

## Recycling and the Need for Information on Chemicals in Products

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Based on the presentations by:

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At the "Chemicals in Products" Workshop in Geneva, Feb 2009

### Message from POPs COP4

- Text inserted to Annex A to the Stockholm Convention -

**A Party may allow recycling of articles that contain or may contain BDEs, and the use and final disposal of articles manufactured from recycled materials that contain or may contain BDEs, provided that:**

- (a) The recycling and final disposal is carried out in an environmentally sound manner and does not lead to recovery of BDEs for the purpose of their reuse;
- (b) The Party takes steps to prevent this exemption to lead to the export of articles containing levels/concentrations of BDEs that exceed those permitted to be sold within the territory of the Party; and
- (c) The Party has notified the Secretariat of its intention to make use of this exemption.

## POPs COP4 Decision

1. **Parties are requested and observers are invited to provide any information** by July 2010 on newly listed POPs as follows:
  - (i) For BDEs found in articles:
    - (a) **Types and quantities of articles containing DBEs including concentrations of these substances in the articles, including recycled articles;**
    - (b) **Types of articles recycled, the extent of recycling, the types of articles produced from this recycling, the options for the environmental management of the recycling operations and releases resulting from these recycling operations;**
    - (c) Cost-effectiveness of different management options;
    - (d) Options for environmentally sound disposal;
    - (e) Methods for identifying the presence and levels of these substances in articles; Identification of remediation methods for contaminated site;
    - (g) Any other related information...
2. The Secretariat is requested to gather and summarize such information for POPRC6.
3. POPRC5 is requested to develop terms of reference for a technical paper to assess the possible health and environmental impact of recycling and BAT/BEP.
4. The Secretariat is requested to commission a technical paper to be submitted to POPRC6.
5. POPRC is requested to review this information, identify information gaps, and prepare reports and recommendations to COP5 on the elimination of BFRs from the waste stream and on risk reduction for PFOS(F).

## Importance of information sharing

- Information disclosure: from Producers to Recyclers

- Safer recycling process ..... Regulatory framework also needed
- Higher recycling rate ..... Economic benefits for recyclers
- Less contaminated materials.....

- Feedback: from Recyclers to Producers

- Improve Design for Environment (DfE)

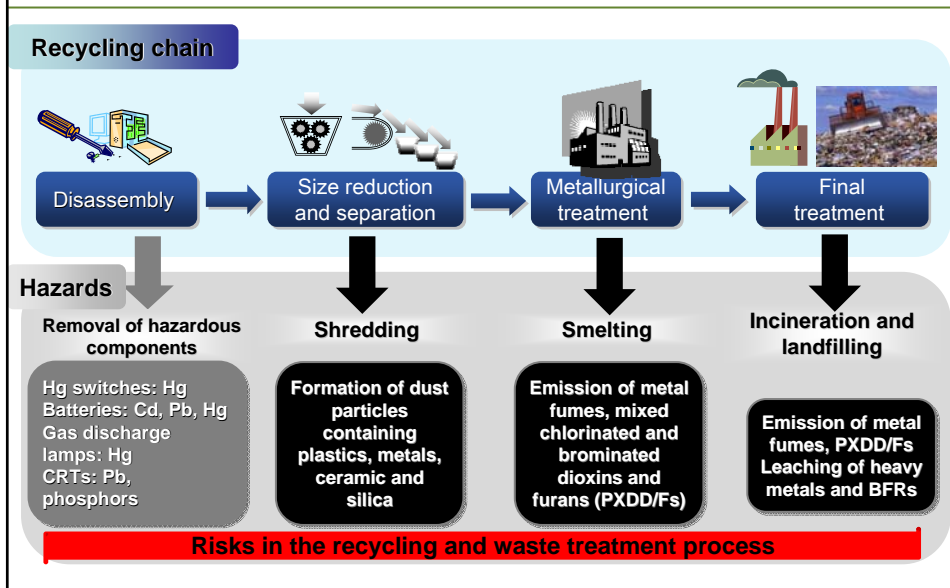
Rationale: With improved knowledge on how products are recycled and how waste is treated, and on hazards related with those operations, producers can improve their product design.



