Total Integration of Repsol Butano's Bottled Gas Plants

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The headquarters of the Repsol Group in Madrid.

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The control room of Repsol Butano`s Pinto (Madrid) factory. The operator is sitting in front of an Advant Station 500 Information Management Station. To his left can be seen an Advant Station 500 Operator Station.

Repsol Butano is the world's leading producer of bottled LPG gas and a member of the Repsol Group, Spain's most important corporation. Globally, Repsol ranks No. 16 in the petrochemical industry and No. 163 among the world's biggest corporations, according to Fortune, July 1995.

After extensive studies and consultations, Repsol Butano decided to undertake, in 1994, the 'SICE' (Integrated Bottling Control System) and 'Factory 2000' projects. The objectives of these projects were twofold. First, the company wanted to upgrade the control of the 20 factories, where all their bottling and distri–bution operations are to be concentrated in the near future. Secondly, they wanted to achieve integrated management of the information generated both in the factories and in the corporate mainframe computer. With the implementation these two projects, they would be able to optimize, by adopting a single system and method of operation, the production of bottled gas with all its associated processes (orders, raw material control, distributor relations, traffic records, deliveries, receipts, invoices, etc.)

In August 1994 Repsol Butano and ABB signed an agreement covering the execution of the two projects. This involved a plan for the successive implementation in the different factories over the period 1994 to 1998. In December 1994 the SICE project was in full operation in the Pinto (Madrid) factory, one of the company's largest and most complex facilities, while the Factory 2000 project started to come into operation one month later. This ensured that the different parts became operative in time with the developments imple–mented by Repsol in their information system.

A process to integrate all the public enterprises operating in the chemical, gas and petroleum sectors started in Spain in 1981 and culminated in 1987 with the founding of the Repsol Group. Right from the beginning the Group focused on the exploration and production of gas and petroleum together with the refining, distribution and marketing of oil and petrochemical products. The composition of the Group has changed since its founding, with the integration of new companies, and the Group's organization has been restructured. Today, the principal companies forming the Repsol Group are: Repsol Butano, Repsol Petróleo, Repsol Química, Repsol Exploración and Repsol Comercial de Productos Petrolíferos. In addition, Repsol is the largest shareholder in CLH (Compañía Logística de Hidrocarburos) with a 60% stake and in Gas Natural SDG with a stake of over 45%.

Repsol Butano

Within the Repsol Group, Repsol Butano's responsibilities cover the supply, storage, bottling, transport and marketing of liquid petroleum gases (LPG), primarily butane and propane.

These gases have varied uses, covering both the industrial sector (furnaces, turbines, welding, fuel, vehicles) and the private sector (central heating, hot water and kitchens). In the latter field, and particularly in rural areas, the most widely spread distribution system is based on butane and propane bottles, consisting of small steel flasks with a capacity of 12.5 or 11.5 kg. Besides gas bottles, the principal means of distribution are tanks and gas pipelines.

In 1994 Repsol Butano distributed over 140 million gas bottles, a figure that confirms the company's world leadership in this particular field. Although the greater part of this production is sold in the Spanish market, exports are steadily growing in importance. As regards bulk and piped gas, sales in 1994 totalled 600,000 tonnes.

In 1994 the Repsol Group invested 55,000 million pesetas (approximately US$ 440 million) in the gas sector out of its total capital expenditure of 190,852 million pesetas (approximately US$ 1,520 million).

Gas is delivered to the Pinto factory by rail. In front of the gas storage spheres can be seen trucks used to distribute gas to customers in the industrial sector.

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Distribution centres

To meet the market demand, Repsol Butano has established a large number of distribution centres throughout Spain. The gas is transported to these centres by means of pipelines, road tankers, ships and/or trains, to a varying degree from refineries or other plants. On arrival, the gas is stored in spheres or tanks depending on the type, analyzed and maintained in an optimum condition until its subsequent distribution.

The processes involved in the filling of the storage tanks and dispatch of piped gas are relatively simple. The bottling of gas, on the other hand, is extremely complex, due not only to the number of operations involved and the work in an explosive zone, but also to the great speed required. Besides its extensive experience, Repsol Butano has its own know-how in this field. The automation of the bottling process was the objective of the SICE project.

