

Lech **BOROWIEC**
Stanisław **TOMASZEWSKI**

OBRUM'S CONTRIBUTION TO THE TECHNICAL DEVELOPMENT OF RADAR FORCES

Abstract. The article presents carriers vehicles designed and manufactured at OBRUM provided with complete equipment for the implementation of mobile and stationary radar equipment. This work was carried out with leading research institutions in Poland: the Industrial Telecommunications Institute (PIT) and the Warsaw Radio Works RAWAR (WZR RAWAR). The most important OBRUM projects covering the development of technical documentation and fabrication of chassis – carriers for radar equipment are described in a synthetic way.

Keywords: radiolocation, radar forces, radar station, special tracked vehicle, special radar vehicle, mobile radar station.

1. INTRODUCTION

One of the important areas of OBRUM's activities related to the implementation of new structures and technologies was the design and production of mobile and stationary radar equipment for the Scientific and Production Centre of Professional Electronics "RADWAR" S.A. and for the Industrial Telecommunications Institute (PIT) in Warsaw [1].

The special radar vehicles designed and made at OBRUM on tracked and wheeled chassis were designed for installing on them special devices and for electronic equipment for mobile radar stations.

For the stations assembled by RADWAR, OBRUM made:

- SPG-1 and SPG-1M vehicles on special tracked chassis - for NUR-21;
- SPR-22 vehicles on wheeled TATRA T815 VP 31 chassis - for NUR-22;
- SPR-175 platform on wheeled IVECO 4012 WM chassis - for MMSR.

For the stations assembled by PIT, OBRUM made:

- SPR-22B-2 vehicles on wheeled TATRA T815 VP 31 chassis - for BREŃ;
- CAR-1100 platform on wheeled TATRA 815 VPR 9 chassis - for CAR;
- JBR-15 platform on wheeled TATRA 815 VPR 9 chassis - for TRS-15;
- JAT-122 antenna unit for stationary long-range radar, part of RST-12M;
- JBR-15G platform on wheeled TATRA 815 280 R84 chassis - for GUNICA.

2. RADAR EQUIPMENT MADE FOR RADWAR S.A.

The beginnings of production of special chassis for radar devices go back to the 1970s. In 1973 OBRUM started to cooperate with WZR RAWAR in the design and production of the Special Tracked Vehicle SPG-1 as the carrier vehicle for the radar station NUR-21. The station carrier was based on the units of multitask tracked tractor 306. The chassis structure, along with the framed support system and antenna power supply, was developed by OBRUM engineers. The product structure was of modular design and was patented (Fig. 1).



Fig. 1. Special tracked vehicle SPG-1 for NUR-21

The modular structure of the product, developed solely by OBRUM engineers, consisted of five main units:

- tracked chassis;
- crew compartment;
- container;
- body/operator cab;
- framed support system (RUW).

SPG-1 was fitted with a 522-kW main engine which provided a max. speed of 60 km/h.

The main pieces of special equipment designed and installed at OBRUM included:

- friction locks of road wheel suspension arms in the suspension system of the product;
- 20 kW power generator with a synchronization system for drawing power from three sources 230/400 V 50 Hz;
- RUW hydraulic system with 0° to 90° movement limiter;
- cooling system for electronic equipment and filtration/ventilation system for the vehicle crew.

A detailed description of the design and operation of the SPG-1 vehicle and its technical specifications are presented in a special article published on OBRUM's 35th anniversary in 2003 [2].

Another product constructed jointly with RAWAR was the SPG-1M vehicle as a carrier vehicle of the NUR-21M radar station for a foreign client. It was built on the basis of the same main units as the SPG-1, except of the chassis. In accordance with the client's request, the tracked chassis was fitted with transmission units of the T-72 tank [3].

The station ready for operation is shown in Fig. 2.



Fig. 2. NUR-21M radar station on SPG-1M tracked chassis

As the manufacturing costs of the special tracked vehicle chassis SPG-1 and SPG-1M were high, in 1989 OBRUM and WZR RAWAR started work on the design of a special radar vehicle SPR-22 on wheeled chassis, as a carrier vehicle for the radar station previously installed in NUR-22.

The station is shown in Fig. 3.

The SPR-22 vehicle was designed to have electronic equipment and antenna installed on it and to power the equipment and antenna from on-board and external high voltage power sources.



