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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
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RESTRICTED

ENGLISH
June 1989

17601

DESIGN OF STEAM INJECTION IN THE VISCOUS OIL FIELDS IN ALBANIA

SI/ALB/88/801/11-02

PEOPLE'S SOCIALIST REPUBLIC OF ALBANIA

Technical Report*

Prepared for the Government of the People's Socialist Republic of Albania

by the United Nations Industrial Development Organization,

acting as executing agency for the United Nations Development Programme

Based on the work of Mr. Hadi Baba-Ahmed
Consultant

Backstopping officer: M. Derrough, Industrial Operations Technology Division

United Nations Industrial Development Organization
Vienna

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ABSTRACT

Albania produces about 1.5 x 10^6 tons of oil a year, of which 60% come from heavy oil fields in Qylet Stalin and Patos.

It has produced oil with cyclic steam injection in Q. Stalin since 1983. Steam soak of this field has started this year in this field. It is extending cyclic injection in Patos. However, because of deeper layers (i.e. 900 meters v.s. 500 meters) problems experienced since 1983 such as packer seal leaks, clay swelling, etc. need urgent solutions for a successful recovery in Patos.

This paper reviews some of the problems and some of the solutions proposed for increased OSR and for better handling of operational problems.

FIG. 1


ALBANIA
International boundary
National capital
Railroad
Road
ADRIATIC SEA
YUGOSLAVIA
GREECE
LAKE SCUTARI
LAKE OHRID
Koplik i Poshtëm
Shkoder
Puke
Kukës
Lezhë
Rrëshen
Dibre
Laç
Burrel
Kruje
Vorë
TIRANË
Durrës
Librazhd
Elbasan
Rrogozhine
Cërrik
Lushnje
Gramsh
Pogradec
Ohrid
Stalin
Fier
Berat
Korce
Selenice
Vlore
Corovode
Mavrove
Kelcyre
Tepelene
Permet
Ersеke
Leskovik
Himare
Gjirokaster
Saranse
25 Miles
25 Kilometers
Mediterranean Sea

COUNTRY BACKGROUND AND STATISTICS

GEOGRAPHY

Being one of the smallest nations in Europe, Albania covers an area of 28,500 km^2. It is bordered on the west by a 362-kilometer (225-mile) coastline on the Adriatic Sea, on the north and east by Yugoslavia, and on the south and east by Greece.

About 20% of Albania is flat to rolling coastal plain, poorly drained in places, thus creating marshes. However, Albanians are reclaiming most of the marshes for agriculture by a system of dikes. Most of the country consists of hills and mountains, often covered with scrub forest. Major cities are located in the coastal plain or in the larger upland valleys. Primary rivers are not large and flow generally east to west. The Buene (Bojana) River, which forms the outlet for Lake Scutari along the Yugoslav border to the north, is the only navigable river.

Along the coast, Albania has mild, wet winters with a January low of 5.5°C (42°F) and dry, hot summers with a July high of 28°C (83°F). The interior is cooler and rainy.

In winter, the mountain peaks are covered with snow.

So far, Albania has not invested in tourism. Its coastline with its clearwater seashores and untouched beaches, its mountain slopes covered with snow, its canyons with numerous springwater falls as well as its numerous and rich archeological sites remain sources of revenue that have not yet been tapped.

PEOPLE

Ninety-six percent of the people are ethnically Albanian, comprising two groups: the Gegs to the north of the Shkumbin River and the Tosks to the south. Their differences in physical traits, dialects, religions, and social customs are distinguishable but not pronounced. Albania has achieved a degree of homogeneity uncommon elsewhere in Eastern Europe. The only significant minority in Albania is ethnic Greek.

More than 1.7 million people of Albanian extraction reside in Yugoslavia (mostly in the autonomous province of Kosovo), and Italy and Greece have large Albanian communities. Most Albanians (70%) were Muslim, a legacy deriving from 500 years of Turkish rule. A Christian minority of Orthodox (20%) and Roman Catholics (10%) traces its origins to the missionary activity of the apostles in the first century A.D All religious organizations and activities are specifically prohibited by the present constitution and by government policy. However, many older Albanians continue to practice their religion privately, and the state has preserved religious buildings (churches and mosques) and relics by restoring and turning these institutions into national museums.

The state has devoted considerable attention to raising the people's educational level. Literacy has been raised from about 20% in 1945 to an estimated 90% in recent years. The national language of the country is Albanian, an Indo-European language thought to stem from the ancient Illyrian. People are extremely warm and friendly to foreigners and seem eager to assist foreigners in learning about their history, culture and background.

HISTORY

Police checkpoints, army patrols, manned anti-aircraft guns, thousands of small "bunker" houses throughout the country, and guns pointed at seashores may seem odd to a foreigner visiting the country. The semi "state of vigilance" that one can observe can only be understood, if one considers that Albanian in historical times, until recently has been subjected to foreign domination. Albanians are proud of their independance and are ready to defend it.

The remains of the several foreign countries that dominated Albania can be found throughout the country: In Durras where in 1966 a completely preserved coliseum of 15,000 spectators was unearthed, in Buthrotem, where several civilizations built walls upon walls, castles on castles, baths on baths - Greeks, Romans, Christians, etc.

Its national hero, Skanderbeg, achieved fame by overcoming superior Turkish forces to establish an independent Albania which lasted from 1443 until 1478 (10 years after his death). This was the only period until the 20th century in which Albania was completely independent. Until then, for four and one-half centuries, Albania was ruled by the Ottoman Turks. Western influence did not begin to penetrate until independence in 1912.

In November 1912, at the height of the First Balkan War, a provisional government was established, and Albania declared its independence from Turkey. Despite the intentions of certain Allied Powers during World War I to dismember the country, Albania was re-established as an independent state by the Paris Peace Conference. In 1920, Albania was admitted to the League of Nations and remained a member until Mussolini's invasion of the country in 1939.

Following Italy's surrender in 1943, German troops occupied the country. Germany retreated from the Balkans in 1944, by which time the communist-led National Liberation Front (NLF) took control of the country on 29 November 1944, establishing the regime which has ruled ever since.

Albania professes a strict Marxist-Leninist doctrine, and as a consequence has isolated itself even from the USSR and China, when these countries seemed to deviate from the doctrines' principles.

However, recently Albania's leadership, seeking to improve its industrial output, has embarked on a business-like approach, and is seeking "rapprochement" with other countries. It has recently opened several embassies in foreign countries, and tourists are becoming more visible in Albania's hotels and resorts.

GOVERNMENT

Albania adopted a new constitution in 1976. Nominally, the supreme organ of government is the 250-member People's Assembly, the unicameral legislative body. In practice, the assembly meets only a few days each year to ratify actions taken in its name by the presidium of the assembly, the chairman of which is the chief of state.

The Council of Ministers is the top executive organ of the government; its chairman is the head of government. The AWP, the communist party, controls all government functions.

The judiciary consists of a Supreme Court and regional and district courts. Administratively, Albania is divided into 27 districts. Authority is vested in People's Councils, which meet several times a year. Actual power rests with the Council's executive committees, which are in continuous session.

ECONOMY

Reliable figures on the Albanian economy are difficult to obtain. Up to now, the Albanian Government has published only percentage indicators of economic growth and plan fulfillment. According to official statistics, national income during the 1960s and 1970s has grown at a rate averaging 7% annually while the annual rise in per capita income was about 4.5%. In the early 1980s, however, the GNP growth appears to have slowed to about 4.5% with the rise in per capita income remaining about the same.

Historically, the Albania reputedly has been the poorest country in Europe. At the outbreak of World War II, more than 80% of Albanians derived their living from agriculture, the highest proportion of any European country.

