SAE International™ SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J1797 | REAF. JUN2008

Issued 1997-01
Reaffirmed 2008-06

Superseding J1797 JAN1997

Recommended Practice for Packaging of Electric Vehicle Battery Modules

Foreword**—**The mission of this document is to provide direction for standardization in packaging of secondary battery modules for Electric Vehicles. Some of the incentives for this standardization effort include component safety, compatibility, availability, and economics. The term battery module used throughout this document implies secondary battery modules.

The document addresses the external features of a battery module and how they interface to a battery pack system, or vehicle system, with a major emphasis on safety. Only commercially available aqueous battery systems which can be modularized within the recommendations of this document will be considered.

This document also provides for the definition of additional package sizes as new vehicle battery system requirements are identified or new battery technologies become commercially available. Module sizes contained herein are agreed upon by vehicle and battery manufacturers and can serve as the basis for Battery Council International Group Sizes and other international standards.

The procedure for acceptance of a new SAE EV battery standard is as follows:

a. A letter to the EV Battery Systems Standards Committee Chairperson must be submitted by a vehicle manufacturer and one battery manufacturer proposing a new SAE EV battery size and documentation showing compliance to SAE J1797.
b. A letter of agreement with another vehicle manufacturer, other than that in Step a, is necessary to approve proposing a new draft to the Recommended Practice.
c. SAE will review for compliance (technical and commercial) and ballot the proposal in the EV Battery Systems Standards Committee to revise SAE J1797.

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1. Scope—This SAE Recommended Practice provides for common battery designs through the description of dimensions, termination, retention, venting system, and other features required in an electric vehicle application. The document does not provide for performance standards. Performance will be addressed by SAE J1798. This document does provide for guidelines in proper packaging of battery modules to meet performance criteria detailed in J1766.

1.1 Purpose—This document provides the guidelines for designing a battery module to effectively package into manufacturer's electric vehicles. It will lay the foundation for electric vehicle battery modules and serve as an industry guideline.

1.2 Field of Application—Electric Vehicles.

1.3 Product Classification—Electrochemical Storage Devices.

1.4 Form—A modular unit consisting of electrochemical cell(s) configured to met the guidelines of this document to provide a component which can be assembled into a battery pack system for electric vehicle applications.

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 issue of SAE Publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1715—Electric Vehicle Terminology
SAE J1718—Recommended Practice for Measurement of Hydrogen Gas Emission from Battery Powered Passenger Cars and Light Trucks During Battery Charging
SAE J1766—Recommended Practice for Electric and Hybrid Electric Vehicle Battery Systems Crash Integrity Testing
SAE J1798—Recommended Practices for Performance Rating of Electric Vehicle Battery Modules

2.1.2 UNDERWRITERS LABORATORIES INC.—Available from Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 1244—

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

SAE TSB 0001—SAE Technical Standards Board Rules and Regulations
SAE TSB 002—SAE Preparation of SAE Technical Reports
SAE TSB 003—Rules for the SAE Use of SI (Metric) Units
SAE Report—Format Guidelines for Electronic Capture of SAE Documents
SAE Committee Guidelines Manual
SAE J1115—Guidelines for Developing and Revising SAE Nomenclature and Definitions
SAE J1495—Test Procedure for Battery Flame Retardant Venting Systems
SAE J1654—Recommended Practice for High-Voltage Wiring
SAE J1673—Recommended Practice for High-Voltage Terminals and Connectors
SAE J1742—Recommended Practice for High-Voltage Connectors
SAE J2288—Recommended Practice for Life Cycle Testing of Electric Vehicle Battery Modules
SAE J2289—Recommended Practice for Electric Vehicle Battery Pack Design and Performance

2.2.2 BATTERY COUNCIL INTERNATIONAL (BCI)—Available from Battery Council International, 401 North Michigan Avenue, Chicago, IL 60611.

Battery Council International Data Book

3. Definitions—See SAE J1715.

4. Symbols

PbA = Lead Acid Batteries

NiCd = Nickel Cadmium Batteries

NiMH = Nickel Metal Hydride Batteries

"+" = Positive Charged Electrode Polarity

"–" = Negative Charged Electrode Polarity

"L" = Length

"W" = Width

"H" = Height

5. Product Description

5.1 Type of Electrochemistry—This specification applies only to the commercially available aqueous electrolyte systems listed in Table 1 which are packageable into the dimensional constraints specified in this document.