Bottling of gas commences as soon as the trucks with empty gas bottles arrive at the distribution centre and the bottles are unloaded in the bottling bays. The first step involves the removal of the plastic cap as well as cleaning and painting. All bottles in good condition are then transferred to a bar code reader. This identifies their characte-

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One of the two carousels at a bottling bay in the Pinto distribution centre. Filling of a gas bottle takes 1.5 or 2.5 seconds depending on the type.

ristics by means of a bar code punched on each bottle (year of fabrication, tare, etc.) and allows the bottle to continue, provided that it conforms to the specifications (if it does not, it is withdrawn from circulation). The bottle then arrives at one of the platform scales of the filling carousel, and the scales are informed by the system about the tare and the total amount of gas the bottle is to contain. Each carousel can accommodate 33 to 40 bottles, depending on the type.
The bottle is then filled with the necessary amount of gas, including the residual quantity of gas present in the bottle. The filling speed of the carousels can be varied so that one bottle leaves the carousel every 1.5 or 2.5 seconds. Once the bottle has been filled, it is weighed again on dynamic scales to check whether the filling error does not exceed the permissible tolerance, passes through a washing tunnel, and is tested for tightness. Provided there is no leakage, a plastic cap is then put on the bottle. Finally, the bottle is transferred to a pallet loader, where the bottles are grouped together and placed in metal crates, ready to be loaded into the distribution trucks.

Implementation of the SICE project

The implementation of the SICE project required not only a deep knowledge of the bottling process, but also the possibility to develop a large number of real-time communications with different types of non-ABB equipment already in use in the distribution centres, each having its own protocol. As an example, it can be mentioned that in the Pinto (Madrid) distribution centre the system currently communicates with a total of 168 objects by means of 11 different protocols. Furthermore, many of these communications are critical with respect to time (e.g., the platform scales of the carousels). At the same time, the SICE project demanded great operational security and the maximum availability of the distribution centres, which imposed stringent demands on the design and programming of the system. For example, redundancy of the equipment was assumed. As a result of all these factors and the specific demands, the Repsol Butano team and ABB were in favour of using ABB Advant OCS equipment.

A typical distribution centre comprises two bottling bays with a total of three to four carousels. MasterPiece 200/1 Process Controllers in a redundant configuration and remote I/O are used at the front end to control the processes. This facilitates the installation of the control equipment and the cabling in the existing plants. MVI cards are used in the MP 200 for the communications. Each channel handles up to five communication lines thanks to the use of intelligent multiplexers based on ABB equipment. In the control room there is an Advant Station 520i Operator Station with two monitors. The information is handled by two Advant Station 515 Information Management Stations (IMS), which are also used for the Factory 2000 project. They are prepared for a redundant configuration so that in the event of a failure of one IMS, the other one can take over all the tasks. The plant bus, MasterBus 300, has a redundant configuration and all the Advant OCS hardware (used for control of both the

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Bottled gas is mainly supplied to customers in the private sector with the help of trucks. In 1994 Repsol Butano distributed over 140 million gas bottles.

bottling and the rest of the plant, operation and information management) and the RS6000 are connected to the plant bus.

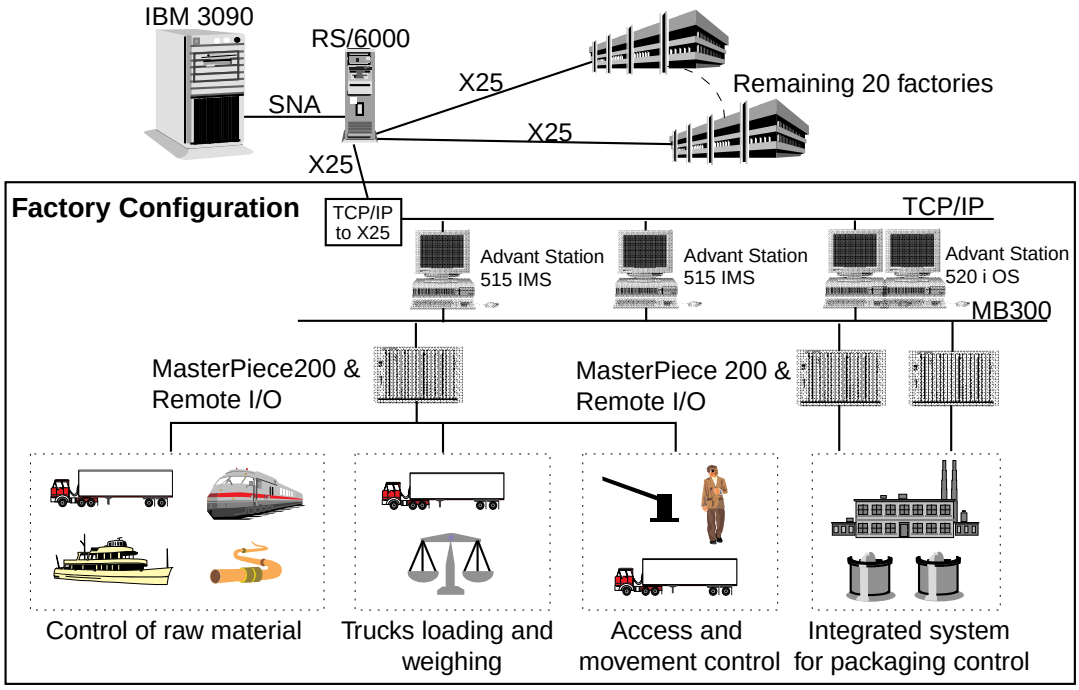
Integrated information management (Factory 2000 project)

