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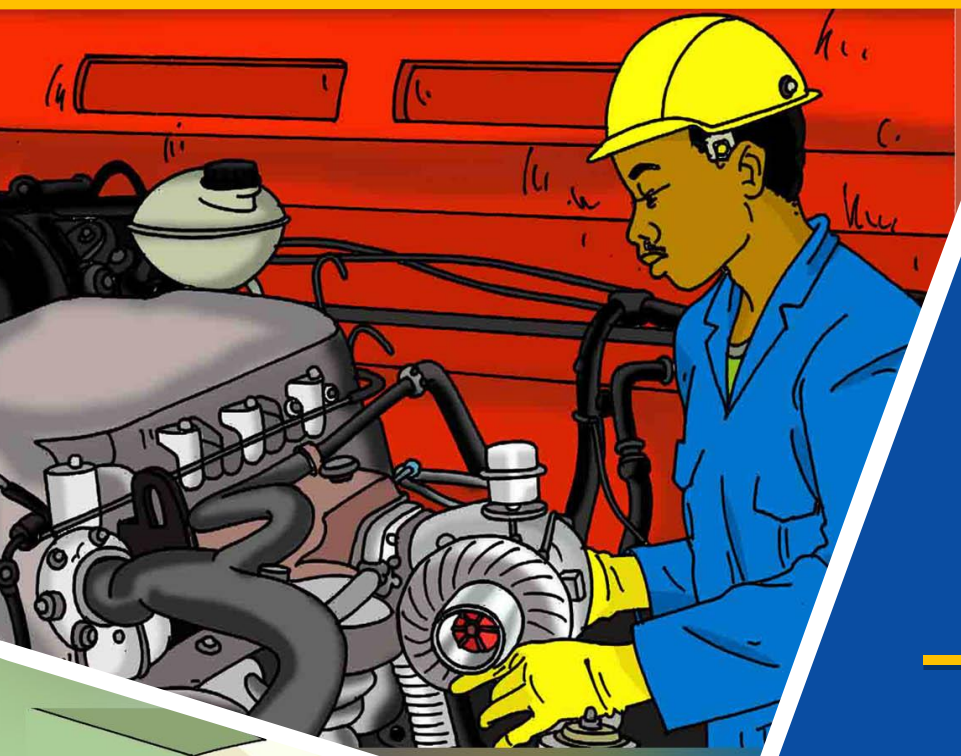
RQF LEVEL 3



AUTSR301

AUTOMOBILE TECHNOLOGY

Engine Supercharging System Repairing

TRAINER'S MANUAL

December 2023

ENGINE SUPERCHARGING SYSTEM REPAIRING

2023

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KIGALI-RWANDA

Original published version: December 2023**.**

ACKNOWLEDGEMENTS

Rwanda TVET Board (RTB) would like to recognize all parties that contributed to the development of the Trainer's and Trainee's manuals for the TVET Certificate III in **Automobile Technology, Module: AUTSR301-Engine Supercharging System Repairing.**

Thanks to Swisscontact for itsr technical and financial support towards the implementation of this project.

We would also wish to acknowledge all trainers, technicians, and practitioners for their contribution to this project.

The Management of Rwanda TVET Board appreciates the efforts of its staff as well who coordinated this project.

Finally, RTB would like to extend its profound gratitude to MCT Global team that technically led the entire assignment.

Under Rwanda TVET Board (RTB) guiding policies and directives

Under Swisscontact supervision and involvement

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LIST OF ABBREVIATIONS AND ACRONYMS

RQF: Rwanda Qualification Framework

RTB: Rwanda TVET Board

TVET: Technical and Vocational Education and Training

%: Percentages

CBET: Competency Based Education and Training

MPH: Miles Per Hour

KM/H: Kilometer Per Hour

A/C: Air Conditioning

TABLE OF CONTENT

INTRODUCTION

This trainer manual encompasses all methodologies necessary to guide you to properly deliver the module titled: Engine Supercharging System Repairing. Students undertaking this module shall be exposed with practical activities that will develop and nurture their competencies. The writing process of this training manual embraced competency-based education and training (CBET) philosophy by providing practical opportunities reflecting real life situations.

The trainer manual is subdivided into learning outcomes; each learning outcome has got various topics. Trainer will start guiding a self-assessment exercise to help students rate themselves on their level of skills, knowledge and attitudes about the learning outcome or unit in their trainee manual.

The trainer manual will give trainer the information about the objectives, learning hours, didactic materials, proposed methodologies and crosscutting issues.

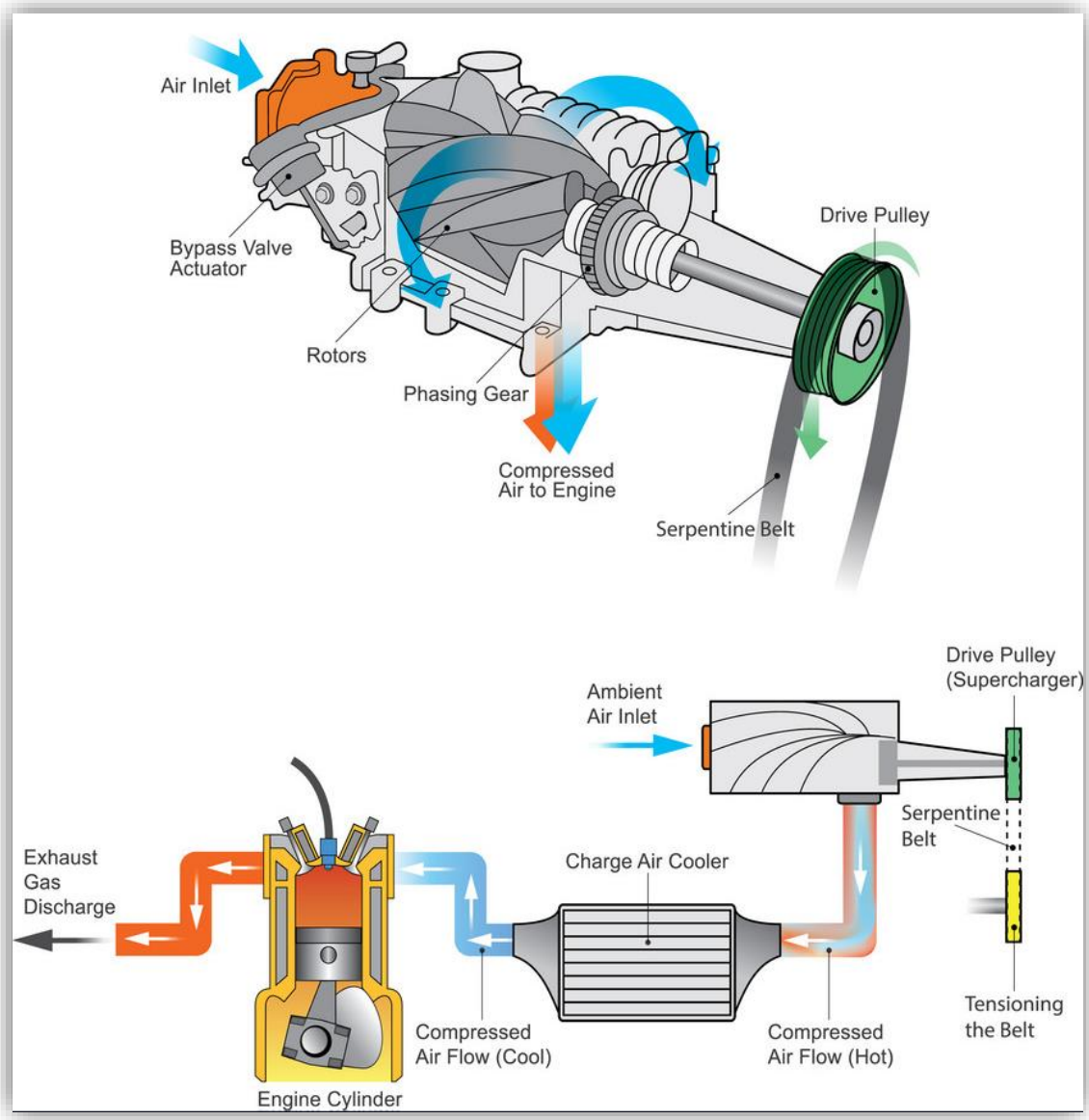
A discovery activity is followed to help students discover what they already know about the unit.

