

Industrial transformer stations

Radosław Kolaciński
ENERGA OPERATOR Produkcja Sp. z o.o.,
Oddział w Kaliszu
62-800 Kalisz, Al. Wolności 8

Marek Paluszczak
ENERGA OPERATOR Techniczna Obsługa Odbiorców, Sp. z o.o.,
Oddział w Kaliszu
62-800 Kalisz, Al. Wolności 8

Grzegorz Twardosz
Politechnika Poznańska
60-965 Poznań, ul. Piotrowo 3a, e-mail: Grzegorz.Twardosz@put.poznan.pl

The paper presents a modern design of semi-underground transformer station of BST-PP 20/630 type. The station is designed to be supplied from medium-voltage distribution network. Maximum transformer power $S = 630$ kVA. The transformer is installed underground. The part situated above the ground may be used as an advertising surface.

1. Introduction

The transformer stations designed for supplying communal customers as well as small and medium servicing-manufacturing companies located at the area of compact settlement, e.g. housing estates in towns, industrial plants and craftsman workshops, suburban settlements or recreation areas must often fulfill additional requirements. In urban agglomerations are used usually the transformer stations of container type, of small dimensions, free-standing, assembled on the ground, or rather rarely of indoor type. The indoor transformer stations may be assembled only in special rooms, taking into account the need of restriction of access of outsiders to the electric power equipment. Mobile transformer stations are commonly used in mines, while the columnar ones in country and recreation areas.

An interesting and, at the same time, future-oriented solution is provided by compact underground transformer stations, e.g. BST-P 20/1000, that are designed and manufactured by ENERGA OPERATOR PRODUKCJA Ltd Company [1].

The semi-underground compact transformer station of BST-P 20/630 type plays also a useful role, as its overground part is used, at the same time, as an advertising surface. The compact transformer stations may be located in a production bay, in a cellar, totally or partially underground. The compact stations have many advantages as compared to the traditional ones. Among the most important

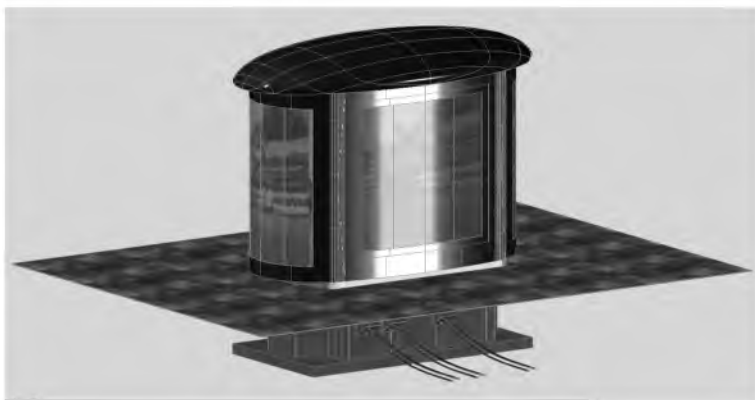
advantages may be mentioned their small dimensions and short assembly duration, but, first of all, such stations reduce the investment cost and active power loss in the conductors supplying the receiver.

2. The semi-underground transformer station BST-P 20/630

The transformer station is designed for supplying the cable line of the voltage reaching up to 20kV. It may supply a LV distribution line that delivers electric power to communal customers as well as small and medium servicing-manufacturing companies located at the area of compact or dense settlement. It has the following dimensions

- width – 1800 mm,
- height– 2600 mm,
- length – 3000 mm.

Figure 1 shows the view of the BST-P 20/630 station. It is provided with up to four advertising surfaces, total about 10 sq. m.



Rys. 1. View of the BST-P 20/630 transformer station

The BST-P 20/630 transformer station is designed, first of all, to be placed in the locations of high intensity of pedestrian traffic, e.g. car parks, recreation and sport areas or parks. It may play additional functions, that enables to improve effectiveness of the investment. The station is not only a part of the electric power network, but also a building structure. Therefore, it must meet both the requirements resulting from the electric function and related to building law.

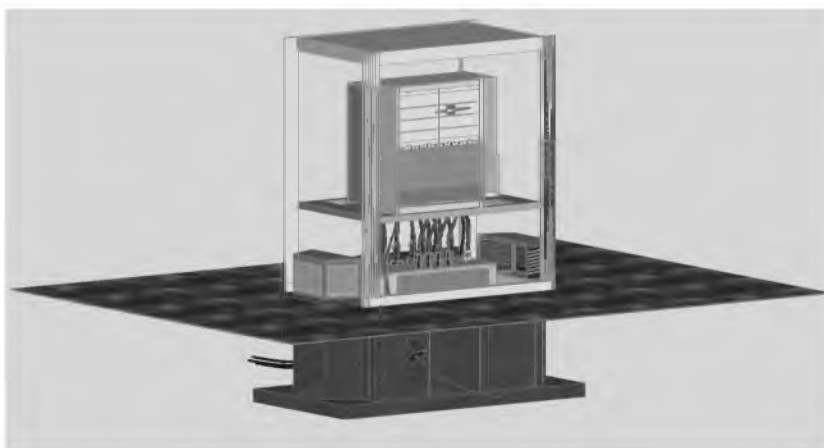
Taking into account compliance with the building law in force the stations satisfies the requirements if the standards PN-EN 206-1:2003 and PN-EN 1992.

