Environmental chemicals may play a role in breast cancer risk. BCERF BRIEFS highlight emerging issues and research on environmental factors. This includes new research on selected endocrine disruptors and their potential to affect cancer and other health risks. Chemicals that are “endocrine disruptors” may influence breast cancer risk by mimicking effects of hormones or affect other pathways that give hormone-dependent breast tumors a growth advantage. Commonly used flame retardants, polybrominated diphenyl ethers (PBDEs), are an emerging concern because some have been identified as endocrine disruptors. They also have been widely detected in the environment, wildlife, and people.

PBDEs – Polybrominated diphenyl ethers
by Suzanne Snedeker, Ph.D.

Rings and bromines
The chemical structure of PBDE is simple. It is composed of two rings (phenyl rings) linked by an oxygen bridge (ether linkage). “Poly” means many. “Bromine” is a type of mineral (a halogen). There are up to ten locations where a bromine atom can attach to a carbon on the rings. If a PBDE has ten bromines, it’s called a deca-BDE; five bromines is a penta-BDE.

Couches, mattresses, and electronics
PBDEs started to be used commercially as flame retardants in 1960. When products containing PBDEs are exposed to a certain level of heat, the bromine atoms come off the rings and quench the fire. Three major types of PBDE mixes are used commercially. Each mixture is named for the predominant BDE.

- **Penta**
  - used in flexible polyurethane foams in upholstery, carpets, mattresses, and pillows.
  - used in rigid foams in personal computers and television sets.

- **Octa**
  - used in plastic (styrene) housing of computer monitors and televisions, and in circuit boards.

- **Deca**
  - used in high impact polystyrene plastic housings for electronic equipment.
  - used in polyethylene for wires, cables, pipes and textile coatings (upholstery and drapes).

They are not bound to the plastic, foam, or textile, but over time they can be released from the product and enter the air as dust or vapor. PBDEs have been detected in outdoor and indoor air, household dust, sewage sludge, soil and sediments, and certain foods. (see other sections for information on levels in wildlife, and levels in blood, fat, and breast milk of people.)

The concern
The structure of PBDEs is very similar to environmental contaminants such as PCBs (polychlorinated biphenyls). Chemicals with similar structures often have similar effects on the body. Because a wide number of health effects have been associated with PCB exposure, there is concern that PBDE exposure may result in similar health effects. Some PCBs are estrogen mimics. While few studies have investigated whether people exposed to PBDEs are at higher risk for breast cancer, researchers have started to investigate whether PBDEs are estrogen mimics.

PBDEs identified as estrogen mimics
The following PBDEs have been identified as estrogen mimics:
- **tri** BDE-19, BDE-30, BDE-38
- **tetra** BDE-49, BDE-51, BDE-75
- **penta** BDE-119, BDE-100
- **hexa** BDE-155
(PBDEs are given numbered names depending on the arrangement of the bromines on the two phenyl rings.)

Sweden – PBDE levels in breast milk and regulatory response
Researchers were alarmed to find a rapid rise in the PBDE levels from 1972 to 1997 in breast milk samples from Swedish women. In response, the Swedish government halted PBDE production. Researchers continued to monitor PBDEs in breast milk from 1998 to 2002, and in this short time levels decreased significantly.
Fish detective work
Researchers analyzed stored fish samples from the Great Lakes to see if there have been trends in PBDE levels over time. Levels of PBDEs in fish rose rapidly during the 1980s and 1990s. PBDE levels doubled in Great Lakes fish in less than three years. In contrast, levels of PCBs (which have been banned for many years) fell in Great Lakes fish during the same time frame. PBDEs also have been detected in commonly consumed fish, such as salmon, mackerel, swordfish, herring, and catfish.

