1. The project

The South Pars gas field is the Iranian portion of what is probably the largest gas field in the world. The other part of the field, in Qatari waters, is known as **North Field (1)**. With the South Pars project, TotalFinaElf has become the foremost oil company in partnership with Iran and has bolstered its position in the Middle East, where the Group has been active for **some 75 years (2)**.

DESCRIPTION

(1) North Field - Qatar :

Although it was discovered in the 1970s, this gas “giant” extending over 8,000 sq. km was only brought into production in 1991. North Field is the key element in Qatar’s hydrocarbon production growth strategy.

(2) 75 years of presence in the Middle East – Milestones

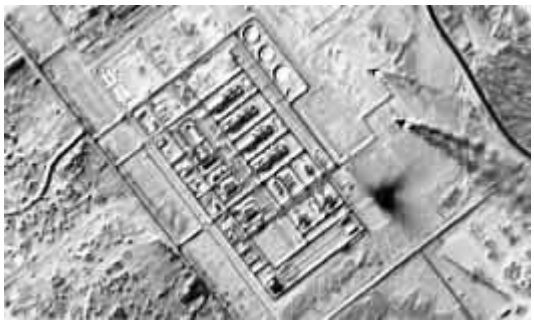
1927: Discovery of the Kirkuk oil field in Iraq by the Turkish Petroleum Company, later to become Iraq Petroleum.
1937: Formation of Petroleum Development Oman.
1954: Formation of Dubai Marine Areas.
1958: Discovery of oil at Umm Shaïf (Abu Dhabi).
1963: Discovery of the Zakum field (Abu Dhabi).
1966: Contract between Erap and Nioc.
1968: First discoveries at Buzurgan and Abu Guirab (Iraq).
1971: Foundation of the United Arab Emirates. Formation of the Abu Dhabi National Oil Company.
1972: Discovery of North Field (Qatar). TotalFinaElf becomes operator for the first time in the region, on Abu Al Bukhoosh (Abu Dhabi).
1972: Discovery of Sirri (Iran).
1973: Formation of Abu Dhabi Gas Liquefaction Company.
1973: Discovery of Kangan (Iran).
1976: Production start-up by Erap on the Buzurgan and Abu Ghirab fields (Iraq).
1978: Formation of Abu Dhabi Gas Industries.
1980: Formation of Fertil.
1984: Agreement concerning the Qatargas LNG project.
1985: Elf Aquitaine becomes operator on the Bahlaf permit (South Yemen).
1987: Total-CFP becomes operator on East Shabwa (Yemen).
1988: SNEA begins activities in Syria (Deir Ez Zor permit).
1989: First offshore drilling on Amran 1 (South Yemen).
1991: Total becomes operator for part of North Field (Qatar).
1995: Total becomes operator for development of Sirri A and E (Iran). Agreement concerning the Yemen LNG project.
1996: Launch of the Oman LNG project.
1997: Total becomes operator for development of Phases 2 and 3 of South Pars. Signature of a technical services agreement with Kuwait.
1999: The Qatargas liquefaction plant reaches full capacity. Signature of contracts for development of Balal and Dorood (Iran)
2000: Production start-up at the Oman LNG plant. Acquisition and expansion of the Taweelah power station and seawater desalination plant (Abu Dhabi). Launch of Phase 2 of development on the Al Khalij field (Qatar).
2001: TotalFinaElf chosen to partner Saudi Arabia on the Core Venture 3 project. Signature of a production-sharing agreement for the Dolphin project and agreement concerning construction of an ethane cracker (Abu Dhabi). Completion of the Sirri A-E project (Iran).
2002: Production start-up on South Pars as well as additional production on Dorood (Iran). Signature of a contract for the Qatafin project (Qatar).

1.1. Geographical localisation

The South Pars field (1) lies in the Arabo-Persian Gulf about 100 kilometres off the south-west coast of **Iran (2)**. It comprises the Kangan/Dalan geological layers, more than 3,000 metres under the seabed and in 65 metres of water. The onshore gas treatment plant is located near the village of **Assaluyeh (3)**, and has involved construction of a significant amount of infrastructure in this desert region of the country.

DESCRIPTION

(1) Satellite map



(2) History and Politics

For nearly 3,000 years, Iran's geographical situation has meant is was one of the more coveted strategic zones in the world. Numerous archaeological sites bear witness to Iran's pre- and proto-historical significance. This period came to an end in the second millennium when Indo-European invaders settled on the immense Iranian plateau, to which they gave their name (Iran = Ayryana Vaejjo or "the home of the Aryans"). The first kingdom at that stage was established by the Medes (-612), who came under Persian domination in -556. With the widespread conquests of Darius I, the Persian Empire became the most extensive in all of Antiquity, its power symbolised by cities such as Susa and Persepolis. However, the Persians were unable to resist the onslaught of Alexander the Great, who burned Persepolis in -330 and put an end to the reign of the Achaemenids. After Alexander's death, a number of successive dynasties ruled Iran, one of which was the Sasanids, whose reign marked a high point for Iranian civilisation, particularly regarding literature and the arts. In the end, weakened by endless wars and a series of revolts, this empire that had lasted for four centuries (224-642), collapsed in less than ten years under the onslaught of the Arabs. Iran then adopted Islam and played a key role in the development of a culture that had until then been essentially Arab. The Ali Caliphate (656-661) marked the beginning of a religious change that was to see Iran become **Shi'ism (4)**. By the 9th century, the Samanids has succeeded in rebuilding an Iranian Empire that stretched from the Arabo-Persian Gulf to India. And despite numerous outbreaks of turbulence, this period witnessed a major cultural revival and gave rise to some of the greatest poetry of the age.

Between the 8th and 10th centuries, the Turks gradually conquered the country, assimilating Iranian culture which they carried with them as far as Asia Minor and India. Thus by the 11th century, the Persian Empire stretched from Afghanistan to the Mediterranean, and the Turko-Iranian culture that it bred survived for more than a thousand years.

In the 13th century, Genghis Khan and his Mongols invaded Iran and adopted Islam in their turn, but they were unable to maintain the unity of the country, which was invaded by Timur in 1381. Despite the ensuing destruction, eastern Iran did experience a cultural renaissance, but the western part of the country remained at the mercy of the Turkmen tribes with their internal rivalries.

