Results of X-Ray Testing for Toxic Chemicals in Washington Homes and Offices

Washington Toxics Coalition

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Written by Erika Schreder

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Introduction

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Recent research has found toxic chemicals in our bodies, house dust, and food. The *Pollution in People* study, which tested the hair, blood, and urine of 10 Washington residents, confirmed that our bodies are contaminated with chemicals including the toxic flame retardants PBDEs, the plasticizers and fragrance carriers known as phthalates, and heavy metals (Schreder 2006). Tests on household dust in Washington and elsewhere have revealed a wide array of toxic chemicals in our homes (Costner 2005, Wu 2007).

Where are these chemicals coming from? During December 2006 and January 2007, WTC sampled common consumer products in five homes and two legislative offices to begin looking at whether consumer products could be sources of some of the chemicals contaminating our bodies and homes. We used a new tool—the handheld XRF analyzer—which provides a convenient means to test for some of these chemicals in the home or office instantaneously.

Here we present the results of our recent testing as part of a series of studies that begin to answer the question of what toxic chemicals are making their way into our homes, workplaces, and bodies.

Background

The XRF analyzer was used to test a large variety of common consumer products in five Seattle-area homes and two Olympia legislative offices. Based on the capabilities of the XRF analyzer as well as knowledge of where toxic chemicals are likely used, we focused our testing on upholstered furniture, mattresses, televisions, electronics, children's products, toys, and clothing. We tested from 8 to 39 items in each home or office for a total of 171 products.

Where possible, we report the year of purchase and the manufacturer. This information is based on observation and the recollection of the homeowner or legislative office.

Key Findings

Testing with the XRF analyzer reveals that our homes and offices are full of products that contain toxic chemicals. Below is a summary of our key findings; the photo pages following this summary highlight several products from each home or office, including products that contained toxic chemicals as well as those in which we did not detect chemicals of concern.

1. Each of us is likely living and working in environments that are rich with items containing toxic flame retardants (PBDEs). Televisions, furniture, and children's items frequently tested positive for bromine, indicating the likely presence of PBDEs.

Offices

We tested the offices of Representative Ross Hunter and Senator Debbie Regala of the Washington State Legislature. In these offices, the items that tested positive for brominated flame retardants were office chairs, televisions, computers and other electronics, and other upholstered furniture.

Homes

We tested products in five Seattle family homes. As in the offices, televisions, computer components, and upholstered furniture were commonly found to contain brominated flame retardands. In addition, children's products such as changing pads, carseats, and mattresses tested positive for PBDEs.

2. In many cases, PBDEs are present in products at very high concentrations. The PBDE-containing televisions we tested averaged nearly 15% bromine, indicating PBDEs make up approximately 17% of the television casing (plastic enclosure).

We tested a total of seven televisions and found significant concentrations (from 13.7 to 15.2%) of PBDEs in six. Detection of bromine in televisions is a strong indicator for the presence of deca-BDE, which is commonly used in television casings. Because bromine makes up approximately 83.3% of deca-BDE (by molecular weight) we estimate that the television casings had an average of 17% deca-BDE.

3. There were PBDE-free products in all product categories we tested. The homes and offices tested contained furniture, mattresses, a television, and electronics (their plastic casings) that appear to have no added PBDEs.

While the percentage of PBDE-free products varies by product category, we did find examples in each category of products made without PBDEs. For example, while every VCR tested was positive for bromine, indicating potential presence of PBDEs, several CD players, a television, and a scanner tested negative for brominated flame retardants.

4. Some household items, including children's items, had unexpectedly high concentrations of lead. We found lead in PVC/vinyl clothing, toys, and electronics, sometimes at very high concentrations. Examples include:

- One vinyl rain jacket tested at 3.3% lead and another at 327 parts per million (ppm) lead. For comparison, Washington State law limits lead in packaging to 100 ppm.
- A child's polyurethane jacket tested at 5534 ppm lead.
- We found lead in electronics such as CD players at levels up to 2284 ppm. The European Union's RoHS (Restriction on Hazardous Substances) Directive limits lead in electronics to 1000 ppm.
- A toy plastic truck tested at 1587 ppm lead.
- We detected lead in a leather couch at 2266 ppm.