TABLE 1—AQUEOUS ELECTROLYTE SYSTEMS

Electrochemical Couple	Label Background Color	Electrolyte Type	Identification Label Acronym
Lead Acid	Black	Sulfuric Acid	PbA
Nickel Cadmium	Blue	Potassium Hydroxide	NiCd
Nickel Metal Hydride	Gray	Potassium Hydroxide	NiMH

5.2 Module Voltage

5.2.1 NOMINAL VOLTAGE—The battery module unit is targeted for a nominal 12 V, or other designated module voltages as specified by the vehicle manufacturer.

5.2.2 MAXIMUM VOLTAGE—Exceeding maximum voltage of 60 V direct current at a single battery module's terminals during any state, including charging, is considered likely to increase the risk of electric shock, per UL 1244, Section 10.

5.2.3 HIGH-VOLTAGE CONSIDERATIONS—Whenever handling modules (installing, charging, etc.) due care is necessary to avoid shock or spark hazard. Reference UL 1244, Section 10 for further guidance.

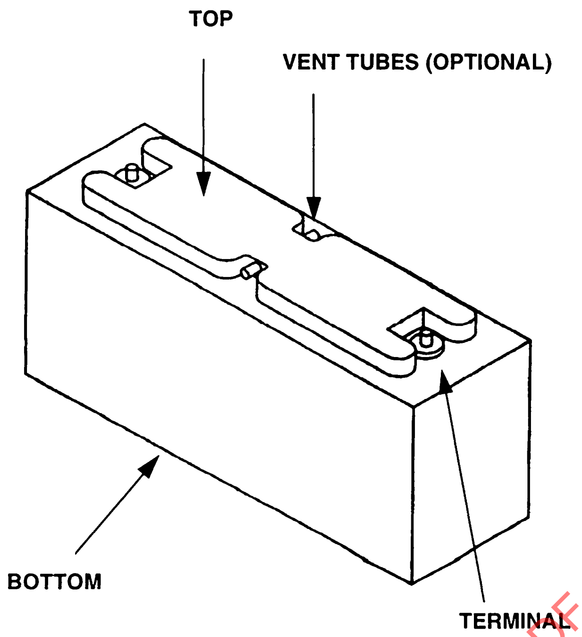
5.3 Package Envelope

5.3.1 DIMENSIONAL—The packaging envelope for battery modules contained in this document are described in Table 2.

TABLE 2—PACKAGING ENVELOPE FOR BATTERY MODULES

SAE Designation	H (Height) mm	W (Width) mm	L (Length) mm	Mass (kg)	Figure Reference
SAE EV1	175 ± 2	116 ± 2	388 ± 2	≤21	1A-1F
SAE EV2	223 ± 2	173 ± 2	306 ± 2	≤30	2A-2E
SAE EV3	260 ± 2	123 ± 1	246 ± 2	≤13	3A-3F
SAE EV4	170 ± 2	165 ± 2	197 ± 2	≤15	4A-4F

5.3.1.1 Pictorial Representation—The isometric and orthorhombic views of the external envelope are shown in Figures 1A through 4F and correspond to the module form factors detailed in Table 2.



Note: The center terminal configuration drawing is for reference only. The location of the terminal is not restricted to the centerline.