This manual will give trainer tips, methodologies and techniques about how to facilitate students to undertake different activities as proposed in their trainee manuals. The activities in this training manual are prepared such that they give opportunities to students to work individually and in groups.

After going through all activities, trainer shall help students to undertake progressive assessments known as formative and finally facilitate them to do their self-reflection to identify strengths, weaknesses and areas for improvements.

Trainer remind trainees to read the point to remember section which provides the overall key points and takeaways of the unit.

Learning outcomes	Learning Hours	Topics
Learning Outcome 1: Describe engine supercharging system	**10**	**1.1** Description of engine supercharging systems
Learning Outcome 2: Prepare workplace	**5**	**2.1** Safety precautions at workplace
		2.2 Selection of PPE
		2.3 Cleaning and arrangement of the workplace
Learning Outcome 3: Repair engine supercharging system	**25**	**3.1** Selection of materials, tools and equipment
		3.2 Diagnosis of engine supercharging system
		3.3 Correction of engine supercharging system



Self-Assessment

1. Ask trainees to look at the illustration above and together discuss:

a. What do you see in the figure?

b. What do you think will be topics to be covered under this Learning Outcome based on the figure?

After some brainstorming, share the main topics.

2. Ask trainees to fill out the self-assessment at the beginning of the learning outcome in their Trainee Manuals. Explain that:
   a. The purpose of the self-assessment is to become familiar with the topics in the learning outcome and for them to see what they know or do not know at the beginning.
   b. There is no right or wrong ways to answer this assessment. It is for their own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process.
   c. They should think about themselves: do they think they have the knowledge, skills or attitudes to do this? How well?
   d. Read the statements across the top. Put a check in column that best represents their level of knowledge, skills or attitudes.
   e. At the end of the learning outcome, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths.
   f. Fill in and complete the self-assessment table below to assess your level of knowledge, skills and attitudes under this Learning Outcome.

Key Competencies:

Knowledge	Skills	Attitudes
1. List types of engine supercharging system.	1. Differentiate supercharger types based on their construction.	1. Commitment 2. Have attention to details
2. Describe dynamic supercharger.	2. Identify dynamic supercharger components.	3. Time management 4. Have attention to details
3. Describe independent supercharger.	3. Identify independent supercharger components.	5. Time management 6. Have attention to details

Steps

Discovery Activity

Task 1:

1. Using an appropriate method such as pair work, small groups, large groups or individuals, ask trainees to answer the following questions under task 1:

Topic 1.1. Description of Supercharging System

	Objectives: By the end of the topic, trainees will be able to: **a.** Define engine Supercharging systems, **b.** Identify Supercharging types, **c.** Differentiate Supercharging system types based on construction and operation.
	Time Required: **10 Hours**
	Learning Methodology: Small Group Work, Video, Brainstorming, Field Visit.
	Materials, Tools & Equipment Needed: Chalks, Papers, Curriculum, Books, Black board, Notebook, Clothes rugs, whiteboard, Marker pen, engine supercharging system components, Spanners, bearing pulling tool, bearing pushing tool, clearance measuring instruments, screwdriver, shaft pushing tool, Impeller removing tool set, pump removing tool set, pump disc locking plate, Projector, Computer.
	Preparation: ❑ Prepare the task sheet ❑ Prepare session plan ❑ Make sure that trainee's manual is corresponding to the number of trainees

	❑ Gather materials according to the numbered of trainees and teaching method
	**Cross-Cutting Issues:** ✓ Sensibilize gender balance within learning periods, ✓ Provides special aid for persons with disabilities, ✓ Clean a discussion debate on fighting drugs, ✓ Familiarize learning area to the environment sustainability ✓ Promote inclusivity during class discussion and presentation
	**Prerequisites:** ▸ Describe the Air supply system ▸ Demonstrate knowledge on operation of engine with multiple inlet valve technology for the purpose of Charge improvement

Activity 1: Problem Solving

Task 2:

Ask trainees to form small group discussion and answer the questions under the task 2:

Activity 2: Guided Practice

Task 3:

Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, trainees answer the questions provided under task 3 based on the situation in their trainee manuals.

Activity 3: Application

Task 4:

Using an appropriate methodology such as individual work, pairs, or small groups tell trainees to read provided situation under the task 4 in trainee manual and choose correctly materials, tools and equipment to use for fixing problems related to engine supercharging systems.

Points to Remember

The compressor draws in the fresh gases and supplies the engine with a pre-compressed fresh gas charge. The charge air is heated by the pre-compression by up to 180^0C.

Pressure Wave Supercharger

A pressure wave supercharger (also known as a wave rotor) is a type of supercharger technology that harnesses the pressure waves produced by an internal combustion engine exhaust gas pulses to compress the intake air.

Formative Assessment

Q1. What is a supercharging system in an internal combustion engine?

Answer:

A supercharging system is a mechanism designed to force more air into the combustion chamber of an internal combustion engine. This allows for a greater volume of air-fuel mixture, leading to increased power and efficiency.

Q2. How does a supercharger work?

Answer:

A supercharger works by compressing the incoming air before it enters the combustion chamber. This compressed air contains more oxygen, allowing for a more significant fuel burn and, consequently, increased engine power.

Q3. List down the main components of an engine supercharging system?

Answer:

The primary components of an engine supercharging system include: the supercharger unit, drive belt, pulleys, intercooler (in some systems), and associated piping.

Q4. Differentiate supercharger from turbocharger?

Answer:

Both superchargers and turbochargers are designed to increase engine power by compressing air, the key difference is in their power sources. A supercharger is belt-driven by the engine, while a turbocharger is powered by exhaust gases.

Q5. Enumerate 3 advantages and disadvantages of engine supercharging system?