After coming to power in 1944, the Communist regime devoted its efforts to building an industrial base as quickly as possible. The economic model employed was that of the Soviet Union under Stalin, and impressive gains in industrial output were achieved. The extremely low starting point is reflected in the fact that even in 1970, about 60% of the workforce was engaged in agriculture. Recently, the Government has shown greater awareness of the need to improve productivity and quality of output.

Albania claimed that self-sufficiency in breadgrains was achieved in 1976 and that in 1977 needs were fully covered despite a damaging drought.

Albania perennially ran a substantial foreign-trade deficit as long as it obtained credits from various benefactors. Since it now ties imports to exports, the deficit seems to have been substantially reduced, if not eliminated. Several countries have given Albania short-term commercial credits to expedite trade. Albania's annual total trade turnover is believed to be under US$ 500 million. Most of this turnover is with noncommunist countries. Trade with Eastern Europe has hovered around 35% during the 1970s. Albania's largest trade partners are Yugoslavia, Czechoslovakia, Italy and Greece.

SOME ECONOMIC INDICATORS

Individuals

Salaries	450 - 1200 Lekes (US$ 1 = 7.00 Lekes)
Rents	25 - 35 Lekes
Bicycle	700 Lekes
Oven	800 Lekes
TV	3,500 Lekes
Income Tax	Zero
Interest on Savings	3-5%
Interest on Personal Loans	Zero
Kwh	0.3 Lekes
Meat kg	9 - 15 Lekes
Fish kg	2 - 7 Lekes
Bread Kg	2 Lekes
Milk ltr	2 Lekes
Vegetables kg	2.5 - 3 Lekes
Kerosene ltr	0.7 Lekes

Expenditure for family of 5 (food, rent, electricity, water, kerosene): approx. 300/350 Lekes

Men's suit	350 - 800 Lekes
Women's dress	50 - 150 Lekes
Men's slacks	60 - 100 Lekes
Shoes	50 - 100 Lekes
Shirt	15 - 30 Lekes
City bus ticket	0.3 Lekes
Restaurant meal	7 - 10 Lekes
Train (Tirana - Fier)	10.50 Lekes

State

Income in million Lekes 1987

Centralized state income	3,934
Income from enterprises	1,864
Social insurance	863
Other	1,823
TOTAL	8,484

Expenditure in million Lekes 1987

Investments	4,452
Social-Cultural	2,635
Defense	1,011
Administration	145
Other	235
TOTAL	8,478

Investments (in million Lekes 1987)

Industry	1,997
Agriculture	1,340
Transport and Communications	239
Education	124
Housing	235
Other	416

Exports (1987)
in percentages of total 100 - exact figures not available

Fuel	11.0
Electricity	13.1
Metals	29.3
Chemicals	1.2
Constr. Materials	1.3
Proc. food stuffs	9.8
Unpr. food stuffs	8.2

Imports (1987)
in percentages of total 100 - exact figures not available

Machinery & equipment	26.2
Spare parts	6.7
Fuels, minerals & metals	28.2
Chemical & rubber products	14.2
Food stuffs	5.4
Consumer goods	6.5

Exports by Country 1987
in percentages of total - exact figures not available

Czechoslovakia	12.4
Yugoslavia	11.1
Romania	9.3
Bulgaria	7.5
East Germany	6.8
China	6.1
Poland	6.0
Greece	5.5
Italy	4.4
Switzerland	4.3
West Germany	4.0
Austria	3.5
Other Communist countries	1.0
Other Non-Communist countries	8.4

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SUMMARY AND RECOMMENDATIONS

1. General Comments

To increase the exposure of Albanian engineers and operators to equipment development in enhanced recoverey methods, it is recommended that the Institute of Technology for Gas and Oil (ITGN) take the following actions:

- Increase informal channels of communication with other institutes (e.g. IAP, IFP, IMP, INTERVEP, etc.), or other institutions (e.g. Alberta Research Council).

- Establish engineering exchange programs with these institutes.

- Establish study tours, on a routing basis, to visit other operators and to exchange information, and at the same time invite other operators to visit Albanian fields and facilities.

- Establish an engineering library equipped with complete sets of international codes and standards, such as ASTM, ASME, DIN, AFN, API, etc., and manufacturer's catalogue and data sheets for equipment.

- Before purchase, send engineers to visit specific manufacturers, facilities, and later witness testing of purchased items.

- Invite specialists to give seminars in Albania, on subjects of concern to Albanian operators.

- Eventually establish design manuals and engineering design standards (i.e. typical curves for heat losses, pressure losses, typical foundations, etc.).

- Propose that annual meetings for EOR specialists and institutions be held in Albania.

- Establish a budget for the above activities and follow-up with scheduled activities.

2. Ovlet Stalin Field

2.1. The oil-to-steam ratio, OSR, is small due to the inherent characteristics of the reservoir. To increase the productivity, the operator will have to review the reservoir characteristics and to test in a laboratory various parameters and various chemicals to see if these can affect productivity. To this end the Patos laboratory should equipped with the following:

- Steam generator: 150 bars, 90% quality steam and Q = 0,5 t/h.

- Cells: 50 cm long with 40 mm diameter equipped with thermocouples at different levels.

- Thermostatic cabinet and a small computer.

However, it is to be noted that the cyclic steam stimulation of Q. Stalin field was carried out successfully by operators and engineers who had no previous experience in steam stimulation.

2.2 There are some equipment and various operating problems such as:

- Erratic steam flow measurements due to damage by frost of flowmeter cells. The operator should prepare a specification and go out for bids for selection of suitable flowmeters.

- Lock-out of the steam generator after a water feed pump shut-down. The operator should install a by-pass line with a check and a se- roid operated valves and a time delay control system, to allow stand-by pump motor to come up to speed.

- Hunting of the air-blower motor due to erratic signals from the steam generator electronic controllers. The operator should purchase from the electric controller manufacturer the testing and calibrating instruments needed to bring the instrument signals within proper operating ranges.

- Vibrating of control panels and corrosion of various components especially the relay contacts due to heat and presence of gaseous or chemical vapors. The operator should install forced draft fans with fresh air intake in the control panels.

- The packers have been removed from the wells due to leakage and swabbing of their seals. The operator has abandoned the idea of using packers for cyclic steam stimulation. The operator should investigate other packers' brands with emphasis on garantee and follow-up in the field by the manufacturer, especially for the continuous steam injection programme.

- Lack of temperature and pressure measurement devices dowhole. The writer will send out to the operator documentation and manufacturer's catalogue information.

3. <u>Patos - Pilot</u>

3.1 The generator size was based on standard design parameters used in the industry (i.e. tons of steam/meter thickness of pay zone, etc.).

To avoid operational problems with the equipment, it is recommended that:

- The control panels and the electrical distribution boards be located in a separate skid-mounted control room to avoid vibration, heat and corrosion problems.

- The feed water pumps skid be mounted on its own foundation.

- The testing and calibration instruments should be purchased at the same time as the steam generator.

3.2 The operator remains very sceptical as to the proper selection of a packer who will have to operate in severe temperature and differential pressure conditions. It is recommended that the operator go out for bids internationally for these packers. We recommend also that Albanian operators and engineers visit the facilities of packer manufacturers while on their forthcoming study tour. To this end we recommend that their study tour be extended beyond three weeks.

3.3 Here again, Patos test laboratory should have the proper equipment to simulate reservoir conditions and test different pressures, flows and different chemicals for solution of problems such as: clay swelling, emulsions, etc.

3.4 The operator is also concerned with the proper design of the well casing. Either the engineering formulas should be made available to him or a well design engineer should be dispatched by UNIDO to Patos for a week.

