SPE International
Northwest Russia Section

II STRATEGIC CONGRESS 2017

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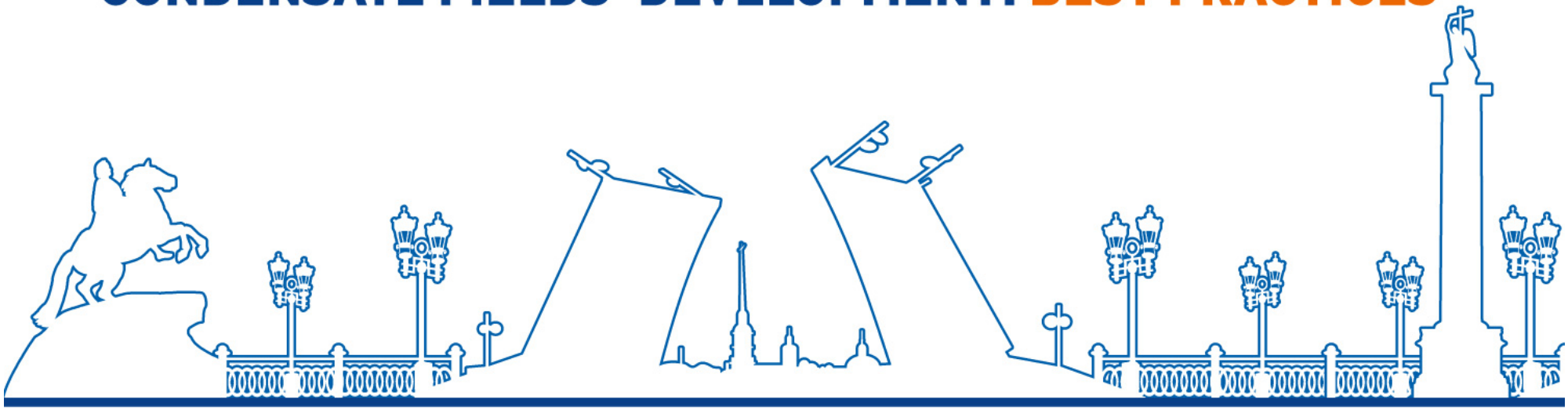
INTEGRATED MANAGEMENT OF OIL AND GAS CONDENSATE FIELDS' DEVELOPMENT: BEST PRACTICES



LUOC's Experience of Applying Integrated Modeling for Enhancement of Gas Field Development and Operation

LLC "LUKOIL Uzbekistan Operating Company"

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26 СЕНТЯБРЯ 2017, САНКТ-ПЕТЕРБУРГ, ГОСТИНИЦА «АСТОРИЯ»

Gas Field Development Features

Gas field development features: the product is transported subsequently starting from the wells and directly to the consumer, no intermediate chain links (tanks, storage facilities) are available.

External factors such as seasonal gas consumption, transportation and treatment/processing engineering capabilities and also non-affiliated companies' production volumes that are operating in the same system, have a significant impact on extent of production.

- **Planning and Forecasting before IAM Introduction**
- IAM Introduction Objectives
- IAM System in LUOC
- IAM Case Study
- IAM Introduction Results

Production Rate Forecasting (as it used to be)

Typical calculation algorithm for production rate is based on the following principles:

Practice Deficiencies:

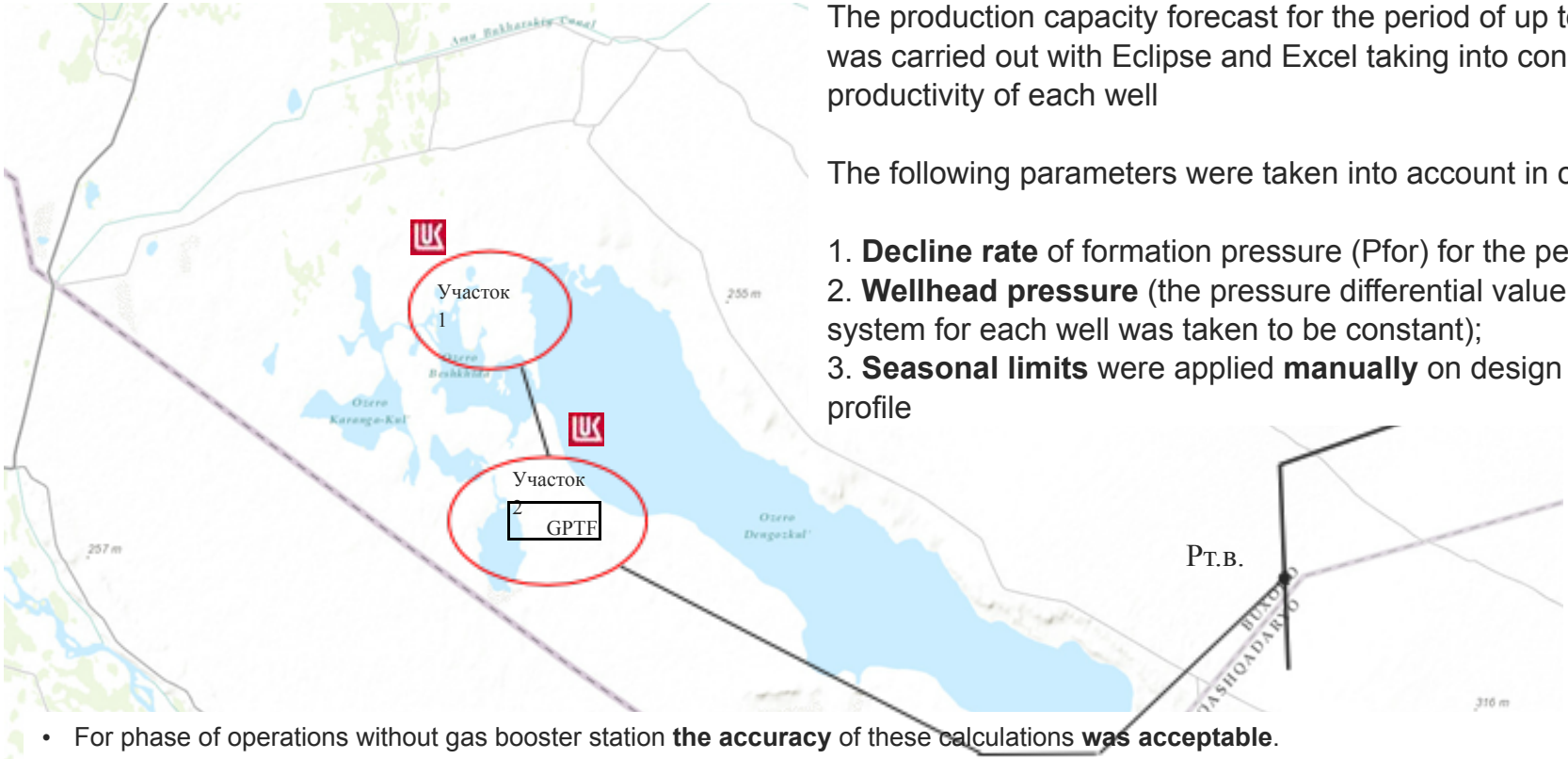
This practice considers no interference of wells neither in the formation nor in the gathering system that could result in the error in evaluation of losses. Increase of calculation accuracy requires heavy man-hours.

