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MINISTERUL MINELOR ŞI ENERGIEI ELECTRICE

INSTITUTUL DE STUDII ŞI PROIECTĂRI ENERGETICE

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DATA
ON THE LUDUSH POWER STATION
RUMANIA

Codul .... Volumul.....................

Contract Nr..................... Faza..................... Exemplar Nr.....................

DATA ON THE LUDUSH POWER STATION - RUMANIA

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The Ludush Power Station is one of the most important gas consuming power stations of Rumania.

The ever rising demand of power consumption, which for the period 1955 - 1960 had a doubling time of 6.2 years, while now it reaches 4 years, has led to the necessity of setting up besides other stations, such gas power stations, which could be erected in very short time and had the needed fuel near at hand.

At the present time, the Ludush Power station operates with a set up power of 300 MW. It's final capacity - just now on the way of building, will attain 800 MW, at the beginning of 1967.

The siting was chosen as a result of careful technical and economical calculations.

It is located in an area where the most can be made of the natural resources of low pressured gases - , whilst an efficient water cooling is ensured from the near-by Muresh River.

The technical and economical calculations have taken into account and compared the costs of transporting electric power against the transporting of the gases by means of ducts.

It is worth while to note, that in the existing conditions of our country, should gases be transpprted without intermediate compression, both transports are equivalent from the economical point of view.

The Power Station is situated on one of the Muresh' River bends. Its proximity to the river was sought for in order to avoid long water supply, which was among the characteristics of the previously built power plants in our country.

The level site of the Plant as regards the river has also been carefully chosen, after thourough checking, so as to avoid flooding danger, while enjoying a high reduction of the pumping of the cooling water.

The lay-out of the Plant is based on the ideea of concentrating the number of buildings in order to occupy a much reduced area.

The indices for the Plant territory are the following :

	U/M	First stage 300 MW	Second stage 800 MW
1. Specific area of the precincts	ha/MW	0.0655	0.0368
2. Structure of the area:			
- zone of the technological buildings	%	38.1	31.4
- zone of the water cooling devices (cooling towers)	%	7.1	27.2
- zone of the high tension electricity stations (11o, 22o and 4oo kV)	%	46.5	33.4
- loading platforms and wads	%	8.3	8
3. Extent of built area	%	57.6	60.6

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The main equipment of the Ludush Power Station in the first stage consists of three 100 MW units made in Czekoslovakia. In a second stage an identical 100 MW unit will be set up and later on two 200 MW Soviet-made units will be set up in place.

The number one 100 MW turbine at its start of running moment has been the greatest unit of the system (about 5% of the system load). The 200 MW turbine in its turn will be the first of its kind installed in Rumania and will represent about 6.2% of the system load, when starting.

These powers fit in rationally in the system. It is well known that technically and economically the best unit size has to be somewhere between 4% and 7% of the total load of the ystem.

For all units the boiler steam pressure is 1950 psig and the temperature 1070°F. All units have a single steam reheat at a temperature of 1000 - 1070°F, thus providing an average bettering of 4% of the specific consumption against the same cycle without reheat.

By the adoption of these temperatures the top limit of the ferritic steel alloys was attained, thus avoiding the special anstenitics steels. Still, the last few meters of the boiler superheater of the steam generators of the 100 MW units were made of austhenitic steels for increased reliability reasons.

Each turbine is fed by a single boiler. The drum boilers feeding the 100 MW units have an output capacity of 730.000 lbs/h, while for the 200 MW units the output of the once-through twin furnace boilers is 1.410.000 lbs/h.

The steam connections follow the widely spread technical ideea applied for the condensation stations, of independent blocks.

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The adoption of this solution brought important simplifications and economies in the piping system which for the given pressures and temperatures, represents about 9% of the equipment value of the station.

The guaranteed specific consumption in normal operating conditions is 8750 BTU/kWh at the generator output (gross), thus representing only 82% of the specific consumption of the former electric power stations built in our country in the period 1955-196o, provided with 25 and 50 MW units, steam conditions (1400 psig) and 950°F, fed on gas fuel.

The steam boilers of the first stage are of a semi outdoor type, with fans on the top and individual small metal chimneys.

The 200 MW units boilers are indoor built using a common chimney for two units, - 18o ft high.