4. Operator's Concerns

4.1 According to the programme established between UNIDO and ITGN (as defined by Albanian operators and engineers to the writer), even after the visit of two experts, the following items have not been resolved:

- Solutions to packer problems;

- Casing design under the temperature and pressure conditions in Patos pilot;

- Mathematical modeling and predictive methods under continuous injection conditions for Q. Stalin. The Operator has used a mathematical model but would like to know if other techniques or models exist in the industry;

- The assistance provided by UNIDO is slow in getting enacted and is delaying the implementation of the Patos pilot programme, thereby causing losses in revenues for Albania;

- Technical literature promised earlier to ITGN has not been delivered yet and recommendations made by previous expert have not been acted on.

To alleviate some of these concerns, it is recommended that the following actions be taken by UNIDO:

- As recommended previously, the programme for the study tour should be amended to include visits of packers manufacturer's plants (Baker, OTIS, etc.). The study tour should be extended as needed to include such visits.

- Provide a well design specialist for high temperature encountered in steam stimulation. The specialist should explicitly review all design calculations with the Albanian engineers. He should also be familiar with downhole equipment problems and give suggestions to solving problems of: packer materials for high temperature, high differential pressure and corrosive conditions; downhole pump gas lock-out; simultaneous steam injection at different levels.

- Contact institutions such as the Alberta Research Council, IFP, INTERVEP, etc., for a programme of development of a mathematical model for Q. Stalin field continuous injection, unless such models already exist.

- Purchase copies of technical literature recommended previously by expert under contract 11-01.

- Purchase test laboratory equipment as recommended previously by expert under contract 11-01.

- Expedite the Albanian engineers study tour. The budget allocated for this programme should be reviewed and readjusted if necessary at the earliest date. Sums for oil sample testing should be allocated to some of the recommended items listed above. Patos laboratory is well equipped for this testing.

- A detailed schedule (acceptable to the ITGN) should be established for the implementation of the above listed recommendations. Follow-up of the schedule should be by both ITGN and UNIDO.

I. Q. STALIN FIELD

1. Field Data/Characteristics

Qylet Stalin field, in Stalin city, is located about 30 km north-west of Fier, a city of 50,000 inhabitants. Fier itself is located 40 km north of Vlore, a major city. Major oil reservoirs of Albania are centered around Fier, in a radius extending 40 km from Fier. Albania produces about 1,500,000 tons of oil each year, of which 60% come from heavy oil reservoirs.

Number of layers	20
Thickness	3 - 10 m
Formation Temperature	28 - 30°C
Viscosity	300 - 10,000 cp
Permeability	70 - 500 md
Clay content %	25 30
Oil saturation	50 - 80 %
Associated Gases	0
Depth of layers	600 - 700 m
Angle of inclination	15 - 20°
Reservoir pressure	30 - 35 bars
Residual oil	80%
Density at 28°C	0.940 - 1.006 gr/cm^3

2. Field experience and field problems with cyclic injection

2.1 Steam injection started in 1980 at a pressure of 25 bars in three wells, with steam generated by a near-by power plant, and piped to the field. Following the good results obtained, data collected and laboratory work, it was decided to go ahead with the full-scale project in 1983. A 9 t/h, 105 Bar, 320°C, Austrian made BERTSH generator was installed. Steam quality was 98%. Cyclic steam injection started in a pilot with 12 wells. The wells were set 100 meters apart. This resulted in a dramatic increase in production from 400 to 1,000%. Since then the project was extended to 60 wells, in a 60 ha area. Fig. shows plan of field. The number of cycles per well was an average of 2 with 7 to 12 days injection, 2 to 3 days soak, 4 to 8 months production and 400 to 500 t of steam injected into each well, for the first year. Thereafter, an additional 20 - 30 % of steam was injected each year. The ratio of steam per thickness meter was approximately 80.5 t/m. The ratio of steam injected to oil recuperated was approximately 4.5.

2.2 Injection was first started with a packer. Due to packer problems (leakage and swelling) the packer was removed in 1983. Production continued without a packer. To compensate for the additional heat losses, injection time was increased. The tubing was fixed at the well head and was allowed to move inside the well. The casing was cemented all the way.

2.3 Insulation of the lines from the generator to the wells consisted of layers of mineral cotton, asbestos, sand-cement mixture, and a tar enamel tape for a maximum temperature loss of 10°C. The piping from the generator to the wells consisted of 3 1/2" main lines and 2.3/8" branch lines for a maximum pressure drop of 5 bars from the generator to the well-head.

2.4 Production experienced sand problems. Screens were installed on the surface.

2.5 Clay swelling problems were not addressed.

2.6 Metering consisting of orifice type flowmeters, temperature and pressure indicators at each well. Pressure and flow were regulated by a manually operated valve on each branch line to each well.

2.7 Major problems still unresolved are due to:

- Lack of calibrating instruments for the steam generator electronic controllers resulting in "hunting" of some equipment (i.e. fuel air blower);

- Lack of spare parts for the flow meter (i.e. freezing in winter of orifices lines caused deformation of flowmeter cells). Operator suspects also that meters used were not suitable for steam injection (i.e. they were direct purchase by barter).

- On shutdown of one of the water feed pumps, tentative manual restart of the standby pump was impossible due to overload of electric motor at start-up.

- Corrosion of relay contacts in the control panels due to heat generated by the steam generator and fumes by near-by fuel system. Corrosion also of control panels in water treatment cubicle.

- Vibration caused by skid-mounted water feed pumps have resulted in removal of pressure gages in suction and discharge lines of the pumps.

- Malfunction caused by the packers resulted in extreme down time of wells.

- Lack of instrumentation to measure pressure and temperature at bottom of well.

RECOMMENDATIONS

- Purchase of electronic calibrating instruments from the electronic controller's supplier: especially a milliamp generator. A temporary solution consits in installing an electronic filter cell at the output of the controller to smooth out output current.

- Purchase new flowm · rs suitable for steam injection. Insulate the lines from the orifice to the meter and install a small heater in each meter cabin to prevent freezing during winter when temperature drops to -10°C.

- Install an on - off by-pass valve with a chech valve around each feedwater pump. The by-pass will open automatically to allow the motor to come up to speed without being overloaded. An automatic control scheme should be installed to start the stand-by pump as soon as pressure drop is sensed (i.e. 3 - 4 bars). Timing should be such that ıe generator tube sections should not sense any significant drop ˉ flow.

- A solution to the corrosion and the heat problems would be tc remove all panels from their present locations and place them in a separate control room. A partial solution would be to install small fans inside the panels with a fresh air intake.

- As the feedwater pump skid is seated directly on the steel floor of a portable type building (with a vibration dampener in between), install additional vibration pads between pump-motor frame and the skid. A better solution would be to install the skid on its own foundation through the cabin floor.

- Operators have had experience with only one manufacturer of packers. Manufacturer representative was unable to resolve the problem of the packer when he visited the site. The Operator should issue specifications and tender documents to survey manufacturers and materials used in packers for the proper selection and installation of new packers. There have been several improvements in sealing components (i.e. elastomer and thermoplastic materials) in the last 10 years. Manufacturers should give laboratory results for the material they use and list applications. The Operator should then contact other operators for experience with the packers used. The Operator has ruled out the use of packers for cyclic injection in Q. Field: it is more expensive to use the packers. However, they still would like to install a suitable packer for continuous injection at Q. Field.

- Contact manufacturers of instrumentation to get detail data on instrumentation available today and permanent methods of installation of temperature and pressure sensing devices at the bottom of the well.

3. Comparison of Q. Field Cyclic Injection with other Fields

3.1 Performance criteria; design criteria.

An index frequently used in cyclic stema stimulation evaluation in the steam-oil ratio (or the inverse). This is defined as the volume of steam (STB water equivalent) per STB of oil recovered. One barrel of oil can evaporate 15 barrels of water, burned under 100% thermal efficiency; thus, a steam-oil ratio of 15 is the upper limit.