In the 16th century, Ismael I founded a Shi'ite dynasty which had sufficient unity to resist the Sunnis. This dynasty reached its high point during the reign of Abbas I, and at that stage Iran exercised a strong cultural influence on Moghol India, the Ottoman Empire and even 18th century Europe.

The adoption of the Shi'ite strain of Islam as the official religion reinforced the differences between Iran and the rest of the Moslem world, but it also sowed the seeds of dissent, causing Iran to go into rapid decline. Its ruins became the foundation on which Nadir was to build his empire, subsequently evicting the Afghans and being crowned Shah in 1736. But Iran was soon once again embroiled in disastrous wars, which, by the early 19th century, opened the way for a rise in Western influence (Russia and Great Britain).

The discovery and production of increasing volumes of oil during the first world war changed the nature of Iran's strategic importance. The growing economic influence of foreign powers, combined with the autocratic rule of the last Kadjars, led to a number of plots against the rulers, including that organised by Reza Khan, founder of the Pahlavi dynasty that undertook to modernise Persia and changed the country's name to Iran in 1934.

During the second world war, the German threat to the Caucasus and the necessity of opening a supply route to the Soviet Union led the Allies to occupy Iran in September 1941, obliging Reza Khan to abdicate in favour of his son, Mohammed Reza Pahlavi, who was to be the last Shah of Iran. With the growing American presence in Iran, the British and Soviets were induced to withdraw from the country in 1946. Then in 1949, as oil production was stepped up, a number of parliamentarians, led by Mossadegh, opposed the new agreement with the Anglo-Iranian Oil Company. And in March 1951, the Iranian parliament voted to nationalise the country's oil industry. After the fall of Mossadegh, the country's new government turned on nationalists and communists alike, suppressed constitutional liberties and signed an oil agreement with an international consortium. But despite American aid, the economic situation continued to cause concern, and an increasingly powerful opposition demanded a return to government in compliance with the constitution, forcing the Shah to agree to some reforms. Refusing all political concessions, the Shah launched his "White

Revolution" in 1963, designed to ensure wide land ownership, education for all and the emancipation of women, which earned the hostility of the country's conservatives.
The rapid development of new socio-economic forces within a society where all forms of criticism were banned created a situation that was ripe for revolution. Anti-government riots were so violent during 1978 that in January 1979, the Shah decided to leave the country. The following month saw the return of Ayatollah Khomeiny, who had been in exile since 1964. He took power and founded an Islamic Republic, which was approved by referendum. But when the time came to approve a constitution, the hitherto united revolutionaries split into factions. In September 1980, Iraq attacked Iran with a view to annexing the Shatt al-Arab. The extreme tension between Iran and the United States, lasting from November 1979 until September 1980, coupled with the war with Iraq, created conditions that radicalised the revolutionaries. After the end of the war with Iraq in 1988 and the death of Khomeiny, the regime in Tehran moderated its policy both economically and diplomatically, and in August 1989 the Constitution was amended to give greater executive powers to the new president, Rafsandjani. President Rafsandjani served two terms (1989-1997), during which he tried to introduce major reforms, but these efforts were frequently curbed by parliament where the conservatives continued to have a majority. It was not until 1996 that Iran's moderates grew strong enough to begin changing the country's political scene. The new trend was confirmed in 1997 by the election as president of the reform-minded Mohammad Khatami, who also won an outright majority in the parliamentary elections held in February 2000.
Parliament in Iran is elected by universal suffrage (citizens have the right to vote at age15). Executive power is shared between the Supreme Leader of the Islamic Revolution and the President. Government ministers are appointed by the President but must be approved by Parliament. Legislative power resides in the Parliament, or Majlis, comprising 270 members elected for a term of 4 years. Judiciary power resides in the Supreme Court.

Geography

Most of Iran comprises a high plateau with an average altitude of 1,300 metres, rimmed by two mountain arcs. The plateaux include ancient lake beds now dried up to form immense stretches of desert salt pan. From the green mountain slopes stretch the outer plains with their more abundant rainfall, forming fertile lands such as that in Khuzestan or the luxurious vegetation of Iran's Caspian provinces. The country is irrigated by three major rivers, the Karun, the Karkhe and the Sefid Rud
Ever since Antiquity, this combination of irrigated plains, rainy mountain valleys and arid hinterland plateau has meant that Iran was made up of two separate communities with different ways of life: nomadic peoples raising livestock and sedentary communities cultivating irrigated lands. Evolving relations between these two groups strongly influenced both the country's history and its social make-up.
Iran's peripheral mountain ranges mean the country has an arid, continental-type climate, with rainfall rarely exceeding 250 mm/year, expect near the Caspian coast (1,300 mm/year). Summer in Iran is hot, sometimes extremely so, and winters are very cold, giving parts of the country an extreme temperature range (-20°C to +40°C in Isphahan).
Iran has land borders with Afghanistan, Armenia, Azerbaijan, Iraq, Pakistan, Turkey and Turkmenistan, and the country also has coastline on the Gulf of Oman, the Arabo-Persian Gulf and the Caspian Sea. Iran has a surface area of 1,648,000 sq. km.

Population and demography

Iran has a population of 67.5 million (1997 census). Some 58% of the population lives in the cities, with 7.7 million of them living in the capital, Tehran. Iran's population is young, with 44% of Iranians being under 15 years of age, and the country's rate of population increase is one of the highest in the world. The official language is Persian.

(3) Assaluyeh

(4) Shi'ism

After the death of the Prophet Mahomet in 632, four separate caliphs vied for leadership. Even though the Prophet's son-in-law and cousin, Ali, appeared to be his designated successor, the choice fell on Abubakr, under whose reign (632-634) began the conquest of Persia. The premature death of Abubakr could well have opened the way for Ali, but his accession to the caliphate was in fact delayed until 656 by the opposition of two other caliphs, Omar and Othman. The dispute between Ali and Abubakr's daughter, who had also been the Prophet's wife, ended in the famous "battle of the camel", with Ali reigning victorious. Obliged to choose sides at this stage, the people of both Mesopotamia and Iran supported Ali.
The major difference between Shi'ites ("partisans") and Sunnis ("traditionalists") is that the former regard Ali as an intermediary being between the Prophet and Man. Shi'ism is to date the only schism in the history of Islam.