The arrangement of the equipment in the main building has taken into consideration the pecularities of the gas fuel boilers, thus setting them side by side next to the turbine room, and placing the internal sevices and the control room between the boilers.

As a result, most adventageous building indices have been obtained even since the first stage of the 300 MW, namely a volume for the turbine room of 0.282 m3/kW, respectively a surface of 0.010 m2/kW and a total volume of the main building of 0.547 m3/kW (surface 0.0199 m2/kW).

These indices may be compared to the best indices obtained at the Condensation Power Stations abroad for this unit size, when using gas fuel ; they hold good even for more powerful units such as the Tavazzano Power Station of Italy (twice 140 MW) which has a volume of 0.67 m3/kW and an area of 0.o23 m2/kW and is considered as one of the best of the kind in that country, or Power station Porcheville in France (units of 125 MW).

Compared to the Power Stations using gas fuel, equipped with 25 and 50 MW units, built during the period 1955-196o in our country, the volume indices and the main building surface represent only 43 %.

When designing the Ludush station a high level of automatical regulation has been taken into account which had to be rational from the point of view of costs, ensuring at the same time a safe operating by using reduced staff,

The control of the whole unit is centralized in the technological control rooms, one for every two blocks.

For the first time in our country industrial television is used for the checking of the drum water level in the boilers.

The coordination of the control rooms in done in the central dispatching rooms. In the future an electronic computer will be set up for informations and the optimizing of the load repartition amongst the units.

Finally the staff of the plant will be limited to 0,62 man/MW (operation 0.31, maintenance and repairs 0.21o, management 0.100). This figure contains the whole staff of the station, repairing personnel and management included - cook and car drivers, firemen.

The electric stations of the power station are operated separatelly from the electric control room.

The main station where the energy is supplied by a voltage of 22o kV, while by means of autotransformers the connexions are obtained for the 400 kV and 110 kV stations.

Electrically, the Power Station is connected by a 400 kV line to the international interconnection grid to the other socialist countries, by 22o kV lines to the main joints of the national energetic grid, and by 110 kV lines to the regional distributors.

These outdoor stations have been built on centrifugated concrete poles, thus realizing importamt metal economies. The 22o kV station has been the first of its kind to be erected in our country, while the 100 kV Ludush station on centrifugated concrete stades at the time of its design and construction was the first of this construction type known to us throughout the world.

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Designer of this station was the INSTITUTE FOR ENERGETIC STUDIES AND DESIGNS - BUCHAREST.

The centrifugated poles of the 400 kV station have a height of 100 ft and are anchoured by metal ropes.

As previously shown the cooling of the electric station is done by water pumped from the river Muresh. While at some periods of the year the water supply of the river does not satisfy the cooling necessities, a complex scheme has been adopted by means of additional cooling towers.

For the first units, we calculated that forced draught cooling towers are the best economical solution.

Finally, four hyperbolic reinforced concrete natural draught cooling towers will be added for the 200 MW units which are designed for a higher cooling water temperature. All towers capacity will permit the cooling of 76000 m3/h water flow. The returning water will operate a hydroturbine which will partially recuperate the hydraulic pumping power and will give an out put of about 1 MW.

INVESTMENTS AND THEIR REALIZATION PERIOD

The building of the Ludush Central Power Plant has been decided in 1958.

In its first stage the station has been set up with a 300 MW power distributed into three units of 100 MW. each.

Works began in autumn 196o ; in the next autumn - 1961 - the main building was ready for the beginning of the assembly works.

The development of the assembly works followed the rate of the deliveries of the imported equipment from Czechoslovakia.

It was during July-August 1963 that the first unit was ready for the test runs. The second unit started work early in 1964, while the third works since August 1964.

At present the extending of the station is on the go.

Construction works have started in May 1964. Jus now the t rbine room is being roofed, while the setting up of the boiler is at its first beginnings.

Tje first 200 MW unit will start work early in 1966.

The specific investments of the previous 300 MW stage has amounted to 93% of the investments of the 150 MW Power station built 10 years ago.

The total specific investments for the 800 MW final stage will amount to 82% of the Fintinele Investments.

