НАВЧАЛЬНО-НАУКОВИЙ ЦЕНТР ГУМАНІТАРНОЇ ОСВІТИ

Кафедра іноземних мов

A GLIMPSE INTO LOCOMOTIVES: FROM BACKGROUND TO REALITY

МЕТОДИЧНІ ВКАЗІВКИ

з розвитку різних видів читання

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Методичні вказівки розглянуто та рекомендовано до друку на засіданні кафедри іноземних мов 10 квітня 2018 р., протокол № 8.

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Робота розроблена у відповідності до робочої програми дисципліни і є складовою частиною УМКД.

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UNIT 1

«WHY ARE YOU HERE?» OR «WHAT DOES THE PROFESSION OF A MECHANICAL ENGINEER MEAN?»

Exercise 1. Study the following words and word combinations. Learn them by heart.

affection – прихильність, любов, потяг
alarming – тривожний, хвилюючий
applied mechanics – прикладна механіка
be over – закінчуватися, скінчитися
camshaft – розподільний вал, кулачковий валик
connecting rod – шатун
crankshaft – колінчастий вал
determination – визначення
doggedly – уперто, завзято
electrical engineering – електротехніка
emergence – виникнення, поява
flywheel – махове колесо, маховик
gear – механізм, привод
in vain – даремно, марно
inspire – надихати
interaction – взаємодія, вплив один на одного
internal combustion engine – двигун внутрішнього згоряння
life cycle – строк служби, строк експлуатації, ресурс, життєвий цикл
lose sight of – втратити з поля зору, забути
main / auxiliary generator – головний / допоміжний генератор
materials technology – матеріалознавство
meet the challenge – справитися із труднощами, гідно відповісти на виклик, вистояти
particularly – особливим чином, особисто, зокрема, докладно, детально
storage battery – акумулятор, акумуляторна батарея
strength of materials – опір матеріалів
theoretical mechanics – теоретична механіка

traction motor – тяговий двигун
traction rolling stock – тяговий рухомий склад

Exercise 2. Translate the following word combinations from English into Ukrainian.

The emergence of railways, at alarming rate, in vain, inspire so much affection, the Department of Operation and Maintenance of Rolling Stock, Internal combustion engine, the theory of locomotive traction, traction rolling stock life cycle, to lose sight of, follow so doggedly, an engineer can't do without the knowledge of foreign languages, crankshaft, flywheel, connecting rod, camshaft, gear, main and auxiliary generator, storage battery, to provide with excellent opportunities, at the disposal, the sphere of activity, well-equipped.

Exercise 3. Pre-text discussion: Why did you choose our University? Why did you decide to be a railwayman? Does anyone in your family work on railway? Do you belong to a railway dynasty?

Exercise 4. Read and translate the text.

The profession of a locomotive engineer

'The duty of an engineer is twofold — to design the work and to see that the work is done.'

Robert Louis Stevenson (novelist)

The emergence of railways changed forever the face of industry and transportation; food, goods and supplies could for the first time be shipped across long distances at alarming rates. Indeed, the railway is often thought of as the birth of the modern age. But nowadays one may hear that the «golden age» of railways is over because we live in the era of high technologies and super-high speeds and more and more people give their preferences to air travel. But it is because of all new technologies that modern railways are ready to meet these challenges! They compete effectively with all the other modes of transport, particularly with the above mentioned air transport and due to computer technologies high-speed trains become more and more «intelligent». They resemble aircraft in design, fully automated operation and speed (the world speed record now is 581 kmh). Advances in rail transportation will make the trains still more powerful and our travel more comfortable with each coming decade.

So, young people choose this speciality – Operation and Maintenance of Rolling Stock – not in vain! Few machines in the machine age have inspired so much affection as railway locomotives in their more than 200 years of operation. During this period of time locomotives have passed a long way of development from Richard Trevithick's locomotive of 1804 to high-speed modern Maglev trains.

I dare remind you that you study at Ukrainian State University of Railway Transport. The faculty you study at, the Mechanical faculty, is one of the oldest in our University. It was founded in 1930 – the same year as Kharkov Institute of Railway Transport Engineers was founded. The Mechanical faculty has many Departments and one of them is the Department of Operation and Maintenance of Rolling Stock. 35 special disciplines are taught at our Department. The most important of them are «Safety and technical diagnostics of general rolling stock», «General construction of locomotives and their interaction with technical means of railway transport», «Internal combustion engines», «Basics of locomotive operation», «The organization of locomotive repair production», «The theory of locomotive traction», «Modern information technologies in locomotive sector», «Basics of the determination of traction rolling stock life cycle» and many others. But all engineers of the present and future should never lose sight of basic principles of natural physics and the basics of railway engineering which the great engineers of the past followed so doggedly. That's why you are delivered such subjects as higher mathematics, physics, chemistry, applied mechanics, theoretical mechanics, strength of materials, materials technology, foreign languages (because modern engineer can't do without the knowledge of foreign languages!), electrical engineering and others.

Locomotive engineers specialize in the field of locomotives and their equipment and deal with a variety of mechanisms such as: crankshafts, flywheels, connecting rods, camshafts, gears etc. They are also concerned with the electrical equipment used on locomotives: main and auxiliary generators, traction motors, storage batteries and so on. A well-equipped diesel laboratory is at the disposal of the students of our University. It provides you with excellent opportunities for studies and research. The basic problems under investigation at our diesel laboratory are: further increase of the economic efficiency and reliability of diesel engines and other locomotive units. A lot of students of our department are engaged in research work. The sphere of activity of a railway mechanical engineer is rather broad. The graduates usually work at locomotive depots, at locomotive building plants and other industrial enterprises, at designing and research institutes and at railway higher educational establishments as well.

Exercise 5. Answer the following questions.

1 What did the emergence of railways change forever? 2 What is the railway often thought of? 3 Why do people think that the «golden age» of railways is over? 4 Why do high-speed trains become «intelligent»? 5 What problems always interested me? 6 Why is the Mechanical faculty one of the oldest? 7 What Department do you study at? 8 How many disciplines are taught at your Department? 9 What should all the engineers of the present and future never lose sight of? 10 What field do locomotive engineers specialize in? 11 What mechanisms do they deal with? 12 What are the basic problems under investigation at our diesel laboratory?

Exercise 6. Translate the following words and word combinations into English.

Змінити назавжди, перевозити на довгі відстані, хвилюючі швидкості, можна почути, віддавати перевагу, ефективно конкурувати, бути схожим на літак, проблема розвитку та модернізації, безпека та технічна діагностика, технічні засоби залізничного транспорту, локомотиворемонтне виробництво, теорія локомотивної тяги, визначення строку експлуатації тягового рухомого складу, уперто прямувати, обходитись без, чудові можливості, займатись науковою роботою, локомотивобудівельний завод.

Exercise 7. Translate the words in italics into English.

1 (*Виникнення залізниць*) changed forever the history of mankind. 2 The railway is often thought of as (*народження нового віку*). 3 Nowadays one may hear that the «golden age» of railways (*скінчилася*) because we live in the era of (*високих технологій та надвисоких швидкостей*). 4 But (*саме завдяки високим технологіям*) modern railways are ready (*гідно відповісти на ці виклики*)! 5 Due to computer technologies high-speed trains (*стають все більше та більше «розумними»*). 6 You have chosen your speciality – (*Експлуатація та ремонт рухомого складу*) – (*не дарма*)! 7 Few machines (*навіювати такі почуття*) as railway locomotives in their more than 200 years of operation. 8 All engineers (*не повинні забувати*) basic principles of natural physics and the basics of railway engineering which the great engineers of the past followed so (*завзято*). 9 A locomotive engineer specializes in (*сфері локомотивів та їхнього обладнання*) and (*має справи з*) a variety of mechanisms. 10 They (*також займаються*) the electrical equipment used on locomotives 11 A (*добре обладнана дизельна лабораторія*) is (*у нашому розпорядженні*). 12 The basic problems under investigation are: further increase of the (*економічна ефективність та надійність дизельних двигунів*) and other locomotive units.

Exercise 8. Read the text again and complete the following sentences.

1 Food, goods and supplies could be shipped … 2 … more and more people give their preferences to air travel. 3 … modern railways are ready to meet these challenges 4 … with all the other modes of transport. 5 Due to computer technologies high-speed trains become ... 6 They resemble aircraft in … 7 … always interested me. 8 Few machines in the machine age have inspired so much affection … 9 … are taught at our Department. 10 We are delivered such subjects as … 11 Locomotive engineers specialize in … and deal with a variety of mechanisms such as: ... 12 They are also concerned with … 13 The … under investigation at our diesel laboratory are: ... .

