BISPHENOL A: INFORMATION SHEET

ENVIRONMENTAL SAFETY

SUMMARY

Bisphenol A (BPA) is an important industrial chemical that is used primarily to make polycarbonate plastic and epoxy resins, both of which are used in a wide variety of applications. For example, polycarbonate is used in eyeglass lenses, medical equipment, water bottles, digital media (e.g. CDs and DVDs), cell phones, consumer electronics, computers and other business equipment, electrical equipment, household appliances, safety shields, construction glazing, sports safety equipment, and in automobiles. Among the many uses for epoxy resins are industrial floorings, adhesives, industrial protective coatings, powder coatings, automotive primers, can coatings and printed circuit boards.

Although the vast majority of BPA is converted at manufacturing sites into products, low-level releases of BPA to the environment are possible. Numerous validated studies have been completed to determine what happens to BPA in the environment ("environmental fate") and the possible impacts ("environmental assessment"). Recent comprehensive reviews of these studies (Staples *et al*, 1998; Staples *et al*, 2002) conclude that current manufacturing and use patterns of BPA pose virtually no risk to the environment.

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ENVIRONMENTAL FATE OF BISPHENOL A

- The vast majority of BPA produced, greater than 99.9%, is consumed at manufacturing sites to make products such as polycarbonate plastic or epoxy resins (Staples *et al*, 1998). Low levels may be released to the environment in the effluent water from biological wastewater treatment plants. Bisphenol A dust (particulates) is controlled by workplace practices and engineering design and is not a significant contributor to environmental exposures. The relatively small amount of vapor released to the atmosphere is rapidly degraded by sunlight.

- The distribution of BPA in the environment can be predicted by its physical properties (Staples *et al*, 1998). Bisphenol A is a solid with low volatility at ambient temperature conditions, water solubility of 120-300 milligrams per liter and a greater solubility at alkaline pH values. Based on these properties, a simple equilibrium model predicts that about 50% of BPA in the environment has the potential to bind to sediments or soils with the rest remaining in the water column.

- Biodegradation plays a major role in the removal of BPA from the environment. Rapid and extensive breakdown of BPA has been demonstrated in a variety of laboratory biodegradation tests. Recent studies demonstrate that BPA degrades

rapidly in surface waters and sediments taken from a wide variety of geographies (including those with no known exposure history), suggesting that microorganisms with the capability to degrade BPA are ubiquitous in the environment (Klecka *et al*, 2001).

- Based on the results of standard laboratory biodegradation tests recommended by the Organization for Economic Cooperation and Development (OECD), BPA is classified as readily biodegradable (West *et al*, 2001).

- Real world monitoring studies confirm that BPA is rapidly biodegraded and extensively removed in wastewater treatment systems. For instance, 92-98% removal was reported in the most common type of sewage treatment system, an activated sludge plant (Staples *et al*, 1998).

- The trace amounts of BPA remaining in treated wastewater will continue to biodegrade in receiving waters and downstream of treatment plants (Klecka *et al*, 2001). Studies using real world surface water samples taken from various geographies demonstrate rapid degradation with a half-life in the range of 1 to 4 days (i.e., time for 50% degradation).

- Numerous publications have reported measured concentrations of BPA in streams and rivers in Japan, Europe and the United States. The median reported water concentrations from 21 European and 13 United States studies are 0.016 and 0.5 micrograms/L respectively (Cousins *et al*, 2002). In cases where individual concentration data are reported, many samples have no detectable level of BPA.

- A recent report from the U.S. Geological Survey provides data on the occurrence of BPA (and numerous other substances) in a large number of U.S. streams, most of which were characterized as streams susceptible to contamination (Kolpin *et al*, 2002). Approximately 60% of the streams contained no detectable level of BPA (detection limit 0.09 micrograms/L), the median detected concentration was 0.14 micrograms/L, and only 2 streams were reported to contain BPA at levels above 1 microgram/L.

- More recently, a Japanese study reported detectable BPA in 67 of 124 water samples selected from "Water Quality Monitoring" sites for downstream rivers. The median concentration of BPA, where detected, was 0.01 micrograms/L and 95% of the samples contained less than 0.24 micrograms/L of BPA (Japan Environment Agency).

- In a 1996 study, the receiving waters upstream and downstream of the five BPA manufacturing sites in the U.S. had no detectable BPA at a 1 microgram/L detection limit. In a follow-up 1997 study, the receiving waters upstream and downstream of four of the five BPA manufacturing sites and two processing sites had no detectable

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BPA at a detection limit (quantification with confirmation) of 1 microgram/L. The fifth manufacturing site had BPA concentrations ranging from 2 to 8 micrograms/L upstream and from 7 to 8 micrograms/L downstream. This facility's discharge makes up a large percentage of the receiving water flow during dry conditions, when samples were collected. Some BPA was apparently present in the discharged effluent and likely flowed back into the area where the upstream samples were collected (Staples *et al*, 2000).

ENVIRONMENTAL ASSESSMENT OF BISPHENOL A

- Bisphenol A does not accumulate in aquatic organisms to any appreciable extent and is not classified as bioaccumulative by the U.S. Environmental Protection Agency. In tests of 42-days duration, measured ratios of BPA in fish to that in the surrounding water (bioconcentration factors) range from 5.1 to 68 (Staples *et al*, 1998). In a freshwater clam, bioconcentration factors in the range of 110-144 were measured at low temperatures (Heinonen *et al*, 2002). Bioconcentration factors less than 100 are considered to indicate a low potential for bioaccumulation. A bioconcentration factor of 1000 has been considered a threshold for concern, while factors greater than 5000 suggest that a substance is bioaccumulative in the environment.

- Acute toxicity levels for BPA, defined as the concentration at which half of the organisms survive (LC50 values), have been measured in a variety of aquatic organisms, including freshwater and saltwater algae, invertebrates (daphnids and mysid shrimp) and fish. LC50 values range from 1000 to 20,000 micrograms/L (Staples *et al*, 1998; Staples *et al*, 2002).

- The No-Observed-Effect-Concentration (NOEC) of BPA in a 21-day chronic reproduction test in Daphnia was 3160 microgram/L (Caspers, 1998). Effect concentrations at the 10% level (EC10) were determined for both freshwater and marine algae to be 1360 to 1680 micrograms/L and 400 to 690 micrograms/L, respectively (Alexander *et al*, 1988).

- The results of a multi-generation study on fathead minnows showed that survival, growth and reproductive fitness for three generations were affected only at concentrations of 640 micrograms/L and higher, with hatchability of F2 (second generation) eggs slightly reduced at 160 micrograms/L. The NOEC measured in this study was 16 micrograms/L. (Sohoni *et al*, 2001; Caunter, 2000).

- A weight-of-evidence analysis of the aquatic hazards posed by BPA was conducted with a focus on validated studies and the ecologically relevant endpoints of survival, growth and reproductive fitness. This analysis included the use of statistical extrapolation techniques to assess the full database of reported effect concentrations. The study concludes that no adverse aquatic effects are expected at concentrations below 100 micrograms/L of BPA (Staples *et al*, 2002).

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- Comparison of this no-adverse-effect level for BPA of 100 micrograms/L, which was deemed protective of the structure and function of aquatic ecosystems, with typically measured values in surface waters of 0.001 to 1.0 micrograms/L indicates that aquatic ecosystems are unlikely to be adversely impacted by BPA (Staples *et al*, 2002).

- The data in the validated studies and reviews described above, combined with current scientific understanding of BPA toxicity, indicate that the current manufacturing and use patterns of BPA pose virtually no risk to the environment.

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