Fig. 3. Special Radar Vehicle – SPR-22

The vehicle comprised four independent units:

- T815 VP31 265 8x8.1R chassis;
- body for installation of electronic equipment;
- framed support system (RUW) for installing radar antennas;
- 25 kVA power generators (main and emergency) for powering the station.

In addition, SPR-22 was equipped with the following modern devices:

- electrohydraulic levelling system (UAP-100);
- central leakage protection device (CZU), for continuous monitoring of the condition of high voltage network insulation;
- dead reckoning system (UNZ-20);
- internal (SOTAS) and external (RRC-9500) communication means.

SPR-22 was set on a special wheeled chassis TATRA T815 VP31 manufactured by TATRA SIPOX a.s., Slovakia, for the gun-howitzers DANA and ZUZANA.

The T815 VP31 chassis was adopted for SPR-22 vehicles by the chassis manufacturer TATRA SIPOX a.s. based on the documentation delivered by OBRUM.

The T815 VP31 with an armoured driver's cab was an off-road four-axle vehicle with all-axle drive and load capacity of 32 tons. It was equipped with an air-cooled 265 kW multi-fuel compression-ignition engine. It had a central tyre pumping system operating both when the vehicle is stopped and during travel. The drive system of the chassis enabled off-road driving at speeds of 3.6 km/h to 40 km/h and at up to 90 km/h on bitumen-paved roads.

The use of a wheeled chassis reduced the manufacturing cost of SPR-22 for NUR-22 stations by ca. 30%.

3. MODERNIZATION OF THE SPR-22 SPECIAL RADAR VEHICLE

In 1996 OBRUM started to cooperate on the design and production of chassis for radar stations manufactured by the Industrial Telecommunications Institute (PIT).

The first vehicle made for PIT was the SPR-22B designed for a MUR-20 station.

The SPR-22B and SPR-22 did not differ from each other with respect to the T815 VP31 chassis and main units. There were only differences in some assemblies and electronic equipment resulting from the different purposes of the products (Fig. 4).



Fig. 4. Modernized Special Radar Vehicle SPR-22B-2

One driver's cab in the adapted T815 VP31 chassis did not fully meet the working requirements of the crew, especially those defined for radar vehicles.

In order to improve the ergonomic features of the cab and the working conditions of the crew, in accordance with the recommendations of the Committee for State Research on the prototype of the MUR-20 product, OBRUM prepared design documentation for the modernized SPR-22 vehicle, intended for two products: N-22 and MUR-20. The modernization of SPR-22B developed by OBRUM and TATRA SIPOX a.s. covered mainly the following units:

- chassis cab T815 VP31 (TATRA SIPOX);
- body/operator cab (OBRUM);
- some other units to provide new generation equipment in the vehicle (OBRUM).

SPR-22 modernization was effected on the first pilot production vehicle SPR-22B-2, as part of launching MUR-20 by PIT, and starting from the fourth serial SPR-22 made for the N-22 assembled by RADWAR S.A (CNPEP RADWAR S.A.).

Detailed description and scope of modernization of the special radar vehicle SPR-22 was presented in September 2000 in SPG issued by OBRUM [4].

4. RADAR EQUIPMENT MADE FOR PIT WARSAW

OBRUM became an expert in the design and production of special radar devices for mobile and stationary radar stations, assembled mainly by PIT, and becoming one of the main subcontractors.

These devices include special radar platforms mounted on civilian TATRA chassis manufactured in Koprzywnica in the Czech Republic. Four-axle wheeled TATRA chassis were a transport means for radar platforms.

Special container-type platforms, containing installed equipment, set on four outrigger hydraulic supports, after levelling and retracting the chassis, formed independently operating radar stations.

The radar platforms developed at OBRUM are presented in chronological sequence in the sections that follow.

4.1. CAR-1100 antenna unit

The first platform designed and made together with PIT was the CAR-1100 antenna unit for a foreign client.

At the client's request, the CAR-1100 antenna unit was designed for transporting the platform on a TATRA T815 VPR9 four-axle chassis (with a total load capacity of 28 tons) offered by the contractor (Fig. 5).



