МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
Національний університет кораблебудування
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Херсонський навчально-науковий інститут

TECHNICAL ENGLISH READER

Методичні рекомендації до самостійної роботи студентів з дисципліни «Іноземна мова за професійним спрямуванням»

Рекомендовано Методичною радою НУК

ВИДАВНИЦТВО
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Рекомендовано Методичною радою НУК

Т30 **Technical** English Reader. Методичні рекомендації до самостійної роботи студентів з дисципліни «Іноземна мова за професійним спрямуванням» для здобувачів вищої освіти першого (бакалаврського) рівня технічних спеціальностей денної форми навчання / уклад. Л. М. Бойко. – Миколаїв : НУК, 2026. – 68 с.

Рекомендації складені відповідно до робочої навчальної програми з дисципліни «Іноземна мова за професійним спрямуванням», містять англомовні автентичні тексти професійного спрямування, вправи до них, глосарій до тем, завдання до текстів та список рекомендованої літератури для підготовки до занять та самостійної роботи.

Призначені для студентів третього і четвертого курсів технічних спеціальностей, які прагнуть поглибити свої знання з основних понять професійної сфери.

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ПЕРЕДМОВА

Методичні рекомендації з дисципліни «Іноземна мова за професійним спрямуванням» до самостійної роботи здобувачів першого (бакалаврського) рівня вищої освіти технічних спеціальностей укладено відповідно до робочої навчальної програми дисципліни «Іноземна мова за професійним спрямуванням» і спрямовано на розвиток у студентів технічних спеціальностей навичок читання і перекладу науково-технічних текстів, а також збагачення словникового запасу.

Завданнями дисципліни є формування необхідної комунікативної спроможності в сферах професійного спілкування в усній і письмовій формах; розуміння та переклад іншомовних джерел; удосконалення комунікативних умінь і навичок володіння іноземною мовою при спілкуванні з професійної тематики.

Самостійна робота студента (СРС) є основним видом засвоєння навчального матеріалу у вільний від аудиторних занять час. Зміст СРС дисципліни «Іноземна мова за професійним спрямуванням» визначається робочою програмою з цієї дисципліни, навчально-методичними матеріалами, завданнями та вказівками викладача відповідно до затверджених в установленому порядку методичних рекомендацій, з метою закріплення та поглиблення теоретичних знань та вмінь студентів, і є важливим етапом у засвоєнні навчального матеріалу. Самостійна робота студентів з цієї навчальної дисципліни включає розвиток і вдосконалення навичок самостійно опрацьовувати навчальний матеріал.

Зміст підібраних текстів охоплює широкий спектр тем, включаючи техніку зварювання, метали морського класу, захист від корозії, системи вихлопних газів, суднові двигуни, котли, валові генератори та суднові електромережі. Кожен розділ супроводжується вправами до та після читання, завданнями на вирішення проблем та списками слів, що дозволяє студентам практикувати розуміння, закріплювати технічну термінологію та розвивати навички критичного мислення в професійному контексті.

Опрацьовуючи ці матеріали, студенти не тільки покращать свої навички читання та розширять вокабуляр технічної лексики, але й отримають практичні знання щодо реальних ситуацій на борту судна. Робота з даними методичними рекомендаціями сприятиме інтенсифікації процесу вивчення англійської мови професійного спрямування та розуміння науково-технічних текстів за фахом.

ПАМ'ЯТКА ДЛЯ КОРИСТУВАЧІВ

Крок 1: Прочитайте вправи перед читанням. Вони підготують вас до сприйняття технічної лексики та основних ідей.

Крок 2: Уважно прочитайте текст. Зробіть нотатки щодо ключових термінів або ідей.

Крок 3: Виконайте вправи після читання. Вони вміщують лексико-граматичні завдання, питання на розуміння тексту та вправи на вирішення проблем.

Крок 4: Використовуйте глосарій, щоб закріпити знання технічної лексики. Спробуйте вживати нові слова у своїх реченнях.

I. WELDING

Pre-reading:

1) Where do you think welding is used in everyday life? Write 2–3 examples.
2) Why do you think welding requires special safety rules?

1. THE KEY ELEMENTS IN A WELDING PROCESS

1. **Heat Source.** Every welding process needs a heat source strong enough to melt the materials being joined. This heat can come from an electric arc, a gas flame, or a high-energy beam such as a laser or electron beam. Each method provides the intense heat needed to create a molten area where metals can fuse.

2. **Filler Material.** A filler metal is often added to fill the gap between the pieces being joined. It melts and blends with the base metals, strengthening the joint. The filler's composition is carefully matched to the materials being welded to ensure a durable bond.

3. **Shielding from Contamination.** When metal melts, it reacts easily with oxygen and other gases, which can weaken the weld. To prevent this, welders use shielding methods such as shielding gases like argon or carbon dioxide, or flux coatings that release protective gases and form a layer of slag over the molten metal.

<u>Basic Terms Every Beginner Should Know.</u> **Weld Pool:** The small molten area created by heat where the metals fuse. As it cools, it forms the weld bead. **Weld Bead:** The visible line of solidified metal left after welding. **Electrode:** The tool that carries current to

the weld. It may melt into the weld (consumable) or remain intact (non-consumable). **Arc:** The bright, high-temperature discharge that generates the heat needed to melt the metal.

How a Weld Is Formed

1. Preparation: Clean and position the metal pieces to ensure a tight fit, removing rust, paint, or oil.
2. Arc Creation: The welder starts the electric arc between the tool and the metal, producing temperatures that can reach 6,000 °C (10,800 °F).
3. Melting and Fusion: The edges of the metal and any filler material melt together, forming a molten pool.
4. Protection: Shielding gas or flux protects the molten area from contamination.
5. Solidification: As the heat source moves along the joint, the molten pool cools and hardens into a continuous weld bead.

Why Welding Matters. Welding builds everything from cars to skyscrapers, ships, bridges, and pipelines. It is essential in industries that shape modern life, providing the strength and permanence required for structures and machines that endure extreme forces and conditions.

Source: https://artizono.com/what-is-welding-a-complete-beginners-guide

Post-reading:

1. Match the terms with their definitions

A. Weld pool
B. Filler material
C. Electrode
D. Shielding gas
E. Arc

1. A material added to strengthen the joint by melting with the base metals.
2. A protective substance used to stop contamination from oxygen or other gases.

3. The bright, high-temperature discharge that melts the metal.
4. The molten area where metals fuse together.
5. A tool that carries current to the weld and may melt or stay solid.

2. Choose the correct option (A, B, or C)

1. A heat source in welding can be __________
   A) water pressure
   B) a laser or an electric arc
   C) cold air
1. Filler material is added to __________
   A) decorate the metal
   B) make the weld joint stronger
   C) stop the weld from cooling
2. Shielding is needed because hot metal __________
   A) reacts with gases in the air
   B) freezes quickly
   C) becomes invisible
3. The visible line of solid metal after welding is the __________
   A) heat source
   B) weld bead
   C) arc flame
4. Before welding, surfaces should be __________
   A) dirty
   B) painted
   C) clean

3. Decide if the sentences are True (T) or False (F)

1. The electrode always melts into the weld. _________
2. Shielding gases like argon help protect the molten metal. _________

3. Welding is used only in making small objects like phones. _________
4. During welding, the metal edges melt and fuse together. _________
5. The weld pool becomes solid as it cools. _________

4. Put the steps of forming a weld in the correct order

A. The molten pool cools into a weld bead.
B. The welder starts the arc and creates intense heat.
C. The metal is cleaned and positioned.
D. Filler metal and edges melt and fuse.
E. Shielding protects the molten area.

5. Vocabulary work. Write down the following words into your vocabulary.

Learn them by heart.

1) *heat source*
2) *electric arc*
3) *molten, fuse*
4) *filler material*
5) *shielding gas*
6) *flux*
7) *slag*
8) *weld pool*
9) *weld bead*
10) *electrode*
11) *joint*

6. Problem-Solving. Read the situation and offer a simple solution (2–3 sentences).

Situation: A student is welding, but the weld becomes weak and full of holes. The metal was not cleaned before welding, and no shielding gas was used.

Questions:
1. What caused the problem?
2. What should the student do to make a stronger weld next time?

2. THE STEP-BY-STEP WELDING PROCESS

Pre-reading:

1. **Answer the questions:**

a) What do you think welders must wear to stay safe?
b) Which materials do you think are easier or harder to weld? Why?

2. **Match the terms with their definitions:**

1 ventilation
2 electrode
3 porosity
4 penetration
5 distortion

  a) melting deeply into the metal for a strong weld
  b) holes in the weld caused by contamination
  c) fresh air flow to remove fumes
  d) tool that carries electric current and may melt into the weld
  e) unwanted change in the shape of metal due to overheating

THE STEP-BY-STEP WELDING PROCESS

Step 1: Prepare Your Work Area and Safety Gear. Before welding, ensure your workspace is clean, dry, and free of flammable materials such as wood, paper, or fuel. Good ventilation is essential to prevent harmful fume buildup. Wear proper safety gear, including an auto-darkening welding helmet, flame-resistant gloves, long-sleeved clothing, and sturdy boots, to protect against sparks, heat, and ultraviolet light.

Step 2: Select the Appropriate Welding Method. Choosing the right welding process depends on the material, thickness, and environment.