5. PVC items were present in every home, making exposure to phthalates likely. While the XRF analyzer cannot test for phthalates, it does test for chlorine, which is an indicator of PVC/vinyl, a material that typically includes phthalates. PVC/vinyl items included clothing, toys, mattress and changing pad covers, flooring, and a yoga mat.

Toxic Chemicals in Our Homes and Offices and Implications for Health

We found the XRF analyzer most useful for testing for the presence of toxic metals and classes of toxic compounds: bromine, indicating the potential presence of brominated flame retardants; lead; and chlorine, indicating the presence of PVC/vinyl. Below is a summary of the health effects of these classes of toxic chemicals and the products in the home they may be found in.

PBDEs or Toxic Flame Retardants (Element analyzed = Bromine)

PBDEs are most commonly found in television casings. They are also used in residential furniture, including mattresses and other upholstered furniture.

Every person tested in the *Pollution in People* study (Schreder 2006, p. 14) had PBDEs in his or her body. A 2004 study found PBDEs in the breast milk of women in the Northwest at levels 20 to 40 times higher than those in European and Japanese women (Williams-Derry 2004).

Health concerns

- Scientific evidence indicates that PBDEs are toxic to the nervous system. Laboratory animals exposed to PBDEs show deficits in learning and memory (Ericksson 2002).
- PBDEs affect thyroid levels in laboratory animals and in wildlife (Zhou 2002), and they may cause reproductive problems and birth defects (McDonald 2005, Darnerud 2003).
- Deca, the most widely used form of PBDE, is classified as a "possible human carcinogen" by the U.S. Environmental Protection Agency (ATSDR 2004).

Children are especially vulnerable to the effects of PBDEs: studies indicate young children's exposure is up to 300 times greater than that of adults and is primarily from breast milk and inadvertent dust ingestion (Jones-Otazo 2005, Stapleton 2005).

Evidence strongly suggests that there is no margin of safety for PBDE exposures. A 2005 study compared levels in people with those that cause toxic effects in laboratory studies, and found that approximately five percent of American women have levels that already exceed those that cause reproductive problems in laboratory animals (McDonald 2005).

Status

U.S. chemical manufacturers have ceased the production of two forms of PBDEs, penta and octa, but have not stopped making deca. Deca has traditionally been used primarily in casings for televisions and electronics, but new federal fire standards (16 CFR Part 1633) may to lead to an increase in its use in mattresses and furniture.

Several signs point to a future phaseout of deca. As of mid-2006, the European Union no longer allows the use of deca in electronics because of contamination with banned forms of PBDEs. In the United States, legislation to ban deca has been introduced in a number of states. In Washington, Governor Gregoire, the departments of Ecology and Health, three state fire associations, and more than forty other organizations are supporting legislation in 2007 to phase out deca in televisions, computers, mattresses, and residential furniture.

A number of companies have already phased out deca or announced their intentions to do so. These include the computer makers Dell, HP, Toshiba, Lenova, and Apple, as well as the television makers Sony, Panasonic, Phillips, Samsung, and LG Electronics.

Lead

Lead continues to be used in a large array of consumer products, including art supplies, specialty paints, and some hair dyes. Children's jewelry and even candy have tested positive for lead.

Some PVC (vinyl) products, primarily soft-vinyl types such as lunchboxes, have also been found to contain lead.

Health concerns

- Children exposed to lead at a young age are more likely to suffer from shorter attention spans and are less able to read and learn than their peers (Lanphear 2005). Scientists have concluded that there is no safe lead exposure level for children (Canfield 2003).

- Other health effects include high blood pressure, anemia, miscarriage, and decreased sperm production (ATSDR 2005, Gilbert 2004).

Status

The United States has restricted lead in paint and gasoline, but continues to allow its use in most other products. The European Union restricts lead in electronics under the RoHS Directive, which controls levels of six toxic chemicals in electronics. The Washington departments of Ecology and Health are likely to develop a chemical action plan to address lead this year.

Phthalates (often in PVC; element analyzed = Chlorine)

Phthalates are one of the most ubiquitous classes of toxic chemicals in our homes. In a national study of household dust, phthalate levels dwarfed those of other chemicals tested (Costner 2005). Every person tested in the *Pollution in People* study had phthalates in his or her body (Schreder 2006, p. 8).

