

Electric Vehicle Terminology

Foreword—This document is an ongoing effort to provide the technical community with the terminology used most frequently in the emerging Electric Vehicle industry.

1. **Scope**—This SAE Information Report contains definitions for electric vehicle terminology. It is intended that this document be a resource for those writing other electric vehicle documents, specifications, standards, or recommended practices. Hybrid electric vehicle terminology will be covered in future revisions of this document or as a separate document.

1.1 **Purpose**—The purpose of this document is to provide a record of commonly used terminology established by the technical community involved with writing practices and information reports for electric vehicles.

1.2 **Field of Application**—This SAE Information Report pertains to electric vehicles.

1.3 **Product Classification**—Information Report.

1.4 **Product Description**—Information Report containing commonly used terminology in the electric vehicle industry.

2. References

2.1 **Applicable Publications**—The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest version of SAE publications shall apply.

2.1.1 **NFPA PUBLICATION**—Available from the National Fluid Power Association, 3333 North Mayfair Road, Milwaukee, WI 53222-3219, web site: www.nfpa.org.

NFPA 30—Flammable and Combustible Liquids Code

2.1.2 **FEDERAL PUBLICATION**—Available from The Government Printing Office, web site: www.access.gpo.gov/nara/cfr.

40 CFR paragraph 86.115-78—Control of emissions from new and in-use highway vehicles and engines

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SAE J1715 Revised JUN2000

2.2 Related Publications—The following publications are provided for information purposes only and are not a required part of this document.

2.2.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J670e—Vehicle Dynamics Terminology, latest revision

2.2.2 INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS—Available from IEEE, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331.

ANSI/IEEE 100—Standard Dictionary of Electrical and Electronic Terms, latest revision

2.2.3 JAPANESE ELECTRIC VEHICLE SOCIETY—Available from Japanese Electric Vehicle Association, web site: evinfo@gw.jeva.or.jp.

JEVS Z 805—Glossary of Terms Relating to Electric Vehicles, latest revision

2.2.4 NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY (NIST)—Internet Address - physics.nist.gov.

For definitions of SI units of measurement - mass, EMF, current, power, etc.

2.2.5 NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION—Available from The Government Printing Office, web site: www.access.gpo.gov/mara/cfr..

49 CFR Ch V, Section 571—Federal Motor Vehicle Safety Standards

2.2.6 SAND PUBLICATION—Available from Sandia National Laboratories, Albuquerque, NM 87185.

SAND88-2852 * UC-212—Glossary of Testing Terminology for Rechargeable Batteries, latest revision

2.2.7 USABC PUBLICATION—Available from USCAR, web site: www.uscar.org/consortia/con-usabc.htm.

USABC TEST PROCEDURES MANUAL, LATEST REVISION

3. Definitions—Electric Vehicle Terminology

3.1 Active Material—The constituents of a cell that participate in electrochemical charge/discharge reactions. This does not include separators, current collectors, catalysts or supports.

3.2 Adequate Ventilation—As defined in NFPA 30, ventilation is adequate if it is sufficient to prevent accumulation of hydrogen vapor-air mixtures in concentrations over one-fourth of the lower flammability limit.

3.3 Air Clearance—The shortest distance through air between two conductive parts.

3.4 Aqueous Electrolyte Batteries—Batteries with water-based electrolytes.

3.5 Available or Deliverable Capacity—The total ampere-hours that can be withdrawn from a fully charged cell or battery under specified operating conditions such as discharge rate, temperature, age, stand time, etc..

3.6 Average Power (W)—Total energy withdrawn (or returned) from (or to) a battery divided by the time of discharge (or charge).

3.7 Average Voltage (V)—The ratio of the watt-hours to ampere-hours for a given discharge or charge. Also known as current weighted voltage.

