UNIT II
DRILLING ENGINEERING

In this unit, you will
- revise and learn new vocabulary related to drilling operations
- revise grammar (Complex Sentences, Passive Constructions)
- read about drilling techniques and types of rigs
- learn to talk about drilling engineering issues

INTRODUCTION
I. Work in pairs to translate the words and word combinations.
- oil accumulation разведочная скважина
dry hole оценочная скважина
oil reservoir разработка месторождения
off-shore промышленная добыча нефти
surface equipment вышка
natural pressure срок службы скважины
well completion забой
oil occurrence буровая установка
on-shore reserves порода
(drill(ing) string долото

- Compare your translations with your group mates.

II. Guess the meaning of the following words and phrases.
- at the start of the industrial revolution; to dominate the industry; the location and
geography of a reservoir; to design and drill a well bore; horizontal distance; maintenance
operations; well intervention operations; navigation systems; safety training; personnel

III. Match a “false friend” and its meaning.

| obstruction | сложный  |
| direction   | конструкция |
| formation   | помеха, препятствие |
| schematic   | рабочая смена буровой бригады |
| length      | работать, функционировать |
| tour        | направление |
| data        | данные |
| complex     | пласт |
| to operate  | труба, как составляющая часть колонны |

IV. Practice to pronounce these words.
1. ch [k] school scholarly mechanic mechanical mechanism chemistry chemical character
   scheme schematic technique technical synchronize
2. c [s] civilization centre central centrifugal process processing cementing
WORD FORMATION

- Form adverbs according to the given patterns and translate them into Russian.

<table>
<thead>
<tr>
<th>English</th>
<th>Russian</th>
</tr>
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<tbody>
<tr>
<td>safe</td>
<td>безопасный</td>
</tr>
<tr>
<td>+ ly</td>
<td>= safely</td>
</tr>
<tr>
<td>безопасно</td>
<td>надёжно</td>
</tr>
<tr>
<td>easy</td>
<td>легкий</td>
</tr>
<tr>
<td>+ ly</td>
<td>= easily</td>
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<tr>
<td>легко</td>
<td></td>
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<table>
<thead>
<tr>
<th>Word</th>
<th>Adverb</th>
<th>Translation</th>
</tr>
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<tbody>
<tr>
<td>artificial</td>
<td></td>
<td></td>
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<tr>
<td>broad</td>
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<td>commercial</td>
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<tr>
<td>common</td>
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<tr>
<td>dangerous</td>
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<tr>
<td>economical</td>
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<tr>
<td>extreme</td>
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<tr>
<td>horizontal</td>
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<tr>
<td>increasing</td>
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<tr>
<td>initial</td>
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<td>relative</td>
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<tr>
<td>successful</td>
<td></td>
<td></td>
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<tr>
<td>ultimate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>vertical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>wide</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GRAMMAR REVISION

I. Analyze the complex sentences below, think of conjunctions (for object clauses) and relative pronouns (for relative clauses) that may be used and translate the sentences into Russian.

We know (that) petroleum industry is divided into upstream and downstream. – Мы знаем, что нефтегазовая промышленность делится на первичные и вторичные отрасли.

The refinery (which/that) our company bought was constructed two years ago. – НПЗ, который купила наша компания, был построен два года назад.

1. I.M. Gubkin proved accumulations of hydrocarbons could be found in the Volga basin.
2. We know wildcat wells are drilled to determine occurrence of oil.
3. We have read Conrad and Marcel Schlumberger are considered the inventors of electric well logging.
4. The surface equipment we use depends on the stage of the oil field development.
5. Our professor has told us derricks are used on both on-shore and off-shore oil rigs.
6. Petroleum products we use are the result of crude oil processing.
7. The downhole pumps the company produces are in great demand in petroleum producing areas.
8. Most of the energy we get from the ocean is oil and natural gas from wells drilled on the ocean floor.
9. We have learned the use of horizontal and directional drilling makes it possible for a single well to produce oil from a much bigger area.
10. Finished petroleum products cost much more than crude oil they are produced from.

II. Translate the sentences with Passive Voice constructions into Russian.
1. The price for oil is strongly influenced by demand.
2. The lecture in Reservoir Engineering was followed by a seminar.
3. Oil prices are much spoken of.
4. Drilling rigs are used to construct the well.
5. The Gulf of Mexico oil spill is looked upon as a major environmental disaster.
6. These logging data can be fully relied on.
7. BP plc (United Kingdom), Chevron Corporation (United States), ExxonMobil Corporation (United States), Royal Dutch Shell plc (Netherlands and United Kingdom) and Total SA (France) are referred to as supermajors.
8. The discoveries of on-shore oil and gas fields in the West Siberian petroleum basin were followed by off-shore discoveries.
9. In the Oil and Gas industry, the individual, company, trust, or foundation responsible for the exploration, development, and production of an oil or gas well or lease is known as operator.
10. Generally, drilling operations are carried out by a drilling contractor that may be hired specifically for a certain well or on a long-term contrat.

READING
• Study the word list and translate the example sentences in writing.
1. to appraise v. оценивать
   The Ghana National Petroleum Corporation is to promote petroleum exploration activities and to appraise existing petroleum discoveries.