1.2. TotalFinaElf in the Middle East

The history of TotalFinaElf has always been closely linked to development of the Middle East oil industry, with the Compagnie Française des Pétroles (CFP) gaining its first assets with the discovery of the **Kirkuk (1)** oil field in Iraq in 1927.
CFP subsequently became a partner in a number of ventures set up to prospect offshore in Abu Dhabi and Dubai, also entering partnerships in Qatar and Oman. In 1954, the company joined the Iranian Oil Participants Consortium formed to carry out exploration and production in Iran on behalf of the National Iranian Oil Company (NIOC).
Over the years, TotalFinaElf gained access to increasing supplies of Middle East crude which have formed the basis for the Group's industrial and commercial growth while allowing it to consolidate its positions and forge new partnerships.
In recent years, TotalFinaElf has strengthened its involvement in the United Arab Emirates, in Iran, Qatar, Syria and Yemen. The Group has also signed a technical assistance agreement with Kuwait and, in 2001, was selected to partner Saudi Arabia in the **Core Venture 3 (2)** project. At the same time, TotalFinaElf has diversified its activities in the region via a number of major oil and gas projects, including petrochemicals and **downstream gas and electricity (3)**.
TotalFinaElf's first assets were in the Middle East and the zone is bound to remain a key region for the Group as regards both reserves and production as well as crude supplies for its trading and refining activities. In 2001, 18% (i.e. 400,000 barrels of oil equivalent per day) of the Group's overall production of oil and gas came from the Middle East.
The Group's significant assets, technical expertise and long experience in the region, plus the fact that it is the only international oil company present in 11 countries throughout the region, provide TotalFinaElf with a unique opportunity to play a major part in promoting **new industrial projects (4)**.
In partnership with national companies, TotalFinaElf is also helping to generate regional synergies via initiatives such as the **Dolphin (5)** project involving Qatar and the United Arab Emirates.

TotalFinaElf in Iran (6)

Iran has the fifth-largest reserves of oil in the world (9% of the world total) and the second-largest gas reserves (15% of supply). TotalFitalFinaElf is today one of the leading international companies in the country, having recently begun production on Sirri and South Pars 2-3 and currently pursuing development on **Balal and Dorood (7)**.
In 1954, the CFP joined major British and American companies in the **Iranian Oil Consortium (8)**, formed to carry out exploration and production work on behalf of the National Iranian Oil Company (NIOC). The consortium (TotalFinaElf 6%) operated until 1979, with production of up to 6 million barrels/day, of which TotalFinaElf's share was 360,000 b/d.
Relations between Iran and the Western oil companies were greatly modified in 1979, when the **Islamic Revolution (9)** meant they had to cease all activities in the country. However, in 1986, TotalFinaElf (at that stage, Total) and NIOC reached an agreement on the compensation due to the Group following the nationalisation of its assets as a member of the Iranian Oil Consortium.
Late in 1988, with the resumption of diplomatic relations between Paris and Tehran, the Group renewed its commercial ties with Iran, making regular purchases of crude oil and selling motor fuels and lubricants to Iran. TotalFinaElf's strategy was to pave the way for participation in industrial projects, as it felt Iran was bound to play a key role in the region's oil and gas development.
In 1995, Iran once again began seeking foreign investors to participate in development of the country's offshore hydrocarbon reserves, and Total was the first foreign oil company to sign contracts with

SOUTH PARS : A giant gas field off the Iranian coast

NIOC. The first contract, signed in June 1995, was a “buy-back” contract concerning the Sirri project and covering development of two offshore oilfields, Sirri A and Sirri E, in the south-east part of the Gulf near the sea border with Dubai. This first contract was followed by an agreement signed in September 1997 concerning the South Pars project.
In 1999, TotalFinaElf signed two further “buy back” contracts with Iran, covering development of the Balal and Dorood oil fields.
Iran’s willingness to involve foreign investors was confirmed by the inclusion in such projects of part of the country’s onshore oil reserves as well as the granting of onshore exploration permits.

DESCRIPTION

(1) Kirkouk

The first oil gusher at Baba Gurgur, in Iraq, on 15 October 1927.

(2) Core Venture 3 – Saudi Arabia

In 2001, the Saudi authorities awarded a contract for the Core Venture 3 project to an international consortium in which TotalFinaElf is a 30% partner. This major project involves:

- Exploration campaigns covering two zones of the Rub’ al Khali covering 140,000 sq. km and 50,000 sq. km respectively
- A feasibility study for development of the Kidan sour natural gas field
- Construction of gas transport and treatment facilities for gas from the Shaybah field, as well as construction of a petrochemicals complex
- Construction of a power station and seawater desalination plant at Jubail.
- The overall project involves capital investment of about $6 billion and will be carried out in partnership with Saudi Aramco.

(3) Natural gas and electricity: new growth vectors

The Group is a major player in gas and power in the region, with interests in a number of large natural gas and LNG projects, with production intended for markets in Asia and Western Europe. With nearly a third of world gas reserves and less than 10% of the population, the Middle East is bound to play an increasingly important role in world gas trade. Easily transportable LNG already accounts for a quarter of all world gas exports.

(4) New industrial projects

The Taweelah A1 site, comprising a power station and a seawater desalination plant, functions in cogeneration mode. It produces not only electricity but also heat to power the desalination plant. An overall view of the site.

(5) Dolphin – Qatar - EAU

In December 2001, a contract was signed by Qatar Petroleum covering the sale, as part of the Dolphin project (TotalFinaElf 24.5%), of 2 billion cu.ft/d of Qatari gas over 25 years starting in 2005. The gas, from the North Field, will be piped to the United Arab Emirates via a 380-km pipeline. The first phase of development of the Dolphin project is estimated to cost $3.5 billion.
The Dolphin project involves:

- Development and production of two blocks of Qatar's giant offshore North Field. Drilling of the first delineation wells began in late 2001
- Construction of a 380-km, 48-inch gas pipeline linking a gas treatment plant in Ras Laffan (Qatar) to the receiving terminal at Taweelah (Abu Dhabi). Most of the gas will be used to fuel power generation and seawater desalination.