FIGURE 1A—ISOMETRIC VIEW

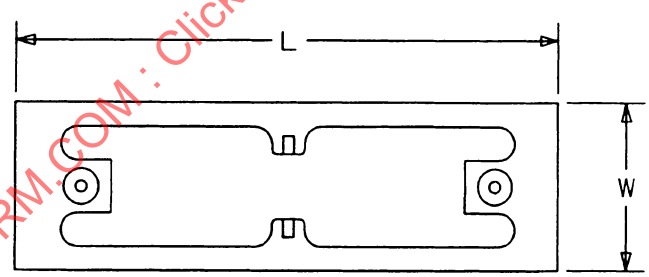


FIGURE 1B—ORTHORHOMBIC VIEW

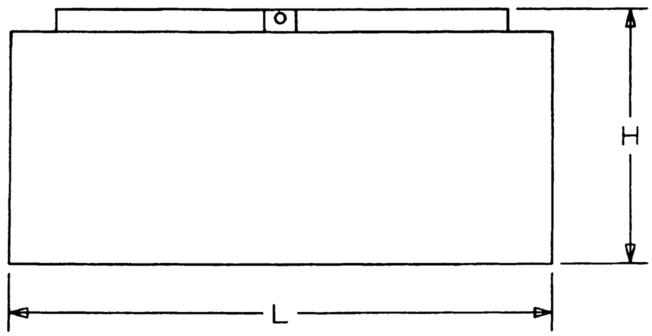


FIGURE 1C—ORTHORHOMBIC SIDE VIEW

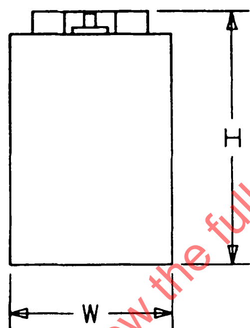


FIGURE 1D—ORTHORHOMBIC END VIEW

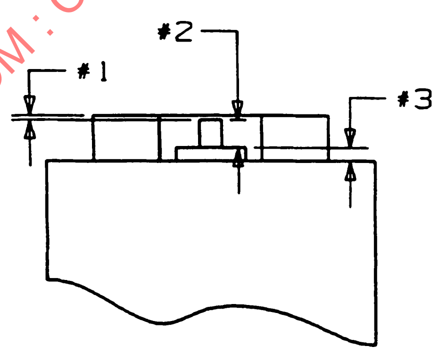


FIGURE 1E—END VIEW

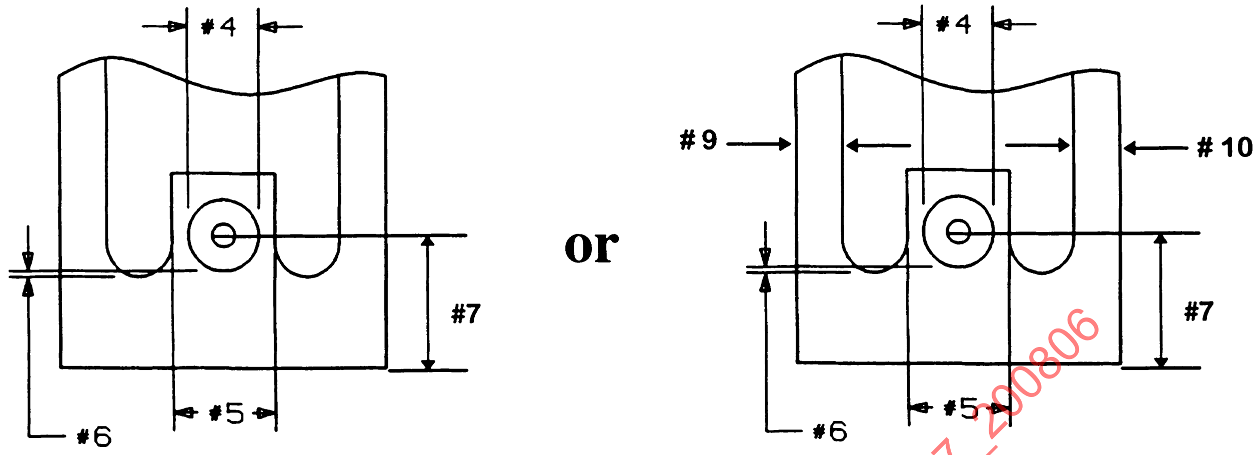


FIGURE 1F—TOP VIEW