The structure of investments on the specific conditions of our country where the main equipment is imported, is the following :

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	800 MW
Buildings - hydrotechnical works included	15,9 %
Investments for site organisation	2 %
Main equipment	58 %
Setting up	17,8 %
Expenses for the new enterprise, laboratories, surveying expenses, expenses with foreign workers	4,3%
Design costs	2 %

HEAT RATE AND ENERGY SUPPLY COST

The average heat rate realized in the first operation year was 9120 BTU per kW/h. The best performances by guarantee checkings were 8500 BTU/kWh, with 59^{o}F cooling water and full load.

The heat rate thus obtained was better than the heat rate designed.

The power consumption of the auxiliaries of the Power Plant was estimated at 5,98% when operating with direct flow cooling and at 6.31% where operating with cooling towers.

The realized consumption for the first operation year was 6 %.

For these given data, the energy supply cost for the Ludush station has the following structure :

Cost of fuel	67 %
Redemption of Investments	23.1 %
Wages and salaries	5.5 %
Costs of operation, maintenance	4.4 %

For the final 800 MW plant, the same costs are estimated to amount to :

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- Fuel	70.4 %
- Redemption	21.1 %
- Wages and salaries	3.0 %
- Cost of operation, maintenance	5.5 %

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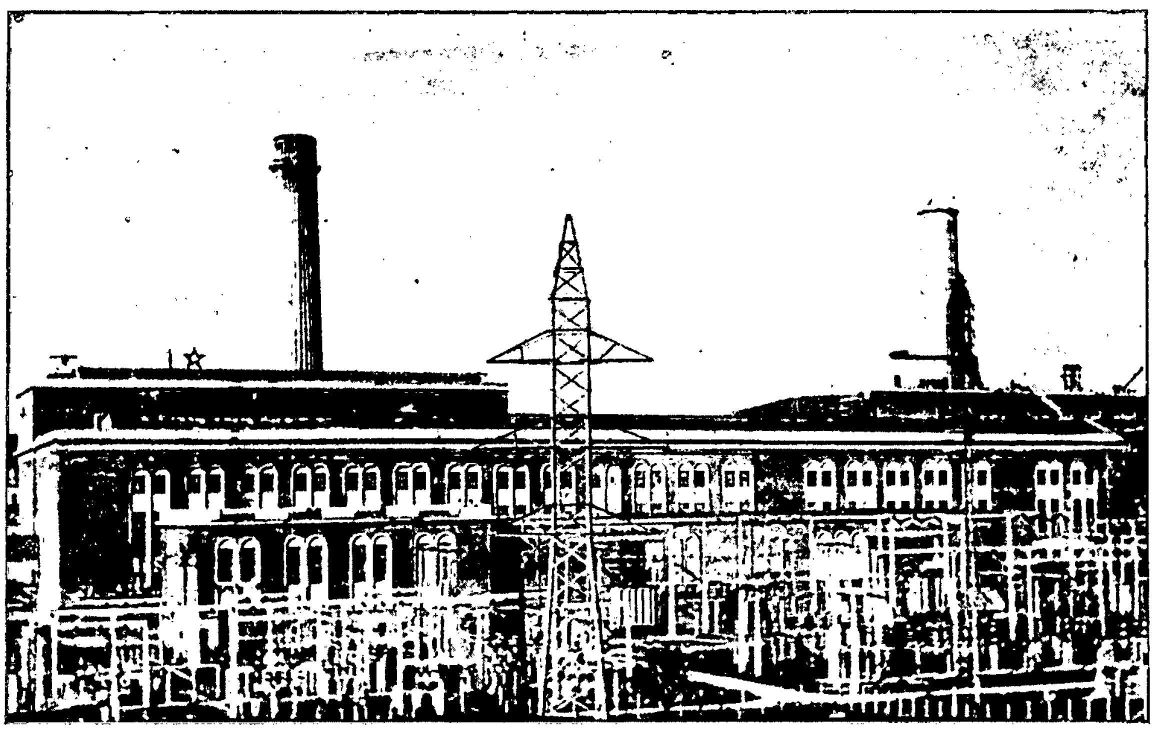
ROUMANIAN PEOPLE'S REPUBLIC

MINISTRY OF HEAVY INDUSTRY

DEPARTMENT OF ELECTRIC ENERGY

HEAT AND POWER PLANT BORZEȘTI



BUCHAREST

1960

ROUMANIAN PEOPLE'S REPUBLIC
MINISTRY OF HEAVY INDUSTRY
DEPARTMENT OF ELECTRIC ENERGY

H E A T A N D P O W E R P L A N T
B O R Z E Ş T I

Bucharest
1 9 6 0

HEAT AND POWER PLANT BORZEŞTI

1. General data

In the years of the people's democratic regime a complex of chemical industries has been created between Borzeşti and Oneşti.

