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REVIEWS

THE 41 MWe LLB CFB-BOILER AS MODEL FOR 200 MWe OIL-SHALE BLOCKS

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A 41 MWe CFB demonstration boiler as module for new 200 MWe CFB-boiler is discussed. The new boilers concern perspective on a rise of thermal efficiency on 10-12 % and elimination of sulphur gas emission of the Estonian power plants.

July 2, 1996, the Second Interim Report of the LLB study "OIL SHALE PERSPECTIVES WITHIN ENERGY PRODUCTION ESTONIA" to the Phare Energy PMV Project Steering Committee (SC) in Tallinn was presented. The Second Interim Report was prepared June 21, 1966 by the Thermal Engineering Department of Tallinn Technical University, State Company Eesti Energia, Stoke Orchard CRE Group Ltd and LLB Lurgi Lentjes Babcock Energietechnik GmbH.

LLB has demonstrated, after the SC meeting, a preliminary design of the 41 MWe oil-shale-fired CFB-boiler. The boiler is equipped with external fluidized bed heat exchanger (FBHE) for the Kohtla-Järve CHP Plant as a pilot boiler to the refurbishment of 200 MWe oil-shale blocks at Narva power plants. The steam characteristics of the 41 MWe boiler are 140 t/h, 97 bar and 540 °C by the feed-water temperature 215 °C. The superheater outlet bundle is embedded into the FBHE.

The preliminary design from June 27, 1996, No 1910800 was presented on plan views +7.5/±0 & +40.0/24.0 m and sections A-A, C-C and D-D.

The results of the combustion-stand-unit tests in Frankfurt and long term corrosion tests in Tallinn, presented in the Second Interim Report, have verified the theoretical proposals of the new qualities of oil shale fly-ash at CFB combustion. The coarse fly-ash precipitated in the cyclone, entering into the FBHE at 850 °C, is relieved of finest particles carrying chlorine and has lost the high-temperature corrosive activity - characteristic of oil shale fly-ash as a whole.

Accordingly the coarse ash as a solid heat carrier to the FBHE allows to increase superheat and reheat steam temperatures up to the level 540 °C in case final tube banks of the superheater and reheater are located in the FBHE.

The existing at Narva power plants 100 MWe boiler modules with combustion of pulverized oil shale for 200 MWe blocks are designed with superheater and reheater bodies final plates in the convective gas pass. The steam temperatures at different times were designed in range from 570 to 515 °C. The actual average steam temperatures are held by 500 °C, limited by the intensive chlorine corrosion of tubes.

Registered in 1992 average annual superheat and reheat temperatures at the Estonian Power Plant were 499/503 °C and at the Baltic Power Plant 503/510 °C.

The loss of efficiency of oil-shale-fired block is approximately 4-6 % per 10 °C decline of both, superheat and reheat steam temperatures. Annual losses by actual power production at Narva power plants will be approximately 60-80 million EEK as compared to steam temperatures 540/540 °C.