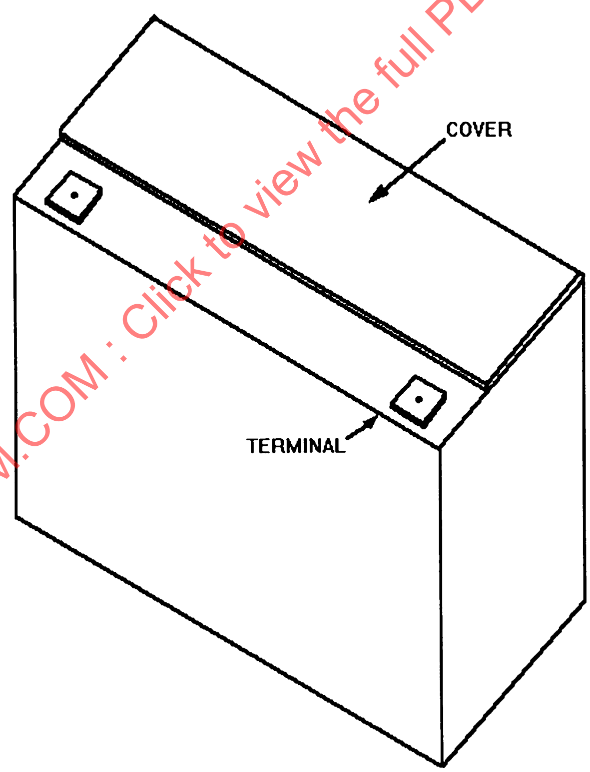


FIGURE 2A—ISOMETRIC VIEW

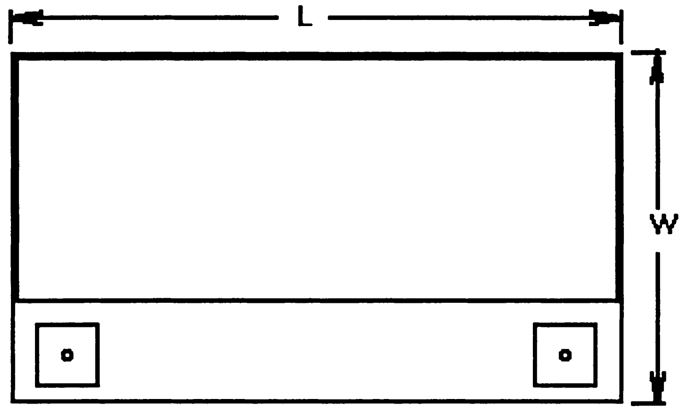


FIGURE 2B—ORTHORHOMBIC TOP VIEW

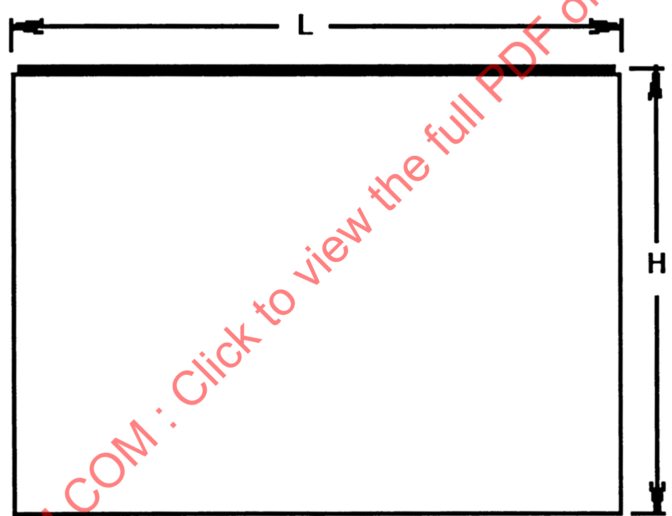
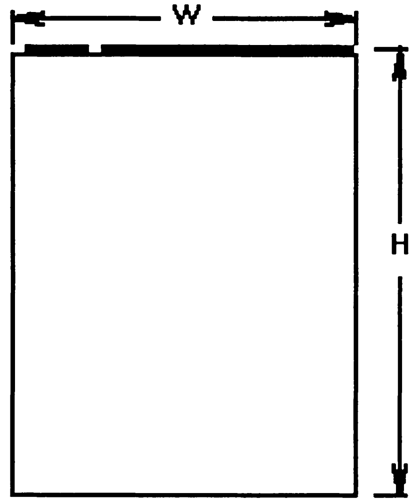


FIGURE 2C—ORTHORHOMBIC SIDE VIEW



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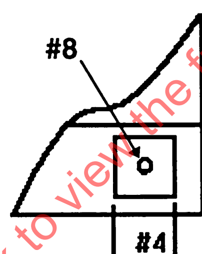

