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INTEGRATED CONTROL SYSTEM IN THE FIELD OF IRON AND STEELMAKING PLANTS

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1. INTRODUCTION

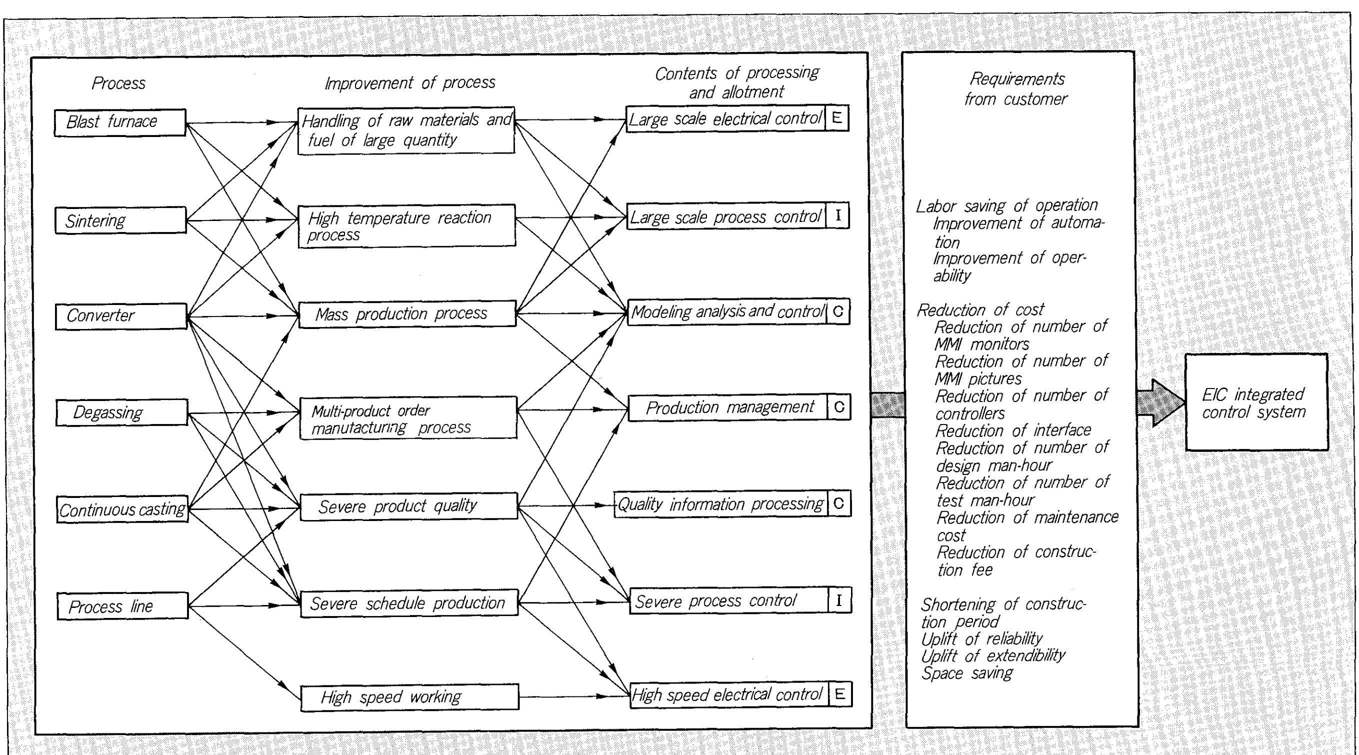
The crude steel production dropped to a level that is lower than 100 million tons in fiscal 1986, and accordingly, management of the steelmaking trade was very critical, and severe rationalization to be reasonable for production of 90 million tons was attempted by means of integration and abandonment of equipment and reduction of the working force. However, thanks to favorable growth of consumption and equipment investment caused by expansion of domestic demand, it is positive that the crude steel production is over 100 million tons continuously for three years since fiscal 1988, and the managing environment was improved largely because full production has been continued under the rationalized. Furthermore, a large scale public investment of an amount of 430 trillion yen is anticipated in the coming ten-year period as a result of U.S.-Japan Structure Negotiation, and the equipment rationalization plans are being reviewed.

Under such circumstances, equipment investment for updating obsoleted equipment, which has been suppressed for a long time, and for cost-down and increase of added value of products has become very active for iron and steelmaking plants in Japan, although investment for new equipment is still minor.