Exercise 9. Using the Internet or some other sources make short reports on the following topics:

- Steam locomotives from the birth to present-day usage;
- Modern locomotives (diesel and electric);
- High-speed rail (currently operating and concepts);
- Light Rail.

Exercise 10. Project. Create your own locomotive of the future. What will it look like? Make presentations.

UNIT 2

THREE GENERAL TYPES AND OTHER VARIETIES OF LOCOMOTIVES

Exercise 1. Study the following words and word combinations. Learn them by heart. Then read and translate Text 1.

literally – буквально, дослівно
advent – прихід, прибуття
back and forth – туди-сюди, вперед-назад
to make into – перетворювати в, переробляти
linear motion – поступальний рух
rotary motion – обертальний рух

Text 1. Engines (Locomotives)

Locomotive power is the driving or pulling power of railroads. The locomotive or engine pulls and/or pushes the train. It seems the words Locomotive and Engine are completely interchangeable.

The word engineer comes from the steam engine. It literally means «the controller of the steam engine». It was a time when there was a great mystic around the steam engine during the industrial revolution and well there should have been, it was changing the world. With the advent of trains the guy who drove the train engine was an engineer. Think about it, this guy could magically transport you to the other end of the world, at a time when the second fastest transportation was the horse and when most people still rarely travelled far from where they were born.

Locomotives/engines come in three general types, divided by how the tractive power is generated.

STEAM – Powered by steam pushed into cylinders to push a piston back and forth, and then this linear motion is made into rotary motion in the wheels.

ELECTRIC – Driven by an overhead electric cable or an electrified third rail to power a large motor on the locomotive or in the wheels.

DIESEL ELECTRIC – Wheels powered by rotary electric motors, electricity generated on the locomotive by a diesel engine driving a generator.

Exercise 2. Answer the following questions.

1 What is locomotive power? 2 What does the locomotive does with the train? 3 Why do the words Locomotive and Engine seem interchangeable? 4 Who was the guy who drove the train engine? 5 What was the magic of that guy? 6 What are the three general types of locomotives? 7 What is the principle of their division?

Exercise 3. Translate the following word combinations from English into Ukrainian.

Locomotive power, driving or pulling power of railroads, pulls and/or pushes the train, completely interchangeable, the controller of the steam engine, a great mystic, during the industrial revolution, with the advent of trains, the second fastest transportation, to come in three general types, steam pushed into cylinders, to push a piston back and forth, an overhead electric cable, an electrified third rail, to power a large motor.

Exercise 4. Study the following words and word combinations. Learn them by heart. Then read and translate Text 2.

beam – брус
wheel arrangement – колісна формула

driver wheel – зчіпне колесо
steering wheel – кермове (стернове) колесо
pilot truck – провідний візок
early on – швидко, одразу, незабаром
stoker – кочегар
trailing truck – задній візок
pivoted bogie – поворотна вагонетка
firebox – топка
articulated – зчленований; той, що складається із двох або більше секцій
pivot – вісь, стрижень
negotiate a curve – вписуватись у криву
thermal efficiency – тепловий коефіцієнт корисної дії

Text 2. Steam engines

A Steam Engine works by injecting steam in cylinders, as the steam expands it pushes the piston in the cylinder outwards. In many cases there is a secondary system which injects steam in the cylinder on the other side of the piston to push it back; this is called the back or return stroke. There is a lot of complex mechanical stuff around the cylinders and wheels to govern the timing of the steam injection for the best performance. A long beam transfers the linear motion of the pistons into rotary motion in the wheels which in turn drives the locomotive. The steam is generated in the boiler. Coal or wood fired, it boils water to make steam, which is gaseous water which can be made to expand and fill the cylinders. It's really simple physics, but complex technology.

Steam locomotives are classified according to the number of wheels.

The way the wheels are arranged under the engine is called *wheel arrangement* . There are often three sets of wheels, performing three different functions. While all steam engines have driver wheels, they are the big powered wheels, there are usually steering wheels in front on the pilot truck. It was learned early on in the history of railroads that having smaller wheels in front of the drivers made the engine safer, they helped to steer or piloted the engine into curves. Then as engines got bigger and the cab end (usually the back end, where the engineer and stoker are) began to extend out farther from the drivers, wheels were needed to support the cab. They are usually the same smaller size as the pilot wheels. So when talking about the wheel arrangement the pilot wheels are the first set, then the drivers, and the final set are those supporting the cab, in the trailing truck.

Except for small engines used in marshalling yards, all modern steam locomotives had leading wheels on a pivoted bogie or truck to help guide them around curves. The trailing wheels helped carry the weight of the firebox. For many years the ‘American standard’ locomotive was a 4-4-0, having four leading wheels, four driving wheels and no trailing wheels. The famous Civil War locomotive, the *General,* was a 4-4-0, as was the New York Central *Engine No 999*, which set a speed record of 112.5 mph (181 kph) in 1893. Later, a common freight locomotive configuration was the *Mikado* type, a 2-8-2.

A Continental classification counts axles instead of wheels, and another modification gives drive wheels a letter of the alphabet, so the 2-8-2 would be 1-4-1 in France and IDI in Germany.

The largest steam locomotives were articulated, with two sets of drive wheels and cylinders using a common boiler. The sets of drive wheels were separated by a pivot; otherwise such a large engine could not have negotiated curves. The largest ever built was the Union Pacific *Big Boy*, a 4-8-8-4, used to haul freight in the mountains of the western United States. Even though it was articulated it could not run on sharp curves. It weighed nearly 600 tons, compared to less than five tons for Stephenson’s *Rocket*.

Steam engines could do a lot of hard work, but they are now obsolete, replaced by electric and especially diesel-electric locomotives. Because of heat losses and incomplete combustion of fuel, their thermal efficiency was rarely more than 6 %.

Exercise 5. Answer the following questions.

1 How does a steam engine work? 2 What pushes the piston in the cylinder? 3 What is called the back or return stroke? 4 What governs the timing of the steam injection for the best performance? 5 What is the role of a long beam? 6 Where is the steam generated? 7 How are steam locomotives classified? 8 What is wheel arrangement? 9 How many sets of wheels are there? What different

functions do they perform? 10 What did all modern steam locomotives (except for small engines) have? 11 What is the «American standard»? What does this configuration mean? 12 What is the difference between American and Continental classification? 13 What were the largest steam locomotives like?

Exercise 6. Complete the following sentences.

1 A Steam Engine works … . 2 As … it pushes the piston in the cylinder outwards. 3 A secondary system injects steam in the cylinder on the other side of the piston to push it back; this is called … . 4 There is … to govern the timing of the steam injection for the best performance. 5 … transfers the … in the wheels which in turn drives the locomotive. 6 The steam is generated in the … .7 Steam locomotives are classified according to … . 8 The way the wheels are arranged under the engine is called ... . 9 … in front of the drivers made the engine safer, they helped … or … the engine into … . 10 All modern steam locomotives had … on a … to help guide them around curves. 11 The … helped carry the weight of the firebox. 12 A Continental classification counts … instead of …, and another modification gives drive wheels a … . 13 The sets of drive wheels were separated by a …; otherwise such a large engine could not have … . 14 Because of …, the … of steam locomotives was rarely more than 6 %.

Exercise 7. Study the following words and word combinations. Learn them by heart. Then read and translate Text 3.

commuter – приміський
streetcar – трамвай
self-contained – незалежний, автономний
prohibitive – надмірний, занадто високий
rectifier – випрямляч (струму)

Text 3. Electric engines

The first electric-powered rail car was built in 1834, but early electric cars were battery powered, and the batteries were heavy and required frequent recharging. Electric Engines are very simple, we see them use often in commuter situations where dense and regular traffic can operate with a low cost. Subways and streetcars are most common uses (and the tunnel is never filled with smoke). Today electric trains are not self-contained, which means that they get their power from overhead wires or from a third rail. The power for the traction motors is collected from the third rail by means of a shoe or from the overhead wires by a pantograph.

Electric trains are the most economical to operate, provided that traffic is heavy enough to repay electrification of the railway. Where trains run less frequently over long distances the cost of electrification is prohibitive. Direct Current (DC) electricity is used to directly power a large motor on the locomotive or in the wheels. DC systems have been used as opposed to AC because lighter traction motors can be used, but this requires power substations with rectifiers to convert the power to DC from the AC of the commercial mains (high voltage DC power is difficult to transmit over long distances). The latest development of electric trains has been the installation of rectifiers in the cars themselves and the use of the same AC frequency as the commercial mains (50 Hz in Europe, 60 Hz in North America), which means that fewer substations are necessary. While this is an efficient transfer of energy, depending on how the electricity is generated, it does rely on a huge network of electrified cable or third rail.

