Minimill

In October 1996, just 20 months after breaking ground, the first Compact Strip Plant in Europe for the production of hot rolled coils entered service. This plant, property of **ACB, S.A.**, with a production capacity of 1 million Tons/year - extensible to 1,6 million Tons/year, is based on **Schlöeman Siemag's** Compact Strip Plant technology **(CSP)** and incorporates state-of-the-art control and automation systems designed and installed by **Ingelectric-Team.**

Plant Description

The plant is composed of two distinct areas; the **melt shop**, producing liquid steel, and the CSP unit itself, producing hot rolled coils. Plant layout is shown in Fig.1.

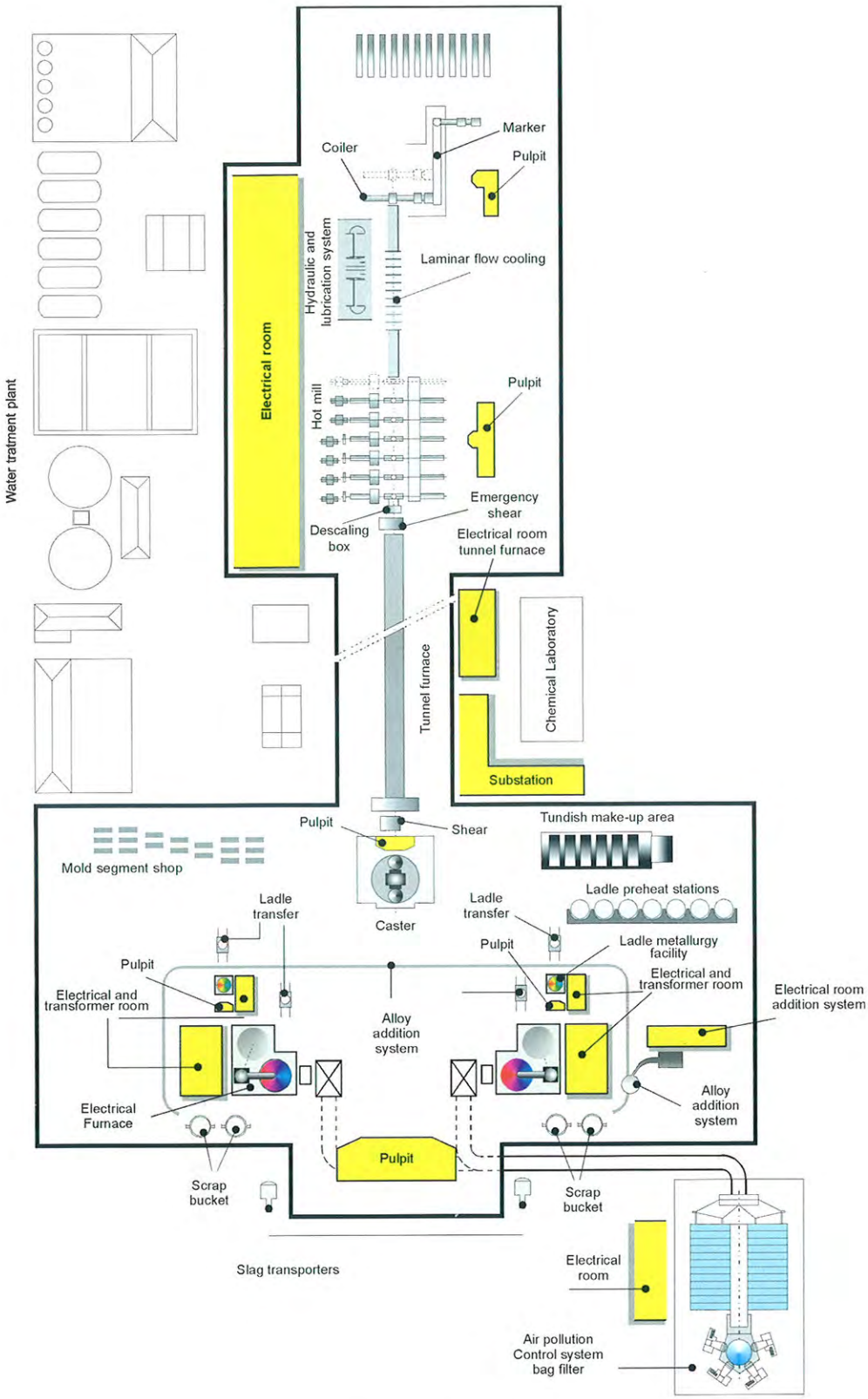


Figure 1 - General lay-out

MELT SHOP

The liquid steel production area is built using Clecim/Cosim technology and includes the following installations:

2 DC Electric-Arc Furnaces

Scrap and DRI (direct-reduced iron) melting installation

Shell:	Tilting, ovoidal shape.
Shell diameter:	7300 mm.
Cooling:	Water.
Capacity:	130 t per furnace.
Tap to tap:	57 min.
Power:	130 MVA per furnace.
Number of 12-pulse rectifiers:	4 (40 kA each).

High-current circuit is water cooled.

Cathode:	1 top electrode, graphite, low consumption.
Anode:	4 bottom electrodes.