- 3.8 Battery**—Electrochemical cells electrically connected in a series and/or parallel arrangement.
- 3.9 Battery Auxiliaries**—The components required to support the operation of a battery pack, such as a tray, watering subsystem, pumps or control electronics.
- 3.10 Battery Cell**—An assembly of at least one positive electrode, one negative electrode, and other necessary electrochemical and structural components. A cell is a self-contained energy conversion device whose function is to deliver electrical energy to an external circuit via an internal chemical process.
- 3.11 Battery Controller/Management System**—Electronic components needed to provide communications between the battery pack and other vehicle components. It may also monitor and/or control other battery functions (watering, temperature, electrolyte flow, etc.). It may also provide an operator interface.
- 3.12 Battery Module**—A grouping of interconnected cells in a single mechanical and electrical unit. Also known as battery monobloc.
- 3.13 Battery Pack**—Interconnected battery modules that have been configured for a specific energy storage application.
- 3.14 Battery System**—Completely functional energy storage system consisting of the pack(s) and necessary ancillary subsystems for physical support, thermal management, and electronic control.
- 3.15 Battery System Components**—The components comprising a traction battery system in an electric vehicle. These include the battery modules, interconnects, venting systems, battery restraint devices, electronic controls, and the battery box or container that holds the individual battery modules.
- 3.16 Battery System Density (kg/L)**—Battery system mass divided by battery system volume.
- 3.17 Battery System Mass Fraction**—Ratio of battery system weight to gross vehicle weight.
- 3.18 Battery Volume (L)**—The volume of the battery. Cell, module, pack, or system should be specified, and should include the usable volume displaced.
- 3.19 Battery Weight (KG)**—The weight of the battery. Cell, module, pack, or system.
- 3.20 Breakdown**—The failure of the dielectric of an insulation due to the effects of an excessive electric field and/or physical or chemical deterioration of the dielectric material.
- 3.21 C_N (Ah)**—The capacity in ampere-hours obtained from a battery discharged at a constant current to an end-of-discharge condition (discharge cutoff voltage) in N hours. C_N is established once and is not adjusted through the battery's life.
- 3.22 C_N Hour Rate**—The constant current at which a fully charged battery can be discharged to its discharge cut-off voltage in N hours.
- 3.23 C/N Rate (A)**—The capacity of the battery divided by the discharge time in hours that yields that capacity.
- 3.24 Calendar Life (years)**—The length of time a battery can undergo some defined operation before failing to meet its specified end-of-life criteria.
- 3.25 Capacity {C} (Ah)**—The total number of ampere-hours that can be withdrawn from a fully charged battery under specified conditions.

- 3.26 Charge (Verb)**—Conversion of electrical energy into chemical potential energy within a cell achieved by applying a direct current to the cell.
- 3.27 Charge Connector**—A conductive or inductive device that establishes an electrical connection to the electric vehicle for the purpose of charging and information exchange.
- 3.28 Charge Profile**—Schedule used for charging a cell or battery, usually defined by voltage, current, and time.
- 3.29 Charge Rate (A)**—The current during charge of a cell or battery. See also finishing charge rate, float charge, and trickle charge.
- 3.30 Charger (Battery)**—The component that supplies the power required for battery charging.
- 3.31 CI**—See constant current charging.
- 3.32 CI/CV**—A constant current charge followed by a constant-voltage charge.
- 3.33 Chassis Ground**—The conductor used to connect the non-current-carrying metal parts of the vehicle high voltage system to the vehicle ground system.
- 3.34 Conductive**—Having the ability to transmit electricity through a physical path (conductor).
- 3.35 Connection Cycles**—Refers to connect and disconnect cycles of connectors. One insertion and withdrawal operation is a connection cycle.
- 3.36 Connector**—A component which terminates conductors for the purpose of providing connection and disconnection to a suitable mating component.
- 3.37 Constant Current Charging or Discharging (CI)**—The charging or discharging of a cell or battery at a constant rate of current flow.
- 3.38 Constant Voltage Charging (CV)**—The charging of a cell or battery by applying a constant voltage while allowing the current to vary.
- 3.39 Contact**—The part of a switch, relay or connector that carries current.
- 3.40 Contact Force (N)**—The force which two contacts exert against each other in the closed position under specified conditions.
- 3.41 Contact Resistance (Ω)**—The electrical resistance of a single mated set of contacts under specified conditions.
- 3.42 Control Pilot**—A conductor that is connected to the equipment ground through the control circuitry on the vehicle. It performs several functions, including assurance that the vehicle is present and connected, start/stop control, charging area ventilation requirements, supply equipment current rating, and provides for the continuous monitoring of the presence of the equipment ground.
- 3.43 Coulombic (Ampere-Hour) Efficiency**—The ampere-hours removed from a cell or battery during a discharge divided by the ampere hours required to restore the initial capacity.
- 3.44 Coupler**—A device connected to the electric vehicle supply equipment that transfers power to the electric vehicle for charging the energy storage system and permits the exchange of information between the electric vehicle and the electric vehicle's supply equipment (see Charge Connector and EV Connector).