The wildlife connection
PBDEs have been detected globally in many types of wildlife. In addition to fish, PBDEs have been detected in shellfish (whelk, hermit crab, mussels), Arctic mammals (seals, polar bears, porpoises, pilot and beluga whales), sea and land birds (bald eagles, barn owls, fulmar gulls, grey herons, sparrow hawks), the eggs of birds (peregrine falcons, owls, great blue herons, cor-morants, ospreys), and in land mammals (foxes, grizzly bears). Some of the highest levels have been detected in harbor seals in the San Francisco Bay area. These findings inspired researchers to look at PBDE-levels in people.

The latest on levels in people – highest in the U.S.
Worldwide, people residing in the U.S. have the highest documented levels of PBDEs in breast milk, blood, and body fat. Levels have been rising over the last 30 years. Levels in the U.S. are generally 10-100 fold higher than levels observed in Europe, Asia, or New Zealand. New findings suggest PBDEs can also be transferred during pregnancy from the mother to the fetus. The U.S. Centers for Disease Control and Prevention has announced plans to add PBDEs to their environmental chemical biomonitoring program. Results should be available in 2007.

Exposure – missing links
PBDEs enter the environment through household dust (from personal computers, TV sets, upholstery, and carpets) and sewage (via landfill run-off that later appears in sludge). PBDEs in the environment enter the food chain, and are found in the fat of livestock and fish. The most likely routes of exposure are through eating contaminated food (meat, fish, and dairy products) or breathing indoor dust. Infants can be exposed to PBDEs from contaminated breast milk. Research is needed on ways to minimize exposure to PBDEs from indoor dust. Trimming fat from meat and allowing the fat to drip away during cooking (e.g. broiling), are methods that can be used to decrease PBDE intake from food.

Health hazards
Virtually no studies have been done assessing health effects in people exposed to PBDEs. Animal models have been used to identify potential health hazards. Most of the effects were seen at high dosage levels. These include:

- Neurological effects – Early life exposures caused hyperactivity in adult rats and mice.
- Thyroid hormone effects – PBDEs impaired brain development and ability to learn.
- Development effects – Skeletal malformations identified in grandchildren of PBDE-exposed rats.
- Reproduction – Sperm function decreased in male mice exposed to deca-BDE. Structural changes also observed in ovaries of PBDE-treated female rats.
- Cancer – Liver tumors detected in rats exposed to high levels of deca-BDE.

The deca debate
Some U.S. manufacturers voluntarily phased out production of octa and penta PBDE mixes in 2004. While many states no longer permit the production or use of penta or octa-commercial mixes, whether deca forms of PBDE should be regulated is still under debate. The highly brominated deca form of PBDE has a bulky structure. Earlier studies indicated that deca-PBDE was not well absorbed when fed to laboratory animals. But recent studies in workers exposed to PBDEs suggest while deca-BDE is not persistent (relatively short half-life), deca-BDE can be absorbed. Other studies have found deca-BDE in the blood or breast milk samples from the general population. Study findings also suggest that deca-PBDE can be “debrominated” into lower forms by fish, and by some types of bacteria. Health effects of PBDEs have been associated with both deca and lower brominated forms of BDEs.

Issues and challenges
- Landfill disposal and release of PBDEs into the air and wastewater are major, unresolved issues.
- Electronic equipment recycling plants are sources of PBDE release. Action to protect workers in both Western nations and in Asia is needed.
- Routine monitoring of PBDEs in the home and workplace is not yet available.
- Methods to minimize exposures to PBDEs from indoor dust and air needs to be developed.
- Levels of PBDEs in people and wildlife should be monitored to characterize trends over time.
- The recent detection of deca-BDE in people supports further review of its use and production.

New directions
- Several manufacturers have phased out PBDE use in favor of alternative flame retardants.
- Some industries have developed new polymers that don’t burn and don’t need flame retardants.
- Consumers can choose to use products that have natural flame retardants (e.g. wool carpets).

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This Brief is on the web: http://envirocancer.cornell.edu/learning/PBDE/PBDEBrief.pdf

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