Comprehensive safety solutions for the South Pars gasfield exploration

ESD, F&G and HIPPS systems from HIMA ensure maximum safety and plant availability

Iran's natural gas reserves account for around 18% of the world's total reserves, second only to Russia. Approximately 60% of Iranian natural gas deposits are located in the South Pars gas field in the Persian Gulf. The Iranian South Pars field is the northern part of the largest gas field in the world; the southern part lies within the area of Qatar. Experts estimate that the Iranian part alone contains around 8 billion m^3 of natural gas, some even suspect deposits amounting to 13 billion m^3.

The gas deposits in the South Pars field (approx. 1,300 km^2 in size) are located at around 3,000 m under the seabed, at an average water depth of 65 m. For the development of the vast gas deposits, the state-run National Iranian Oil Company (NIOC) responsible for exploration and production has defined 28 phases, each calling for investments amounting to 1 billion US dollars and more – the investment volume for phases 4 and 5 alone amounts to around 3.8 billion US dollars.

Platforms pump the crude gas around 100 km out to sea off the Iranian coast. Before the gas is sent through the pipelines from the offshore to the onshore facilities on the Iranian mainland, ethylene is added in order to improve its flowability. On land, the natural gas is dried and the condensate contained within is isolated. The gas from the South Pars field contains a high volume of hydrosulphide, which is also separated in the cleaning process. The cleaned sales gas is only transported further via tankship or pipeline. Therefore, an uninterrupted, safe production is indispensable in order to refinance the immense volume of investment.

Maximum availability safety systems. The offshore production of natural gas, its transport as well as processing onshore require the use of safety systems that guarantee safety for man and the environment and help in

Press Contact:
HIMA Paul Hildebrandt GmbH + Co KG
Nicole Pringal
Postfach 1261
68777 Brühl
Phone: (+49 6202) 709-405
Fax: (+49 6202) 709-123
E-Mail: n.pringal@hima.com
Internet: http://www.hima.de

achieving maximum system availability . Requirements which the fault tolerant, SIL-certified systems from HIMA are ideally able to fulfil.

For this reason, HIMA was commissioned with delivering the complete Emergency Shutdown Systems (ESD), Fire&Gas Systems (F&G) as well as the High Integrity Pressure Protection Systems (HIPPS) for phase 1 (phases 2 and 3 were scheduled before phase 1 in terms of time) and phases 4 to 8. The HIMA systems process in total over 25,000 signals. The SIL 3-certified ESD systems take over typical tasks related to monitoring process signals such as pressure or temperature and control corresponding actuators such as motors or safety / blowdown valves. The SIL 4-certified HIPPS systems, on the other hand, take over the pressure monitoring of the gas pipelines.

Basically, ESD and HIPPS safety systems work according to the closed-circuit-principle, that is, in the event of failure, the control switches to the (de-energized) state which is defined as safe. In contrast to this, the F&G system as an alarm system is designed on the basis of the open-circuit principle. The F&G systems work as a monitoring system for the detection of gas and fire, are used for alert purposes and for the initiation of evacuation, extinguishing and other counter measures.

Processes completely separate in terms of control.

The raw gas is prepared in the units via parallel process trains. This allows a train to be maintained if necessary or production to continue if a train breaks down . All trains are also designed separately from a safety-related point of view for reasons of availability. The ESD and F&G systems work completely independently of each other, but are connected with each other via an interface. The safety-related safeethernet protocol from HIMA was used for networking the ESD/F&G systems. In addition to performance (100 Mbps), the safety bus offers immense savings in cost for the otherwise necessary conventional cross wiring and creates

Press Contact:
HIMA Paul Hildebrandt GmbH + Co KG
Nicole Pringal
Postfach 1261
68777 Brühl
Phone: (+49 6202) 709-405
Fax: (+49 6202) 709-123
E-Mail: n.pringal@hima.com
Internet: http://www.hima.de

more transparency. A clear cost advantage compared to conventional solutions.

All controls and buses were constructed as redundant due to the required availability. The communication between the HIMA and the different process control systems takes place by means of redundant MODBUS coupling.

The safety systems being used.

In South Pars, the SIL3-certified PES (Programmable Electronic System) H51q systems are being used for the ESD and F&G applications as well as the hard-wired, SIL4-certified Planar4 system for the HIPPS application.

