SURFACE VEHICLE RECOMMENDED PRACTICE	J1455™	MAR2017
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Recommended Environmental Practices for Electronic Equipment Design in Heavy-Duty Vehicle Applications

RATIONALE

Added to 2.1.1 SAE Publications, SAE J2721 Recommended Corrosion Test Methods for Commercial Vehicle Components.

Changed title of section 3 to "Document Application and Organization".

Changed title of 3.1 to "Application".

Added paragraph title under 3.1 of "Environmental Data and Test Method Validity".

Changed title of 3.2 to "Organization".

Clarified 3.2.1 to reflect changes in organization of Section 4.

Added 3.2.2 to reflect changes in organization of Section 4.

Added 3.2.3 – removed original list of factors and replaced with a table that lists the factors discussed in Section 4 and what section number they are.

Added 3.2.4 to replace discussion of Section 5 from 3.2.1.

Added 4.3.3.3 to include SAE J2721 corrosion standard.

Added SAE J2721 to 4.3.4.

1. SCOPE

The scope of this Recommended Practice encompasses the range of environments which influence the performance and reliability of the electronic equipment designed for heavy duty on and off road vehicles, as well as any appropriate stationary applications which also use these vehicle derived components. A few examples of such vehicles are on and off highway trucks, trailers, buses, construction equipment, and agricultural equipment including implements.

1.1 Purpose

This document is intended to aid the designer of commercial vehicle electronic systems and components by providing guidelines that may be used to develop environmental design goals. Specific test requirements are to be agreed upon by the customer and supplier.

2. REFERENCES

2.1 Applicable Documents

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 International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J400 Test for Chip Resistance of Surface Coatings

SAE J1113-1 Electromagnetic Compatibility Measurement Procedures and Limits for Components of Vehicles, Boats (up to 15 m), and Machines (Except Aircraft) (16.6 Hz to 18 GHz)

SAE J1211 Handbook for Robustness Validation of Automotive Electrical/Electronic Modules

SAE J1812 Function Performance Status Classification for EMC Immunity Testing

SAE J2721 Recommended Corrosion Test Methods for Commercial Vehicle Components

2.1.2 ISO Publications

Available from International Organization for Standardization, ISO Central Secretariat, 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, Tel: +41 22 749 01 11, www.iso.org.

ISO 11452-8 Road vehicles - Component test methods for electrical disturbances from narrowband radiated electromagnetic energy - Part 8: Immunity to magnetic fields

ISO 11452-10 Road vehicles - Component test methods for electrical disturbances from narrowband radiated electromagnetic energy - Part 10: Immunity to conducted disturbances in the extended audio frequency range

ISO 5011 Inlet air cleaning equipment for internal combustion engines and compressors -- Performance testing

2.1.3 IEC Publications

Available from IEC Central Office, 3, rue de Varembe, P.O. Box 131, CH-1211 Geneva 20, Switzerland, Tel: +41 22 919 02 11, www.iec.ch.

IEC CISPR 25 CORR 1 Vehicles, boats and internal combustion engines – Radio disturbance characteristics – Limits and methods of measurement for the protection of on-board receivers CORRIGENDUM 1

2.1.4 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM B117 Standard Method of Salt Spray (Fog) Testing

ASTM C150 Specification for Portland Cement

ASTM D880 Method for Incline Impact Test for Shipping Containers

ASTM D5276 Method for Drop Test for Loaded Boxes

2.1.5 Military Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, http://assist.daps.dla.mil/quicksearch/.

MIL-STD-810F Environmental Test Methods and Engineering Guidelines MIL-STD-202G—Test Methods for Electronic and Electrical Component Parts

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

TAPPI T801 Impact Resistance of Fiberboard Shipping Container

TAPPI T802 Drop Test for Fiberboard Shipping Containers

3. DOCUMENT APPLICATION AND ORGANIZATION

3.1 Application

Environmental Data and Test Method Validity

The information included in the following sections is based upon test results achieved by major North American truck manufacturers and component equipment suppliers. Operating extremes were measured at test installations normally used by manufacturers to simulate environmental extremes for vehicles and original equipment components. They are offered as a design starting point. Generally, they cannot be used directly as a set of operating specifications because some environmental conditions may change significantly with relatively minor physical location changes. This is particularly true of vibration, engine compartment temperature, and electromagnetic compatibility. Actual measurements should be made as early as practicable to verify these preliminary design baselines.

The proposed test methods are currently being used for laboratory simulation or are considered to be a realistic approach to environmental design validation. They are not intended to replace actual operational tests under adverse conditions. The recommended methods describe standard cycles for each type of test. The designer must specify the number of cycles over which the vehicle electronic components should be tested, as well as the specific pass and fail criterion for the conducted tests prior to testing. The number of cycles will vary depending upon equipment, location, and function. While the standard test cycle is representative of an actual short term environmental cycle, no attempt is made to equate this cycle to an acceleration factor for reliability or durability. These considerations are beyond the scope of this document.