Exercise 8. Answer the following questions.

1 When was the first electric-powered rail car built? 2 What source of energy did they use? 3 Where are electric engines used? 4 What are the most common uses of electric engines? 5 Where do today's electric trains get their power from? 6 How do traction motors collect power? 7 What conditions make electric trains the most economical to operate? 8 When is Direct Curent electricity used? 9 What is necessary to use DC systems and why? 10 What has the latest development of electric trains been? What does it mean?

Exercise 9. Match the words in the left column to their definitions in the left column

1) streetcar;	a) an underground railway;
2) pantograph;	b) an electric vehicle for carrying people which travels on rails in the streets of a town. [AM];
3) alternating current;	c) a system of wires transmitting electricity which is situated over the ground;
4) subway;	d) an additional rail supplying electric current, used in some electric railway systems;
5) rectifier;	e) a jointed framework conveying a current to a train, tram, or other electric vehicle from overhead wires;
6) overhead wires;	f) is an electric current that always flows in the same direction;
7) third rail;	g) is an electric current that continually changes direction;
8) direct current	h) an electrical device which converts an alternating current into a direct one by allowing a current to flow through it in one direction only

Exercise 10. Study the following words and word combinations. Learn them by heart. Then read and translate Text 4.

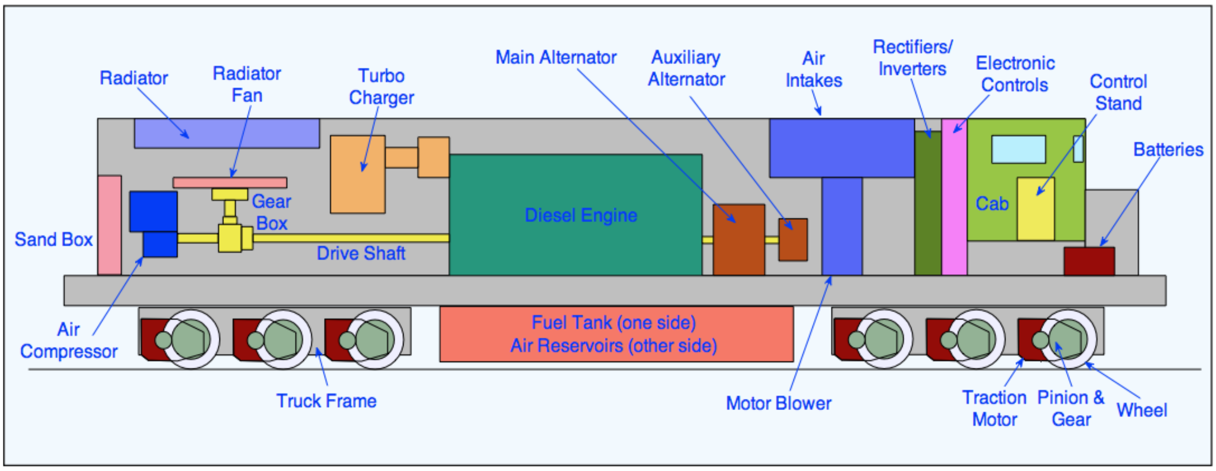
sheer – чистий, виключний
logistics – матеріально-технічне забезпечення
volatile – летючий; той, що швидко випаровується
throttle – дросель, дросельний клапан
mechanical output – механічна корисна потужність
clutch – зчеплення, муфта; затискний пристрій; зчіпка; захват; кулачок
torque – обертальний момент
spin up – розкручуватись, розганятись
grill – решітка
torque converter – (гідравлічний) редуктор, гідротрансформатор

housing – виїмка, гніздо, паз
centrifugal pump – відцентровий насос
guide wheel – напрямне колесо
prone to – схильний до
lashed – скріплений, зв'язаний

Text 4. Diesel engines

(A brief overview of how diesel locomotives work. Diesel-electric and hydraulic engines are discussed.)

The sheer logistics of labor and coal started to weigh heavily on the steam locomotive rail system after World War II. More people started to see the advantages of the diesel-electric engine. A diesel-electric engine works by having the ignition of diesel fuel powering pistons connected to an electric generator. Diesel fuel is low volatile, cheaper and readily available, which makes it the preferred fuel for trains today. In addition, diesel-electric engines are less polluting than steam and are healthier for the crew.



The diesel fuel is stored in a storage tank on the engine. An electric fuel pump delivers the fuel to the engine. The diesel engine is an internal combustion engine. There are various numbers of cylinders connected to a crankshaft. The pressure from compression ignites the fuel, which pushes the piston down. The downward movement turns the crankshaft.

The engine is connected to a main generator. This generator converts the mechanical power to electrical power that moves the traction motors. There is one traction motor directly connected to a pair of driving wheels.

The engineer, using an electrically controlled throttle, controls the power output. If the throttle is opened, more fuel is injected into the cylinders. This increases the mechanical output, which increases the main generator to higher electrical output. Since a mechanical clutch would be burned out in a short time, using electricity is more reliable and makes for less maintenance time.

Electric transmission is the saving point on a diesel-electric engine. Electric motors have a high torque, even when stationary. The engine is spun up fast, which puts a high difference across the axle motors. This is enough torque to make the train start moving and continue accelerating. The system has some other features like the control system that changes the voltage on the electricity so fuel is saved. There are batteries for start-up that can start the diesel engine. Fans and radiators keep the engine cool. The large grills that are seen on the side of diesel engine are part of the cooling system.

There are also diesel-hydraulic engines. Instead of electricity, they use hydraulic transmission to take power from the engine to the wheels. A torque converter is used instead of a motor. It has three parts, one part is fixed and the other two rotate. All of the main parts are sealed in a housing that is filled with oil. The inner rotating part is a centrifugal pump, outer rotating part is the turbine wheel and between them is a fixed guide wheel. These mechanical parts make the engine more complicated and prone to breakdowns, which is why there are fewer of them in service.

The limitations of diesel engines are speed and power. The motors can rotate at a maximum speed. Diesel engines are large and heavy – that makes them poor at high speeds. That is why you will see multiple engines «lashed» together in front of the train. Engines can also be placed in the middle of the train and at the end for pushing.

Exercise 11. Answer the following questions.

1 Why did more people start to see the advantages of the diesel-electric engine? 2 How does a diesel-electric engine work? 3 Why is diesel fuel the preferred fuel for trains today? 4 Where is the diesel fuel stored? 5 What kind of engines does diesel engine belong to?

6 How does it work? 7 What is the engine connected to? 8 What does the generator do? 9 Who controls the power output? What does he use? 10 What increases the mechanical output? 11 Why is using electricity more reliable and makes for less maintenance time? 12 What is the saving point on a diesel-electric engine and why? 13 Are there any diesel-hydraulic engines? 14 What do they use? 15 How many parts does it has? Describe it in details. 16 What are the limitations of diesel engines? 17 Why are multiple engines «lashed» together in front of the train? 18 Where else can engines be placed?

Exercise 12. Complete the following sentences.

1 A … works by having the … of diesel fuel powering … connected to an electric generator. 2 … is low volatile, cheaper and readily available, which makes it the preferred fuel for trains today. 3 An … delivers the fuel to the engine. 4 The diesel engine is an … . 5 The engine is connected to a … . 6 The … from compression … the fuel, which … the piston down. 7 The … movement turns the … . 8 The generator converts the … power to … power that moves the … motors. 9 There is one traction motor directly connected to a pair of … wheels. 10 The engineer, using an …, controls the … . 11 … is the saving point on a diesel-electric engine. 12 The engine is … fast, which puts a high difference across the … motors. 13 There are … for start-up that can start the diesel engine. 14 … keep the engine cool. 15 The large … that are seen on the side of diesel engine are part of the … . 16 Instead of … diesel-hydraulic engines use … to take power from the engine to the wheels. 17 A … is used instead of a motor. 18 All of the main parts are sealed in a … that is filled with … . 19 The inner rotating part is a …, outer rotating part is the … and between them is a fixed … . 20 The limitations of diesel engines are … . 21 The motors can … at a maximum speed.

