Why Halogen-Free?

Five Things to Know When Specifying Halogen-Free Wiring Duct

White Paper

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Introduction

In applications ranging from networking and computer equipment to industrial machine controls, engineers and project managers are encountering new material requirements that are driving new offerings of alternative “halogen-free” wire management products. As environmental and other trends lead toward future growth of these products, confusion exists among those who must specify their use. What does “halogen-free” mean? Why is it important? And, in what applications is a halogen free product needed, now and in the future?

Halogen-free wiring duct has been available for quite some time and its use is expected to increase (along with other halogen-free products) over the coming years. This increase is driven by industry initiatives and legislation aimed at protecting the environment, by applications with enhanced fire safety needs and by applications requiring higher continuous use temperatures.

This paper will attempt to identify and shed light on several of the issues that arise in deciding when to specify a halogen-free wiring duct.

1. What does Halogen-free mean?

The halogens are five non-metallic elements found in Group 7 of the periodic table. The term "halogen" means "salt-former" and compounds containing halogens are called "salts".[1]

The Halogens are:

- Fluorine
- Chlorine
- Bromine
- Iodine
- Astatine

In general as the term implies “halogen-free” means the product material does not contain any compounds derived from these elements. Many persons in the electrical and electronic industry would give a definition of “halogen-free” similar to what the IPC organization (known as the Association Connecting Electronics Industries) provided in a recent paper, “Electrical and electronic products may be considered ‘halogen-free’ if they are assembled without the intentional use of these elements in the raw materials and these elements are not intentionally present in the end product.”[2]

This definition does not eliminate the potential for some unintentional halogenated compounds to be present in the form of material impurities or as the by-products of the production process. Test methods will typically allow some small trace amounts of halogen to be present to account for this incidental occurrence.

In the electrical and electronic industry confusion does exist with “halogen-free” terminology in part since the term is often associated with environmental directives and manufacturer driven “green” product initiatives. “Halogen-free” does not alone indicate that a product

Common “Halogen-Free” Terminology:

- *Halogen Free*
- *Zero Halogen*
- *No Halogen*
- *0H*
- *ZH*

Variations of terms indicating products are “halogen-free”.

enhances safety, health or is better environmentally for a given application. To equate any of these two directly is a misconception, which has lead many in the industry to consider “halogen-free” simply a marketing term. When halogen-free material is required for wire management products, consideration should be given to all product attributes prior to selecting the product for use in a particular application.

2. Why are Halogens used in plastic materials?

Halogenated compounds are used to produce properties in plastic products that can be hard to duplicate, at the same performance and cost, in non-halogenated compounds. As an example, Fluorine derived FEP (Fluorinated Ethylene Propylene) or Teflon®[3] provides extremely high heat resistance when used in the insulation of plenum rated communications cabling, which limits its combustion in a fire and provides excellent fire safety performance. Teflon® in other forms is also used in many other consumer and industrial products.

Take as a second example Chlorine, which is a component of PVC (Polyvinyl Chloride). According to the Vinyl Institute, “Vinyl is the second largest selling plastic and the most versatile one. Vinyl’s low cost, versatility and performance make it the material of choice for dozens of industries such as health care, communications, aerospace, automotive, retailing, textiles and construction.”[4] The chlorine in vinyl is derived from common salt and water, a readily available, inexpensive commodity allowing PVC to be produced at a lower cost compared to alternative materials.

The abundance of raw material components, relatively low material cost and desirable product properties are the key reasons many halogenated compounds are the materials of choice today. In many applications a halogenated material can provide the required product performance at a lower overall cost than halogen-free materials.

In the longer term to meet more application requirements, the challenge to halogen-free product developers will be to provide comparable or superior material properties to halogenated products at a comparable cost.

3. Why is there a need for alternatives to Halogenated plastic materials?

For some applications there is a concern that halogenated plastic materials will release corrosive and toxic gases if ignited in a fire. The corrosive element of these gases has the potential to damage electronics wherever the smoke travels, and the toxic element can be potentially hazardous to persons if they cannot easily evacuate from the area.