(6) TotalFinaElf in Iran

(7) Development of Balal and Dorood

In 1999, TotalFinaElf entered into partnerships to develop two offshore oil fields, Balal (TotalFinaElf operator, 46.75%) and Dorood (TotalFinaElf operator, 55%). Dorood, which has been producing for about thirty years, is located in the vicinity of Kharg Island in the northern part of the Gulf. The new development project, which is aimed at boosting production by about 85,000 barrels per day by 2004, involves drilling 29 new wells, 5 of them offshore, and building new onshore facilities. These facilities have now been connected to two offshore wells which were brought into production in May 2002.
The Balal field is located in the middle of the Gulf, 100 km from the island of Lavan. The development scheme here involves setting up two platforms (wellhead and production) and drilling 10 wells, divided between production and water injection. Start-up was achieved in early 2003 and production should quickly reach 40,000 barrels per day. The oil will be transported to Lavan Island by an existing NIOC pipeline.
Development of both Dorood and Balal is being carried out under “buy-back” contracts.

(8) The Iranian Oil Consortium

Between 1954 and 1979, Total was a 6% partner in the Iranian Oil Consortium, alongside BP, Shell, Exxon, Mobil, Texaco, Standard Oil of California, Gulf and Chevron. The consortium undertook development of a number of fields, and by 1978 has reached a production capacity of about 6 Mb/d. During this period, Total had access to amounts of crude oil varying between 12 Mt/y and 16 Mt/y (240,000b/d-360,000 b/d).
In addition to its activity as a member of the Consortium, in 1974 Total began exploration in southern Iran.

(9) The Islamic Revolution

The Islamic Revolution in 1979 put an end to the participation of foreign companies in Iran’s oil industry. For nearly twenty years, the American embargo on the supply of spare parts necessary to maintain the country’s oil wells prevented NIOC from taking advantage of ongoing technological progress in exploration and drilling techniques.

1.3. South Pars in figures

- **Operator:**
TotalFinaElf 40%

- **Partners:**
Gazprom 30%
Petronas 30%

- **Overrall investment:** .....About $2 billion
- **Production plateau:**
2 billion cu.ft/day (=56 million cu.m/day)

2. The challenge of South Pars

South Pars is the **largest project (1)** undertaken so far in Iran by international oil companies. The project was carried out in close cooperation with the Iranian authorities, NIOC, the project partners and service companies, under a so-called “buy back” contract.
At the outset, **NIOC (2)** chose to divide the South Pars field into 14 geographical zones or **phases (3)**, each corresponding to **production (4)** of 1 billion cubic feet (28 million cu.m) of gas per day. Development of Phases 2 and 3 was awarded to a **consortium (5)** made up of TotalFinaElf (operator 40%), Malaysia’s **Petronas (6)** (30%) and Russia’s **Gazprom (7)** (30%).
One particularity of the South Pars project is that the development scheme involves multi-phase transport of **sour gas (8)** over a distance of more than 100 kilometres.

DESCRIPTIONS

(1) South Pars :general overview

(2) National Iranian Oil Company

With production standing at nearly 4 million barrels/day, the National Iranian Oil Company (NIOC) is one of the world’s largest oil producers. The company is also a player in domestic distribution and sales as well as oil export. TotalFinaElf also partners NIOC on the Sirri A and Sirri E oil fields.

(3) Fourteen phases

Phase 1 of the South Pars field, being developed by the NIOC subsidiary POGC, involves production of 28 million cu.m of gas and 40,000 barrels/day of condensates, as well as transport facilities for the condensates and solid sulphur (loading port) and a pipeline to Kangan. A number of the facilities built for Phase 1 are also to be used for Phases 2 and 3, including the 56-inch pipeline to the existing gas grid, a condensate export line and loading buoy, a seawater intake pipe (used by Phases 1 to 6), an accommodation camp for the operators, and floodwater protection for the onshore site.Phases 4 and 5 are currently being developed by Agip (operator, 60%) in partnership with Petropars (40%), with part of the production intended for export to Pakistan by pipeline.
Phases 6, 7 and 8 are being developed by Petropars, which is a NIOC subsidiary. Production is to be piped to the oil fields in northern Iran for use in gas-injection schemes to maintain oil production levels.
Development contracts for Phases 9 to 14 are currently being negotiated and TotalFinaElf has tendered for a contract to develop Phases 11 and 12.

(4) Production

(5) Consortium

(6)Petronas

Malaysia's national oil company Petronas was formed in 1974 to manage all the country's oil and gas resources. Petronas currently operates two oil refineries and a domestic network of service stations and is also a player in LNG and petrochemicals. The company exports both crude oil and refined products to world markets and since 1990, Petronas has been an active international player, investing in exploration-production projects abroad. The company currently has interests in Asia, the Middle East and Africa.

(7) Gazprom

The Russian gas company Gazprom, which is 40% state owned, is the world's largest producer of natural gas. Gazprom accounts for nearly 23% of world gas production and about 40% of all gas exports. The company is active in all areas of the gas industry, from extraction and treatment to transport and distribution. Gazprom has its own shipping company and its own airline as well as pipeline and offshore platform construction subsidiaries.
Gazprom supplies gas to all regions of Russia and exports to a dozen countries, including Germany, Greece, Italy, France and Austria. The company supplies nearly 20% of all natural gas used in Western Europe.

(8) Gaz acides

With deposits of sweet gas becoming increasingly rare, most undeveloped deposits now involve sour or very sour gas, i.e. containing acid gases. Gas deposits are considered normal or moderately sour when they contain less than 10% hydrogen sulphide (H_2S) and less than 15% carbon dioxide (CO_2). South Pars (1%-1.5% H_2S and 3% CO_2) contains moderately sour gas. Some 97% of the H_2S and CO_2 is removed before the gas is fed into the grid.
Other deposits being developed by the Group are extremely sour.