Exercise 13. Study the following words and word combinations. Learn them by heart. Then read and translate Text 5.

pursue – продовжувати, (говорити); іти, прямувати
scrap – здавати на брухт, викидати через непридатність
starting torque – пусковий момент

fuel efficiency – ефективність використання палива
maintain in steam – забезпечувати парою
gradient – уклон, похил
gearing – зубчаста передача, привод
waste heat – відпрацьоване тепло
dismantle – демонтувати, ліквідовувати
thermal efficiency – тепловий (термічний) коефіцієнт корисної дії
energy storage system – система накопичування енергії
regenerative braking – рекуперативне гальмування
dynamic braking – реостатне (динамічне) гальмування
boosting – підвищення тиску
rooftop resistor bank – поглинальний реостат
petroleum gas – нафтовий газ
idling – холостий хід, працювати на холостому ходу
fuel cell – паливний елемент

Text 5. Hybrid trains

A **steam diesel hybrid locomotive** was a railway locomotive with a piston engine which could run on either steam from a boiler or diesel fuel. Examples were built in the United Kingdom, Russia and Italy but the relatively high cost of fuel oil meant that the designs were not pursued. In 1926 Kitson and Company, Leeds, built an experimental example for the London and North Eastern Railway, using as their model the Still engine already in use for stationary and marine applications. It was on trial until 1934, but then scrapped. It was designed because a steam engine offered a high starting torque while a diesel engine offered a high fuel efficiency and it was considered desirable to combine the two.

The sequence of operation was to heat the boiler in the normal way, but using fuel oil instead of coal. The start from rest would be made with steam power, but at about five mph (8 km/h) the diesel injectors would be started and the steam turned off. The waste heat from the cylinder jackets and diesel exhaust then maintained the boiler in steam for auxiliary functions (brakes and whistle) and in readiness to supplement the diesel power if required, or for the next start.

Overall power output did not compare well with conventional steam locomotives, although the performance on gradients was good because of the gearing. During the trials it was used successfully with coal trains and it proved very efficient in terms of fuel used, because the waste heat from the diesel power was recovered. However its running costs depended on the price differential between coal and oil and this was not favourable. When Kitson & Co. failed in 1934 the LNER handed the machine back to the company's receivers and it was dismantled.

Diesel-hydraulic locomotives use one or more torque converters, in combination with gears, with a mechanical final drive to convey the power from the diesel engine to the wheels.

Hydrostatic transmission systems are also used in some rail applications, primarily low speed shunting and rail-maintenance vehicles.

Diesel-hydraulic locomotives are less efficient than diesel-electrics. The first-generation BR diesel hydraulics were significantly less efficient (c. 65 %) than diesel electrics (c. 80 %) — moreover initial versions were found in many countries to be mechanically more complicated and more likely to break down. Hydraulic transmission for locomotives was developed in Germany. There is still debate over the relative merits of hydraulic vs. electrical transmission systems: advantages claimed for hydraulic systems include lower weight, high reliability, and lower capital cost.

By the 21st century, for diesel locomotive traction worldwide the majority of countries used diesel-electric designs, with diesel hydraulic designs not found in use outside Germany and Japan, and some neighbouring states, where it is used in designs for freight work.

In Germany and Finland, diesel-hydraulic systems have achieved high reliability in operation. In the UK the diesel-hydraulic principle gained a poor reputation due to the poor durability and reliability of the Maybach Mekydro hydraulic transmission. Argument continues over the relative reliability of hydraulic systems, with questions over whether data has been manipulated to favour local suppliers over non-German ones.

Diesel-pneumatic. The diesel-pneumatic locomotive was of interest in the 1930s because it offered the possibility of converting existing steam locomotives to diesel operation. The frame and cylinders of the steam locomotive would be retained and the boiler would be replaced by a diesel engine driving an air compressor. The problem was low thermal efficiency because of the large amount of energy wasted as heat in the air compressor. Attempts were made to compensate for this by using the diesel exhaust to re-heat the compressed air but these had limited success. A German proposal of 1929 did result in a prototype but a similar British proposal of 1932, to use an LNER Class R1 locomotive, never got beyond the design stage.

A **hybrid diesel-electric train** is a locomotive, railcar or train that uses an onboard rechargeable energy storage system (RESS), placed between the power source (often a diesel engine prime mover) and the traction transmission system connected to the wheels. Since most diesel locomotives are diesel-electric, they have all the components of a series hybrid transmission except the storage battery, making this a relatively simple prospect.

Surplus energy from the power source, or energy derived from regenerative braking, charges the storage system. During acceleration, stored energy is directed to the transmission system, boosting that available from the main power source. In existing designs, the storage system can be electric traction batteries, or a flywheel. The energy source is diesel, liquefied petroleum gas, or hydrogen (for fuel cells) and transmission is direct mechanical, electric or hydrostatic.

Diesel electric locomotives may have most of what they need for regenerative braking since they might already use dynamic braking. This uses the traction motors as generators to absorb much of the train energy, but without a way to store the generated electricity it is simply dumped into the atmosphere as heat with large rooftop resistor banks and cooling fans.

Using a storage system means that a non-fully electric train can use regenerative (as opposed to merely dynamic) braking, and even shut down the main power source whilst idling or stationary. Reducing energy consumption provides environmental benefits and economic savings. A smaller scale version of the concept is found in hybrid automobiles, such as the Chevy Volt.

In May 2003, JR East (East Japan Railway Company) started test runs using an **«NE Train»** («New Energy») railcar, testing the system performance in cold regions.

The design had two 65-kilowatt fuel cells and six hydrogen tanks under the floor, with a lithium-ion battery on the roof. The test train was capable of 100 kilometres per hour (60 mph) with a range of 50–100 kilometres between hydrogen refills. Research was underway into the use of regenerative braking to recharge the test train batteries, intending to increase the range further. JR had stated that it hoped to introduce the train into scheduled local service during the summer of 2007.

The «NE Train» underwent modifications to become a battery electric multiple unit with the addition of a pantograph and storage batteries replacing the earlier fuel cell, and rebranded «NE Train Smart Denchi-kun». This railcar has a maximum service speed of 100 km/h (60 mph) and can operate on battery power alone a distance of up to 50 km away from an overhead power supply.

The unit was modified in August 2011, with one of the four lithium battery units relocated beneath the passenger seats, increasing available space.

In February and March 2012, the programme entered its final phase, with night-time test-running on the non-electrified Karasuyama Line outside operating hours. A recharging facility was built at the end of the line, consisting of a rigid overhead conductor enabling the train to be recharged via its pantograph. The overhead conductor bar is electrified at 1,500 V DC, powered from the local electricity grid 6.6 kV AC supply, and a 10-minute charge allows the train to travel approximately 20 km.

Exercise 14. Answer the following questions.

1 What was a steam diesel hybrid locomotive? 2 Why was an experimental model designed? 3 What was the sequence of operation? 4 What can you tell about overall power output in the comparison with the performance on gradients? 5 What do diesel-hydraulic locomotives use? 6 Where are hydrostatic transmission systems also used? 7 Are diesel-hydraulic locomotives less efficient than diesel-electrics? Prove that. 8 What are the advantages claimed for hydraulic

systems in debate? 9 Where have diesel-hydraulic systems achieve high reliability in operation? 10 Why did diesel-hydraulic principle gain a poor reputation in the UK? 11 Why was the diesel-pneumatic locomotive of interest in the 1930s? 12 What was changed in the diesel-pneumatic locomotive? 13 What was the problem with the diesel-pneumatic locomotive and why? 14 What was a hybrid diesel-electric train? 15 What charges the storage system? 14. What can be the storage system in existing designs? 16 What is the energy source and transmission? 17 How are the traction motors used? 18 What does using a storage system mean? 19 What is a «NE Train»? 20 What modifications did the «NE Train» undergo? 21 What happened in February and March 2012?

