Zone Module Construction Method for Large Coal-Fired Power Plant

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In recent years it has become increasingly important that the construction period for large-capacity coal-fired power plant must be reduced, and that the factor of safety during construction must be improved. In order to achieve the above objectives we have recently introduced the zone module construction method for Shinchi No.2 Boiler which is now under construction. The side section of the boiler has been divided into modules of 600 tons, and are fabricated in an area adjacent to the boiler location. The modules are then transported and lifted sequentially into position, where they are finally located and securely connected. After the side modules have been set, the top zone module, weighting 3 200 tons, is lifted into position using hydraulic jacks mounted on the top of the boiler frame. As a result of the above, the boiler construction period was reduced by four months, and the level of safety was higher, when compared with normal construction methods.

1. Introduction

For on-site construction work of large-capacity boilers, the term of construction work has been shortened and the safety of work has been improved by applying methods such as "large block unit fabrication method," "advanced installation method," and "top girder and pressure parts integrated method." However, there is a limit to drastic shortening of the term of construction work. It has therefore become necessary to develop epoch-making new construction methods.

Nagasaki Shipyard & Machinery Works of Mitsubishi Heavy Industries, Ltd. (MHI) had previously applied the "split boiler module fabrication method" to the boiler construction work of power plants for foreign countries. This method is such that a boiler is divided into upper and lower parts and each part is assembled into a completed block in the shop. These blocks are transported by ship and assembled at the plant site.

MHI newly developed the "zone module construction method" for large-capacity coal-fired boilers for domestic customers on the basis of integrated technologies of design, manufacture, transportation, and construction which were gained from construction work using the aforementioned method. This new method was applied to the construction of the Shinchi No.2 boiler of Soma Kyodo Power Company, Ltd. It was proved that this method contributed to the shortening of the term of construction work and the improvement in safety owing to a reduction in tasks at elevated places.

Furthermore, MHI applied a newer construction method to the Haramachi No.1 boiler of Tohoku Electric Power Co., Inc. This method is such that the scope of modularization is doubled and all modules are assembled at the module center of Nagasaki Shipyard & Machinery Works. They are transported by barge and assembled at the plant site. This method could reduce the area of necessary space for construction, relieve the shortage of lodging and the congestion of commuter lines due to a reduction in the number of workers at the plant site, relieve the congestion of unloading work due to a reduction in

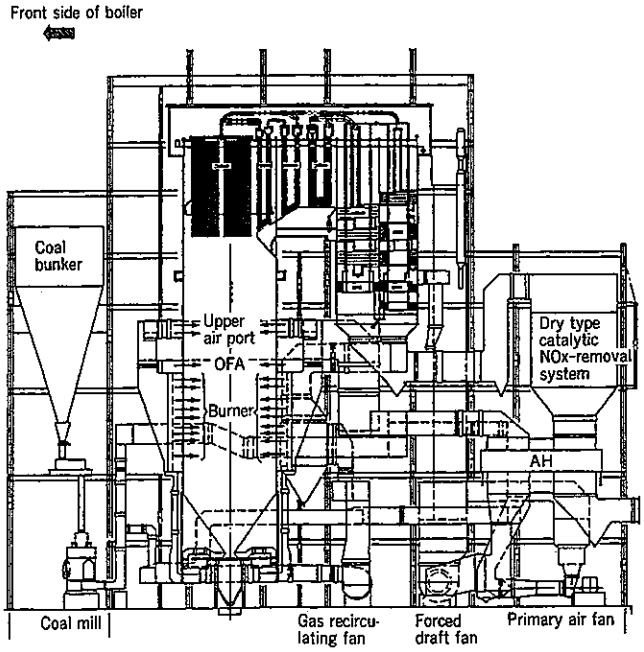

Fig.1 Boiler arrangement of Shinchi No.2

Table 1 Boiler specifications of Shinchi No.2

Item	Specification
Boiler type	Mitsubishi Supercritical Sliding Press. Operation Once-through Boiler Radiant Reheat Type (outdoor type)
Maximum continuous rating	3 080 t/h
Main steam press. (turbine inlet)	246 kgf/cm²
Main steam temp. (turbine inlet)	538°C
Reheat steam temp. (turbine inlet)	566°C
Fuel	Pulverized coal, heavy oil (for start-up, 50 vol. %)
Mill	MRS-1303 XRP× 6 units (including one spare unit)
Burner	Mitsubishi Puiverized Coal Burning PM Burner Coal 6 stages × 8 corners Oil 3 stages × 8 corners
Forced draft fan	Axial type, 2 units
Induced draft fan	Axial type, 2 units
Primary air fan	Axial type, 2 units
Gas recirculating fan	Centrifugal type, 2 units