PVC products such as vinyl flooring, vinyl shower curtains, and children's toys contain phthalates, as do many personal care products such as perfumes, nail polish, and lotions (CDC 2005).

Health concerns

- Human studies have linked phthalate exposure to altered male genital development and decreased sperm production (Swan 2005, Duty 2003).
- Animal studies reveal an array of reproductive problems in male offspring including small or otherwise abnormal testes, abnormal urinary openings, and undescended testes (Gray 2000).
- Phthalates may also cause asthma as well as liver and kidney damage (ATSDR 2002).

Status

The European Union passed legislation banning some phthalates in cosmetics in 2003, and has kept three phthalates out of toys since 1999. The United States has no restrictions on phthalates.

Ross Hunter's Office, 333 John L. O'Brien Building

Couch

Manufacturer: Stickley
Year of purchase: 1996
Results:

- ❖ positive for brominated flame retardants, most likely penta-BDE[1]
- ❖ tested at 3.2% bromine

Modem

Manufacurer: Cisco Systems
Results:

- ❖ positive for brominated flame retardants
- ❖ tested at 938 ppm bromine

Computer monitor

Manufacturer: Hewlett Packard
Results:

- ❖ negative for brominated flame retardants
- ❖ tested at 9 ppm bromine, indicating no PBDEs were added[2]

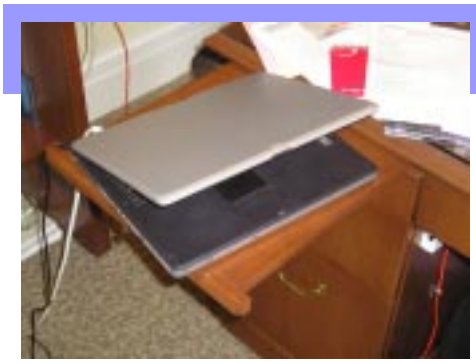
[1] Detection of bromine is a very strong indication for the presence of brominated flame retardants. In each case, where possible we indicate which flame retardant is most likely to be present.

[2] While we cannot be certain, our judgment is that bromine levels in this range indicate no added bromine, but may indicate presence of flame retardants in recycled stock used.

Debbie Regala's Office, 233 John A. Cherberg Building

Television

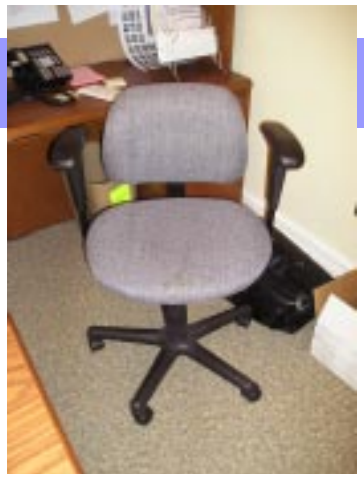
Manufacturer: Magnavox
Year of purchase: 1996
Results:
- ❖ positive for brominated flame retardants, most likely deca-BDE
- ❖ tested at 13.7% bromine



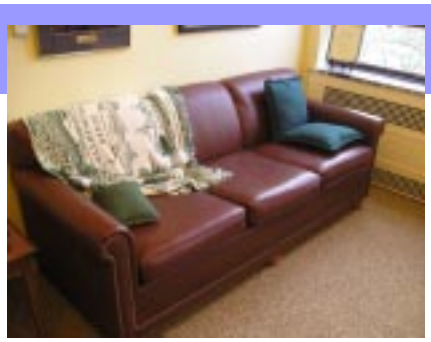
Laptop computer

Manufacturer: Gateway
Results:
- ❖ positive for brominated flame retardants, most likely deca-BDE
- ❖ tested at 7468 ppm bromine

Office chair



Manufacturer: CRAIN S Office Center
Results:
- ❖ positive for brominated flame retardants
- ❖ tested at 1.1% bromine

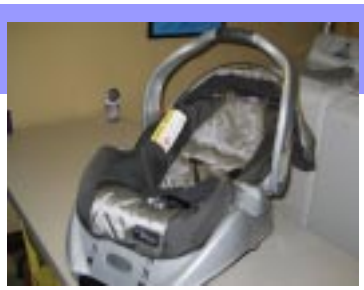


Leather couch

Results:
- ❖ tested at 2266 ppm lead
- ❖ negative for brominated flame retardants