2 AC Ladle Furnaces

Steel grade and temperature adjusting installation.

Ladle capacity:	130 t.
Cycle time:	40 min.
Power:	25 MVA per furnace.
Additions:	Mixture of lime, fluorspar, ferro-alloys.

Dedusting plant

Furnace gases are collected, cooled and cleaned in dedusting facilities.

Storage and additives system

Dosified additions can be delivered automatically to the following points: scrap buckets, arc furnaces, ladle under arc furnaces and ladle in metallurgical stations.

Water treatment plant

Provides clean, cooled water to the various users and recovers hot, dirty water.

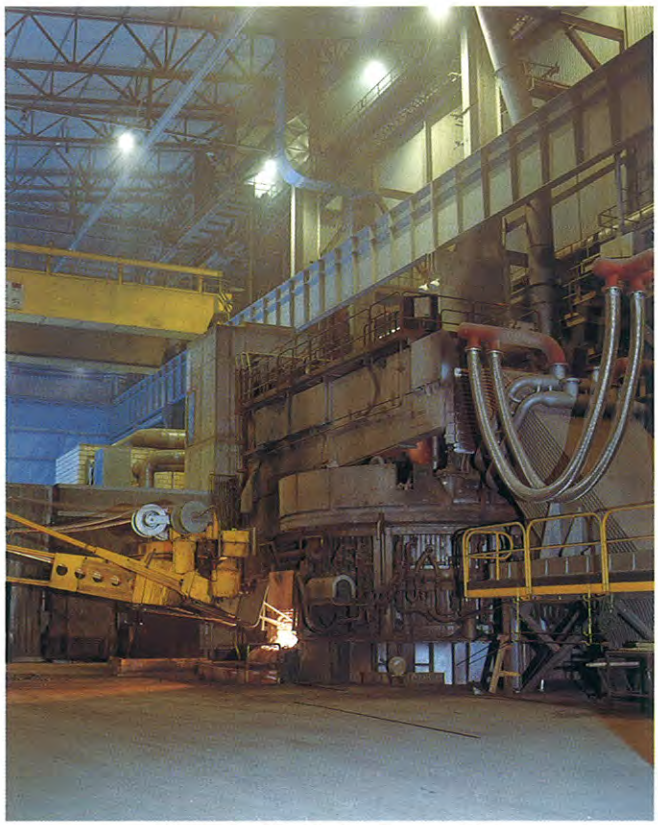


Figure 2 - Electric-Arc Furnace N.° 1

C S P

The CSP plant, based on SMS technology, includes the following installations:

Caster

1	Type:	Vertical bending.
	Number of strands:	1.
	Strip thickness:	53 mm.
	Strip width:	790 a 1560 mm.
	Landle handing:	Turret with two independent arms.
	Tundish handling:	2 tundish cars.
	Tundish capacity:	28 t.
	Mould length:	1.1 m.
	Casting speed:	5.5 m/s.
	Metallurgical length:	6970 mm.
	Dummy bar system:	Rigid dummy bar for insertion into mould from below.
	Bending radius:	3000 mm.
2	Withdrawal:	2 drives.
	Straigthener:	3 drives.
3	Strip cutting:	Pendulum shear.
	Strip length:	50 m.