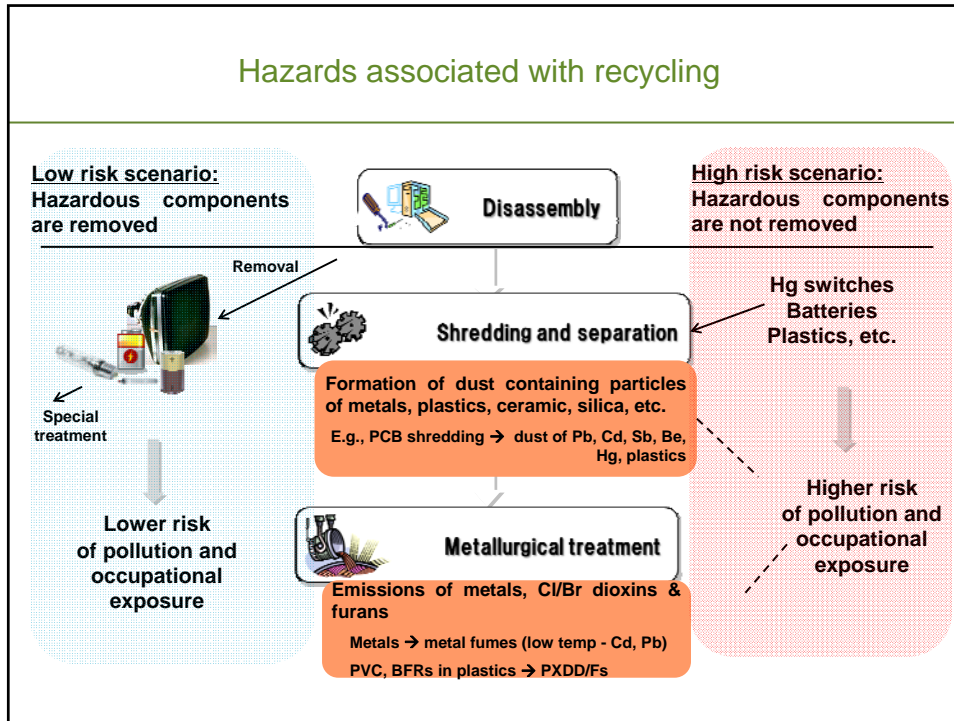
## Hazardous substances and components in WEEE

Components	Found in	Substances of concern
Cathode ray tubes	Old TV sets, PC monitors, oscilloscopes	Pb in cone glass Ba in electron gun getter Cd in phosphors
Printed circuit boards	Ubiquitous, from beepers to PCs	Pb, Sb in solder Cd, Be in contacts Hg in switches BFRs in plastics
Batteries	Portable devices	Cd in Ni-Cd batteries Pb in lead acid batteries Hg in batteries
Gas discharge lamps	Backlights of LCDs	Hg
Plastics	Wire insulation, plastic housing, circuit boards	Brominated flame retardants

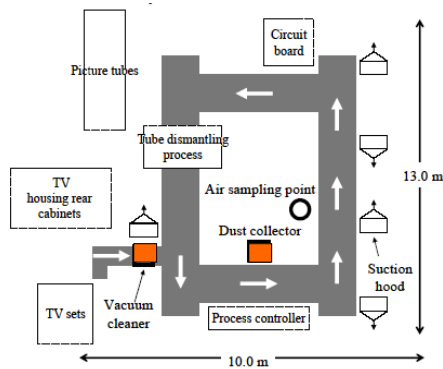
## Hazards associated with the recycling chain



## Hazards associated with recycling



### Behavior and emission control at recycling/waste treatment stage BFRs and PBDD/DFs in recycling plant of waste home appliances



**Investigated facility:**

- Dismantling and shredding of waste TVs.
- Dismantling approximately 600 TVs/day.
- New dust collection apparatuses were introduced.

**Survey:**

- Sampled air in working place before and after introduction of the apparatus.
- Difference of BFRs and PBDD/DFs concentrations and patterns in air samples was evaluated.