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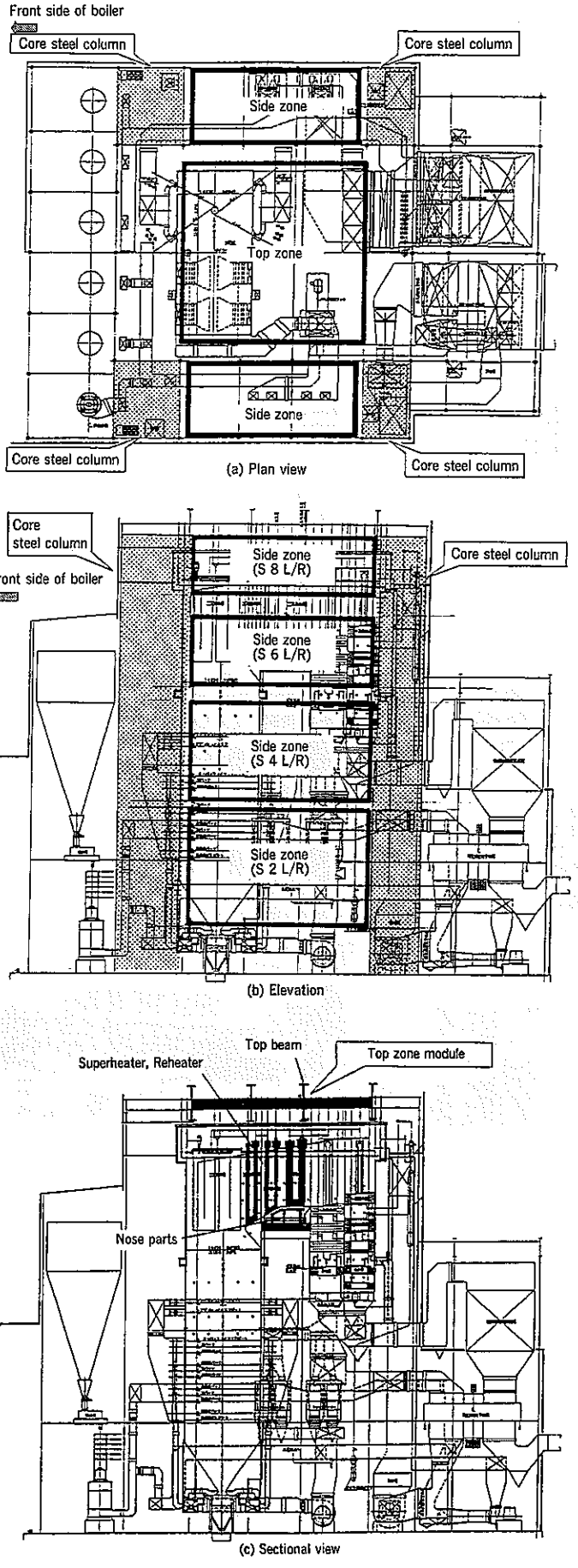


Fig.2 Sectional arrangement drawing of Shinchi No.2 zone module

the number of ships used, and further shorten the term of construction work.

2. Zone module construction method for Shinchi No.2 boiler of Soma Kyodo Power Company, Ltd.

2.1 Outline of Shinchi No.2 boiler of Soma Kyodo Power Company, Ltd.

Table 1 and **Fig.1** show specifications and arrangement of the boiler respectively.

2.2 Division and construction of zone modules

Fig.2 and **Table 2** show the division of zone modules of the Shinchi No.2 boiler of Soma Kyodo Power Company, Ltd. and the weight of each module respectively. **Fig.3** explains symbols for modules. Core steel columns, which become supporting steel structures when lifting side zone modules, are installed at four corners as the boiler-supporting steel column.