FIGURE 2E—TERMINAL TOP VIEW

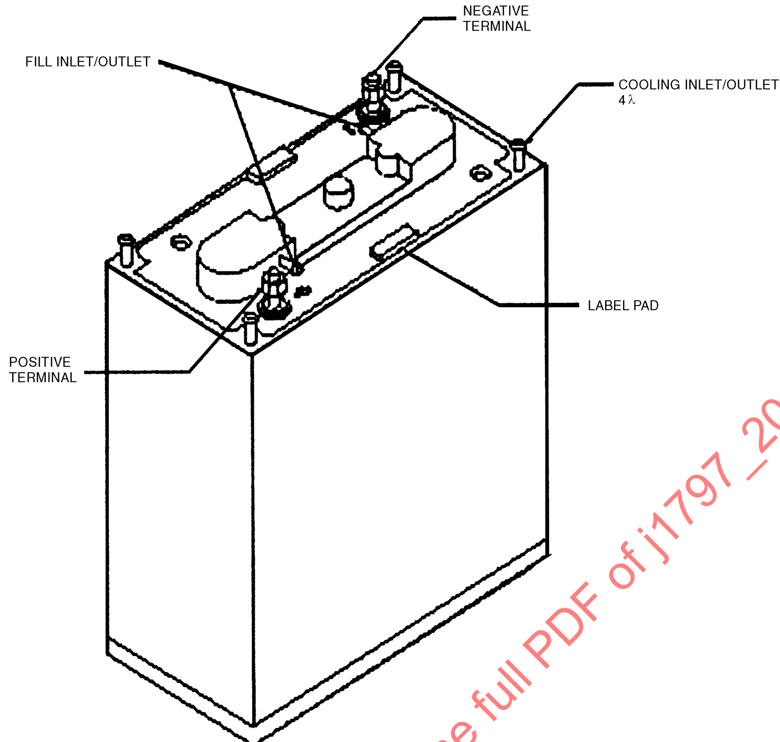

FIGURE 3A—iSOMETRIC vIEW

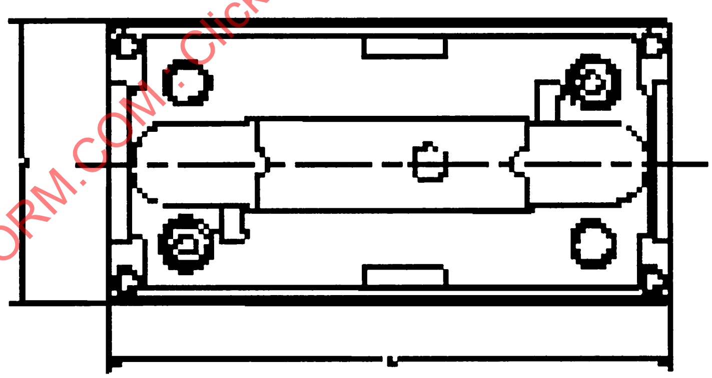

FIGURE 3B—ORTHORHOMBIC TOP VIEW

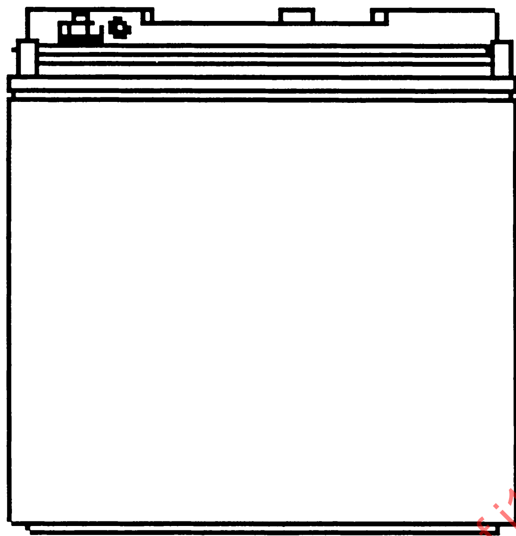

FIGURE 3C—ORTHORHOMBIC SIDE VIEW

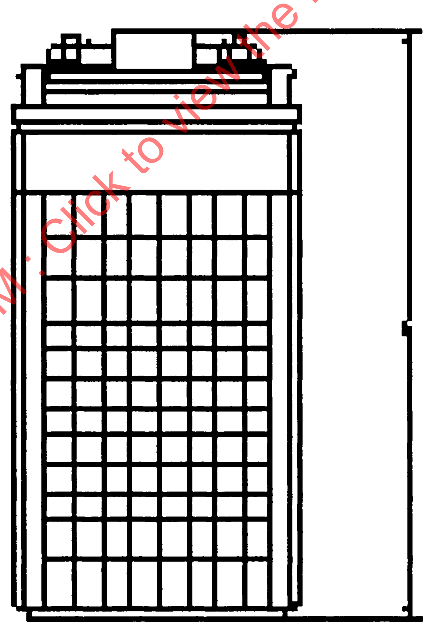

FIGURE 3D—ORTHORHOMBIC END VIEW

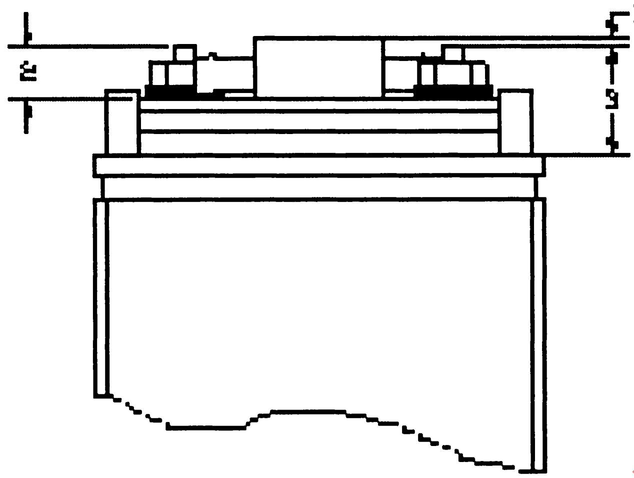

FIGURE 3E—TERMINAL END VIEW

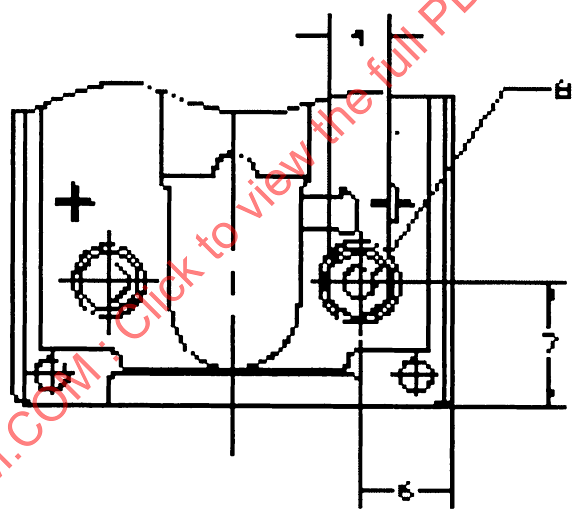

FIGURE 3F—TERMINAL TOP VIEW

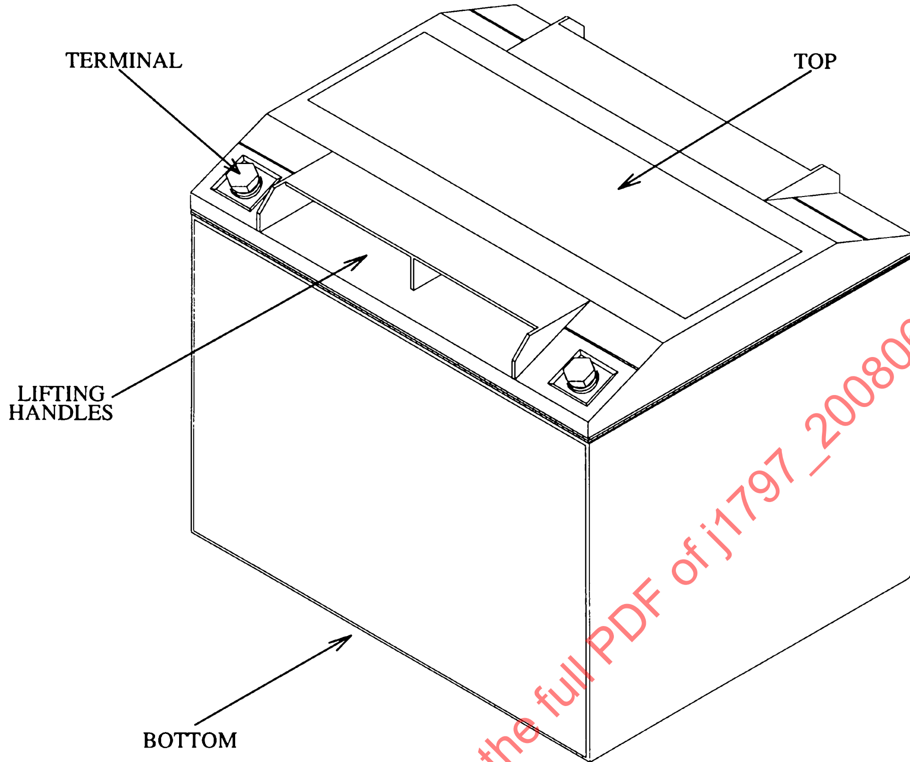

FIGURE 4A—ISOMETRIC VIEW

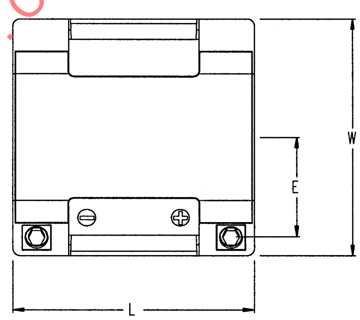

FIGURE 4B—ORTHORHOMBIC TOP VIEW

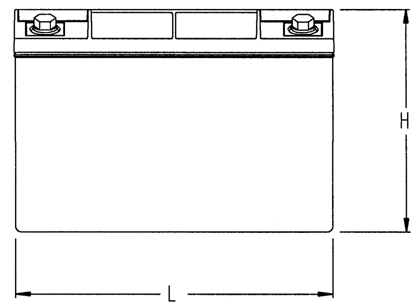

FIGURE 4C—ORTHROHOMBIC SIDE VIEW

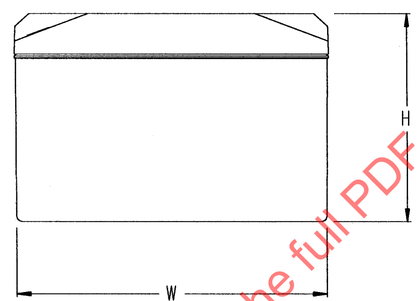

FIGURE 4D—ORTHORHOMBIC END VIEW

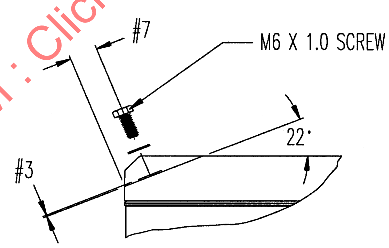

FIGURE 4E—TERMINAL END VIEW

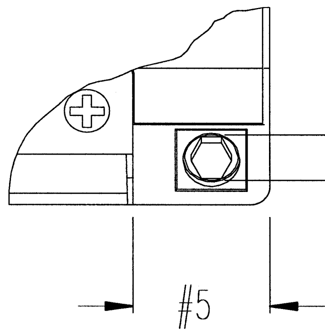

FIGURE 4F—TERMINAL TOP VIEW

5.4 Capacity—The capacity is determined by the Baseline Capacity Test as defined in SAE J1798.

5.5 Mass—The maximum mass of the modular unit is found in Table 2 and excludes peripheral systems interface components, i.e., thermistors, cables, terminal protectors, etc. Ergonomic considerations must be made by the pack manufacturers to ensure due care is used when handling individual modules during installation and servicing of packs.