2. to evolve v. развиваться, претерпевать изменения, видоизменяться
   The small company has evolved into a major chemical producer.

 evolution n. эволюция
3. cable-tool rig установка для ударно-канатного бурения
4. rotary drilling rig установка для вращательного бурения
5. drillship n. буровое судно
6. semi-submersible (rig/platform) n. полупогружная буровая площадка
7. jackup (rig) n. самоподъемная буровая установка
   The cost of semisubmersibles is generally higher than that of a jackup.

1 Plc – public limited liability company (компания с ограниченной ответственностью открытого типа в Великобритании)
2 S.A. – Société Anonyme (акционерное общество с ограниченной ответственностью открытого типа во Франции)
8. fixed adj. стационарный; неподвижный, фиксированный; определенный  
op. mobile  
fixed platform стационарная морская платформа  
Fixed off-shore platforms are best suitable for depths up to about 500 m.

9. workover n. ремонт, ремонтные работы; капитальный ремонт скважины;  
operации для увеличения дебита скважины  
A workover is a service on an oil or gas well, requiring interventions in the wellbore itself to correct a problem with the well.

workover rig установка для ремонта скважин  
Drilling rigs have bigger and taller derricks than workover rigs.

10. conventional adj. стандартный, традиционный, обычный  
op. unconventional  
Oil industries and governments across the globe are investing in unconventional oil sources due to the increasing scarcity of conventional oil reserves.

11. pay zone продуктивный пласт  
Pay zone (or pay, or pay sand) is a reservoir or portion of a reservoir that contains economically producible hydrocarbons. The term derives from the fact that it is capable of “paying” an income.

gross pay общая толщина пласта  
net pay эффективная толщина пласта  
The overall interval in which pay sections occur is the gross pay; the smaller portions of the gross pay that meet local criteria for pay (such as minimum porosity, permeability and hydrocarbon saturation) are net pay.

12. extended reach drilling бурение с большим отклонением от вертикали  
13. multilateral drilling многоствольное бурение  
14. directional drilling (наклонно-)направленное бурение  
Engineers often use directional-drilling techniques for drilling under rivers, highways, and other obstacles.

15. target n. задание, план; объект, цель; проектная цель  
16. to locate v. расположить, разместить; обнаружить, установить  
located adj. расположенный; обнаруженный, определенный  
location n. точка или место заложения скважины; определение местонахождения  
17. wellbore n. ствол скважины
18. **to resemble** v. иметь сходство, напоминать

*Hydrates resemble snowflakes and can clump together* (образовывать комки) *to form plugs in pipes.*

19. **to tap** v. вскрывать пласт

*There are many oil reserves around the globe that remain untapped, and explorers continue to discover new fields deep beneath the earth's surface.*

20. **whatever** adj. какой бы ни, любой, независимо от того, какой

21. **bottomhole location** (BHL) местонахождение забоя (скважины); определение местонахождения забоя (скважины)

*“Bottom-hole location” means the subsurface point at the greatest measured penetration of a well or a well branch.*

22. **rigging up** монтаж буровой установки

*Rigging up is placing and assembling the various parts of equipment that make up the rig, and preparing the rig for drilling.*

23. **to extinguish** (fire) v. тушить (пожар)

24. **coiled tubing drilling** бурение на гибких трубах

25. **continuous** adj. непрерывный, сплошной

*continuous logging while drilling (LWD)*

26. **producing well** эксплуатационная скважина

27. **acceptance** n. признание, одобрение

*to accept* v. принимать, соглашаться, признавать

28. **to plug and abandon (a well)** (P&A) затампонировать и ликвидировать скважину

*The purpose of P&A is to establish permanent barriers to prevent migration of hydrocarbons to the surface.*

29. **commercially viable** рентабельный

30. **to strengthen** v. укреплять, закреплять

*The application of these and similar materials to strengthen the wellbore has proved successful.*

31. **casing** n. обсадная колонна

*Casing consists of a series of metal pipes installed into the new well in order to strengthen the walls of the well hole, to prevent fluids and gases from seeping out of the well as it is brought to the surface, and to prevent other fluids or gases from entering the rock formations through which the well was drilled.*
32. **to run** v. управлять (инструментом; оборудованием)

*Magnetic sensors must be run within a nonmagnetic environment.*

33. **hand** n. рабочий

*Last summer I worked as a hand at an oilfield in Siberia.*

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- **Scan Text II A and match each part of the text with a heading.**
  - Part … directional drilling techniques
  - Part … drilling techniques
  - Part … personnel training
  - Part … final stages of drilling a well
  - Part … the past and the present of drilling engineering
  - Part … coiled tubing technology
  - Part … applications of directional drilling

- **Now, find in Text II A the English equivalents of the following:**

<table>
<thead>
<tr>
<th>Russian phrase</th>
<th>English equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>развитие науки и техники</td>
<td>development of science and technology</td>
</tr>
<tr>
<td>наземная буровая установка</td>
<td>land drilling rig</td>
</tr>
<tr>
<td>выполнять операции</td>
<td>perform operations</td>
</tr>
<tr>
<td>выполнить поворот</td>
<td>perform a turn</td>
</tr>
<tr>
<td>в общих чертах</td>
<td>in general</td>
</tr>
<tr>
<td>там, где монтаж вышки над необходимым забоем невозможен</td>
<td>where mounting of the derrick above the required area is impossible</td>
</tr>
<tr>
<td>легендарные символы</td>
<td>legendary symbols</td>
</tr>
<tr>
<td>первоначально разработанный</td>
<td>originally developed</td>
</tr>
<tr>
<td>получила широкое признание</td>
<td>gained widespread recognition</td>
</tr>
<tr>
<td>современные самолеты и космические корабли</td>
<td>modern aircraft and spacecraft</td>
</tr>
<tr>
<td>обучение технике безопасности при полетах на вертолете</td>
<td>training in flight safety for helicopter pilots</td>
</tr>
</tbody>
</table>
TEXT II A