Home One

Infant carseat



Manufacturer: Graco
Year of purchase: 2005
Results: ❖ positive for brominated flame retardants
❖ foam pad tested at 2.1% bromine
❖ fabric padding tested at 7515 ppm bromine

Child's bomber jacket

Manufacturer: Rock River Active Apparel
Year of purchase: 2006
Results: ❖ tested at 5534 ppm lead

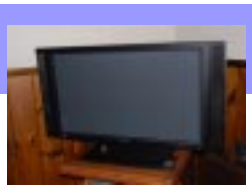
Moses basket

Manufacturer: Heritage
Year of purchase: 2002
Results:
❖ positive for brominated flame retardants, most likely penta-BDE
❖ tested at 3.2% bromine

UCR

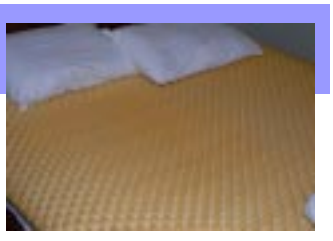
Manufacturer: JVC
Year of purchase: 2003
Results: ❖ positive for brominated flame retardants, most likely deca-BDE
❖ tested at 13.5% bromine

Television



Manufacturer: Pioneer
Year of purchase: 2006
Results: ❖ negative for brominated flame retardants
❖ tested at 4 ppm bromine, indicating it does not contain PBDEs

Foam mattress pad



Manufacturer: purchased at The Bon
Year of purchase: 1998
Results:
❖ positive for brominated flame retardants, most likely penta-BDE
❖ tested at 4% bromine

Home Two

Televisions

Manufacturers: JVC and Hitachi
Year of purchase: early 1990s
Results:

- ❖ positive for brominated flame retardants, most likely deca-BDE
- ❖ tested at 14% (Hitachi) and 15% (JVC) bromine

Toy plastic truck

Manufacturer: Ritvik
Year of purchase: 2004
Results:

- ❖ tested at 1587 ppm lead

Twin mattress

Manufacturer: IKEA
Year of purchase: 2005
Results:

- ❖ negative for brominated flame retardants
- ❖ no detectable bromine

CD Player

Manufacturer: TEAC
Year of purchase: 2005
Results:

- ❖ tested at 2284 ppm lead

Home Three

Baby changing pad

Manufacturer: purchased at Babies R Us
Year of purchase: 2003
Results:

- ❖ cover is likely PVC/vinyl
- ❖ positive for brominated flame retardants, most likely penta-BDE
- ❖ testing revealed 3% bromine

Television

Manufacturer/model: Sony Trinitron
Year of purchase: 1980s
Results:

- ❖ positive for brominated flame retardants, most likely deca-BDE
- ❖ tested at 14.2% bromine

Child's rain jacket

Manufacturer: Carter's
Year of purchase: 2006 (used)
Results:

- ❖ testing indicates material is PVC/vinyl
- ❖ tested at 327 ppm lead; may also contain phthalates

Clock radio

Manufacturer: Sony
Year of purchase: 2000
Results:

- ❖ tested at 4 ppm bromine, indicating no PBDEs used in casing
- ❖ no lead or mercury detected

UCR

Manufacturer: Emerson
Year of purchase: 1995

- ❖ positive for brominated flame retardants
- ❖ tested at 13.4% bromine

Home Four

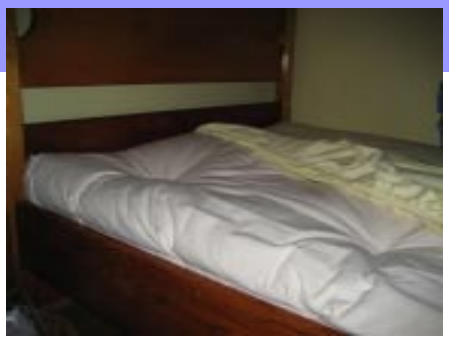
Rain jacket

Manufacturer: Helly Hansen
Year of purchase: 1990
Results:
- ❖ testing indicates material is PVC/ vinyl
- ❖ tested at 3.3% lead

Couch

Manufacturer: Norwalk
Year of purchase: 2000
Results:
- ❖ positive for brominated flame retardants, most likely penta-BDE
- ❖ tested at 2.9% bromine