This practice considers no impact of duty of gas treatment facility and booster compressor station that could reduce the forecast accuracy especially for medium-term and long-term period.

This practice considers no impact of external factors and seasonal variations of gas production. Assessment of variations could be based on historical evidence only.

Assessment of scheduled events impact on adjacent processes (Power System, Emergency Shutdown Distribution System Facilities, Equipment Integrity Management etc.) is difficult.

Production Rate Forecasting (as it used to be)



The production capacity forecast for the period of up to three years was carried out with Eclipse and Excel taking into consideration productivity of each well

The following parameters were taken into account in calculation:

1. **Decline rate** of formation pressure (Pfor) for the period;
2. **Wellhead pressure** (the pressure differential value on gathering system for each well was taken to be constant);
3. **Seasonal limits** were applied **manually** on design production profile

- For phase of operations without gas booster station **the accuracy** of these calculations **was acceptable**.
- Well and field **production capacities** were subject **to annual assessment** at the stage of production targets development.
- Current well **capacity allowed to maintain production** at the planned level along the year even if any deviation of the actual parameters of wellhead and bottomhole pressures from the calculation.
- **No well interference in the gathering system** were taken into account, no system gas flow velocity calculated.

Production Rate Forecasting (as it used to be)

“As it used to be” Forecasting Main Data Package:

1. Design production rate, maximum allowable pressure drawdown (Design Document)
2. Rate and forecast of decline of formation pressure for each well (Eclipse)
3. Adaptation accuracy of bottomhole pressure with Eclipse Model is +/- 5 bar, adaptation frequency of Eclipse Model quarterly
4. Pressure in tie-in point (historical evidence for similar period of previous year)
5. ShutDown scheduled date and duration (Shutdown Date and Duration)
6. Target loss and shortage level (in terms of Kop)
7. Technical conditions at tie-in point (P, T)
8. Loss codes (SNIP)

Disadvantages:

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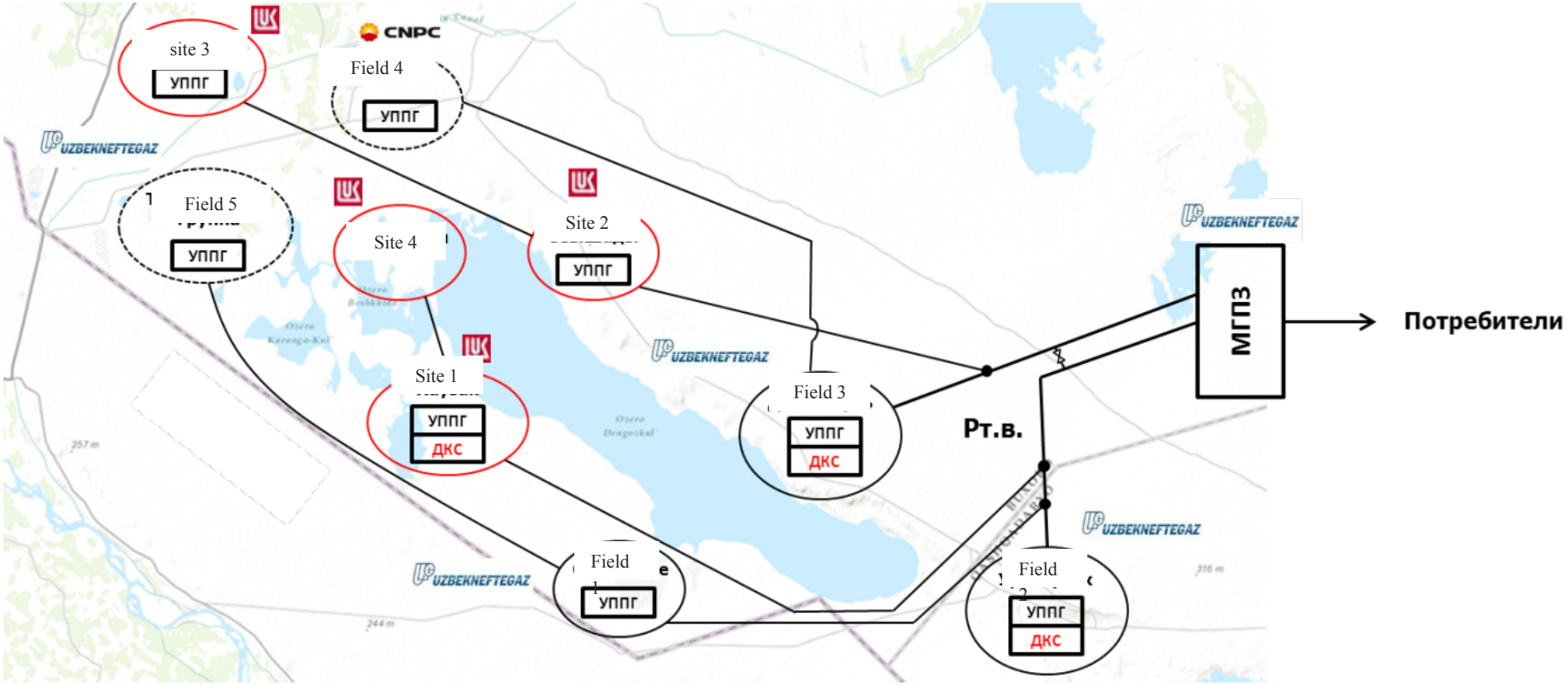
Schematic diagram of gas recovery and transport



Current condition!!!

IAM Introduction Basis

How to consider the impact of limits of gathering and transport system in forecasting of gas production?

How to consider Gas Treatment Facility and BCS limits?

How to assess impact of scheduled events on production volume?

How to compensate missing data?

How to identify potentially dangerous sites and bottlenecks?

Is it possible to optimize design solutions at the design stage and how efficiently the developer works?

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Integrated Modeling

Introduced in LUOC as part of Life Field project implementation, Integrated Modeling System has been in active operation since December 2014 .

Интегрированная модель

Life-Field

- Application of IAM **helps expedite** preparation and elaboration of process solutions and considerably **improve** their **quality** without engaging specialized scientific organizations;
- IAM system provides abundance of means for **solution of unconventional** tasks within a wide range of their practical application;
- IAM system ensures **multidisciplinary** approach in the course of solutions elaboration;
- IAM system allows **planning and forecasting** hydrocarbons production both **for** individual **sites** and for **groups** of fields at all stages of planning (from 14 days till the end of development);
- IAM system allows **multi-variant estimations and assessment of various strategies of field development and operation**;
- IAM system allows **detailed calculations** for development of new and **updating** of existing **design documents** for field development;
- IAM system allows **expert examination** and **optimization of design solutions** for new and existing production facilities considering mutual influence of the facilities from the point of view of the reservoir and surface infrastructure;
- IAM system allows **detailed** development of **performance specification** for design of new and revamp of the existing production facilities.

Modeling Tools

ECLIPSE – reservoir dynamic calculations and analysis software complex. It consists of the following components-models: *Formation/Development Objects Dynamic Models* (Reservoir Modeling) *Shlumberger*

PIPESIM - production, gathering and transport system analysis software complex. It consists of the following components-models: *PVT Models, Well Models* (Well); *Ground Infrastucturure Hydraulic Models* (Network); *Shlumberger*

Petro-Sim – product processing and treatment equipment analysis software system. It consists of the following components-models: *Treatment and processing models* (Facilities); *KBC Process Technology LTD*

AVOCET - *components - models integration* software complex ensuring integrated modeling technology. IAM Avocet is used as unified software environment to manage either single hydrodynamic and proxy-models, product transportation/gathering system models or complex of such models. *Shlumberger*