6. Systems Interfaces—Systems interfaces shall include all peripheral device(s), component(s) or sub-system(s) which interact with the battery module unit(s).

6.1 Mechanical Interfaces

6.1.1 RETENTION OF MODULE IN BATTERY PACK SYSTEM—It is recognized that there are a multitude of methods by which to restrain both single modules and multiple modules connected together in a system. Although electrical cables and connections may seem to provide some form of retention and restraint of modules in relation with one another, this is not considered to be a part of an acceptable retention system that provides restraint in normal and some safety critical situations. Any method used shall consider the following areas and features of the module(s). Use SAE J1766 for retention performance standards.

6.1.2 RETENTION LOCATION AND FEATURES—The retention system used shall provide for retention in the three mutually perpendicular axes. The restraint need not contact the entire surface in the axis being restrained, i.e., small areas of contact are satisfactory as long as no damage is done to the modules and the system can meet SAE J1766 performance standards.

Any retention system should maintain electrical isolation during a crash as referenced in J1766. The retention system should prevent current leakage and should be protected against electrolyte corrosion. If an air draft system is used for thermal management or hydrogen gas emissions, the retention system should not hinder air flow around the module(s) needed for proper thermal management or venting of the entire battery system. The retention system should not interfere with the vent system or high-voltage wiring.

6.1.3 TOP/INTERMEDIATE RETENTION—If applicable, all remaining area on the top surface may be contacted for restraint and should be available to the restraint system. If there is a heat seal area of the intermediate cover to top cover, it should not be used to provide edges by which to clamp or connect a restraining system. However, the top surface of the module may be used as a contact surface for the restraint system and should provide as much surface area as possible for maximum usage in retention.

6.1.4 BOTTOM RETENTION—The bottom surface of the module shall provide a level plane for placement in the retention and restraining system. Other retention features are optional.

6.1.5 CLAMPING AREA AND FORCE—The clamping area and force should be designed and specified to comply with battery manufacturer's performance requirements. The clamping area and force applied shall not damage the battery module, particularly in consideration of material creep.

6.1.6 INSTALLATION/REMOVAL—The retention system should be designed for easy removal and installation of battery modules for service.