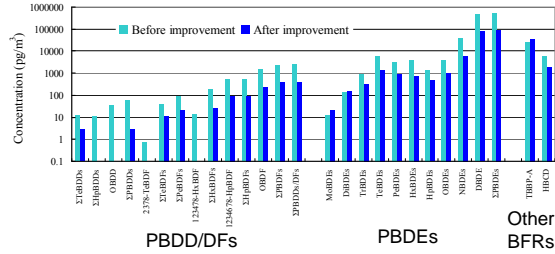
**Schematic diagram of the investigated TV dismantling process**

( ■ : introduced apparatus for dust collection)

H. Takigami; Organohalogen Compounds, 68, 2190-2193 (2006)

## Behavior and emission control at recycling/waste treatment stage BFRs and PBDD/Fs in recycling plant of waste home appliances

**Air concentration of PBDD/DFs and BFRs in the TV dismantling process before and after introducing dust collection apparatuses**



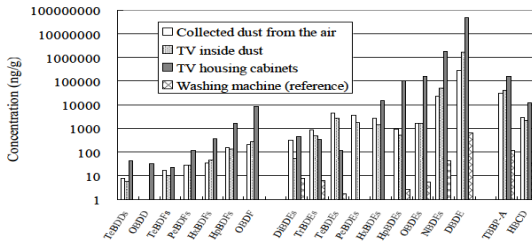
**Before improvement**

PBDEs: 510,000 pg/m<sup>3</sup>  
PBDD/DFs: 2,400 pg/m<sup>3</sup>

**After improvement**

One order magnitude lower

**The difference in concentration of PBDD/DFs and BFRs for two dust samples and two related plastic samples**



- The patterns and concentrations of PBDEs in the airborne dust were quite similar to those of the TV inside dust.

**=> The airborne dust derived from the TV inside dust.**

- Emission control of dust is effective for reducing the concentration of BFRs and PBDD/DFs.

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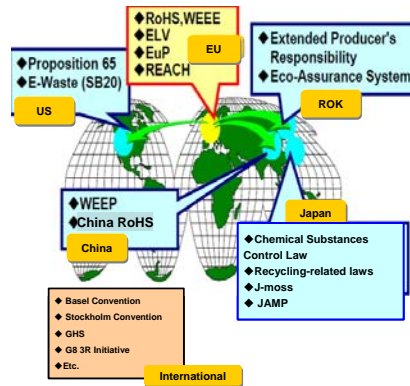
## Recent initiatives on treatment of end-of-life products and hazardous chemicals in products

### Globalizing movement

- Many policy initiatives, mainly originating from the EU
- Fewer and less hazardous substances used
- Improved availability of information on hazardous substances used in products
- Regional initiatives have global impact

### Domestic initiatives in Japan

- Revision of the Chemical Substances Control Law
- Recycling-related laws (e.g. Electronic Home appliances, PCs)
  - **JAMP** (industry response to REACH)
  - **Waste Data Sheet**
  - **Marking and Labelling**
  - **J-moss** (Japanese RoHS labeling)



Adapted from : Yoshiaki Ichikawa (Hitachi), "Eco-conscious design and the 3Rs", IGES/ K- FACE Global Environmental Seminar Economic Globalization and the 3Rs, January 31, 2007

## Current situation in Japan

### Collection and recycling of e-waste

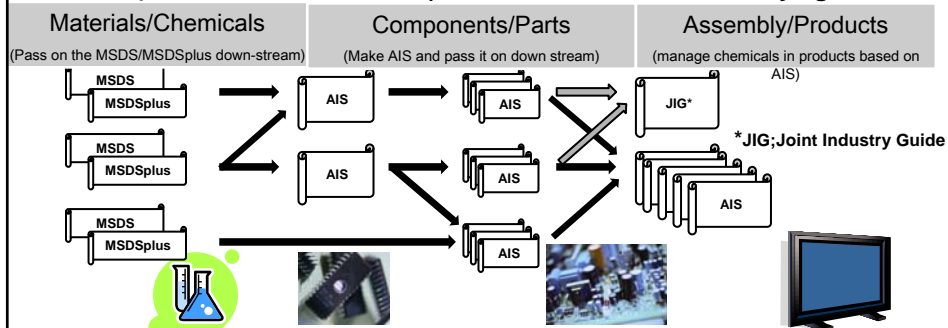
Products	Collection scheme
Refrigerators, Washing machines, TVs, PCs, Air conditioners	<ul style="list-style-type: none"> <li>• Producer responsible for recycling</li> <li>• Consumers pay recycling fee at disposal</li> </ul>
Mobile phones	Network operators run a joint initiative to collect and recycle
Other large household electronics (Stereos, Microwave ovens etc.)	<ul style="list-style-type: none"> <li>• Some municipalities collect as “large waste” on designated days</li> <li>• Sold to recyclers</li> </ul>
Small electronics (Cameras, MP3s etc.)	<ul style="list-style-type: none"> <li>• A few pilot projects to collect</li> <li>• Often public-private partnerships</li> </ul>