IAM System in LUOC

Integrated model

14-30-90 days

IAP

Investment program

Plan of technical

Plan of geological

List of chokes

Перечень допущений List of assumptions

Сценарии

Avocet

ECL ECLIPSE

P=tro-SIM

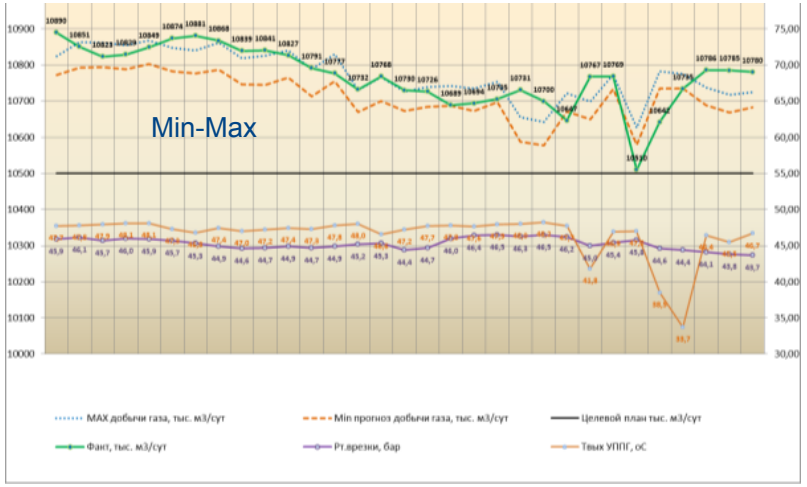
Production profiles1…n

Analysis of result

Decision maker Option selection

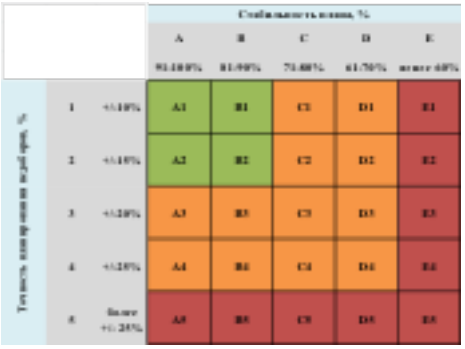
Execution control

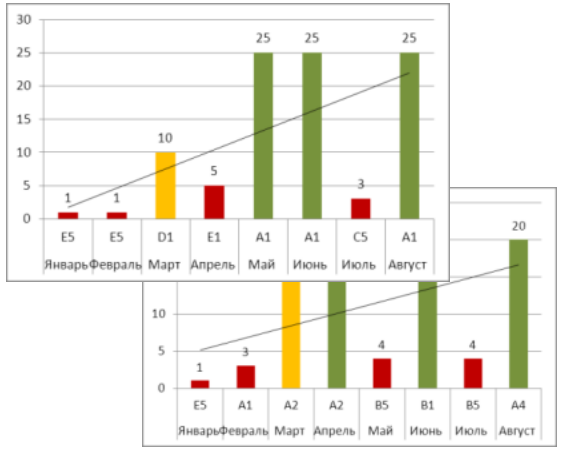
November 2012 – December 2014



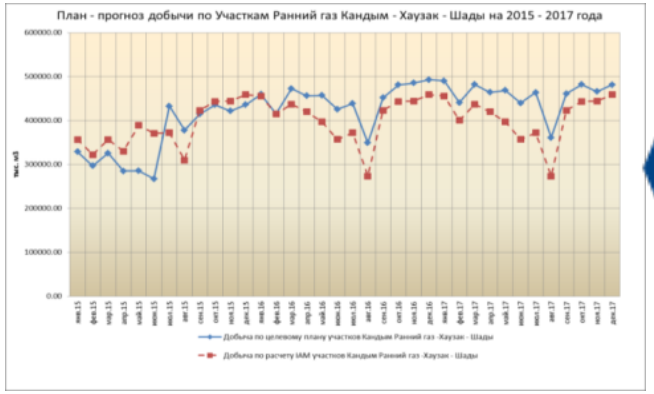
Accuracy of forecasts up to 99 %

Comprehensive KPI





Long-term planning (3-5 years)



Production Profile Calculation Scenario

Preparation of Calculation Scenario (IAP Plan + Choke/Assumption List)

Limiting conditions are tentative permanent limits determined by regulations and procedures**:**
- Acceptable **drawdown** pressure
- Acceptable **flow velocity** in the gathering system
- Technical conditions in tie-in point (**P, T**)
- Scenario conditions as per **dates** of new facilities **commissioning** (wells, facilities, fields)
- Planned **loss level /shortages** calculated on the basis of IAP preliminary plan (shutdown, studies, inhibition, equipment preventive operations/ technical maintenance, well workover)
- **Rate of production** as per design document
- **Event Program**
- Limited **operating conditions** of GPTF, BCS, GSP, gathering
system

Basis Assumptions are variables of transport and gas treatment system operation**:**
- Non-affiliated company's **production levels**
- **Commissioning** of non-affiliated company's **new facilities**
- **Plant efficiency**, plant inlet pressure
- **Plant technical maintenance/ preventive operation** of non-affiliated companies
- **Weather** conditions
- Tie-in point **pressure forecast**
- **Plant** gas extraction levels /**seasonal chokes**
- Risks **identified**

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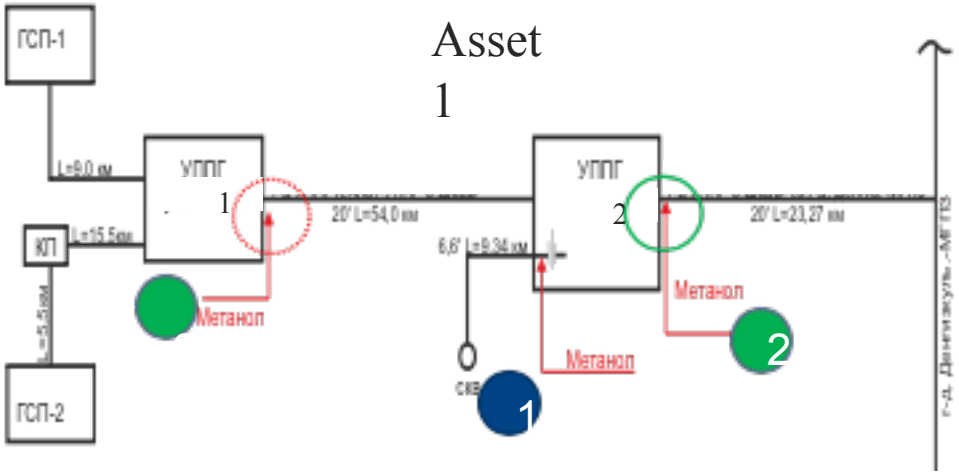
Shortage Minimization (2016 Shutdown) operating efficiency

Site/Field	Shutdown Duration Base Scenario	Shutdown Duration Scenario 1	Shutdown Duration Scenario 2
Site 1,4	6 days, August,2016	6 days, May,2016	6 days, August,2016
Site 2	6 days, May,2016	6 days, June,2016	6 days, June,2016
Site 3	6 days, May,2016	6 days, June,2016	6 days, June,2016
Gas potential production		**(- 2 353 ths m3)**	**(+ 8 163 ths m3)**

- In consolidated study of integrated plan (IAP) and integrated model the case study to alter complete shutdown schedules is completed (Shutdown);
- Appropriate shutdown date (scenario 2) is determined, annual performance schedule is modified;
- Effect of modification of shutdown schedule in 2016 is estimated at 8 163 ths m3.

