

Halogen Free 什么是无卤素 What is it and How Did We Get Here 怎样实现无卤素

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Use of Halogens 卤素的使用

- BFRs are added to plastics used in electrical and electronic equipment (EEE) to slow down or prevent the ignition of fire
溴化阻燃剂添加到电子电气产品中用的塑料里面，以减轻或防止火灾的发生。
- PVC is used as the base resin for certain cable jacketing and vibration dampening materials 聚氯乙烯以树脂基形态用在某些线缆的外被和减震材料中。
- Halogenated compounds (chlorinated and brominated) used as reducing agent in solder flux 卤素化合物，包括氯化物和溴化物，在助焊剂中用作还原剂。
- Polytetrafluoroethylene (PTFE) as a high performance PCB substrate
更为熟知的聚四氟乙烯是高性能的PCB基材。

Halogens in Epoxy Resins

环氧树脂中的卤素

- **Most PCB Resins are Epoxies**
大多数树脂都是环氧型树脂。
- **Epoxy resins contain measurable levels of Chlorine**
环氧树脂中的氯含量本身已达到可测得水平
- **Additional halogens are added to PCB laminates through glass sizes, wetting agents, curing agents and resin accelerators.**
卤素还会以其他形式添加到PCB中，例如玻纤胶料，润湿剂，固化剂，树脂促进剂，等。

Why use Brominated Flame Retardants?

为什么要使用阻燃剂？

- The major human health hazard is fire itself, not which materials are burning
危害人类健康主要是火灾本身，而非燃烧的物体。
- Flame retardants must balance health, environment, performance, cost
阻燃剂的使用必须权衡健康、环境、性能、成本等因素。



Why use Brominated Flame Retardants?

为什么要使用阻燃剂？

- Only a few chemical elements have flame retardant properties:
 - Halogens (Cl & Br mainly), P, N, inorganics
自然界中仅有少数几种元素具有阻燃特性：
如卤素(主要是氯和溴)，磷，氮，以及无机物。
- Different flame retardant families work by different mechanisms 不同的阻燃剂族具有不同的阻燃机制。
- End application influences level of flame retardancy needed
最终产品的应用将决定所需的阻燃等级。

Drivers for Removal of Halogens – Marketing 消除卤素的市场推动因素

- OEMs in Japan and Europe “environmental friendly” campaigns have moved from “lead-free” to “halogen free” 日本和欧洲的OEM厂商兴起的环境友好运动，以经从无铅转到无卤素。
- Eco-Labels awarded products that meet specific environmental requirements; some include halogen criteria 满足特定环境要求的产品上标注的环保标签，其中有些包含卤素要求。

Japanese OEM Green Marketing Goals

日本OEM的绿色市场目标

Company	Br-free PWBs	
	Timeline	Products Affected
Sony	2002	All new products
Ericsson	By end of 2001	80% of New Products
Fujitsu		Numerous products introduced, e.g. Notebook PC PWBs
Panasonic™	March 2001	Eliminate Br flame retardants
NEC	March 2003	All products
Toshiba	March 2003	All Products
Motorola	2001	Introduction in Select Products