4 Tunnel Furnace

	Fuel:	Natural gas
	Length:	185.5 m.
5	Emergency shear:	Hydraulic.

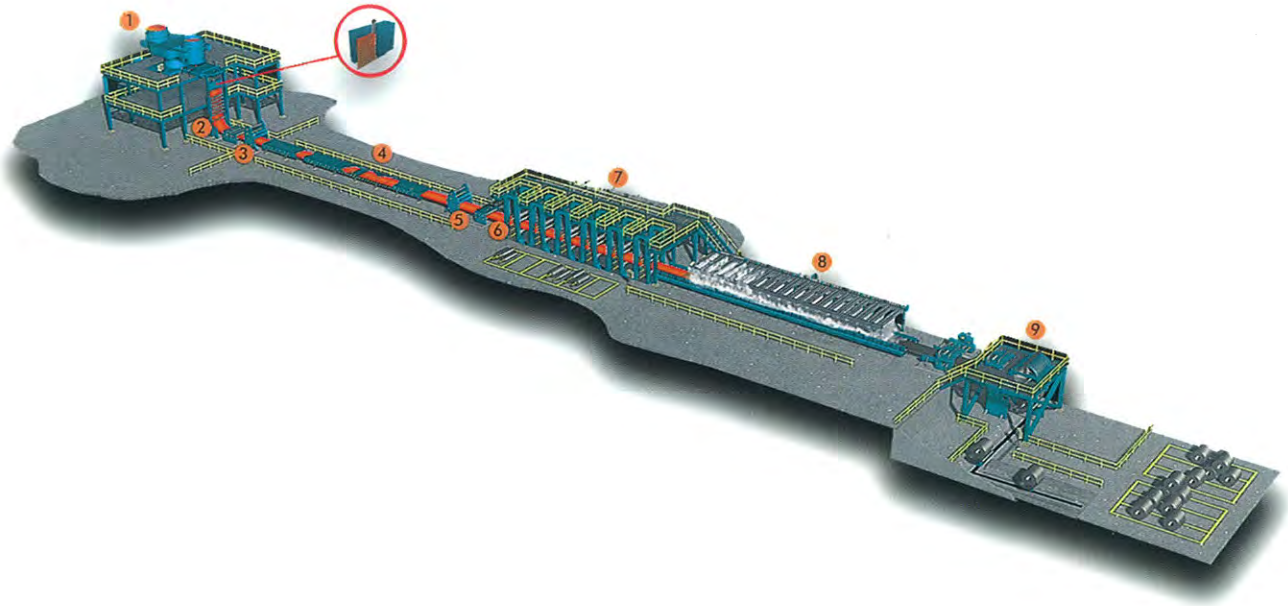


Figure 3 - CSP view

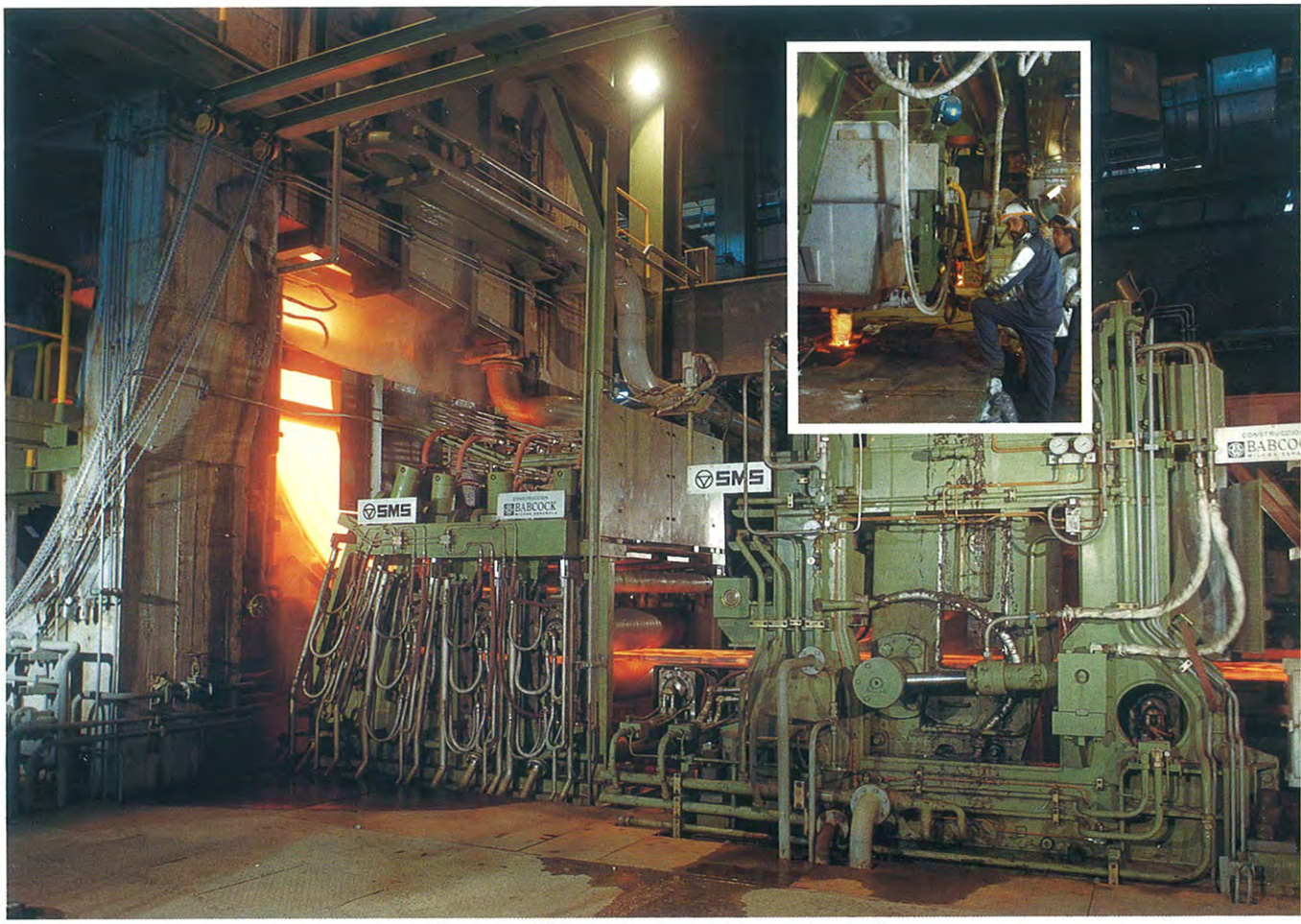


Figure 4 - Withdrawal and straightener unit and shear

6 Descaling

Type: Water jet.

7 Hot strip mill

Number of stands:	6.
Final strip thickness:	1.3 to 12.7 mm.
Coil outside diameter:	1000 to 2000 mm.
Coil inside diameter:	760 mm.
Max. coil weight:	28 t.
Work roll diameter:	780 mm.
Work roll barrel length:	1700 mm.
Shifting, bending:	CVC technology.
Backup roll diameter:	1350 mm.
Roll force:	40 MN.
Motor Power:	7000 kW per stand.

8 Strip cooling

Type:	Laminar cooling.
Zones:	8.

9 Coiler

Type:	Downcoiler with step-control.
Speed:	12.6 m/s.