- **MIG Welding (Gas Metal Arc Welding):** Easy to learn and ideal for steel and aluminum; uses a continuous wire feed and shielding gas.
- **Stick Welding (Shielded Metal Arc Welding):** Works well outdoors and on thicker materials; uses a coated electrode that creates its own shielding gas.
- **TIG Welding (Gas Tungsten Arc Welding):** Provides precise control for thin metals but requires more practice and uses a tungsten electrode.

MIG Welding Process

Step 3: Set Up the Welding Equipment. Connect the ground clamp securely to the workpiece or worktable. Choose the correct electrode or wire type for the material and process. Adjust amperage and voltage according to electrode size and metal thickness. For MIG or TIG welding, attach the shielding gas cylinder correctly and set an appropriate flow rate.

Step 4: Prepare the Metal Pieces. Clean the metal surfaces thoroughly to remove rust, paint, grease, or dirt using a wire brush, grinder, or chemical cleaner. Contaminants weaken welds by causing porosity or poor fusion. Align and clamp the pieces firmly so the joint stays stable during welding, ensuring tight fit-up for even bonding.

Step 5: Strike the Arc and Establish the Weld Pool. Start welding by creating the arc – an intense electrical discharge between the electrode and the metal surface. In stick welding, lightly tap the electrode against the metal, then lift it slightly to maintain the correct gap. The heat forms a small molten area called the weld pool, where the metal fuses. Keeping a steady arc produces consistent, strong welds.

Step 6: Lay the Weld Bead. Move the electrode or torch smoothly along the joint, maintaining a consistent distance from the surface – typically between 1/4 and 3/4 inch. Use steady, controlled motions such as small circles or gentle side-to-side weaving to shape the bead evenly. A uniform bead indicates proper heat and motion control.

Step 7: Control Heat and Travel Speed. Proper heat and travel speed are essential for quality welds. Too much heat can warp thin metal, while too little prevents full penetration. Move at a steady pace – too fast yields a weak, narrow bead; too slow causes excess buildup and distortion. Adjust amperage or electrode distance as needed to maintain balanced heat and smooth progress.

Step 8: Inspect and Finish the Weld. Allow the weld to cool naturally, then inspect the joint for visible defects such as cracks, uneven surfaces, or porosity. If necessary, grind out flawed areas and re-weld them. Remove slag with a hammer or wire brush to reveal the finished surface and confirm weld integrity.

Step 9: Clean Up and Maintain Equipment. Clean the workspace, disconnect equipment safely, and store materials properly to keep everything in good condition. Remove spatter and residue from tools and metal surfaces, and store electrodes or wires in dry containers to prevent moisture damage. Regular maintenance ensures safe and reliable performance for future welding projects.

Source: https://artizono.com/what-is-welding-a-complete-beginners-guide

Post-reading:

3. Join the parts of the sentences:

1. MIG welding uses	a) to see if the weld has defects
2. TIG welding is good for	b) outdoors and thick metals
3. Stick welding works well	c) thin metals and high precision
4. Good ventilation is needed	d) a continuous wire and shielding gas
5. After welding, you must inspect	e) to avoid breathing harmful fumes

4. Correct the false statements:

a) Welders should work near paper and wood.
b) Stick welding uses a tungsten electrode.
c) You should move very fast when laying a weld bead.
d) You should cool the weld with water immediately.
e) Cleaning the workspace is not important after welding.

5. Rearrange the words to make true sentences:

a) and metal the surfaces Clean welding before
b) too heat much distortions metal causes
c) arc the Strike to welding start
d) bead weld uniform a control motion good needs
e) safety gear Wear sparks from protect to yourself

6. Put the letters into order to make words, then write each correct word in a short sentence of your own:

a) DOESWGN (type: tool part)
b) AEBD (type: welding result)
c) LSAHG (protective layer)
d) TNEOCTAMNIOI (something harmful)
e) NTOISLTAID (a problem from heat)

7. Find the best synonym for the marked words:

a) Welders must <u>*inspect*</u> the weld after it cools.
check / *ignore* / *paint*

b) A uniform bead shows <u>*proper*</u> heat and motion.
correct / *dangerous* / *careless*

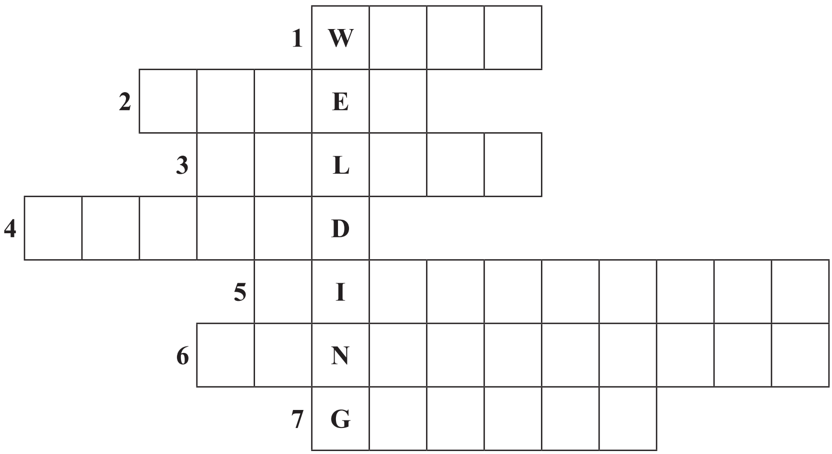
c) The workspace should be *free of* flammable items.
full of / *without* / *covered in*

d) Some methods require *precise* control.
inaccurate / *exact* / *random*

8. Problem-solving:

A student makes a weld, but it has holes and cracks. There was paint on the metal, and the travel speed was too fast.What caused the bad weld?What should the student do differently next time?

9. Welding crossword puzzle:



1. Metal in the form of a thin flexible thread or rod (4)
2. Gas or smoke produced while welding (5)
3. Liquefied by intense heat (6)
4. A face protector used during welding (6)
5. A dangerous situation that can cause fire (4, 6)
6. Fresh air flow for a safe workspace (10)
7. Hand protection (6)

II. SHIPBUILDING MATERIALS AND MAINTENANCE

1. MARINE GRADE METALS

Pre-reading:

1. **Answer the questions.**
    1. What problems do you think metals face in seawater?
    2. Why do ships need special materials?
    3. Which metals do you already know that are used in shipbuilding?
    4. Do you think lightweight metals are important for ships? Why or why not?

Marine grade metals are specifically designed alloys that possess enhanced corrosion resistance and durability in marine environments. These metals are engineered to withstand prolonged exposure to saltwater, which can be highly corrosive and damaging to conventional materials. Common marine grade metals include marine grade stainless steel, aluminum, copper alloys, and titanium, each offering unique properties that make them suitable for various marine applications.

In marine environments, where the forces of saltwater can quickly corrode and deteriorate materials, the use of specialized marine grade metals is imperative.

Marine Grade Carbon Steel. Most carbon steels are unsuitable for marine use due to their vulnerability to oxidation and rust. However, marine grade carbon steels like AH36, DH36, and EH36, approved by the American Bureau of Shipping, contain elevated levels of manganese and chromium for increased strength and corrosion resistance.

Marine Grade Alloy Steel. Alloy steels such as MD, ME, MF, and MG offer the strength of traditional alloy steels with added corrosion resistance, meeting ABS standards for shipbuilding and offshore applications.

Marine Grade Stainless Steel. Stainless steel, renowned for its chromium content aiding corrosion resistance, includes specific grades suitable for marine settings. Grade 316, with increased molybdenum content, excels in resisting saltwater-induced corrosion, while grade 304 remains popular but is less chlorine-resistant. Higher molybdenum levels enhance corrosion resistance, making marine grade stainless steel ideal for marine structures, fasteners, and fittings.

In the realm of marine construction, **aluminum** emerges as a prized material for its remarkable blend of strength, durability, and lightweight characteristics. Widely favored for its high strength-to-weight ratio, aluminum finds extensive application in ship structures and specialized structural components.

Similar to carbon and alloy steels, the corrosion resistance of these aluminum grades is bolstered by the incorporation of chromium and manganese. These aluminum alloys find use in structural shipbuilding, offshore structures, boat hulls, docks, and boat lifts, underscoring their adaptability and reliability in marine settings.

Marine grade copper offers a robust solution for marine environments, with specific copper-nickel alloys designed to withstand the challenges of saltwater conditions. Notable among these alloys is C70600, which incorporates nickel and manganese to enhance durability and corrosion resistance.

Copper possesses a unique advantage in its high biofouling resistance, mitigating damage caused by barnacles and algae to piping systems. Applications of marine grade copper span across marine fittings, fasteners, valves, pumps, water lines, and desalination equipment, showcasing its versatility and efficacy in marine engineering applications.

Silicon **marine grade bronze** alloys are specifically engineered to offer enhanced durability in marine environments. These marine grade bronze alloys find extensive use in critical marine components such as propellers, propeller shafts, pipes, and marine fasteners, where their superior corrosion resistance and durability are paramount for long-term performance and reliability in challenging maritime conditions.

In marine applications, each type of marine metal serves specific purposes based on its distinct properties:

Marine steel is often employed in structural elements such as ship hulls, offshore platforms, and marine infrastructure due to its robustness and endurance. It also finds utility in marine hardware, fasteners, and fittings.

Marine grade aluminum, prized for its lightweight composition and resistance to corrosion, is commonly used in boat construction for hulls, masts, superstructures, and decks. It also features in marine components like gangways, ladders, and platforms where weight reduction is a priority.