This concentration of chemical industries, which are important consumers of heat, has led to the necessity of building a great industrial heat and power station. Energetic reasons too have imposed the choice of the site of the power station in this part of the country.

The whole industrial group being newly erected, a workmen's town - Oneşti - was built in the neighbourhood, which is also provided from the heat and power station with hot water for heating purposes, at a distance of about 5 km.

The power station has been designed by "Teploenergoproject" of Moscow, in collaboration with the Institute of Energetic Studies and Designs (I.S.P.E.) of Bucharest. The main equipment of the power station is delivered by the U.S.S.R. The contractor is the Trust of Energetic Constructions, with the technical aid of soviet specialists.

The power plant has been initially designed for a capacity of 125 MW. The development of the industrial group has imposed the extension of the power plant to a final capacity of 225 MW.

The first set of 25 MW, of the VPT-25-3 type, was started in December 1955.

The power station supplies steam to the industrial group at 10, 16, 21 and 23 kg/cm^2 abs.

The heat and power station can deliver, in its final stage, 873 Gcal/h steam.

The whole quantity of heat is produced by using the extractions and the back-pressure of the installed turbines, the modulus of distance heating being 64 % (the rate of the heat delivered from the extractions and the back-pressure of the turbines to the whole heat delivered by the station).

The combined production of electric energy and heat for industrial and household purposes grants an important economy of fuel, while investments and operating coats are smaller.

The Borzeşti heat and power station is supplying electric energy to the chemical industries of the neighbourhood, being at the same time connected to the national network.

2. Natural conditions

The power station is located on the right side terrace of the Trotuş river. The ground displays a layer of gravel at a depth of 3,5 m, permitting foundation in good conditions. The underground water is at a depth of 4,5 m.

The water supply of the industrial group as well as of the power station is taken from the Trotuş river.

The plant will be operated on gas delivered by the neighbouring oil fields, natural gas, residual gas from the chemical industries and fuel oil from the near-by oil refinery.

3. The heat cycle

The power station was built in two stages. The characteristics of the steam of the first stage are loo kg/cm^2 abs., 51o$^\circ$C. Two boilers of the TM-23o type, loo kg/cm^{2}abs., 51o$^\circ$C each having an output of 23o t/h, and one boiler of the TM-17o type with an output of 17o t/h were installed.

The feed water temperature is 215°C.

The boilers are connected to a steam lead, feeding two condensing automatic extraction turbines of the VPT-25-3 type and one back-pressure turbine of the VR-25-18 type. The VPT-25-3 turbines have an industrial extraction at lo kg/cm^2 abs. and a heating extraction at 1,2-2,5 kg/cm^2 abs. The back-pressure of the VR-25-18 turbine is at 18 $\pm$ 3 kg/cm^2 abs.

In the second stage higher characteristics of the steam 14o kg/cm^2abs., 57o^{o}C, have been adopted. Three boilers of the TGM-84 type, 42o t/h each, two turbines of the VPT-5o-3 type (with the industrial extraction at 13 ± 3 kg/cm^2 abs. and the heating extraction at 1,2-2,5 kg/cm^2 abs.) and one back-pressure turbine of the PVR-5o-13 type will be erected.

The VPT-5o-3 turbines have 7 extractions for the feed water heating and the PVR-5o-13 turbine has 2 extractions.

The feed water temperature of the second stage boilers is 234^{o}C.

Attention is drawn to the two deaerating stages (at 1,2 and 6 kg/cm^2abs.), the first stage beeing utilised for preheating and deaerating the make-up water delivered by the treatment installation.

4. Mechanical equipment

The six boilers are of the radiant type with natural circulation; the superheater is of the combined convection and radiant type.

The construction of the TGM-84 boilers, erected in the second stage, is granting a great simplicity and suppleness by the natural circulation of the boiler water, the providing of a single drum and the light masonry of precast fireproof concrete. The superheated steam temperature control is made by water injection.

The induced draft fans of the TGM-84 boilers are of the out-door type, with variable speed.