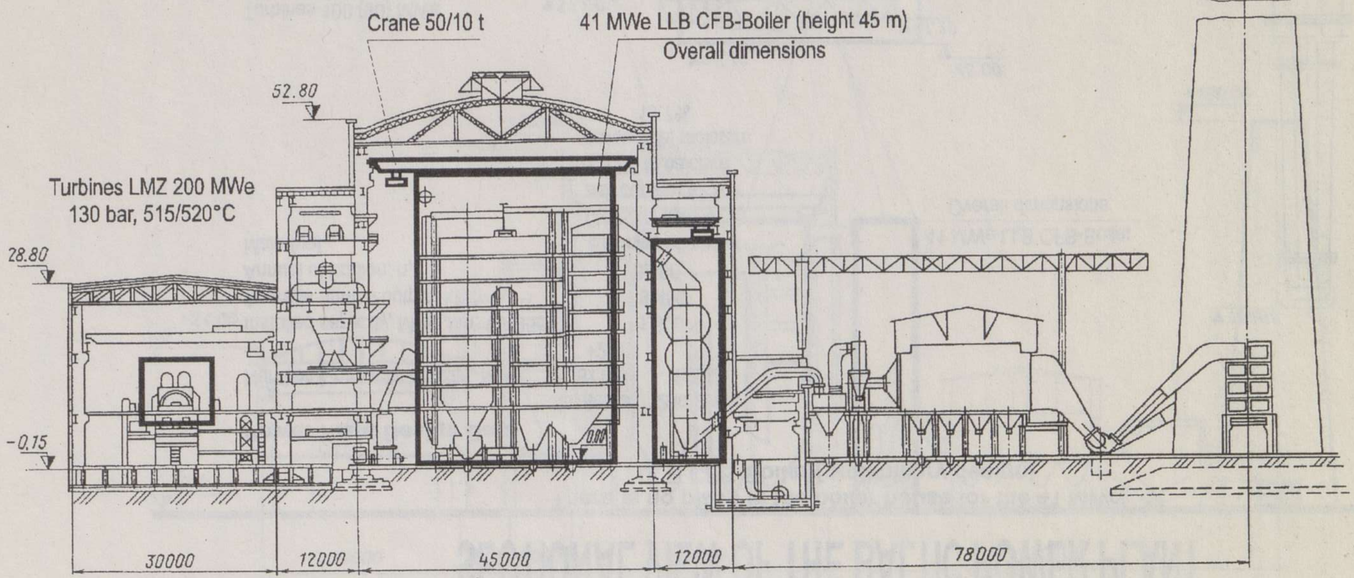
The boiler rooms at Narva power plants are served with double-beam travelling cranes essentially simplifying and declining the costs on dismantling of the old pulverized oil-shale boilers and on montage (installing) of the new ones. The last, of course, if the new CFB-boiler falls within the clearance limits of boiler rooms.

There are no problems about the horizontal clearances: the long pitch of 200 MWe turbines is 60 m and of 100 MWe ones 43 m, as well as there is enough space in depth of the boiler rooms. Attention insists the clear height - the clear headway of the travelling cranes is 44 m on the 200 MWe boiler rooms and only 34 m on the boiler room for the 100 MWe turbines. The cross sectional views of first stages of the Baltic Power Plant with 100 MWe turbines and of Estonian Power Plant are presented in Figures.

The height of the 41 MWe LLB unit is 45 m, the top of the boilers TP-67 and TP-101 for 200 MWe turbines is 43.5 m. In all likelihood the 200 MWe CFB-boiler is to design as two separate 100 MWe bodies, each as a doubled 50 MWe module. The height of the module will be proportionate approximately on square root of the capacity. Accordingly, the height of the 50 MWe CFB-module will be, keeping the proportions on the 41 MWe design, approximately 50 m: $45 \times (50 : 41)^{0.5} = 1.10 \times 45 = 49.5$ m.

SECTIONAL VIEW OF THE ESTONIAN POWER PLANT

Top mark under the travelling crane of the boiler room is ~ 44 m (clear height).
The clearens between the crane and boiler top is to be adjusted by safety devices.
The boiler room is equipped with 3 travelling cranes by weight carrying capacity 50/10 t of each.

