

COMPETENCY STANDARDS

HYBRID ELECTRIC VEHICLES HIGH VOLTAGE SYSTEM SERVICING



TECHNICAL EDUCATION AND SKILLS DEVELOPMENT AUTHORITY

East Service Road, South Luzon Expressway (SLEX), Taguig City, Metro Manila

*Technical Education and Skills Development Act of 1994
(Republic Act No. 7796)*

Section 22, “Establishment and Administration of the National Trade Skills Standards” of the RA 7796 known as the TESDA Act mandates TESDA to establish national occupational skill standards. The Authority shall develop and implement a certification and accreditation program in which private industry groups and trade associations are accredited to conduct approved trade tests, and the local government units to promote such trade testing activities in their respective areas in accordance with the guidelines to be set by the Authority.

@ 2024 by Technical Education and Skills Development Authority

All rights reserved. Any part of this publication may be used and reproduced, provided proper acknowledgement is made.

The Competency Standards (CS) serve as the basis for the development of:

- 1 Competency-Based Curriculum
- 2 Micro-Credential
- 3 Institutional Assessment Instruments

The CS has two sections:

Section 1 **Definition** describes and defines the competencies that comprise the of Competency Standards.

Section 2 **Competency Standards** gives the specifications of competencies required for effective work performance.

TABLE OF CONTENTS

HYBRID ELECTRIC VEHICLES HIGH VOLTAGE SYSTEM SERVICING

	Page No.
SECTION 1 DEFINITION	1
SECTION 2 COMPETENCY STANDARDS	2 - 13
GLOSSARY OF TERMS	13 – 15
ACKNOWLEDGEMENTS	16 - 18

COMPETENCY STANDARDS FOR HYBRID ELECTRIC VEHICLES HIGH-VOLTAGE SYSTEM SERVICING

SECTION 1 DEFINITION

The **HYBRID ELECTRIC VEHICLES HIGH-VOLTAGE SYSTEM SERVICING** competency standards consist of competencies required that a person must apply to safely service the high-voltage system of hybrid electric vehicles (HEVs) and plug-in hybrid electric vehicles (PHEVs).

The Core Competency comprising this Competency Standards:

UNIT CODE	UNIT TITLE
CS-ALT311501	Service High Voltage System of Hybrid Electric Vehicles

SECTION 2 COMPETENCY STANDARDS

This section gives the details of the contents of the units of competency required in **HYBRID ELECTRIC VEHICLES HIGH VOLTAGE SYSTEM SERVICING**.

CORE COMPETENCIES

UNIT OF COMPETENCY : **SERVICE HIGH-VOLTAGE SYSTEMS OF HYBRID ELECTRIC VEHICLES**

UNIT DESCRIPTOR : This unit covers the skills, knowledge, and attitudes required to service and maintain electrical components in hybrid electric vehicles (HEVs) and plug-in hybrid electric vehicles (PHEVs). It involves working with the automotive high-voltage system that supports the control and operation of the vehicle.

ELEMENT	PERFORMANCE CRITERIA <i>Italicized terms</i> are elaborated in the Range of Variables	REQUIRED KNOWLEDGE	REQUIRED SKILLS
1. Prepare for Service Operations	1.1 Safety practices are applied following OSHS. 1.2 Job requirements are determined from workplace instructions. 1.3 Diagnosis information is sourced and interpreted according to workplace procedures. 1.4 Hazards associated with the work are identified and risks are managed following industry criteria 1.5 Tools and equipment are selected and checked for serviceability according to industry criteria.	1.1 Overview of Hybrid Vehicles 1.2 Definition of Hybrid Vehicles 1.3 Purpose of Hybrid Vehicles 1.4 Types of Hybrid Vehicles 1.5 Safety Knowledge of Hybrid Vehicles 1.6 Overview and Understanding of the following: 1.6.1 Republic Act No. 11697 – Electric Vehicle Industry Development Act (EVIDA Law)	1.1 Interpreting job requirements from workplace instructions 1.2 Clarifying instructions 1.3 Locating appropriate sources of information 1.4 Selecting and checking tools and equipment 1.5 Reporting defective tools and equipment 1.6 Preparing of supplies and materials 1.7 Applying safety practices