Applications where corrosion potential is of particular concern include communications data centers and phone switching stations with large amounts of expensive electronics. As a case in point the fire called “the worst disaster in telecommunications history” occurred on May 8th 1988 in a Hinsdale, IL Central Office facility for Illinois Bell. The fire cut local service to 35,000 suburban Chicago phone customers and was estimated to have cost many millions of dollars in recovery cost. In the after effects of the fire the central processor of the phone switch, which was not directly involved in the fire, had to be replaced reportedly due to the effects of acid corrosion.[5]

The toxicity of smoke is of highest concern within enclosed spaces where means of escape by persons are limited; examples include mass transit rail cars, ships, and Offshore Oil and Gas platforms. There have been several tragic fires that have occurred involving transit vehicles over recent years that have brought heightened

concern to this issue. In a February 2003 incident, news reports of a fire involving two trains in a Daegu, South Korea subway station told of how toxic fumes and heavy black smoke prevented firefighters from making a quick rescue of those trapped. 120 were killed and many others injured in that incident.[6]

There are several different approaches that can be taken in product selection in order to address the issue of toxic and corrosive smoke. One is to choose halogenated products that do not easily ignite, or ignite at a very high temperature, reducing the chance of toxic or corrosive gases being released. Another alternative is to choose non-halogenated products (halogen-free) that may ignite but will not release toxic or corrosive gases.

Beyond fire safety performance, a driver in choosing an alternative to PVC wiring duct in wire management applications can be environmental temperature. This driver is not directly related to the alternative material being halogen-free, but rather related to the maximum UL continuous use temperature of the product. Environmental temperature can become an issue for a wiring duct in applications such as outdoor utility enclosures, where the ambient temperature can rise above the continuous use temperature of most general-purpose PVC products. Halogen-free wiring duct will typically have a higher continuous use temperature rating, such as 95°C (203°F) [7], and is more suitable for these environments.

"Halogen-Free" Wiring Duct Drivers:

- *Fire Safety*
  - *Smoke Toxicity*
- *Fire Damage Prevention*
  - *Prevent Corrosive Effects to Electronics*
- *Higher Application Temperatures*
  - *When higher temperature PVC products are not available*
- *Environment*
  - *Legislative Directives*
  - *Manufacturer "Green Product" Initiatives*

Another growing driver toward alternatives to halogenated materials is the trend toward specifying more environmentally friendly products. At the moment the greatest emphasis toward environmentally friendly products is occurring in Japan and in the European Union. The essence of these movements is to identify substances that could be hazardous to the environment, and ban or restrict their use in certain products to prevent them from entering landfills or incinerators. The EU RoHS (Restriction of Hazardous Substances) and WEEE (Waste Electrical and Electronic Equipment) Directives[8] restrict the use of 6 substances in certain electrical and electronic equipment, mostly consumer related. The Japanese manufacturer initiatives are guided by the JGPSSI (Japan Green Procurement Survey Standardization Initiative)[9] and are more wide ranging, banning, restricting or requiring reporting on as many as 100 different substances that may be contained in a product or its packaging. Sony, Matsushita and NTT are among companies with such green procurement policies[10]. The effect on suppliers into these industries can be direct: a component they supply is directly used in the manufactured final product, or indirect: to facilitate their own compliance the OEM manufacturer requires or gives preference to suppliers that are compliant, regardless of where the product is used. This indirect effect can impact the product supply chain globally.

As a result these initiatives, and others like them, are changing the product/material decision process for a growing number of applications. Where as it is entirely possible that halogenated materials can meet certain environmental requirements, if a halogen-free product exceeds these requirements they may become preferred over the long term.

4. How do you know a Wiring Duct is Halogen-free?

Halogen-free truly is just a claim unless it can be verified with actual test data. Determining whether a product is halogen-free based on the material supplier information is possible, but difficult since most non-metallic products are a mixture of materials that may include a base resin, flame-retardant, colorants and other additives to give specific properties to the product. The preferred method is to conduct independent lab tests on the product's material to determine if the entire product can be classified as "halogen-free".

IEC-60754-2 recommended values to be classified as "halogen free":

- *The pH value should not be less than 4.3 when related to one liter of water*
- *The conductivity value should not exceed 10 µS/mm when related to one liter of water.*

The test methods used to determine whether a product is "halogen-free" do vary among electrical and electronic products. All methods however will seek to determine the presence and level of halogens and determine if they are considered unintentional.

The test method used to determine if a Wiring Duct is "halogen-free" is one commonly used for electrical and optical cables, IEC 60754-2, "Determination of the Degree of Acidity of Gases Evolved During the Combustion of Materials Taken from Electric Cables by Measuring pH and Conductivity." [11] The primary driver behind this standard is the prevention of damage to electrical and electronic equipment near the source of a fire.

To be considered "halogen-free" per the test method, the pH and conductivity values outlined in the standard should be met for the material (see inset). Methods for testing and calculating the recommended pH and conductivity values are discussed in the body of this standard.

5. What specification factors are important in a Halogen-free Wiring Duct?

Fire Safety

Specification factors in regard to fire safety with any non-metallic product can include flammability, flame spread, smoke toxicity and the optical density of smoke generated in the event of fire.