3.2 Organization

3.2.1 Section 4 describes the environmental factors that need to be considered when developing electronic equipment and the test methods recommended for evaluating the factor.

3.2.2 Section 4 is organized to cover three facets of each factor:

Definition of the factor.

Description of its effect on control, performance, and long-term reliability.

A review of proposed test methods for simulating environmental stress.

3.2.3 The following lists identifies the factors and the relevant Section 4 paragraph.

Factor	Section
Temperature	4.1
Humidity	4.2
Salt Spray Atmosphere	4.3
Exposure to Chemicals and Oils	4.4
Steam Cleaning and Pressure Washing	4.5
Fungus	4.6
Dust and Sand	4.7
Gravel Bombardment	4.8
Altitude	4.9
Mechanical Vibration	4.10
Mechanical Shock	4.11
Combined Environmental Testing	4.12
General Heavy-Duty Truck Electrical Environment	4.13

3.2.4 Section 5 lists the various areas in the vehicle and parameters to be considered when designing components for these areas.

a. Under-hood

1. Engine (Lower Portion)

2. Engine (Upper Portion)

3. Bulkhead

b. Interior (Forward)

1. Floor

2. Instrument Panel

3. Headliner

4. Inside Doors

c. Interior (Rear)

1. Bunk Area

2. Storage Compartment

d. Chassis

1. Forward

2. Rear

e. Exterior of Cab

1. Under Floor

2. Rear

3. Top

4. Doors

3.3 Combined Environments

The vehicle environment consists of many natural and induced factors. Combinations of these factors are present simultaneously. In some cases, the effect of a combination of these factors is more serious than the effect of exposing samples to each environmental factor in series. For example, the suggested test method for humidity includes high and low-temperature exposure. This combined environmental test is important to vehicle electronic components when proper operation is dependent on seal integrity. Temperature and vibration is a second combined environmental test method that can be significant to components. During design analysis, a careful study should be made to determine the possibility of design susceptibility to a combination of environmental factors that could occur at the planned mounting location. If the possibility of susceptibility exists, a combined environmental test should be considered (see 4.12).

3.4 Test Sequence

The optimum test sequence is a compromise between two considerations:

3.4.1 The order in which the environmental exposures will occur in operational use.

3.4.2 A sequence that will create a total stress on the sample that is representative of operation stress.

The first consideration is impossible to implement in vehicle testing since exposures occur in a random order. The second consideration prompts the test designer to place the most severe environments last. Many sequences that have been successful follow this general philosophy, except that the temperature cycle is placed or performed first in order to condition the sample mechanically.

3.5 Sample Size

3.5.1 The engineering team should consider factors that could influence the number of samples required to draw reasonable conclusions about system performance. Some factors might include cost, system application, relation to safety, new or modified design, etc. This number should be determined at the beginning of the test process.

4. ENVIRONMENTAL FACTORS AND TEST METHODS

4.1 Temperature

4.1.1 Definition

Thermal factors are probably the most pervasive environmental hazard to vehicle electronic components. Sources for temperature extremes and variations include:

4.1.1.1 The Vehicle's Climatic Environment, Including the Diurnal and Seasonal Cycles

Variations in climate by geographical location must be considered.

4.1.1.2 Heat Sources and Sinks Generated by the Vehicles Operation

The major sources are the engine and drive-train components, including the brake system. Wide variations are found during operation. For instance, temperatures on the surface of the engine can range from the cooling system 88 °C (190 °F) to the surface at the exhaust system at 816 °C (1500 °F). This category also includes conduction, convection, and radiation of heat because of the various modes of the vehicle's operation.

4.1.1.3 Self-Heating of the Equipment Due to Its Internal Dissipation

A design review of the worst-case combination of peak ambient temperature (see 4.1.1.1 and 4.1.1.2), minimized heat flow away from the equipment, and peak-applied steady-state voltage should be conducted.

4.1.1.4 Vehicle Operational Mode and Actual Mounting Location

Measurements should be made at the actual mounting site during the following vehicular conditions while they are subjected to the maximum heat generated by adjacent equipment, and while they are at the maximum ambient environment:

a. Engine start

b. Engine idle

c. Engine high speed

d. Engine turn off (prior history important)

e. Various engine/road conditions

4.1.1.5 Thermal Cycling

a. Extremes - The ultimate upper and lower temperatures the equipment is expected to experience.

b. Cycling - The cumulative effects of temperature cycling within the limits of the extremes.

c. Shock - Rapid change of temperature. Figure 1 illustrates one form of vehicle operation that induces thermal shock and is derived from an actual road test of two vehicles. Thermal shock is also induced when vehicle electronic components at elevated temperature is exposed to sudden rain or road splash, or when it is moved from a heated shelter into a low (-40 °C/-40 °F) ambient temperature environment.

The vehicle electronic component designer is urged to develop a systematic, analytic method for dealing with steady-state and transient thermal analysis. The application of all devices containing semiconductors is temperature limited. For this reason, the potential extreme operating conditions for each application must be scrutinized to avoid failure in the field.