Copper and its alloys, including brass and bronze, are favored in marine fittings, propellers, valves, and pumps for their corrosion and biofouling resistance. These marine grade metals are essential in marine fasteners, shafts, and underwater equipment.

Bronze alloys are prevalent in marine propellers, propeller shafts, pipes, and marine fasteners due to their durability and corrosion resistance. They are also suitable for marine hardware and components that require protection against saltwater corrosion.

Source: https://www.zavamarine.com/types-and-applications-of-marine-grade-metals

Post-reading exercises:

2. Match the definitions with the correct terms from the text.

a. A metal that contains chromium and resists rusting.
b. A type of steel approved for shipbuilding by ABS.
c. Metals with added elements to improve strength and corrosion resistance
d. Copper-based metals used in propellers and shafts.
e. A metal known for biofouling resistance.

3. Correct the false sentences.

1. Marine grade aluminum is very heavy and used only in underwater pipes.
2. Grade 304 stainless steel is more resistant to saltwater than grade 316.
3. Marine copper has poor resistance to biofouling.
4. Alloy steels MD–MG have weak corrosion resistance.
5. Bronze alloys are not used in propeller shafts.

4. Rearrange the words to make true sentences.

1. marine / are / alloys / aluminum / lightweight / grade
2. corrosion / metals / saltwater / marine / against / protect
3. contains / 316 / molybdenum / stainless steel / more
4. used / fittings / copper / marine / in / often / is
5. strength-to-weight / good / ratio / has / aluminum / a

5. Put the letters into the correct order to form words or collocations, then use them in your own sentences.

1. T E L S N S S A E I E L T- __________
2. P E R O P R L E L- __________
3. O P E C P R – __________
4. O R N E Z B – __________
5. U M I N M A L U – __________

6. Find the best synonym for the marked word.

1. Marine metals must be **durable** in harsh environments.
   a. strong
   b. cheap
   c. flexible
2. Copper alloys can **resist** biofouling.
   a. avoid
   b. fight
   c. stop
3. Aluminum is **lightweight**, which makes it useful in ship construction.
   a. strong
   b. not heavy
   c. expensive
4. Some steels are **unsuitable** for marine use.
   a. not appropriate
   b. very strong
   c. highly recommended
5. Bronze is **reliable** for long-term use in saltwater.
   a. safe
   b. dependable
   c. similar

7. Problem-solving task.

A shipyard is building a new medium-sized patrol vessel. The engineers must choose materials for three parts:

– the **hull**,
– the **propeller**,
– the **ladder and deck structures**.

Based on what you read:

1. Which material is best for the hull? Why?
2. Which material should be used for the propeller? Why?

3. What metal is suitable for ladders and deck structures? Why?
4. Which materials should they avoid using?

2. SACRIFICIAL ANODES ON SHIPS

Pre-reading:

1. Answer the questions.

Why do you think corrosion is a serious problem for ships?

What materials do you think are most affected by saltwater on a ship?

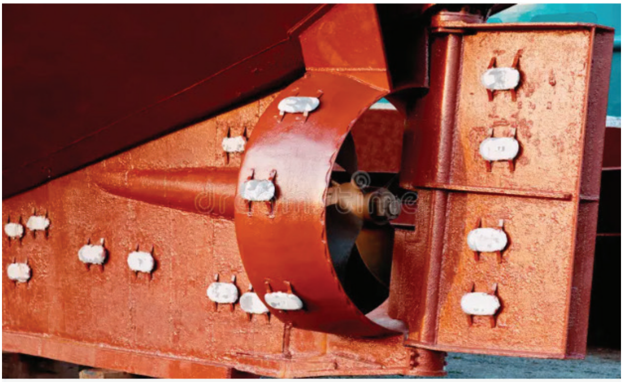
How do you think ships can protect their metal parts from rust and corrosion?

Corrosion is one of the greatest enemies of the ship and its machinery. It is also the toughest enemy to fight against, for the people working on the ship.

Iron is one substance which is used in abundance on the ship. From the main body of the ship to the smallest equipment used in operations, iron makes its presence felt in almost every type of equipment used onboard.

Iron is also the most corrosion-prone material when it comes in contact with air and water. A ship is continuously in contact with water and moisture-laden winds which makes it highly susceptible to corrosion. The outer body of the ship (mainly hull) is continuously in contact with water, making it extremely vulnerable to corrosion. It is for this reason sacrificial anodes are used to protect the parent material.

Sacrificial Anodes: Metal strips of top-order metals in the reactivity series serve as anodes and are installed for cathode protection. These are called as sacrificial anodes. For example, zinc can preferably be employed to serve the purpose of a sacrificial anode for aluminium as well as iron in the process of electrolysis.



Rudder and propeller of a fish trawler

Sorce: https://www.dreamstime.com/photos-images/sacrificial-anode.html

The anode is divided into two parts namely Anode Insert and the Anode body. Out of these two, the one which serves as an anode in the process of electrolysis is termed an anode body, whereas the other is called as anode insert, which is used to securely fix the anode to the parent surface by using brackets, bolts or weld.

Parent surface is the surface which is to be protected against corrosion. In general, we can say that the part of the ship to be protected against corrosion is called parent surface or cathode, whereas the more reactive material covering on the ship's part which acts as an anode is termed as a sacrificial anode.

How Sacrificial Anodes Work? Sacrificial anodes work on the principle similar to electrolysis, according to which, if an anode and a metallic strip are dipped in an electrolytic solution, anode electron will dissolve and deposit over the metallic strip and make it a cathode.In the case of a ship, seawater acts as an electrolyte and transfers the electrons from the anode by oxidizing it over the steel plate and making a protecting layer. If the metal is more active it will be easily oxidized and will protect the metallic compound by making it act as cathode. The anode will corrode first sacrificing itself for the other compound and it is thus called sacrificial anode.

Functions of Sacrificial anode: Important functions of the sacrificial anode are as follows: 1) They are used to protect the main hull; ballast tanks and heat exchangers of a ship from corrosion. 2) Close the bottom of the vessel, storage chests are provided to cater to storage requirements by the sailor. In these sea chests too, sacrificial anode protection is provided to save them from corrosion.

Anode materials: Magnesium (Mg), Aluminium (Al), Zinc (Zn), Chromium(Cr), Iron(Fe), Nickel(Ni). These metals are preferred because they are easy and cheap to replace the anodes rather than complete a large sheet of metal. These anodes are used in various applications such as:

1) Protecting the ship's hull. 2) Protecting the ballast tanks corrosion. 3) Protecting the heat exchangers. 4) Sea Chests

Most Commonly Used Anode Materials: Materials arranged as per their decreasing reactivity are: Magnesium (Mg); Aluminium (Al); Zinc (Zn); Chromium (Cr); Iron (Fe) and Nickel (Ni). The materials which are at the top of this reactivity series can be used as anodes for the materials which are at a comparatively lower level.

Frequency of Changing Anodes. Anodes have to be changed only after they are completely decayed. The frequency for changing of anodes depends on the application where the anodes have been used. In case the anodes are attached to the ship's hull, then they are to be checked during dry dock which takes place after 2 to 3 years. If the anodes are found completely corroded then anodes of bigger size should be fitted, for fully corroded means that the material used was of poor quality or a large amount of material is required to protect the hull. Generally, sacrificial anodes are changed at every dry dock. If sacrificial anodes are used for heat exchangers and it is found during an inspection that the anode left is only 10 % then also it has to be changed.

Source: https://www.marineinsight.com/tech/understanding-sacrificial-anodes-on-ships

Post-reading Exercises:

2. Put the letters in order to make words, then use them in the sentences (fill the gap):

1 **D A O N E** – __________
The __________ corrodes first to protect the ship's metal parts.

2 **T H A C D O E** – __________
The __________ is the metal surface that needs protection.

3 **Y T E L C R E E O T** – __________
Seawater acts as an __________ during the corrosion process.

4 **S L L U H** – __________
The ship's __________ is constantly exposed to water and needs protection.

5 **T A B L S L A** – __________
Sacrificial anodes protect the __________ tanks from corrosion.

6 **I N O R** – __________
__________ is one of the most used metals on a ship but is prone to corrosion.

7 **O C R O S R N O I** – __________
Metal gradually reacts with water and oxygen during __________.

3. Find the opposites of the following words from the text:

1. corroded – __________
2. active – __________
3. top – __________
4. easy – __________
5. cheap – __________

4. Complete the sentences:

1. Sacrificial anodes are made of ____________, __________, and __________.
2. The parent surface is also called the __________.
3. Anodes have to be changed when they are __________.
4. Magnesium, aluminum, and zinc are used because they are __________ and __________.
5. During dry dock, the hull anodes are checked every __________ years.

5. Correct the false statements:

1. The hull is protected by the cathode, not the anode.
2. Zinc cannot be used as a sacrificial anode for iron.
3. Sacrificial anodes corrode before the parent metal.
4. Anodes should be changed every month, regardless of their condition.
5. Seawater acts as an electrolyte in the corrosion protection process.

6. Find words in the text which mean:

1. The main metal surface to be protected – __________
2. A metal that corrodes first to protect another – __________
3. A chemical solution that conducts electricity – __________
4. Fully worn away – __________
5. Expensive or hard to replace – __________

7. Problem-Solving Task

You are a marine engineer responsible for protecting a small cargo ship from corrosion. The ship has: A steel hull; Aluminium superstructure; Zinc-coated ballast tanks; Heat exchangers made of copper

Tasks:

1. Which parts of the ship need sacrificial anodes, and which metals would you choose for each? Explain your reasoning.
2. During inspection, you find that the anodes on the hull are half-corroded and the heat exchanger anodes are 90% corroded. What actions should you take?
3. If the ship is sailing in particularly warm, salty waters, how might this affect the frequency of replacing the anodes?
4. Suggest one additional preventive measure (other than anodes) to reduce corrosion on the ship.