Besides the gas bottling in the distribution centres, there are many other tasks to be performed, ranging from the reception of the gas in different transport modes, the control of the departure of the distribution trucks loaded with gas bottles or tanks, to document generation. Most of these tasks are similar in character; they require information emanating from Repsol's corporate information system for their execution.

Repsol's Host Computer (an IBM 3090 located in Madrid) stores all the information about gas movements, optimization of costs and transport modes, orders, distributor data, identification of the trucks and drivers, the system for generating official documents (the gas is subject to special prices and taxes), etc. Earlier the required information was sent on paper to each factory and they in turn sent the daily results to the headquarters for entering manually into the Host Computer.

The purpose of the Factory 2000 project was to automate this process and to get real-time information, which would be as complete as required. To make this possible, it was necessary for Repsol's Host Computer to be able to communicate with the Advant OCS of each factory. The final concept chosen optimizes the hardware and software needed (both commercial and applications) and raises the level of security, determining a minimum of intervention in the IBM 3090 and making use of the IBM RS6000, which Repsol Butano had already installed in the factories and their dispatching centre. Both the IBM 3090 and the RS6000 of the dispatching centre (located in the same room) thus communicate with each other via SNA using Procedural Gateway; the RS6000 remains connected to X25 and that of each factory is also connected to the TCP/IP network of the Advant OCS. The Advant OCS systems of the factories utilize SQL *NET against Oracle V7, which runs in the RS6000 of the dispatching centre for communication. The RS6000 of each factory are assigned in practice the task of functioning as routers, which are transparent at least to the Advant Stations and the Host Computer.

The choice of communications system and the structure of the data to be exchanged was the subject of a study made by ABB. This resulted in a functional specification agreed on with Repsol Butano. The information needed by the Advant OCS systems of each factory is stored in the Host Computer in databases having different formats (DB2, Natural, VSAM, etc.). One function of the RS6000 in the dispatching centre is to convert this information to Oracle format for transmission to the Advant OCS systems of the factories. This information is basically related to the movements of the gas to be produced in the plant, orders to be



System configuration of the Advant OCS supplied to Repsol Butano to control all the processes in their SICE and Factory 2000 projects.

executed, and data about the trucks used to distribute the gas (licences, maximum load, permits, drivers, etc.). In turn, each factory sends to the RS6000 of the dispaching centre the production data (deliveries made, produc-tion, gas balance and inventory statistics, nonconformities, etc.). Depending on special circumstances, the Advant OCS systems are also permitted to communicate directly with the Host Computer in such a way that the RS6000 performs via Procedural Gateway a CICS transaction in it. The Host Computer can directly access the Advant OCS systems at any time.

All this mass of information is generated automatically in real time, without the operator having to intervene. The system is nevertheless prepared to continue functioning independently in the event of any loss of the communications line with the dispatching centre in such a way that the data can be entered or corrected manually via the displays prepared for the purpose. The information is updated in both directions as soon as the communications line has been restored.

The programs that execute all these tasks are located in the Advant Station 515 Information Management Stations. These programs also compile the information coming from the whole factory. It is important to note that the project has been implemented using in each case standard tools like Oracle, Procedural Gateway, SQL *NET and SQL *Forms together with the tools of Advant OCS like AdvaBuild Object Type Builder and AdvaInform Object Handling.