3.2 Comparison with other fields/Design criteria

The following comments should be considered as observations and not as conclusions.
Field parameters fall within design criteria established in table 1. However, recovery is low as compared to other successful fields. Recovery by cyclic steam in Q. Stalin has been estimated to begin at 2.5% to finally reach 5%. The OSR is also very low.

For other fields, this project would have been considered uneconomical. However, only a portion of the field has been covered and different characteristics of the field and methods used should be analyzed to determine, if a higher OSR can be obtained (i.e. use of adequate chemicals to offset the effects of clay swelling, steam quality, etc.). This requires an investment in laboratory equipment and chemical samples.

4. Continuous Injection at Q. Stalin

Continuous injection started in February 1989 in a 7-well pattern, with one injector and seven producers wells, at 73 bars and 1 ton/hour of steam, at temperature 220°C to 240°C.
Cycle will be: started 15 February - start producing 3 months after in 3 wells (15 May), and other wells 15 June. Cycle will last total of 18 months for this seven-spot pattern. Results will then be evaluated to extend steam soak for part of or the total field. Steam soak distribution presently is not uniform. On 13 June one producing well was shut because of water production.

It is too early at this stage to make any meaningful remarks. However, characteristics of soak fall within the design parameters established in table 1 and compare well with other fields.

TABLE 1

Stimulation and steam flood/Design criteria/1

	Cyclic	Steam flood
Formation thickness (ft)	20	30
Depth (ft)	3,000	3,000
Porosity	30	30
Permeability (md)	1000-2000	1000
Oil saturation (bbl/ac-ft)	1200	1200-1700
API gravity	15°	12-25°
Oil viscosity (Cp, at Res. Temp)	4000	up to 1050
Primary recovery (% OIP)	10	-
Steam quality (%)	80--85%	80-85%
Steam pressure (psi)	1400	2500
Spacing acres*	-	2,8
Steam injection/cyclic (bbl)	7000	-
Soak time (days)	1-4	-
Injection time (days)	14-21	-
Number of cycles	3-5	-
Cycle length (months)	6	-

* 1,5 acres in California, 2 acres in Alberta

/1 Farouk Ali

T A B L E   2

Q. FIELD

P bars	T °C	Year	No. of gen. work. days	Steam quality	Total steam injected	Oil/ steam ratio	Fuel (tons)	Output		Nb of wells	Total Nb of cycles	Production costs Leke/ton produced
								t/day	Total			
105	312	1983	117	44	1,820	0.357	982	43.5	5,096	8	20	1611,2
107	318	1984	144	75	6,157	0.30	2,832	142.5	20,503	17	48	1025.8
106	312	1985	231	86	9,444	0.234	3,399	174.6	40,326	32	52	773,6
105	312	1986	264	92	10,442	0.259	2,820	152.3	40,202	48	57	707.6
96	308	1987	225	98.2	9,832	0.261	2,950	167.6	37,657	56	58	700,9
94	305	1988	120	98,9	5,196	0.338	1,430	128.1	15,376	60	40	776,0

- Costs include investment costs (surface eqt., downhole eqt., storage, treatment produced oil, transport and operating costs such as fuel, maintenance, etc.).