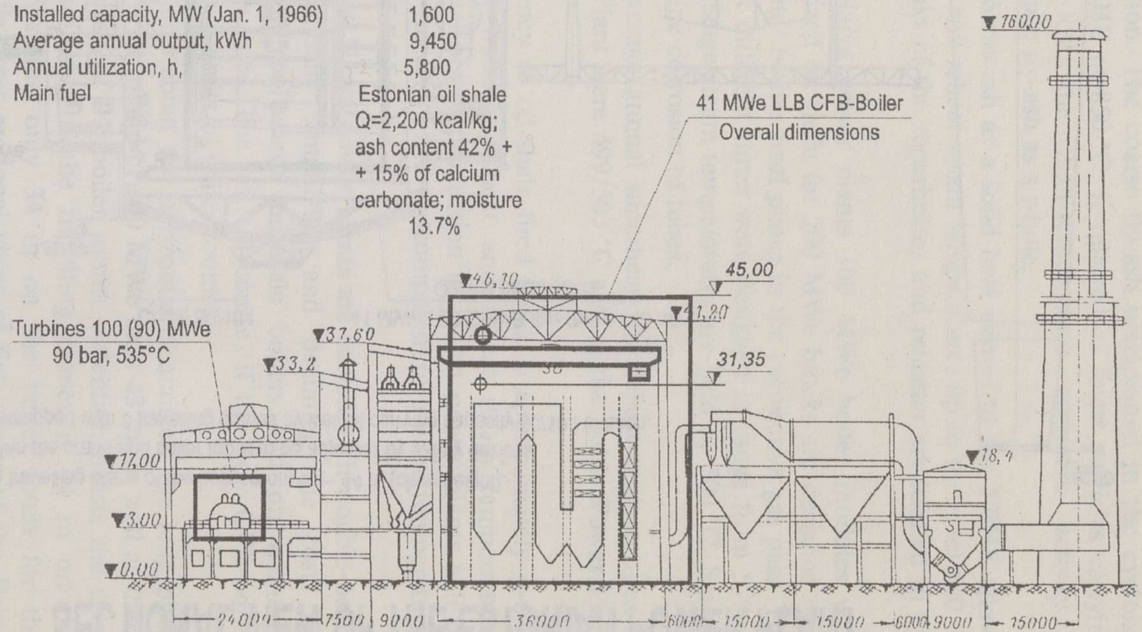


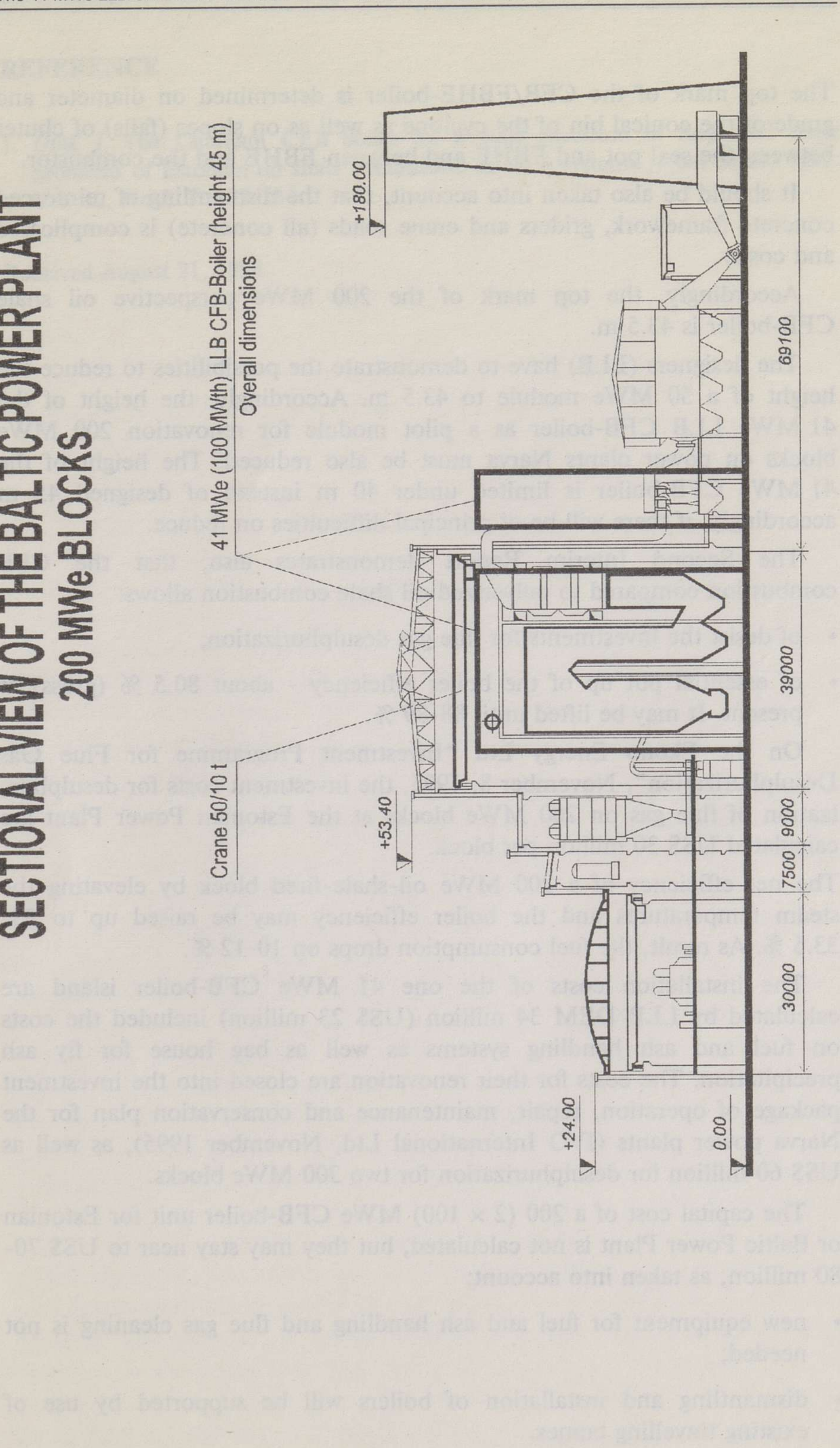
SECTIONAL VIEW OF THE BALTIC POWER PLANT