Table 2 Weight of Shinchi No.2 module

Name	Weight
Side zone module	S 8 L・R: 660 t × 2 units=1 320 t S 6 L・R: 550 t × 2 units=1 100 t S 4 L・R: 570 t × 2 units=1 140 t S 2 L・R: 770 t × 2 units=1 340 t
Top zone module	3 200 t
Total	8 100 t

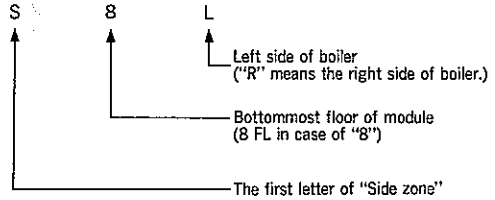


Fig.3 Symbols for Shinchi No.2 module

The boiler side span is divided into four side zone modules in the vertical direction and each module is assembled into a completed block on the ground incorporating machinery and equipment, pipes, ducts, measuring instruments, platforms, and handrails within a steel structural framework. The top zone module is assembled on the ground in the boiler area while lifting up in turn with hydraulic jacks, the top beams, top pressure parts, superheater, reheater, and nose parts.

2.3 Outline of zone module construction method

(1) Installation of boiler side zone modules

The modules which were assembled into completed blocks at a place adjacent to the boiler site(Note) are transported to the site by dollies. The topmost module (S 8 L/R) is lifted up with hydraulic jacks previously fitted on the tops of core steel columns which were already built and connected to the core steel columns. Thus, the gantry type steel structure is completed.

Next, hydraulic jacks (200 t × 24 units) are installed on the top of the gantry type steel structure. Step rods from the hydraulic jacks are inserted into the gantry type steel structure and they extend to its base. Modules S 6 L/R, S 4 L/R and S 2 L/R are each lifted up one at a time in this sequence using the jacks and connected to each other. Short columns are then fitted to the bottommost module (S 2 L/