Pasuritë minerale Mineral/Oil/Gas Resources

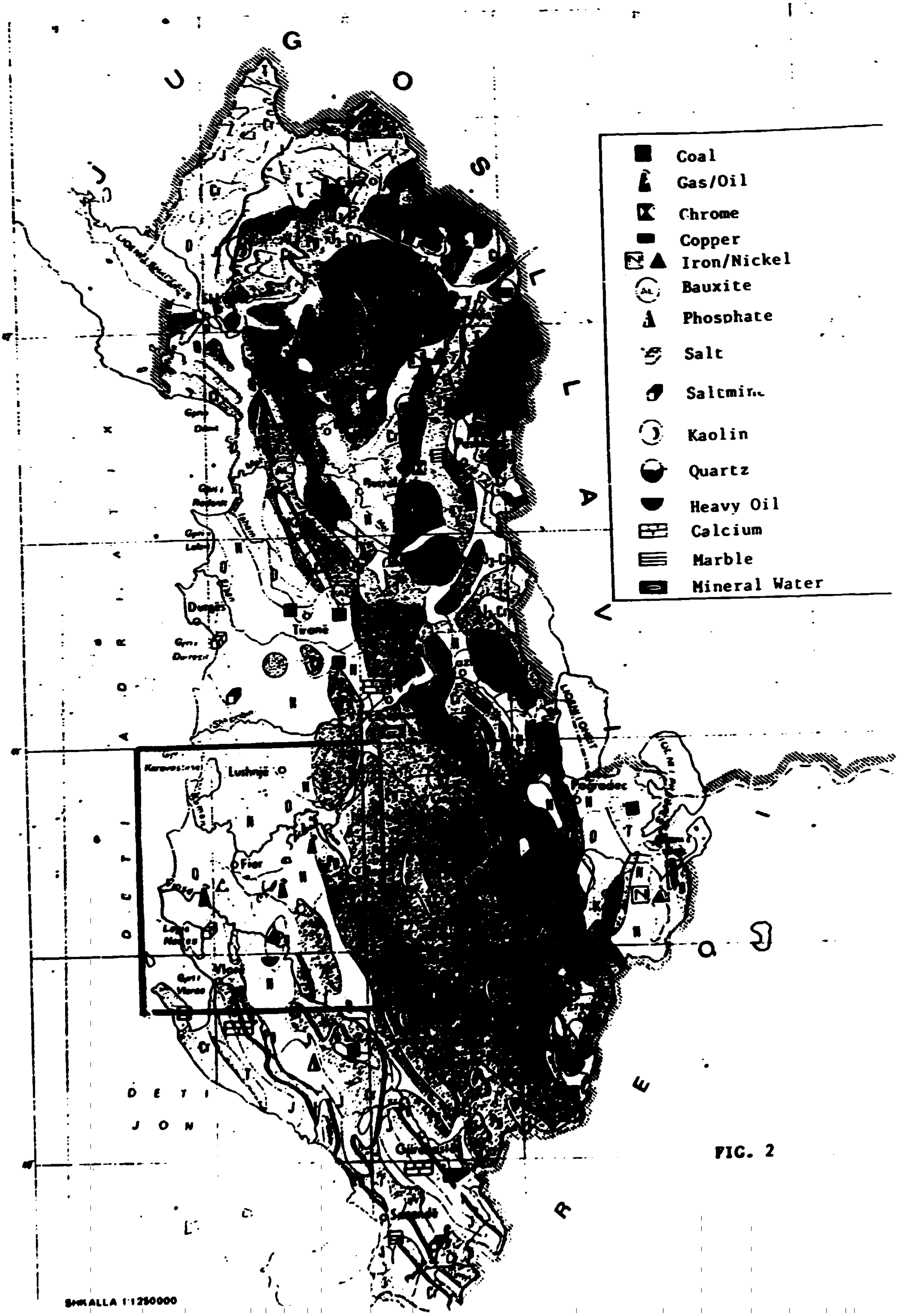

FIG. 2

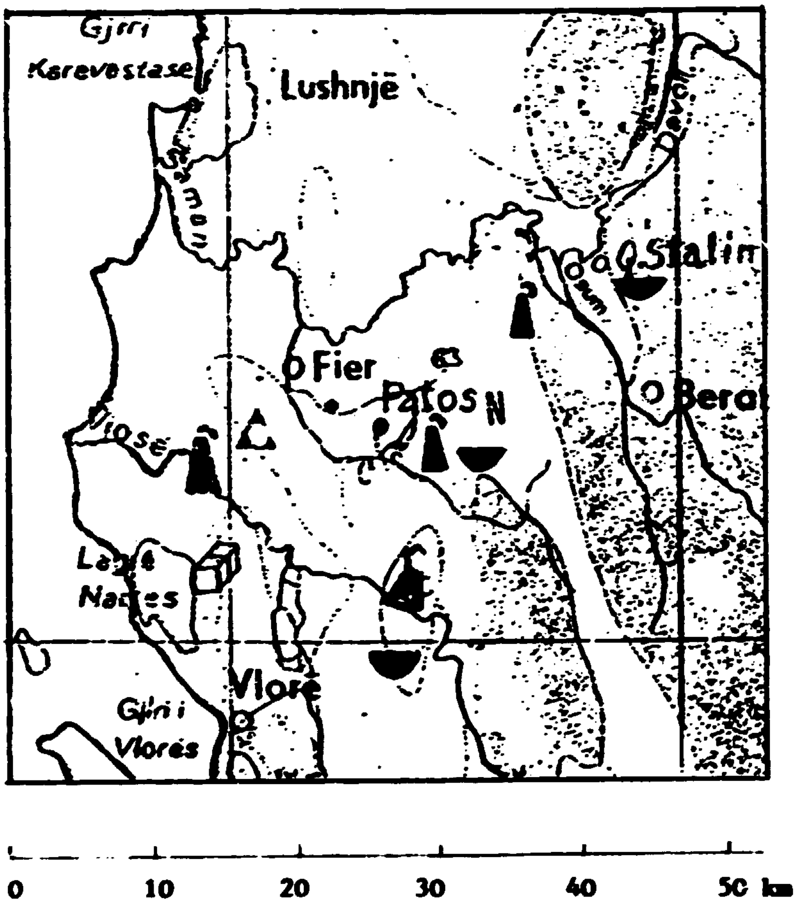

FIG. 3

Oil Reservoirs are all within 40 km from Fier

II. PILOT CYCLIC INJECTION AT PATOS

Patos field was the last discovered field, and is located about 15 km west of the city of Fier.

1. Field characteristics

Area	65 ha for Pilot
Nr. of layers	4
Thickness	8 - 16 meters
Formation temperature	28 - 30°C
Specific gravity	0.991 - 1.002 g/cm^3
Viscosity	15,000 - 33,000 cp
Permeability	200-1200-2400 md
Clay content/layers	Oil layers located within clay layers. Also clay layers between 0.5 to 3 m inside oil layers.
Oil saturation	70 - 80%
Asphaltenes %	10 - 25
Resins %	10 - 31
Oil %	25 - 45
Associated fases	CO_2+H_2S - 9-20%
Depth of layers	900 - 1000 m
Angle of inclination	10 - 15 %
Sulphur %	2.5 - 6, increasing w. depth

2. Pilot Site Selection

The pilot site selection was influenced by the following factors:

- There are old wells whose casing is cemented all the way.
- There is room where new wells can be drilled.
- Terrain accessibility.
- Be as far away as possible fcrm area where in-situ injection is being carried out (i.e. south of the field).

The steam generator will be on a hill overlooking the first area (to the North) that will be steam injected; it overlooks also the area that will be injected (south slope) later.

Directional drilling is not considered at this time, but for other well sites located on a hill opposite of the selected generator hill, this may be possible at a later date.

The first phase will consist of injection into 8 old wells and 12 new wells.

The spacing between the wells will be between 80 to 140 meters. The injection rate will be between 60 to 80 t/meter/cycle. The injection period will be between 10 and 15 days, depending on the thickness of the layer. The soak period will be 3 days for a total cycle of 12 months. the second phase will last approximately 5.3 years.

Cycles will be reconsidered after results of the first phase have been evaluated. It has been estimated that 7 to 9 % of reserves will be recuperated.

3. Generator selection

Based on reservoir pressure (30-35 bars), and allowable pressure drops in piping, a 150 bar steam generator will be selected with 80% quality steam and flow at 5 or 8 t/hour of steam. The 5 t/hour generator will be for injection into 2 wells simultaneously, while the 8 t/h one will be for simultaneous injection into three wells. The generator will be skid-mounted and movable. Output temperature will be 340.6°C. The main line will be 3 1/2" and the branchlines will be 2.318". Piping will be insulated for a maximum temperature loss of 10°C (i.e. 10 cm for the main line and 7 cm for the branch lines). Each wellhead line will be equipped with a manual shutoff valve, an orifice flowmeter and pressure and temperature indicators at the wellhead.

4. Costs

Costs have been established as follows:

- Drilling	30 x 10^6 leke
- Generator (incl. water and steam treatment)	4.8 x 10^6 leke
- Surface Eqt. (incl. piping, wellhead, insulation, motors, etc.)	5.1 x 10^6 leke
- Downhole Eqt. (tubing, rods, pumps)	4.1 x 10^6 leke
TOTAL	44.0 x 10^6 leke

Operating expenses will be between 42 and 53 x 10^6 leke/year. Production of 1 ton of oil will be approximately 680 leke (i.e. 9.7 US$).

5. Comparison with other fields/Q. Field and recommendations

To avoid certain problems experienced in Q. Stalin, it is recommended that for the steam generator:

- All control panels and electrical distribution equipment be located in a separate skid-mounted control house with proper heating and ventilation.
- The water-fed pumps be mounted on one skid, and that the skid be mounted on a separate foundation to avoid transmission of vibrations to other equipment or piping.
- The test and calibrating instruments be purchased at the same time as the generator.
- The fuel control and fuel distribution and on fuel treatment equipment be mounted on a separate skid or with water treating package.

Again here the selection of the steam generator was based on design standards as practiced in the industry (i.e. tons/meter thickness to be injected per table 1).

Piping design is well within allowable standard practices.

The site location of the steam generator is well suited for this application (i.e. power supply at 50 meters, access road existing (however needs grading), fuel gas line approximately 300 meters away, water supply tanks approximately 300 meters away and will feed generator feed pumps by gravity, generator situated in middle and overlooking pilot field to reduce heat losses and pressure losses in piping).

6. Operator concerns

The following items remain a concern to the Operator:

6.1 Packer design and selection

6.2 Casing design

6.3 Clay swelling problems

6.1. There are several packer manufacturers who have developed designs for severe temperature and corrosive conditions, and have developed materials for high temperature and differential pressures applications: elastomers and thermoplastics (i.e. Baker, OTS, Brown, Guiberson, Camco, Hughes Oil Tools, etc.). However, the Operator remains skeptical as to correct functioning in Patos, since the failure of the packers used in Q. Stalin. The use of packers in Patos is essential and the Operator is rightfully concerned that without it the steam injection will become a hot water injection.

Recommendations

- Beyond steps to be taken in selecting the best packer available in the industry as explained in previous sections (i.e. international bidding, inquiries with operators that have used the same packers) it is recommended that the operators engineers be allowed to visit manufacturers' plants and manufacturers' laboratories where these packers were developed and tested. Bid documents for the packers should have a section on testing of packers at the factory under similar field conditions (i.e. high temperature and high differential pressure).

- Some operators to prevent leakage of packers have used gases, at high pressures, in the annulus to reduce differential pressure across the packer. Patos operators might have to revert to this procedure.

- Patos operators might also have to consider the use of double wall insulated tubing which reduces to more than 5 times the temperature loss in a normal tubing.

6.2 Due to high temperature and depth, the operator is concerned with the design of the casing (i.e. buckling, cork-screwing). Well designers normally recommend the use of a N-80 casing with "Buttress" connections above 450^{o}F, fully cemented. Patos operators are not familiar with the engineering calculations for stresses developed under these severed conditions.