Fig. 5. CAR-1100 antenna unit

A prototype of the CAR-1100 antenna unit platform [5] made in 1999 was adapted to operate in tropical climate (-20°C to $+55^{\circ}\text{C}$) and comprised the following main units:

- intermediate frame for installing the platform on the TATRA T815 VPR9 chassis;
- platform tray with supporting system, equipped with a hydraulic system with four outrigger support arms;
- framed support system (RUW) for lifting the radar antenna;
- operator cab (body) bolted to the platform frame, designed for installing electronic equipment;
- subantenna cage, designed for installing antennas and their drive mechanisms and levelling system;
- radar antenna shield moved by means of hydraulic cylinders on the rear rack of the platform;
- hydraulic platform outrigging and lifting system including a levelling system;

The platform, electronic circuits, drive units and antennas were made by PIT. PIT and OBRUM commissioned the product at the client's site and provided operator training [5].

4.2. JBR-15 antenna unit

Another product developed and fabricated in 2001 was the prototype of the JBR-15 antenna unit made at OBRUM as part of a research and development work carried out for PIT.

The platform of JBR-15, designed for a TRC-15 radar station, was used for:

- installation of electronic equipment of the tracking radar;
- providing proper temperature conditions for the radar equipment;
- ensuring stable rotation of the antenna set;
- deploying and retracting the antenna set by means of the hydraulic system;
- levelling of the entire radar unit during operation.

The platform of the JBR-15 antenna unit could operate at any time of year, day and night, meeting the mechanical and climatic requirements in the temperature range of -40° to $+50^{\circ}\text{C}$.

The platform was designed using similar units to those of CAR-1100, but for a temperate-cold climate. After being transported on the TATRA 815 chassis to a designated site and levelling on special hydraulic supports, it formed an independent unmanned radar station, used to track a dozen or more air-borne objects at the same time.

The platform, after its construction at OBRUM and installation of the electronic equipment together with the antenna at PIT, successfully passed preliminary tests and was put into production (Fig. 6).



Fig. 6. JBR-15 antenna unit

4.3. JAT-122 antenna unit

Another antenna unit, the JAT-122, is a stationary object – carrier for long-range radar, and forms part of the RST-12M product.

It was placed on the top of an antenna tower ca. 27 m tall, and covered with a dome that protected it against changing weather conditions. The interior of the dome is air-conditioned inside during radar operation. The size of the dome enables performing the necessary assembly and maintenance operations using special hoists and instruments.

The antenna unit comprises the following components:

- frame with supporting system that enables levelling of the unit at the top of the tower;
- subantenna cage;
- antenna cage;
- supports for securing the main antenna and AFF-600 identification system antenna,
- main antenna;
- AFF-600 identification system antenna;
- set of equipment for installing and replacing main antenna blocks;
- set of equipment for replacing main bearing;
- blocks and electronic equipment installed in cages.

The JAT-122 antenna unit is shown in Fig. 7.