Exercise 15. Match the words in the left column to their definitions in the left column

1) piston engine	a) a cell producing an electric current direct from a chemical reaction;
2) torque	b) containing or operated by air or gas under pressure;
3) jacket	c) a method of braking in which energy is extracted from the parts braked, to be stored and reused;
4) torque converter	d) a device that transmits or multiplies torque generated by an engine;
5) hydraulic	e) equipment or machinery involves or is operated by a fluid that is under pressure, such as water or oil;
6) regenerative braking	f) an engine, especially in an aircraft, in which power is derived from cylinders and pistons rather than a turbine;
7) pneumatic	g) an outer covering, especially one placed round a tank or pipe to insulate it;
8) fuel cell	h) is a force that causes something to spin around a central point such as an axle

Exercise 16. Study the following words and word combinations. Learn them by heart. Then read and translate Text 6.

congested – перевантажений
inconspicuous – непомітний, непримітний, який не привертає уваги, який не впадає в очі
propel – приводити в рух, просувати вперед, штовхати
array – маса, безліч, сукупність; (of) набір, комплект (чого-небудь)
inversely – обернено пропорційно
divergence – відхід, відступ, відхилення (від норми або стандарту)
exacerbate – поглиблювати, посилювати
offset – відшкодовувати, компенсувати
misconception – неправильне уявлення
downside – негативні аспекти, негативні наслідки
flux – течія, потік
drag – гальмування, затримка руху, повільний рух, волочіння

Text 6. Maglev

If you've been to an airport lately, you've probably noticed that air travel is becoming more and more congested. Despite frequent delays, airplanes still provide the fastest way to travel hundreds or thousands of miles. Passenger air travel revolutionized the transportation industry in the last century, letting people traverse great distances in a matter of hours instead of days or weeks.

The only alternatives to airplanes – feet, cars, buses, boats and conventional trains – are just too slow for today's fast-paced society. However, there is a new form of transportation that could revolutionize transportation of the 21st century the way airplanes did in the 20th century.

A few countries are using powerful electromagnets to develop high-speed trains, called **maglev trains**. Maglev is short for magnetic levitation, which means that these trains will float over a guideway using the basic principles of magnets to replace the old steel wheel and track trains.

The big difference between a maglev train and a conventional train is that maglev trains do not have an engine – at least not the kind of engine used to pull typical train cars along steel tracks. The engine for maglev trains is rather inconspicuous. Instead of using fossil fuels, the magnetic field created by the electrified coils in the guideway walls and the track combine to propel the train.

There are two particularly notable types of maglev technology:

- For **electromagnetic suspension (EMS)**, electronically controlled electromagnets in the train attract it to a magnetically conductive (usually steel) track.
- **Electrodynamic suspension (EDS)** uses superconducting electromagnets or strong permanent magnets which create a magnetic field that induces currents in nearby metallic conductors when there is relative movement which pushes and pulls the train towards the designed levitation position on the guide way.
- Another experimental technology, which was designed, proven mathematically, peer reviewed, and patented, but is yet to be built, is the **magnetodynamic suspension (MDS)**, which uses the attractive magnetic force of a permanent magnet array near a steel track to lift the train and hold it in place. Other technologies such as repulsive permanent magnets and superconducting magnets have seen some research.

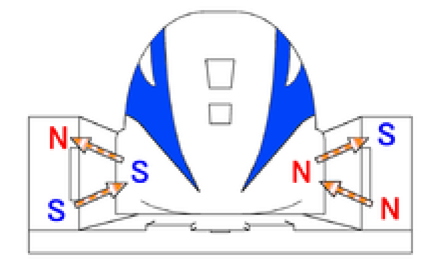
Electromagnetic suspension

In current electromagnetic suspension (EMS) systems, the train levitates above a steel rail while electromagnets, attached to the train, are oriented toward the rail from below. The system is typically arranged on a series of C-shaped arms, with the upper portion of the arm attached to the vehicle, and the lower inside edge containing the magnets. The rail is situated between the upper and lower edges.

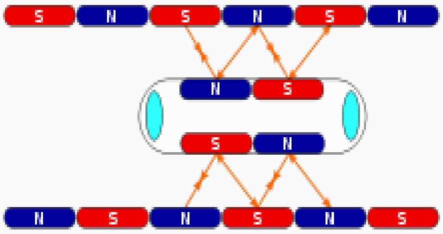
Magnetic attraction varies inversely with the cube of distance, so minor changes in distance between the magnets and the rail produce greatly varying forces. These changes in force are dynamically unstable – if there is a slight divergence from the optimum position, the tendency will be to exacerbate this, and complex systems of

feedback control are required to maintain a train at a constant distance from the track, (approximately 15 millimeters (0.59 in)).
The major advantage to suspended maglev systems is that they work at all speeds, unlike electrodynamic systems which only work at a minimum speed of about 30 km/h (19 mph). This eliminates the need for a separate low-speed suspension system, and can simplify the track layout as a result. On the downside, the dynamic instability of the system puts high demands on tolerance control of the track, which can offset, or eliminate this advantage

Electrodynamic suspension



The Japanese SCMaglev EDS suspension is powered due to the magnetic fields induced either side of the vehicle by the passage of the vehicle's superconducting magnets.



EDS Maglev propulsion via propulsion coils.

In electrodynamic suspension (EDS), both the guideway and the train exert a magnetic field, and the train is levitated by the repulsive and attractive force between these magnetic fields. In some configurations, the train can be levitated only by repulsive force. In the early stages of maglev development at the Miyazaki test track, a purely repulsive system was used instead of the later repulsive and attractive EDS system. There is a misconception that the EDS system is purely a repulsive one, but that is not true. The magnetic field in the train is produced by either superconducting magnets (as in JR–Maglev) or by an array of permanent magnets (as in Inductrack). The repulsive and attractive force in the track is created by an induced magnetic field in wires or other conducting strips in the track. A major advantage of the EDS maglev systems is that they are naturally stable – minor *narrowing* in distance between the track and the magnets creates strong forces to repel the magnets back to their original position, while a slight increase in distance greatly reduces the repulsive force and again returns the vehicle to the right separation. In addition, the attractive force varies in the opposite manner, providing the same adjustment effects. No feedback control is needed.

EDS systems have a major downside as well. At slow speeds, the current induced in these coils and the resultant magnetic flux is not large enough to support the weight of the train. For this reason, the train must have wheels or some other form of landing gear to support the train until it reaches a speed that can sustain levitation. Since a train may stop at any location, due to equipment problems for instance, the entire track must be able to support both low-speed and high-speed operation. Another downside is that the EDS system naturally creates a field in the track in front and to the rear of the lift magnets, which acts against the magnets and creates a form of drag. This is generally only a concern at low speeds (this is one of the reasons why JR abandoned a purely repulsive system and adopted the sidewall levitation system); at higher speeds the effect does not have time to build to its full potential and other forms of drag dominate.

Exercise 17. Answer the following questions.

1 What revolutionized the transportation industry in the last century? 2 What is Maglev? 3 What is the big difference between a maglev train and a conventional train? 4 What combine to propel the train? 5 What are two particularly notable types of maglev technology? 6 What happens in current electromagnetic suspension (EMS) systems? 7 What is the major advantage to suspended maglev systems? 8 What happens in electrodynamic suspension (EDS) systems? 9 What is the magnetic field in the train produced by? 10 What is the repulsive and attractive force in the track created by? 11 What is a major advantage of the EDS maglev systems? 12 What are the downsides of EDS systems?

Exercise 18. Complete the following sentences.

1 Air travel is becoming more and more … . 2 Passenger … travel revolutionized the transportation industry in the last century. 3 A few countries are using powerful … to develop high-speed trains, called **… trains**. 4 Maglev is short for …, which means that these trains will … over a guideway using the basic principles of … to replace the old steel wheel and track trains. 5 The big difference between a maglev train and a conventional train is that maglev trains do not have an … – at least not the kind of engine used to … typical train cars along steel tracks. 6 The engine for maglev trains is rather … . 7 Instead of using …, the magnetic … created by the electrified coils in the guideway walls and the track combine to … the train. 8 For … , electronically controlled electromagnets in the train attract it to a magnetically conductive (usually steel) track. 9 … uses superconducting electromagnets or strong permanent magnets. 10 … uses the attractive magnetic force of a permanent magnet array near a steel track to lift the train and hold it in place. 11 The major advantage to … is that they work at all speeds, unlike … which only work at a minimum speed of about 30 km/h (19 mph). 12 EDS systems have a major … as well.

UNIT 3

GREAT ENGINES

Exercise 1. Study the following words and word combinations. Learn them by heart.

reciprocating – із зворотно-поступальним рухом
lb = pound – фунт
psi = PSI = pounds per square inch – фунти на квадратний дюйм
slump – криза, різке падіння
fortuitous – випадковий
articulated – шарнірно-зчленований
chassis – шасі, корпус, ходова частина
grate – колосникова решітка (колосник)

turntable – обертовий стіл; поворотна платформа, обертове коло
eventually – із часом
logging – лісозаготівлі
drive rod – приводний стрижень
idler wheel — проміжне (неприводне) колесо; лінивець
hinge – шарнір, шарнірний
in working order – готовий до експлуатації, на повному ходу
agility – швидкість, жвавість, спритність
in essence – по суті
flue – димохід, газохід

Exercise 2. Read and translate the text.

