the anode circuits of the receiver and transmitter in the radio. The 2NKN-24 battery allowed the radio to operate continuously for 12 hours, with a receive-to-transmit time ratio of 3:1. The radio, including its power supply, weighed 10.5 kg. The radio set included: a transceiver, a handset, a headset and microphone set, a rod antenna, a 2NKN-24 battery and a vibrator converter. The radio was operated by a single soldier.[31]

R-105, R-108 and R-109 radios

The R-105 radio was a portable, simplex transceiver operating on VHF frequencies with frequency modulation. This radio was designed to establish

[30] Biblioteka Morskiego Oddziału Straży Granicznej (hereafter MOSG) w Gdańsku-Nowym Porcie, *Podręcznik łącznościowca, cz. III. Sprzęt i urządzenia radiowe*, Wydawnictwo MON, Warszawa 1961, pp. 7–8.

[31] Ibidem, pp. 13–14.

communication without searching for a correspondent and to maintain communication without retuning, at any operating frequency, with a temperature difference of up to 30 ºC between the operating radios. The radio had a frequency range of 36.0–56.1 MHz (8.33–6.5 m). Within this range there were 203 tunable frequencies.

The radio set included the following types of antennas:

- a flexible antenna of the Kulikov system, 1.5 m high (using the radio housing as a counterweight) – for use while on the move,
- a combined antenna, consisting of a Kulikov-system flexible antenna and four elbows (total antenna height 2.7 m), using a counterweight made of three rods, each 1 m long – for use while stationary,
- a vehicle-mounted antenna, consisting of a combined antenna, a special shock-absorbing mount for securing the antenna to the vehicle body and a 1-meter-long connecting cable – for use while driving,
- a 40-meter-long directional radial antenna suspended 1 meter above the ground – for covert operations and to ensure long-range communication,
- an elevated radial antenna, 40 m long, suspended next to the radio at a height of 5–6 m, with the opposite end gradually sloping downward toward the correspondent – for covert operations and to ensure communication over longer distances.

This radio station provided two-way communication with a radio station of the same type in moderately hilly and forested terrain, at any time of day or year, on any selected frequency within the range, with a battery voltage of 4.4–5.2 V, at distances of up to 25 km, as shown in the table below.

Table 1. Range of the R-105 radio when using different types of antennas

No.	Operating mode of the R-105 radio with an antenna	Communication range in km
1.	Working while marching with a 1.5-metre-tall rod antenna.	6
2.	Stationary operation using a 2.7-metre-tall rod antenna with a counterweight consisting of three 1-metre-long rods.	8
3.	Operating from a stationary position with a directional radiating antenna suspended 1 m above the ground.	15
4.	Operating in a concealed location at depths of no more than 3 m (with a covering no more than 1 m thick) using a radiating antenna.	15

No.	Operating mode of the R-105 radio with an antenna	Communication range in km
5.	Operations from a station set up using a TAI-43 telephone set, connected to a radio station via a 2-km-long PTF-7x2 two-wire cable, with a rod antenna.	8
6.	Operating under the same conditions as above, using a radiating antenna.	15
7.	Operating with a radial antenna suspended above the radio at a height of 5–6 meters above the ground.	25

Note: The radio operated while the vehicle was in motion using an on-board antenna with a range of 6 km.
Source: Biblioteka MOSG w Gdańsku-Nowym Porcie, *Podręcznik łącznościowca, cz. III. Sprzęt i urządzenia radiowe*, Wydawnictwo MON, Warszawa 1961, p. 20.

Differences between the R-105 radio and the R-108 and R-109 radios:

- Frequency range:
  - for the R-108 radio, 28–36.5 MHz (10.7–8.22 m). This range included 171 tunable operating frequencies,
  - for the R-109 radio, 21.5–28.5 MHz (13.95–10.5 m). This range included 141 tunable operating frequencies.
- Operating range:
  - with the combined antenna of the R-108 and R-109 radios – 12 km,
  - with the onboard antenna for the R-109 radio – 8 km.