On the other hand, automation, labor saving, energy saving and upgrading of performance are requested to control systems move strongly than before. At the same time, systems which integrate electricity (E), instrumentation (I) and computer (C) have become the conditions for employment at many equipment because of their economy and rationality.

Recent EIC integrated control systems are introduced in this paper including cases of abundant delivered equipments.

Fig. 1 Processing and configuration of steelmaking process control system



2. NECESSITY OF INTEGRATED CONTROL SYSTEMS AND THEIR BACKGROUND

Steelmaking processes can be roughly classified into pig iron, steelmaking and process line groups, and each process group is further divided into several processes. Typical process of iron and steelmaking as well as their characteristics and allotment of functions are shown in *Fig. 1*. Each process is run automatically by an E, I, C control system which has grown independently.

The reasons why the conventional control systems are not necessarily integrated control systems include the following.

(1) Separate organizations were formed for E and I in each of steelmaking and electrical equipment manufacturers.

Fig. 2 Integrated control system of sintering mill

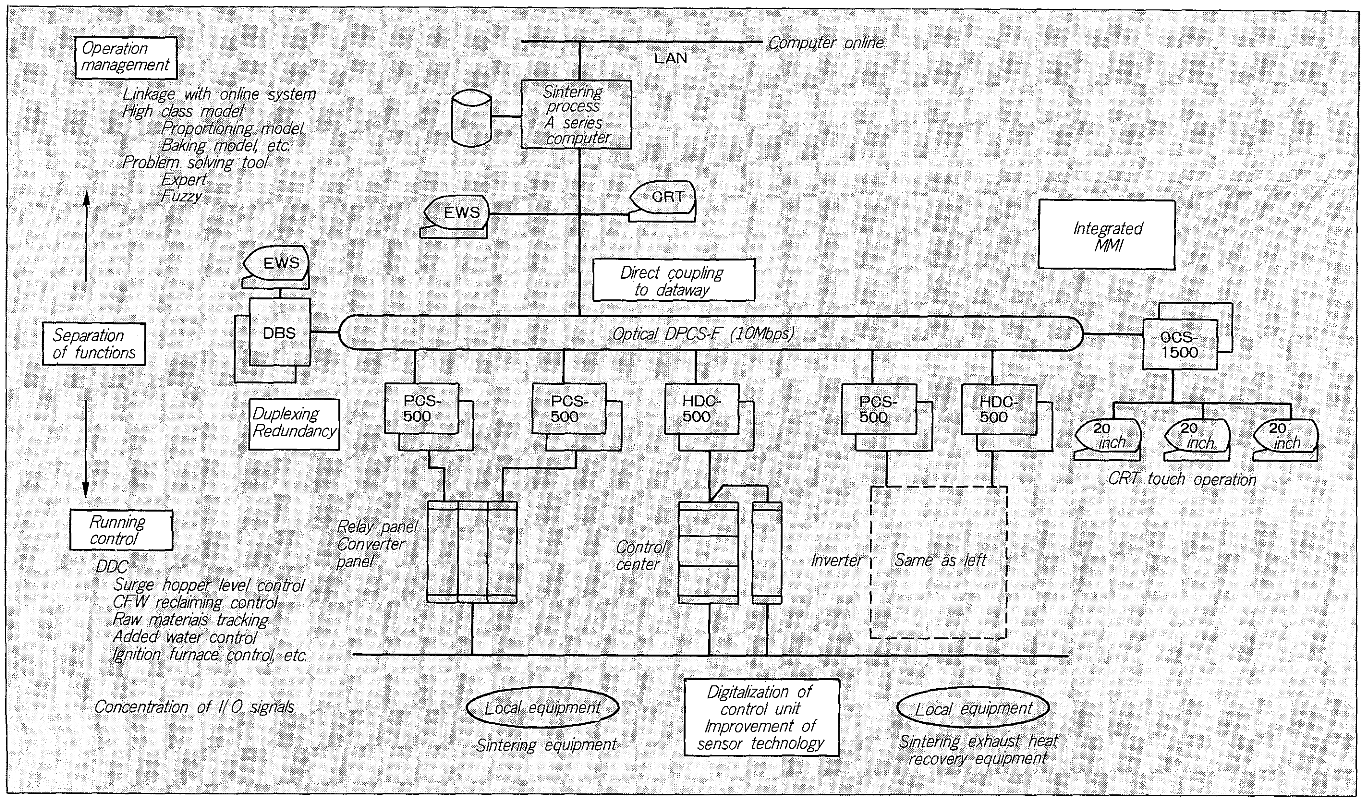
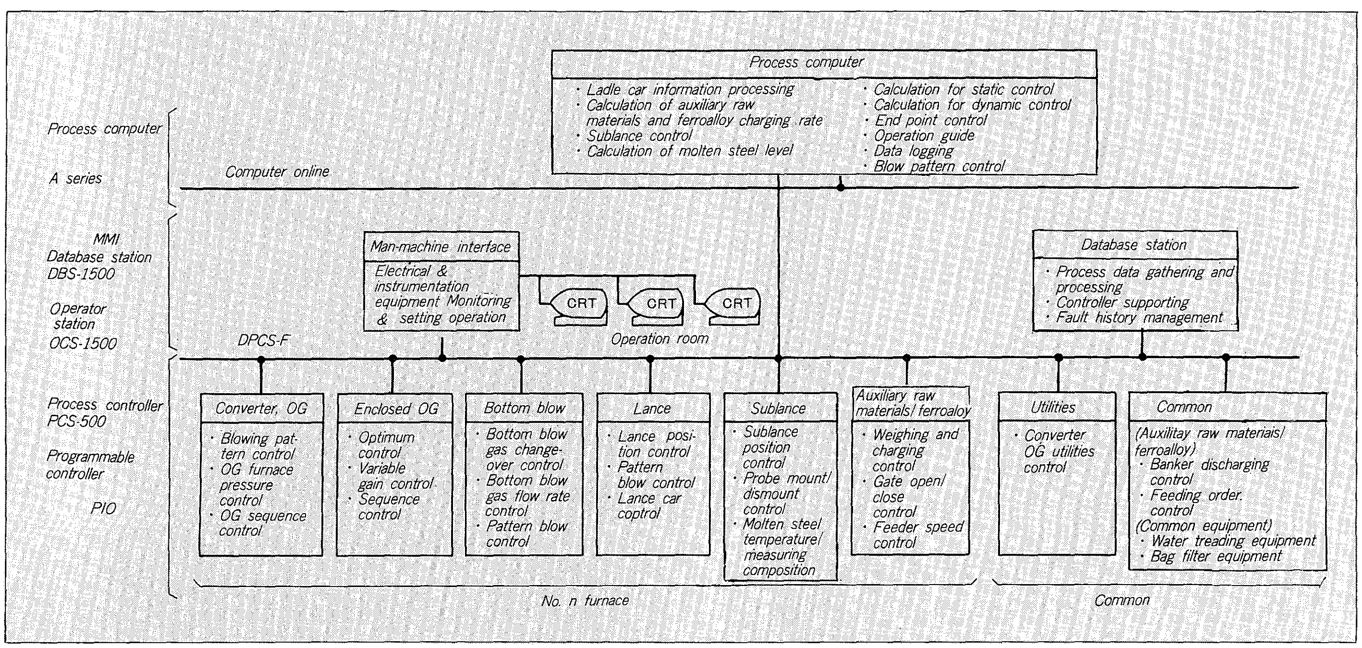