The H51q systems, developed by HIMA, were the world's first safety systems with HIQuad technology. This 2oo4D/QMR (Quadruple Modular Redundant) architecture was necessary because the hitherto current safety technologies of the dual systems or 2oo3/TMR systems had reached the limit of their performance and economic efficiency. HIQuad technology is characterised by dual processors on every CPU. Both processors are constantly checked down to the nanosecond by a safety-related hardware comparator. With redundant architecture, communication to the second CPU is established per quick Dual Port RAM (DPR) thereby realising a 2oo4D/QMR architecture. The use of dual processor technology allows the H51q systems already to be used in mono configurations up to SIL 3 – TÜV approved and without restrictions. Since maximum safety is already given with the mono systems, redundant modules are only needed for increasing availability. Redundancy concepts can be tailored exactly to the economic and technical requirements of the respective application. The leading position which these systems have in the field of safety technology is proven. They have the lowest probability of failure of all safety systems according to IEC-61508-

Press Contact:
HIMA Paul Hildebrandt GmbH + Co KG
Nicole Pringal
Postfach 1261
68777 Brühl
Phone: (+49 6202) 709-405
Fax: (+49 6202) 709-123
E-Mail: n.pringal@hima.com
Internet: http://www.hima.de

compliant calculations and are the world's first IEC-61508-certified 2oo4/QMR systems.

H51q systems of type HRS are being used in the South Pars projects. Their total redundancy of CPUs, I/O bus and I/O modules ensure maximum availability and fault tolerance across the entire system. If a fault should occur in a HIMA module, the faulty module can be replaced without having to shut down the system for this purpose.
Redundant, hard-wired Planar4 systems are being used for the HIPPS applications. The Planar4 system from HIMA is the only safety system which may be used up to SIL 4 in accordance with IEC 61508. In the hard-wired system, inputs, logic processing as well as outputs are integrated on every module. The Planar4 systems are also the first hard-wired systems with integrated diagnosis and communication capability. This self-diagnosis capability ensures that faults are signalled quickly. In the event of failure, the defect modules can be localised quickly and exchanged during operation. In addition to maximum safety and availability, the extremely quick switching times of 2-10 ms were a decisive factor for the employment in South Pars.

International project management.

As with all projects of this size, a major challenge was the international background with a large number of contact persons in Iran (end user), Korea (EPC) and Japan (DCS), amongst whom the data transfer, the definition of interfaces, dates etc. had to be coordinated. HIMA's worldwide presence proved to be a great advantage: besides the central project manager, local contact persons were also always on call if necessary. The HIMA sales and service centre in Dubai performed the service, contact in Iran was conducted by a regional representative and the Korean HIMA sales and service centre managed the communication with the contractors in Korea. Engineering is being carried out at the com-

Press Contact:
HIMA Paul Hildebrandt GmbH + Co KG
Nicole Pringal
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68777 Brühl
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E-Mail: n.pringal@hima.com
Internet: http://www.hima.de

pany's headquarters in Brühl in Germany. With its global presence on site concept, also within the Middle East region HIMA is providing quick and effective support for customers with almost 1,000 installed systems in Egypt, Bahrain, India, Kuwait, Oman, Pakistan, Qatar, Saudi Arabia, Sudan and in the United Arab Emirates.

To manage the immense amount of data, which along with the safety-relevant data also contained, among other things, system data, cross wiring data, application software interface data, SER data and description, as well as data for the delivered F&G sensors, HIMA used an intelligent, database-orientated engineering which allowed them to minimise the effort required in explaining the interfaces, avoid problems and thus also save lot of time, which meant that the original dates could be met without problems despite changes in the course of the project. The revision process was simplified considerably, and in addition the database formed the basis for the EPC documentation.

On-schedule processing.

Phase 1 onshore (68 control cabinets) had a duration of 9 months within HIMA for engineering. The installation and commissioning of the automation technology took place from October 2002 to September 2003. Phase 1 offshore took up 12 months planning at HIMA, the commissioning took place parallel to offshore. All projects were processed by HIMA within schedule. Total production capacity of train 1 and 2 of phase 1 will be 1,000 million cubic feet a day of natural gas, 40,000 barrels a day of condensates and 200 tonnes a day of sulphur.

In phase 4 and 5, 128 control cabinets incl. marshalling were planned, wired and tested within 9 months using the experience gained during the first project. The systems are to be accepted in December 2004.

Press Contact:
HIMA Paul Hildebrandt
GmbH + Co KG
Nicole Pringal
Postfach 1261
68777 Brühl
Phone: (+49 6202) 709-405
Fax: (+49 6202) 709-123
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Currently HIMA is occupied with the deliveries for phase 6, 7 and 8. The scope of delivery includes ESD, F&G as well as HIPPS systems, distributed to around 180 control cabinets. Put side by side that results in a 200 meter long row. After completion, the systems will process around 10,170 I/O in terms of control.

South Pars is one of the world's largest gas exploration and production projects with outstanding demands on safety-related automation technology. HIMA systems and project management were able to contribute towards making South Pars a safe and cost-effective project.

Press Contact:
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