Optimization of Design Decisions for Hydrate Suppression in Gas Gathering and Transport System

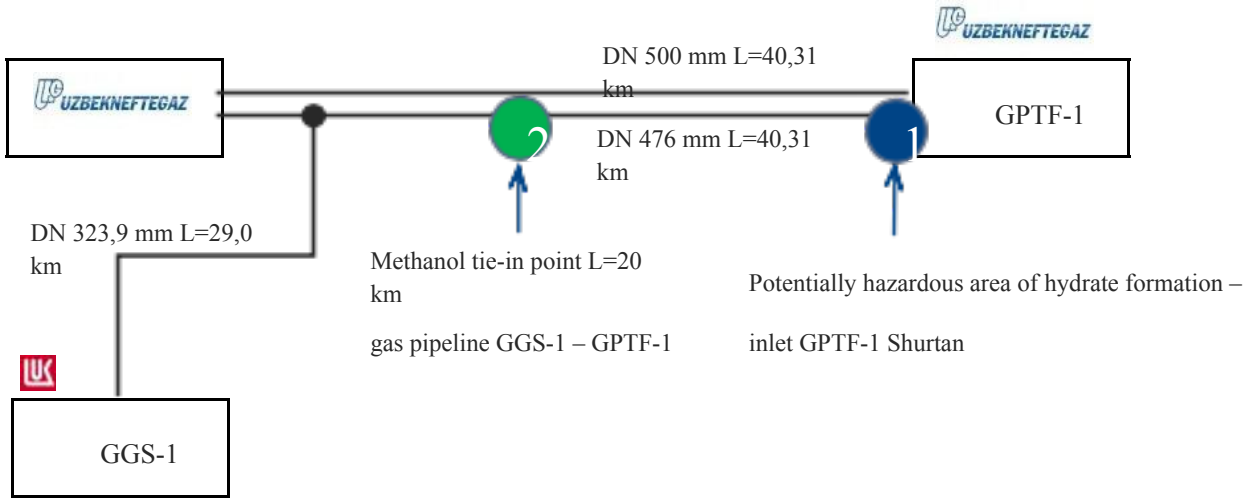


	Точка подачи метанола	Кол-во метанола по данным НЕС, кг/ч	Кол-во метанола по данным ИАМ, кг/ч
1	Внутрипромысловый газопровод УППГ – УППГ	3,6	20,0
2	Экспортный газопровод УППГ точка врезки в газопровод ДКС МГПЗ	15,0	40,0
3	Шлейф скв.№1050 на БВН после дросселя	4,9	-
4	Шлейф скв.№1052 на БВН после дросселя	22,5	-
5	Скв. №1052 – УППГ	28,2	-
6	Общее потребление метанола в зимний период , кг/год	160272	161000
7	Общее годовое потребление метанола, кг/год	253872	161000

- According to IAM study non-methanol operation is considered to be impossible.
- LUOC specialists have performed IAM study, the results received are as follows:
  - 1 Methanol injection is not required by flow lines XXX.
  - 2 Methanol shall be injected in volume of 40 kg/hour by “GPTF” gas pipeline - tie-in point to “Asset 1”- “MGPP” BCS gas pipeline.
  - 3 Methanol shall be injected in volume of 20 kg/hour by “GPTF1” – “GPTF2” export gas pipeline.
- Based on estimated data Methanol Injection Program for Sites was amended, methanol injection volume shall be 161 ton. Methanol saving amounts to 93 tn/year.
- Fields development optimization