The operating range from a remote location using the R-108 and R-109 radios was:

- 12 km with a rod antenna,
- 15 km with a low-hanging radial antenna,
- 25 km with a high-hanging radial antenna.[32]

FM-302 Radio

The FM-302/I/IV radio was a transceiver operating on phase modulation. It was designed to operate in the following bands:

- FM-302/I: 31–47 MHz,
- FM-302/IV: 148–174 MHz.

[32] Biblioteka MOSG w Gdańsku, *Podręcznik łącznościowca*…, op. cit., pp. 19–22.

Each band was divided into three sub-bands. Switching to a different sub-band required replacing the crystals, transmitter coils and receiver input circuit coils. The radio-telephone could operate on one of four quartz-stabilized frequencies within a given band. It was designed for use on mobile units and as a fixed-station device. Its purpose was to provide communication between a mobile unit and a fixed control unit or another mobile unit. Thanks to four switchable frequencies within a single band, the radio could operate with stations from various networks. It effectively provided horizontal-range communication. To a large extent, the range depended on the height at which the antennas were mounted and on the terrain. The FM-302 radio-telephone was not designed for remote control.

The FM-302 radio-telephone, manufactured by the State-owned "MORS" Enterprise in Gdynia, had the following technical specifications.

Frequency: four selectable frequencies in the following bands:

- 31–47 MHz for the FM-302/I,
- 148–174 MHz for the FM-302/IV.

Transmission mode: F-3.

Transmitter power: 8–10 W.

Power supply: 12 V or 24 V rechargeable battery, or 12 V or 220 V/50 Hz AC power.[33]

APPENDIX 2

Selected military wired communications equipment

Ptai-43mr field telephone

The TAI-43MR field telephone was designed to provide telephone communications via wired landline and multiplex connections, as well as radio links and radio lines. This type of telephone could be used for:

- operation in conjunction with other TAI-43MR sets or any MB system sets with inductor dialling,
- operation in networks of any CB or CA system telephone exchange after installing an additional attachment with a dial,
- as an operator's (service) set in ŁP-10 switching centres,

[33] Biblioteka MOSG w Gdańsku, *Radiotelefon FM-302. Instrukcja techniczna*, Wydawnictwo Morska Obsługa Radiowa Statków, Gdynia 1966, pp. 5–6.

- for remote control of radio stations adapted for this purpose,
- as a control telephone at intermediate telephone stations.

Two sets connected to each other via a two-wire line with an attenuation of 5 Neper (5 Np = 43 dB) at a frequency of 1,000 Hz still ensured clear speech intelligibility, even with an ambient noise level of 60 dB at the receiving end. This ensured reliable telephone communication without additional amplifying devices over the following distances.

On field cable lines:

- PKL cable – up to 20 km,
- PKA cable – up to 45 km,
- PKD cable – up to 60 m.

On fixed lines with wire conductors:

- 3 mm diameter steel wire – up to 150 km,
- 4 mm diameter steel wire – up to 150–200 km.

The device was powered by a 3S dry cell or similar with a voltage of 1.5 V. It was operated by a single soldier-telephonist and it took 1–3 minutes to set it up and establish a connection on a functional telephone line. The set consisted of: the telephone in a case, a carrying strap, a headset and an inductor crank.[34]

APPENDIX 3

Communications unit personnel of the Kashubian Border Guard Brigade in Gdańsk Nowy Port until 1991

Table 2. Communications and Radar Division of the Kashubian Border Guard Brigade in Gdańsk Nowy Port

No.	Position Held	Title, first name and last name
1.	Head of Department	Lt. Col. Julian Kąty / Lt. Col. Ryszard Muchowski / Lt. Col. Edward Kaleta / Maj. Zbigniew Wojno
2.	Deputy Head of the Technical Department	Capt. Mieczysław Wądołowski / Lt. Col. Wojciech Pytasz / Lt. Col. Jarosław Dobrowolski, Eng.