	1.6 Defective tools and equipment are reported following workplace procedures.	1.6.2 Implementing Rules and Regulation of Republic Act 11697	
2. Deactivate the High Voltage system according to Standard operating procedure.	<p>2.1 The HV system is deactivated using authorized isolation procedures and following manufacturer instructions.</p> <p>2.2 The absence of voltage is verified using appropriate high voltage testers and following lockout/tagout procedures.</p> <p>2.3 Additional safety measures are implemented such as grounding and blocking high voltage components in accordance with manufacturer procedures.</p>	<p>2.1 Working principle of HEV and PHEV main parts</p> <p>2.2 Construction and function of high-voltage battery</p> <p>2.3 Required Diagnostic and HV measuring tools.</p> <p>2.4 Construction and Function of Electric Motor</p> <p>2.5 Construction and function of DC-AC Inverter</p> <p>2.6 Mensuration</p> <p>2.7 Construction and Function of DC-DC Converter</p> <p>2.8 Construction and function of PCU (Power Control Unit)/PDU (Power Distribution Unit)</p> <p>2.9 Construction and Function of Contactor</p> <p>2.10 Construction and function of high-voltage fuse</p> <p>2.11 Construction and function of junction boards</p>	<p>2.1 Analyzing diagnostic symptoms</p> <p>2.2 Interpreting information from manufacturer and workshop</p> <p>2.3 Using of the required Diagnostic and HV measuring tools.</p> <p>2.4 Interpreting and comparing diagnostic data using troubleshooting guide and manufacturer's manual</p> <p>2.5 Diagnosing electrical system of HEVs and PHEVs</p> <p>2.6 Reporting inspection findings, recommendations, and repair instructions</p> <p>2.7 Applying safety practices</p> <p>2.8 Mensuration skills</p>

		<p>2.12 Construction and function of current sensor</p> <p>2.13 Construction and Function of Thermistor</p> <p>2.14 Power control method</p> <p>2.15 Manufacturer diagnostics process</p> <p>2.16 High-voltage system work regulation</p> <p>2.17 Reading electrical/electronic schematic diagram</p>	2.9 Applying arithmetic operations
--	--	---	------------------------------------

<p>3. Service and Maintain the High Voltage System</p>	<p>3.1 Visual inspections are conducted of HV components for signs of damage, corrosion, or other potential defects in accordance with organizational procedures</p> <p>3.2 Specific service and maintenance tasks are performed on HV components based on the manufacturer’s manual</p> <p>3.3 Proper tightening of all electrical connections is ensured based on manufacturer specifications.</p> <p>3.4 All service and maintenance activities are documented in accordance with organizational procedures.</p>	<p>3.1 Key characteristics of HV battery charger and direct current (DC) to DC converter</p> <p>3.2 Operating principles of power distribution unit (PDU)</p> <p>3.3 Diagnostic procedures for HEVs and PHEVs electrical components.</p> <p>3.4 Identification and function of HEVs and PHEVs electrical components</p> <p>3.5 Overview of Electric Vehicle Charging Station and Portable Charger</p> <p>3.6 Function and Operation Hybrid EV Charger according to manufacturer</p> <p>3.7 Mensuration</p> <p>3.8 Arithmetic operations</p> <p>3.9 Use of measuring devices</p> <p>3.10 Reporting procedures</p> <p>3.11 OSHS</p> <p>3.12 Wearing of PPEs</p>	<p>3.1 Analyze diagnostic problems whether symptom or DTC related</p> <p>3.2 Follow the symptom troubleshooting guide from the manufacturer’s service manual</p> <p>3.3 Understand Advance Diagnostics information from the manufacturer’s service manual</p> <p>3.4 Locate and follow the DTC (Diagnostic Trouble Codes) troubleshooting guide from the manufacturer’s service manual</p> <p>3.5 Utilize electrical measuring tools</p> <p>3.6 Conduct available voltage measurement</p> <p>3.7 Conduct a megger test (insulation resistance testing).</p> <p>3.8 Conduct equipotential bonding test.</p>
--	---	---	--