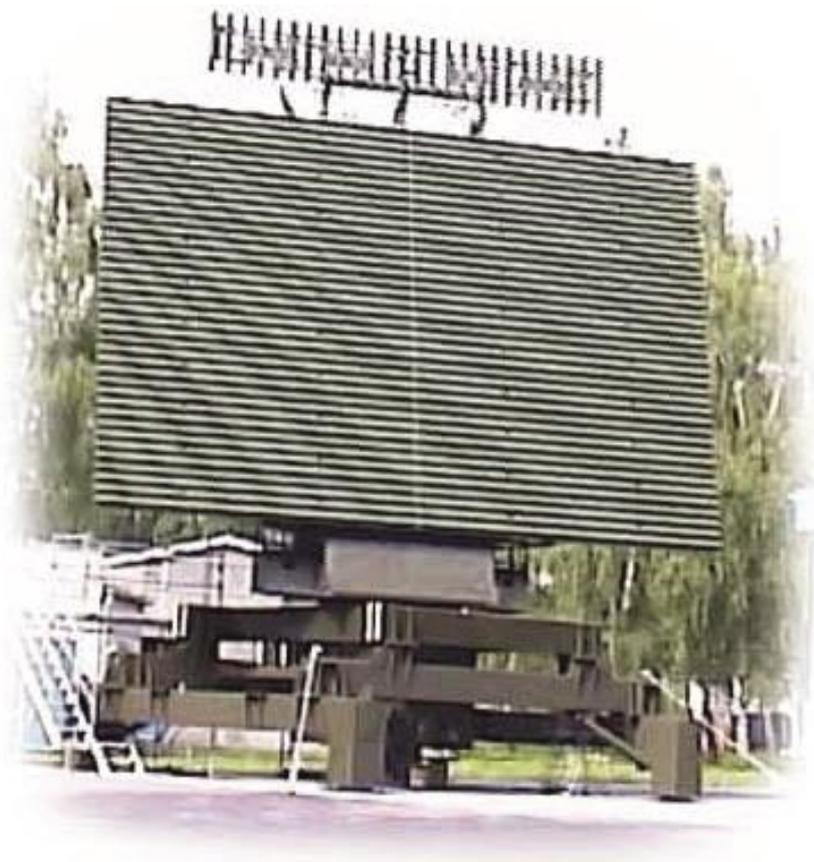


Fig. 7. JAT-122 antenna unit

Cooperation with the Industrial Telecommunications Institute (PIT) in the construction of the JAT-122 antenna unit was a major challenge for the OBRUM engineering, technical and production staff because of the novel design of the products that have never been manufactured before by OBRUM. The development and fabrication of the first antenna unit required a lot of effort from OBRUM's scientific and technical staff [6].

Computer calculations, using the finite elements method, of the key structural components, enabled optimization of the design. Unique technologies for assembling antenna arrays and for replacing the main bearing have been developed. All structural solutions were verified in preliminary tests of the first unit built and were confirmed in tests carried out by PIT.

An extensive description of JAT-122 is given in SPG No. 14 issued by OBRUM in 2001 [7].

4.4. JBR-15G antenna unit platform

Another product implemented in 2003 for PIT was the platform of the JBR-15G antenna unit codenamed GUNICA. It was based on the main units of the JBR-15 radar platform (Fig. 8).

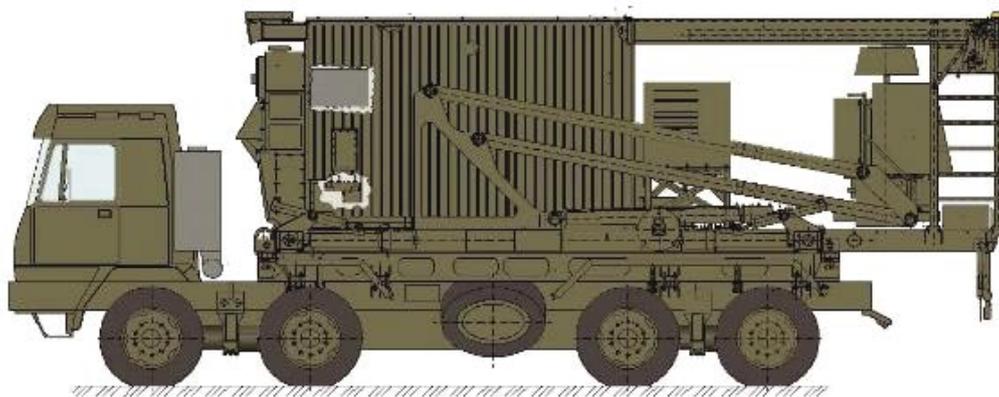


Fig. 8. JBR-15G antenna unit platform

The main distinctive units that distinguished the new platform from CAR-1100 and JBR-15 included:

- new four-axle chassis with a load capacity of 32 t and a 280-kW EURO 3 engine;
- modified framed support system (RUW) installed in tray supports, enabling the lifting of the antenna to a height of ca. 9 m;
- a newly designed operator cab bolted to the platform tray, designed for the installation of electronic equipment and two operator stations;
- an independent 24-kVA power generator, adapted to operate in the temperature range of -40°C to $+50^{\circ}\text{C}$.

In addition, the antenna unit platform was furnished with equipment listed below, adapted to operate in the temperature range of -40°C to $+50^{\circ}\text{C}$:

- air conditioner and filtration/ventilation system for the operator cab;
- fans for cooling electronic equipment;
- air drier in the operator cab;
- hydraulic platform support outrigger and RUW lifting system;
- electrohydraulic antenna levelling system;
- antenna shield with hydraulic drive.