[34] Biblioteka MOSG w Gdańsku, *Polowy aparat telefoniczny typu TAI-43 MR*, Wydawnictwo MON, Warszawa 1968, pp. 15–17.

3.	Surveillance Department	Major Mieczysław Paradowski
4.	Senior Assistant to the Head of the Wired Communications Department	Major Stefan Paradowski
5.	Senior Assistant to the Head of the Radio Communications Department	Major Zdzisław Niemcowicz
6.	Department Officer	Major Stanisław Burakowski
7.	Department Officer	Major Ludwik Borusiak
8.	Department Officer	Major Stanisław Mroczkowski
9.	Department Officer	Major Zbigniew Gramse
10.	Department Officer	Lt. Włodzimierz Szczęsny
11.	Department Officer	Capt. Piotr Sontowski
12.	Communications Department Storekeeper	Staff Sergeant Jan Szurek

Source: Information provided by the authors.

Table 3. Communications and Radar Division of the Kashubian Border Guard Brigade in Gdańsk Nowy Port

No.	Position Held	Title, first name and last name
1.	Workshop Manager Career	Capt. Franciszek Kawicki / Capt. Janusz Chylicki / Maj. Augustyn Basiak
2.	Non-Commissioned Officer	Staff Sergeant Bogdan Cabański
3.	Career Non-Commissioned Officer	Sgt. Leszek Kowalski
4.	Civilian Employee	Col. Leszek Ciołek
5.	Civilian Employee	Col. Aleksander Kwiatkowski
6.	Civilian Employee	Col. Edmund Kulej
7.	Civilian Employee	Col. Mirosław Kochalski

8.	Civilian Employee	Col. Roman Salmanowicz
9.	Civilian Employee	Col. Tadeusz Szynkowski

Source: Information provided by the authors.

Table 4. Communications and Radar Division of the Kashubian Border Guard Brigade in Gdańsk Nowy Port

No.	Position Held	Title, first name and last name
1.	Company Commander	Capt. Jan Załuski / Maj. Stanisław Burakowski / Maj. Leopold Wojtyła / Capt. Sławomir Kruszczyński / Lt. Jerzy Kalinowski / Lt. Mirosław Włodarczyk
2.	Deputy Commander	Capt. Ryszard Cikacz / Capt. Marcin Koczewski / Sgt. Roman Fandrejwski / 2nd Lt. Jarosław Górski
3.	Company Chief	Staff Sgt. Janusz Jasiński / Sgt. Henryk Puzdrowski / Cpl. Włodzimierz Idler
4.	Platoon Commander	Wiesław Świokło, M.D.
5.	Platoon Commander	Wiesław Świokło, M.D.
6.	Platoon Commander	Lt. Zbigniew Błocki
7.	Platoon Commander	Lt. Janusz Chylicki
8.	Platoon Commander	Ensign Augustyn Basiak
9.	Platoon Commander	Second Lieutenant Jerzy Kalinowski
10.	Platoon Commander	Second Lieutenant Bernard Cudny
11.	Platoon Commander	Second Lieutenant Zbigniew Wojno

Source: Information provided by the authors.

Table 5. Cipher Station of the Kashubian Border Guard Brigade in Gdańsk Nowy Port

No.	Position Held	Title, first name and last name
1.	Station Manager	Staff Sergeant Kazimierz Sawicki / Staff Sergeant Henryk Kopik

No.	Position Held	Title, first name and last name
2.	Coder	Corporal Ryszard Wlazły
3.	Coder	Corporal Józef Borowik
4.	Coder	Corporal Zdzisław Krawiel
5.	Coder	Corporal Jacek Nowak

Source: Information provided by the authors

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Summary

This article (Parts I and II) describes the role of communications in the protection of Poland's maritime border, which was guarded by personnel of the Border Protection Forces during the second half of the 20th century. It also discusses selected types of communications equipment used at that time by soldiers of the formation's coastal brigades.