		3.13 Industry criteria	3.9 Conduct data analysis from diagnostic system equipment 3.10 Conduct final judgment of diagnosis result
4. Activate the High Voltage system according to Standard operating procedure	4.1 The proper operation of the HV system is carefully re-energized and verified following manufacturer procedures. 4.2 Diagnostic tests are performed to ensure the HV system is functioning correctly in accordance with the manufacturer's specified parameters. 4.3 All lockout/tagout procedures are cleared and temporary safety measures implemented during service are removed in accordance with organizational procedures.	4.1 Key characteristics of HV battery charger and direct current (DC) to DC converter 4.2 Operating principles of power distribution unit (PDU) 4.3 Diagnostic procedures for HEVs and PHEVs electrical components. 4.4 Identification and function of HEVs and PHEVs electrical components 4.5 Mensuration 4.6 Arithmetic operations 4.7 Use of measuring devices 4.8 Reporting procedures 4.9 OSHS 4.10 Wearing of PPEs 4.11 Industry criteria	4.1 Analyzing diagnostic symptoms 4.2 Interpreting information from manufacturer and workshop 4.3 Interpreting and comparing diagnostic data using troubleshooting guide and manufacturer's manual 4.4 Diagnosing electrical system of HEVs and PHEVs 4.5 Reporting inspection findings, recommendations, and repair instructions 4.6 Applying Safety Practices 4.7 Mensuration skills 4.8 Applying arithmetic operations

<p>5. Complete work processes</p>	<p>4.1 Final inspection is conducted based on workplace procedure.</p> <p>4.2 Vehicle is turned over to immediate superior for quality control following workplace procedure.</p> <p>4.3 The work area is restored following 5S of good housekeeping.</p> <p>4.4 Wastes are managed following environmental rules and regulations.</p> <p>4.5 Tools and equipment are checked and stored according to workplace procedures.</p> <p>4.6 Workplace documents are accomplished according to workplace procedures.</p>	<p>4.1 Final inspection procedure: 4.1.1 Visual inspection 4.1.2 Checking of tightening of torque</p> <p>4.2 Turn-over of vehicle</p> <p>4.3 Accomplishment of the repair order and other forms</p> <p>4.4 OSHS</p> <p>4.5 Wearing of PPEs</p> <p>4.6 3Rs</p> <p>4.7 5S of Good Housekeeping</p> <p>4.8 Waste management</p> <p>4.9 Checking and storage of tools and equipment</p> <p>4.10 Workplace documents</p>	<p>4.1 Filling out workplace documentation</p> <p>4.2 Conducting final inspection</p> <p>4.3 Performing vehicle turn-over</p> <p>4.4 Restoring work area</p> <p>4.5 Managing wastes</p> <p>4.6 Checking and storing tools and equipment</p> <p>4.7 Wearing of PPEs</p> <p>4.8 Applying Safety Practices</p>
-----------------------------------	---	---	---

RANGE OF VARIABLES

VARIABLE	RANGE
1. Job Requirements	Job requirements may include: <ul style="list-style-type: none"> 1.1 Diagnosis of HEVs and PHEVs High-Voltage System 1.2 Replacement of traction motor 1.3 Replacement of generator 1.4 Replacement of PCU 1.5 Replacement of high-voltage system main parts 1.6 Available voltage measurement 1.7 Conduct a megger test. (Insulation resistance test). <i>Megohmmeter test.</i> 1.8 Conduct equipotential bonding test. <i>Milliohm meter test.</i> 1.9 Diagnostic system data analysis 1.10 Removal and installation of the high-voltage system main parts
2. Industry criteria	Industry criteria may include: <ul style="list-style-type: none"> 2.1 Repair Manual 2.2 Workplace procedures 2.3 Safety and environmental requirements 2.4 Service history 2.5 Work Regulations
3. Tools and equipment	Tools and equipment may include: <ul style="list-style-type: none"> 3.1 Tools: <ul style="list-style-type: none"> 3.1.1 Standard technician hand tools 3.1.2 Insulated tools 3.1.3 Standard technician hand tools 3.1.4 Lock-Out Tag-Out tools 3.1.5 Soldering kit 3.1.6 Trouble light 3.2 Equipment: <ul style="list-style-type: none"> 3.2.1 Lifter 3.2.2 Battery Charger 3.2.3 Insulation Tester 3.2.4 Milliohmmeter 3.2.5 Scan Tools (can connect to a diagnostic laptop computer) 3.2.6 Diagnostic laptop computer
4. HV components	HV Components may include: <ul style="list-style-type: none"> 4.1 Traction Battery Pack 4.2 Electric Motor 4.3 Inverter 4.4 DC-DC Converter 4.5 High Voltage Wiring Harness 4.6 Battery Management System (BMS)