- 3.45 Current Collector**—The part of an electrode that conducts electrons.
- 3.46 Cutoff Voltage (V)**—The battery voltage at which charge or discharge is terminated.
- 3.47 CV**—See constant voltage charging.
- 3.48 Cycle**—The period commencing from the start of one charge/discharge to the start of the next charge/discharge where said period includes discharge time, open-circuit time, and charge time. The depth of discharge (or percentage of capacity) associated with each cycle must be specified.
- 3.49 Cycle Life**—The number of cycles, each to specified discharge and charge termination criteria, under a specified charge and discharge regime, that a battery can undergo before failing to meet its specified end-of-life criteria.
- 3.50 Deep Discharge**—A qualitative term indicating the withdrawal of a significant percentage of capacity (typically, 80% or more).
- 3.51 Depth of Discharge (%)**—The number of ampere hours withdrawn from a battery or cell divided by its rated capacity at the test current and temperature and expressed as a percentage.
- 3.52 Derived Peak Power (W)**—An estimate of the maximum power capability of a cell or battery calculated from the results of power profile tests specified by the Dynamic Capacity Test (SAE) and the Dynamic Stress Test (USABC).
- 3.53 Discharge**—Conversion of chemical energy into electrical energy within a cell or battery by the passage of direct current.
- 3.54 Discharge Profile**—Schedule used for cell or battery discharge that follows a particular current, voltage or power versus time sequence.
- 3.55 Discharge Rate (A)**—The current during discharge of a cell or battery.
- 3.56 Discharge Segment**—A contiguous subsection of a discharge regime.
- 3.57 Discharge Step**—A change from one power level to another in a discharge regime.
- 3.58 Discharge Voltage Limit**—The minimum voltage permitted under load during specified performance tests.
- 3.59 DOD**—See depth-of-discharge.
- 3.60 Driving Profile**—A vehicle speed-versus-time schedule that is used to test vehicle and battery characteristics.
- 3.61 Dynamic Capacity Test (DCT)**—A variable-power discharge test developed by SAE to simulate the expected duty cycle of an electric vehicle battery.
- 3.62 Dynamic Stress Test (DST)**—A variable-power discharge test developed by USABC to simulate the expected duty cycle of an electric vehicle battery.
- 3.63 Electric Vehicle (EV)**—A vehicle powered solely by energy stored in an electrochemical device.
- 3.64 Electric Vehicle Supply Equipment (EVSE)**—The conductors, including the ungrounded, grounded, and equipment grounding conductors, the electric vehicle connectors, attachment plugs, and all other fittings, devices, power outlets, and other components intended to deliver energy to an electric vehicle.