GENERAL

The automation system includes two levels:

Level 1, based on **Ingelectric-Team** equipment, performs all high-speed direct automation, control, regulation and logic functions.

The process is monitored and controlled by plant operators from pulpits and auxiliary control desks in which man/machine interface (MMI) units have been installed. These units are integrated with the automation units via the communications buses of this level.

Level 1 receives the process information directly from field sensors and via remote units over field buses.

It receives setpoint values and discrete digital operator commands from the operator work stations and from level 2.

Values received from level 2 can be modified by the operators via the MMI workstations.

Control algorithms incorporated in this level receive process information and determine appropriate control responses and setpoints based on current plant conditions and known setpoints and operator selections.

Level 1 is fully autonomous –it may continue to function without Level 2 systems.

The second automation system level, Level 2, performs process modelling and plant technological functions. All process information received by this level comes from the level 1 system, and is used to feed mathematical models that calculate optimal process setpoints and process instructions that it then sends as recommendations to the Level 1 system.

MELT SHOP

Ingelectric-Team, developed the steelworks automation system in accordance with the functional requirements defined by Clecim/Cosim.

The system was designed in close cooperation with Clecim/Cosim, resulting in a consistent and homogeneous equipment configuration in which overall plant and process control functions could be easily implemented across the two levels in a clear and co-ordinated manner. For example, special Clecim/Cosim equipment for specific DC arc-furnace control functions incorporating proprietary technology were integrated with **Ingelectric-Team**, level 1 equipment via field buses.

The following are functions of the level 1 system of the DC Arc Furnaces:

- furnace charging,
- tap control of the power transformers,
- furnace and cover movements,
- weighing and charging of additives,
- injections,
- ladle car positioning,
- ladle weighing,
- master control of the heat,
- hydraulic unit control,
- etc.

Figure 5 - Coiler pulpit

The following functions are implemented in the Level 1 system of the Ladle Reheat Furnaces:

- ladle car positioning,
- electrode control,
- additives dosing and charging,
- ladle weighing and blowing,
- etc.

The Ladle Reheat Furnace system developed and installed by **Ingelectric-Team** also controls furnace gas collection, gas cleansing and dust removal.

Level 2 receives all process information from the Level 1 systems and applies mathematical models to that data to calculate optimal process setpoints and process instructions such as electrode currents, duration of process phases, transformer tap changes, material flows, weights, etc. These values are then transmitted to the Level 1 system as recommendations.

C S P

Ingelectric-Team, S.A. developed the CSP automation system in accordance with the functional requirements defined by SMS. See control equipment scheme in Fig. 8.

The following functions are all functions implemented by the Level 1 system in the plant area:

- dummy slab insertion,
- ladle reception,
- positioning of ladle in cast position,
- automatic cast start,
- slab width control,
- mould level control,
- cooling water control,
- cutting control,
- etc.

Figure 6 - Rolling mill

The system was designed in close cooperation with SMS, resulting in a consistent and homogeneous equipment configuration in which overall plant and process control functions could be easily implemented across the two levels in a clear and co-ordinated manner. The unified SMS process technologies are smoothly integrated in the system. These include SMS equipment for specific technological functions, such as thickness, width and flatness control at each stand of the rolling mill.

Speed stabilisation in the continuous rolling mill, including loop correction and implementation of operator loop control commands, is carried out in this first Level by the standard SISTEAM CONTIMILL function.

The system controls the opening and closing of water sprays in the strip cooling section of the line so as to achieve the required temperature profile, and thus the required mechanical properties of the strip.

Coil discharge, weighing and marking is performed automatically.

Kinematic behaviour of the plant, from ladle arrival up to coil discharge is controlled by the material tracking function.

Figure 7 - Coiler

Level 2 receives all process information from the Level 1 system and applies mathematical models to that data to calculate optimal process setpoints and process instructions for casting speed, slab width and thickness, cooling water flows, slab length, etc. Rolling mill setpoints for stand speeds strip tensions, thickness and widths are also calculated. These values are then transmitted to the Level 1 systems as recommendations.