Answer:

Advantages

✓ Higher power output,	✓ Greater induction of charge mass,
✓ Better atomization of fuel,	✓ Better mixing of fuel and air,
✓ Better scavenging products,	✓ Better torque characteristics over whole range,
✓ Quick acceleration of vehicle,	✓ Complete and smooth combustion,
✓ Even fuel with poor ignition quality can be used,	✓ Improved cold starting,
✓ Reduced exhaust smoke,	✓ Reduced specific fuel consumption,

Disadvantages

✓ Increased detonation tendency in SI engines,	✓ Increased thermal stress,
✓ Increased heat loss due to increased turbulence,	✓ Increased gas loading,
✓ Increased cooling requirements of the engine.	

Q6. What is the role of an intercooler in an engine supercharging system?

Answer:

An intercooler is used to cool the compressed air before it enters the engine. Cooler air is denser, providing a higher concentration of oxygen, which improves combustion efficiency and prevents potential issues associated with hot, compressed air.

Self-Assessment

1. Ask trainees to look at the illustration above and answer the following questions:

a. What do you see in the figure?

b. What do you think will be topics to be covered under this Learning Outcome based on the figure?

After some brainstorming, share the main topics.

2. Ask trainees to fill out the self-assessment at the beginning of the learning outcome in their Trainee Manuals. Explain that:

a. The purpose of the self-assessment is to become familiar with the topics in the learning outcome and for them to see what they know or do not know at the beginning.

b. There is no right or wrong ways to answer this assessment. It is for their own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process.

c. They should think about themselves: do they think they have the knowledge, skills or attitudes to do this? How well?

d. Read the statements across the top. Put a check in column that best represents their level of knowledge, skills or attitudes.

e. At the end of the learning outcome, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths.

f. Fill in and complete the self-assessment table below to assess your level of knowledge, skills and attitudes under this Learning Outcome.

Key Competencies:

Knowledge	Skills	Attitudes
1. Identify Personal safety precautions.	**1.** Select and wear PPE.	**1** Have attention to details when selecting and wearing PPEs.
2. Explain work area safety precautions .	**2.** Perform work area cleaning .	**2** Be attentive when arranging tools and equipment.
3. Identify safety tool and equipment	**3.** Apply Tool and equipment safety precautions	**3** Be efficient during selection of cleaning medium
4. Identify cleaning types.	**4.** Arrange workplace.	**4** Being rapid.

Steps:

Discovery Activity

Task 5:

Using an appropriate methodology such as pair-share, small group discussions, guided discussions or large group discussion, ask trainees to share their prior experience in the questions provided under task 5.

Topic 2.1. Safety Precautions at Workplace

Objectives: By the end of the topic, trainees will be able to: **a.** Identify personal safety precautions, **b.** Apply personal safety precautions, **c.** Identify work area safety precautions, **d.** Apply work area safety precautions, **e.** Identify tools and equipment safety, **f.** Apply tools and equipment safety.
Time Required: 2 Hours
Learning Methodology: Small Group Work, Video, Brainstorming, Field Visit
Materials, Tools & Equipment Needed: Chalks, Papers, Curriculum, Books, PPE, Solvent, Soap, Water, Rags, Bucket, Jerry cans, Mop, white board, spray bottle, soft brushes, scrubber sponge, Broom, Marker pen, black board, Electric blower, cleaning drill brush, cleaners' corner & edge brush, Notebook, Projector, Personal Computer, dustbin and Air compressor.
Preparation: ❑ Prepare the task sheet, ❑ Prepare session plan,

- ❑ Make sure that trainee's manual is corresponding to the number of trainee,
- ❑ Gather materials according to the numbered of trainees and teaching method.

Cross Cutting Issues:

- ✓ Sensibilize gender balance within learning periods,
- ✓ Provides special aid for persons with disabilities,
- ✓ Promote inclusivity during class discussion and presentation.

Prerequisites:

- Describe cleaning technics
- Identify cleaning agents accordingly
- Demonstrate safety signs

Activity 1: Problem Solving

Task 6:

1. Using an appropriate methodology such as pair-share, small groups, large group discussion, or guided discussion, brainstorming and based on the information in the pictures, ask trainees to answer the questions under task 6 in their trainee manual. After all groups have finished discussing, they should present to the rest of the class and encourage other groups to give their contributions.

Activity 2: Guided Practice

Task 7:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, ask trainees to answer the questions provided under task 7 in their trainee manual.

   Make sure instructions are understood.

2. Using an appropriate methodology such as question and answer in a large group, pair presentations, or small group presentations, students share their answers to the class. Write their responses for reference. Encourage all students to give their views.

Activity 3: Application

Task 8:

Ask the trainees to perform safety measures for the tools and equipment that have been used as requested under task 8. The task may be individual or in small groups according to the number trainees.

Make sure instructions are understood, all the students are actively participating and necessary materials/tools are provided and being used.

Topic 2.2: Selection of PPE

Objectives: By the end of the topic, trainees will be able to: **a.** Classify PPE, **b.** Wear PPE, **c.** Maintain PPE.
Time Required: 1 Hours
Learning Methodology: Small Group Work, Video Demonstration, Brainstorming, Field Visit, Individual Work.
Materials, Tools & Equipment Needed: Curriculum, Books, PPE, Soap, Water, Bucket, solution, Solvent, Clothes rugs, white board, Electric blower, Personal Computer, dustbin and Air compressor
Preparation: ❑ Make sure that the workshop with PPE is available, ❑ Prepare the task sheet,

- ❑ Prepare session plan,
- ❑ Make sure that trainee's manual is corresponding to the number of trainees,
- ❑ Gather PPE according to the numbered of trainees and teaching method.

Cross Cutting Issues:

- ✓ Sensibilize gender balance within learning periods,
- ✓ Provides special aid for persons with disabilities,
- ✓ Apply inclusivity during class discussion and presentation.

Prerequisites:

- **Identify PPE according to their use.**

Activity 1: Problem Solving

Task 9:

Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, ask trainees to answer the questions provided under task 9 in their manuals.

Activity 2: Guided Practice

Task 10:

Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, ask trainees to answer the questions provided under task 10 in their trainee manuals.

Remember to provide special aid for trainees with disabilities.

Activity 3: Application

Task 11:

1. Using an appropriate methodology such as individual work, pairs, or small groups tell trainees to read provided situation under task 10 in their trainee manuals

2. This activity can be done during class time and/or after class. Give students more independence in doing this task.

Topic 2.3. Cleaning and Arrangement of the Workplace

Objectives: By the end of the topic, trainees will be able to:

a. Identify cleaning types.

b. Clean workplace, tools and equipment

c. Properly arrange workplace.

Time Required: 2 Hours

Learning Methodology:

Role Play, Small Group Work, Individual Work.

Materials, Tools & Equipment Needed:

Curriculum, Books, PPE, Solvent, Soap, Water, Bucket, Jerry cans, Mop, Soap solution, Solvent, Clothes rugs, spray bottle, soft brushes, scrubber sponge, Broom, Electric blower, cleaning drill brush, cleaners' corner & edge brush, Notebook, Personal Computer, dustbin and Air compressor.