The Factory 2000 project also utilizes MasterPiece 200/1 with remote I/O and MVI cards, which are dedicated to the communications and automation tasks excluded from the SICE project. This equipment is used to control the loading terminals (for trucks, trains, etc.), the gas in the storage spheres and their status, leakage detection equipment, security and fires, access, etc. In connection with the control of the gas movements, each transport element and the operator responsible for directing this possess a chip card for complete identification. This card has to be inserted into different card readers located in the plant to enable the system to authorize the operations to be performed (entrance, exit, loading or unloading of a specified amount of gas, etc.). At the same time, the system also changes the card data, if required (e.g., to record the orders to to be executed, the amount of transported gas). In this way, the system performs an automatic sequence of all the movements and makes certain that they are set to what has been specified by the Host Computer. Similarly, it prints all the documents needed, both internal and external (transport and delivery receipts, order routes, etc.)

Opinions of Repsol Butano

In the Engineering Department of Repsol Mr. José Ramón Argüelles has been responsible for the projects. Besides the speed with which the ABB engineers familiarized themselves with the very special

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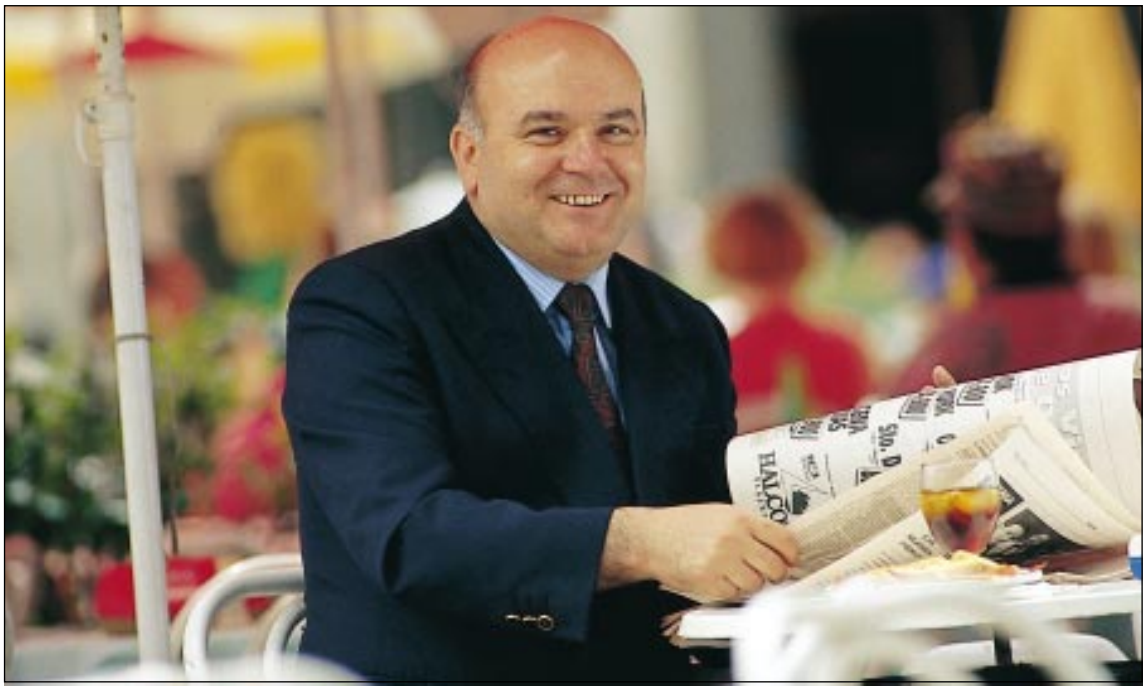

Mr. José Ramón Argüelles, Engineering Department, Repsol, has been responsible for the implementation of the SICE and Factory 2000 projects at Repsol Butano.

know-how of Repsol Butano's bottling plants, with leading-edge technology in this field, Mr. Argüelles wishes to underline the "benefits obtained by working with a company like ABB, with employees, equipment and tools capable of implementing a comprehensive vertical integration needed by our projects. The use of standard products available in the market, on the other hand, ensures that we can rely on the future feasibility of our investment."

Conclusion

The implementation of the SICE and Factory 2000 projects at Repsol Butano demonstrates the capability of ABB to carry out a complete integration not only on the level of large plants, but also covering an entire company, including equipment supplied by both ABB and other firms.

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Bottled gas is extensively used for central heating, hot water and cooking in many Spanish households.

Information & Reklam, ABB Support 9606

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