Tip: Use what you learned about parent surfaces, anode materials, and the reactivity series.

III. MECHANICAL ENGINEERING

1. UNDERSTANDING COMPONENTS AND DESIGN OF EXHAUST GAS SYSTEM OF MAIN ENGINE ON SHIP

Pre-reading:

1. Answer the questions:

1. What do you think happens to exhaust gases after they leave the engine cylinders?
2. Why is waste heat recovery important on ships?
3. Which problems can occur if exhaust gas systems are badly designed?

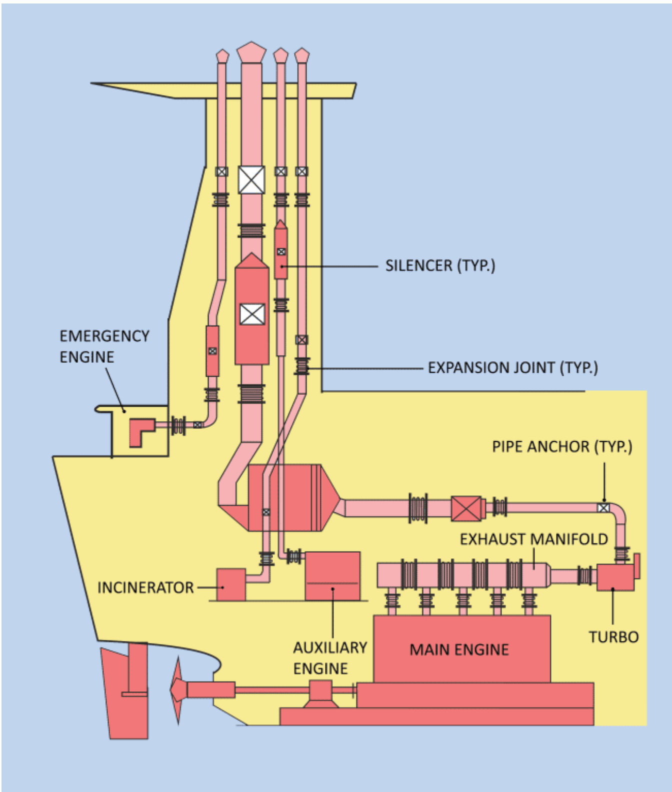
2. Match the terms with their definitions:

1. Exhaust gas boiler
2. Back pressure
3. Silencer
4. Spark arrester
5. Expansion joint

   a) A device used to reduce noise from exhaust gases
   b) Resistance created in the exhaust system that affects turbocharger performance
   c) A component that absorbs thermal expansion and contraction
   d) Equipment that uses waste exhaust heat to produce steam
   e) A device that prevents burning particles from leaving the funnel

The modern exhaust gas system of marine engines is designed in such a way that the unused gases coming out of the cylinders are further directed to turbocharger and exhaust gas boiler to recover most of the waste energy from the same. To utilize the maximum energy from the waste gases, the exhaust gas system of marine engine is provided with the following components

- Exhaust gas pipes
- Exhaust gas boiler
- Silencer
- Spark arrester
- Expansion joints



Exhaust gas-piping system for marine engine:

The exhaust gas piping system conveys the gas from the outlet of the turbocharger(s) to the atmosphere. For designing the exhaust piping system, following important parameters must be observed: 1) The exhaust gas flow rate; 2) Maximum back force from exhaust piping on turbochargers; 3) Exhaust gas temperature at turbocharger outlet; 4) Maximum pressure drop within the exhaust gas system; 5) Maximum noise level at gas outlet to atmosphere; 6) Sufficient axial and lateral elongation ability of expansion joints; 7) Utilization of the heat energy of the exhaust gas.

The Exhaust gas from the cylinder unit is sent to exhaust gas receiver where the fluctuating pressure generated from different cylinders are equalized. From here, the gases which are at constant pressure are sent to turbocharger where waste heat is recovered to provide additional scavenge air to engine.

The most important thing to consider while designing the exhaust piping system is the back pressure on the turbocharger. The back pressure in the exhaust gas system at specified Maximum Continuous Rating (MCR) of engine depends on the gas velocity, and it is inversely proportional to the pipe diameter to the 4th power. It is general ship practice to avoid excessive pressure loss within the exhaust pipes, the exhaust gas velocity is maintained about 35 m/sec to 50 m/sec at specified MCR. The other factors which affect the gas pressure are the installation of EGB, Spark arrestor etc. in the path of exhaust gas travel.

At the specified MCR of the engine, the total back pressure in the exhaust gas system after the turbocharger (as indicated by the static pressure measured in the piping after the turbocharger) must not exceed 350 mm WC (0.035 bar). In order to have a back pressure margin for the final system, it is recommended at the design stage to initially use a value of about 300 mm WC (0.030 bar).

Exhaust gas boiler. Exhaust gas boiler is considered to be one of the most efficient waste heat recovery system designed for a ship.

When the ship's propulsion plant is running at its rated load, the auxiliary boiler can be switched off as the EGB can generate the required steam for various ship's systems. The exhaust gas passes an exhaust gas boiler, which is usually placed near the engine top or in the funnel.

The efficiency of the EGB will be affected by the pressure loss of the gases across the boiler and the parameters governing the pressure loss (exhaust gas temperature and flow rate) are affected by the ambient conditions. The recommended exhaust pressure loss across the EGB is generally considered as 150 mm WC at specified MCR. If the exhaust system is not provided with additional equipment (spark arrester or silencer), the pressure loss value can be considered little bit higher than the value stated above (150 mm WC at specified MCR).

Silencer. The engine room plays a major role in high Noise levels in the accommodation, which is now moderated under Maritime Labor Convention.

The Exhaust gas piping system are generally close to accommodation hence the reduction of noise form them is important. To get the noise level, it is recorded at a distance of 1m from the exhaust gas pipe outlet edge at an angle of 30° provided the exhaust gas system of the engine are without EGB or silencer.

Silencer is used to reduce the noise level in the exhaust gas manifold and they are generally placed after the EGB. The Conventional silencers consist of absorptive and reactive chambers. They are constructed for a gas velocity of 35 m/s and the reactive chamber is only effective at one frequency. The latest design of silencer consist of three chambers to overcome the limitation (of being effective at one frequency)

The three elements are composed of a reactive element for attenuation of lower frequencies, a resistive element-absorptive silencer to tackle with higher frequencies, and a combination element of both reactive and resistive elements. This set up will reduce the noise effectively without increasing the back pressure on the turbocharger by tuning the elements to match the engine over the noise range.

Spark arrester: The low load operation of marine engine tends to produce partially burnt carbon deposits and soot with the exhaust gas piping system of engine. As the exhaust gases produced after combustion are rich with oxygen, these partially burnt carbon particles are discharged from the exhaust funnel as highly dangerous spark.

A spark arrester can be fitted in the exhaust piping system to prevent sparks from the exhaust gas being spread over deckhouse. It is placed at the end of the exhaust gas system of the engine.

The new design of spark arrester helps the gases to create rotatory movements by forcing them to pass through fixed number of angel positioned blades. The heavy carbon particles are smoothly collected in the designed soot box, which can be cleaned or drained as required. They can be combined with silencer as one unit to save space or cost.

Expansion joints. The Exhaust gas system of engine experiences huge temperature variations. It is not possible to construct the entire exhaust piping system in one single piece hence; multiple sections are joined to complete the system. When the engine is standstill, the temperature of the exhaust pipe may vary from 10 to 40 deg C (depending upon the surrounding environment or geographical location of the ship) and when the engine is up and running, the exhaust system temperature crosses 200 deg c. This major temperature variation requires need of joints to safely absorb the heat-induced expansions and contractions of pipes and tubing systems.

Source: https://www.marineinsight.com/main-engine/exhaust-gas-system-of-main-engine-on-ship/

Post-reading:

3. Join the parts of the sentences:

1. Exhaust gas systems are designed not only to remove gases	a) to prevent sparks and fire hazards.
2. Back pressure depends on gas velocity	b) equalizes fluctuating pressure from cylinders.
3. The exhaust gas receiver	c) to reduce noise near accommodation areas.
4. Silencers are installed	d) and pipe diameter.
5. Spark arresters are fitted	e) but also to recover waste energy.

4. Correct the false statements:

1. Exhaust gases are released directly to the atmosphere without any energy recovery.
2. High back pressure improves turbocharger efficiency.
3. Exhaust gas velocity is usually kept between 35 and 50 m/s.
4. Silencers always increase back pressure significantly.
5. Expansion joints are used only for mechanical strength.

5. **Rearrange the words to make correct sentences:**
   1. gas / turbocharger / exhaust / the / drives
   2. boiler / exhaust / steam / generates / gas / the
   3. noise / silencer / reduces / exhaust / the
   4. expansion / absorb / joints / temperature / changes
   5. arrester / sparks / prevents / spark / the

6. **Find words in the text which mean:**
   1. Unused heat energy – __________
   2. A place where gases are collected – __________
   3. Resistance to gas flow – __________
   4. Movement caused by heat – __________
   5. Burning particles from exhaust – __________

7. **Problem-solving task:**

You are designing an exhaust gas system for a ship operating mainly at low engine load.