Recommendations

UNIDO should be made available to Patos operators a specialist in well design under high temperature, high differential pressure conditions for one week. The specialist should be prepared to review in detail engineering computations. He should also be familiar with design of downhole equipment.

6.3 Clay content is high both in Q. Stalin and Patos field.
Clay consists mainly of MONTMORILONITE AND KAOLIN, which increases by 50% in volume in the presence of water. Patos laboratory tests at atmosphere conditions have shown that the swelling of the clay was reduced to 30-40% range with additives such as $CaCl_2$ and or KCl (with 2 to 4% per volume).

The Operator intends to inject slugs of KCl. No chemicals were injected in Q. Stalin. Other operators have injected slugs of KCl and have added a dilution of KCl to the generator feedwater. These operators claim success.

However, nothing is known of the stability of these products at high temperature conditions as they exist in Patos.

Recommendations

There are other chemicals in the open market for treating clay swelling (see Annex). Here again, Patos operators need to have the necessary laboratory equipment to test, under reservoir conditions, these various products, and to select the proper chemical for their reservoir.

TABLE 3

HEAT LOSSES IN PATOS CYCLIC STEAM INJECTION

Fuel Energy Lurning in Boiler	Heat loss in boiler		Variant	Wells injected at same time	Heat loss in surfact lines		Borehole heat losses				Heat losses at bottom and top of payzone		Overall heat loss	
							with packer		without packer				with packer	without packer
Kcal x 10^9	Kcal x 10^9	%			Kcal x 10^9	%	Kcal x 10^9	%	Kcal x 10^9	%	Kcal x 10^9	%	%	%
2.3	0.47	28.1	5 t/h	2	0.002	0.1	0.147	8.8	0.295	18	0.115	7	43.3	53
			8 t/h	3	0.002	0.1	0.15	9	0.3	14.3	0.117	7.2	45.3	53.2

OTHER OPERATIONAL PROBLEMS

AND SOLUTIONS PROPOSED

ADDITIONAL QUESTIONS
raised by operators

1. At each surface producing well pump-motor set, can we ground the motor to the casting? Question was raised especially for areas where pump-motor set are in a rocky area where ground resistivity is high.

   Answer: The well casing is the best ground well one can hope to have. However, due to emv potential between copper ground wire and carbon steel, there will be corrosion problems with the casing. It is best to drill a well and add bentonite to achieve lower resistivity of the ground.

2. There have been cases of explosion on the surface of wells because of static electricity build-up by friction between the well rod and the casing, and the presence of gas above the casing.

   Answer: Ground the well rod.

3. On electrical transmission lines and distribution lines to various well pump-motors the breaker of the transmission line trips (thereby deenergizing the whole field and shutting down all pump motors) before a motor circuit-breaker trips in case of a short-circuit or an overload at the motor. This is undesirable.

   Answer: The motor-starter should be equipped with an overload relay to allow for motor start-up (i.e. start-up current about 5 to 6 times normal running current) and an instantaneous (magnetic) relay to sense motor stalling or a short-circuit to deenergize the motor circuit to prevent damages. The transmission line protective device setting should be set at higher currents for tripping, in case of malfunction of the motor protective devices.

4. The Power factor at the motor in a production field covering several well pump-motor sets varies between 0.3 and 0.8. Is it best to install capacitors at a central point for the whole field?

   Answer: This is not a technical problem but a cost evaluation problem. Costs of centralized location v.s. individual capacitor sets at the motor should be compared for the selection of the system. However, for practical purposes it is best to have each motor equipped with its own capacitor sets, thus allowing interchangeability, and standardized spare parts.

5. Is it necessary to install a by-pass around each flow-meter set in a line to each injection well?

   Answer: If line is equipped with shut-off valves (i.e. at branch line and at the well) it is not necessary (not desirable) to have a by-pass line around an orifice meter set, since inspection and servicing of orifice happens rarely.

6. What is the optimum point for insulating of lines (thickness of insulation)?

   Answer: Once desired temperature at wellhead has been determined, insulation should be sized for DT between steam generator output temperature and temperature at wellhead. Within practical limits of insulation thickness, the optimum will be determined by comparing steam generator costs per unit centigrade v.s. costs of insulation costs per unit centrigrade gain.

7. What are "bid documents" or "Appel d'offres international"?

<u>Answer</u>: We will prepare an international bid package for the steam generator. A bid document consists o: technical specifications, commercial terms and conditions including: payments, deliveries, garanties, etc.

It is necessary to advertize in international newspapers as well as in local papers, to have interested suppliers pick-up the bid package.

8. Is it necessary to have automatic control of injection pressure and automatic control of flow on the branch lines to the wellhead with an override controller to select either pressure or flow?

<u>Answer</u>: Manual valve is sufficient to control flow of steam into well. Pressure at the wellhead can be precalculated based on steam generator pressure output and pressure drops in piping and valving. Temperature and pressure indicator with flow measurement and manual control valves are sufficient for the application.

9. How is a project carried out?

<u>Answer</u>: Once the basic parameters are assembled, a project team is established to carry out the project for engineering, procurement, construction and start-up.

The project team will establish budgets, costs estimates, design specifications, equipment and materials specifications, design drawings and construction drawings. Schedules are established with the assistance of the project control team. The team is lead by a project manager assisted by project control manager (responsible for the design phase), a project control manager (responsible for the project costs and schedules), a procurement manager (responsible for purchase of equipment and materials, and for expediting of manufacturers at plants), a construction manager (responsible for the construction of the facilities).

Each group (or manager) will have the needed engineers and specialists to carry out the work load, and will be accountable for the quality of work, the budget allocated to them and the delays in the overall schedule. A separate group (distinct from the project team) carries out audits to verify the quality of design and work, and the compliance with the approved budgets and schedule.