2.1. Le contrat de « buy back »

In January 2002, President Khatami paid an official visit to the South Pars 2 and 3 site.

Most contracts entered into by oil companies today involve either concessions or production-sharing arrangements (PSC) which grant the company all or part of production.
On the other hand, all the contracts signed by TotalFinaElf and Iran are “buy back” agreements, because Iranian law does not allow foreign companies to own mining rights on Iranian soil or any hydrocarbons that may be found there. Buy back agreements allow Iran to avoid the investments necessary for exploration and construction of production facilities. All reserves and production on South Pars remain the property of Iran.
A buy back contract is a fixed-term agreement covering field development. The relevant company undertakes to finance, construct and commission all facilities
necessary to develop the field, in this case Phases 2 and 3 of South Pars. Under the terms of the contract, after **production start-up (1)**, operatorship will be **transferred (2)** to NIOC. Over a period of seven years starting from **first production (3)**, the consortium partners will be reimbursed their development expenses – up to an agreed ceiling – together with interest, and will also receive remuneration for their services. This reimbursement and remuneration is to be paid in the form of condensates lifted and marketed by the partners and, if necessary to make up the amount, by additional crude oil from Sirri A and Sirri E or other fields being developed under buy back contacts.
The terms of the contract committed the Group to generate a return on investment in a relatively short time and to transfer the necessary know-how to Iranian engineers and technicians.
The contract between NIOC and TotalFinaElf was signed on 28 September 1997.

DESCRIPTION

(1) South Pars : january 2002

(2) Operatorship transfer

Operatorship of the facilities has been transferred to the national company NIOC. The contract provides for TotalFinaElf and its partner to be reimbursed for their investments and remunerated for their services in crude oil from the field, over a period of five years from production start-up, with this period not to exceed seven years after first production.

(3) First production

First production is deemed to mean the first day of the following month once production has reached 250 million cu.ft per day for 21 days out of 28.

2.2. Phases 2 et 3

Via its subsidiary Total South Pars, TotalFinaElf is operator for Phases 2 and 3 of the South Pars field. As operator, the Group is responsible for engineering, procurement, construction, commissioning and production start-up, which was achieved in early 2002. The total development investment made by the project partners comes to about $2 billion.
The gas produced will be transported by pipeline to feed the Iranian gas grid, the condensates will be exported, and the sulphur recovered will be stored for export. Building the Assaluyeh gas-treatment facility in a desert zone in less than three years was a **tremendous challenge (1)**, both because of the **sheer size (2)** of the facilities and because of the complete absence of existing infrastructure.
As regards development of the offshore field, the short time frame meant that it would be difficult to apply the conventional model comprising data acquisition, processing and interpretation. In fact, the knowledge acquired on similar Middle East fields involving carbonate deposits allowed Group engineers to optimise the development scheme for Phases 2 and 3 of the South Pars field while minimising the geological uncertainties: definition of the structure, distribution of the petro-physical parameters (porosity, permeability), fluid quality (condensate ratio of the gas, H2S content), and location of the **gas-water contact (3)**. This last factor, the position of the gas-water contact, is primordial. As the zones to be produced on Phases 2 and 3 were not actually situated on the gas-water contact, it was not necessary to include water separation and water treatment units on the platforms, which will not automatically be the case when developing the other phases of the South Pars field.
A geological field mission was undertaken to provide more detailed information on the size and geological make-up of the porous elements of the **Kangan/Dalan (4)** reservoir, so as to be able to build an accurate geological model. Integration of data contributed by different disciplines (geology, geophysics, reservoir studies) was used to construct a 3D geological model.
Development of these two phases of the field involves construction **of two unmanned offshore platforms (5)**, with the untreated effluent being transported ashore to the treatment plant in multi-phase pipelines. The huge onshore facilities, stretching over nearly **150 hectares (6)**, include units for treating the **gas (7)** and **condensates (8)** and recovering solid **sulphur (9)**.

DESCRIPTIONS

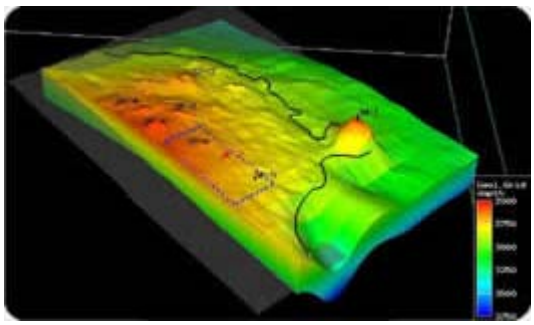
(1) Phases 2 and 3

SOUTH PARS : A giant gas field off the Iranian coast

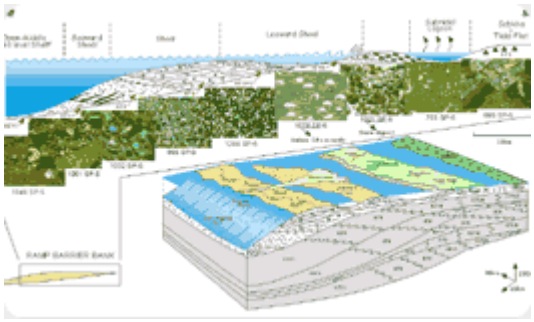
(2) The onshore site in figures

7 million cu.m of earth and rock excavated
130,000 cu.m of concrete
16 km of roads
2,200 km of cable
15,000 tonnes of metallic structure
520 km and 25,000 tonnes of pipes
1,000 items of equipment
1 boiler weighing 300 tonnes
2 incinerator chimneys 114 m high
2 gas flares 147 m high
120,000 tonnes of equipment
60 million man-hours of work
123 MW of power (enough for a city of 100,000 people)
2,600 tonnes/day of fresh water produced
680 tonnes/hour of steam produced
105 km of 32-inch subsea multi-phase pipeline (a world record)

(3) Gas-water contact



(4) Kangan/Dalan



The Kangan/Dalan formation (known as Khuff on the Qatar side) comprises four reservoirs, named K4 (the deepest) to K1, separated by impermeable non-reservoir layers.