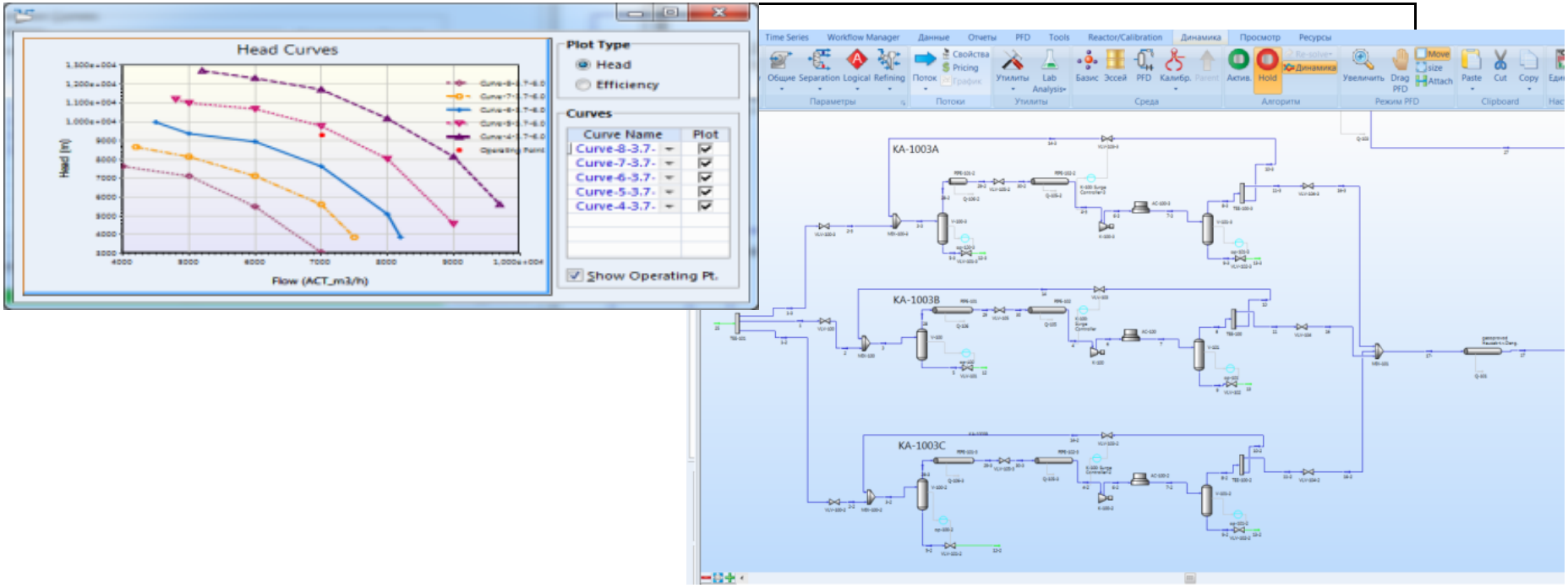
Optimization of design decisions for Hydrate Suppression in Gas
Gathering and Transport System

Asset 2



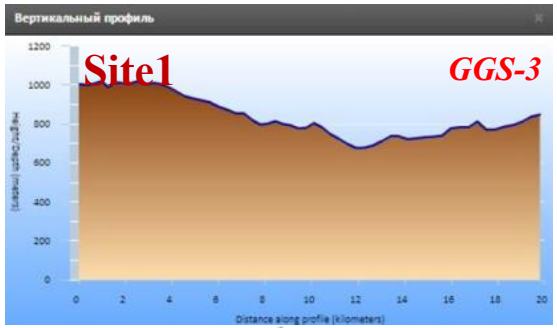
- Chemical is determined - methanol, appropriate injection points and dosing are also set.
- Arrangement of methanol injection under selected diagram and dosing ensured no-failure operation of the facility up to the present.
- Shortages caused by production reduction due to pressure increase in transport system are precluded.

Identifying and Managing “Bottlenecks”

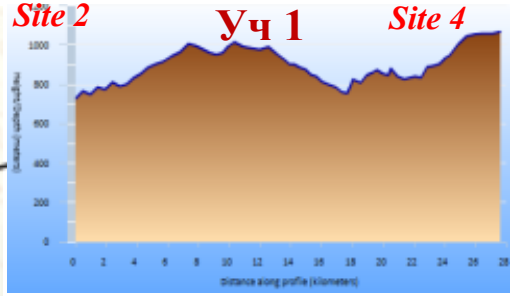


- Chokes were identified at the BCS inlet, at the inlet control valve, solutions were suggested to increase valves capacity and efficiency of the solutions was assessed;
- Measures were developed based on calculations and implemented to increase capacity of control valves at BCS “Site-1” (result +240 thousand m3/day), side effect of the activities is decrease in BCS power consumption (saved 17.5 thousand US dollars/month or 87.5 thousand US dollars in 2015)