Allegheny, Big Boy, Challenger

There are many factors that make an engine great: size, power, art and the like. However, their greatness comes down to a feeling we get when we see, or are near the locomotive.

The Allegheny 2-6-6-6

The Chesapeake and Ohio (C&O) Railroad's 2-6-6-6 Class H-8 Alleghenies were the most powerful reciprocating steam locomotives to be built anywhere in the world. Designed by the Lima Locomotive Works, sixty Alleghenies were delivered to the C&O from December 1941 until December 1948.

With a weight of more than 775,000 lbs and a boiler pressure of 260 psi, they could develop a tractive effort of 110,200 lbs and generate 7500 horsepower at 40 miles per hour. Their boilers were capable of delivering 8000 horsepower. This, coupled with their 67-inch diameter drivers, gave them a wonderful turn of speed however they were rarely used in high-speed operations.

While most of American industry was in a terrible economic slump during the 1930's, the C&O was busy constructing new tunnels, laying double track, rebuilding bridges and generally upgrading their system. This fortuitous situation was because of the main product that they transported – coal. Some of the finest bituminous coal deposits in America were adjacent to the C&O routes and coal was needed even during a poor economic climate.

In the late 1930's, it became evident that the C&O would need additional motive power for the 80-mile coal run between Hinton, West Virginia and Clifton Forge, Virginia.

The new locomotive was to weight over 775,000 lbs and would utilize four 22.5-inch diameter cylinders with a 33-inch stroke. The articulated chassis would carry a huge boiler with a 9 ft x 15 ft firebox containing 135 square foot grate. The resulting rear weight required a six-wheel trailer truck to support it. The tender would be the largest ever designed for the C&O, weighing over 430,000 lbs, and would have a 25,000-gallon water tank and a 25-ton coal bunker.

The overall length of the locomotive and tender was limited by the length of existing turntables so the tender was designed to be short and its rear section was designed «high» to carry a great deal of weight. This configuration required an eight-wheel rear tender truck to distribute the load to the rails. The forward tender truck had six wheels. The final length of the locomotive and tender was slightly over 125 feet. The increased power and improved economics of the new design over the Texas class was the deciding factor. The C&O selected it and never regretted their decision, as it would prove to be one of the finest locomotive designs in American railroad history. The name «Allegheny» was given to the new giants in honor of the mountain range over which they would be operated.

The first ten locomotives were delivered in December 1941 and were immediately pressed into service to meet the demands of World War II. The performance of the Allegheny was so impressive that the C&O ordered an additional ten locomotives.

During the war, the C&O had 23 of its Alleghenies modified to include steam heat and signal lines for passenger service but used them only rarely to haul a troop train or heavy mail train.

They continued to give faithful service over the post war years but they were eventually replaced by diesels staring in 1952. The last Allegheny was removed from service in 1946.

The Big Boy 4-8-8-4

Eventually, every railroad faces the same problem: how to move trains over mountains? Small logging and mining railroads purchased geared locomotives – Heislers, Climaxes and Shays – which could pull trains at low speed up steep hills. Medium railroads, like the Delaware, Lackawanna & Western, bought lots of medium-sized engines – 4-6-2s, 4-8-2s and 4-8-4s – and put as many as ten engines on one train. Large railroads preferred a different solution. The Union Pacific ordered larger, more powerful engines such as the 4-12-2 Union Pacific type and the 4-6-6-4 Challengers. The trend toward size and power culminated in the 1.2 million pound, 6,200 horsepower 4-8-8-4 Big Boy.

The Big Boys were built for power. They did the work of three smaller engines, pulling 120-car, 3800-ton freight trains at forty miles per hour in the mountains of Utah and Wyoming.

With power though, comes weight – larger cylinders, pistons, drive rods, boiler, firebox. Steam locomotive manufacturers added more wheels, both powered drive wheels and unpowered idlers.

The extra wheels added length. Long engines had difficulty squeezing through the sharp corners in mountains. A French designer named Anatole Mallet added a hinge to the middle of a locomotive to allow it to bend. Two pairs of cylinders supplied power to the two sets of drive wheels.

Big Boys had over one mile of tubes and flues inside the boiler. Their firebox grate measured 150 square feet. The Big Boys had sixteen drive wheels, each measuring 68 inches. From coupler to coupler they measured 132 feet 9 inches. The tender held 24,000 gallons of water and 28 tons of coal and the engine and tender weighed 1,189,500 pounds in working order. The engines well deserved the name 'Big Boy' which was written on one of the drive rods by an unknown worker.

They served there until 1959 when the new diesel-electric locomotives took over. The Big Boys were not the most powerful engines, though they were the heaviest. But no engine ever came close to matching Big Boy's combination of speed, power and agility.

The Challengers 4-6-6-4

Challenger: Union Pacific at one time owned 105 Challenger locomotives. Built between 1936 and 1943, the Challengers were nearly 122 feet long and weighed over one million pounds. Articulated like their big brother, the Big Boy, the Challengers had a 4-6-6-4 wheel arrangement. They operated over most of the Union Pacific system, primarily in freight service, but a few were assigned to passenger trains operating through mountain territory to California and Oregon.

The name Challenger was given to steam locomotives with a 4-6-6-4 wheel arrangement. This means that they have four wheels in the leading «pilot» truck, which helps guide the locomotive into curves; two sets of six «driving» wheels, and finally, four «trailing» wheels, which support the rear of the engine and its massive firebox. Each set of driving wheels has its own steam cylinder. The result, in essence, is two engines under one boiler.

The frame of the locomotive is «articulated», or hinged, to allow it to go through curves. When watching the approaching locomotive go through a curve, you can see the boiler swing out left or right independently of the lower half of the engine, as the rear half of the locomotive remains in a straight direction until its wheels and frame are halfway through the curve.

The Challengers were designed for fast freight service, but occasionally pulled passenger trains.

Exercise 3. Answer the following questions.

1 What are the factors that make an engine great? 2 What locomotives were the most powerful reciprocating steam locomotives to be built anywhere in the world? 3 What were their technical specifications? 4 What economic situation was in America in the 1930s? 5 Why was this situation fortuitous for C&O? 6 What proved to be one of the finest locomotive designs in American railroad history? 7 Why was the name «Allegheny» given to the new giants? 8 What happened to Allegheny during the war? 9 What problem does each railroad face? 10 Why did small logging and mining railroads purchase geared locomotives – Heislers, Climaxes and Shays? 11 Why were the Big Boys built for and what work did they do? 12 What did Anatole Mallet add to the middle of the locomotive and why? 13 When were the Challengers built? 14 Where did they operate? 15 What was their wheel arrangement? 16 What was the frame of the locomotive and why?

Exercise 4. Make a presentation telling about the history of steam locomotives all over the world.

UNIT 4

THE HISTORY OF STEAM LOCOMOTIVES IS NOT OVER!

Exercise 1. Study the following words and word combinations. Learn them by heart.

compelling – захопливий, інтригуючий
revenue earning service – комерційна експлуатація, обслуговування
against time – гранично швидко, якомога швидше
untenable – неспроможний, необґрунтований
from scratch – з нуля, на пустому місці
regiment – полк
endorsement – схвалення
predominantly – переважно
smokebox – димова коробка
axleboxe – букса

Exercise 2. Read and translate the text.

Modern Steam Locomotive Construction

«No other product of man's mind has ever exercised such a compelling hold upon the public's imagination as the steam locomotive. No other machine in its day has been a more faithful friend to mankind, nor has contributed more to the growth of industry in this, the land of its birth and indeed throughout the whole world. Those who have lived in the steam age of railways will carry the most nostalgic memories right to the end ...»

The words of R F Hanks, Chairman of the Western Area Board of British Railways at a ceremony in Swindon Works on 18th March 1960, marking the end of steam locomotive construction in the UK with the completion and naming of 9F 2-10-0 No 92220 «Evening Star».

One of the major attractions of almost all the many tourist railways in the UK and throughout the world is the continued use of steam traction. Most standard gauge lines in the UK use locomotives that were previously in revenue earning service, either with British Rail or with any one of a number of industrial operators. However, the newest of these locomotives is now more than half a century old, and the possibility of constructing replacements against such time as maintenance of the originals becomes untenable is being seriously considered.

A number of small, specialized engineering firms regularly build steam locomotives for narrow gauge and miniature railways, but the construction of an all new, main line steam passenger locomotive is a major project. It is pleasing to note, therefore, that there are a number of such projects in progress in the UK, with one already completed.