1. Which components of the exhaust gas system become especially important in this case?
2. What problems may occur if back pressure exceeds the recommended limit?
3. How can noise and fire risks be reduced without increasing back pressure too much?

Explain your answers using information from the text.

2. TWO-STROKE MARINE ENGINES: POWERING THE GIANTS OF THE SEA

Pre-reading:

1. **Answer the questions:**
1. What types of propulsion systems do modern ships use today?

2. Why do you think large commercial ships still rely on diesel engines?
3. What differences do you expect between marine engines and car engines?

While today's marine vessels may be powered by a variety of propulsion systems – including fully electric drives, medium-speed 4-stroke engines, and even hybrid solutions – he vast majority of the world's large commercial ships still rely on the brute force of 2-stroke marine diesel engines. These powerplants are designed to deliver steady, unrelenting power on the open sea. Unlike the engines in cars or trucks, 2-stroke marine engines are built for endurance, efficiency, and simplicity. This article breaks down how they work, which models rule the industry, and how engine choice varies depending on the type of ship.

How 2-Stroke Marine Engines Work

A 2-stroke marine engine completes its combustion cycle in just one crankshaft revolution. That means for every turn of the shaft, there's one power stroke – giving it a significant edge in torque and power output over 4-stroke engines, which require two revolutions for the same cycle.

Unlike 4-stroke engines, which separate intake, compression, combustion, and exhaust across two crankshaft revolutions, 2-stroke engines combine these stages into a single up-and-down movement of the piston. This results in: One power stroke per revolution; higher torque at lower RPMs; Simpler mechanical design with fewer moving parts.

This streamlined cycle is especially effective for large marine vessels, where continuous, heavy-duty operation is essential for long voyages and cargo efficiency. That means for every turn of the shaft, there's one power stroke – giving it a significant edge in torque and power output over 4-stroke engines, which require two revolutions for the same cycle.

What Makes Them Unique? **Crosshead Design:** Keeps crankcase oil and cylinder oil separate, improving lubrication and reducing contamination. **Uniflow Scavenging:** Fresh air enters from the bottom, exhaust exits at the top. This design improves airflow and combustion. **Turbocharging:** More air = more power. Exhaust-driven turbochargers feed high-pressure air into the scavenge system.

2-Stroke Marine Engine Construction: From Bedplate to Exhaust Valve

A 2-stroke marine diesel engine is built like a vertical tower, and its structural hierarchy from bottom to top is as follows:

1. **Bedplate** – The foundation of the engine that supports the crankshaft and absorbs dynamic loads.
2. **A-Frame** – Mounted above the bedplate, it houses the crosshead guides and supports the entablature.
3. **Entablature** – Contains the scavenge air box, cylinder liners, and cylinder lubrication system.
4. **Cylinder Cover** – Seals the top of the cylinder and holds the fuel injector and starting air valve.
5. **Exhaust Valve** – Located on the cylinder cover, it opens during the exhaust phase to release combustion gases.

Each of these parts plays a critical role in engine function, strength, and durability.

Long-Stroke vs Short-Stroke: What's the Difference?

Marine engines are often described by their stroke-to-bore ratio. This affects not only engine speed but also how efficiently power gets transferred to the propeller.

Long-Stroke Engines (Stroke-to-bore ratio: up to 4:1; Slower RPM (typically 50–80); Allow larger propellers; Better fuel economy; Ideal for tankers and bulk carriers.

Short-Stroke Engines (Lower stroke-to-bore ratio; Higher RPM; Compact build; Often used in container ships where height clearance is limited; Matching Engine Type to Ship Type).

Tankers & Bulk Carriers. These ships prioritize fuel efficiency over speed. Most use long-stroke engines with fewer cylinders (often 6 or 7). They sail slowly but steadily, minimizing fuel costs over long distances.

Container Ships. Here, speed matters. They tend to use short-stroke engines with 8 to 12 cylinders. These engines spin faster and are better suited for tighter engine rooms.

Ro-Ro Ships. Roll-on/roll-off (Ro-Ro) vessels, used for transporting wheeled cargo like cars, trucks, and trailers, typically operate on fixed schedules and require engines with quick load response and consistent fuel economy. These ships often use medium-speed 2-stroke or electronically controlled long-stroke engines that balance power with flexibility in varying port schedules and operating conditions.

Offshore Supply Vessels & Tugs. These specialized workboats operate in demanding environments – often maneuvering near offshore rigs, platforms, or harbors. As such, they rely on 2-stroke marine engines with quick load response, reliable torque at low speeds, and enhanced maneuverability. Many are equipped with controllable pitch propellers and shaft generators that benefit from electronically controlled engine systems.

Cruise Ships. While most large cruise ships today use medium-speed 4-stroke engines in diesel-electric configurations, several long-range cruise vessels or hybrid polar expedition ships now feature advanced 2-stroke marine engines for propulsion, thanks to their high efficiency and long maintenance intervals. Environmental compliance and noise reduction are also major considerations.

Naval Vessels. Some auxiliary naval vessels (like fleet oilers, training ships, or logistics carriers) use 2-stroke marine engines when endurance and long-range capability are prioritized. These engines are favored for their low maintenance cycles and ability to run on multiple fuel types in varied global conditions.

LNG Carriers. LNG carriers increasingly use dual-fuel engines like ME-GI or X-DF to take advantage of the onboard cargo as fuel. These engines offer operational flexibility and significantly lower emissions, especially when running on LNG. While environmental regulations apply to all vessel types, LNG carriers are uniquely positioned to comply by using their own transported fuel as a cleaner-burning energy source.

Source: https://marineprogress.com/2-stroke-marine-engines/

Post-reading exercises:

2. Match the terms with their definitions:

1. 2-stroke marine engine
2. Crosshead design
3. Uniflow scavenging
4. Long-stroke engine
5. Short-stroke engine
   a) A design where fresh air enters from the bottom and exhaust leaves at the top
   b) An engine that completes a working cycle in one crankshaft revolution
   c) An engine type with slower RPM and better fuel efficiency
   d) A system that separates crankcase oil and cylinder oil
   e) An engine type with higher RPM and compact dimensions

3. Complete the sentences:

1. A 2-stroke engine produces one ___________ for every crankshaft revolution.

2. Crosshead engines improve lubrication by keeping oils __________.
3. Turbochargers increase engine power by supplying more __________.
4. Long-stroke engines are commonly used on __________ and bulk carriers.
5. LNG carriers use dual-fuel engines to reduce __________.

4. Correct the false statements:

1. 2-stroke engines require two crankshaft revolutions to complete a cycle.
2. Short-stroke engines usually operate at lower RPM.
3. Crosshead design reduces contamination between lubrication systems.
4. Container ships prefer compact engines with higher speed.
5. LNG carriers cannot use their cargo as fuel.

5. Rearrange the words to make correct sentences:

1. power / stroke / one / produces / engine / 2-stroke / per / revolution
2. scavenging / improves / combustion / uniflow / efficiency
3. engines / endurance / marine / for / designed / are
4. ships / engine / type / on / depends / the / vessel
5. fuel / economy / engines / better / long-stroke / offer

6. Find words in the text which mean:

1. Strength produced by an engine – __________
2. Continuous operation over long periods – __________
3. The bottom supporting structure of the engine – __________

4. The movement of fresh air through the cylinder – __________
5. Ships that carry containers – __________

7. Problem-solving task:

You are selecting an engine for three different vessels: *a bulk carrier*; *a container ship*; *an LNG carrier*

For each ship, choose the most suitable engine type and explain your choice using:

- stroke type
- fuel efficiency
- operational requirements.

3. MARINE BOILERS

Pre-reading:

1. Answer the questions:

1. What do you know about steam and where it is used on ships?
2. Why do ships need heating systems, especially tankers?
3. What sources of heat can be found onboard a vessel?
4. Do you think exhaust gases can be reused? How?

2. Match the words with their meanings:

A	B
1. Steam	a. Heat energy taken from machinery
2. Boiler	b. Change of vapour into liquid
3. Exhaust gas	c. Hot vapour used for heating or power
4. Heat recovery	d. Equipment that produces steam
5. Condensate	e. Hot gases released after combustion

Boilers generate steam and have been used since the era of steamships, and are used to date. They utilise the heat index generated from engines and machinery onboard to produce steam vapour by boiling water at very high temperatures and pressures, and this steam is used for various utilities on the vessel that use heating systems.

Source: www.trans-ec.com

For tanker vessels carrying various forms of heavy fuel and bunker fuels, complex heating systems supply constant heat to the cargo so that they remain at the desired low viscosity levels necessary for transfer and distribution.

In colder climates, this steam content is also used for areas like the sea chest and associated seawater cooling systems, cooling and heating lines, ballasting systems, freshwater reserves, and so on, frozen due to very low temperatures.

Moreover, this steam is used for other purposes, such as driving several pumps, turbines, motors, equipment, and other machinery dependent on steam. Furthermore, steam is also used for various purposes for onboard consumption, like galley, air conditioning and heater systems, steam geyser systems, and so on.

In the era of steamships, the steam from boilers was essentially routed, along with these utilities, to main and auxiliary engines that were powered by constant steam supply, and this was a means of constant replenishment in addition to the mainstream supply.