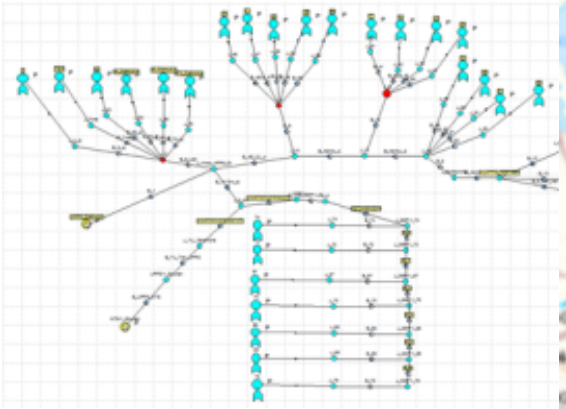
Field Facilities



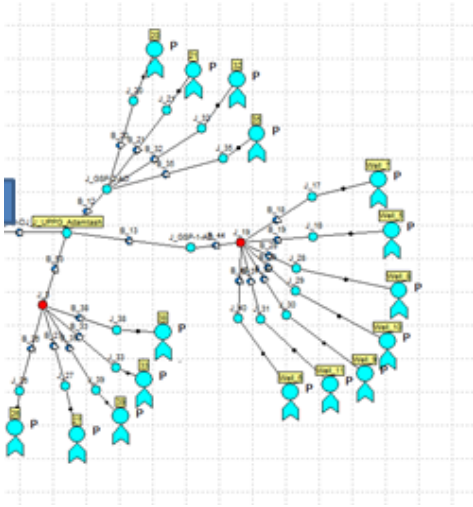
River crossing



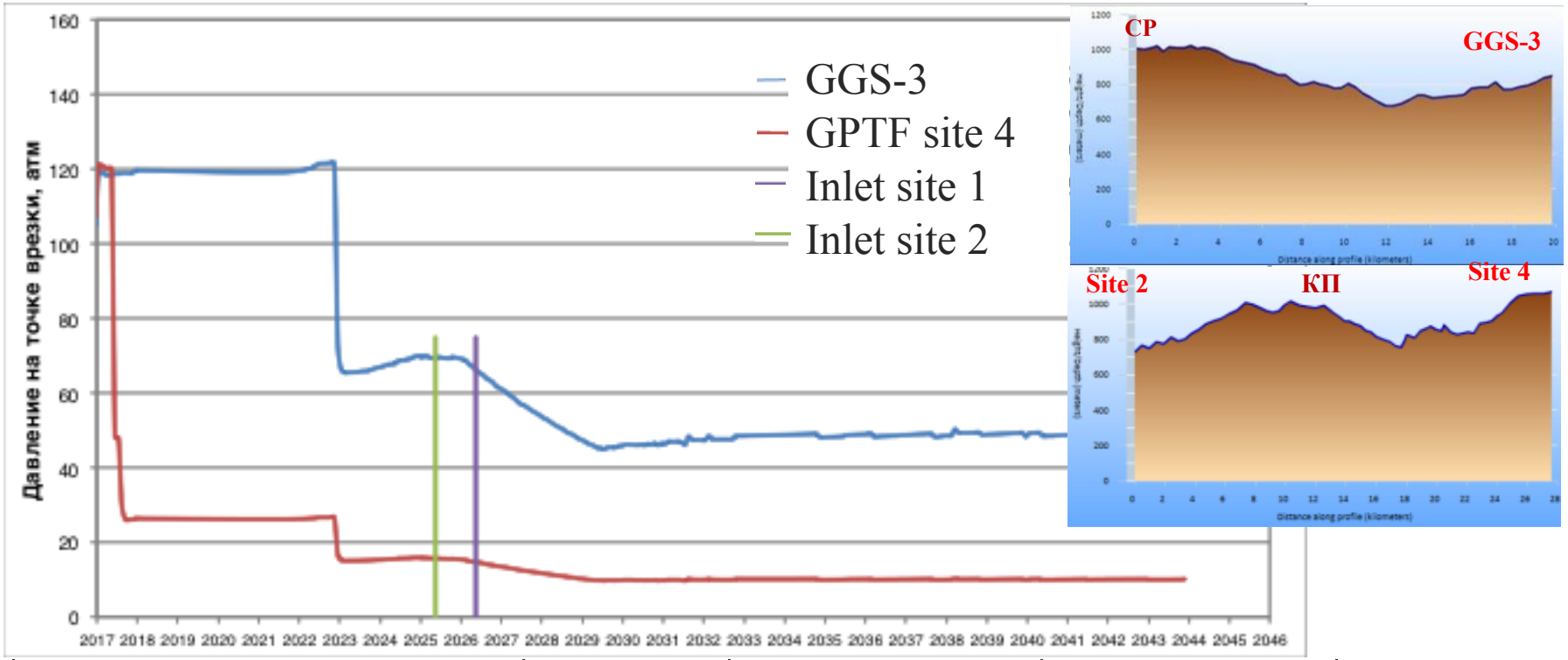
Model of gathering system site 3



Model of gathering system site 4

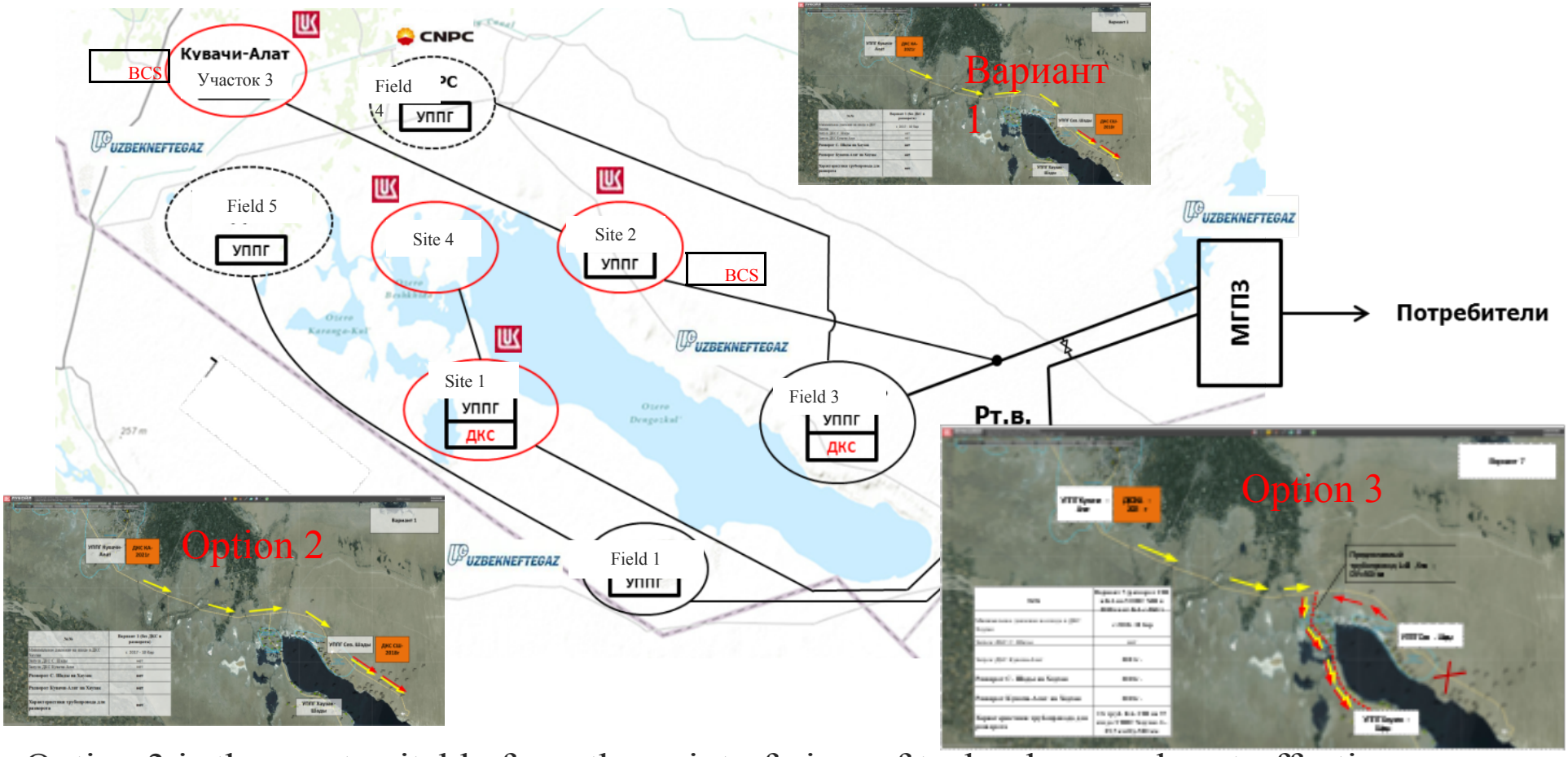


Comparison of Field Facilities Options



Parameter	unit	Site 3	Site 4
Pressure at tie-in point	atm	48	15
Length of gathering line	km	19,8	27,3
Length of roads	km	2,3	7,3
Cost	mn. dol.	24,4	29,8
Incremental rate of production	mn. m3	+0	+228
IRR	%	22,04	21,95
Relative NPV 10%	mn. dol.	+0	+1.1

Strategic Decisions (Giving up BCS Construction)



Option 3 is the most suitable from the point of view of technology and cost-effectiveness. Implementation of Option 3 will raise IRR and NPV@15%LF as compared with design solutions and current strategy. The option has bee adopted for implementation.

Conclusions

- Influence of surface infrastructure must be taken into consideration for gas fields, as it considerably improves accuracy of forecasts.
- Integrated modeling (hereinafter IM) is a tool of design solutions assessment and elaboration of strategies.