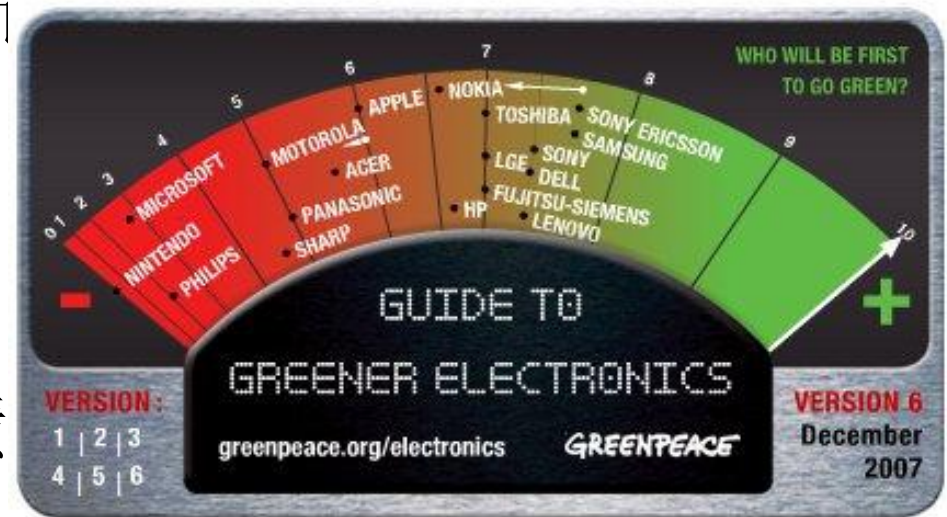
Drivers for Removal of Halogens – Marketing 消除卤素的市场推动因素

- Concern by some stakeholders over environmental and human health impacts 股民对环境和健康的担心
- Certain BFRs are toxic (PBBs, PBDEs)
某些溴化阻燃剂确实有毒(多溴联苯、多溴二苯醚)
 - Structural similarities between many BFRs and polychlorinated biphenyls (PCBs) which are known to be hazardous 许多溴化阻燃剂与已知有毒的多氯联苯结构相似
 - Precautionary principle applied to all BFRs
刺激了对所有溴化阻燃剂的防范心理
- EOL combustion byproducts
产品寿命终止燃烧处理产生的毒副产品
 - Incomplete combustion of halogens creates dioxin
卤素的不完全燃烧产生二恶英
 - Prevalent in uncontrolled burning
废弃电器常温燃烧在全球范围内盛行

Drivers for Removal of Halogens – Marketing 消除卤素的环境推动因素

- Strong Opposition to BFRs by Environmental Groups 环境组织强烈反对溴化阻燃剂
- Marketing campaign targeting computer manufacturers 针对计算机制造商的营销运动

- Computer Takeback
- [Silicon Valley Toxics](#) SVTC计算机绿色成绩



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Greenpeace

绿名和亚知知自形亚△△

“HP laptops more toxic than they say, Apple more toxic than you'd think” – Greenpeace, September 18, 2006