A1 Steam Locomotive Trust

New A1 Pacific 60163 Tornado
on the East Coast Main Line south of Newcastle-upon-Tyne

After 18 years of effort, in 2008 the trust succeeded in its aim of completing the construction from scratch of a modern replica of an A1 Pacific, designed by AH Peppercorn for the London & North Eastern Railway but ultimately constructed in 1948/49 by the then newly formed Britsh Railways. All the original examples were scrapped by 1966.

The new locomotive, 60163 *Tornado*, made its debut on the Great Central Railway, Loughborough in August, 2008 and has since operated a number of main line excursions.

P2 Steam Locomotive Company

Gresley Class P2 2001 Cock o' the North

The same team that created *Tornado* are now constructing a replica of a *Gresley* class P2 locomotive. As with *Tornado,* it will be given a new name and number - in this case 2007 *Prince of Wales.* The frames and wheels are almost complete and work continues.

1014 Great Western County Project

Hawksworth County Class 1022 County of Northampton

This project was initiated in the early years of the 21st century to recreate a locomotive of the County class designed by FW *Hawksworth* of the Great Western Railway. The original design made use of components that were readily available at Swindon Works towards the end of the Second World War. These included frames from *Hawksworth's* own *«Modified Hall»* design (a development of the Collett «Hall») and boilers constructed at Swindon for wartime freight locomotives based on the *Stanier 8F* design. The first locomotive of the County class entered traffic in 1945. All were scrapped in the 1960s.

The 1014 Project is not strictly a new build project as it was intended use components from existing locomotives; however, the end result will recreate a locomotive of which no examples survive. The replica will use *«Modified Hall»* frames and the boiler of a *Stanier 8F*, from which the *Swindon* design was derived. A new set of wheels would be required, as these were slightly larger than those of the *«Hall»*. Most components have been obtained and construction is well in hand.

LMS Patriot Project

An artist's impression by Colin Wright
of the new Patriot class locomotive, 45551 The Unknown Warrior

This project started in 2007 and, like *Tornado,* is essentially a project to build a new, working locomotive from scratch.

Many of the original *Patriot* class carried the names of regiments or of individual recipients of the Victoria Cross, and of course one of the locomotives was named *Patriot*, giving its name to the class. The new locomotive will carry the name *The Unknown Warrior* and will be dedicated as a National Memorial, with the full endorsement of the Royal British Legion.

Fundraising and build progress have been encouraging, and it is hoped to have the locomotive running by 2018, the 100th Anniversary of the Armistice.

GCR 567

Official photograph of Manchester, Sheffield & Lincolnshire Railway locomotive no.567 at Gorton Works when newly built.
The Manchester, Sheffield & Lincolnshire was a predecessor to the Great Central

A project to recreate a Victorian era locomotive, the Parker designed class 2 4-4-0 of the Great Central Railway, which later became class D7 of the London & North Eastern Railway.
A number of important components have been donated but the locomotive will be predominantly new build. Fundraising commenced in 2011.

Brighton Atlantic

A Brighton Atlantic leaves Farnborough with an Air Display special in 1950

A project to recreate a London, Brighton and South Coast Railway class H2 Atlantic, as operating under the Southern Railway and British Railways. The locomotive represented will be 32424 *Beachy Head*.

Many components have been recovered from old locomotives but a substantial amount of adaptation and new fabrication is still required. Frames, wheels and motion are nearly complete. A boiler, tender frame and wheels have been acquired. Work is progressing well but further funds are required.

British Railways Standard Class 3MT 2-6-2T

Artists' impression of the completed 82045

A project to build a new British Railways Standard Class 3MT 2-6-2 Tank locomotive, no examples of which survive. The locomotive will take the number 82045, the next in sequence after the last built by British Railways.

This locomotive will be almost entirely new build. Frames are complete, work is in hand on cab, bunker, smokebox and axleboxes. Fundraising continues.

Exercise 3. Answer the following questions.

1 What did R F Hanks, Chairman of the Western Area Board of British Railways said about steam locomotives? 2 What is one of the major attractions of almost all the many tourist railways in the UK and throughout the world? 3 What uses locomotives that were previously in revenue earning service? 4 How old is the newest of these locomotives? 5 What do a number of small, specialized engineering

firms regularly build? 6 What is a major project? 7 What is pleasing to note? 8 Tell about different modern steam locomotives.

Exercise 4. Make a presentation telling about the use of modern steam locomotives all over the world.

UNIT 5

MODERN LOCOMOTIVES AND NEW ENVIRONMENTAL STANDARDS

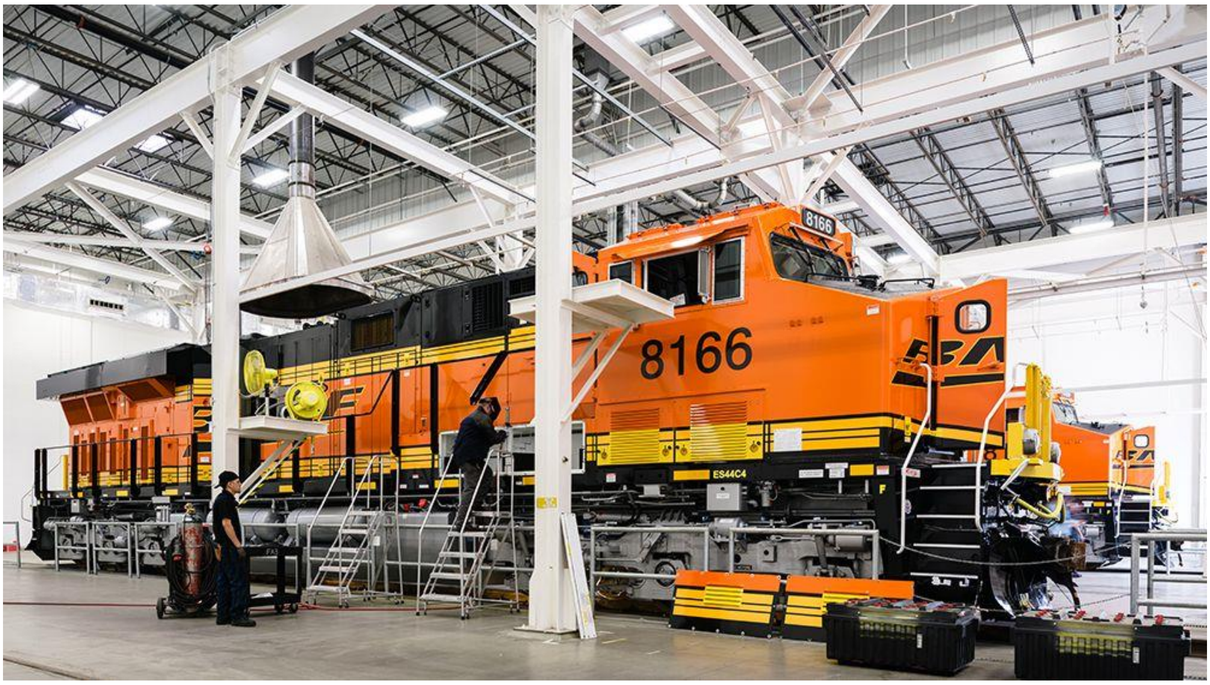
Exercise 1. Study the following words and word combinations. Learn them by heart.

stringent – строгий
seek – прагнути, намагатися
particulate matter – тверді частинки (у відпрацьованих газах)
commitment – зобов’язання, зацікавленість
viable – життєздатний
retrofit – модернізувати, реконструювати
urea – сечовина, карбамід
ingenious – винахідливий
data points – вимірювальні точки
leviathan – левіафан (гігант, велетень)

Exercise 2. Read and translate the text.

This is the locomotive that meets 2015’s new environmental standards

This January, the US started enforcing aggressively stringent environmental rules for railroads. The latest Tier 4 emission standards seek to cut locomotive emissions of nitrogen oxide by 76 percent and particulate matter by 70 percent from the levels set by Tier 3 standards.



When it comes to meeting the new norms, GE, which partnered to build the first diesel-electric locomotive about a century ago, is a first mover again. GE is the only manufacturer ready with an engine that will meet the tough Tier 4 standards, as it decided to go ahead with an investment of $200 million to develop the latest version of the Evolution Series of diesel locomotive. The company's philosophy of *Ecomagination* – the commitment to make products that are environment-friendly and economically viable–has once again led to major innovation for the transportation sector: Other manufacturer's Tier-4 compliant models aren't scheduled to be unveiled until 2017.