- IM helps optimize solutions for infrastructure facilities, select equipment and modes of its operation (for instance: BCS operation mode);
- IM helps work out in detail options of field facilities system and assess its influence on field development.

Best

LUOC's approaches to geological and hydrodynamic modeling were declared the best and most eminent in the Caspian region


Schlumberger

CERTIFICATE of EXCELLENCE

awarded to

Ignatiy Volnov

for winning the

"Best Presentation Award"

at the Annual Caspian Schlumberger Conference

held in Astana, Kazakhstan on 22nd of October, 2015

Alexander Makjeda


Schlumberger

CERTIFICATE of EXCELLENCE

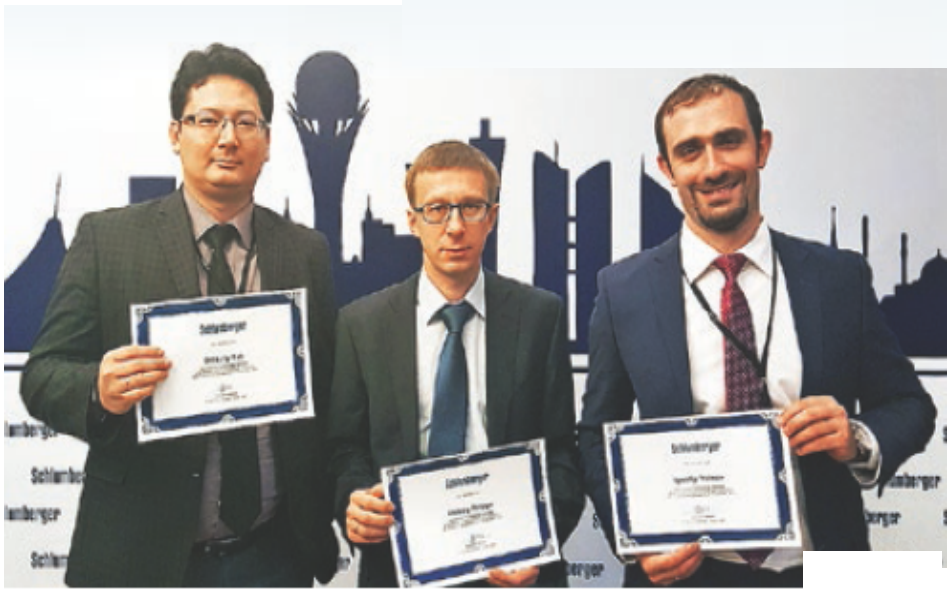
awarded to

Service of the deputy of the General Director for Geology

LUKOIL Uzbekistan Operating Company

for

"Outstanding Achievements in Geological and Reservoir Modeling"



According to the poll of the participants of the annual Caspian Conference of Schlumberger Software Users in 2015

LUOC's reports on uncertainty analysis and integrated modeling were declared up to date and innovative at SPE (Society of petroleum Engineers) conference on geological and hydrodynamic modeling in 2016

Thank you!!!