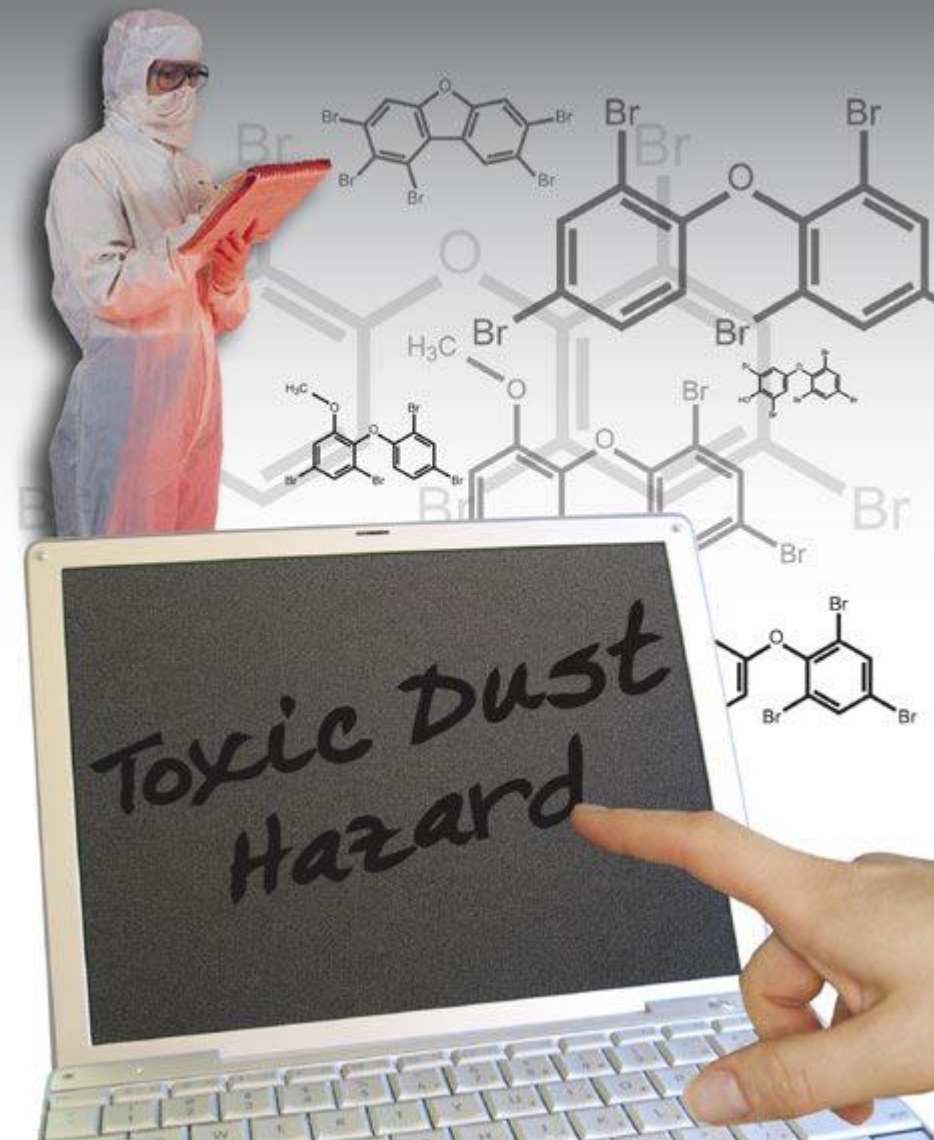
2006年9月18日，绿色和平公布调查结果：
惠普手提电脑所含的有毒物多于他们自己所说的；
苹果所含毒素比公众想象的要多。



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Brominated Flame Retardants in Dust on Computers:

THE CASE FOR SAFER CHEMICALS AND BETTER COMPUTER DESIGN



Drivers for Removal of Halogens – Marketing 消除卤素的环境推动因素

- OEMs are now seeking “halogen-free” solutions and imposing these requirements on their supply chains
在环境组织的推动下，OEM正在寻求无卤素解决方案并将这一要求推及整个供应链。
- Major OEMs announce elimination of bromine
各大主要OEM公告消除溴化物
 - Apple (PVC and BFR by the end of 2008)
苹果：2008年底消除聚氯乙烯和溴化阻燃剂
 - Dell (BFR 2009)
DELL：2009年消除溴化阻燃剂
 - HP (BFR and PVC 2009)
HP：2009年消除聚氯乙烯和溴化阻燃剂

PBBs (Polybrominated Biphenyls) 多溴联苯

- Found to be persistent, bioaccumulative toxins
发现其毒性持久积蓄在生物体内
- Classified possible carcinogens 可能属于致癌物
- Most production of PBBs ceased in the 1970s.
大多数多溴联苯的生产终止于70年代
- Prohibited under RoHS 在RoHS中禁用
- Result: rarely found in EEE manufactured today
现今生产的电子电器产品中鲜含多溴联苯

Penta & Octa-BDE 五溴和八溴联苯醚

- Considered possible endocrine disruptors
可能扰乱内分泌系统
- Penta-BDE used predominately in PU foam
五溴联苯醚主要用于聚氨酯泡沫
- Octa-BDE used to minor extent in EEE, mostly in automotive applications
八溴联苯醚少量用于EEE，多数用在汽车业
- Banned in EU from August 15, 2004
2004年8月15日被欧盟禁用
- Sole manufacturer of both products ceased global production in 2004
这两种产品的唯一制造商2004年全球范围内终止了生产
- Result: rarely found in EEE manufactured today
目前罕见于电子电器产品中