Futon



Manufacturer: Soaring Heart Futon and Natural Bed Company
Year of purchase: 2006
Results:
- ❖ tested at 7 ppm bromine, indicating no PBDEs used

Bike light battery charger

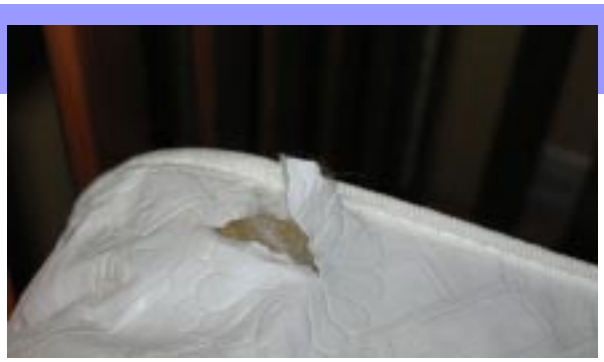
Manufacturer: Nite Rider
Year of purchase: 2000
Results:
- ❖ positive for brominated flame retardants
- ❖ tested at 9.4% bromine

Home Five

Television

Manufacturer: RCA
Year of purchase: 1991
Results:
- ❖ positive for brominated flame retardants, most likely deca-BDE
- ❖ tested at 14.6% bromine

Crib mattress



Manufacturer: unknown (hand-me-down)
Year of purchase: unknown
Results:
- ❖ positive for brominated flame retardants, most likely penta-BDE
- ❖ tested at 4.6% bromine
- ❖ testing indicates cover is PVC/vinyl

Computer monitor

Manufacturer: Dell
Year of purchase: 2000
Results:
- ❖ negative for brominated flame retardants in casing
- ❖ no detectable bromine, lead, or mercury

Modem

Manufacturer: Arescom
Year of purchase: 2004
Results:
- ❖ positive for brominated flame retardants, most likely deca-BDE
- ❖ tested at 3% bromine

Results of Sampling with XRF Analyzer

Location	Item	Manufacturer	Testing Area	Chlorine	Bromine	Lead
Rep. Ross Hunter's Office	Couch	Stickley	bottom cushion (through cover)	<LOD	31646	89
Rep. Ross Hunter's Office	Modem	Cisco Systems	side	<LOD	938	102
Rep. Ross Hunter's Office	Computer monitor	Hewlett Packard	back	<LOD	9	<LOD
Sen. Debbie Regala's Office	Television	Magnavox	front of casing	<LOD	137025	573
Sen. Debbie Regala's Office	Laptop computer	Gateway	top adjacent to keyboard	<LOD	7468	9
Sen. Debbie Regala's Office	Office chair	CRAIN S	back cushion	<LOD	10700	37
Sen. Debbie Regala's Office	Leather couch		back cushion (through cover)	<LOD	<LOD	2266
Home 1 (Duncan/Monnin home, demo site)	Infant carseat	Graco	foam padding	<LOD	21050	78
Home 1 (Duncan/Monnin home, demo site)	Infant carseat	Graco	fabric padding	<LOD	7515	17
Home 1 (Duncan/Monnin home, demo site)	Child's bomber jacket	Rock River	sleeve	<LOD	<LOD	5534
Home 1 (Duncan/Monnin home, demo site)	Moses basket	Heritage	foam mattress	<LOD	31811	124
Home 1 (Duncan/Monnin home, demo site)	VCR	JVC	front panel, top left	<LOD	135272	422
Home 1 (Duncan/Monnin home, demo site)	Television (plasma)	Pioneer	front panel, top right	<LOD	4	<LOD
Home 1 (Duncan/Monnin home, demo site)	Foam mattress pad	purchased at The Bon	side	<LOD	38151	109
Home 2	Television	JVC	front panel, left side	<LOD	151567	795
Home 2	Television	Hitachi	front bottom panel	<LOD	140557	755
Home 2	Toy plastic truck	Ritvik	side	<LOD	<LOD	1587
Home 2	Twin mattress	IKEA	side	<LOD	<LOD	<LOD
Home 2	CD player	TEAC	top	550000	<LOD	2284
Home 3	Baby changing pad	purchased at Babies R Us	top (through cover)	550000	30460	136
Home 3	Television	Sony	casing, front top	<LOD	141719	489
Home 3	VCR	Emerson	front left	<LOD	133711	670
Home 3	Child's rain jacket	Carter's	outside fabric	550000	<LOD	327
Home 3	Clock Radio	Sony	casing	<LOD	4	<LOD
Home 4	Rain jacket	Helly Hansen	sleeve	550000	<LOD	33433
Home 4	Couch	Norwalk	foam (cover removed)	<LOD	28975	115
Home 4	Futon	Soaring Heart Futon	top (through cotton cover)	<LOD	7	<LOD
Home 4	Bike light battery charger	Nite Rider	top	<LOD	93900	302
Home 5	Television	RCA	front top panel	<LOD	145717	56
Home 5	Crib mattress	Unknown	top (through cover)	550000	22223	85
Home 5	Crib mattress	Unknown	side (through hole in cover)	<LOD	45635	18
Home 5	Computer monitor	Dell	front bottom panel	<LOD	<LOD	<LOD
Home 5	Modem	Arescom	front middle	<LOD	29960	109