Preparation:

- ❑ Prepare the task sheet,
- ❑ Prepare session plan,
- ❑ Make sure that trainee's manual is corresponding to the number of trainees,
- ❑ Gather cleaning materials according to the numbered of trainees and teaching method.

Cross Cutting Issues:

- ✓ Apply gender balance within learning periods,
- ✓ Provides special aid for persons with disabilities,
- ✓ Apply inclusivity during class discussion and presentation.

Prerequisites:

- Identify cleaning technics,
- Describe cleaning agents accordingly.

Activity 1: Problem Solving

Task 12:

Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, ask trainees to answer the questions provided under task 12 in their manuals.

Make sure instructions are understood, all the students are actively participating.

Activity 2: Guided Practice

Task 13:

Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, guide trainees to answer the questions provided under task 13 based on the situation in their trainee manuals.

Make sure instructions are understood, all the students are actively participating and encourage all students to give their views.

Activity 3: Application

Task 14:

1. Using an appropriate methodology such as individual work, pairs, or small groups ask trainees to carefully read and perform the activities under the task 14 in their manuals.

Make sure instructions are understood, all the students are actively participating and necessary materials/tools and equipment are provided and being used efficiently

2. This activity can be done during class time and/or after class. Give students more independence in doing these activities.

Formative Assessment

Q1. Choose the correct answer among the following:

An incident is notifiable if it involves:

a. The death of a person
b. Dangerous incidents that expose people to serious risk.
c. All the above
d. No one of the above

Answer: All the above

Q2. Answer by true if the statement is correct and false if the statement is incorrect

A. The following indicate the Safety measures at the Workplace:

a. No need to report Unsafe Conditions. False
b. Keep a clean workstation. True
c. Wear non-suitable protective equipment. False
d. Work the whole day without breaks to save time False
e. Don't skip steps. True

f. Stay up to date with new procedures or protocols. True
g. Maintain proper posture. True
h. Offer guidance to new employees. True

B. The following are the types of PPE according to its function.

a. For head protection we use gloves. False
b. For eyes protection safety boots are used. False
c. For respiratory protection, eye protector may be used. False
d. Hands protection we use face shield. False

Q3. Depending on its protective effects, classified PPE

Answer:

Depending on its protective effects, PPE may be classified as:

- **Partial:** aimed at protecting against hazards that are localized in specific areas or parts of the body (e.g. helmets, boots, gloves, etc.).
- **Complete:** which protects against hazards whose scope of action does not have a specific area of localization (e.g. fireproof clothing, safety belts, etc.).

Q4. Enumerate the procedures to follow for Cleaning Dirty Tools

Answer:

- ✓ Start by filling the bucket with hot water and a small amount of commercial cleaner.
- ✓ Soak your tools in the bucket for 30 seconds to a minute.
- ✓ With your wire brush, scrub the tools to remove dirt and grime.
- ✓ Rinse and repeat until all dirt have been cleared from the tool.
- ✓ Let dry atop a cloth rag. For older tools with a considerable amount of rust, you will want to take the steel wool and scrub the rust off.
- ✓ Allow time for everything to dry. It's important to make sure all of the tools are absent of moisture to prevent future rusting.
- ✓ Use your dry cloth rag and wipe down as much as possible to ensure that all water is gone.

- ✓ As a final cleaning, use a small amount of Klein's Multi-Purpose Cleaner and wipe down each tool.

Q5. List any five (5) PPE to be selected while working on engine supercharging system

Answer:

- ✓ **Head Protection**

  Examples: Head covers, cask
- ✓ **Face Protection**

  Examples**:** Face shields
- ✓ **Hand Protection**

  Examples: Gloves
- ✓ **Body Protection**

  Examples**:** High visibility hat, vest, pants, overall, overcoat
- ✓ **Feet Protection**

  Examples: Safety boot
- ✓ **Respiratory Protection**

  Examples: Mask
- ✓ **Hearing Protection**

  Examples: Eye Protector

Q6. What are the Conditions that must be fulfilled by PPE?

Answer:

1. Not suppose a hazard in itself.
2. Not be the cause of additional hazards.
3. Not produce unnecessary inconveniences.

Q7. Enumerate the procedures to follow for Cleaning Dirty equipment

Answer:

- ✓ Dismantle all the removable parts of the equipment to be cleaned.

- ✓ Adhere “To be cleaned” sticker on the equipment and transfer the removable parts to the designated washing area.
- ✓ Clean the immobile part of the equipment according to the manufacturer’s suggested cleaning procedure then fill-out the Equipment Log Book after completion.
- ✓ Reassemble all the cleaned removable parts to the cleaned equipment after assuring that every part is dried.
- ✓ Affix the signed and dated “Cleaned” sticker on the reassembled cleaned equipment. The “Cleaned” sticker must identify previous batch being processed by the equipment.
- ✓ Use the cleaned equipment within 72 hours from the date of cleaning. Wipe all product contact parts with clean lint-free cloth prior to next use.
- ✓ If the equipment is not used within 72 hours after the date of cleaning, adhere “To be cleaned” sticker on the equipment and perform cleaning procedure again before use.

Q8. List any five (5) general safety precautions to be observed in any workplace area.

Answer:

- ✓ Understand risks,
- ✓ Be aware of your surroundings at all time,
- ✓ Know where the first aid kit/officer are,
- ✓ Taking regular breaks,
- ✓ Always using equipment properly,
- ✓ Pay attention to signage,
- ✓ Know where emergency exits are,
- ✓ Keep emergency exist accessible,
- ✓ Reporting unsafe conditions,
- ✓ Wear correct safety equipment.

Self-Reflection

1. Ask learners to re-take the self-assessment at the beginning of the unit. They should then fill in the table in the Trainee's Manual to identify their areas of strength, areas for improvement and actions to take to improve.