The basic electrical standard the requirements of which must be met by the container transformer stations is PN-EN 6227-202:2010 [2, 3]. The underground part includes the transformer of the power not exceeding $S = 630$ kVA. The transformer may be of dry or oil-immersed type. In case of an oil-immersed

transformer an oil tray containing 100 percent of the oil is assembled at the foundation bottom. The tray is protected against oil leakage to the environment and against humidity. Figure 2 presents arrangement of the station equipment parts inside the housing. Figure 3 shows the way of assembling the MV and LV switchgears.



Rys. 2. Arrangement of the BST-P 20/630 station equipment parts



Rys. 3. The way of assembling the BST-P 20/630 station

At the MV side the switchgears of rated voltage 25 kV are used, that are provided with one transformer field and with one, two, or three linear fields. The following switchgear types – Table 1 [4, 5] – may be used. The station configuration may be different.

Table 1. MV switchgear types used in the BST-P 20/630

Switchgear type	Manufacturer	Insulation type
Safe Ring	ABB	SF ₆
RM6	SCHNEIDER formerly MERLIN GERIW	SF ₆
FBX	ALSTOM formerly AEG	SF ₆
XIRIA	EATON formerly HOLEC	air, vacuum circuit breaker
GA	UESA	SF ₆
8DJ10	SIEMENS	SF ₆
SVS	EATON formerly HOLEC	solid insulation

The station is operated from outside. Therefore, it meets the most severe requirements with regard to protection against arc development, i.e. JAC-AB. In consequence, security of the operators and outsiders present nearby is ensured even in case of a short-circuit occurring inside the equipment. The standard [2] specifies six classes of the housing. The station meets very high requirements since the housing class is defined to be equal to 10. What concerns the housing protection against mechanical shock its protection is equal to 20 J, which corresponds to the class IK 10.

The considered station has been manufactured at an individual order. Nevertheless, its electrical and building design is so developed as to satisfy the repeatability criterion, maintaining, at the same time, its individual features.

3. Final remarks

Infrastructural development in urban and countryside agglomerations, imposes more and more severe operation conditions of electric power equipment, inclusive of the transformer stations. The container transformer stations are at present offered by many manufacturers. The MRw-b stations manufactured by ZPUE Włoszczowa May be mentioned here, as well as STKB from Apator Control, CSS from ABB Warszawa, STLmb from Elektromontaż Lublin, or KST/PAS from the Centre of Electric Power Industry Supplies PAS. These stations are provided with internal operating passage. The most modern constructions include externally operated underground or semi- underground transformer stations. Taking into account their small dimensions they are well suited for use in urban agglomerations, for power supply of housing estates or recreation houses. Therefore, the underground and semi-underground stations will be used more and more frequently. The need of fulfilling the electrical and building requirements makes a remarkable challenge for the designers and constructors. An interesting solution consists in possible use of

the above-ground part of the BST-PP 20/630 station as an advertising surface. One recommends to provide the stations of this type with a remote managing and operating systems. Possible managing and control of the power transmitted by the station enables implementation of intelligent network concentration. In the Energia-Operator SA Company it is attained, among others, by general automation of the distribution network and improvement of network observability. Intelligent network operation enables advanced network management and control in the conditions of extensive increase of the diffused generation. The new control model imposes the need of use of the aiding system of network operation and distribution management solution of new generation (SCADA/DMS). Modern information and communication technologies (ICT) make a basis for intelligent electric power networks. In order to ensure security and continuous operation of key systems, for example security of the SCADA dispatch system, the TANA tele-computer framework network is built that is designed for transmitting the data related to operation of the intelligent network. The operator while using his/her control stand would be able to control the positions of the switches, to record short-circuit currents, to separate damaged parts of the network or to reconfigure them. The semi-underground BST-PP 20/630 transformer station is registered in the Polish Patent Office as a Utility Pattern.

Economic analysis of the use of the compact station was not the objective of the present paper. According to [6] delivery of electric power with a MV cable line to the final customer and the use of a computer station may reduce the investment cost even by 50 per cent. Active power loss in the supply conductors decrease still more.

The power of the compact stations manufactured at present does not exceed 1000 kVA. They are designed for rated voltage up to 20 kV. The compact stations for the voltage reaching 30 kV are built only for purposes of the strip mines. They are usually single transformer stations, or rather rarely two-transformer ones. The three-transformer stations are reckoned only among non-standard solutions.

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