Fig. 3 Integrated control system of steelmaking mill



(2) The product concept of controllers is different between the field of E and the field of I.
(3) Both of dataway and man-machine interface (MMI) are of insufficient capacity for integration.
(4) Devices for E, I, C are produced by different manufacturers.

However, the tendency to integrate EIC has rapidly become strong because of changes in technical and economical environment, i.e.,

(1) Changes in technical environment
   (a) Trend for high functions and high speed of controllers and dataways
   (b) Trend for high performance of MMI
   (c) Increase in the scale of control systems
(2) Changes in economical environment
   (a) Integration of E and I in the fields of design and maintenance by rationalization at steelmaking manufacturers
   (b) Attachment of importance to equipment investment for cost competition of products, that is, less expensive equipment, labor saving in design, maintenance and operation, and reduction of maintenance expenses
   (c) Shortening of construction period

3. INTEGRATED CONTROL SYSTEM BY PROCESS

The features of the process, system configuration and allotment of functions are introduced below for each process out of various iron and steelmaking processes.

3.1 Integrated control system in sintering plant

It can be indicated as a feature of a sintering plant that it is a process that accompanies long time lag from raw materials compounding to products (sintered ore). Accordingly, DDC of centralized type using a process computer and SPC combined with analog controllers, have been conventionally used.