4.5. SPR-175 Small Size Mobile Radar Station

The Small Size Mobile Radar Station (MMSR) is designed for detecting and tracking airborne targets and transmitting information to special units (launchers) operated by the land forces company. MMSR was developed jointly with CNPEP RADWAR S.A., for which OBRUM has designed and fabricated a special radar platform SPR-175 shown in Fig. 9.

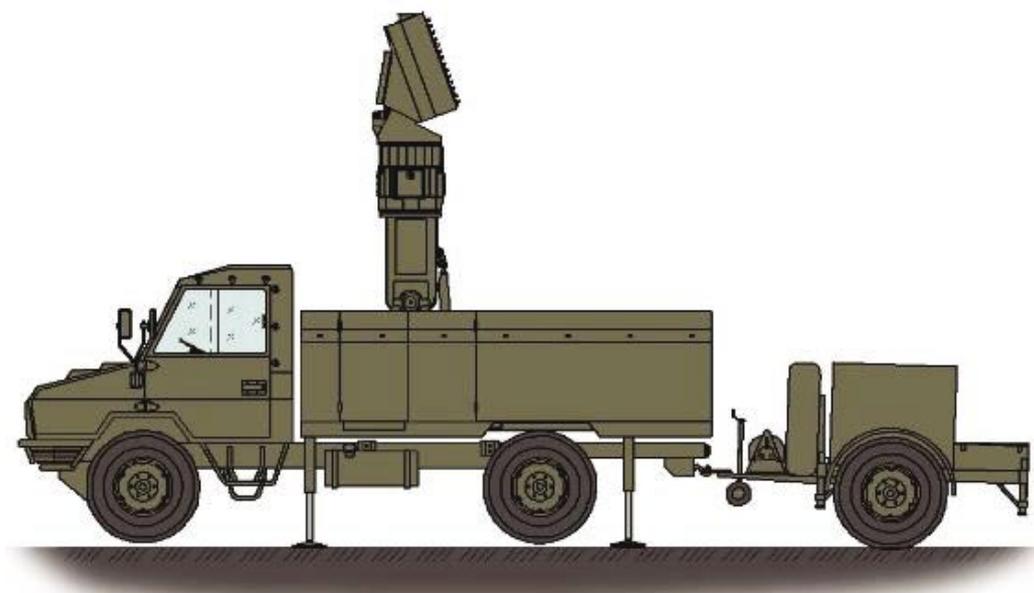


Fig. 9. SPR-175 Small Size Mobile Radar Station

The special radar platform comprised the following main units:

- tray as a support frame with aluminium floor and sidewalls made of aluminium profiles, installed on the 40.12WM chassis frame;
- supporting system, bolted to the crossbars of the support frame;
- antenna pole set on journals supported on bearings in the support system, the antenna pole settable in two positions: vertical operating position, set with an accuracy of ± 0.5 , and transport position, retracted onto the tray by 90° by means of hydraulic cylinder;
- hydraulic system fed from a hydraulic power unit (54V);
- four hydraulic side supports for setting and levelling of MMSR;
- 10 kW power generator, carried on a single axle trailer, pulled by IVECO chassis, designed for powering the drive unit of the radar antenna and the converter for powering the hydraulic system.

Special radar platform is installed on two-axle IVECO 40.12 WM chassis supplied by WZR RAWAR. It is possible to disengage the chassis from the platform frame and to set MMSR on four hydraulic supports. After levelling, the station can work independently when powered from an external power generator, which can be disconnected from the platform and set to work within 50 m. Due to the low weight (900 kg) of the SPR-175 radar platform, the maximum permissible loads on the axles of the chassis and the levelling accuracy and short time for preparing the station for operation, working out a new approach to the design of a special platform required the construction of the main components of the station: support frame, antenna pole, support system underwent optimization that enabled meeting the technical requirements set by the client.

5. SUMMARY

Projects completed at OBRUM on the design, production and testing of specialized equipment for the radar forces are an important part of OBRUM's achievements during its 50-years history. It is accurate to say that technical progress and military development, as well as virtually all station deployments for use in the Polish radar forces, have occurred with OBRUM's participation [8]. The developed designs of station carrier vehicles, starting from tracked chassis (SPG-1) to the small-size station (MMSR), were innovative at the time of their creation. Numerous patents granted to OBRUM confirm the above statement [5].

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