Deca-Brominated Diphenyl Ethers 十溴联苯醚

- Deca-BDE is still used as a flame retardant in some plastic housings, particularly in TVs
十溴联苯醚仍然作为阻燃剂用在某些塑料机壳内，特别是电视机
- EU risk assessment concluded May 2004
2004年5月欧盟风险评估结论是
 - No risk to human health or the environment
对健康和环境没有风险
 - No need for risk reduction measures
不需要降低风险措施
 - No restriction on marketing 无市场限制
- Flame retardant, plastics, and textiles industries are implementing voluntary monitoring and measures to and reduce industrial emissions
阻燃剂业，塑料业，以及纺织业都在主动监测其使用

TBBPA 四溴双酚A

- TBBPA is the leading flame retardant used reactively in circuit boards (95%) and computer chip casings
TBBPA主要用于电路板(95%)和计算机芯片封装外壳
- EU Risk Assessment 欧盟风险评估结果
 - Final report on Human Health RA published in 2006
2006年公布的影响人类健康报告确定为
 - No risks identified 无危险
 - No need for risk reduction measures 无需降低危险措施
 - Draft Environmental Section, March 2007年3月环境草案中列为R50/53, 对水栖生物体剧毒, 仅限于添加型TBBPA
 - TBBPA is classified R50/53, very toxic to aquatic organisms
 - Applies only to additive use of TBBPA
- EU Authorities agreed that TBBPA is not a Persistent, Bioaccumulative, Toxic (PBT) chemical
欧盟权威机构同意TBBPA不属于持久可积聚的有毒化学品

EOL - Dioxins and Furans

产品寿命终止 - 二恶英和呋喃

- Proper incineration ($>800^{\circ}\text{C}$) of halogenated FRs does not generate furans or dioxins.
卤化阻燃剂适当焚烧 (800°C 以上) 不会产生呋喃或二恶英
 - Controlled 控制
 - Regulated 管制
- Residential wood burning releases 5x more dioxin than municipal incineration
住宅木制品燃烧释放的二恶英5倍于城市焚烧炉
- Backyard barrel burning releases 52 times amount of dioxin compared to municipal incineration
家庭废弃物自行燃烧释放的二恶英52倍于城市焚烧炉

EOL - Dioxins and Furans

产品寿命终止 - 二恶英和呋喃

- Formed at low levels during any hydrocarbon combustion where chlorine is present
含氯的碳水化合物燃烧期间会形成少量的二恶英和呋喃
- From firefighter data, levels of furans and dioxins generated in accidental fires are not a health concern 根据消防数据，意外火灾产生的呋喃和二恶英水平对人身健康的影响不大。

EOL - Dioxins and Furans

产品寿命终止 - 二恶英和呋喃

- Halogenated aromatics having “similar chemical structures, similar physical-chemical properties and involve a common battery of toxic responses” (USEPA) to 2,3,7,8 Tetrachlorodibenzo Dioxin (TCDD) 根据美环保署资料, 某些卤化芳香族具有与2,3,7,8四氯二苯二氧芑“类似的化学结构, 类似的理化特性, 以及类似的毒性反应”
- Expanded family of dioxins and furans includes Br and Cl species 二恶英和呋喃的扩展成员包括溴和氯
- Of the expanded family, only TCDD is listed as a human carcinogen 在二恶英和呋喃的扩展成员中, 只有四氯二苯二氧芑是致癌物

BFR Regulation in the Europe

欧洲溴化阻燃剂法规

- Bans use of PBBs and Penta-and Octa-BDE
禁用多溴联苯，五溴和八溴联苯醚
- EU RoHS Exemption for Deca-BDE 欧盟RoHS豁免十溴联苯醚
 - Commission decision on October 13, 2005 to exempt DecaBDE
2005年10月13日通过对十溴联苯醚的豁免决议
 - Revoked by the EU Court of Appeals July 1, 2008 on technicalities
2008年7月1日欧盟地区法院从技术面撤销上述豁免
- WEEE Directive 指令
 - Separation requirement for plastics containing brominated flame retardants before further treatment
要求分离含有溴化阻燃剂的塑料
 - WEEE Directive requires separation of All PWBs greater than 10 cm², regardless of content, and all PCBs in mobile phones
WEEE指令要求分离所有大于10平方厘米的PCB，以及手机内的PCB，无论含量多少