1. The story of modern oil well drilling began at the start of the industrial revolution. The first modern oil well was drilled in Baku in 1848 to a depth of 69 feet (21 metres). By 1872 the Baku area had so many wells that it became known as the “Black City.” Now wells are drilled for various purposes, e.g. to explore for oil and gas, to appraise an earlier discovery, or to create a development well. Types of rigs have evolved along with the development of science and technology: cable-tool rigs drilled many wells in the past while rotary drilling rigs dominate the industry today. In other words, currently, rotary drilling is the standard oilwell drilling method, with almost all operations being performed by rotary drilling rigs. Depending on the location and geography of a reservoir a variety of rotary drilling rigs may be used. Generally, rotary rigs may be classified as either land rigs (which can be categorized as conventional and mobile) or marine rigs (drillships, semi-submersible rigs, jackup rigs, fixed platforms, etc.). According to the type of operations performed rigs can be broadly classified into exploratory, drilling and workover rigs.

2. As for drilling techniques, they vary from field to field. Conventional wells are drilled vertically from the surface straight down to the pay zone. However today most wells are drilled using such drilling techniques as horizontal drilling, extended reach drilling and multilateral drilling and which fall into the category of directional drilling techniques. The term directional drilling is a broad term that refers to all activities that are required to design and drill a wellbore to reach a target, or a number of targets, located at some horizontal distance from the top of the hole. In other words, the purpose of directional drilling is to connect the surface location with oil/gas reservoirs that are not located right below it.

3. Horizontal drilling uses technologies that allow making a turn and drilling horizontally along the pay zone. Extended reach drilling is a directional drilling of very long horizontal wells. Roughly speaking, it is drilling a well horizontally to at least twice its vertical depth. In multilateral drilling a schematic of wellbores (often several from the same drill site) resembles the roots of a plant, which allows operators to branch out from the main well to tap reserves at different depths. This drastically increases production from a well and reduces the number of wells drilled on the surface.

4. It should be noted that whatever directional drilling technique is used, it can be done for many reasons, e.g. when the bottomhole location (BHL) is under an obstruction such as a building or lake where rigging up over the required BHL is not possible, or when it is necessary to drill several wells from a fixed place, such as an offshore platform or an onshore drilling island to different BHLs. Some of the applications of directional drilling are:
   - reaching under a river or lake;
   - extinguishing an oil fire by drilling from a site some distance away and pumping in mud;
   - drilling under a city or other occupied place;
   - undersea drilling from the shore;
   - offshore drilling from a platform.

5. Today, drilling or workover rigs, iconic symbols of the oil field, are not always required for drilling, completions or maintenance operations. Increasingly, the coiled tubing technology is used for many well intervention operations and certain drilling applications. Coiled tubing

9 Делать ответления
refers to a continuous length of small-diameter steel pipe and related surface equipment as well as associated drilling, completion and workover techniques. Being initially developed for working on producing wells, coiled tubing oil field technology has more recently gained wider acceptance among operators for a wide variety of workover and drilling applications and for its ability to reduce costs.

6. Once the formation evaluation is done, the operator must decide if the well should be completed as a producing oil or gas well. If the well does not contain hydrocarbons, or not enough to pay for the completion, the well will be plugged and abandoned (P&A). In case a well is commercially viable, it must be completed to allow for the flow of oil or gas. The completion process involves strengthening of the well walls with casing and installing the appropriate equipment to control the flow of oil or gas from the well.

7. Nowadays drilling has become a specialized and technologically advanced business. The equipment used to drill a well is technically complex (for example, the navigation systems used in directional drilling are as sophisticated as those found on modern jet aircraft or spacecraft), and those who run the equipment must be well trained. Safety training is part of everyday life for all hands on a drilling rig. There are safety meetings at the beginning of every tour and before each new part of a job. Outside training, such as helicopter safety training for offshore crews, is also required for drilling personnel.

- Read Text II A again and do COMPREHENSION exercises below.

COMPREHENSION

I. Answer the following questions:
1. What are the reasons for drilling?
2. What is the oldest drilling technique?
3. What types of drilling rigs are mentioned in the text?
4. What techniques of well drilling do you know?
5. What is the advantage of multilateral drilling?
6. When are wells completed?
7. What operations does completion involve?
8. When are wells plugged and abandoned?
9. Why is safety training a must for all hands on a drilling rig? How often is it done?
10. How do feet and meters correlate?

II. Choose A, B or C.
1. The first modern oil well was drilled in Baku in
   A. 1848.
   B. 1746.
   C. 1946.
2. Today, the most common types of rigs are
   A. rotary rigs.
   B. cable-tool rigs.
   C. both rotary and cable-tool rigs.
3. Conventional wells are drilled using
A. vertical drilling.  
B. horizontal drilling.  
C. extended-reach drilling.  