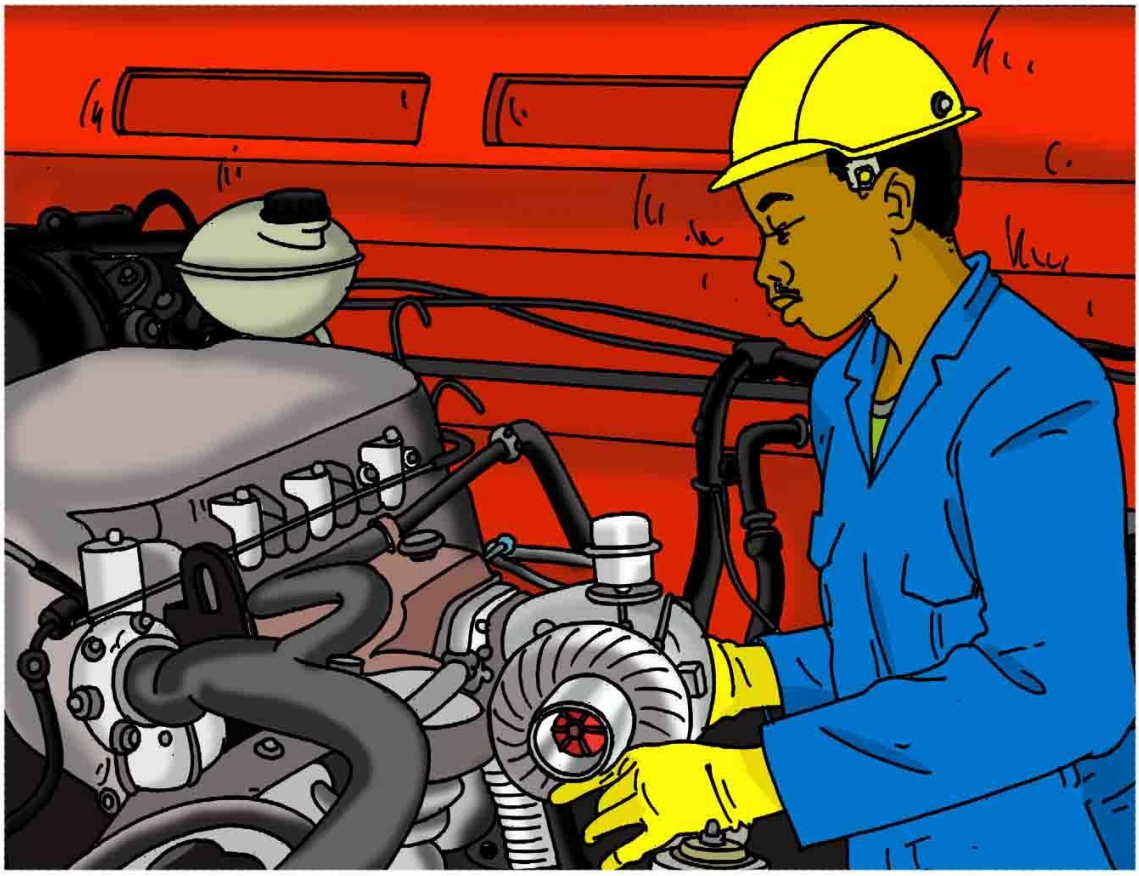
2. Discuss trainees' results with them. Identify any areas that are giving many trainees difficulties and plan to give additional support as needed (ex. use class time before you begin the next learning outcome to go through commonly identified difficult concepts).

Points to Remember

For personal safety or workplace user's safety, Safe work systems in the workplace should exist and supervised.

For the workplace Safety, the safety measures should be taken into consideration Remember that at the end of the day, tools and equipment should be cleaned and arranged for safety and next day easy work.

PPEs must be selected worn and used before each activity and accordingly. The workplace should be cleaned and arranged according to appropriate cleaning and arranging methods.



Learning outcome 1: Self-Assessment

1. Ask trainees to look at the unit Illustration in their Trainee Manuals and together discuss:
   a. What do you see in the illustration?
   b. What is happening in the illustration?
   c. What do you think will be topics to be covered under this unit based on the illustration?
2. After the discussion, inform students that this unit is intended to provide them with the knowledge, skills and attitudes to repair engine supercharging systems. They will cover identification selection of materials, tools and equipment, Diagnose, Correct and Test engine supercharging systems.

3. Ask trainees to fill out the self-assessment at the beginning of the unit in their Trainee Manuals. Explain that:
   a. The purpose of the self-assessment is to become familiar with the topics in the unit and for them to see what they know or do not know at the beginning.
   b. There is no right or wrong way to answer this assessment. It is for their own reference and self-reflection on the knowledge, skills and attitudes acquisition during the learning process.
   c. They should think about themselves: do they think they have the knowledge, skills or attitudes to do this? How well?
   d. They read the statements across the top and put a check in column that best represents their level of knowledge, skills or attitudes.
   e. At the end of the unit, they will do a self-reflection, which includes re-taking the self-assessment and identifying their strengths, areas of improvement and actions to be taken.

Key Competencies:

Knowledge	Skills	Attitudes
1. Identify materials, tools and equipment used for engine supercharging system repairing.	1. Perform engine supercharging system dismount from the engine.	1. Being organized to achieve the required results.
2. Identification of engine supercharging system.	2. Perform engine supercharging system disassembling.	2. Be patient
3. Describe procedures to dismount, disassemble, reassemble and remount of engine supercharging systems.	3. Perform engine supercharging system Reassembling.	3. Be precise

4. Differentiating different methods used to solve engine supercharging system faults.	**4.** Perform engine supercharging system remounting to the engine.	**4.** Have attention to detail
5. Outline and differentiating methods used to test engine supercharging system.	**5.** Perform engine supercharging system testing.	**5.** Be responsible

Steps:

Activity 1: Discovery

Task 15:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, ask trainees to carefully observe the image under task 15 in their manuals, read and answer the questions related to the observed image.

Make sure instructions are understood, all the students are actively participating and necessary materials/tools are given.

2. Invite students to share their answers to the class.
3. Encourage all students to give their views.
4. Introduce Topic 3.1: Selection of materials, tools and equipment

Topic 3.1. Selection of Materials, Tools and Equipment

Objectives: By the end of the topic, trainees will be able to:

a. Identify materials used to repair engine supercharging system.

b. Identify tools used to repair engine supercharging system.

c. Identify equipment used to repair engine supercharging system.

Time Required: 3 Hours

Learning Methodology:

Role Play, Small Group Work, Brainstorming, Individual Work, Large Group Discussions.

Materials, Tools & Equipment Needed:

Gaskets, bolts and nuts, turbocharger oil, seals. Spanners, bearing pulling tool, bearing pushing tool, clearance measuring instruments, screwdriver, shaft pushing tool, Impeller removing tool set, pump removing tool set, pump disc locking plate, Black board, Book, Notebook, Clothes rugs, whiteboard, Marker pen and Chalks, supercharging system components. Projector, Computer, PPE, jack, jack stands, car lift, service bay.

Preparation:

- ❑ Make copies of standards/guidelines of materials, tools and equipment selection

Cross Cutting Issues:

- ✓ Ensure gender balance while forming groups, allocating tasks and during presentations,
- ✓ Ensure inclusivity while allocating tasks to students and provide facilities/environment that enable/allows participation of all,
- ✓ Promote financial education by emphasizing the need/importance of quantifying materials, tools and equipment for engine supercharging system repairing,

- ✓ Promote standardization culture among students through realizing the need/importance of quantifying materials, tools and equipment for engine supercharging system repairing.

Prerequisites:

- Knowledge on vehicle systems,
- Safety health and environment (SHE) procedures.

Activity 1: Problem Solving

Task 16:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, ask trainees to read carefully and answer the questions under task 16 in their manuals:

Make sure instructions are understood, all the students are actively participating and necessary materials/tools are provided and being use.

2. Tell students to share their answers to the class. Write their responses for reference
3. Encourage all students to give their views.
4. After the sharing session, refer students to **Key facts 3.1.1: Identification of Materials** and discuss them together while harmonizing their responses provided in the sharing session and answer any questions they have.