Notes

1. <LOD means less than the limit of detection
2. Concentrations are in ppm (parts per million)
3. The instrument does not quantify accurately at very high concentrations. Therefore, chlorine concentrations reported at 550000 should be regarded as estimates.
4. High levels of one element can affect quantitation of other elements. Here, we report the data reported by the analyzer for lead; where there were high levels of bromine, however, visual examination of the spectra did not provide strong validation for the presence of lead.

Methods

The use and functioning of the XRF analyzer are described in detail in Appendix 1. For each test, we used a standard testing time of 30 seconds. We tested each item in one to several locations, depending on the size of the item and apparent variability in materials (for example, both back and bottom cushions were generally tested in furniture). For electronics, we sought to test the plastic casing, where flame retardants are typically used, and chose the testing area accordingly. Because the x-ray penetrates from just a few microns (metal) to 1/4 inch (softer substrates), the measurement should be considered a surface measurement.

We interpreted the data using the concentrations and deviations reported by the analyzer in conjunction with visual examination of the spectra generated by the instrument. The analyzer reports concentrations of elements by analyzing the spectra using reference data for the elements it reports, and measuring the area under the curve in the spectrum (see Appendix 2 for a sample spectrum).

The XRF analyzer quantifies bromine in the consumer products tested, rather than PBDEs. Direct analysis for PBDEs would be more desirable, but would require extracting foam, fabric, or plastic samples from each product and sending them to a lab for analysis. Bromine, as the major constituent of PBDEs by molecular weight, is thus used as a surrogate measure to identify the presence of PBDEs in the consumer products. Based on knowledge of marketplace uses of bromine, we can conclude with confidence in some cases that the bromine detected is from PBDEs. For example, penta-BDE has been the primary flame retardant used in polyurethane foam for furniture, and is the only brominated flame retardant generally known for that use (EPA 2005). Therefore, foam items (such as upholstered furniture) that test positive for bromine at significant levels can be considered with some certainty to contain penta-BDE.

Likewise, industry has indicated that deca-BDE is by far the most common brominated flame retardant used in televisions (particularly those purchased 2005 or earlier), so high levels of bromine are a very strong indicator of deca-BDE in televisions (Pure Strategies 2005). Other brominated flame retardants are fairly commonly used in other electronics, so there is less certainty with those products that a positive result for bromine indicates the presence of PBDEs.

We tested a number of items that appeared to be PVC/vinyl, using the presence of the element chlorine to indicate this material because chlorine is a major constituent of all PVC/vinyl. Because many PVC/vinyl items also include phthalates as softeners or plasticizers, the presence of chlorine in flexible PVC/vinyl also indicates that phthalates are likely to be present.

Appendix 1: The XRF Analyzer

How it Works

The XRF Analyzer uses a technology known as x-ray fluorescence (XRF) spectrometry to detect certain chemical elements such as lead, mercury, bromine, and chlorine. This process includes several steps:

1. An x-ray tube emits high-energy x-ray photons which strike the sample being analyzed.
2. These photons knock electrons in each atom from the innermost orbitals of some atoms in the sample, making the atoms unstable.
3. As electrons move from outer orbitals to the vacant space closer to the nucleus of the atom, they emit energy in a secondary x-ray photon; this is known as fluorescence.
4. The analyzer measures the amount of energy in the x-rays emitted by the atoms in the sample material as they return to their original state, an energy that is characteristic of each element.
5. The analyzer quantifies this energy and makes a conversion to report whether an element is present and in what concentration.