(5) Unmanned offshore platforms

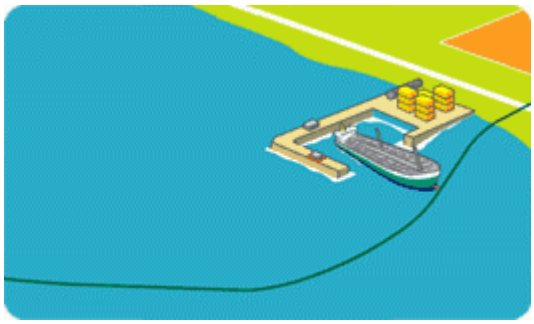
(6) An extraordinary construction project

As if the huge size of the construction site, the short time frame and the complete absence of existing infrastructure we're not enough, the challenge of South Pars was made even more difficult by cultural differences (the project included 21 different nationalities) and the extreme conditions (temperatures can go even higher than 50°C in summer).

(7) Gas treatment train

(8) Condensate stabilisation

(9) Sulphur solidification



2.3. The treatment plant

The Assaluyeh plant can treat 56 million cu.m of gas per day (amounting to about half the gas consumed in all of France). The facility produces 80,000 barrels of condensates and 400 tonnes of sulphur per day. The facilities use cutting-edge technology and comply with international standards. The “buy back” contract is thus a particularly advantageous arrangement for Iran, giving the country access to the latest technical innovations.
TotalFinaElf sub-contracted overall management of site construction to the Korean firm **Hyundai (1)**, which was responsible for procuring material and coordinated the teams of Iranian workers. The items of **plant (2)** at Assaluyeh in fact comprise a sort of “**gas refinery (3)**”: four **treatment trains (4)** each including desulphurisation or “sweetening”, dehydration and mercaptan removal, plant to compress the gas for export, condensate stabilisation and **storage facilities (5)**, **sulphur recovery (6)** units and **MEG (7)** (mono-ethylene glycol) regeneration and injection units, as well as the usual utilities (units for producing **electricity (8)**, **steam (9)**, instrument air, nitrogen and fresh water), **office buildings (10)** and **laboratory (11)**.
The first treatment train was brought into service in February 2002 and the first gas was fed into the national grid on 11 March 2002. The three other trains were commissioned in turn over the next few months, and by the end of the third quarter of 2002 the Assaluyeh site had reached maximum capacity. The condensates are piped to a loading **buoy (12)** for **export (13)** by tanker and the gas, all of which is intended for domestic consumption, is fed into Iran’s national grid via a 56-inch pipeline.

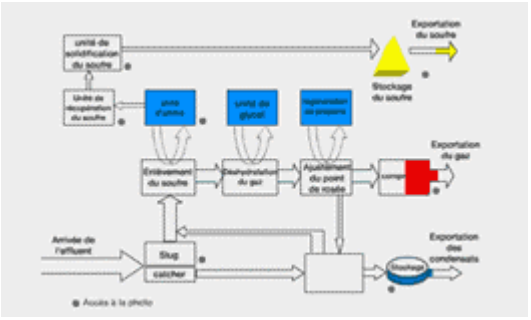
DESCRIPTIONS

(1) The site entrance

SOUTH PARS : A giant gas field off the Iranian coast

(2) Phase 2 - Phase 3

(3) Gas treatment



(4) Treatment trains

(5) Stockage facilities

(6) Sulfur recovery

(7) MEG : regeneration and injection

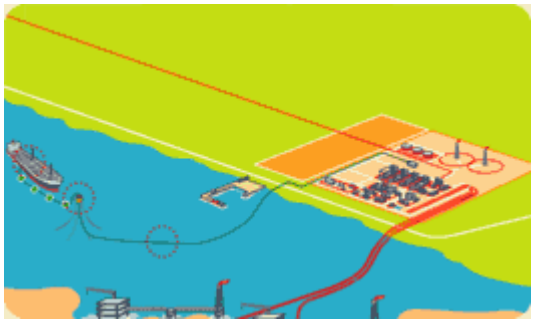
(8) Power generation

(9) Steam generation

(10) Office building

(11) Gas analysis laboratory

(12) Loading buoy



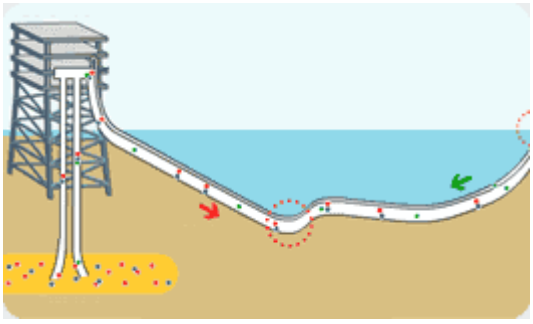
(13) Loading buoy SBM

3. Developing South Pars

Operations on South Pars use technologies such as deviated drilling and especially **multi-phase transport (1)**, allowing the gas to be piped untreated from the depths of the sea to the onshore facility at Assaluyeh.
In order to extract the gas from South Pars, the Group constructed two wellhead platforms (**SPD3 (2)** and **SPD4 (3)**) in 65 metres of water and a total of about 20 wells were drilled from these two unmanned platforms. Once extracted, the gas is piped directly ashore, without separation on the platforms, via two 32-inch pipelines 105 kilometres in length. This arrangement is known as a "**wet scheme (4)**".

DESCRIPTIONS

(1) Multi-phase transport



(2) SPD3 Platform

(3) SPD4 Platform

(4) Wet scheme

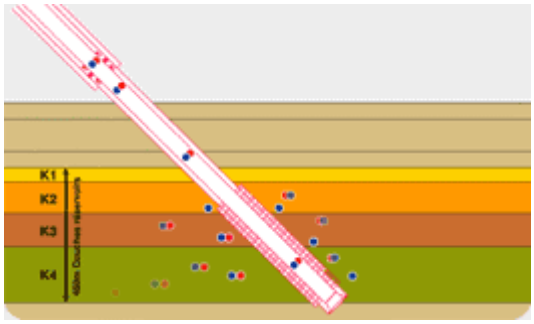
With a wet scheme, all the effluent is exported ashore in a single pipeline together with the production water and related condensation. In this case, additives such as glycol or methanol must be included to prevent corrosion and the formation of hydrates.