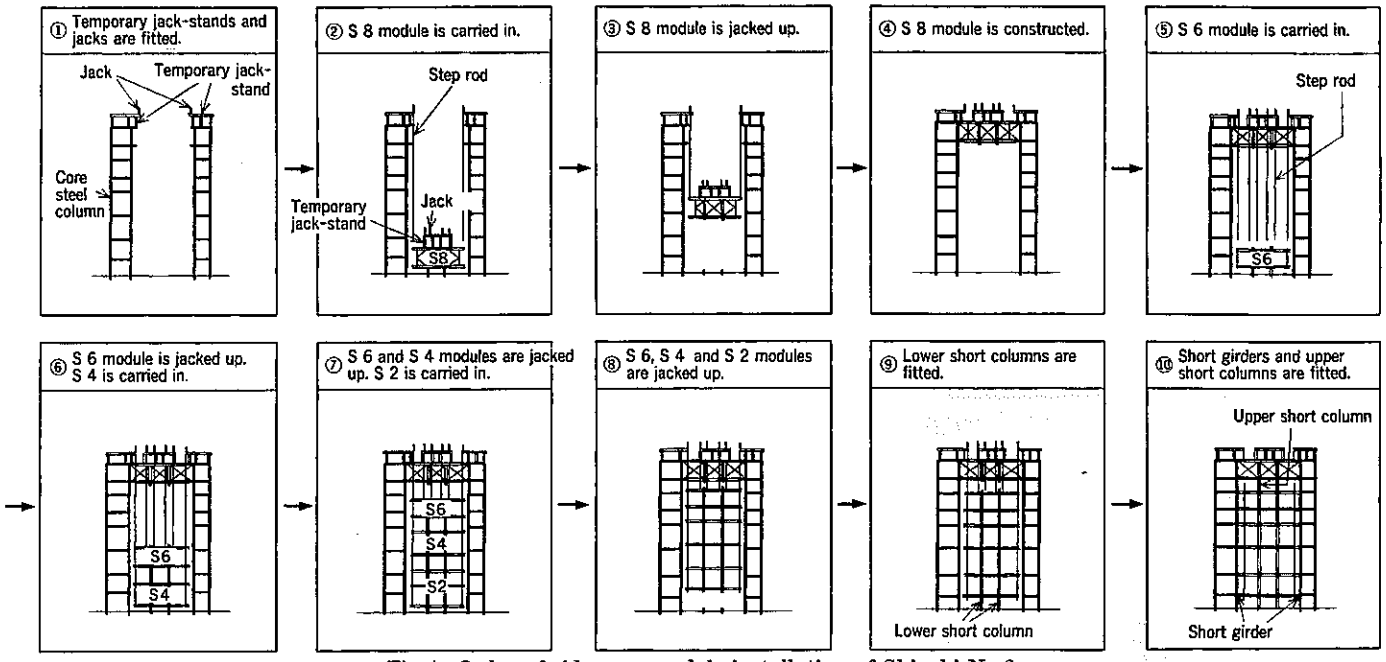
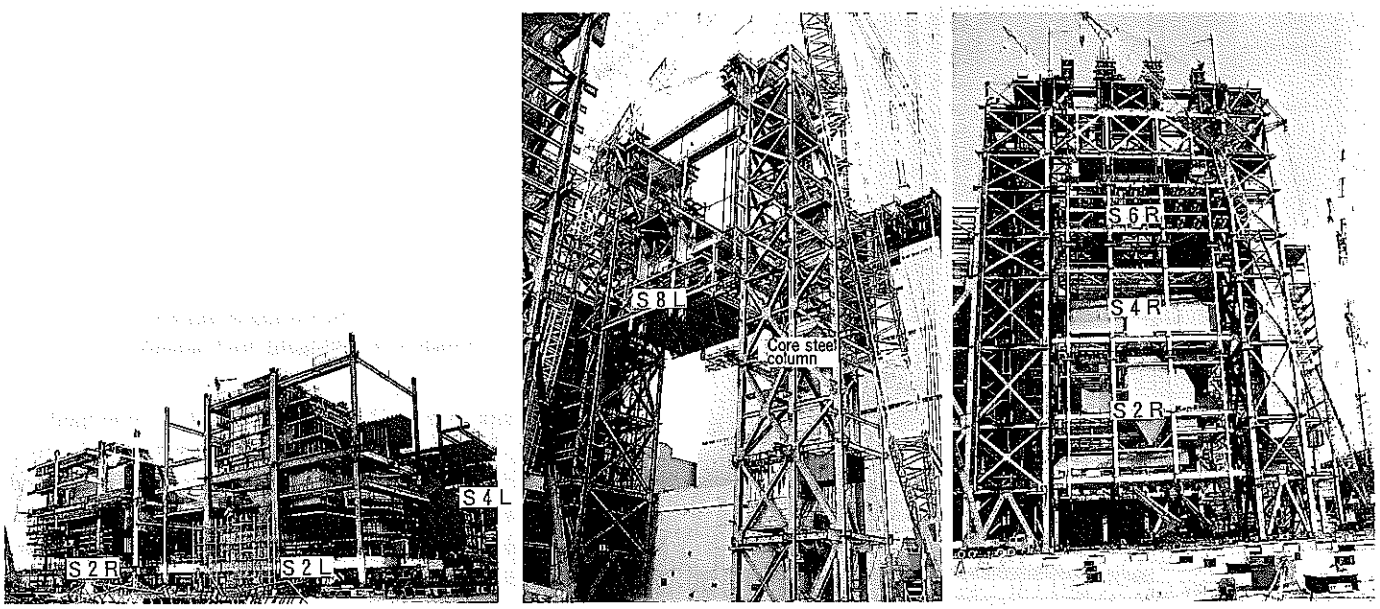


Fig.4 Order of side zone module installation of Shinchi No.2



(a) Modules on the ground (b) Lifting of S 8 L module (c) Lifting of S 6 + S 4 + S 2 modules

Fig.5 Field construction of Shinchi No.2 zone module

R). Finally short girders are connected to the core steel columns, and upper short columns are fitted between S 8 L /R and S 6 L/R. Thus the side zone modules are completed.

The above-mentioned procedures are as shown in **Fig.4**. **Fig.5** is a photograph showing construction work.