4.1.1.6 Ambient Conditions Before Installation Due to Storage and Transportation Extremes

Shipment in unheated aircraft cargo compartments may lower the minimum storage (non-operating) temperature to -50 °C (-58 °F). Under certain conditions the upper storage temperature may exceed the maximum ambient operating temperature (i.e., paint booth requirements).

4.1.2 Effect on Performance

The damaging effects of thermal stock and thermal cycling include:

4.1.2.1 Cracking of printed circuit board or ceramic substrates.

4.1.2.2 Fatigue failures of solder joints.

4.1.2.3 Delamination of printed circuit boards and other interconnect system substrates.

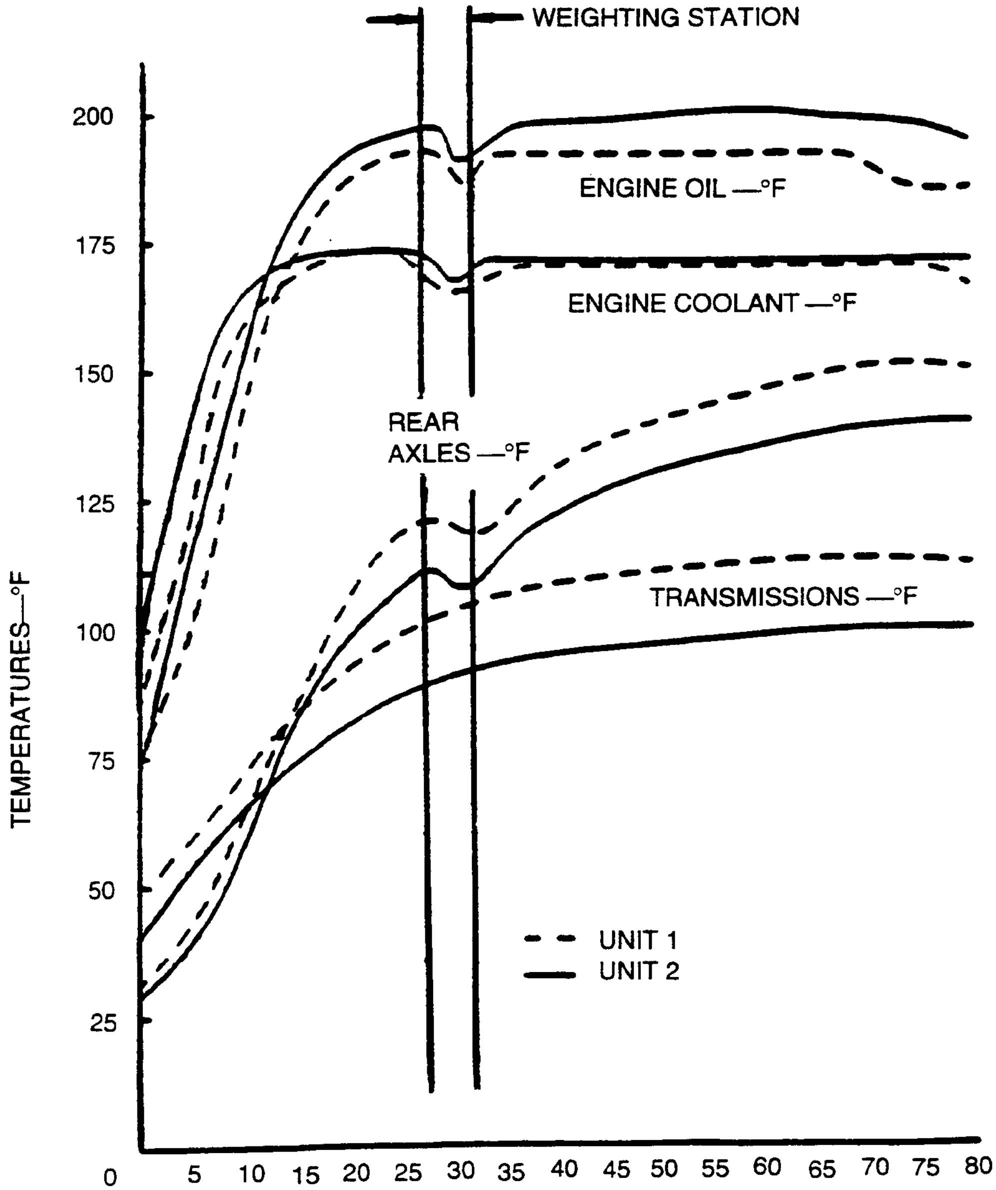

Figure 1 - Time into run-minutes vehicle warm-up characteristics

4.1.2.4 Seal failures, including the breathing action of some assemblies, due to temperature-induced dimensional variation that permits intrusion of liquid or vapor borne contaminants.

4.1.2.5 Failure of circuit components due to direct mechanical stress caused by differential thermal expansion.

4.1.2.6 The acceleration of chemical attack on interconnects, due to temperature rise, can result in progressive degradation of circuit components, printed circuit board conductors, and solder joints.

4.1.2.7 Exceeding the dissociation temperature of surrounding polymer or other packaging components.