The turbines are provided with a Curtis stage and pressure stages, with small reaction. The VPT-25-3, VR-25-18 and PVR-5o-13 turbines are of the single casing type.

The VPT-5o-3 turbines are tandem-compound.

The turbines are of high capacity admission (2oo t/h), while from the automatic extractions 8o-1oo t/h of steam may be obtained. The robust construction of the single casing double automatic extraction turbine is of special interest. This construction has the following advantages : small necessary area, reduced foundation dimensions, lighter weight and as a result lesser investment costs.

The operation with variable load of the single case turbine, is more economical.

The heat rate of the condensing extraction turbines, when operating on the condenser only, differs but slightly from that of the condensing turbines.

In the first stage 4 motor-driven feed pumps and two turbine-driven feed pumps of 270 m^3/h each, at 150 kg/cm^2, were installed.

In the second stage 4 motor-driven feed pumps of 500 m^3/h, at 180 kg/cm^2, are intended to be installed for the three boilers.

Each of these pumps is driven by a 4 MW electric motor through a hydraulic coupling, enabling a fine adjustment of the feed water output.

The high condensate losses of the industrial group and the hardiness of the make-up water made necessary an important treatment installation (520 t/h).

In the first stage the make-up water is lime and iron sulphate pretreated, filtered and demineralized by means of Na ion exchangers. In the second stage, due to the high pressure boilers, needing a high quality feed water, a total two-step demineralisation installation with ion exchangers is designed.

The steam and hot water to and from the consumers will be carried by pipe-lines on reinforced concrete poles.

The automatic operation of the plant is made by using electronic equipment. In the first stage a local control is used, while for the second stage a thermal control room, with modern equipment, has been designed. This equipment will grant a high safety degree of the operation of the mechanical equipment, the increasing of the efficiency with 1,5-2,5 %, while the staff will be reduced by 30 %.

5. Plant arrangement

The plant has been designed as a close construction, the arrangement being :

- boiler room
- deaerator room

- turbine room

The turbines are parallel to the division wall. The distance heating equipment is located at elevation ± 0.00 of the turbine room. The electric stations for the internal services are located at elevation ± 0,00 of the deaerator room.

In the second stage the roof of the boiler room will be supported by the framework of the boilers, the back of the boilers being out-door. The fans are out-door too.

Above +8 m there is no partition wall between boiler and turbine room.

6. Cooling water circuit

The cooling water intake and exterior ducts are common for the industrial group as well as for the power plant.

The water is taken from the Trotuş river, a dam, a sand trap, an open headwater channel 3 km in length, sieves and finally a concrete duct with branchings to the industrial group being erected.

The waste water is evacuated to the Trotuş river through siphon shafts, which enable the using of the natural head, without circulation pumps.

The flow of the river being variable and relatively small, two hyperbolical natural draft cooling towers, each for lo ooo m^3/h, were erected.

It is worth to mention the combined open and close cooling circuit. While operating on the close circuit, the water from the condensers is pumped to the cooling towers, and from there through a second pumping stage to the sieves. By these means the circulating pumps are avoided and an important amount of electric energy is saved.

By supplying simultaneously the industrial group and the power station with cooling water, the investments are smaller. The whole cooling water circuit is under the common administration of the industries and the station and is operated by the power station staff.

7. Electric equipment

The 25 MW generators are connected to the busbar systems of the 6,3 kV station. The station is divided into three sections, each being connected to the other by longitudinal couplings equipped with choke coils, which can be shunted by breakers. Each section is also equipped with transversal couplings.

Two three phase 110/38,5/6,3 kV transformers are connected to the busbars. On the high voltage side the transformers are connected to the busbars of the 110 kV and 35 kV station.

The voltage of the 50 MW generators is 10,5 kV. They are bloc connected with the 110/35/10,5 kV three-phase transformers.

The 35 kV and 110 kV stations are of the out-door type, on reinforced concrete poles. The 6 kV and 35 kV stations feed the near-by industrial consumers, while the 110 kV station connects the power plant to the national high voltage network.

The internal services are fed at 6 kV and 0,4 kV, the stations being at elevation ± 0,00 of the deaerator room.

The transformers for the internal services are of the dry type. The breakers of the 6 kV and 35 kV station are of the VV-type, operated by compressed air with high breaking capacity.