(2) Installation of boiler top zone module

After the construction of the side zone modules are finished, top girders and beams are assembled into a block on the ground in the boiler area, and the block is lifted up for the first time with hydraulic jacks previously fitted on the top of the boiler.

Next, after incorporating boiler hanger rods and top pressure parts into the above-mentioned block, it is lifted up for the second time. Then the superheater, reheater and nose parts are incorporated into this block. When the module weight reaches 3 200 tons, this module is lifted up to the top of the boiler at a stretch and top beams are connected to column haunches. Thus, the lifting-up of the boiler top zone module is finished.

(Note) In the case of the Shinchi No.2 boiler of Soma Kyodo Power Company, Ltd., modules were assembled at the plant site because of restrictions on the transportation route.

3. Zone module construction method for Haramachi No.1 boiler of Tohoku Electric Power Co., Inc.

3.1 Division and construction of zone modules

The boiler side zone modules and top zone module are the

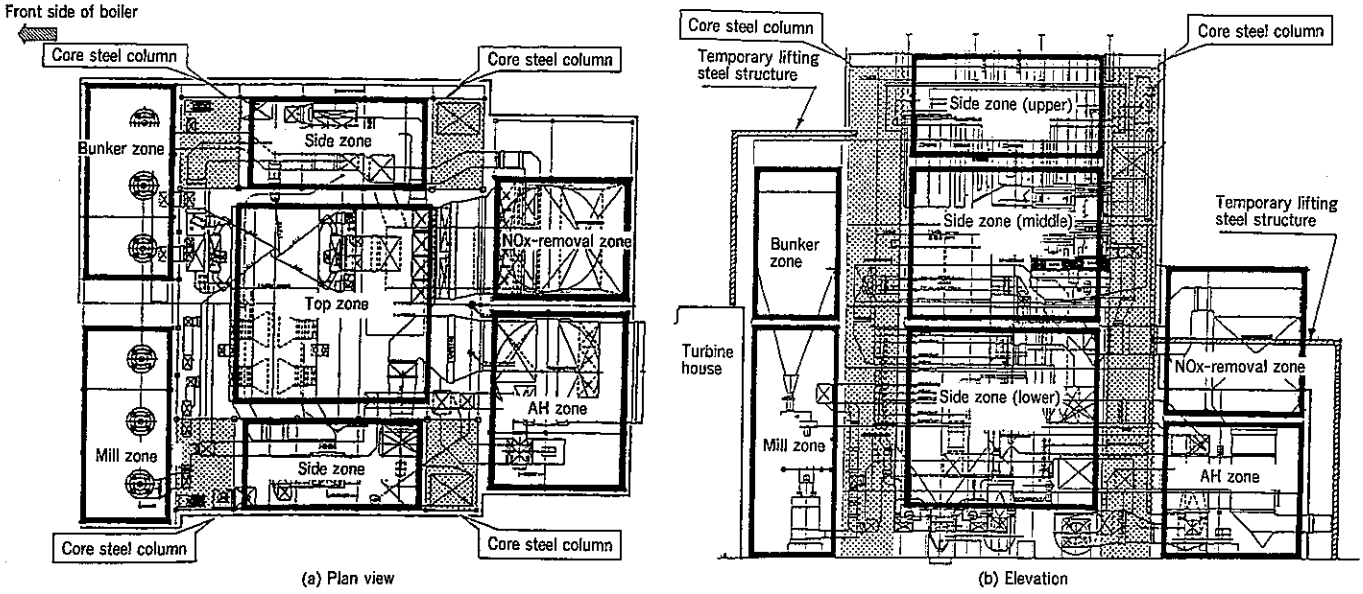


Fig.6 Sectional arrangement drawing of Haramachi No.1 zone module

Table 3 Weight of Haramachi No.1 module

Name	Weight	Place of construction
Boiler side zone	Upper module : 600 t× 2 units = 1 200 t Middle module: 700 t× 2 units = 1 400 t Lower module: 1 000 t× 2 units = 2 000 t	Plant site Shop Shop
Boiler top zone	2 400 t	Plant site
Bunker zone	1 100 t × 2 units = 2 200 t	Shop
Mill zone	900 t × 2 units = 1 800 t	Shop
AH zone	950 t × 2 units = 1 900 t	Shop
NOx-removal zone	650 t × 2 units = 1 300 t	Shop
Total	14 200 t	