Teams from GE Global Research and GE Transportation spent many years experimenting with new designs and systems to build the Tier 4 Evolution Locomotive. One option was retrofitting a large filter and a 4,000-pound catalytic converter on top of the engine that would use urea to split the nitrogen oxide in diesel exhaust into nitrogen and water. GE engineers declined to pursue this option due to a need for extra maintenance and difficulty in accessing the engine. The design would have also meant US railroads would need to invest at least $1.5 billion in urea distribution infrastructure.

So GE researchers and engineers built a single cylinder engine for testing, collected its exhaust data and used software models to simulate a full-size locomotive. Testing led to a discovery that the temperature inside the cylinder must be kept at an optimum level to reduce nitrogen oxide and particulate matter. And that finding led to the development of an ingenious system that recirculates hot exhaust gas back into the engine, eliminating the requirement to have so-called after-treatment technology**.** GE is currently testing seven of the new locomotives around the world.

The Evolution Series had its genesis in the quest for cleaner environment. After the US Environmental Protection Agency announced a new set of regulations in 1998, GE began developing a new series of locomotives that would meet the new lower emission level standard, helping reduce carbon footprints. The first Evolution model entered production in 2005, the result of eight years of development and investments of $400 million.

Today, more than 6,500 of these locomotives are in operations in 10 countries including Australia, Kazakhstan, Mongolia, and China. The Evolution, named by Trains magazine as one of «the 10 locomotives that changed railroading», is powerful enough to pull 170 Boeing 747 jetliners, but its 12-cylinder engine consumes 5 % less fuel than the larger and traditionally more powerful 16-cylinder engines. Inside the Evolution, some 250 sensors emit about 9 million data points per hour, adding a digital brain to the leviathan that measures 73-feet long and weighs around 220 tons.

When the new Tier 4 Evolution Locomotives are released onto the tracks in the coming months, it will mark a new era for the rail industry. It will also mark a moment when GE’s vision of the future is once again brought to reality.

Exercise 3. Answer the following questions.

1 What did the US start enforcing aggressively and when? 2 What do the latest Tier 4 emission standards seek to do? 3 What is the only manufacturer ready with an engine that will meet the tough Tier 4 standards? 4 What is *Ecomagination*? 5 What did teams from GE Global Research and GE Transportation spend many years for? 6 Was retrofitting a large filter and a 4,000-pound catalytic converter on top of the engine a good idea? 7 What did GE researchers and engineers build? 8 What did GE begin developing after the US Environmental Protection Agency announced a new set of regulations in 1998? 9 How did Trains magazine named Evolution? 10 What will

the release of the new Tier 4 Evolution Locomotives onto the tracks mark?

Exercise 4. Make a presentation telling about the use of modern environmentally friendly locomotives all over the world.

APPENDIX

Tier 4 Emission Standards

The Tier 4 emission standards—phased-in from 2008 through 2015—introduce substantial reductions of NOx (for engines above 56 kW) and PM (above 19 kW), as well as more stringent HC limits. CO emission limits remain unchanged from the Tier 2-3 stage.

Engines up to 560 kW. Tier 4 emission standards for engines up to 560 kW are listed in Table 3.

Table 3
Tier 4 Emission Standards—Engines up to 560 kW, g/kWh (g/bhp-hr)

Engine Power	Year	CO	NMHC	NMHC+NO_x	NO_x	PM
kW < 8 (hp < 11)	2008	8.0 (6.0)	-	7.5 (5.6)	-	0.4[a] (0.3)
8 ≤ kW < 19 (11 ≤ hp < 25)	2008	6.6 (4.9)	-	7.5 (5.6)	-	0.4 (0.3)
19 ≤ kW < 37 (25 ≤ hp < 50)	2008	5.5 (4.1)	-	7.5 (5.6)	-	0.3 (0.22)
	2013	5.5 (4.1)	-	4.7 (3.5)	-	0.03 (0.022)
37 ≤ kW < 56 (50 ≤ hp < 75)	2008	5.0 (3.7)	-	4.7 (3.5)	-	0.3[b] (0.22)
	2013	5.0 (3.7)	-	4.7 (3.5)	-	0.03 (0.022)
56 ≤ kW < 130 (75 ≤ hp < 175)	2012-2014[c]	5.0 (3.7)	0.19 (0.14)	-	0.40 (0.30)	0.02 (0.015)

130 ≤ kW ≤ 560 (175 ≤ hp ≤ 750)	2011-2014[d]	3.5 (2.6)	0.19 (0.14)	-	0.40 (0.30)	0.02 (0.015)
a - hand-startable, air-cooled, DI engines may be certified to Tier 2 standards through 2009 and to an optional PM standard of 0.6 g/kWh starting in 2010 b - 0.4 g/kWh (Tier 2) if manufacturer complies with the 0.03 g/kWh standard from 2012 c - PM/CO: full compliance from 2012; NOx/HC: Option 1 (if banked Tier 2 credits used)—50% engines must comply in 2012-2013; Option 2 (if no Tier 2 credits claimed)—25% engines must comply in 2012-2014, with full compliance from 2014.12.31 d - PM/CO: full compliance from 2011; NOx/HC: 50% engines must comply in 2011-2013						

In engines of 56-560 kW rated power, the NOx and HC standards are phased-in over a few year period, as indicated in the notes to Table 3. The initial standards (PM compliance) are sometimes referred to as the 'interim Tier 4' (or 'Tier 4i'), 'transitional Tier 4' or 'Tier 4 A', while the final standards (NOx/HC compliance) are sometimes referred to as 'Tier 4 B'.

As an alternative to introducing the required percentage of Tier 4 compliant engines, manufacturers may certify all their engines to an *alternative NOx limit* in each model year during the phase-in period. These alternative NOx standards are:

- Engines 56-130 kW:
    - Option 1: NOx = 2.3 g/kWh = 1.7 g/bhp-hr (Tier 2 credits used to comply, MY 2012-2013)
    - Option 2: NOx = 3.4 g/kWh = 2.5 g/bhp-hr (no Tier 2 credits claimed, MY 2012-2014)
- Engines 130-560 kW: NOx = 2.0 g/kWh = 1.5 g/bhp-hr (MY 2011-2013)

Engines Above 560 kW. Tier 4 emission standards for engines above 560 kW are listed in Table 4. The 2011 standards are sometimes referred to as 'transitional Tier 4', while the 2015 limits represent final Tier 4 standards.

Table 4

Tier 4 Emission Standards—Engines Above 560 kW, g/kWh (g/bhp-hr)

Year	Category	CO	NMHC	NO_x	PM
2011	Generator sets > 900 kW	3.5 (2.6)	0.40 (0.30)	0.67 (0.50)	0.10 (0.075)
	All engines except gensets > 900 kW	3.5 (2.6)	0.40 (0.30)	3.5 (2.6)	0.10 (0.075)
2015	Generator sets	3.5 (2.6)	0.19 (0.14)	0.67 (0.50)	0.03 (0.022)
	All engines except gensets	3.5 (2.6)	0.19 (0.14)	3.5 (2.6)	0.04 (0.03)

Other Provisions. The Tier 4 regulation and later amendments include a number of additional provisions:

- *Smoke Opacity*—Existing Tier 2-3 smoke opacity standards and procedures continue to apply in some engines. Exempted from smoke emission standards are engines certified to PM emission standards at or below 0.07 g/kWh (because an engine of such low PM level has inherently low smoke emission).
- *Crankcase Ventilation*—The Tier 4 regulation does not require closed crankcase ventilation in nonroad engines. However, in engines with open crankcases, crankcase emissions must be measured and added to exhaust emissions in assessing compliance.
- *DEF Refill Interval*—For SCR-equipped nonroad diesel engines, a minimum DEF (urea solution) refill interval is defined as at least as long (in engine-hours) as the vehicle's fuel capacity.
- *Ammonia Emissions*—While ammonia emissions are unregulated, the EPA recommends that ammonia slip should be below 10 ppm average over the applicable test cycles.
- *Emergency Operation*—To facilitate the use of certain nonroad engines in temporary emergency situations, the engines can be equipped with an AECD to override performance inducements related to the emission control system—for example, to allow engine operation without urea in the SCR system during an emergency. This flexibility is intended primarily for engines used in construction equipment and portable equipment used for temporary power generation and flood control.
- *ABT Program*—Similarly to earlier standards, the Tier 4 regulation includes such provisions as averaging, banking and trading of emission credits and FEL limits for emission averaging.