On the other hand, operating of many belt conveyers and of constant feeders and tracking control of raw materials should function in close linkage with loop control such as raw material tank level and pallet speed control. Furthermore, recent progress of sintering operation analysis urged various mathematical models to be put into practical use, and approach by AI technique is also attempted these days. Thus, the functions should be allotted to process computers became clearly distinguished and positioned.

Allotment of functions of management level (C) and operation level (I, E) was made, and by close organic linkage of (E) that is mainly in charge of drive technology and product tracking and (I), which is in charge of general matters including loop control, through the dataway of each one of them, establishment of an integrated system has become feasible while securing the reliability. *(Fig. 2)*

3.2 Integrated control system of steelmaking mill

A converter is an extremely complicated refining process. Its control system is a complex system in which process computer for model calculation, electrical equipment for lance height and auxiliary raw materials charging control and instrumentation equipment for process control are closely related to each other.

Today, the automation of blow is in progress accompanying update of equipment, and positive attempts are made to achieved EIC integration.

Fig. 3 illustrates the typical configuration of an integrated control system for a steelmaking plant. As a result of this integration;

(1) By sharing of MMI, operation desks and CRT's, which are found for each equipment before, are replaced by a few CRT's for converter operation, and one-man blow can be achieved.
(2) Systems, which are functionally distributed to horizontal (E, I) and vertical (C) by hierarchical network, are organically united together. As an example, display of temperature trend after measurement of sublance and indication from the process computer directed to the end point control, which were hard before, can be displayed momentarily in the same picture.
   Furthermore, since a network that makes use of Broadcast transfer can be constructed independently from the system on the receive side, the engineering becomes easy.
(3) The common architecture eliminates the boundary between electricity and instrumentation in the maintenance. As a result, all the equipment except for motors are being included in the category of instrumentation.

3.3 Integrated control system in continuous casting plant

A continuous casting system is located between a converter, for which the weight of instrumentation control is high, and a rolling plant, for which the weight of electrical control is high, and it is a system where instrumentation control and electrical control are balanced. we have such an experience that an EIC integrated control system was delivered for continuous casting in an early day, and it is possible to construct a system of high cost performance providing the following features *(Fig. 4)*.