3.1. Deviated drilling

Deviated drilling allows operators to reduce the number of surface facilities required, particularly in the case of offshore deposits. It is today possible to drill several drains at different depths, in different directions, sometimes involving long and indeed twisting trajectories, all starting from the same original well.
On South Pars, deviated drilling was used is a fairly conventional way. The **wells (1)** have an average inclination of 50° and are about 4,500 metres in length with a vertical depth of 3,000 metres. Each of the two production **platforms (2)** comprises ten producer wells: a cluster of nine deviated wells drilled out at an angle of 50° from a central vertical well. As the reservoir is made up of carbonate rock, all the wells were acidified in order to enhance well productivity.
The wells on South Pars were designed to be particularly robust so as to permit maximum production per well of 150 million cu.ft/day and to ensure maximum working life.
The last wells to be drilled were brought into production in early 2003.

DESCRIPTIONS

(1) Deviated well



(2) SPD4 Platform

3.2. The principle of multi-phase transport

With a conventional offshore gas production scheme, the effluents are treated on an offshore platform. This involves a number of different operations: separation of the hydrocarbons and production water, dehydration of the gas and adjustment of the dew point to avoid condensation. Once the oil and gas have been treated and separated, they are transported ashore in separate pipelines. This is known as mono-phase transport, with each fluid being considered as a single product, homogenous and isotropic.
Multi-phase transport (1) is an innovative technique that allows operators to reduce both development and operating costs for oil and gas production, particularly in the case of satellite fields. If the effluent is not to be treated on the platform, there is no need to build and maintain complex and expensive equipment. So the production platforms on South Pars are simple unmanned structures. There are two different types of multi-phase transport: **wet schemes (2)** and **dry schemes (3)**. South Pars was developed using a wet scheme.

Multi-phase pipeline flow (4)

With single-phase flows (i.e. transport of a single fluid), the fluid in the pipeline is considered to be homogeneous and isotropic. But with two-phase flows (when both liquid and gaseous phases of fluid are transported in the same pipe), the two phases tend to undergo separation because of gravity, particularly at low flow rates, with the liquid tending to flow in the lower part of the pipe and the gas in the upper part.
Depending on the interior shape of the pipeline, at low flow rates the flow of liquids may become intermittent die to a **“siphoning” phenomenon (5)**, causing “slugs” of liquid to alternate with pockets of gas at the pipeline landing point, along with extreme pressure fluctuations (severe slugging). As the flow rate increases, this intermittent flow regime will tend towards a more regular flow, thanks to a more even mixture of **liquid and gaseous phases (6)** in the pipeline.
The quantity of liquid contained in the pipeline depends on a combination of all the flow parameters, but particularly the slope of the pipe and the flow rate. With a steady flow, the liquid content is very high at low flow rates, and quantity diminishes with a rise in the flow rate.

DESCRIPTIONS

(1) Developing multi-phase transport techniques

After the second world war, new developments in the oil industry required advanced techniques. In the 25 years following the war, research gathered pace with more than 7,500 articles being published on two-phase pipeline flow phenomena. In 1974, Elf Aquitaine, Total and the French Petroleum Institute (IFP) joined forces to study loss of pressure during two-phase transport, in an effort to find ways of transporting untreated effluent in large-diameter pipelines over uneven terrain.
Experiments to observe the phenomena involved in two-phase pipeline flow were carried out in southwestern France, and the results led to the development of software called Pepite (for Profils d'Ecoulements Pétroliers IFP Total Elf-Aquitaine), able to calculate permanent two-phase flow characteristics, with the emphasis on horizontal and slightly inclined terrains. In 1987, the same Group designed another programme, called Wellsite, able to calculate vertical flow characteristics. Then in 1992, Elf Aquitaine, Total and IFP launched the Tacite programme aimed at developing software capable of modelling two-phase flows.
On a slightly different note, in 1984 a consortium comprising Total, Statoil and IFP launched the Poseidon project aimed at developing the pumping technologies required for multi-phase effluents. Their combined research led to the development of the multi-phase pumps used on the Dunbar field in the North Sea.
Work done on the Poseidon programme also contributed to the Olga programme.

(2) Wet scheme

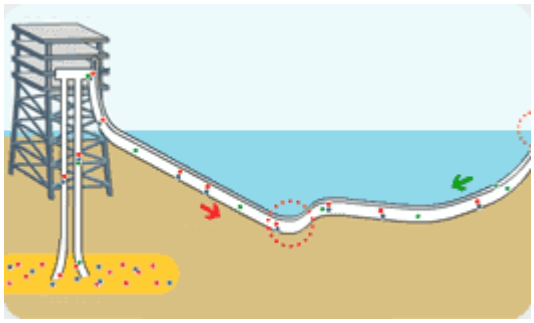
With a wet scheme, all the effluent is exported ashore in a single pipeline together with the production water and related condensation. In this case, additives such as glycol or methanol must be included to prevent corrosion and the formation of hydrates.

(3) Dry scheme

With a dry scheme, the offshore platform includes facilities for treating production water and dehydrating the gas. The residual water content in the gas is then adjusted to reduce the risk of hydrate formation and corrosion once the liquid and gaseous hydrocarbons are mixed together again for export ashore in a single pipeline.