Makeup and Use of the Analyzer

The XRF analyzer has three major components. These include an x-ray tube, a spectrometer, and a data collection/processing unit. To test a sample, the front end of the analyzer is placed against the object to be tested, and held there for the duration of the test.

Safety Considerations

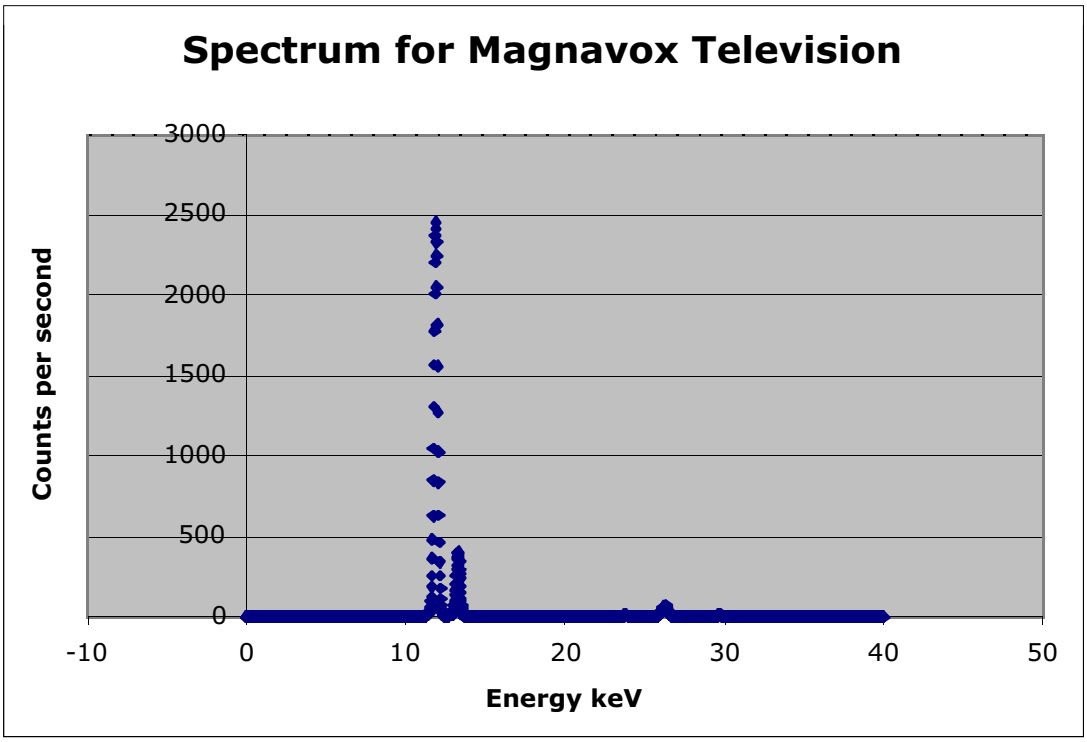
When in use, the analyzer emits radiation from the exit port (the front of the instrument). Radiation levels at the port are approximately 28,000 millirems per hour in the direct x-ray beam, and 2,000 millirems per hour 4 inches away. To put these numbers in perspective, a chest x-ray provides a dose of 100 millirems; 5,000 millirems total per year are considered acceptable for a non-pregnant adult. The radiation level for the operator is less than 0.1 millirems per hour.

Therefore, the analyzer should not be pointed at anyone or any body part, and it is important that no person be located in the direction of the x-ray beam within 10 feet of the instrument. The analyzer does not emit radiation when it is not in use. When it is emitting radiation during a test, the red light on the top of the analyzer blinks.

Manufacturer

The XRF Analyzer is manufactured by Innov-X Systems, Inc., located in Woburn, Massachusetts. Their website contains more information about the analyzer and the company, at www.innov-xsys.com.

Appendix 2: Spectrum for Magnavox Television



Note: This is an example of the spectra generated by the XRF Analyzer. The two prominent peaks in this example correspond to the energies emitted by the electrons in the bromine atoms in response to the x-ray.

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