For most applications the primary specification factor for a non-metallic product, with regard to safety, is its ability to sustain and spread fire, or its flammability. As a result, almost all non-metallic materials (halogenated or not) are tested to determine their flame rating. A typical test method is UL94, which provides a rating of the material at the product thickness. The classifications of this test range from V-0, V-1, V-2 to HB based on their performance characteristics[12]. Engineers selecting products for use in electrical machine controls often specify an acceptable rating for non-metallic components. Non-metallic products, including halogen-free wiring duct, that are V-0 rated are more optimal as they have the preferred rating under this test method.

The amount of toxicity and smoke generation can also be specification factors for a particular material or product. As previously mentioned these two factors are of greatest concern in environments where people will be within enclosed spaces where movement away from a fire source may be restricted. Examples of such environments are transportation applications such as in mass transit vehicles, in offshore oil and gas drilling rigs, and in shipbuilding. In addition to other factors, reducing the level of toxicity of any smoke generated during a fire in these environments is a key specification factor and safety requirement. With regard to fire safety, the

term “halogen-free” refers only to the toxicity of the smoke generated during combustion of a material. By its nature a halogen-free product will not release significant levels of toxic or corrosive gases when it is ignited.

A verified halogen-free wiring duct with UL94V-0 flame rating is more suitable in environments where fire safety and specifically very low smoke toxicity are required. Applications requiring a very low toxicity material may specify the product by the term “halogen-free” material, by test method such as IEC 60754-2, or by a material or product name. An example V-0 material used for wiring duct is a halogen-free polyphenyl oxide, which is used in Panduit Type NNC Halogen-Free Wiring Duct.

Fire Damage Prevention

In applications such as data centers and phone switching stations, and other areas where large concentrations of electronics exist, there is concern that the smoke from even a small fire could travel to other areas and damage or affect the performance of nearby equipment. The mechanics of how this damage may occur and the extent of the damage possible from corrosive smoke are not entirely clear, as industry research on cabling and digital equipment showed[13]. However, companies can reduce the potential risk by specifying halogen-free products as part of a fire damage prevention strategy. A halogen-free wiring duct will not produce any significant corrosive gases during combustion. Test method IEC 60754-2 will verify a product is halogen free by determining the amount of corrosive gases present during combustion.

Applications using Halogen-free Wiring Duct:

- *Oil, Gas and PetroChemical Facilities*
  - *Offshore Petroleum and Gas Platforms*
  - *Land based*
  - *FPSO ships*
- *Transportation*
  - *Merchant ships*
  - *Mass transit railcars, stations*
  - *Bus*
- *Telco, CATV, Electrical Utilities*
  - *Power Generation Facilities, Machinery*
  - *Outdoor Utility Enclosures*
  - *Data Centers*
- *Electronics/Semiconductor Manufacturing*

Higher Application Temperature

As the environment temperature raises the likelihood that a more specialized material will be required increases. This can become an issue for a wiring duct in applications such as outdoor utility enclosures, where the temperature can rise above the continuous use temperature of most general-purpose PVC products[5]. As a halogen-free wiring duct will typically have a higher continuous use temperature rating, such as 95°C (203°F), it can find application in these environments. A product manufacturer typically provides the temperature rating in a product specification sheet or catalog. It is important to ensure this rating is UL verified to ensure the product will perform as expected at these elevated temperatures.

Environmental Initiatives

Many companies with a global presence will likely have already had some experience with the EU-RoHS directive, which will be implemented in July 2006. Compliance with this directive is becoming a specification factor. When a product supplier can verify compliance, it eliminates concern on the part of the purchaser that a product change may be required down the road to do business in the European Union. Some halogenated products, including some PVC wiring ducts, may not be capable of compliance due to the use of heavy metals

such as lead. To ensure their own compliance, OEM manufacturers may prefer to use products and suppliers that are RoHS compliant, which can include halogen-free products as an alternative.

As previously mentioned the Japanese manufacturer initiatives are guided by the JGPSSI (Japan Green Procurement Survey Standardization Initiative)[7] and are more wide ranging, banning, restricting or requiring reporting on as many as 100 different substances that may be contained in a product or its packaging. Sony, Matsushita and NTT are among companies with such green procurement policies. Several of these manufacturers specifically monitor use of PVC materials in their products and a few, such as Matsushita, plan to ban the use of PVC materials in their products in the future. For those who supply these manufacturers either with product components or equipment direct and indirect effects have moved product specifications and usage to more compliant products, including halogen-free wiring duct.