4. Well completion is the  
A. first stage of drilling operations.  
B. intermediate stage of drilling operations.  
C. final stage of drilling operations.  

III. Say whether the statements below are true, false or not mentioned in the text. Discuss those not mentioned.  
1. Drilling engineers are well paid.  
2. Cable-tool drilling is older than rotary drilling.  
3. Onshore and offshore rigs do not differ in design.  
4. Vertical drilling has developed from horizontal drilling.  
5. Horizontal drilling is considered a conventional drilling technology.  
6. Directional drilling is the most commonly used drilling technology.  
7. Coiled tubing technology is not used offshore.  
8. If a well is commercially viable, it is to be completed.  
9. Completion process involves strengthening the well with casing.  
10. Today, drilling is a much more technologically advanced business than it used to be.  

VOCABULARY  
I. Find synonyms of the following words in Text II A.  
1. borehole __________________  
2. oil platform __________________  
3. traditional __________________  
4. oil accumulation __________________  
5. to need __________________  
6. section of pipe __________________  
7. to operate equipment __________________  
8. worker __________________  
9. shift __________________  

II. Find antonyms of the following words in Text II A.  
1. old __________________  
2. onshore __________________  
3. mobile __________________  
4. vertical __________________  
5. thick __________________
III.  Match a word and its meaning.
1. to evolve  a. staying the same; not changing or able to be changed; not able to be moved
2. conventional  b. to look like or be similar to another person or thing
3. continuous  c. normal and ordinary
4. to resemble  d. spreading in a line or over an area without any spaces
5. hand  e. to develop gradually, especially from a simple to a more complicated form
6. to strengthen  f. the people who work for an organization
7. to run  g. to operate; to use something or make it work
8. personnel  h. to become stronger; to make somebody/something stronger
9. fixed  i. a person who does physical work

IV.  Fill in the gaps with the words from the box:

**evolved whatever tapped strengthened hand personnel**

**continuous conventional run untapped**

1. The new director is likely to make major changes in __________.
2. The company has__________ over the years into a multi-million dollar organization.
3. I joined the firm as a factory __________ and gradually worked my way up to the top.
4. __________ oil and gas refers to petroleum, or crude oil, and raw natural gas extracted from the ground by conventional means and methods.
5. Do you know how to __________ this sort of machinery?
6. Yesterday the pound __________ against the dollar.
7. Western and central China will experience increasing energy development because they hold many __________ and fewer __________ oil and gas fields.
8. She was in __________ employment until the age of sixty-five.
9. The personnel may take ___________ action is needed.

V. Circle the word or word combination in bold that fits best.
1. A **producing well** / **An exploratory well** is a well drilled in a proven producing area for the production of oil or gas.
2. An **appraisal well** / **An injection well** is an exploratory well drilled to establish the extent and size of a petroleum deposit that has already been discovered by a wildcat well.
3. **Cable-tool** / **Rotary** drilling was the first method used to drill a bore hole.
4. **Pay zone** / **Drill site** refers to the rock in which oil and gas are found in exploitable quantities.
5. **Rotary rigs** / **Cable-tool rigs** drill the vast majority of wells today, including all medium and deep wells.
6. **Jack-Up Rigs** / **Semisubmersibles** are offshore rigs with retractable steel legs that can be placed on the ocean floor and raise the rig above the water line.
7. **Vertical drilling** / **Horizontal drilling** is a conventional type of drilling.
8. **Horizontal drilling** / **Vertical drilling** starts with a vertical well that turns horizontal within the reservoir rock.
9. If the well is commercially viable, it is **completed** / **plugged and abandoned**.
10. The purpose of **safety training** / **guidance systems** is to provide the knowledge necessary to perform job safely.

TEXT II B

- Translate the text into Russian and do the exercises below. Use the link to look up the new words: http://www.multitran.ru.

Today, almost all oil and gas wells are known to be drilled using rotary drilling method. In rotary drilling, special equipment is used to turn the drill bit. This equipment consists of the swivel, the kelly, the rotary table, the drill pipe and the drill collar. The swivel is suspended under the traveling block by a hook and permits the drill string to rotate. The kelly is a square or hexagonal shaped section of pipe that is attached to the swivel and fits in a matching slot in the rotary table. As the rotary table turns the kelly is also turned. The movement of the kelly rotates the drill string and the drill bit. The drill pipe is round steel tubes about 30 feet long with a diameter of from 4 to 5 inches. The drill collar is used to add weight on the bit. The drill pipe has threaded connections on each end that allow the pipe to be joined together to form longer sections as the hole gets deeper. The drill bit is used to create the hole. The drill bit sizes vary from four inches to three feet in diameter. The most common drill bits are roller cone bits and PDC (polycrystalline diamond compact) bits with diamond bits also being used. Roller cone bits have three cones containing rows of teeth. The cones rotate on bearings and turn as the drill bit rotates. The teeth cut and crush the rock to create the hole. PDC bits use small disks of synthetic diamond to provide the scraping/cutting surface. The small discs may be manufactured in any size and shape and are not sensitive to failure along cleavage planes as natural diamond bits are. Diamond bits have a single fixed head that contains many small diamonds. As the bit turns the diamonds cut the rock. Different drill bits are used
depending on the type of rock that is encountered. During drilling, the circulating system pumps drilling mud/fluids into the well bore to cool the drill bit, remove rock chips, and control subsurface fluids. Mud is circulated down through the hollow drill pipe. The mud exits the pipe through holes or nozzles in the drill bit, and returns to the surface through the annulus between the drill pipe and the well bore wall.