- 3.65 Electrode**—The conducting body that contains active materials and through which current enters or leaves a cell.
- 3.66 Electrolyte**—The medium that provides ion transport between the positive and negative electrodes of a cell. It may participate directly in the charge/discharge reactions.
- 3.67 End of Life**—When a cell or battery fails to meet specified capacity or power performance criteria under specified test criteria.
- 3.68 Energy Capacity**—See energy output.
- 3.69 Energy Density (Wh/L)**—The rated energy of a battery (Wh) divided by the total battery volume (L). Also known as volumetric energy density.
- 3.70 Energy (Watt-Hour, Round Trip) Efficiency (%)**—The energy delivered by a cell or battery during a discharge divided by the total energy required for restoration of the initial capacity.
- 3.71 Energy Output (Wh)**—The total watt-hours that can be withdrawn from a fully charged battery under specified operating conditions (such as temperature, rate, age, stand time, and discharge cutoff criteria).
- 3.72 Equalization**—The process of restoring all cells in a battery or pack to approximately the same state-of-charge.
- 3.73 Equipment Ground (Grounding Conductor)**—A conductor used to connect the non-current-carrying metal parts of the EV supply equipment to the system grounded conductor, the grounding electrode conductor, or both at the service equipment.
- 3.74 EV Charging System**—The equipment required to condition and transfer energy from the constant frequency, constant voltage supply network to the direct current, variable voltage EV traction battery bus for the purpose of charging the battery and/or operating vehicle electrical systems while connected.
- 3.75 EV Connector**—Off-board component used to interface with the vehicle-mounted EV inlet to supply power and provide communication interface.
- 3.76 EV Inlet**—Vehicle-mounted component which interfaces with the EV connector to receive power and provide communication interface (also called a charge port).
- 3.77 Failure Criteria**—Specific cell or battery performance characteristics that indicate the cell or battery can no longer perform its intended function.
- 3.78 Federal Urban Driving Schedule (FUDS)**—The Environmental Protection Agency (EPA) urban dynamometer driving schedule, as defined in 40 CFR, paragraph 86.115-78. A velocity-versus-time profile defined by the EPA to test for vehicle emissions and city fuel economy.
- 3.79 Finishing Charge Rate (A)**—The current specified for completing the charging of a cell or battery that is nearing the fully charged condition.
- 3.80 Flame Arrestors**—Devices located at the outlet(s) of a battery venting system designed to prevent damage of the battery system from an external spark or flame that could ignite gases within the battery system under normal operating conditions.
- 3.81 Float Charge**—Charging a cell or battery at a fixed voltage for extended periods of time to obtain or maintain the fully charged condition.

SAE J1715 Revised JUN2000

- 3.82 Formation**—The initial charging process during which cell or battery active material are transformed into the constituents required for proper electrochemical operation.
- 3.83 Gassing**—The evolution of gas from one or both of the electrodes in a cell.
- 3.84 Gradeability**—The maximum percent grade which the vehicle can traverse for a specified time at a specified speed at a specified weight.
- 3.85 High Voltage**—Any wiring system which contains one or more circuits operating between 60 V DC or AC RMS and 600 V DC or AC RMS.
- 3.86 Inductive Charging System**—A charging system that transfers power across a two part transformer and rectifies that power into DC voltage to the batteries.
- 3.87 Insertion Force (N)**—The force required to fully insert a set of mating components.
- 3.88 Internal Impedance (ohm)**—A measure of the opposition to alternating current flow under specified conditions.
- 3.89 Internal Resistance (ohm)**—A measure of the opposition to direct current flow
- 3.90 Level 1 Charging**—A charging method that allows an electric vehicle to be connected to the most common grounded receptacle (e.g., in the USA, 120 VAC Nominal, 60 Hz, 15A, 1-phase).
- 3.91 Level 2 Charging**—A charging method that utilizes dedicated electric vehicle supply equipment in either private or public locations. In the USA, the maximum power supplied for level 2 charging is 208 or 240 VAC Nominal, 60 Hz, 40A, 1-phase or 3-phase.
- 3.92 Level 3 Charging**—A charging method that utilizes dedicated electric vehicle supply equipment to provide DC energy from an appropriate off-vehicle charger to the electric vehicle. In the USA, the maximum power supplied for level 3 charging equipment should be in the range of 25 KW to 160 KW, 208 to 600 VAC Nominal, 60 Hz, 3-phase.
- 3.93 Minimum Discharge voltage**—See Discharge Voltage Limit.
- 3.94 Module**—See battery module.
- 3.95 Negative Electrode**—Of the two electrodes composing a cell, the electrode at which the associated half-cell reaction has the lower potential. It is negative in voltage compared to the other electrode of the cell. It is the electrode at which oxidation occurs during discharge of the cell.
- 3.96 Net Ampere-Hours (Ah)**—For a discharge test including both negative (discharge) and positive (regen) current or power steps, the difference between the Ah removed from the battery during discharge steps and the Ah returned to the battery during regen steps, regardless of battery charge acceptance.
- 3.97 Nominal Operating Voltage (V)**—The voltage of a battery, as specified by the manufacturer, discharging at a specified rate and temperature.
- 3.98 Nonaqueous Electrolyte Batteries**—Cells or batteries with electrolytes that are not water based, such as those with molten salts or organic electrolytes.
- 3.99 Nonvented Batteries**—A hermetically sealed battery comprised of one or more rechargeable cells that has no provision for venting, or the addition of water or electrolyte, or for the external measurement of specific gravity.