Activity 2: Guided Practice

Task 17:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, under your guidance ask trainees to perform activities under task 17:

Make sure instructions are understood, all the students are actively participating and necessary materials/tools are provided and being used.

2. Using an appropriate methodology such as question and answer in a large group, pair presentations, or small group presentations, students share their answers to the class. Write their responses for reference.

Encourage all students to give their views.

3. After the sharing session, refer students to **Key facts 3.1.2: Identification of Tools & Equipment** and discuss them together while harmonizing their responses provided in the sharing session and answer any questions they have.

4. Inform students that the **key facts (3.1.1 & 3.1.2)** will be used in the next activity which requires them to use the knowledge, skills and attitude to perform the tasks given. Provide students with the guided activity in trainee's manual.

Activity 3: Application

Task 18:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, large group discussion, ask trainees to read and perform the activities under task 18 in their manuals.
2. Give students more independence in doing this task.
3. Ask the learners to present or submit their reports to you for correction/marking.

Topic 3.2. Diagnosis of Engine Supercharging System

Objectives: By the end of the topic, trainees will be able to:

a. Inspect engine supercharging system.

b. Locate faults of engine supercharging system.

Time Required: 7 Hours

Learning Methodology:

Role Play, Small Group Work, Brainstorming, Individual Work, Large Group Discussions.

Materials, Tools and Equipment Needed:

Turbocharger oil, Spanners, clearance measuring instruments, screwdriver, Book, Notebook, Clothes rugs, engine supercharging system components, Computer, PPE, jack, jack stands, car lift, service bay, Vehicle or simulator with engine supercharging system.

Preparation:

❑ Make copies of standards/guidelines for inspection of vehicle systems.

Look for user manual of the vehicle or simulator with engine supercharging system.

Cross Cutting Issues:

- ✓ Ensure gender balance while forming groups, allocating tasks and during presentations
- ✓ Ensure inclusivity while allocating tasks to students and provide facilities/environment that enable/allows participation of all.

Prerequisites:

- Knowledge on vehicle systems,
- Safety health and environment (SHE) procedures.

Activity 1: Problem Solving

Task 19:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, ask trainees to read carefully and answer the questions under task 19 in their manuals:

Make sure instructions are understood, all the students are actively participating and necessary materials/tools are provided and being used.

2. Using an appropriate methodology such as question and answer in a large group, pair presentations, or small group presentations, students share their answers to the class. Write their responses for reference.

Encourage all students to give their views.

3. After the sharing session, refer students to **Key fact 3.2.1: Inspection of Supercharging System** and discuss them together while harmonizing their responses provided in the sharing session and answer any questions they have.

Activity 2: Guided Practice

Task 20:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, guide trainees to work on the activities under task 20 as requested in their manuals.

Make sure instructions are understood, all the students are actively participating and necessary materials/tools are provided and being used.

2. Using an appropriate methodology such as question and answer in a large group, pair presentations, or small group presentations, students share their answers to the class. Write their responses for reference.

Encourage all students to give their views.

3. After the sharing session, refer students to **Key fact 3.2.1: Inspection of engine Supercharging System** and discuss them together while harmonizing their responses provided in the sharing session and answer any questions they have.

4. Inform students that the **key fact 3.2.1** will be used in the next activity which requires them to use the knowledge, skills and attitude to perform the tasks given. Provide students with the guided activity in trainee's manual.

Activity 3: Application

Task 21:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, large group discussion, ask trainees to read and perform the activities under task 21 in their manuals.

2. Make sure instructions are understood, all the students are actively participating.

3. Trainees make a written summary on a report of identified faults and key areas inspected on the engine supercharging system.

4. Give students more independence in doing this task. Students present their reports for correction/marking.

Topic 3.3. Correction of Engine Supercharging System

Objectives: By the end of this topic, trainees will be able to:

a. Dismount engine supercharging system from the engine.

b. Disassemble engine supercharging system components.

c. Apply methods for solving engine supercharging system faults.

d. Reassemble engine supercharging system components.

e. Remount engine supercharging system on the vehicle.

Time Required: 10 Hours

Learning Methodology:

Role Play, Small Group Work, Brainstorming, Individual Work, Large Group Discussions.

Materials, Tools & Equipment Needed:

Gaskets, bolts and nuts, turbocharger oil, seals. Spanners, bearing pulling tool, bearing pushing tool, clearance measuring instruments, screwdriver, shaft pushing tool, Impeller removing tool set, pump removing tool set, pump disc locking plate, Black board, Book, Repair/ Service Manuals, Notebook, Clothes rugs, engine supercharging system components. Computer, PPE, jack, jack stands, car lift, service bay.

Preparation:

❑ Make copies of standards/guidelines on engine supercharging repairing

Cross Cutting Issues:

- ✓ Ensure gender balance while forming groups, allocating tasks and during presentations,
- ✓ Ensure inclusivity while allocating tasks to students and provide facilities/environment that enable/allows participation of all,

- ✓ Promote financial education by emphasizing the need/importance of quantifying materials, tools and equipment for engine supercharging system repairing,
- ✓ Promote standardization culture among students through realizing the need/importance of quantifying materials, tools and equipment for engine supercharging system repairing.

Prerequisites:

- Knowledge on vehicle systems
- Safety health and environment (SHE) procedures
- Knowledge on the interpretation of repair manual

Activity 1: Problem Solving

Task 22:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion, ask trainees to read carefully and answer questions under task 22 as they are in manuals.

2. After the sharing session, refer students to **Key facts 3.3.1** to **3.3.5** and let them discuss while harmonizing their responses provided in the sharing session and answer any questions they have.

Activity 2: Guided Practice

Task 23:

1. With your guidance and appropriate methodology such as individual work, pair-share, small group discussions, large group discussion, ask trainees solve car's problems stated under task 23 following the recommended procedures as written in their manuals.

Make sure instructions are understood, all the students are actively participating and that all resources are properly used.

Activity 3: Application

Task 24:

Using an appropriate methodology such as individual work, pair-share, small group discussions, large group discussion, ask trainees to read the situation and perform related activities under task 24 in their manuals.

Make sure instructions are understood, all the students are actively participating in the performance activity and that are properly using the provided resources and ask trainees to make a report of activity.

Topic 3.4. Test Engine Supercharging System

	Objectives: By the end of this topic, trainees will be able to: **a.** Perform static testing of engine supercharging system. **b.** Perform Dynamic testing of engine supercharging system.
	Time Required: 5 Hours
	Learning Methodology: Small Group Work, Brainstorming, Individual Work, Large Group Discussions
	Materials, Tools & Equipment Needed: Spanners, Screw drivers, oscilloscope, scan tool, Pliers, vehicle with supercharger, simulator, Personal protective equipment (PPE), lamp tester, wires, Multi-meter, Exhaust gas analyzer
	Preparation: ❑ Make copies of standards/guidelines on engine supercharging repairing

Cross Cutting Issues:

- ✓ Ensure gender balance while forming groups, allocating tasks and during presentations
- ✓ Ensure inclusivity while allocating tasks to students and provide facilities/environment that enable/allows participation of all
- ✓ Promote financial education by emphasizing the need/importance of quantifying materials, tools and equipment for engine supercharging system repairing
- ✓ Promote standardization culture among students through realizing the need/importance of quantifying materials, tools and equipment for engine supercharging system repairing

Prerequisites:

- Knowledge on vehicle systems
- Knowledge on the interpretation of repair manual

Activity 1: Problem Solving

Task 25:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, guided discussions or large group discussion ask trainees to observe carefully the picture under task 25 and answer questions that follows.