Things to look for in a Halogen-free Wiring Duct:

- *Halogen-free Confirmed by Independent Lab Testing*
  - *IEC 60754-2 typical test method*
- *V-0 Flammability Rating of Material*
  - *Per UL 94 test method (V-0 rating preferred)*
- *Higher Continuous Use Temperature*
  - *UL Recognized to at least 95°C (203°F)*
- *Environmental Compliances*
  - *RoHS Compliance*
  - *Compliance with manufacturer "green product" initiatives*

Conclusion

There is not a single reason, but several as to why halogen-free products including halogen-free wiring ducts are being specified. This paper has clarified the meaning of halogen-free components, that halogen-free is an indicator of a products material attributes. Has explained the test method used for verification that a wiring duct is halogen-free, IEC 60754-2 Test on Gases Evolved During Combustion of Electric Cables - Part 2. Has identified both current and future areas of application for halogen-free wiring duct which include oil, gas and petrochemical facilities, transportation applications, outdoor utility enclosures, data centers and electronics/semiconductor manufacturing machinery. And finally, has identified desirable attributes of a halogen-free wiring duct, that it is halogen-free as confirmed by independent lab testing, has a good flame rating (V-0 preferred), has a UL recognized continuous use temperature up to 95°C (203°F) and is compliant with environmental initiatives such as RoHS.

Usage of halogen-free products will continue to be driven by industry initiatives and legislation aimed at protecting the environment and by applications with enhanced fire safety needs, fire damage prevention needs and/or higher application use temperatures.

PANDUIT will continue its leadership role in offering the best wire & cable management solutions for the electrical and network infrastructure markets.

About *PANDUIT*

PANDUIT is a global leader in wiring and communication products, delivering end-to-end solutions in support of demanding electrical and network infrastructure requirements. The *PANDUIT* solution is built on a foundation of quality and durability to ensure maximum reliability and performance. Continually focused on market needs, research and development assists *PANDUIT* in providing innovative products that meet the application and

environmental requirements of today and tomorrow. This provides leading-edge solutions that allow businesses to move forward with their strategic objectives.

PANDUIT manufactures several different types of wiring duct, which includes PVC wiring duct, halogen-free wiring duct and low smoke/low toxicity wiring duct. *PANDUIT* Type NNC Halogen-Free wiring duct is made from a UL94V-0 PPO (polyphenyl oxide) material and has a UL verified maximum continuous use temperature of 95°C (203°F). All *PANDUIT* wiring duct, including PVC wiring duct, is RoHS compliant per the directive 2002/95/EC. *PANDUIT* reviews compliance with manufacturer green procurement requirements on a case-by-case basis.

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[1] Bentor, Yinon. Chemical Element.com- http://www.chemicalelements.com/groups/halogens.html

[2] IPC-WP/TR-584 April 2003, IPC White Paper and Technical Report on Halogen-Free Materials Used for Printed Circuit Boards and Assemblies

[3] Teflon® is a registered trademark of Dupont; See http://www.teflon.com/cablingmaterials

[4] The Vinyl Institute-The History of Vinyl; http://www.vinylinstitute.com/materialvinyl/history.html

[5] Hinsdale's aftermath: COs at risk. (Hinsdale, IL fire at Illinois Bell's central office), Telephony, March 20, 1989 v216 n12 p21(4); Hinsdale Co fire scrambles Chicago phones, Telephony, May 16, 1988 v214 n20 p8(2)

[6] S Korea subway fire kills 120, BBC News, Tuesday 18 February, 2003; Arrests over S. Korea train fire, CNN.com, Monday, February 24, 2003

[7] 50°C (122°F) is a typical maximum continuous use temperature for PVC Wiring Ducts.

[8] DIRECTIVE 2002/95/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment; DIRECTIVE 2002/96/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 January 2003 on waste electrical and electronic equipment (WEEE)

[9] JGPSSI (Japan Green Procurement Survey Standardization Initiative) is a committee at JEITA (Japan Electronics and Information Technology Industries Association).

[10] Sony Technical Standards SS-00259 Third Edition 2004-02-01; Matsushita Electric Industrial Co. Ltd., Chemical Substances Management Rank Guidelines Version 3 (For Products) August 29, 2003; NTT Group "Guidelines for Green Procurement" Revised May 2003.

[11] International Electro-technical Commission, IEC 60754-2 -- Test on Gases Evolved During Combustion of Electric Cables - Part 2.

[12] See UL Website under http://ulstandardsinfonet.ul.com/scopes/0094.html

[13] Comparison of Communications LAN Cable Smoke Corrosivity - Fire Risk & Hazard Research Assessment Research Application Symposium San Francisco, CA June 25-27, 1997, J. Thomas Chapin-Lucent Technologies, Bell Laboratories, Pravin Gandhi, Underwriters Laboratories, L.M. Caudill, Dupont