SAE J1715 Revised JUN2000

- 3.100 Open Circuit After Charge {OCAC} (h)**—The period during which the battery is placed on open-circuit following a charge.
- 3.101 Open Circuit After Discharge {OCAD} (h)**—The period during which the battery is placed on open-circuit following a discharge.
- 3.102 Open-Circuit Voltage {OCV} {V}**—The voltage of a cell or battery at a specified state-of-charge and temperature in the absence of charge or discharge current.
- 3.103 Operating Temperature(°C)**—The temperature range in which a component is designed to operate under normal conditions.
- 3.104 Overcharge (Ah)**—The amount by which the charge in ampere-hours exceeds the ampere-hours removed on the previous discharge from a fully charged condition.
- 3.105 Overcurrent Protection Device**—A fuse, circuit breaker, intelligent contactor, or other device placed in an electrical circuit to provide current overload protection.
- 3.106 Pack**—See battery pack.
- 3.107 Peak Power (W)**—The maximum power obtainable from a cell or battery for a specified period of time when discharged at constant current (or power), generally determined as a function of depth of discharge.
- 3.108 Peak Power Density (W/L)**—The peak power available from a cell or battery divided by its volume.
- 3.109 Performance Degradation**—The extent to which the battery system is unable to meet the original performance specification or rating established for the battery.
- 3.110 Peukert Curve**—A plot of the logarithm of discharge current versus the logarithm of discharge time to a specified end-of-discharge voltage.
- 3.111 Polarization (Battery) {V}**—The electrical potential deviation from equilibrium open-circuit voltage caused by the passage of current in a cell or battery.
- 3.112 Positive Electrode**—Of the two electrodes comprising a cell, the electrode at which the associated half-cell reaction has the higher potential. It is positive in voltage relative to the other electrode of the cell. It is the electrode at which reduction occurs during discharge of the cell.
- 3.113 Power Continuous (W)**—A power level characteristic of a battery providing constant power for constant-speed vehicle operation.
- 3.114 Power Density (W/L)**—The rated power of the battery (W) divided by the total volume of the battery (L). Also known as volumetric power density.
- 3.115 Power-to-Energy Ratio {P/E}**—Ratio of the peak power obtained under specified conditions, such as depth-of-discharge, to the energy output obtained under specified discharge conditions.
- 3.116 Powertrain**—The elements of a propulsion system that convert electrical energy from a battery to mechanical energy at the wheels of a vehicle. It includes all drivetrain components plus an electrical power inverter and/or controller, but not the battery system.
- 3.117 Propulsion System**—The combination of the powertrain and energy supply system.