## Current situation in Japan

**JAMP (Joint Article Management Promotion-consortium)** is an industry initiative to manage information on chemicals in products (response to REACH)

**JAMP MSDSplus:** supplemental MSDS regarding substance/preparation. MSDSplus focuses on materials and the amount.

**JAMP AIS (Article Information Sheet):** Information format for conveying chemical



- **Information sharing from up-stream to down-stream in the supply chain**
- **Producers of articles can receive “complete” chemical information**

reference: <http://www.jamp-info.com/>

## Current situation in Japan

Waste Data Sheets contain information of industrial waste to assure proper disposal and to prevent accidents

<ol style="list-style-type: none"> <li>1. Date</li> <li>2. Name of Waste</li> <li>3. Name and Contact of Waste Provider</li> <li>4. Class of Waste (check lists)</li> <li>5. Type of Packing</li> <li>6. Amount of Waste</li> <li>7. Hazardous information             <ol style="list-style-type: none"> <li>1) Hazardous Characteristics</li> <li>2) Stability</li> </ol> </li> </ol>	<ol style="list-style-type: none"> <li>8. Physical/Chemical Property</li> <li>9. Composition/Component Information</li> <li>10. Remarks             <ol style="list-style-type: none"> <li>1) Measure for Safety</li> <li>2) Accident Response(Emergency Treatment , Treatment for Leaking, and Treatment for fire)</li> </ol> </li> <li>11. Special Note. <small>Reference: MOEJ, WDS guideline</small></li> <li>12. Others.</li> </ol>
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- Information from waste generators to recycling and treatment
- Only industrial waste and focus on physical hazards

## Current situation in Japan

### Marking and Labeling

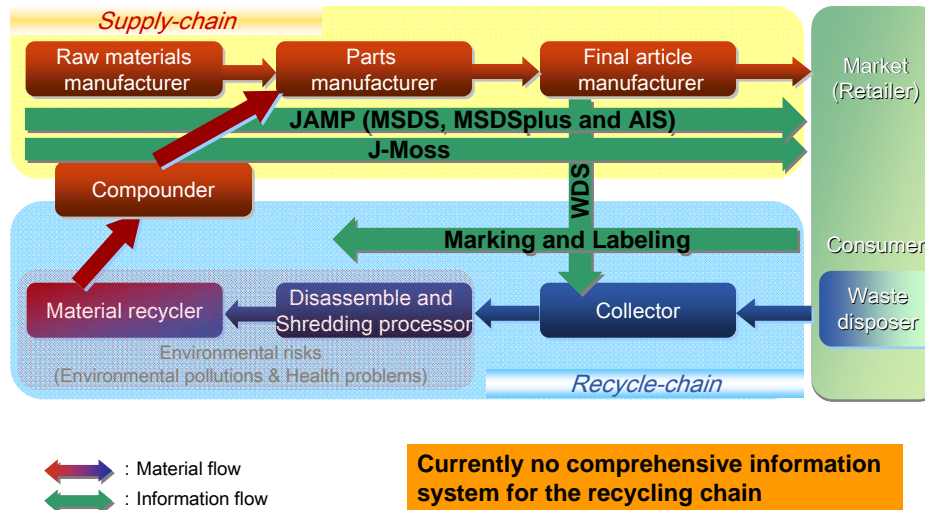
1. Identification of plastic parts
2. Symbols to make manual disassembly easier
3. Marking for presence or absence of selected chemical substances
4. Labeling of equipment containing rechargeable batteries

- Mostly voluntary systems
- Developed for large household appliances
- Introduced over the last few years

