Product Technical Bulletin #28

Vacuum Outgassing of MIL-DTL-55302 Connectors

In addition to AirBorn's "M-Series" of connectors which is qualified to Mil-DTL-83513, AirBorn also manufactures two series of connectors ("W-Series" and "R-Series") which are qualified to Mil-DTL-55302. Mil-DTL-83513 includes a special classification, referred to in the specification as "Space Class", which covers connectors which are to be used in space applications where outgassing due to high temperature and vacuum is a potential concern. Mil-DTL-55302 on the other hand does not include any separate classifications or requirements for connectors which are to be used in high vacuum, space applications. Although Mil-DTL-55302 doesn't include such a classification, many of AirBorn's customers use both the W-Series and R-Series connectors in such applications.

Generally speaking, use of any of these connectors in a space application implies that they must be tested for vacuum outgassing characteristics as described in ASTM E 595 and NASA SP-R-0022. When tested according to these specifications, the outgassing characteristics of the polymeric materials are quantified by two values: the "TML" (Total Mass Loss) and "CVCM" (Collected Volatile Condensable Material, sometimes shortened to "VCM") percentages. The TML value is a measure of the total weight loss of the polymer due to the volatilization of the polymer itself or of moisture which may have been absorbed in the polymer. The CVCM value gives an indication of how much of the evaporated material may recondense on a cooler surface such as an optical component whose performance could be impaired by surface condensation.

Although the test itself is fairly straightforward, interpretation of the results is not. For example, NASA SP-R-0022 contains a list of polymeric materials and their TML and CVCM percentages. Any material that exceeds 1.0% TML or 0.1% CVCM will not be approved for listing on the approved materials list. From a connector standpoint, this is often taken to mean that each and every material used in the connector must, when tested individually, meet the 1.0% TML and 0.1% CVCM requirements. This is a sensible interpretation when considering a connector consisting of several relatively large plastic parts of similar size, made from different materials. In this case, if the mass loss percentage (TML or CVCM) of any of the plastic materials was higher than the allowed value, then that plastic part would generate a significant mass of outgassing product by virtue of its relatively large mass (even though the *percentage* loss was still relatively small).

However, for a connector which consists of a large plastic part(s), made from a single material, plus much smaller amounts of other polymeric materials (such as adhesives, protective coatings, contact conditioner, etc.) it may be unreasonable to apply the same "all materials must pass" criteria under these circumstances. Certainly, if all the materials used in the connector do meet the 1.0% TML and 0.1% CVCM requirements, then there should be no question that the entire connector should meet the outgassing requirements. However, if one of the materials used in the connector in very small quantities has a TML or CVCM which is slightly above the NASA limit, it is more reasonable to assess the connector as a whole. This interpretation is recognized in Mil-DTL-83513 paragraphs 3.5.18 and 4.7.19 which state:

> *"3.5.18 Thermal vacuum outgassing (space classes only). The entire connector assembly, when tested in accordance with 4.7.19 shall have a maximum total mass loss (TML) of 1.0 percent of the original specimen mass and shall have a maximum volatile condensable material (VCM) content of 0.1 percent of the original specimen mass."*
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> *"4.7.19 Thermal vacuum outgassing (space classes only). All nonmetallic materials, including lubricants, used in the manufacture of these connectors shall be tested in accordance with SP-R-0022 to determine the maximum TML of the original specimen mass and the VCM content of the original specimen mass. For the purpose of determining TML and VCM of connectors, the original specimen mass shall be the assembled connector mass excluding metallic parts. The TML and VCM for the connector may be determined by testing the specific materials of the connector and calculating the loss for the connector."*

A specific example occurs in the case of the Surf-Guard™ surface conditioner that AirBorn sometimes applies to connector contacts in order to meet certain customer requirements. The Surf-Guard™ material has been tested in accordance with SP-R-0022 and found to have a TML of 0.38%, and a CVCM of 0.18%. Since the CVCM value is over the 0.10% maximum allowed by SP-R-0022 the surface conditioner would fail the requirements if judged by itself. However, in tests conducted by AirBorn it has been determined that if the entire connector is evaluated on the basis of the thermal vacuum outgassing requirements as defined in Mil-DTL-83513, the connector assembly will easily meet the TML and CVCM requirements. Because the amount of surface conditioner applied to the connector is so small (typically less than 10 milligrams even for a large connector) by comparison to the "nonmetallic" mass of the connector (the mass of the entire connector assembly minus the mass of the contacts), the calculated TML and CVCM values for the connector assembly (including the contribution from the plastic housing) are less than 0.20% and 0.001% respectively.

CONCLUSIONS AND RECOMMENDATIONS:

Because the amount of Surf-Guard™ which is applied to the connector is so small, we believe that AirBorn connectors which have been treated with Surf-Guard™ meet the *intent* of NASA SP-R-0022 and ASTM E 595 even though the Surf-Guard™ itself fails to meet the TML and CVCM requirements. It is therefore our recommendation that customers allow the use of Surf-Guard™ on R-Series and W-Series connectors which are to be used in space applications. If, for some reason, even in light of the rationale presented above, the customer still cannot accept use of a material which is not listed on the approved materials list in NASA SP-R-0022, there is still one other option.

In section 4.0 NASA SP-R-0022 states as follows:

> *"The use of materials that have been tested but failed the requirements of this specification may be allowed if the contractor can provide rationale for their use that is approved by NASA JSC. The following are examples of some considerations for use as rationale for a material that has failed the VCM of mass loss requirements.*
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> *a. The material may be brought within vacuum stability limits by vacuum baking for a specified period of time (usually 48 hours at maximum use temperature at a pressure of less than 10^{-4} torr)."*

By special request, AirBorn can subject connectors to a vacuum baking process as described above although we do not recommend this because the additional operation increases the cost of the connector to the customer without providing any benefit. In a similar manner, although it is possible to supply the connector without Surf-Guard™, we do not recommend this option either because of the tremendous improvement in durability and insertion force that the Surf-Guard™ provides.