Level 2 also performs other functions, such as material tracking for quality evaluation, marker control, process and production reports, etc.

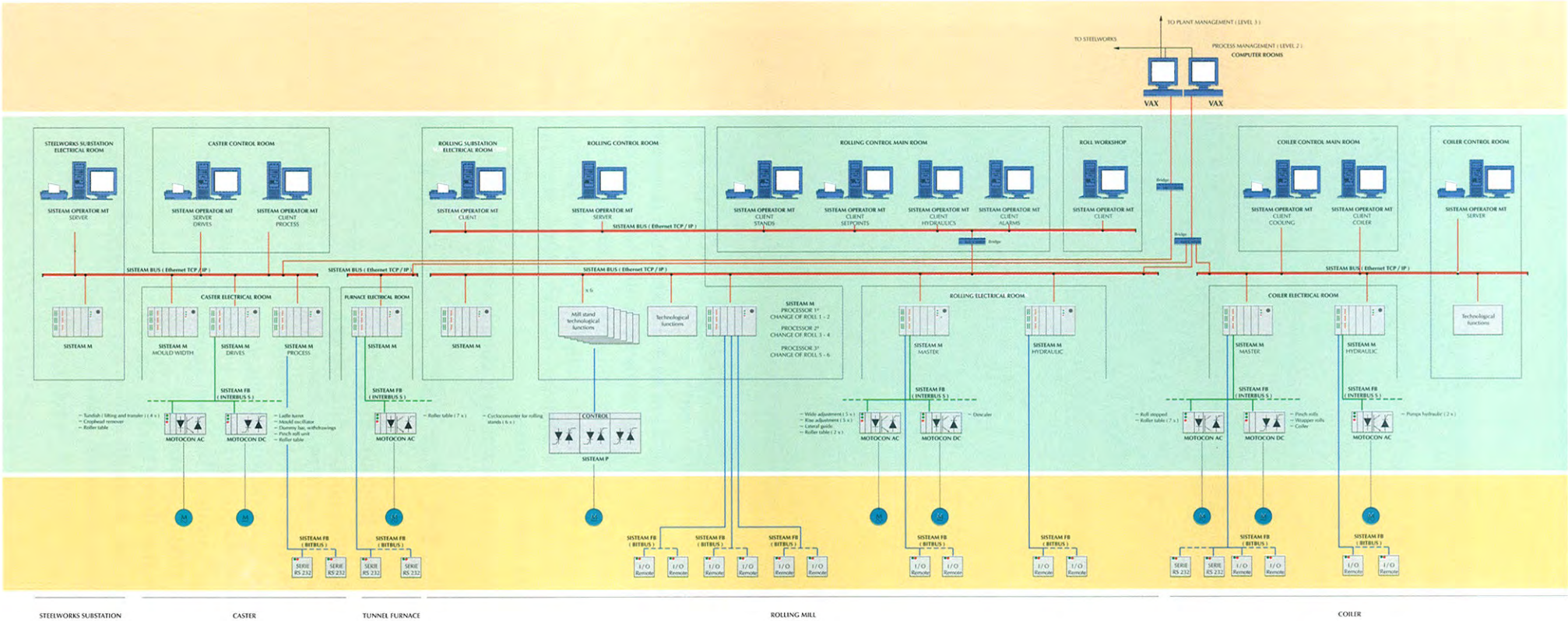
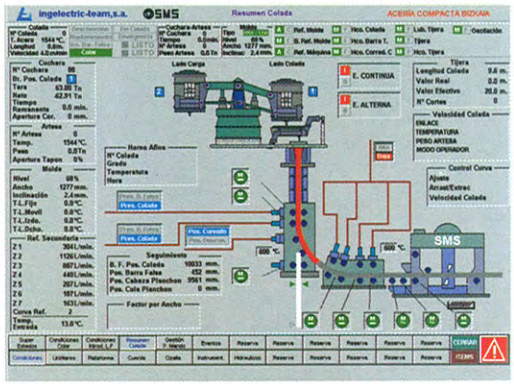
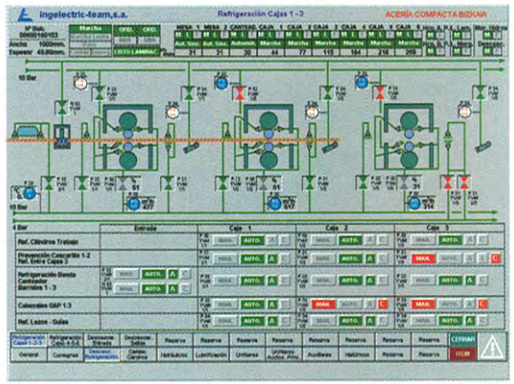