I. Choose the most suitable heading.
   - Diamond bits.
   - Rotary drilling.
   - Types of bits.

II. Find the English equivalents of the following terms in Text II B.

<table>
<thead>
<tr>
<th>Term</th>
<th>English Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>бурильная труба</td>
<td>drill pipe</td>
</tr>
<tr>
<td>насадка</td>
<td>bit</td>
</tr>
<tr>
<td>буровой раствор</td>
<td>drilling fluid</td>
</tr>
<tr>
<td>ведущая труба, квадрат</td>
<td>leading pipe</td>
</tr>
<tr>
<td>вертлюг</td>
<td>rotary table</td>
</tr>
<tr>
<td>талевый блок</td>
<td>wireline</td>
</tr>
<tr>
<td>резьбовое соединение</td>
<td>thread</td>
</tr>
<tr>
<td>роторный стол; ротор буровой установки</td>
<td>rotary table;</td>
</tr>
<tr>
<td>выбуренная порода; шлам; обломки породы</td>
<td>drilled</td>
</tr>
<tr>
<td>УБТ (утяженные бурильные трубы)</td>
<td>UBT (heavy drill pipe)</td>
</tr>
<tr>
<td>долото шарошечного типа</td>
<td>shothole bit</td>
</tr>
<tr>
<td>алмазное долото</td>
<td>diamond bit</td>
</tr>
<tr>
<td>колонна бурильных труб</td>
<td>drill collar</td>
</tr>
<tr>
<td>затрубное пространство</td>
<td>stand pipe</td>
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</tbody>
</table>
### III. Complete the captions.

<table>
<thead>
<tr>
<th>Hybrid roller cone - … bit</th>
<th>Drill …</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Hybrid roller cone - … bit" /></td>
<td><img src="image2" alt="Drill …" /></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Roller … bit</th>
<th>Drill …</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3" alt="Roller … bit" /></td>
<td><img src="image4" alt="Drill …" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rock …</th>
<th>Casing … connections</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image5" alt="Rock …" /></td>
<td><img src="image6" alt="Casing … connections" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>… block</th>
<th>Drill collar is used to …</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image7" alt="… block" /></td>
<td><img src="image8" alt="Drill collar is used to …" /></td>
</tr>
</tbody>
</table>

### IV. Finish the sentences.

The rotating equipment consists of ...
The swivel is attached to … and permits...
The kelly is …
The drill pipe is …
The drill collar is used to …
The drill bit is used to …
The most common drill bits are …
Roller cone bits have …
The cones rotate on …
PDC bits use …
Diamond bits have …
The drilling mud is pumped into the wellbore to …
The mud exits the pipe through …
Oil country tubular goods (OCTG) include casing, tubing, line pipe, and drillpipe. Casing serves several important functions in drilling and completing a well. It prevents collapse of the borehole during drilling and hydraulically isolates the wellbore fluids from the subsurface formations and formation fluids. It minimizes damage to the subsurface environment by the drilling process and to the well by the hostile subsurface environment. With blowout preventers (BOPs), it enables the safe control of formation pressure.

Tubing conducts well fluids from the formation to the wellhead. Line pipe is typically used in surface facilities to convey gas, oil, and water in both the oil and natural-gas industries. Line pipe is sometimes used in oil wells because it is available in larger sizes and is often needed for shallow oilwell strings. Drillpipe is used to drill wells, and it functions as a workstring that enables application of torsion, weight, and hydraulics during the drilling process. The function of drillpipe is very different from that of other types of OCTG, and design issues such as fatigue are more important.

As the search for commercial hydrocarbon deposits reaches greater depths, the number and sizes of the casing strings required to drill and complete a well successfully have also increased. Casing has become one of the most expensive parts of a drilling program; studies have shown that the average cost of tubulars is approximately 18% of the average cost of a completed well. Therefore, an important responsibility of the drilling engineer is to design the least expensive casing program that will enable the well to be drilled and operated safely throughout its life.

A well that will not encounter abnormal formation pore-pressure gradients, lost-circulation zones, or salt sections may require only conductor casing and surface casing to drill to the objective for the well. Conductor casing is needed to circulate the drilling fluid to the shale shakers without eroding the shallow sediments below the rig and rig foundations when drilling is initiated. Surface casing prevents cave-in of unconsolidated weaker near-surface sediments and protects the shallow freshwater sands from contamination. Surface casing also supports and protects from corrosion any subsequent casing strings run in the well. In the event of a kick, surface casing generally makes it possible to contain the flow by closing the BOPs.