Fig. 4 Integrated control system of small scale continuous casting mill

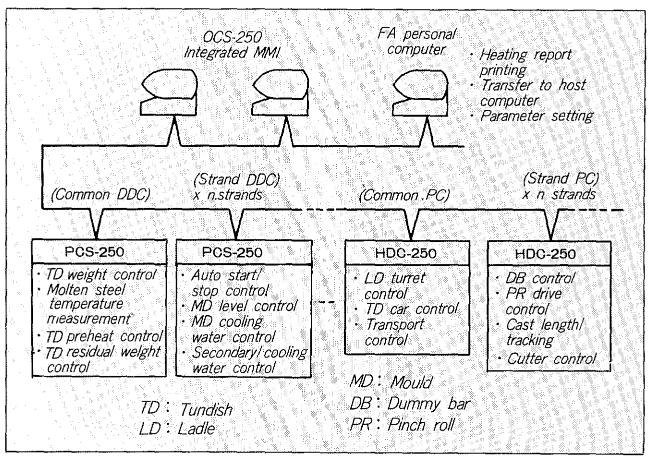


Fig. 5 Integrated control system of process line

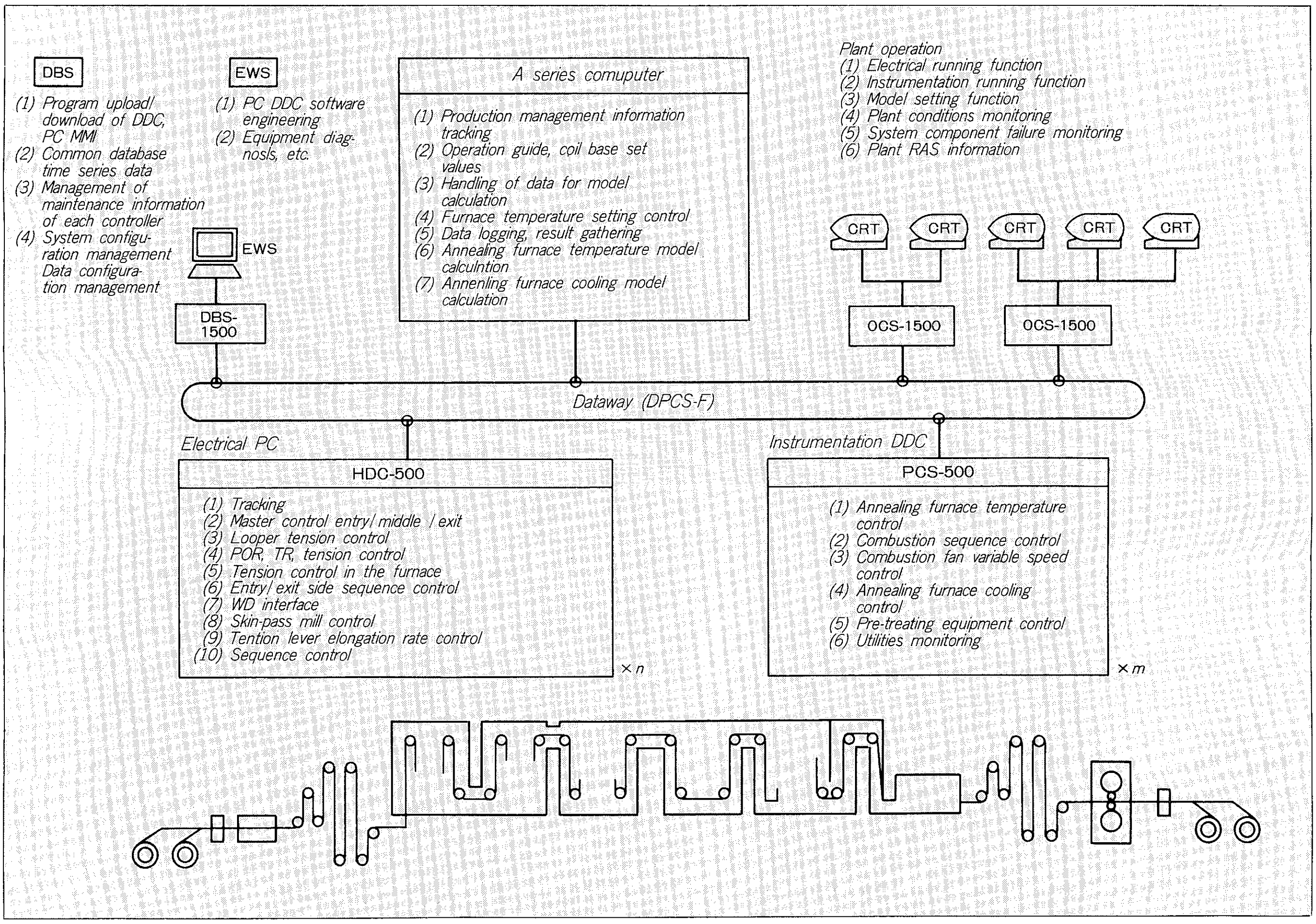


Fig. 6 Functional configuration of energy center

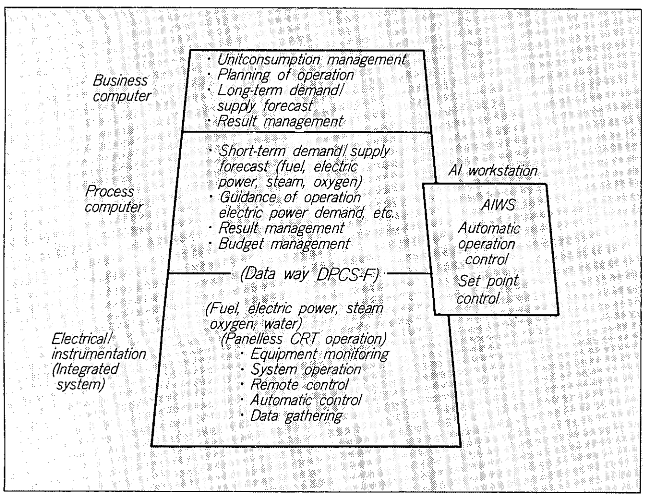
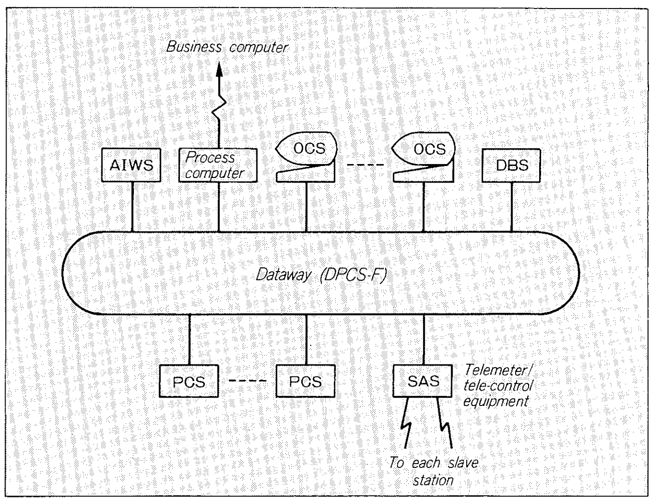