   Make sure instructions are understood, all the students are actively participating in the activity.
2. After the sharing session, refer students to **Key fact 3.4.1** and let them discuss while harmonizing their responses provided in the sharing session and answer any questions they have.

Activity 2: Guided Practice

Task 26:

1. By using appropriate methodology such as individual work, pair-share, small group discussions, large group discussion. Guide trainees to solve car's problems stated under task 26 following the right procedures.

   Make sure instructions are understood, all the students are actively participating and that all resources are properly used.

Activity 3: Application

Task 27:

1. Using an appropriate methodology such as individual work, pair-share, small group discussions, large group discussion, ask trainees to read the situation and perform related activities under task 27 in their manuals

   Make sure instructions are understood, all the students are actively participating in the performance activity and that are properly using the provided resources and ask trainees to make a report of activity.

Formative Assessment

1. **Give three name and function of tools used in engine supercharging system**

ANSWER:

- ✓ **Pliers:** are hand engine tools that you use to grip and hold objects.
- ✓ **Wrench set:** are used for gripping, fastening, turning, tightening and loosening things like pipes, pipe fittings, nuts and bolts

- ✓ **Socket & Ratchet Set:** is a collection of sockets that fit onto a ratchet, which is a hand-held tool that can be turned in either direction to loosen or tighten bolts and nuts
- ✓ **Breaker Bar:** is used to provide extra leverage when loosening or tightening bolts and nuts
- ✓ **Screwdrivers:** As the name suggests, screwdrivers are used to tighten or loosen screws

2. List 5 equipment used in engine supercharging system and describes their function

ANSWER:

- ✓ **Car lifter:** are used in garages for increasing the parking space and for easily performing car maintenance and servicing
- ✓ **Hydraulic Jack:** These car engine tools repairs help you to lift your vehicle so that you can work on it more easily
- ✓ **Jack Stands:** is a metal height-adjustable mechanical device that is used to support the weight of a lifted vehicle. Most commonly, they are placed underneath the car as a safety net to protect against a vehicle falling on a body part
- ✓ **Engine Stand:** stand is a tool commonly used to repair large heavy gasoline or diesel engines
- ✓ **Engine crane:** is a common repair tool used in vehicle repair shops to remove or install gasoline or diesel engines in small and crowded vehicle engine compartments

3. Name the following images

	**Exhaust Manifold**
	**Air Cleaner Housing**
	**Nozzle Ring**

	**Impact Wrench**

4. What are the common faults of engine supercharging system?

ANSWER:

- ✓ Air filter blockage
- ✓ Compressor fouled
- ✓ Cooler tube and air side fouled
- ✓ Turbine fouled

5. Explain the following terms

a. Gear Whine

b. Growling

ANSWER:

A: Worn gears. Rare, regardless of the mileage, unless run low on the oil or out of oil. The Supercharger must be rebuilt. Gear shavings will damage seals.

B: Debris in the rotor or slight rotor to cause contact. It will never be a burden. Rebuild supercharger if case and rotor are useable

6. What is the process to disassemble the engine supercharging system components?

ANSWER:

- ✓ Prepare Workplace
- ✓ Select materials, tools and equipment
- ✓ Review the service manual
- ✓ Remove waste gate turbocharger by unscrewing nuts on hot and cold sides of turbocharger
- ✓ Remove V-band clamp
- ✓ Separate Cartridge from exhaust side of turbocharger (If stuck, carefully use penetrating fluid and hummer for separation)
- ✓ Separate Cartridge from cold side of turbocharger (If stuck, carefully use penetrating fluid and hummer for separation)

- ✓ Take out compressor wheel from the casing
- ✓ Take out turbine wheel and intermediate shaft from the casing
- ✓ Separate turbine wheel from intermediate shaft
- ✓ Take off the seal plate assembly
- ✓ Use 2 screwdrivers to equally pry the center's trust surface out
- ✓ Peel O-rings off
- ✓ Take out thrust washers
- ✓ Take back plate off from the casing

7. List the process to perform static and dynamic testing and of engine supercharging system

ANSWER:

- **Performing a Static Engine Supercharging system Test**

  - ✓ **Preparation:**

    Make sure the engine is in good working condition and properly maintained.

    Check and calibrate all instruments and sensors to ensure accurate data acquisition.

    Verify that the engine supercharger system is properly installed and functioning correctly.

  - ✓ **Data Acquisition:**

    Set up data acquisition systems to record relevant parameters such as RPM, boost pressure, intake air temperature, exhaust gas temperature, fuel flow rate, and any other critical engine parameters.

    Ensure that all sensors are connected correctly and their readings are displayed in real-time.

  - ✓ **Engine Warm-up:**

    Start the engine and let it warm up to its normal operating temperature. This helps stabilize the engine performance during the test.

- ✓ **Baseline Measurement:**

  Conduct a baseline measurement without supercharging to establish the engine's performance under normal conditions.

- ✓ **Supercharger Setup**

  Activate the supercharger system and set it to provide the desired boost pressure. The boost pressure can be adjusted based on the engine's specifications and test objectives.

- ✓ **Test Procedure:**

  Gradually increase the engine RPM while monitoring the boost pressure and other relevant parameters.

  Record data at various RPM points to create a performance map.

  Repeat the test for different boost pressure settings to understand how the engine responds to various levels of supercharging.

- ✓ **Data Analysis:**

  After completing the test, analyze the recorded data to evaluate the engine's performance under different supercharging conditions.

  Look for changes in power output, torque, and other relevant parameters as the boost pressure varies.

- ✓ **Validation:**

  Compare the results with the engine manufacturer's specifications and performance charts to ensure everything is within the acceptable range.

  Verify that the supercharger system is operating efficiently and effectively.

- ✓ **Post-Test Procedures:**

  Shut down the engine and supercharger system following the manufacturer's guidelines.

  Review the data and documentation to ensure accuracy and completeness.

- **Performing a Dynamic Engine Supercharging system g Test**

✓ **Safety Precautions:**

Ensure that the vehicle is in good working condition, and all safety features are operational.

Wear appropriate personal protective equipment (PPE), including safety glasses and ear protection.

Make sure the test area is clear of obstacles, and bystanders are at a safe distance.

✓ **Pre-Test Preparation:**

Confirm that the supercharging system is correctly installed and connected to the engine.

Check the supercharger for any leaks, damages, or loose fittings.

Verify that the engine is in proper working condition with all maintenance up to date.