	Contents	Example of Marks	Year
Plastic Parts	Material Info.	>PC+ABS-CF FR(40)<	2007
	No Flame Retardants	>ABS< FR0	
	Contents Recycled Plastic	>PP< CR30	
	Label and Seal	>PET< / >PS<	
	Metal Info.	-Fe-	2008
Recycling Symbols	Metal has been inserted into the plastic parts		2004
	Hole puncture location		
	Symbols to show the direction of the compressor's refrigerant enclosing pipe		
	J-Moss Red mark		2006
	Marking presence of specific chemical substances in mounted boards		2005
	Rechargeable battery		2001

Reference; <http://www.aeha.or.jp/>

## Overview of information systems in Japan



## Chemicals in products/articles

### Analysis of chemicals in new products/articles

#### Samples:

- Liquid crystal display (LCD) TV, Laptop PC, Power supply unit
- Wallpaper, Curtain, Heat insulation material

#### Analyzed chemicals:

- Organobromine compounds (PBPhs, TBBPA, HBCDs, PBDEs)
- Phosphoester plasticizers and flame retardants (TMP, TEP, TPrP, TBP, TCIPP, TCEP, TBEP, TDCPP, TOP, TPhP, TCP)

#### Analysis method:

- Samples were pulverized by frost shattering using liquid N<sub>2</sub>.
- HRGC/HRMS and LC/MS methods.



#### LCD TV

New model (2008)

Rear cover



Pulverized samples

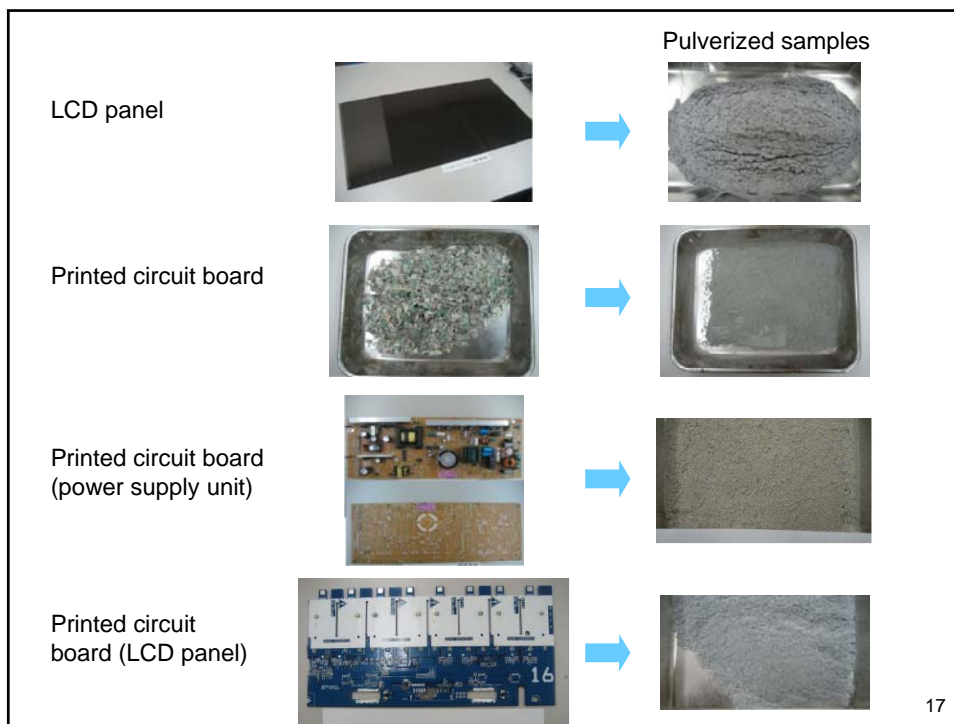


Front cover



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Chemicals in products/articles							
BFRs and PFRs in new model LCD TVs							
LCD TV (containing BFRs in its casings, SONY Bravia)							
	Concentration (ng/g-unit)						
	Rear cover	Front cover	LCD panel	Printed circuit board	Printed circuit board (power supply unit)	Printed circuit board (LCD panel)	
B F R	PBPhs	5,700	4,600	33	730	980	1,200
	TBBPA	68	92	7	87	90	890
	HBDCDs	< 0.5	6	2	< 0.5	130	680
	PBDEs	14,000	14,000	2	59	15	54
	DBDPE	130,000	92,000	NA	36	1,100	770
	T-Br (XRF)	136,000,000	125,000,000	ND	23,900,000	133,000	22,600,000
P F R	TMP	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
	TEP	1	3	6	1	4	1
	TPrP	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
	TBP	16	11	3	2	3	2
	TCIPP	10	14	4	23	52	16
	TCEP	7	4	< 4	9	< 4	4
	TBEP	< 80	< 80	< 80	< 80	< 80	< 80
	TDCPP	< 2	< 2	< 2	< 2	< 2	< 2
	TOP	3	17	< 0.9	< 0.9	< 0.9	6
	TPhP	1,100	2,400	1,200,000	1,600,000	6,700,000	320,000
	TCP	180	370	54	480	4,500,000	140,000
	T-P (XRF)	ND	ND	1,100,000	NA	ND	ND