ANNEX I

EOR CHEMICALS

EOR Chemicals

Trade name	Generic name	Bulk form	Application	Company
Cyanatrol 700	Anionic, hydrolyzed polyacrylamides	Powder	For polymer-augmented waterfloods. Variety of mol wts available.	Cyanamid
Cyanatrol 900	Anionic, hydrolyzed polyacrylamides	Liquid	Polymer-augmented flooding. Four grades in increasing mol wt.	Cyanamid
Flocon 4800	Biopolymer (xanthan)	Liquid	Viscosifier and gelling agent for use in polymer, micellar polymer, and alkaline floods; permeability reduction, profile modification.	Pfizer
Flocon 4800C	Biopolymer (xanthan)	Liquid	Similar to Flocon 4800. Higher xanthan concentration.	Pfizer
K-Trolservice	Low-viscosity monomer	Liquid	Reacts in reservoir to form high-viscosity polymer for profile control.	Halliburton Services
Maraflood	Petroleum sulfonates	Liquid	Micellar solutions for EOR using the Maraflood process.	Marathon
N-Hance	Anionic copolymers	Gelled log	Mobility control on alkaline and surfactant-type floods. Various mol wts.	Hercules
N-Hance HEC	Nonionic hydroxy-ethylcellulose polymer	Powder	Mobility control. High brine and divalent ion tolerance	Hercules
NAL-FLO 3827	Anionic acrylate-acrylamide copolymer	Liquid	X Mobility control.	Nalco Chemical
NAL-FLO 3837	Anionic acrylate-acrylamide copolymer	Liquid	Mobility control. Higher mol wt than NAL-FLO 3827.	Nalco Chemical
NAL-FLO 3857	Anionic acrylate-acrylamide copolymer	Liquid	Mobility control. Very high mol wt.	Nalco Chemical
Narlex-RP-1	Acrylamide copolymer	Water-soluble emulsion	Mobility control.	National Starch
Narlex-RP-2	Acrylamide copolymer	Emulsion	Mobility control. Similar to Narlex-RP-1 with a surfactant system.	National Starch
Narlex-RS-1	High molecular weight ethoxylate	Liquid	Facilitate inversion of Narlex-RP-1 and -2 into hard or briny waters.	National Starch
Narlex-RS-2	High molecular weight ethoxylate	Liquid	Higher degree of ethoxylation than Narlex-RS-1 for unusually contaminated injection water.	National Starch
OFC IF-4801 Interface Compound	Blend of oxyalkylated materials et al	Liquid	Interface improver in steam flooding.	Chemlink
OFC WT-6230	Propietary polymer	Liquid	Water-blocking polymer for profile modification.	Chemlink
OFC WX-9712	Crosslinker: proprietary blend	Liquid	Crosslinking agent for OFC WT-6230 polymer.	Chemlink
Petrostep 100	Synthetic sodium sulfonate	Liquid	Interfacial tension reducing agent for micellar polymer, alkaline surfactant augmented polymer, and hot water, low tension flooding. Medium mol wt.	Stepan
Petrostep 105	Anionic	Liquid	Same as Petrostep 100. High mol wt.	Stepan
Petrostep 110	Synthetic sodium sulfonate	Liquid	Same as Petrostep 100. High mol wt.	Stepan
Petrostep 120	Synthetic sodium sulfonate	Liquid	Same as Petrostep 100. Low mol wt.	Stepan
Petrostep 420	Natural sodium sulfonate	Liquid	Same as Petrostep 100. Medium mol wt.	Stepan
Petrostep 465	Natural sodium sulfonate	Liquid	Same as Petrostep 100. High mol wt.	Stepan
Petrostep HMW	Natural sodium sulfonate	Liquid	Same as Petrostep 100. High mol wt.	Stepan
Petrostep MMW	Natural sodium sulfonate	Liquid	Same as Petrostep 100. Medium mol wt.	Stepan
PHPA	Partially hydrolyzed polyacrylamide	Liquid	Mobility buffer for Maraflood projects.	Marathon and Dow Chemical
Polyflood	Polyacrylamide polymer	Liquid	Custom-designed service for particular reservoir conditions: Anionic or nonionic in any molecular weight.	Halliburton Services
Pusher 50 Inversion Surfactant	Surfactant	Liquid	Mobility control in conjunction with emulsion polymers.	Dow Chemical
Pusher 75 Inversion Surfactant	Surfactant	Liquid	Same as Pusher 50.	Dow Chemical
Pusher 500E	Acrylamide polymer	Emulsion	Mobility control in polymer-augmented waterflood or in caustic or surfactant chemical flood.	Dow Chemical
Pusher 500F	Acrylamide polymer	Flake	Same as Pusher 500E.	Dow Chemical
Pusher 700E	Acrylamide polymer	Emulsion	Same as Pusher 500E.	Dow Chemical
Pusher 700F	Acrylamide polymer	Flake	Same as Pusher 500E.	Dow Chemical
Pusher 1000E	Acrylamide polymer	Emulsion	Same as Pusher 500E.	Dow Chemical
Pusher CO_2 Diverter	Surfactant	Liquid	Foam diverter for CO_2.	Dow Chemical
Pusher Mobility Control Monomer	Acrylamide	Liquid	On-site polymerization for mobility control in polymer-augmented waterfloods and caustic or surfactant floods.	Dow Chemical

Trade name	Generic name	Bulk form	Application	Company
Alcoflood 935	Anionic polyacrylamide	Microbeads	Polymer flooding in high salinity reservoirs, profile control, and water shut-off.	Allied Colloids
Alcoflood 935L	Anionic polyacrylamide	50% active dispersion	Same as Alcoflood 935.	Allied Colloids
Alcoflood 955L	Anionic polyacrylamide	50% active dispersion	Same as Alcoflood 955.	Allied Colloids
Alcoflood 1115L	Anionic polyacrylamide	50% active dispersion	General applications for polymer flooding and profile control.	Allied Colloids
Alcoflood 1135	Anionic polyacrylamide	Microbeads	Same as Alcoflood 1115L.	Allied Colloids
Alcoflood 1135L	Anionic polyacrylamide	50% active dispersion	Same as Alcoflood 1115L.	Allied Colloids
Alcoflood 1175	Anionic polyacrylamide	Microbeads	Same as Alcoflood 1115L.	Allied Colloids
Alcoflood 1175L	Anionic polyacrylamide	50% active dispersion	Same as Alcoflood 1115L.	Allied Colloids
Alcoflood 1255	Anionic polyacrylamide	Microbeads	Mobility control, polymer flooding with fresh water.	Allied Colloids
Alcoflood 1255L	Anionic polyacrylamide	50% active dispersion	Same as Alcoflood 1255.	Allied Colloids
Alcoflood 2315	Cationic polyacrylamide	Microbeads	Crosslinking for profile control and water shut-off.	Allied Colloids
Alcoflood 2315L	Cationic polyacrylamide	50% active dispersion	Same as Alcoflood 2315.	Allied Colloids
Brezxit	Surfactant	Liquid	Cosurfactant tailoring for surfactant floods. Flow-back improvement after steaming cycle.	Exxon Chemical
Chevron Chaser SD1000	Alpha olefin sulfonate dimer	Liquid	Steam diversion, foam blocking.	Chevron Chemical
Chevron Chaser XP100	Alkyl toluene sulfonate	Liquid	X Steam chemical for cyclic stimulation.	Chevron Chemical
Corexit	Surfactant	Liquid	Cosurfactant tailoring for surfactant floods. Flow-back improvement after steaming cycle.	Exxon Chemical
Cyanagel	Polymers	Liquid	Treatment of high-permeability zones with the Chromium-Redox gel process	Cyanamid
Cyanaperm	Polymers	Liquid	Profile improvement using the aluminum citrate process.	Cyanamid
Pusher Steam Diverter	Surfactant	Liquid	X Foam diverter for steam.	Dow Chemical
Stepanflo 10	Sodium alpha olefin sulfonate	Liquid	X Mobility control for steam (300 F) and foam flooding Brine tolerant.	Stepan
Stepanflo 20	Sodium alpha olefin sulfonate	Liquid	Same as Stepanflo 10 except for 350 F. Higher mol wt.	Stepan
Stepanflo 30	Sodium alpha olefin sulfonate	Liquid	X Mobility control for steam foam, 450 F. High mol wt	Stepan
Stepanflo 50	NH_4 ether sulfate	Liquid	Mobility control for foam flooding	Stepan
Stepanflo 60	Betaine	Liquid	x Mobility control for steam (500 F) and foam flooding	Stepan
Stepanflo 80	Synthetic sodium sulfonate	Liquid	Mobility control for steam foam flooding (550-600 F). Low brine tolerance	Stepan

EOR Chemical Suppliers

Chevron Chemical Co
P.O. Box 7144
San Francisco, CA 94120-7144

Marathon Oil Co
539 S. Main St.
Findlay, OH 45840

Nalco Chemical Co
P.O. Box 87
Sugarland, TX 77487-0087

National Starch and Chemical Co.
P.O. Box 6500
Bridgewater, NJ 08807

Pfizer
Oil Field Products Group
235 E. 42nd St.
New York, NY 10017

Allied Colloids Inc.
P.O. Box 820
Suffolk, VA 23434

Allied Colloids Ltd.
P.O. Box 38
Cleckheaton Rd., Low Moor
Bradford, Yorkshire,
England BD12 0JZ

Halliburton Services
Duncan, OK 73536

Chemlink
Oil Field Chemicals Division
P.O. Box 370
Sand Springs, OK 74063

Dow Chemical U.S.A.
P.O. Box 3387
Houston, TX 77253-3387

Exxon Chemicals Americas
P.O. Box 3272
Houston, TX 77253-3272

Hercules Inc.
Hercules Plaza
Wilmington, DE 19894

Stepan Chemical Co.
Northfield, IL 60093

ANNEX II

TECHNICAL SPECIFICATION

FOR

STEAM GENERATOR FOR OIL RECOVERY

PROJECT NUMBER: *

MAKINA IMPORT
4 Rue Shkurti
Tirana, ALBANIA

* by ITNG

I. GENERAL

1. The steam generator, complete with controls, feedwater treatment skid, fuel skid and feedpumps will be installed in a heavy oil recovery field in Albania.