Intermediate casing is usually required in deeper wells that penetrate abnormally pressured formations, lost circulation zones, unstable shale sections, or salt sections. Intermediate casing is often referred to as “protective” or “drilling” casing. Some wells may require one or more strings of intermediate casing between the surface casing depth and the final well depth. When abnormal formation pore pressures are present in the deeper portions
of a well, intermediate casing is needed to protect formations below the surface casing from the pressures created by the required high drilling-fluid density. Similarly, when normal pore pressures are found below sections having abnormal pressure, an additional intermediate casing makes it possible to reduce the mud density to drill deeper formations economically. If a troublesome lost-circulation zone is encountered or an unstable shale or salt section is penetrated, intermediate casing may also be required to prevent well problems when drilling below these zones.

**Liners** are casing strings that do not extend to the surface, but are suspended from the bottom of the next larger casing string. A **liner hanger** is used to suspend the top of the liner in the larger casing size; the liner hanger often can seal the annulus between the liner and the larger casing size. A drilling liner can be used either as an intermediate casing (in that it serves to isolate troublesome zones that tend to cause well problems during drilling operations) or as production casing.

**Production casing** is usually the final casing string set in a well. It comes in contact with formation fluids below the **production packer** and with the **completion fluid (packer fluid)** in the tubing-casing annulus above the production packer. This casing string provides protection for the environment in the event of a **failure** of the tubing string during production operations and enables the production tubing to be replaced or repaired later in the life of a well.

**VOCABULARY TO TEXT II C**

- **oil country tubular goods (OCTG)** трубные изделия нефтепромыслового сорта́мента
- **tubing** насосно-компрессорные трубы (НКТ)
- **line pipe** труба для трубопровода
- **collapse** обвал; осадка
- **hostile** неблагоприятный; агрессивный
- **blowout preventer (BOP)** противовыбросовое оборудование для герметичного закрытия устья скважины в случае фонтанирования (превентор)
- **to conduct** проводить, пропускать
- **to convey** транспортировать; передавать; проводить
- **string** колонна (труб) *e.g.* **casing string** колонна обсадных труб
- **workstring** рабочая колонна
- **torsion** кручение, скручивание
- **fatigue** усталость (*напр.* металла)
- **to encounter** встречаться, сталкиваться
- **pore-pressure gradient** градиент порового давления
- **lost-circulation zone** зона поглощения (потери циркуляции) бурового раствора
- **salt section** солевая толща
- **conductor (casing)** направляющая обсадная колонна
- **surface casing** кондуктор
- **shale shaker** вибрационное сито (для очистки бурового раствора от шлама)
- **to erode** размывать, выветривать; разъедать; разрушать, вызывать эрозию
- **sediment** осадок, отложение
- **foundation** фундамент, основание
cave-in обвал, обрушение стенок скважины
cave-in обвал, обрушение стенок скважины
unconsolidated неуплотненный, рыхлый, несцементированный
weak неустойчивый; мягкий
kick выброс
intermediate casing промежуточная обсадная колонна
to penetrate проходить (при бурении)
shale section глинистый интервал
density плотность
liner хвостовик
to suspend подвешивать
liner hanger подвешное устройство для хвостовика
production casing эксплуатационная колонна
production packer эксплуатационный пакер
completion fluid жидкость для заканчивания скважин
packer fluid (над)пакерная жидкость
failure 1. авария; неисправность; поломка 2. обрушение, обвал; оседание

VOCABULARY AND TRANSLATION BANK

I. Fill in the gaps with the words from the box.

Offshore Drilling Rig Today

As offshore drilling moves into greater water depths and more __________ environments, all costs increase rapidly. It also leads to the increase in size of petroleum __________ required to justify the drilling. In some cases, oil companies must consider a reserve __________ at 100 million barrels (16 million cubic metres) of oil marginal; that is, if they estimate that they can __________ only 100 million barrels from a reservoir, then that reservoir will not be __________ due to the high costs of drilling, producing, and transporting the oil to shore. Commercial reserves begin at 300 million barrels (48 million __________ metres) of expected production for some fields. However, exploring for offshore oil and gas is __________ as improvements in drilling and production techniques help __________ costs and increase the chances of success. The type of rig used in offshore drilling depends largely __________ whether the company is drilling for exploration or for development. Development wells are the wells drilled in a reservoir that __________ has found. Oil companies almost always use mobile rigs in exploratory drilling, and often use fixed platforms with production and well maintenance __________ for development drilling.
II. **Translate the texts below into Russian in writing and give them headings.**

- Perhaps the most obvious difference between drilling offshore and onshore is that an onshore rig sits directly on the surface through which it is to drill. However an offshore rig can be floating anywhere from a few tens of meters to a couple of thousand meters above the sea bed, and must therefore be attached to the sea floor by a large steel pipe called a marine riser. The riser then acts as a conduit for the drill string and the drilling mud. In essence, it is an extension of the casing that allows the drilling mud and rock cuttings to be isolated from the water column and circulated back to the rig.

