Committee of Experts on the Transport of Dangerous Goods
and on the Globally Harmonized System of Classification
and Labelling of Chemicals 28 June 2023

Sub-Committee of Experts on the Transport of Dangerous Goods
Sixty-second session
Geneva, 3-7 July 2023
Item 2(a) of the provisional agenda
Review of Test Series 6

Information related to document ST/SG/AC.10/C.3/2023/26:
Exit from class 1, relating to electrostatic discharge and
electromagnetic interference / radio frequency interference

Transmitted by the Council on the Safe Transportation of Hazardous
Articles (COSTHA)

Introduction
1. COSTHA’s and SAAMI’s document ST/SG/AC.10/C.3/2023/26 was submitted to allow for test reports of ongoing research on this topic. While the research focused on gathering packaging-independence data and exclusion test data, information was found relating to the probability of ignition from electrostatic discharge (ESD) and electromagnetic interference (EMI) / radio frequency interference (RFI).\(^1\)

2. COSTHA poses questions about the potential usefulness of further research related to the probability of accidental ignition of articles of the type being considered. Available test standards and threshold values are discussed.

Discussion
3. The ability of truck radios to initiate electric detonators is known, at least in the past. While electric detonators may have long lead wires which function as antennae to concentrate electromagnetic energy, microgas generators (MGG’s) have very short leads, for example 4 millimeters. Additionally, the thickness of metal in the devices is a factor, as thinness of metallic components can reduce the potential effect of EMI, for example, the bridge wire and leads. It is the opinion of industry experts that accidental ignition via ESD or EMI is not credible for various modern explosives. Per other discussions in the explosives working group, no transport incident data exists to corroborate accidental electrical activation of the explosive articles under discussion.

4. The criticality of operations within the automotive and aerospace industries, coupled with harsh conditions in uncontrolled circumstances, require high standards to protect against accidental functioning. The lack of incidents indicates that the standards are effective for the prevention of unplanned events.

5. Electrical testing information has been provided by a manufacturer of non-lethal policing tools. Such tools are critical to provide law enforcement with alternatives that do not rely on pain for compliance or inflict lethal force. Such tools have been exempted from

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\(^1\) The terms RFI and EMI are often used interchangeably. In practice, EMI may refer to short range interference caused by high frequency emissions within the device itself, but also includes ESD. RFI refers to longer wavelength interference from sources external to the device. Applicable test standards use the term “electromagnetic” to cover EMI, RFI and ESD.
explosives requirements for security and safety purposes. They are exempted for transport when carried by government representatives. However, difficulties arise in global distribution when classified as explosives, which falsely indicates an ability to explode\(^2\), resulting in national controls to prevent explosions, loss of life and damage to infrastructure.

**Testing approach**

6. Guidelines for EMI testing are provided in military and civil standards, which were used in the attached test report:

- The U.S. Department of Defense has standard MIL-STD-461G, Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment. This standard includes both RFI and ESD tests.

- The International Electrotechnical Commission (IEC) has standard IEC 61000-4-2, Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test.

7. Automotive standards were not used in the attached test report, but include USCAR28, Initiator Technical Requirements and Validation and AK-LV 16 Electric Igniters for Pyrotechnical Systems.

**RFI discussion and test results**

8. RFI is measured in volts/meter. Typical values\(^*\) are:

<table>
<thead>
<tr>
<th>Source</th>
<th>V/m at source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battleship radar</td>
<td>400</td>
</tr>
<tr>
<td>Radio station</td>
<td>95</td>
</tr>
<tr>
<td>Police and fire radio</td>
<td>5-30</td>
</tr>
<tr>
<td>Amateur Radio</td>
<td>5-100</td>
</tr>
<tr>
<td>Aircraft Radio</td>
<td>118-137</td>
</tr>
<tr>
<td>Truck radio (&quot;CB radio&quot;)</td>
<td>5-50</td>
</tr>
<tr>
<td>Normal maximum exposure</td>
<td>25-30</td>
</tr>
<tr>
<td>Normal high maximum exposure</td>
<td>50</td>
</tr>
</tbody>
</table>

\(^*\) Estimated

9. RFI test results are attached in Annex 1 for a device containing a sub-assembly ("cassette") containing two MGG’s each containing 96 mg NEM. The energetic components of the MGG include zirconium potassium perchlorate and smokeless powder:

- The MIL-STD-461G RS103 TEST was performed at a strength of 50 V/m and frequency of 500 – 1,000 MHz of a the device including MGG’s. There was no malfunction of the device and no reaction of the MGG’s.

- The MIL-STD-461G RS103 TEST was performed at a strength of 100 V/m and frequency of 500 – 1,000 MHz of a the device including MGG’s. There was no malfunction of the device and no reaction of the MGG’s.

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2 See Model Regulations, Appendix B, Glossary of Terms: “Explode. The verb used to indicate those explosive effects capable of endangering life and property through blast, heat and projection of missiles. It encompasses both deflagration and detonation.”
10. ESD test results are attached in Annex 2 for a sub-assembly ("cassette") containing two MGG’s each containing 96 mg NEM. The energetic components of the MGG include zirconium potassium perchlorate and smokeless powder:

<table>
<thead>
<tr>
<th>Contact Point</th>
<th>Direct/Indirect</th>
<th>Level (kV)</th>
<th>Contact Type</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1, P2, P3, P6, P7</td>
<td>Direct</td>
<td>6, 8</td>
<td>Normal Use</td>
<td>None</td>
</tr>
<tr>
<td>P1, P2, P3, P6, P7</td>
<td>Direct</td>
<td>4, 8</td>
<td>During Service</td>
<td>None</td>
</tr>
<tr>
<td>P1, P2, P3, P6, P7</td>
<td>Direct</td>
<td>2, 4, 8</td>
<td>Installation</td>
<td>None</td>
</tr>
<tr>
<td>P1, P2, P3, P6, P7</td>
<td>Indirect</td>
<td>11, 13, 15</td>
<td>Normal Use</td>
<td>None</td>
</tr>
<tr>
<td>P1, P2, P3, P6, P7</td>
<td>Indirect</td>
<td>9, 15</td>
<td>During Service</td>
<td>None</td>
</tr>
<tr>
<td>P1, P2, P3, P6, P7</td>
<td>Indirect</td>
<td>5, 9, 15</td>
<td>Installation</td>
<td>None</td>
</tr>
</tbody>
</table>

*Note: “Px” in the table above refers to the cassette interface board pin numbers / layout.*

**Summary**

11. The results show that the tested MGG’s are not susceptible to ignition from energies exceeding credible amounts of ESD. While probability may be assumed to be 1.0 (100% certainty of an accidental activation), this is not always credible. Perhaps industry should be incentivized to provide a higher level of safety, and prove it with testing as part of the classification process.

**Proposal**

12. COSTHA requests that the explosives working group consider this data with respect to the probability of initiation and discuss the potential benefit of these and similar tests.

**Annexes 1 to 2 attached below**
MIL-STD-461G

RS103 TEST 100 V/m STRENGTH

Frequency, Hz

Amplitude V/m

500.0M 550.0M 600.0M 650.0M 700.0M 750.0M 800.0M 850.0M 900.0M 950.0M 1.0G

500-1000MHz TEST

Operator: NOLAN B

12:14:13 PM, Friday, July 22, 2022
Revision
A – July 16 2019 – Initial draft from prior standard

1. Purpose
To verify that the DUT will survive reasonable ESD discharges during the assembly and use of the product.
The intention of these tests is that over time we will learn what, if any, sections can be reduced or eliminated in the future. Therefore, it is important to thoroughly document and communicate any failures found.

2. Applicable Standards or Documents
IEC 61000 – 4 – 2: Electrostatic discharge immunity test
MIL-STD-461G – CS118: Personnel borne electrostatic discharge

3. Test Setup and Procedure
   1. Please review the test setup below, ensure the product is placed properly on the insulation pad and the test setup is clear of all unnecessary items not pictured below

   2. The DUT should be grounded, if line powered, with only the grounding method used in the installation instructions of the DUT
   3. The following test procedure shall be applied to the following points on the DUT:
      1. Control grounds
2. Mounting holes that are plated and connected to a signal (earth ground)
3. Any point that is accessible during installation or use (e.g. switches, keypads, displays)
4. Connectors – Note, conductive housings / shielded connectors need only be tested on their shield not each connection point.
4. Sensitive circuits (like RF inputs) can be skipped if allowed by end product standard and the input is appropriately labeled as ESD sensitive

5. **Air (Indirect) Discharge Test**
   1. Set the EDS gun to the test threshold signified by the product standard or application. Record this value
   2. For each test point, squeeze the trigger on the ESD while separated from the DUT
   3. Approach test point rapidly until discharge to test point occurs
   4. Record any failures and product mis-operations
   5. Repeat steps 2 to 4 for all test points.

6. **Contact (Direct) Discharge Test**
   1. Set the EDS gun to the test threshold signified by the product standard or application. Record this value
   2. For each test point, place the tip of the ESD gun on the test point and squeeze the trigger
   3. Record any failures and product mis-operations
   4. Repeat steps 2 to 3 for all test points.

7. Upon completion of test, perform a functional test of the product to ensure no mis operations or product failures. Record any results

4. **Pass / Fail Criteria**
Pass fail criteria depend on end product standard. IEC and MIL-STD require different pass-fail criteria for contact usage and allowed mis operation or resets and lockouts. If no standard is specified, the following default IEC levels can be used:

**Direct Contact Tests:**
- Points accessible by operator during normal use (includes insulated surfaces)
  - 6Kv = No mis-operations or resets, 8Kv = No lockouts, or damage.
- Points accessible only during service that are normally contacted
  - 4Kv = No mis-operations, or resets, 8Kv = No lockouts, or damage.
- Points accessible only during service that are not normally contacted
  - 3Kv = No mis-operations, or resets, 8Kv = No lockouts or damage
- Points accessible only during installation
  - 2Kv = No mis-operations, or resets, 4Kv = No lockouts, 8Kv=No damage

**Air Discharge Tests:**
- Points accessible by operator during normal use (includes insulated surfaces)
  - 11Kv = No mis-operations, 13Kv = No resets, 15Kv = No lockouts or damage
- Points accessible only during service that are normally contacted

Page 2 of 4
28 Gorilla – Electronics Qualification Test
E-7 Electric Static Discharge – Rev A

9Kv = No mis-operations or resets, 15Kv = No lockouts or damage
- Points accessible only during service that are not normally contacted
  7Kv = No mis-operations or resets, 15Kv = No lockouts or damage
- Points accessible only during installation
  5Kv = No mis-operations or resets, 9Kv = No lockouts, 15Kv = No damage

Test Report Form
Date Test Performed: 10-22-21
Customer: Wrap Technologies
DUT Part Numbers with Revisions:
PCBA SLA – 0007, Rev. Z5.
PCB BRD-0003, Rev. Z5
Test Performed By: Nemanja Kuzmanovic
Test Setup Image(s):
Contact point test results:

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<tr>
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<td>During Service</td>
<td>None</td>
</tr>
<tr>
<td>P1, P2, P3, P6, P7</td>
<td>Direct</td>
<td>2, 4, 8</td>
<td>Installation</td>
<td>None</td>
</tr>
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</table>

Notes:

Integrity of the DS28E05 EEPROM will be tested at a TBD date.