various building blocks or modules. Each module must perform its intended function within a defined degree of flexibility and must be capable of being fitted to adjacent modules to form an integrated final product. The main purpose of applying this design concept is, of course, to produce a better product at lower cost. With a properly conceived and executed program, better quality and lower cost are compatible.

For this modular design concepto, welded-wall construction was ideally suited because it allowed the fabrication of large tube panels in the shop. Backed up by the necessary buckstays, the welded wall, because of its continuity, provides structural strength for support of the boiler and also a tight gas enclosure for pressurized firing of fuel. It eliminates the need for, and attendant problems with, a pressure casing. Welding the modular inlet and outlet headers to the sidewall tube panels in the shop minimized the field welding to a limited number of large dia feeder and relief tubes, completing this portion of the circulation system. Fins on edge tubes of the individual shop-assembled panels are welded together in the field to complete an integral pressure-tight envelope around not only the furnace, but the boiler section as well. This gas-tight envelope, made up of tubes and fins, operates at a saturation temperature corresponding to the operating pressure of the boiler. This temperature is well above the dewpoint of the corrosive gases in the products of combustion. Insulation on the welded walls is isolated from this corrosive atmosphere on the hot side and covered by a preformed metal casing on the cold side.

VU-60

This modular concept was applied in developing the VU-60 in the early 1960's (Fig. 8). This is a bottom-supported, field-erected, natural-circulation,

pressurized, two-drum boiler designed for firing oil and gaseous fuels in a capacity range from 100,000 to 750,000 lbs of steam per hr, with design pressures to 1600 psig and steam temperatures to 960 F.

It is worth mentioning at thispoint the names of various contracts our subsidiary company CE-rrey S.A. of Monterrey has in various stages of construction. These units are among the largest industrial boilers totally fabricated in Mexico.

The VU-50, the predecessor of the VU-60, is a field erected boiler. Units of this type have been fabricated for various industrial firms in Mexico by CE-rrey S.A. Recent typical installations are a 34 ton/hr capacity unit operating at 42 Kg/cm^2 and 400°C for Celanese Mexicana; a 63 ton/hr boiler at the same operating conditions installed at Industrias del Alcali. CE-rrey has also fabricated for CIA. Fundidora de Fierro y Acero de Monterrey, S.A. two VU-50 with 60 ton/hr at 43 Kg/cm^2 and 445° C steam outlet conditions.

Recent contracts include two modified VU-60, 180 ton/hr, 42 Kg/cm^2 and 400°C for Pemex, C.D. Madero, Tamaulipas.

The latest contract has been awarded to CE-rrey by Westinghouse in connection to the expansion of the CIA Fundidora de Fierro y Acero de Monterrey, S.A. This contract calls for a blast furnace gas and natural gas fired modified VU-60 with a capacity of 110 ton/hr at 64 Kg/cm^2 and 490°C steam outlet conditions.

The VU-60 has evolved from previous VU designs built over a 40-year period. Good features from previous designs, proven by years of successful operation, have

been retained. To further increase the reliability of this unit, service reports were analyzed to establish the natural of all previous problems, however minor, and, as necessary, design modifications were made. In addition, the latest technology and manufacturing techniques were used whenever applicable.

Based on accepted performance parameters, the range of physical dimensions of the steam generator was established. It was desirable to provide maximum flexibility to meet varying operating conditions and possible on-site space limitations. The major variables of width, depth, and height as well as steamdrum dia were set up to be varied independently of each other and were exactly defined. For example, the furnace width is varied in 16-in. increments and furnace depth in 12-in. increments. There are several incremental drum-center distances, boiler-tube sizes, and a considerable variation in design pressures. Considering the width, depth, height, drum diameters, boiler tube sizes, and design pressure variables, there are over 10,000 usable combinations.

Flexibility

To illustrate the application of the modular concept to achieve wide flexibility, consider a section of the VU-60 as shown in Fig. 9. These furnace sidewall modular panels consist of tubes, whose terminal ends are welded into pipe headers.

The top illustration shows three basic modules; A, B, and C; each having a particular width. When welded together in the field, they make up the sidewall of a unit having a furnace depth of 19 ft. The lower illustration uses the same basic modules to form the sidewall of a unit having a furnace depth of 31 ft., but in this

case utilizing a greater number of B modules. This example was not selected as an over simplification, but rather to illustrate the repetitious use of these modules as they are actually used in this boiler design. The VU-60 is currently available in 22 different furnace depths in which modules such as A, B and C are used in varying quantities. In actual practice, modules A and B are each available in several widths and each module A, B, and C may also be furnished in three different height dimensions.

As mentioned before, each module consists of tubes and pipe headers which are shop assembled into finned paneled walls. There are 6 basic tubes and 5 basic headers which may be used in varying quantitites to make 24 different variations of assembled modules similar to A, B, and C. When used in combination, modules A, B, and C will permit 66 variations in furnace height and depth.

Figure 10 illustrates two VU-60 units of different furnace width and furnace depth. As mentioned before, with the modular approach, steam generators of varying size may be constructed using standard components. In the illustration, modules identified with a subscript are identical to those without the subscript except for a linear dimension.

The largest single cost reduction realized is in erection. Erection time is considerably reduced by the use of the large modular welded panels. Insulation is attached to, and supported by, the welded-wall envelope by impaling pins welded to the fins. Application of the preformed metal lagging is simple. The structural strength of the welded-wall envelope permits a simple four-point support and attendant savings

in foundation costs. Because of the physical size of the boiler bank, the tubes are individually expanded into the drums.

With standard modules, it is far simpler and requires considerably less time to process the necessary fabrication information. This is essential since many units are sold for short delivery. With the necessary engineering information covering all possible assemblies and parts available in the shop, engineering processing can frequently be reduced to indentifying rather than completely describing these items.

To pre-engineer all modules represents a considerable initial investment in engineering costs. When distributed over a large number of boilers, however, the cost against each becomes nominal and obviously substantially less than the cost to completely engineer each unit on an individual contract basis.