- The type and number of rig personnel is related to the size and complexity of the rig. At the simplest level, a basic rig includes a toolpusher, a driller, a derrickman, a motorman, and a floorhand. The toolpusher is the senior manager at the rig and is responsible for personnel, parts, and performance. The driller reports directly to the toolpusher and is responsible for the active drilling phase, trips, and the safety of the floorhands. Reporting to the driller are the derrickman, motorman and floorhand. The derrickman handles the top end of each stand of pipe during trips. When not tripping pipe, the derrickman is in charge of the circulating system. The motorman keeps the engines and other parts of the rig in working order and functions as the lead tong during trips. The floorhand, or roughneck, handles the backup tong in trips and is apprenticed to the senior crew members. Any unskilled manual laborer on the rigsite is referred to as roustabout. A roustabout may be part of the drilling contractor's employee workforce, or may be on location temporarily for special operations. Roustabouts are commonly hired to ensure that the skilled personnel that run an expensive drilling rig are not distracted by peripheral tasks, ranging from cleaning up location to cleaning threads to digging trenches to scraping and painting rig components. Although roustabouts typically work long hard days, this type of work can lead to more steady employment on a rig crew.

- Horizontal drilling starts with a vertical well that turns horizontal within the reservoir rock in order to expose more open hole to the reservoir. These horizontal "legs" can be over a mile long; the longer the exposure length, the more oil and natural gas is drained and the faster it can flow. Horizontal wells are attractive because they (1) can be used in situations where conventional drilling is impossible or cost effective, (2) reduce surface disturbance by requiring fewer wells to reach the reservoir, and (3) can produce as much as 15 to 20 times as much oil and gas compared to a vertical well.

- The success of the rotary-drilling process (completion of an oil or gas well) and its cost depend on three important factors: the bit penetrating the rock, cleaning the bit face and transport of the cuttings to surface, the support of the borehole. The drilling fluid (commonly known as "drilling mud" or simply "mud") used affects all of these factors. The drilling fluid density and ability to penetrate rock have an effect on the rate of
penetration. The hydraulic energy expended on the bottom of the hole and the viscosity and flow rate of the fluid affect the cuttings transport. And the density of the fluid and its ability to form a layer on the wellbore (wall cake) affects the wellbore stability and support. It is often said that the majority of the problems in drilling are related in some manner or another to the drilling fluid. The drilling engineer is concerned with the selection and maintenance of the drilling fluid because of its relation to most drilling operational problems. The cost of the drilling fluid is comparatively small as compared to the rig or casing costs; but, the selection of the proper fluid and the testing and control of its properties has considerable effect on the total well cost.

III. Match a definition and a term.

<table>
<thead>
<tr>
<th>Definition</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>one of several strings of steel pipe in a well design that, together with</td>
<td>plug and abandon</td>
</tr>
<tr>
<td>cement, forms a barrier to fluid movement along the drilled hole. It is</td>
<td></td>
</tr>
<tr>
<td>commonly at least partly cemented in the wellbore</td>
<td></td>
</tr>
<tr>
<td>a rig supported by attached pontoons</td>
<td>drilling</td>
</tr>
<tr>
<td>the main rotating shaft on a rotary drilling rig that connects to and</td>
<td>reservoir</td>
</tr>
<tr>
<td>turns the drill string</td>
<td></td>
</tr>
<tr>
<td>the equipment at the surface used to lift and run the drilling string</td>
<td>pay zone</td>
</tr>
<tr>
<td>provide the rotation and pump fluids down the string</td>
<td></td>
</tr>
<tr>
<td>the fluid, water, oil or gas based, that is used to establish well</td>
<td>multilateral</td>
</tr>
<tr>
<td>control, transport cuttings to the surface, provides fluid loss</td>
<td></td>
</tr>
<tr>
<td>control, lubricates the string and cools the bottom hole assembly</td>
<td></td>
</tr>
<tr>
<td>the action of placing a hole to a depth and location</td>
<td>drilling rig</td>
</tr>
<tr>
<td>hydrocarbon producing interval</td>
<td>kelly</td>
</tr>
<tr>
<td>setting cement and mechanical plugs to seal off pays, potential leak</td>
<td>semisubmersible</td>
</tr>
<tr>
<td>points, fresh water zones and the surface</td>
<td></td>
</tr>
<tr>
<td>an independent hydrocarbon holding rock</td>
<td>casing</td>
</tr>
<tr>
<td>more than one producing wellbore from a single wellbore or mother bore</td>
<td>drilling mud</td>
</tr>
</tbody>
</table>

IV. Translate the sentences into English using connectors if or whether for Russian “ли”.

Ex. Дай мне знать, есть ли у тебя мобильная связь. – Let me know if/whether you can get cell phone reception.

1. Нужно понять, следует ли бурить здесь.
2. Необходимо решить, следует ли заканчивать скважину.
3. Он спросил, сильно ли износились (wear off) долото.
4. Мы обсудили, уменьшит ли наклонная скважина ущерб для окружающей среды.
5. Он не знает, возможен ли монтаж вышки над забоем.
6. Интересно, все ли члены буровой бригады прошли обучение технике безопасности.
7. Вы знаете, должны ли мы запустить оборудование?
8. Нам не сказали, стоит ли применять этот метод.
9. Тип буровой установки зависит от того, будут ли бурить разведочные или эксплуатационные скважины.
10. Интересно, какие виды долот они собираются использовать.