✓ **Instrumentation Setup:**

Connect data logging equipment to monitor critical engine parameters such as RPM, boost pressure, air-fuel ratio, temperature, etc.

Attach pressure sensors to measure the supercharger boost pressure accurately.

Set up a means of monitoring engine performance in real-time.

✓ **Warm-Up the Engine:**

Start the engine and let it warm up to its operating temperature.

✓ **Baseline Run:**

Conduct a baseline run without engaging the supercharger. This run will serve as a reference for later comparisons.

✓ **Supercharger Engagement:**

Engage the supercharger system according to the manufacturer's recommendations.

Gradually increase the engine RPM while monitoring the boost pressure and other relevant parameters.

- ✓ **Data Collection:**

  Log and record all data during the dynamic test, including RPM, boost pressure, air-fuel ratio, temperature, and any other relevant parameters.

- ✓ **Performance Evaluation:**

  Analyze the data to assess the performance of the supercharger system. Look for changes in power output, boost efficiency, and any issues that may have arisen during the test.

- ✓ **Cool Down:**

  After completing the test, allow the engine to cool down before performing any further inspections or adjustments.

- ✓ **Post-Test Analysis:**

  Review the data collected during the test to understand the engine supercharger system's behavior and performance.

  Compare the results with the baseline run to gauge the effectiveness of the supercharging system.

- ✓ **Address Issues:**

If any problems or anomalies are identified during the test, address them accordingly. This may involve adjusting the supercharger system or performing maintenance on the engine engine

Summative Assessment

Ask trainees to read the integrated situation in their manuals and perform the stated related tasks:

KAREKEZI is a driver of RUHENGERI referral hospital located in Musanze District. He brought the car Toyota LANDCRUISER (TXL) with Turbocharger at UMUKOZI Garage located in MUSANZE District, MUHOZA sector for repairing. He told to the head of garage that the car has the following problem: the lack of engine power, blue smoke, consumption of turbocharger oil, and abnormal noise. As an automotive engine mechanic, the head of garage requested you to solve the above-mentioned problems within 6 hours.

Tell trainees that they are allowed to request any other materials, tools and equipment they may need apart the shared list in their manuals.

Tools	Wrenches and Sockets, Torque Wrench, Screwdrivers, Pliers, Allen Wrenches/Hex Keys, Socket Set, Belt Tension Gauge, Diagnostic Tools, Multi-Meter, Hoist or Jack Stands, Lamp Tester, Electric Blower, Scriber
Equipment	Maintenance and Repair Manuals, Vehicle with Supercharger, Simulator, Personal Protective Equipment (PPE), Curriculum, Books, White Board, Black Board, Projector, Personal Computer, Air Compressor.
Materials/ Consumables	Gaskets, Seals, Bearings, Belts, And Other Supercharging System Components, Bolts and Nuts, Rags, Wire Brushes, Chalks, Papers, Solvent, Wires, Soap, Water, Bucket, Jerry Cans, Mop, Spray Bottle, Soft Brushes, Scrubber Sponge, Broom, Marker Pen, Cleaning Drill Brush, Cleaners' Corner & Edge Brush, Notebook, Dustbin.

CHECKLIST

Criteria	Indicators and Elements of Verification		Score	
Criteria 1: **Quality of Process /30Marks**	**Indicator 1: Tools, Materials and Equipment are selected**		Yes (Y)	No (N)
	Tools			
	Element 1	Spanners		
	Element 2	Screw Drivers		
	Element 3	Pliers		
	Element 4	Allen Keys		
	Element 5	Diagnostic Tools		
	Element 6	Multi-meter		
	Element 7	Lamp Tester		
	Materials			
	Element 1	Gaskets and Seals		
	Element 2	Bolts and Nuts		
	Element 3	Rags		
	Element 4	Belts		
	Element 5	Brushes		
	Element 6	Solvent/Soap		
	Equipment			
	Element 1	Personal Protective Equipment (PPE)		
	Element 2	Vehicle with Supercharger		
	Element 3	Repair Manual		
	Element 4	Air Compressor		
	Indicator 2: Engine Supercharging systems are properly identified			
	Element 1	Engine Supercharging systems types are properly identified		

	Indicator 3: Supercharging system components are properly identified			
	Element 1	Dynamic engine supercharging system types components are properly identified.		
	Element 2	Independent engine supercharging system types components are properly identified.		
Criteria 2: **Quality of Product / 30Marks**	**Indicator 1: Engine supercharging system is properly inspected**			
	Element1	Dynamic engine supercharging system is properly inspected.		
	Element2	Independent engine supercharging system is properly inspected.		
	Indicator 2: Engine supercharging system is completely dismounted			
	Element 1	Dynamic supercharging system is properly is dismounted.		
	Element 2	Independent engine supercharging system is properly dismounted.		
	Indicator 3: Engine supercharging system components are completely disassembled			
	Element 1	Dynamic engine supercharging system types is disassembled.		
	Element 2	Independent engine supercharging system types is disassembled.		
	Indicator 4: Damaged engine supercharging system components are correctly repaired			
	Element 1	Engine engine supercharging system components are properly inspected after disassembling.		
	Element 2	Dynamic engine supercharging system types is repaired.		
	Element 2	Independent engine supercharging system types is repaired.		
	Indicator 5: Engine supercharging system components are methodically reassembled			

	Element 1	Dynamic engine supercharging system types is reassembled.		
	Element 2	Independent engine supercharging system types is reassembled.		
	Indicator 6: Engine supercharging system is properly re-mounted			
	Element 1	Dynamic engine supercharging system is properly is remounted.		
	Element 2	Independent engine supercharging system is properly remounted.		
	Indicator 7: Engine supercharging system performance is correctly tested			
	Element 1	Static testing is carried out.		
	Element 2	Dynamic testing carried out.		
Criteria 3: Relevance /10Marks	**Indicator 1: Time is respected**			
	Element 1	Time (3 hours) is respected.		
	Indicator 2: Respecting instructions			
	Element 1	All given instructions are well followed accordingly.		
	Element 2	Tools ,materials and equipment are well arranged and used accordingly.		
	Indicator 3: Hazard control and health measurement			
	Element 1	No hazard at workplace		
	Element 2	Environment is well protected		
Criteria 4: Safety /10Marks	**Indicator 1: Person and work done are safe**			
	Element 1	Personal Protective Equipment are used.		
	Element 2	No materials are wasted		
	Element 3	Environment is protected		
	Element 4	No hazardous created		
	Element 5	Workplace is well ventilated		

Criteria 5: Safety **Hygiene and Sanitation** **/10Marks**	**Indicator 1: The Working area is well cleaned**			
	Element 1	Workplace is cleaned at the beginning and at the end of the task		
	Indicator 2: Tools and Equipment are well cleaned and maintained			
	Element 1	Tools and equipment used are cleaned before the work		
	Element 2	Tools and equipment used are cleaned after the work		
	Element 3	Tools and equipment are well stored at the convenient place.		
	Element 4	No materials wasted		
Total marks			**100**	
Percentage Weightage			**100%**	
Minimum Passing line % (Aggregate): 70%				

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December, 2023