BFR Regulation in the Europe

欧洲溴化阻燃剂法规

- No Regulation of TBBPA 尚未纳入法规
- TBBPA is unlikely to undergo further restrictions under REACH.
不大可能列入REACH限制范围
- TBBPA is not a PBT and would not have to go through Authorization.
不是聚酯树脂，不必经过许可

BFR Regulation in the Asia

亚洲溴化阻燃剂法规

- China RoHS
 - Disclosure of PBBs, PBDE use
披露多溴联苯和多溴二苯醚的使用
 - Restriction of PBBs and PBDEs in items listed in forthcoming catalogue
列入目录的产品限用多溴联苯和多溴二苯醚
- Japan
 - labeling requirements for PBB and PBDE use
使用多溴联苯和多溴二苯醚的产品需要标示
- Korea
 - Restriction of PBBs and PBDEs
限用多溴联苯和多溴二苯醚

BFR Regulation in the U.S.

美国溴化阻燃剂法规

- **States with current laws restricting penta- and octa-PBDE**
限用五溴/八溴联苯醚的州
 - California, Hawaii, Illinois, Maryland, Maine, Michigan, New Jersey, New York, Oregon, Rhode Island, Washington, and Wisconsin
加州, 夏威夷, 伊利诺伊, 马里兰, 缅因州, 密西根, 新泽西, 纽约, 奥尔良, 罗德岛, 华盛顿, 威斯康星等
- **Many originally called for a total BFR ban**
许多州最初都提倡全面禁用溴化阻燃剂
- **Do not limit use of TBBPA** 不限制使用TBBPA
- **States studying Deca Bans** 研究禁用十溴的州
 - Maine, Washington have released initial studies
缅因州, 华盛顿, 已经公布了研究成果
 - Illinois, Maryland, Massachusetts, Oregon, Hawaii, and Rhode Island have studies underway
加州, 夏威夷, 伊利诺伊, 马里兰, 密西根, 新泽西, 纽约, 奥尔良, 罗德岛, 威斯康星等还在进行之中

Industry Dilemma 工业界面临两难

- ∅ Wholesale product bans, without scientific justification are bad public policy and business practice
未经科学辩护而实施大规模产品禁止是一种不健康的行政行为和商业做法
- ∅ Are alternatives any safer or worse?
替代品更安全还是更恶劣尚无定论
- ∅ Even the most rigorous evaluations (EU Risk Assessment) have not been accepted by some groups
即使是最严格的评估(欧盟风险评估)也还没有得到某些组织的接纳
- ∅ How long until alternatives are targeted?
还需要多久才能敲定替代品

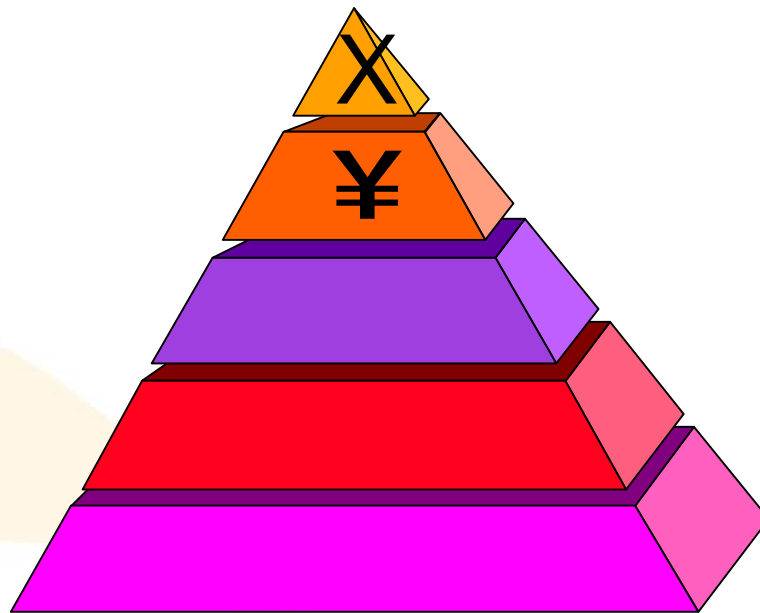
Activist Flame Retardant Deselection Strategy