V. Render the following into English.

a) Цели и назначение буровых скважин различные. Эксплуатационные скважины закладывают на полностью разведенном и подготовленном к разработке месторождении. В категорию эксплуатационных входят не только скважины, с помощью которых добывают нефть и газ (добывающие скважины), но и скважины, позволяющие организовать эффективную разработку месторождения (оценочные, нагнетательные, наблюдательные скважины). Оценочные скважины предназначены для уточнения режима работы пласта [natural recovery drive] и степени выработки участков месторождения, уточнения схемы его разработки. Нагнетательные скважины служат для организации нагнетания в эксплуатационный пласт воды, газа или воздуха в целях поддержания пластового давления. Наблюдательные скважины сооружают для систематического контроля режима разработки месторождения [reservoir drive]. Конструкция эксплуатационной скважины определяется числом рядов труб, спускаемых в скважину и цементируемых в процессе бурения для успешной проводки скважин, а также оборудованием ее забоя. В цикл строительства скважины входят подготовительные работы; монтаж вышки и оборудования; подготовка к бурению; процесс бурения; крепление скважины обсадными трубами и ее тампонаж; вскрытие пласта и испытание на приток нефти и газа [production test].

b) Обсадная колонна предназначена для крепления буровых скважин, а также изоляции продуктивных горизонтов при эксплуатации. Обсадные трубы, применяемые при бурении нефтяных и газовых скважин, изготовляются в основном из стали. Применяются обсадные колонны трех видов: кондукторы; промежуточные; эксплуатационные. Промежуточные колонны предназначены для крепления стенок нижних интервалов скважин. Кондукторы и промежуточные колонны обычно цементируются, но могут быть и съемными (например, при бурении некоторых геолого-разведочных скважин или глубоких скважин для борьбы с износом спущенных предыдущих промежуточных колонн). Эксплуатационная колонна
перекрывает продуктивные горизонты. Через перфорационные отверстия в колонне в скважину поступают нефть и газ, которые перемещаются к устью по колонне насосно-компрессорных труб [tubing]. Обсадные колонны подвергаются воздействию наружного давления жидкости и газа в пластах; воздействию внутреннего давления нефти, газа, а также бурового раствора, собственной массы и усилия натяжения [tension force] колонн, обусловленного влиянием температуры и давления. Длины, диаметры и число обсадных колонн определяются геологическими условиями бурения, уровнем техники и технологии строительства скважин, условиями предупреждения и ликвидации возможных осложнений и аварий и др. Диаметр эксплуатационных колонн и глубина скважины являются основными параметрами для определения диаметра промежуточных колонн. При выборе конструкций колонн учитывается экономичность сооружения и длительность эксплуатации.

c) Бурение скважин – сложный технологический процесс строительства ствола буровых скважин, состоящий из следующих основных операций: углубление скважин посредством разрушения горных пород буровым инструментом; удаление выбуренной породы из скважины; крепление ствола скважины в процессе ее углубления обсадными колоннами; проведение комплекса геолого-геофизических работ по исследованию горных пород и выявлению продуктивных горизонтов; спуск на проектную глубину [total depth] и цементирование последней (эксплуатационной) колонны.

d) Для бурения глубоких скважин используют обычно роторный способ бурения. Это наиболее распространенный способ бурения, составляющий до 80 процентов общего объема буровых работ. При этом способе бурения скважин порода разрушается при помощи вращающегося бура. Ротор, расположенный на поверхности, с помощью колонны бурильных труб передает вращение на бур. Использование долот различного диаметра дает возможность производить бурение внутри обсадных труб. Во избежание обрушения стенок скважины и для перекрытия верхних водоносных горизонтов [water shut-off] в нее опускают обсадную трубу, и дальнейшее бурение производят внутри обсадной трубы долотом меньшего диаметра. Затем в скважину опускают следующую обсадную колонну, затем эксплуатационную колонну, которая будет находиться в водоносном слое. Бурение производится долотами различных размеров, начиная с большего.

**SPEAKING**

1. *Look at the way the rotary drilling process is described. Choose any drilling technique you know and describe how it works using the words in bold.*

First/First of all, the site that contains crude oil is selected.
Next/Second, the land for the drilling process is prepared.
After the land preparation, the rig must be placed on the site, and holes are dug for this purpose.
Later, the oil rig is set up in the holes, and the drilling process is started.
The next step/stage is to place the drill bit and the drill collar in the main hole. Then, the kelly and turntable are attached and at this point the actual process can begin. As drilling progresses, new joints to the drilling pipe are attached. Once the preset depth of the process is reached, the drilling bit and the pipe are removed from the hole. After this, the casing pipe sections are placed in the main hole. The process of drilling is continued, and finally the casing pipe is placed in the hole/the final stage is to place the casing pipe in the hole, until the oil is not found. As soon as it is found, the drilling apparatus is removed from the hole.

II. Look at the picture, name the drilling techniques depicted in it and describe them using the vocabulary you learnt in Unit II and the phrases below.

- The technique involves/includes/consists of the following operation/steps/processes...
- Firstly, Secondly, Next, Finally
- In my view, …
- As far as … is concerned
- Also, besides, apart from, on the one hand … on the other hand, moreover, while
- The strong point/advantage/benefit/advanced feature of … is...
- Among the weak points/disadvantages/drawbacks/problems of the technique I would mention...
- I believe that … is an advantage because ...

III. Discuss in pairs.
- If you were a drilling engineer, would you like to work onshore or offshore? Why?
- What kind of bits would you use in soft/hard rocks?
- Why do you think the oil industry started drilling offshore?
- Which is more expensive, drilling onshore or offshore?