Figure 8 - CSP control scheme





The automation of the ACB plant is an integrated application of the standard **Ingelectric Team** process control products, implemented by the Industrial Systems Department of the Company.

A highly-qualified team has applied modern project development and execution techniques, standard in-house products and technologies, years of accumulated experience and the company's information systems resources to achieve success in delivering the working control and automation system within the planned delivery schedule. This team has worked for over 20 months in coordination with Clecim/Cosim and SMS engineers and with customer's personnel.

Figure 9 - Coiler A.C. MCC

The importance of adequately preparing plant operation and maintenance personnel was recognised early in the project and extensive training of these people was undertaken. Design of display screen formats both for operation and process data presentation, was undertaken under close consultation with the customer's engineers. By this means, high-quality ergonomic data presentation formats were achieved with excellent, selective, data access to simplify plant operation and fault diagnosis.

The following statistics give some idea as to the size and complexity of the project:

MELT SHOP

Installed Power (motors):	9800 kW
A.C. Motor Control Centre:	132 drives
Frequency Converters:	6 drives
I/O signals, direct wired:	6000
Operator display formats (MMI):	70
Auxiliary display formats (MMI):	145
Control desks:	14
Local control boxes:	135
Number of nodes in Bus (level 1):	15
Number of nodes in Bus (level 0):	4
Number of motors:	125

Figure 10 - Rolling mill A.C. MCC

C S P

Installed Power:	93 MVA
A.C. Motor Control Centre:	105 drives
D.C. Motor Control Centre:	14 drives
Frequency Converters:	31 drives
I/O signals, direct wired:	9500
Operator display formats (MMI):	201
Auxiliary display formats (MMI):	43
Control desks:	13
Local control boxes:	245
Number of nodes in Bus (level 1):	24
Number of nodes (level 0):	100
Number of motors:	360

Technology and Equipment

Figure 11 - Cycloconverter (1-phase power view)

In this plant, extensive use is made of standard automation and drive control equipment and components designed and manufactured by **Ingelectric Team S.A.**

In fact, all critical plant functions are implemented in equipment based on the **SISTEAM** family of automation and control systems.

The **SISTEAM M** automation units offer powerful multi-processing capabilities based on the Multibus II® specification. Programming procedures follow the IEC 1131 standard.

All man-machine interface systems use our **OPERATOR MT** process-operation workstation. These units are standard industry-compatible PCs running the Windows NT® operating system. The client/server architecture permits a clear and powerful configuration.

All field buses implemented in the plant use **SISTEAM FIELD** units. In this plant, three standards, Bitbus®, Interbus-S® and Profibus have been used for different technical reasons.

The high-capacity Ethernet-based **SISTEAM BUS** is used for communications between automation units, and between these and the operator workstations. The protocol used is TCP/IP.

AC and DC drive controllers are digital units from the **MOTOCON** family, offering powerful performance and functionality with comfortable user interface and fault diagnosis. The **SISTEAM P** power equipment used for the mill stand cycloconverters are air cooled.

All our automation and control systems include powerful user-friendly configuration software for the application and maintenance engineers. This software runs under the Windows® operating systems.

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