- Only 0.1% of total-Br was detected in rear and front cover as MS-measured BFRs.  
=> Other BFR compounds may be used in this TV. (TBBPA epoxyoligomer and carbonate oligomer )

- Both BFRs and PFRs were used in liquid crystal and printed circuit board.

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Chemicals in products/articles  
**BFRs and PFRs in new model LCD TVs**

**LCD TV (containing PFRs in its casings, SHARP Aquos)**




	Concentration (ng/g-unit)						
	Rear cover	Front cover	LCD panel	Printed circuit board	Printed circuit board (power supply unit)	Printed circuit board (LCD panel)	
<b>BFR</b>	PBPhs	41	65	5	230	270	120
	TBBPA	15	21	9	770	900	74
	HBCDs	53	40	< 0.5	550	250	4
	PBDEs	32	540	5	13	12	45
	DBDPE	NA	NA	NA	3,500	1,300	380
	<b>T-Br (XRF)</b>	<b>ND</b>	<b>ND</b>	<b>ND</b>	<b>41,700,000</b>	<b>41,700,000</b>	<b>89,900,000</b>
<b>PFR</b>	TMP	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
	TEP	0	0	0	190	190	0
	TPrP	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
	TBP	2	2	2	6	9	2
	TCIPP	4	9	4	2	9	26
	TCEP	< 4	< 4	< 4	6	5	7
	TBEP	< 80	< 80	< 80	< 80	< 80	< 80
	TDCPP	< 2	< 2	< 2	< 2	< 2	< 2
	TOP	< 0.9	80	< 0.9	< 0.9	< 0.9	< 0.9
	TPhP	600,000	940,000	1,200,000	13,000,000	15,000,000	870
	TCP	47	140	110	85,000	83,000	72
	<b>T-P (XRF)</b>	<b>527,000</b>	<b>252,000</b>	<b>490,000</b>	<b>ND</b>	<b>ND</b>	<b>ND</b>

- Most of the units contained approx. 1-1.5 % of TPhP, which may be used as plasticizer and flame retardant. => Other PFR compounds, such as condensed phosphate, may be used in this TV.

- These results show use of flame retardants is changing from BFRs (e.g., PBDEs) to other BFRs and PFRs in accordance with some regulations such as RoHS and REACH.

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Chemicals in products/articles  
**BFRs in "recycled" products/articles**

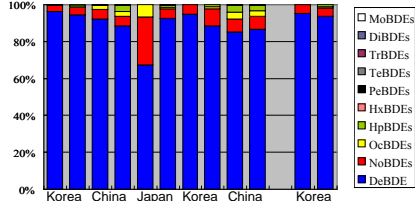




Waste plastics      Video tapes

**BFRs and other chemicals in video tape (mg/kg)**

Country of production	PBDEs	TBBP-A	HBCD	DeBDEthane	T-Br	Sb	Pb
Japan	0.54	0.0030	<0.03	<0.07	<10	<10	<10
China	6700	340	15	na	4400	1700	na
China	2400	280	30	190	2500	1100	<10
Korea	1600	34	1.1	na	1500	650	na
Korea	1300	46	1.6	260	1600	780	53
Korea	1000	9.5	0.31	na	610	270	na

**Homolog profiles of PBDEs in video tape**



- BFRs are usually added by around 10 wt% of plastics for flame resistance.
- Recycled products could be contaminated with BFRs by using waste flame retarded plastics (e.g., TV casing).
- PBDEs contained in video tapes is mainly DeBDE

PBDEs  
V  
DeBDEthane, TBBP-A  
V  
HBCD

Y. Hirai; Organohalogen Compounds, 68, 2190-2193 (2006)

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