激进分子取消阻燃剂的策略

“The Flame Retardant Pyramid of Problems”

阻燃剂金字塔(毒性从上到下依次减弱排列)

激进分子将按照这个顺序逐级歼灭下面列出的阻燃剂



PBB, Penta, Octa 多溴联苯, 五溴, 八溴

Deca, HBCD, TBBPA

十溴, 六溴环十二烷, 四溴双酚A

TPP & All BFR's

磷酸三苯酯和所有溴化阻燃剂

Phosphorus FR's 磷阻燃剂

Remaining FR's 其他阻燃剂

Adapted from Greenpeace toxic pyramid of plastics



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Source: <http://www.greenpeace.org/~comms/pvctoys/reports/loomingfuture.html>

Summary: After All Data Has Been Considered, the IPC Believes:

总结：综合考虑所有因素后IPC相信

- “Halogen-free” is a marketing term currently
无卤素目前已流为一个市场术语
- The halogenated flame retardant TBBPA is safe for people and environment
卤化阻燃剂TBBPA对人与环境是安全的
- No differences exist between TBBPA and non-halogenated alternatives for environmental issues
就环境而言TBBPA与替代品之间没有什么不同
- Reductions in use of TBBPA is not appropriate and we cannot recommend specific non-halogenated flame retardants
减少使用TBBPA不合适，我们推荐不出任何非卤素阻燃剂
- Reports of improved performance needs verification
充斥市场的性能改良报告需要验证

IPC Supporting Industry Needs

应业界之需采取的相关行动

- IPC-4101A Slash Sheets for Halogen Free Laminates
无卤素基材规格单
- IPC-TM-650 TM 2.3.41 *Test Method for Total Halogen Content in Base Materials* 基材中卤素总含量的测试方法
- J-STD-609 “Marking and Labeling of Components, PCBs and PCBAs to Identify Lead (Pb), Pb-Free and Other Attributes”
区别元件PCB和PCBA含铅无铅及其他属性的标记标签
- [Draft J-709 Low Halogen Electronics](#) 低卤素电子产品
- Electronics Manufacturing with Lead-Free, Halogen-Free, & Conductive Adhesive Materials Handbook
无铅无卤素以及导电胶电子制造材料手册
- WP/TR-584A IPC White Paper and Technical Report on the Use of Halogenated Flame Retardants in Printed Circuit Boards and Assemblies (Correcting the Misunderstandings on "Halogen-Free")
IPC关于卤化阻燃剂在印制电路板和组件中的使用的白皮书和技术报告(纠正无卤素的误解)

值得注意的是委员会
在7月到9月期间将无
卤素名称改为低卤素

IPC Low Halogen Electronics Standard Task Group 4-33a & JEDEC JC14 Committee

IPC低卤素电子标准工作组4-33A & JEDEC JC14委员会

Update on Working Draft of **J-STD-709** 工作草案更新

“DEFINITION OF MAXIMUM LIMITS ON BROMINE AND CHLORINE USED IN MATERIALS FOR LOW HALOGEN ELECTRONIC COMPONENTS AND ASSEMBLIES”

对于低卤素电子元件和组件材料中溴和氯最大含量的定义

Halogen-Free – Industry Standard Status

无卤素行业标准现状

Proposed definition 定义提案

- An article must meet all of the following requirements:

物品必须满足下列所有的要求:

- All PCB laminates must meet Br and Cl requirements for low halogen as defined in IPC-4101B **所有PCB基材必须满足IPC-4101B标准中定义的低卤素溴和氯的要求**

- For components other than PCB laminates, all homogeneous materials must contain less than 900 ppm of Bromine [if the Bromine (Br) source is from BFRs] and less than 900 ppm of Chlorine [if the Chlorine (Cl) source is from CFRs or PVC or PVC congeners]. Higher concentrations of Br and Cl are allowed in homogenous materials of components other than PCB laminates as long as their sources are not BFRs, CFRs, PVC or PVC congeners.