<p>5. Service and maintenance</p>	<p>Repair of the electrical system may include:</p> <ul style="list-style-type: none"> 5.1 Removal and installation of related HEV/PHEV high-voltage system main parts 5.2 Diagnosis of related HEV/PHEV high-voltage system 5.3 Removal and installation of related HEV/PHEV high-voltage system components 5.4 Replacing HV batteries or modules. 5.5 Repairing or replacing HV cables and connectors. 5.6 Cleaning and inspecting HV contacts and terminals. 5.7 Performing high voltage leakage tests.
<p>6. Workplace documents</p>	<p>Workplace documents may include:</p> <ul style="list-style-type: none"> 6.1 Repair order 6.2 Inspection form 6.3 Diagnostic form 6.4 Diagnostic Timeline Report

EVIDENCE GUIDE

<p>1. Critical aspects of competency</p>	<p>Assessment requires evidence that the candidate:</p> <ul style="list-style-type: none"> 1.1 Safely serviced the HEV/PHEV high-voltage system 1.2 Safely rectified the problem related to the HEV/PHEV high-voltage system 1.3 Other damage was not created to the high-voltage system 1.4 Conducted final inspection to confirm restored functionality of the high-voltage system 1.5 Conducted 5S to workstations
<p>2. Resource implications</p>	<p>The following resources should be provided:</p> <ul style="list-style-type: none"> 2.1 Actual or simulated workplace 2.2 Tools, materials, and equipment needed to perform the required task 2.3 References and Manuals 2.4 PPEs 2.5 Training vehicle 2.6 First Aid Kit
<p>3. Method of assessment</p>	<p>Competency in this unit shall be assessed through:</p> <ul style="list-style-type: none"> 3.1 Demonstration/Observation with Oral Questioning 3.2 Written Test
<p>4. Context for assessment</p>	<ul style="list-style-type: none"> 4.1 Competency may be assessed in an actual workplace or at the designated TESDA-accredited Assessment Center

GLOSSARY OF TERMS

Adjustment	A small alteration or movement made to achieve a desired fit, appearance, or result.
Diagnose	Identify the nature of the problem by inspection of the symptoms.
Diagnostic symptoms	A physical manifestation that is regarded as indicating a condition of malfunction.
Evaluation of components	The making of a judgment about the condition of a part/component.
Final inspection	Includes road testing, oil leakage, functionality, etc.
HEV (Hybrid Electric Vehicle)	A traditional hybrid electric vehicle that runs a petrol engine that charges a battery that drives an electric drivetrain. It cannot be plugged in.
Maintenance	The regular or periodic maintenance servicing of vehicles to keep them in top condition.
Out of standard	Worn-out, unserviceable components, not conforming to manufacturer's standard.
Overhaul	Take apart a major automobile component to examine it and repair/replace a part if necessary to bring back the major component of working conditions.
PHEV (Plugin Hybrid Electric Vehicle)	It is a plug-in hybrid electric vehicle. It has petrol and an electric drivetrain.
Repair	Fix or return to working condition a part/component. It refers to cleaning, adjustment, and replacement.
Service	The act of rendering maintenance service and repair/replacement of parts of an automobile to keep it in top condition.