(4) Multi-phase transport

(5) « Siphoning » phenomenon



(6) Checking gas content

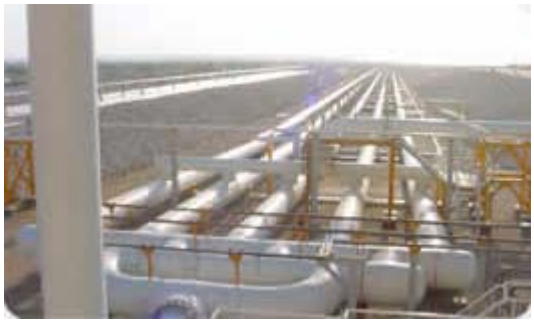
3.3. The South Pars gas transport scheme

South Pars is the largest project in the world to date using multi-phase transport over such a distance. The transport scheme involves two 32-inch pipelines stretching over 105 kilometres from the field to the onshore facilities. The scheme also includes a 4.5-inch line mounted on each of the main pipelines to carry the **glycol (1)** (MEG) that is injected on the platform and then regenerated ashore for reuse. The role of the glycol is to prevent the formation of gas hydrates -- which could block the pipeline at low flow-rates – and to reduce the acidity of the effluents so as to avoid corrosion and thus prolong pipeline life.
On South Pars, TotalFinaElf opted for a wet scheme to transport the effluent to shore. This technique allows the effluents to be carried together in the same pipeline. It is known as a wet scheme because the effluents have undergone no treatment on the production platform and thus still contain water (both production water and condensation). Glycol, brought out to the platform in a special line mounted piggy-back on each of the main gas pipelines and laid at the same time, is injected on the production platform.
A **slug catcher (2)**, installed where the gas line enters the onshore facility, separates the gas and liquids, thus ensuring an even flow into the treatment plant.

DESCRIPTIONS

(1) MEG unit

(2) Slug catcher



A buffer apparatus installed at the end of a pipeline and designed to cushion the flow-rate surges (by means of a fluctuating liquid level) and ensure an even flow of effluent into a treatment plant downstream.

4. South Pars and the local community

Given its scope, the South Pars project is providing significant economic stimulus for the surrounding province, which is destined to become a major industrial zone.
In addition to the industrial infrastructure related to the project and the numerous jobs created, as well as the training provided for local personnel, TotalFinaElf has launched a number of initiatives designed to benefit local communities, with the emphasis on health-care and **social programmes (1)**.

DESCRIPTION

(1) Social programes

As part of its commitment to sustainable development, TotalFinaElf financed the renovation of the Ibne-Sina school in Nakle-e-Taqi.

The girls' classroom..

The boys' classroom.

4.1. Employment and development

As early as 1998, the Group began building a veritable town on the South Pars site, complete with health, sports and leisure facilities, as well as restaurants. Provision was also made for installation of local tradesmen such as barbers and tailors – not forgetting of course **bakers (1)** to provide traditional Iranian bread.
The project managers had to recruit and coordinate the efforts of more than 10,000 people at South Pars, a mix of local and international contractors and sub-contractors involving managers, operators and technicians from all over the world. In all, the project team included people of 21 nationalities – Koreans, Thais, Filipinos, Indians and Europeans. Despite the cultural spread, 90% of the people employed on the project were Iranians, most of whom came from the northern part of the country. Local and international employees quickly learned to work together towards the successful realisation of this gigantic project.

Training (2)

One of the key element of the project partnership is the commitment made by Total South Pars to transfer skills to the Iranian personnel. Given that for a number of years Iran had been cut off from ongoing developments in the oil industry, the local engineers and technicians needed to be brought up to date on the latest techniques and new equipment being used by the international oil industry. It was also necessary to prepare the eventual **transfer of operational responsibility (3)** by ensuring the effective transfer of the necessary know-how.
Right from the start of the design studies, a team was specially set up to ensure that the future production operators were suitable prepared for their tasks. As construction of the facilities progressed, the teams began drawing up operating procedures and writing manuals covering operation and maintenance of the various plants.
At the same time, a training programme for young university graduates was set up, including courses in English language (3 months), basic oil and gas industry knowledge (5-6 months) and then 16 weeks training in specialised areas.
To make this training more effective, TotalFinaElf developed dedicated software designed to monitor progress of individual trainees. Following the theoretical courses, hands-on training under field conditions was organised in several refineries operated by NIOC.
Since the beginning of 2000, 650 young graduates chosen from among 7,000 applicants have benefited from this training. Courses have been organised at four different sites – Assaluyeh, Isphahan, Tehran and Mahmud Abad – by Iranian instructors working under the supervision of TotalFinaElf specialists.
By March 2000, 350 of the trainees had already been integrated into **production teams (4)**. Furthermore, a number of operators recruited in other parts of Iran and made available by the future operator NIOC have also received specific training in language and technical skills.
Expatriates are now gradually being replaced by the operator's own personnel.

SOUTH PARS : A giant gas field off the Iranian coast

DESCRIPTION

(1) Iranian bakers

(2) Training

(3) Transfer of operational responsibility

(4) Production teams

4.2. Safety and Environment

Safety (1)

A major effort was made to ensure that safety remained a permanent concern for every person working on the project, and Total South Pars drew up a special set of safety recommendations for the project site.
Nearly 6,000 drills and **training sessions (2)** were **organised (3)** to boost safety awareness and to ensure that **all personnel (4)** complied with the relevant safety procedures.

Environment (5)

In November 1998, less than a month after work on the onshore site began, Total South Pars ordered an Environmental Impact Assessment (EIA) to be carried out on the site and in the surrounding area. A similar assessment was carried out in October 2002, once production had begun. Oily (production?) water and water from cooling systems are decontaminated in special treatment units before being **discharged into the sea (6)**.
The Group has also set up a system of sensors placed around the various facilities to detect hydrogen sulphide (H_2S) and sulphur dioxide (SO_2) contained in any emissions released into the atmosphere.
Lastly, TotalFinaElf has launched a special operation called **Flamingo (7)** aimed at protecting the only **mangrove (8)** forest in the whole of the Arabo-Persian Gulf.

DESCRIPTION

(1) Safety

(2) Safety

The Group's Health Safety Environment Commission (HSE) funded special training in France for two Iranian doctors, who attended a course in emergency medical care.
In addition, 19 young Iranian graduates attended courses culminating with the award of the internationally recognised British National Examination Board in Occupational Safety and Health (NEBOSH) diploma.

(3) Training

(4) « Tool box meeting »

Before receiving instructions on the day's tasks and a security brief, a team gathers for a short gymnastics session – a healthy custom learned from the Koreans working for Hyundai.

(5) Environment

(6) Burn pit

(7) Operation Flamingo

The South Pars facility is located close to the only mangrove forest in the Arabo-Persian Gulf. Operation Flamingo involves using anti-pollution materials to close off the entrances to the backwaters, thus protecting the mangroves.

(8) Mangrove