其它非**PCB**基材的元件中所有均质材料所含的溴（如果来源于溴化阻燃剂）和氯（如果来源于氯化阻燃剂和/或聚氯乙烯）必须低于**900ppm**。除此之外，在非溴化阻燃剂，氯化阻燃剂或聚氯乙烯的均质材料中，较高含量的溴和氯是允许的。



Halogen-Free – Industry Standard Status

无卤素行业标准现状

Proposed definition 定义提案

- Although the elemental analysis for Br and Cl in homogeneous materials can be performed by any analytical method with sufficient sensitivity and selectivity, the presence or absence of BFRs, CFRs, PVC, and PVC congeners must be verified by any acceptable analytical techniques that allow for the unequivocal identification of the specific Br or Cl compounds, or by appropriate material declarations agreed to between customer and supplier.

虽然均质材料中溴和氯元素的分析可以用任何具有足够灵敏度和选择性的分析方法进行，但是溴化阻燃剂、氯化阻燃剂和聚氯乙烯的存在与否，必须通过可接受的分析技术确认，以提供不含糊的具体溴或氯化化合物的鉴定，或者由客户和供应商协商适当的材料声明

。

Working Draft J-STD 709 – Open Issues

遗留问题

- **Article Level vs Homogeneous Material Level Compliance**
符合性定在哪个层面：物品还是均质材料
- **Alignment of MCV levels to RoHS (1000ppm vs 900ppm)**
与RoHS的限量要求相一致(1000ppm vs 900ppm)
 - Joint Industry Guide (JIG) material declaration standard for industry currently have non-RoHS BFR and PVC reporting thresholds at 1,000 ppm (0.1 wt%).
联接工业指南（**JIG**）工业材料声明标准现行非**RoHS**溴化阻燃剂和聚氯乙烯申报限量为**1000ppm（0.1wt%**）
 - JIG has been asking for reporting since 2005
JIG自2005年起已经要求申报

Working Draft J-STD 709 – Open Issues

遗留问题

- Non-PCB sector of industry supply chain is more familiar with RoHS than IEC standard; RoHS threshold is 1,000 ppm (0.1 wt%)

电子供应链除**PCB**企业外对**RoHS**标准比**IEC**标准更为熟悉，**RoHS**的限量是**1000ppm (0.1wt%)**

- RoHS II is going through revision. It is in industry's best interest to not set a potential policy precedence by setting voluntary lower thresholds as this could get put into legal regulatory thresholds

RoHS II正在修订中。对行业最有利的做法是不要主动设立更低限量的政策，极可能诱使其成为法定限量。

- Eg. If a BFR is covered by IPC/JEDEC std and then becomes regulated under RoHS, it does not make sense to have threshold increase from 900 ppm (voluntary) to 1,000 ppm (regulated)

例如，已列入**IPC/JEDEC**标准的某溴化阻燃物，同时属于**RoHS**管制范围，实际操作中把限量从**900ppm(非官方)**增加到**1000ppm(立法)**没有任何意义。



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Future Policy Goals 未来政策目标

- Change environmental procurement principles 改变环境保护法则
- Drive for criteria-based selection versus product de-selection
推动基于标准的选择而非禁用产品
- Use REACH & risk assessments to support sustainable risk management
采用REACH和风险评估支撑风险管理
- Full life cycle assessments instead of toxicity based bans 全程寿命评价取代基于毒性的禁用