There is no place in the boiler house for the 41 MWe LLB CFB-Boiler (preliminary design)

Power Plant Design Data

	1st stage	2nd stage
Number & capacity of units, MW	8x100+ +2x12	4x200
Installed capacity, MW (Jan. 1, 1966)	1,600	
Average annual output, kWh	9,450	
Annual utilization, h,	5,800	
Main fuel	Estonian oil shale Q=2,200 kcal/kg; ash content 42% + + 15% of calcium carbonate; moisture 13.7%	




SECTIONAL VIEW OF THE BALTIC POWER PLANT
200 MWe BLOCKS
41 MWe (100 MWth) LLB CFB-Boiler (height 45 m)
Overall dimensions
Crane 50/10 t
+180.00
+53.40
+24.00
0.00
69100
39000
9000
7500
30000

The top mark of the CFB/FBHE-boiler is determined on diameter and grade of the conical bin of the cyclone as well as on slopes (falls) of chutes between the seal pot and FBHE and between FBHE and the combustor.

It should be also taken into account, that the dismantling of reinforced concrete framework, griders and crane roads (all concrete) is complicated and costly.

Accordingly, the top mark of the 200 MWe perspective oil shale CFB-boiler is 43.5 m.

The designers (LLB) have to demonstrate the possibilities to reduce the height of a 50 MWe module to 43.5 m. Accordingly, the height of the 41 MWe LLB CFB-boiler as a pilot module for renovation 200 MWe blocks on power plants Narva must be also reduced. The height of the 41 MWe CFB-boiler is limited under 40 m instead of designed 45 m accordingly, if there will be of principal difficulties on reduce.

The Second Interim Report demonstrates also, that the CFB combustion compared to pulverized oil shale combustion allows:

- of desist the investments for flue gas desulphurization;
- of essential put up of the boiler efficiency - about 80.5 % (gross) at present. It may be lifted until 88-89 %.

On the Ekono Energy Ltd "Investment Programme for Flue Gas Desulphurization", November 8, 1995, the investment costs for desulphurization of flue gas on 200 MWe blocks at the Estonian Power Plant are calculated US$ 30 million per block.

The net efficiency of a 200 MWe oil-shale-fired block by elevating the steam temperatures and the boiler efficiency may be raised up to 33-33.5 %. As result, the fuel consumption drops on 10-12 %.

The installation costs of the one 41 MWe CFB-boiler island are calculated by LLB DEM 34 million (US$ 23 million) included the costs on fuel and ash handling systems as well as bag house for fly ash precipitation. The costs for their renovation are closed into the investment package of operation, repair, maintenance and conservation plan for the Narva power plants (IVO International Ltd, November 1995), as well as US$ 60 million for desulphurization for two 200 MWe blocks.

The capital cost of a 200 (2 × 100) MWe CFB-boiler unit for Estonian or Baltic Power Plant is not calculated, but they may stay near to US$ 70-80 million, as taken into account:

- new equipment for fuel and ash handling and flue gas cleaning is not needed;
- dismantling and installation of boilers will be supported by use of existing travelling cranes.

REFERENCE

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