Fig. 7 Integrated control system of energy center



(1) Sharing of MMI

Reduction of operation desks and reduction of burden to operators can be realized by sharing MMI of E and I and by displaying the information of EI as integrated.

(2) Sharing of PIO signals

Input/output (PIO) signals of each equipment of EIC can be reduced by connecting EIC by means of a high speed dataway. In practice, input/output signals of C is entirely permitted through the dataway, and direct PIO's are unnecessary. Also between E and I, about 20% of PIO's, which are overlapping, can be eliminated.

(3) Allotment of optical functions of EIC

A simple configuration is obtained by making optimal allotment of functions which are overlapping among EIC. For example, IC can be made to a simple configuration by making collective control in E of cast length/tracking, which occupies a large past among functions of EIC.

3.4 Integrated control system of process line

Recent process lines are of strong trend of combination with other equipment, high speed, diversified products and diversified processing, and control systems with superior controllability, flexibility, reliability and cost performance are requested for these complicated equipment. EIC integrated control systems can satisfy these needs.

Direct linkage can be made without using communication means such as modems, by means of a high speed dataway that organically and efficiently connects controllers. The operation points are diversified such as entry side, center and exit side at a process line. But single window can be realized by integrated CRT's, and the number of CRT's can be largely reduced Furthermore, the data of all the controllers are uniformly managed by the DBS, and thus a system of good software constructibility and of good maintainability is obtained. *(Fig. 5)*

3.5 Integrated control system of energy center

3.5.1 Trend of energy center

The main problems for improvement of functions at the energy center of iron and steelmaking plant have changed in the recent years. Measures for energy saving constituted the nucleus since the first oil crisis, but today there is such a trend that labor saving such as integration of equipment related to energy and rationalization of operation is the nucleus together with update of obsolete equipment. The necessity for EIC integrated system becomes serious from the aspects of improvement of operability, maintainability and uniformity, in addition to hierarchy such as conventional business computer, process computer and controller (electrical and instrumentation system) as the system configuration.

The configuration of functions at each hierarchical level of an energy center is shown in *Fig. 6*.

3.5.2 EIC integration at energy center

The configuration of EIC integrated control system at an energy center is shown in *Fig. 7*.

The following two are features of EIC integration at an energy center.

(a) Use of telemeters and tele-control devices for electrical control

(b) Application of AIWS for automatic operating control

(1) CRT operation with focus on ON/OFF operation through telemeters and tele-control devices applicable to electric power and power equipment is of unique operation system, and has been installed separately from DCS equipment, which is mainly for analog control, due to restrictions in both of hardware and software. By developing telemeters and tele-control devices which can be connected to dataways and which can also be connected to diversified slave stations diverted from existing ones and by mounting a unique software package, the operation through telemeters and tele-control devices from CRT's of DCS equipment is realized.

(2) Integration of equipment, which was conventionally outside of the scope of control of the energy center, is executed, as a part of labor saving. The tendency to introduce expert systems (AI) to fields, where automation was considered difficult, has become strong as a measure for reducing the burden to operators. Fuji Electric Co., Ltd. developed a system (FECS-AI) that fuses AI tools, which may be operated real time, with energy control technology, which has been cultivated for a long period of time, and has been conducting this system in the EIC integrated control system. It is already applied to automatic mixing of by-product gases or to automatic operation of oxygen plant, and is in satisfactory operation.

4. AFTERWORD

The background and the examples of EIC integrated control system in iron and steelmaking process control have been introduced. The majority of steel refinery plants had been conducted with hierarchical system configuration of business computer, online computer, process computer and E and I controllers since early days. Therefore, the economy and rationality of EIC integrated control system have been recognized early, and its introduction is positively made.

Fuji Electric Co., Ltd. has developed MICREX-MS for small scale in addition to MICREX for medium and large scale plant, and has become possible to provide a system that is matched with the scale of every plant.

We intend to provide systems which are matched with needs of customers with results of technology, which will keep growing in the future, suitably incorporated.