The principle used in Boilers. From a technical point of view, boilers used in ships are based on what is known as the principle of a waste heat recovery system. Though the terminology may seem new and pioneering, this simple concept has been used for ages, right from the era of steamships, as mentioned above. The heat index extracted from all relevant machinery is tapped to be utilized in boiling the water, generating steam at a very high-temperature gradient, which is then circulated suitably.

How do you tap or make use of the heat content? The answer is simple: the exhaust gases or blow offs from engines and equipment. All heavy machinery running on a power source, diesel or electric (steam itself in earlier days) releases hot gases that need to be expelled.

Hence, these hot gases, having very high temperatures, are ideal sources of heat that can be further utilized. For all practical purposes, the main and auxiliary machinery on a vessel are the main sources of this heat, and hence, the working principle of marine boilers is also essentially known as the exhaust gas recovery mechanism.

The heat content, which is a thermodynamic parameter, extracted from the gases recovered from the exhaust or release lines, is dependent on the following factors:

- Flow rate of the gas
- The density of the gas
- Specific heat (the gas's inherent physical property)
- Temperature gradients at the outlet

These gases are then made to pass through a bundle of tubes and piping and made to circulate in the region where there is a volume of water to be evaporated. The gases lose heat on the go, and the temperature decreases significantly in contact with the water medium. Nonetheless, the average temperatures of the gas residues remain more than 100 degrees, the boiling point of water.

From a theoretical point of view, a heat exchange occurs between the gases and the working water medium in the container using all three types of heat transfer: conduction, convection, and radiation.

The heat transfer through the hot surface contact of the tubes and piping takes care of the conduction, whereas the high energy of the gases transfers a significant amount of heat in the form of radiation. Lastly, water is an ideal fluid medium. It also has a great deal of heat transfer internally within itself continuously and uniformly, thanks to convection.

The water boils off into steam, which is routed to the points of consumption. After the steam is consumed, the cooled-off vapours further convert back into a liquid state, known as the condensate. The condensate water is used as the replenishment supply for again the working fluid of the boiler system, and a feeder pump is often used to fill up the tank of the boiler drum with the recycled water.

For all practical purposes, the heat is extracted from two the exhausts of two main sources: the main engine and the auxiliary engine. When the engines are shut off, additional burners are used to heat the boilers like an ordinary stove if there is a demand.

Source: https://www.marineinsight.com/tech/working-of-marine-boilers-explained/

Post-reading:

3. Complete the sentences:

1. Marine boilers produce steam by ______ water at high temperatures.
2. Exhaust gases from engines are used as a source of ______.

3. Steam is required to maintain fuel at low ______ for transfer.
4. After use, steam turns back into liquid called ______.

4. Correct the false statements:

1. Marine boilers only work when the ship is in port.
2. Steam is not used for onboard services like galley or air conditioning.
3. Exhaust gases have too low a temperature to be reused.
4. Condensate water is discharged and never reused.

5. Put the letters in the correct order to make words:

1. **RETMAETUEPR**
2. **ESASG XESHAUT**
3. **TACEDENONS**
4. **REYCRE VHOEAT**

Then use **two** of the words in your own sentences.

6. Find words in the text which mean:

1. Change from liquid to vapor
2. Additional supply
3. Removal of hot gases
4. Device that moves liquid into the boiler

7. Problem-solving task:

A ship is operating in cold climate, and both main and auxiliary engines are stopped. However, steam is still required onboard.

Explain: 1) How the boiler can continue to operate; 2) What equipment is used; 3) Why this is important for ship safety. (5–7 sentences)

8. Mini-presentation:

Prepare a short presentation (4–5 slides) on one of the following topics:

1 Uses of steam on ships

2 Waste heat recovery in marine boilers

3 Importance of condensate reuse

IV. ELECTRICAL ENGINEERING

1. SHAFT GENERATORS

Pre-reading:

1. **Answer the questions:**
   1) What is the main challenge for electricity production on ships?
   2) How does a shaft generator differ from a conventional genset?
   3) Why were early shaft generators limited in their performance?

2. **Match the terms with their definitions:**
   1) Shaft generator; 2) Genset; 3) Frequency converter; 4) Permanent magnet

Definitions:

a) Strong magnets used to create a magnetic field without extra energy.
b) A device that converts mechanical energy from a ship's main engine into electricity.
c) A generator set powered by an auxiliary engine.
d) A device that stabilizes the frequency of electricity regardless of engine speed.

A ship is like a floating city that needs electricity to power its operations and amenities on board. *So how to generate that electricity while being mobile*? That question has been challenging the shipping industry for more than 150 years, when exciting new technologies were being pioneered at the forefront of the new age of electricity. Fast forward to today, and the challenges surrounding the production of electricity on board vessels have been spurred again. The International Maritime Organization's new regulations, among other new protocols, mean ship owners and operators must find ways to cut emissions and make their vessels more efficient.

Propulsion is one obvious area to look at for improvements, and the fuels that drive that. Shaft generators also play a key role in the modern propulsion system and so also require scrutiny.

Everyone can visualize what a propeller shaft looks like and what it does, but what exactly is a shaft generator and how does it help to reduce fuel use and cut emissions? We are back to electricity production again, but these units, hidden inside the hull, are not as mysterious as they may sound.

Standalone generator sets (gensets) need an external fuel source in order to operate and produce electricity, and this is typically done through an auxiliary diesel engine separate from the ship's main engine.

Shaft generators cut out the need for gensets and their auxiliary engines as they connect directly to the propeller shaft and make electricity by utilizing the propulsion drive already supplied by the main engine. This is why they are called shaft generators. Gensets can then be turned off, which saves fuel and cuts emissions.

In addition, utilizing the larger 2-stroke main engine in this way is much more efficient than the 4-stroke engines that typically power the gensets. Finnish company Yaskawa Environmental Energy / The Switch has developed a system that it says can cut fuel use by a further 2 % to 4 % more than conventional shaft generators.

A Little History

The first shaft generators were developed in the 1960s and took their place next to the gensets that had been shouldering the job of producing electricity on board vessels for the previous decades.

These first shaft generators were a big step forward and reduced the need to use gensets. But there was still one major drawback – they were directly connected to both the ship's propulsion shaft and the grid, but without a frequency converter in between.

That meant the shaft generator was limited as it could only cope with a constant speed from the ship's propulsion drive. When the ship's speed would change, the frequency of the electric current produced would fluctuate, making it unusable. And so the shaft generator had to be disconnected, making way for the genset to take over.

This frequency issue was resolved in the 1980s when frequency converters were introduced. The shaft generator then came into its own as it could cope with any speed from zero up to the ship's rated speed and feed a constant frequency to the ship's grid.

The conventional shaft generator and frequency converter combination can be used as the sole generating source of electricity on board a vessel or as a supplement to the gensets, reducing the need to burn fuel.

Shaft generators can also be used as a source of power to drive the propeller at very low speeds, which is useful when entering port to save on emissions. Plus, the system can be used for occasional propulsion power boosts of up to 15 % if needed to break through ice or against strong headwinds.

However, despite these benefits, there are some key areas where conventional shaft generators fall short. This is where The Switch permanent magnet shaft generator takes things a step further, bringing savings that are becoming ever more potent as curbs on emissions grow tighter.

Conventional shaft generators still require a current to flow in a rotor winding to create the magnetic field, so there is always energy loss through heat. This heat loss means lower power conversion efficiency, resulting in higher fuel consumption in the main engine.

Permanent Attraction

The permanent magnet shaft generator uses Neodymium magnets. This means the magnetic field can be created more simply and efficiently, without the need for external power supplying a current to the rotor, and so immediately saving on the amount of fuel that needs to be used.

The simple mechanism also means there are almost no wearing parts, increasing reliability. The first permanent magnet shaft generator was installed by The Switch in 2014 and, with more than 100 in operation today, not a single failure has occurred, the company says.

The permanent magnets in these machines are also so strong the whole unit can be reduced in size, typically weighing up to 30–50 % less than conventional machines.

The permanent magnet shaft generator's efficiencies are where the extra 2 % to 4 % reductions in fuel savings come from – over and above savings seen in conventional shaft generators. This reduction applies to emissions as well. Over a typical 20 to 25-year lifespan of a large vessel, these savings can bring a $2 million reduction in fuel costs and eliminate 5,000 tons of carbon dioxide emissions.

The first generator sparked into life in 1831 to light up inventor Michael Faraday's smile. If only he could see how far that attraction to magnets has come, as the need to cut emissions drives engineers to deliver exciting new technologies all over again.

Source: https://www.marinelink.com/news/tech-file-shaft-generators-505563

Post-reading:

3. Join the parts of sentences:

Shaft generators connect directly …	by creating a magnetic field without requiring a rotor current, saving fuel.
Permanent magnet generators increase efficiency …	to provide constant-frequency electricity regardless of ship speed.
Frequency converters allow the generator …	to the ship's propeller shaft, producing electricity from the main engine.

4. Correct the false statements:

1) Conventional shaft generators can work at any ship speed without a converter.
2) Permanent magnet generators require a rotor current to produce a magnetic field.
3) Shaft generators cannot assist with propulsion at low speeds.