The operation of the electric equipment is centralised in a single control room, common to the power plant and the out-door electric station. It is located in the 6 kV switch house.

8. The structural part

The main body of the plant has a monolith framework of reinforced concrete. The roof consists of precast concrete slabs, supported on metallic trusses.

The stack is 80 m in height, being built of precast concrete bricks.

The two stacks of the second stage will be 100 m in height.

The roof of the boiler room in the second stage is supported by the framework of the 420 t/h boilers and the back of the boilers will be out-door, thus obtaining a reduced volume of the boiler room.

The erection of the plant has been carried out by using ample mechanisation and preassembling platforms.

9. Technical-economical factors

Underneath some characteristic factors are given.

Noticeable is the reduced cost of electric energy, due to the using of large units and centralised control.

Installed capacity	MW	200
Conventional fuel consumption	kgcf/kWh	0,22
	kgcf/Gcal	169
Internal services energy consumption	%	9
Investment costs	lei/kW	3965
Cost of energy	bani/kW	5,4
Cost of heat	lei/Gcal	26,6
Staff	man/MW	1,8

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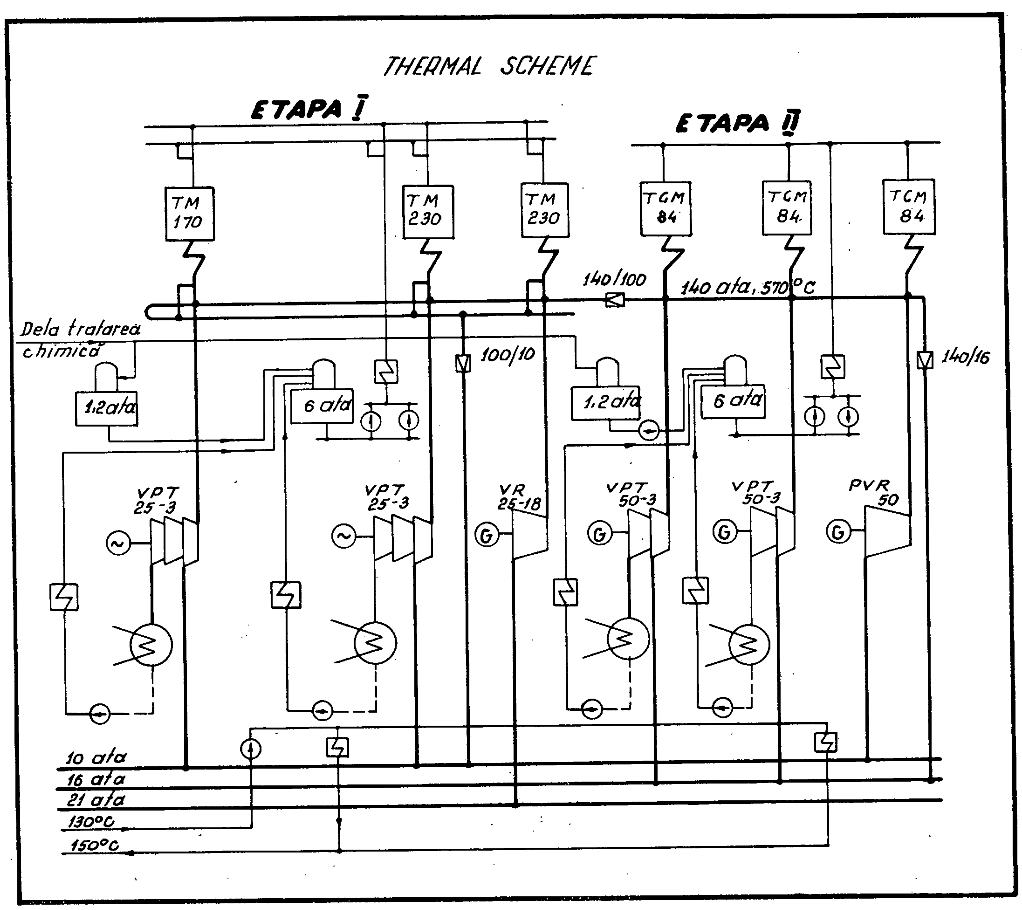
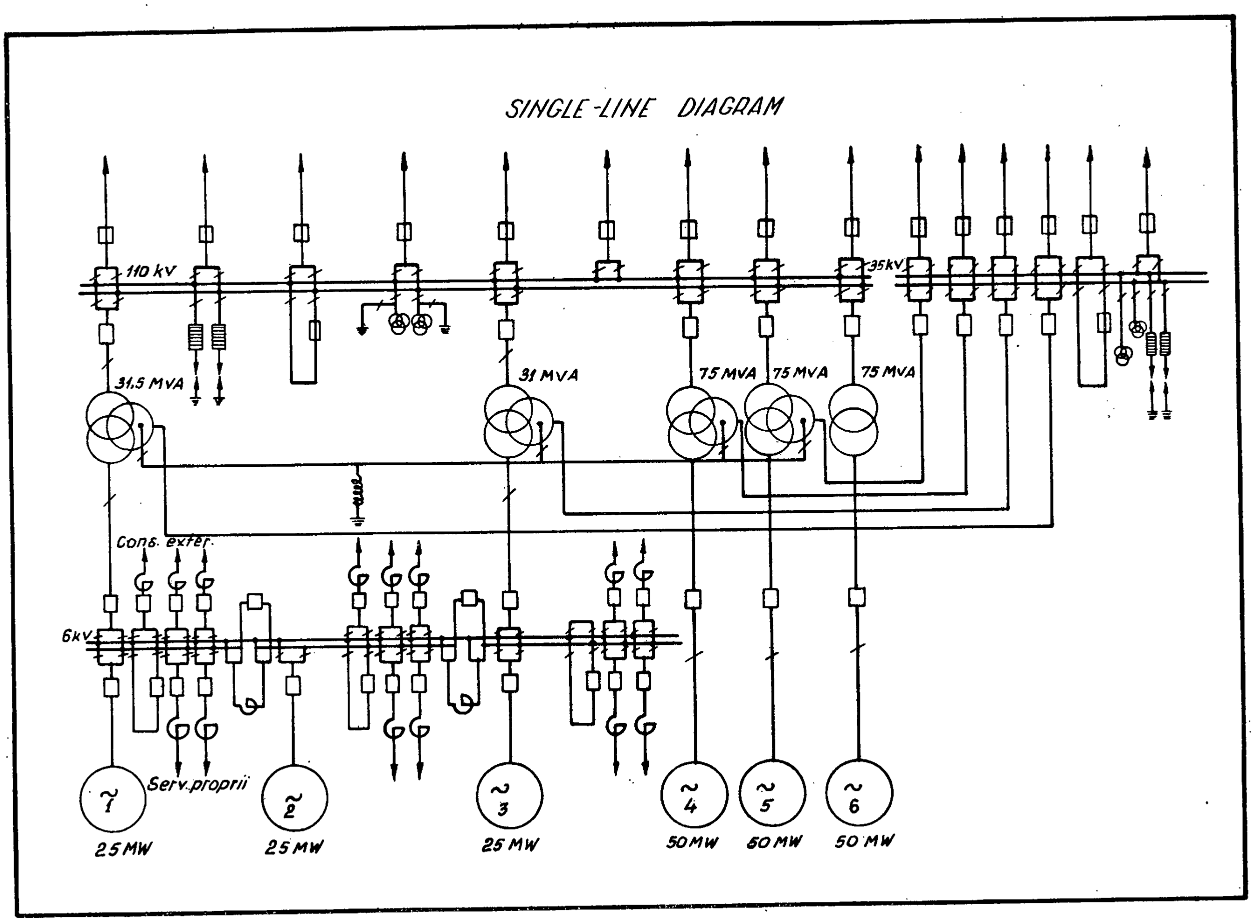
The heat and power plant Borzeşti is a great station for industrial heating purposes.

By the combined production of electric energy and heat for industrial and domestic consumers, the efficiency level of the station is high, important fuel savings for the national economy being obtained.

By applying high steam characteristics, simple and sure methods of construction, a high degree of automatic control and a bulk steam delivery to the industries, Borzeşti is a very modern heat and power plant.