6.1.7 PERFORMANCE REQUIREMENTS—Any restraining system used shall not inhibit the normal electrical operation of the module(s) through either physical or electrical obstructions. The restraints should retain the orientation and position of the modules during vehicle operations. A test referencing SAE J1766 must be performed to ensure that the retention system remains intact at the completion of the crash and rollover tests.

6.2 High-Power Connection Requirements—The type of fastener used to connect the high-power leads to the terminal should be agreed upon by both battery and vehicle manufacturer. Vibration, thermal environments, number of times fastener removed and reinstalled, are to be considered in system design. The connector used to mate with the terminal land area and cable or bussbar shall be adequate to carry maximum expected current without heat generation which would cause damage to the modular unit or interconnects.

6.3 Dielectric—The battery module should be encased in a sufficiently high dielectric material as to not allow electrical punch through during highest module voltage spikes during regenerative braking instances or initiation of charge.

6.4 Vented Emissions Interfaces—It is essential that gas emissions from all batteries be considered in the module and battery pack design. Two provisions for enhancing the safety of the overall system are a flash/flame arrestor system in the module and a venting system in the battery pack.

6.4.1 FLAME/FLASH ARRESTOR SYSTEM PERFORMANCE STANDARDS—Appropriate flame/flash arrestor systems are recommended in other SAE standards.

6.4.2 VENTING SYSTEM—There are two common types of venting systems used in battery pack systems or containers.

The first type of vent system is a combination of a vent connection on the battery module and a means of carrying away any gaseous emissions from the batteries, such as a tube, in the battery pack system. Some of these systems may need a flame/flash arrestor.

A second type is a fail-safe air draft system. This system simply sweeps away any hydrogen gas emissions via an air draft.

*6.4.2.1 Location—*The vent connection on the battery module, if needed, should be located on the upper level of the battery in an area for connections to be made with a reduced risk of pinched or bent tubing. Reference Table 2 and the appropriate figure from Figures 1A to 4F for specific location of that specific technology vent system location.

6.4.3 HYDROGEN GAS EMISSIONS—SAE J1718 shows how to measure gas emission from a vehicle with a mass of less than 4536 kg. It is up to the vehicle manufacturer to follow the battery manufacturer's recommended charging procedures and to certify hydrogen gas emissions from their vehicle to ascertain whether ventilation is required.

6.4.4 Tube Connection Requirements—Size and Retention—It is up to the discretion of the vehicle manufacturer whether to use hydrogen vent tubes in their design. However, the recommended dimensions for minimum inner diameter of tubing is 4.76 mm and the maximum outer diameter should not extend past the top of the battery module. Retention should be considered for attachment to the battery to preclude detachment under normal operating conditions as detailed in Section 11.

6.4.5 Electrolyte Containment—SAE J1766 addresses electrolyte containment performance standards during crash and static rollover for vehicle mass less than 4536 kg. Electrolyte containment in normal operation is affected by several factors including due care in module and battery packaging system through proper retention, handling, and vibration. Under normal operation no electrolyte leakage from or within the battery pack system is permitted. A concern is electrolyte leakage causing ionic conductance in a high-voltage system which, without the proper safety circuits, may energize the vehicle chassis.

6.4.6 Temperature Sensing Interface—Each module will allow for the temperature sensor to be installed on either of the end walls. This allows for flexibility in installing the sensor on any module within the pack. The location for temperature sensing should be in an appropriate position as to avoid assembly clearance problems. Location should not interfere with thermal management but give the best wiring harness configuration and the best representative temperature of the internal components of the battery from this position.

6.5 High-Power Electrical Interfaces—The most common connection in the battery market today is called termination or terminal. This is descriptive of the point of contact between the battery and the electrical connection.

6.5.1 Termination—A description of relative position, type, and dimensions at the point(s) where high-power electrical connection(s) is(are) made.

6.5.2 Terminal Location and Features—The terminal location and features are shown in Figures 1A to 4F referencing Table 2 for the specific figure number with generic drawings and detailed dimensions. When working with individual modules, due care must be taken to avoid shorting the terminals. In addition, when assembling or servicing individual modules within a high-voltage battery pack, due care is to be taken to assure safety particularly when connections are to be made in close proximity to high voltages.

6.5.3 Terminal Type

6.5.3.1 Bolt/Stud Type Connections (Male)—The threaded bolt and its assembly shall be recessed below the overall height of the battery so that no conductive parts extend above the non-conductive protective material. Refer to Figures 1A to 4F and Table 3 for more information and dimensional values. Conductive substrate performance for terminal land area shall be adequate to carry maximum expected current.