5. Rearrange the words to make sentences:

electricity / ships / produces / shaft generator / on / a / the

magnets / permanent / field / create / a / a / generator / in

6. Put the letters in order to make words and use them in sentences:

RTOOR

REFCYQUNE

PROSILONPU

7. Find words in the text which mean:

“reduction of fuel use” – …

“lasting reliability” – …

“excess heat lost in system” – …

8. Problem-solving task:

A ship at port can run its auxiliary engines at minimal load or use a shaft generator. Calculate approximate fuel savings if the main engine provides 3 MW and the permanent magnet shaft generator increases efficiency by 3 % compared to conventional generators over a 24-hour port stay. Explain why permanent magnets reduce energy loss.

2. SHIP POWER GRID

Pre-Reading:

1. Before reading the text, answer the questions:

What sources of electrical power are used on board a ship?

What do you think a ship power grid consists of?

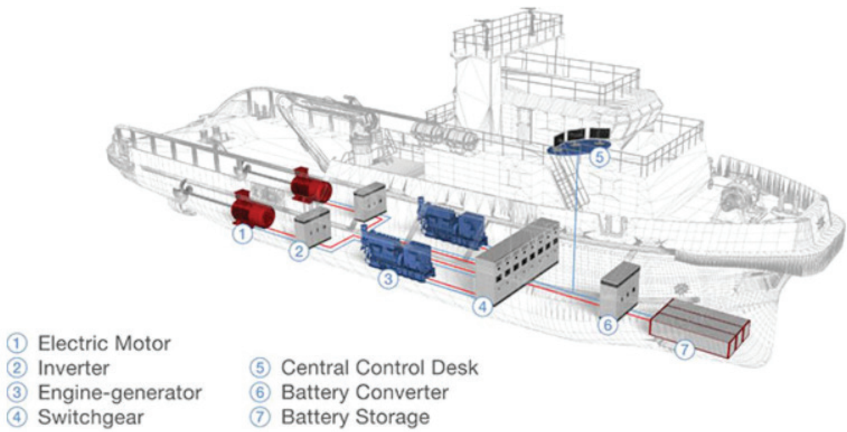
Why is reliability especially important for electrical systems at sea?

2. Read the following words and try to explain their meaning or guess it from your professional knowledge:

power grid
switchboard
distribution board
load
reliability
protection
fault
overload

3. True or false? Decide whether the statements are true or false before reading the text:

1) The main switchboard supplies all electrical equipment on a ship directly.
2) A ship power grid includes both power supply and power distribution networks.
3) Protection devices are only needed during normal operation.



Overview of ship power grid

The marine power grid is a whole composed of marine cables, wires and power distribution devices in a certain connection mode. Just as the blood vessels in the human body transport blood to various organs, the electrical energy generated by the generator is transmitted to the various electrical equipment on the ship through the power grid. The ship power grid includes a power supply network and a power distribution network. The power supply network refers to the electrical connection network between the main generator and the main switchboard, between the emergency generator and the emergency switchboard, between the main switchboard, and between the main switchboard and the emergency switchboard and the shore power box. The power distribution network refers to the electrical connection network between the main switchboard, emergency switchboard and electrical equipment. When there are many electrical equipment on the ship, it is impossible for all the loads to be directly supplied by the main switchboard. Instead, the electric energy is distributed from the main switchboard to the load via the distribution board or distribution box. For the convenience of analysis, the network between the main distribution board and the distribution board and the network directly supplied by the main distribution board to the load are usually called the primary network, and the network between the distribution box and the electrical equipment is called the secondary network.

The basic requirements for ship power grid design are:

(1) The power grid has strong vitality and high reliability. That is to say, the power grid is required to ensure continuous power supply to the load within the maximum range when the generator set and line fail or partially break, and limit the development of the failure and limit the impact of the failure to the minimum range; when the power grid is severely damaged, continue to maintain continuous power supply to the most important equipment.

(2) The grid design should ensure the flexibility of system operation. That is, the mobility of the grid operation and the convenience of maintenance, including the mobility of the operation of the control part, the diversity of the operation scheme, the standardization of the power interface, the reduction of the type and specification of the electrical equipment, and the increase of the unity of the parts. In addition, the design of the power grid should take into account the need for local refitting and adding new equipment to the ship in the future, and set up a certain number of backup power supply branches in certain locations.

In order to ensure the performance of the control functions determined in the design of the power station, the power grid design should take corresponding measures:

On the one hand, the status of the control part is guaranteed from the network facilities: on the other hand, it is guaranteed to realize the conversion conditions of the control part, that is, it can be switched from one part to another according to the system usage requirements, and it can also be switched back to this part from another part. .

For example, the ship is equipped with two power stations A and B, which usually requires parallel operation from power station

A to power station B, and parallel operation from power station B to power station A. For this reason, both ends of the jumper line between the two power stations should be equipped with air circuit breakers that can be closed on power to achieve bidirectional operation between the two power stations.

(3) Power grid design should strive to improve its technical and economic indicators. The most economical grid connection scheme should be selected when designing: strive to reduce intermediate links and save power distribution appliances; appropriately limit the reserve section of the cable; on the premise of meeting the requirements, choose low-priced electrical equipment to reduce the cost of power grid construction; improve the automation of grid operation and reduce operation and management personnel; reduce equipment failure rates, reduce operating losses and maintenance workloads; rationally allocate loads to maintain efficient grid operation; control operating power factors to reduce line losses; improve load equipment operating efficiency.

(4) The grid design should carefully consider the protection measures of the grid. To measure the success of the design of a ship's power grid, it depends not only on its operating conditions under normal conditions, but more importantly, by observing its behavior under fault conditions and whether it has the ability to control faults.

For some important grid parameter abnormalities, an early warning should be issued before the fault action occurs, so as to alert the staff on duty and take necessary measures in advance.

The action of protecting electrical appliances should have a selective function. The selection function includes two points:

The ability to discriminate the point of failure, carry out regional selection and protection, and reduce the impact of the failure;

The ability to judge the nature of the fault, such as distinguishing instantaneous overcurrent, short-term overload, etc., and then adopting different protective measures.

The action value of the protective electrical appliance should be selected very carefully. If the action value is selected too large, the meaning of safety protection will be lost; if the action value is selected too low, it will cause unnecessary actions of the protection appliances and affect the normal operation of the power grid. Therefore, the power grid design should accurately grasp the possible range of various parameter changes when the system fails, and reasonably select the safe range of protection electrical operation values.

After the power grid fault is eliminated, it is hoped that the protection equipment at all levels can quickly return to normal, and the protection equipment that is not often managed by people should choose the protection equipment with self-recovery function.

The reasonable design of the ship's power grid is directly related to the reliability of the power supply of the power system, so the importance of the power grid is no less than that of the power station. Without a good power grid, no matter how good the performance of the power station is, it will not be possible to play a role. The practice of ship design shows that the selection of appropriate power supply and distribution methods is of great significance for improving the design quality of the ship's power system and enhancing the vitality of the power grid.

Source: https://electronictestfixtures.com/overview-of-ship-power-grid/

Post-reading:

4. Answer the questions based on the text:

What elements form the marine power grid?

What is the difference between the power supply network and the power distribution network?

Why are distribution boards and distribution boxes used on ships?

What is meant by primary and secondary networks?

Why must a ship's power grid remain operational even after serious damage?

5. Decide whether the statements are true or false according to the text:

a) The emergency generator is connected only to the main switchboard.
b) Flexibility of grid operation includes ease of maintenance and future expansion.
c) Protection devices must react the same way to all types of faults.
d) A higher protection action value always improves system safety.

6. Match the term with its description:

TERM	DESCRIPTION
1. Selective protection	a) A network that supplies power directly from the main switchboard to large consumers or to distribution boards
2. Power factor	b) The ability of a system to continue supplying electricity even when part of it is damaged or fails
3. Primary network	c) A warning issued before a fault occurs to allow preventive action
4. Early warning	d) A protective principle that isolates only the faulty section of the grid
5. Vitality of the grid	e) A parameter that influences line losses and overall efficiency of power transmission
6. Secondary network	f) A network that supplies power from distribution boxes to individual electrical equipment
7. Emergency switchboard	g) A control point designed to supply power to essential equipment during failures

7. Complete the sentences using information from the text:

The ship power grid must ensure continuous power supply even when ________ occurs.

Selective protection helps to limit the ________ of a fault.

Early warning systems allow crew members to take action before ________ happens.

8. Problem-solving task: Ship power grid under failure conditions:

You are an electrical engineer on board a container vessel. The ship is operating in heavy weather, and the following situation occurs simultaneously: One main generator suddenly trips due to an internal fault. A distribution board supplying several non-essential consumers loses power. The emergency generator is available but has not started yet.

Using the information from the text, analyze the situation and answer the tasks below.

1. Identify which part of the ship's power grid is affected first: the power supply network or the power distribution network. Explain your reasoning using the definitions from the text.
2. Decide which electrical equipment must continue to receive power immediately and which equipment can remain disconnected. Justify your decision based on the basic requirements for ship power grid design.
3. Explain how the concepts of reliability and vitality of the power grid apply in this situation. What design features help prevent a total blackout?
4. Describe how selective protection should operate in this case. What would happen if the protection settings were chosen too low or too high?
5. Propose one specific action the engineer on watch should take before the emergency generator is fully connected to the emergency switchboard.