THERMAL SCHEME
ETAPA I
ETAPA II
TM 170
TM 230
TM 230
TCM 84
TCM 84
TCM 84
140/100
140 ata, 570°C
Dela tratarea chimică
100/10
140/16
1,2 ata
6 ata
1,2 ata
6 ata
VPT 25-3
VPT 25-3
VR 25-18
VPT 50-3
VPT 50-3
PVR 50
10 ata
16 ata
21 ata
130°C
150°C


SINGLE-LINE DIAGRAM
110 kV
35kV
31,5 MVA
31 MVA
75 MVA
75 MVA
75 MVA
Cons. exter.
6kV
Serv.proprii
1
2
3
4
5
6
25MW
25MW
25MW
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50MW

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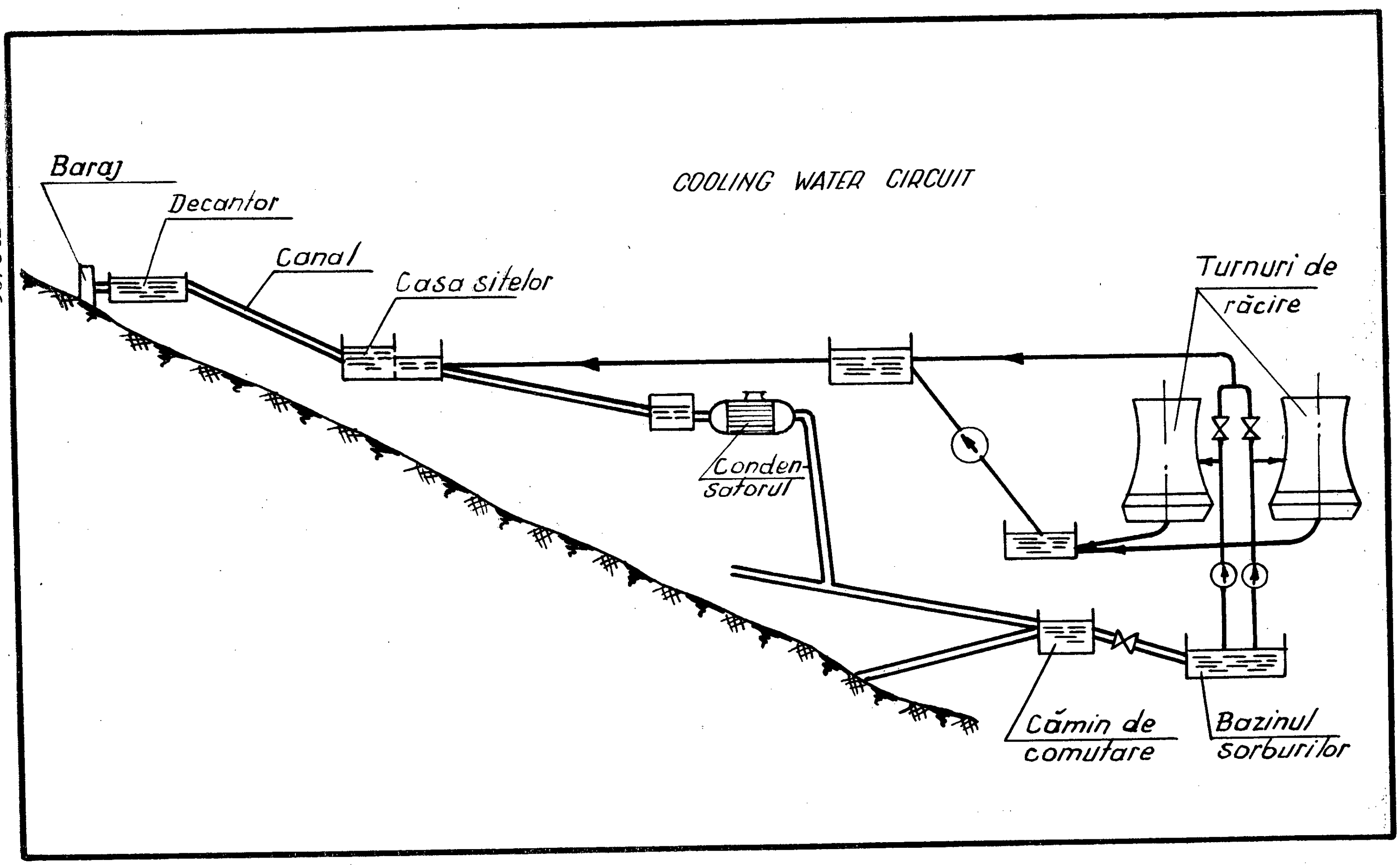

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SECTION THROUGH THE MAIN BUILDING