ACKNOWLEDGEMENTS

The Technical Education and Skills Development Authority (TESDA) would like to extend thanks and appreciation to the representatives of industry, academe, and government agencies who provided their time and expertise to the development and evaluation of the Competency Standard.

INDUSTRY EXPERTS/VALIDATORS

NAME	COMPANY	POSITION/ DESIGNATION
Mr. Frankhil Ramos	Don Bosco Technical Institute - Makati	Automotive Trainer
Mr. Jeffrey B. Andrada	Don Bosco Technical Institute - Makati	Automotive Trainer
Mr. Marlon Padoan	Honda Cars Philippines Inc.	Technical Training Specialist
Mr. Ashley Lapastora	Toyota Motor Philippines – School of Technology	Technical Trainer
Mr. Apolinar Rampola	Toyota Motor Philippines – School of Technology	Technical Trainer
Mr. Gener Vergara	Toyota Motor Philippines – School of Technology	Technical Trainer
Mr. Johnel G. Nazareno	ITE College West-Singapore	Automotive Engineering Lecturer
Mr. Jesus R. Boces Jr.	Autohub Group/ Autohub Institute of Technology	Assistant Vice President – After Sales Support/ School Administrator
Mr. Johmel O. Peniero	Autohub Institute of Technology	Technical Trainer
Mr. Nelson Crucis Jr.	Autohub Institute of Technology	Head Trainer
Mr. Richard A. Pangan	R-Tech Auto Care Center	Owner/ Technician
Mr. Marco B. Cantalejo	Mitsubishi Motors Philippines Corporation	Supervisor
Mr. Undrico D. Corpuz	APTi (Automotive Professionals and technician Inc.)/ Lyceum Alabang	Vice President/ Trainer-Assessor
Mr. Allen R. Rufo	VSO Group	Chief Technology Officer
Mr. Christopher H. Suarez	Pampanga Manpower Training Center	Trainer/ Assessor
Mr. Charlie Rham A. Posadas	Administrator	University of Pangasinan

Mr. Roderick B. Laurena	RJ Ilocandia Technical and Vocational School	School Administrator
Mr. Mike E. Joaquin II	Davao Institute of Technical Education, Inc. (DITE)	School Administrator
Mr. Constantino B. Panes	Regional Training Center – KorPhil Davao	Center Administrator
Mr. Allen Glen G. Malaluan	Bondoc Peninsula Technological Institute (BPTI)	Instructor
Mr. Joel Dominador C. Canapi	Regional Training Center - Tuguegarao	Senior TESD Specialist
Mr. Elpidio R. Tuboro	Cabugao School of Handicraft and Cottage Industries	Vocational School Administrator III
Mr. Marjon L. Duayao	Regional Training Center - Iligan	ATS and MSES Trainer
Mr. Jovert M. Cabaces	Regional Training Center - Batangas	Supervising TESDS
Mr. Alexander T. Aguilar	Provincial Training Center - Tarlac	Trainer
Mr. Angelo L. Manalili	Wangan National Agricultural School	Trainer
Mr. Roland D. Lopina	Zamboanga Sibugay Polytechnic Institute	Trainer
Mr. Michael M. Neo	Regional Training Center - Pili	Senior TESD Specialist
Mr. Edgardo T. Galicia	Wangan National Agricultural School	Assistant Professor I
Mr. Eduardo C. Lagayan Jr.	Southern Isabela College of Arts and Trades	Instructor I
Mr. Edgar Allan M. Abrea	Davao Oriental Polytechnic Institute	Trainer
Mr. Edgar Martin R. Salcedo	Simeon Suan Vocational and Technical College	Trainer
Mr. Marnilo S. Sugano	Davao National Agricultural School	Instructor III

The MANAGEMENT and STAFF of the TESDA Secretariat

Qualifications and Standards Office (QSO)

- **DIR. EL CID H. CASTILLO**, Executive Director
- **MS. MERCEDES E. JAVIER**, Division Chief
- **MR. VENZEL Y. CONCOLES**, Supervising TESD Specialist