GLOSSARY

THE KEY ELEMENTS IN A WELDING PROCESS

Welding – зварювання
Heat source – джерело тепла
Electric arc – електрична дуга
Gas flame – газове полум’я
Laser / Electron beam – лазерний / електронний промінь
Filler material – присадковий матеріал
Base metal – основний метал
Shielding – захист від забруднення
Shielding gas – захисний газ
Flux – флюс
Molten pool / Weld pool – розплавлена ванна / зварювальна ванна
Weld bead – зварний шов
Electrode – електрод
Consumable electrode – плавкий електрод
Non-consumable electrode – неплавкий електрод
Arc – дуга
Melting / Fusion – плавлення / злиття
Solidification – твердіння, затвердіння
Weld strength – міцність зварного шва

THE STEP-BY-STEP WELDING PROCESS

Welding method – метод зварювання
MIG welding / Gas Metal Arc Welding – МІГ-зварювання /

дугове зварювання плавким електродом у середовищі захисних газів
Stick welding / Shielded Metal Arc Welding – дугове зварювання покритим електродом
TIG welding / Gas Tungsten Arc Welding – ТІГ-зварювання /дугове зварювання неплавким вольфрамовим електродом в середовищі інертного газу
Wire feed – подача дроту
Shielding gas – захисний газ
Tungsten electrode – вольфрамовий електрод
Ground clamp – заземлювальний зажим
Amperage – сила струму
Voltage – напруга
Metal thickness – товщина металу
Work piece – деталь, що зварюється
Contaminants – забруднення
Porosity – пористість
Fusion – злиття
Travel speed – швидкість руху електрода або пальника
Heat control – контроль тепла
Slag – шлак
Spatter – бризки металу
Weld integrity – цілісність шва
Maintenance – обслуговування
Safety gear – захисне обладнання

MARINE GRADE METALS

Marine grade metals – морські метали спеціального призначення
Alloys – сплави
Corrosion resistance – стійкість до корозії
Durability – довговічність
Saltwater – морська вода

Marine grade stainless steel – морська нержавіюча сталь
Aluminium – алюміній
Copper alloys – мідні сплави
Marine grade carbon steel – морська вуглецева сталь
Oxidation – окислення
Rust – іржа
Manganese – марганець
Chromium – хром
Marine grade alloy steel – морський легований сталевий сплав
ABS standards / American Bureau of Shipping – стандарти ABS / Американське бюро судноплавства
Marine grade aluminium – морський алюміній
Strength-to-weight ratio – співвідношення міцності до ваги
Marine grade copper – морська мідь
Copper-nickel alloys – мідно-нікелеві сплави
Biofouling resistance – стійкість до обростання живими організмами
Fasteners – кріпильні елементи
Valves – клапани
Pumps – насоси
Desalination equipment – опріснювальне обладнання
Silicon bronze alloys – кремнієві бронзові сплави
Marine infrastructure – морська інфраструктура
Superstructures – надбудови
Gangways – трапи
Decks – палуби

SACRIFICIAL ANODES ON SHIPS

Corrosion – корозія
Corrosion-prone – схильний до корозії
Oxidation – окиснення
Rust – іржа
Moisture-laden air – повітря з високою вологістю

Hull – корпус судна
Parent surface – основна поверхня
Cathode – катод
Anode – анод
Sacrificial anode – жертовний анод
Electrolysis – електроліз
Electrolyte – електроліт
Reactivity series – ряд активності (металів)
Oxidize – окиснюватися
Metal dissolution – розчинення металу
Protective layer – захисний шар
Carbon deposits – вуглецеві відкладення
Soot – сажа
Decay / decayed – руйнування / зруйнований
Dry dock – сухий док
Inspection – огляд
Heat exchanger – теплообмінник
Ballast tank – баластний танк
Replacement – заміна
Durability – довговічність

UNDERSTANDING COMPONENTS AND DESIGN OF EXHAUST GAS SYSTEM OF MAIN ENGINE ON SHIP

Exhaust gas system – система відпрацьованих газів
Exhaust gases – відпрацьовані гази
Waste heat recovery – утилізація відпрацьованого тепла
Turbocharger – турбокомпресор
Exhaust gas boiler (EGB) – котел-утилізатор відпрацьованих газів
Silencer – глушник
Spark arrester – іскрогасник
Expansion joint – компенсатор теплового розширення
Exhaust gas piping – трубопровід відпрацьованих газів
Back pressure – зворотний тиск

Maximum Continuous Rating (MCR) – номінальна безперервна потужність
Gas velocity – швидкість газу
Pressure drop – падіння тиску
Noise level – рівень шуму
Exhaust gas receiver – колектор відпрацьованих газів
Scavenge air – продувне повітря
Auxiliary boiler – допоміжний котел
Ambient conditions – умови навколишнього середовища
Reactive chamber – реактивна камера
Absorptive (resistive) silencer – поглинальний (резистивний) глушник
Low-load operation – робота на малому навантаженні
Carbon deposits / soot – вуглецеві відкладення / сажа
Funnel – димова труба
Thermal expansion – теплове розширення
Contraction – стискання
Standstill – зупинка (двигуна)

2-STROKE MARINE ENGINES: POWERING THE GIANTS OF THE SEA

2-stroke engine – двотактний двигун
Power stroke – робочий хід
Crankshaft – колінчастий вал
Torque – крутний момент
Crosshead design – крейцкопфна конструкція
Turbocharger – турбокомпресор
Bedplate – станина
Long-stroke engine – довгохідний двигун
Short-stroke engine – короткохідний двигун
Fuel efficiency – ефективність використання палива
Emissions – викиди
LNG carrier – газовоз ЗПГ

MARINE BOILERS

Boiler – котел
Steam/ vapour – пара
Heat index / heat content – тепловий запас / теплова енергія
Waste heat recovery system – система утилізації відпрацьованого тепла
Exhaust gases – відпрацьовані гази
Auxiliary engine – допоміжний двигун
Main engine – головний двигун
Heating system – система підігріву
Viscosity – в’язкість
Cargo heating – підігрів вантажу
Sea chest – кінгстон
Ballasting system – баластна система
Freshwater reserves – запаси прісної води
Thermodynamic parameter – термодинамічний параметр
Flow rate – витрата
Temperature gradient – температурний градієнт
Heat transfer – теплопередача
Convection – конвекція
Radiation – теплове випромінювання
Evaporation – випаровування
Condensate – конденсат
Feeder pump – живильний насос
Boiler drum – барабан котла
Burner – пальник

SHAFT GENERATORS

Shaft generator – валовий генератор
Genset – генераторна установка
Frequency converter – перетворювач частоти
Permanent magnet – постійний магніт

Propeller shaft – гребний вал
Auxiliary engine – допоміжний двигун
Rotor – ротор
Magnetic field – магнітне поле
Efficiency – ефективність(ККД)
Fuel consumption – витрати палива
Emissions – викиди
Power conversion – перетворення енергії
Torque – крутний момент
Low speed operation – робота на низьких обертах
Reliability – надійність

SHIP POWER GRID

Power grid – система електропостачання судна
Marine power grid – суднова електрична мережа
Generator – генератор
Main generator – головний генератор
Emergency generator – аварійний генератор
Electrical equipment – електрообладнання
Power supply network – електромережа
Power distribution network – розподільна електрична мережа
Main switchboard – головний розподільний щит
Emergency switchboard – аварійний розподільний щит
Shore power box – берегове джерело електроживлення
Distribution board – розподільний щит
Distribution box – розподільна коробка
Primary network – первинна електрична мережа
Secondary network – вторинна електрична мережа
Load – електричне навантаження
Reliability – надійність
Continuous power supply – безперервне електропостачання
Fault – аварія, несправність
Grid vitality – живучість електричної мережі

Maintenance – технічне обслуговування
Circuit air breaker – автоматичний повітряний вимикач
Power factor – коефіцієнт потужності
Line losses – втрати в лініях електропередачі
Protective devices – захисні електричні пристрої
Selective protection – вибірковий захист
Overcurrent – перевищення струму
Overload – перевантаження
Early warning – раннє попередження
Self-recovery function – функція самовідновлення
Power distribution method – спосіб розподілу електроенергії

РЕКОМЕНДОВАНА ЛІТЕРАТУРА
ТА ІНФОРМАЦІЙНІ ІНТЕРНЕТ-РЕСУРСИ

1. Dearholt J. D. Career Paths. Mechanics. Express Publishing, 2021. 121 p.
2. Eyres D. J., Bruce G. J. Ship Construction. 7th ed. Oxford, 2012. 400 p.
3. Glendinning E. H., Glendinning N. Oxford English for Electrical and Mechanical Engineering. Oxford University Press, 2008. 190 p.
4. Heywood J. B. Internal Combustion Engine Fundamentals. Second Edition. McGraw Hill Education: New York, 2018. 1056 p.
5. Hirdaris S. E. Lecture Notes on Basic Naval Architecture. Aalto University, Finland, 2021. 161 p.
6. Ibbotson M. Professional English in Use. Engineering. Cambridge University Press, 2009. 144 p.
7. Pivnenko B.A. English for Maritime Studies for Engineer Officers. Одеса, 2007. 352 с.
8. White L. Engineering. Workshop. Oxford University Press, 2003. 41 p.
9. Бєлоусова С. М., Кисельова Т. В., Смуглякова М. К. English for Engineering : навч. посібник з англійської мови. Миколаїв : НУК, 2021.152 с.
10. https://science.howstuffworks.com/transport/engines-equipment.htm
11. https://encyclopedia2.thefreedictionary.com/Direct-Current+Machine

12. https://www.explainthatstuff.com/refrigerator.html
13. https://www.marineinsight.com
14. https://www.popularmechanics.com
15. https://www.machinedesign.com

ЗМІСТ

Навчальне видання

TECHNICAL ENGLISH READER

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