same as those of the Shinchi No.2 boiler of Soma Kyodo Power Company, Ltd. However, the scope of modularization could be expanded to about twice as large as that of the Shinchi No.2 boiler of Soma Kyodo Power Company, Ltd. by separating the bunker and AH zones from the boiler-supporting steel columns and adopting the structure of supporting steel columns which enables the bunker, mill, AH, and NOx-removal zones to be modularized.

Fig.6 and **Table 3** show the division of zone modules and the weight of each module respectively.

3.2 Outline of zone module construction method

(1) Installation of boiler side zone modules

The upper module is modularized at the plant site since it is mainly composed of steel columns and platforms, and less machinery and equipment need to be incorporated into it. The middle and lower modules are assembled into completed blocks integrating steel columns, machinery and equipment, ducts, pipes, and measuring instruments at the module center of Nagasaki Shipyard & Machinery Works. They are transported by a large-sized barge to the port near the plant site and then by dollies to the plant site. After that, all side zone modules are lifted up with hydraulic jacks and constructed in the same way as the case of the Shinchi No.2 boiler of Soma Kyodo Power Company, Ltd.

(2) Installation of boiler top zone module

The top zone module is assembled on the ground, lifted up with hydraulic jacks, and constructed in the same way as the case of the Shinchi No.2 boiler of Soma Kyodo Power Company, Ltd.

(3) Installation of bunker and mill zone modules

The bunker and mill zones are divided in the transverse direction into two modules each left and right, making four modules in total, and each module is assembled into a completed block at the module center of Nagasaki Shipyard & Machinery Works. They are transported by barge to the port near the plant site and then by dollies to the plant site. The method of lifting-up is such that the bunker module which was carried in by dollies is lifted up with hydraulic jacks fitted on the temporary lifting-up steel structure spanning the top of the turbine house and the boiler steel column. The mill module is carried in under the bunker module and connected to the latter after jacking it down.

(4) Installation of AH and NOx-removal zone modules

The AH and NOx-removal zones are divided into four modules and carried into the plant site by a barge and dollies in the same way as the case of the bunker and mill zone modules.

The method of lifting-up is such that the temporary lifting-up steel structure which was used for lifting up the bunker module is shifted to this position and is used to lift up the NOx-removal module. The AH module is then

carried in under the NOx-removal module and connected to the latter after jacking it down.

4. Conclusion

Single component fitting tasks at elevated places conducted before in the construction work of large-capacity coal-fired boilers have been greatly reduced by developing the zone module construction method such that modules are lifted up with hydraulic jacks after having been assembled on the ground.

It has been verified that this construction method can relieve issues peculiar to on-site construction work such as a shortage of skilled workers (steeplejacks and smiths) and prolonged work time. Decreases in the area of material depots and the equalization of the amount of tasks at plant sites can be made possible by assembling modules at the module center of Nagasaki Shipyard & Machinery Works, transporting them, and carrying them into plant sites just in time. It is also a feature of this construction method to enable boilers to be improved in quality through total inspection by designers during the assembly of modules at the module center.

When using the zone module construction method, the arrangement and structural design of boiler supporting steel columns, which are main structures of modules, becomes important since modules are transported by barges and dollies under self-supporting conditions. Moreover, places of barge berths and paths for carrying modules into plant sites should be taken into consideration when planning plant arrangements. It is, therefore, necessary to fully consult with customer construction departments (including building design sections) and machinery and electrical system designing sections.

The authors intend to improve this construction method further on the basis of experience gained with the Shinchi No.2 boiler of Soma Kyodo Power Company, Ltd. and the Haramachi No.1 boiler of Tohoku Electric Power Co., Inc. which is under construction now in order to make it optimum for the on-site installation of large-capacity coal-fired boilers.

Finally, the authors wish to thank Soma Kyodo Power Company, Ltd. and Tohoku Electric Power Co., Inc. for their deep understanding and great cooperation in realizing this construction method.