2. Climatic conditions:

	Winter		Summer	
	Max.	Min.	Max.	Min.
Temperature	3°C	-8°C	42°C	12°C
Rain Fall (mm)	850			

3. Fuel characteristics

GAS		DIESEL FUEL
H_2S	4%	*
CO_2	7.95%	
H_2	0.38%	
CH_48	82.15%	
C_2H_6	3,84%	
C_3H_8	1.35%	
i C_4H_{10}	0.27%	
n C_4H_{10}	0.25%	
e C_5H_{12}	0.25%	

Density = 0.709 g/cm^3
Cal. Value = 8.400 Kcal/N.m^3

4. Feedwater characteristics

Water is river water stored at the site and has the following characteristics.

	mg. eq./ltr.
Ca^{+2}	2
Na^+K^+	2.81
Mg^{+2}	4.75
Fe^{2+} and Fe^{3+}	6.7
HCO_3^-	35.5
Cl^-	36.48
SO_4^{-2}	-
Ph	8.5
Drag matter is 118°C	105
Hardness	3.3
Carbonate hardness	9.24
Non-carbonate hardness	6.65
Total mineralization	0.45

The water will be supplied to the feedwater pumps at * bars.

5. Electrical supply: 380 volts, 3 phases, 50 Hz

The manufacturer will provide power distribution boards for electric motors and electric devices.

* To be filled by ITNG.

II. STEAM GENERATOR: GENERAL CHARACTERISTICS

1. The manufacturer will propose a complete package consisting of water treatment, steam generator, fuel treatment, feedwater pumps and control system for local operation of the system.

2. The manufacturer will propose the best combination of skid-mounted equipment for transport and transfer to already established foundations considering the following:

   - Transport by trailer: max. weight 30 tons

   - Trailer: width * m, length * m

   - Asphalt road max. allowable load: 0.8 to 1 kg/cm^2

   - Total height: trailer + equipment = *

   - Ease of hook-up: Pipe spools between skids, centralized power hook-up, centralized instrumentation loop hook-up.

3. Skid or skids will be enclosed in weather proof enclosures designed for field conditions.

4. Harzardous material or equipment shall be segregated from rest of equipment, such as fuel scrubber, fuel feed pumps, fuel reservoir or fuel pressure regulating stations.

5. All skids will be movable and transferable to other sites.

6. All control panels and electric distribution boards will be mounted separately on a skid-mounted control house. The control house will be equipped with heaters and fans to keep dust from the electronic electric devices.

7. The manufacturer will list and quote on an item per item basis all test and calibration devices for electronic and air controllers.

III. STEAM GENERATOR OUTPUT

1. The manufacturer will make 2 propositions: one for a 5 t/h output and one for 8 t/h output. Output pressure at 150 atm, temperature at 340.56°C, steam quality at 80%, min. pressure output will be *.

2. The manufacturer will propose the best design for trouble free operation, ease of maintenance and minimum down-time for dismanteling of piping, electrical and control connections, transport, reset on other foundations, and hook-up of piping, electrical and control connections.

3. Steam characteristics: *

* = to be filled by ITNG

IV. SPECIFICATIONS

1. The manufacturer will provide details and design characteristics of the following:

   - Steam generator
   - Piping at generator output
   - Water system
   - Fuel system
   - Pre-heater and water de-aerator
   - Air system
   - Water filtration system
   - Water treatment system
   - Watherproofing
   - Painting
   - Control systems
   - Alarm and shutdown system
   - Instrumentation type and manufacture
   - Electrical distribution and protection system

2. The manufacturer will provide data sheets for components of each system.

3. The manufacturer will provide heat balance sheets.

4. The manufacturer will provide:

   - Fuel consumption data
   - Water consumption data
   - Chemical consumption data
   - Electrical power consumption data.

COMMERCIAL CONDITIONS

FOR

STEAM GENERATOR FOR OIL RECOVERY

PROJECT NUMBER: *

MAKINA IMPORT
4 rue Shkurti 6
Tirana, ALBANIA

*** To be filled by ITNG**

I. GENERAL

1. The steam generator, complete with controls, feedwater treatment equipment, fuel regulating and treatment equipment, feedwater pumps mounted on skid(s) will be installed on foundation footings in a heavy oil recovery field in Albania.

2. The manufacturer will propose the best combination of skids and equipment segregation for safe, trouble-free, maintenance-free operation and ease of hook-up between skids and ease of transport and relocation in another site. All skids will be transportable from one site to another in the oil field.

3. Technical characteristics of the total package are described in the technical specification document.

4. Delivery port will be: DOURRES, Albania. Manufactuer will quote prices for delivery to Dourres, including freight and insurance cost.

II. TERMS AND CONDITIONS

1. Manufacturer will quote best prices and best delivery.

2. Manufacturer will garantee equipment will meet operating conditions for the life of the steam generator.

3. Garantee will extend to one year after installation and commissioning. Ten percent of the total equipment cost will be retained for one year.

4. The manufacturer will list and quote spare parts for two-year operation. Manufacturer will garantee (and supply) spare parts for the life of the equipment.

5. Manufacturer will supply also:

   - Operating manuals for start-up, normal operation, and emergency shutdown of systems.

   - Detailed maintenance manuals of all equipment, controls, electric devices, measuring instruments, etc. with detailed parts lists and exploded drawings showing details of devices on equipment.

6. Manufacturer will quote separately:

   - Prices for commissioning and start-up assistance.

   - Prices for assistance (daily rates) for assistance after garantee expiration.

7. Manufacturer will provide access to manufacturer's facilities to buyer's representative for:

   - Inspection of equipment.

- Review of progress in manufacture.

- Pre-commissioning of systems before packing for sea and road transport.

8. Manufacturer will provide:

   - Welding records.

   - Hydrotesting tests records.

9. Manufacturer will list and quote prices for tools and special instruments for the maintenance of the equipment and systems he will propose.

10. Equipment, systems, packages cannot be delivered without release by buyers' representative.

11. Manufacturer will have "dry runs" in factory to simulate operating conditions at site in Albania

12. Manufacturer will quote separately prices for training of buyers' operators, at site, on equipment use and operation under normal and emergency conditions.

13. Manufacturer will list the standards and norms applicable to his equipment. He will list any exceptions to the norms/standards listed in the technical specifications.

14. Manufacturer will list his progress payments against schedule progress points (and inspection of progress points). Payment will be made after verification of progress. To this end the manufacturer will provide a detailed schedule of manufacturers and sub-suppliers for his manufacture.

15. Manufacturer will provide:

    - Detailed drawings for buyer's hook-up
    - Detailed drawings for anchoring
    - Drawings of components and systems.

    Manufacturer cannot proceed with manufacture without buyer's approval of drawings. A one-month delay will be included between sending and receiving of approved drawings by manufacturer.

16. Quotations by manufacturer will be valid, with no price escalation, for 4 months from date of submission.

ANNEX III

EOR UPDATE

TECHNICAL ARTICLES

TABLE OF CONTENTS