1. PUBLIC HEALTH STATEMENT

This Public Health Statement summarizes the Agency for Toxic Substances and Disease Registry's (ATSDR) findings on toluene diisocyanate (TDI) and methylenediphenyl diisocyanate (MDI), including chemical characteristics, exposure risks, possible health effects from exposure, and ways to limit exposure.

The U.S. Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are sites targeted for long-term federal clean-up activities. The EPA has found TDI in at least 4 of the 1,854 current or former NPL sites. MDI was not found in any of the current or former NPL sites. The total number of NPL sites evaluated for TDI and MDI is not known. But the possibility remains that as more sites are evaluated, the number of sites at which TDI and MDI are found may increase. This information is important because these future sites may be sources of exposure, and exposure to TDI and MDI may be harmful.

If you are exposed to TDI or MDI, many factors determine whether you'll be harmed. These include how much you are exposed to (dose), how long you are exposed (duration), how often you are exposed (frequency), and how you are exposed (route of exposure). You must also consider the other chemicals you are exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

WHAT ARE TDI AND MDI?

TDI and MDI do not occur naturally in the environment. TDI is a clear, colorless to pale yellow liquid. MDI is a light yellow crystalline solid. There are several forms of TDI and MDI, which are called isomers. The two most common TDI isomers are 2,4-TDI and 2,6-TDI. The most common isomer of MDI is 4,4'-MDI.

TDI and MDI are used to make many household products. They combine with other chemicals to produce various polyurethanes. Some of the products made with these polyurethanes include foam for furniture cushions and carpet padding and waterproof sealants.

WHAT HAPPENS TO TDI AND MDI WHEN THEY ENTER THE ENVIRONMENT?

TDI and MDI can be released into the air, water, and soil at places where they are produced or used. TDI and MDI are extremely reactive chemicals and are not likely to stay in the environment. In air, TDI and

MDI have half-lives of less than 1 day (half-life is the amount of time needed for the amount of TDI or MDI in air to be reduced by one-half). TDI and MDI rapidly react with water to form other compounds in a process called hydrolysis. The half-lives of TDI and MDI in water range from a few minutes to a few hours. Significant concentrations are not likely to be found in moist soil or sediment due to the rapid hydrolysis of these compounds; however, small amounts may be detected near point sources such as industrial waste streams and hazardous waste sites. TDI and MDI will not bioaccumulate in the food chain and are therefore not expected to be found in significant concentrations in fish and foods.

HOW MIGHT I BE EXPOSED TO TDI AND MDI?

TDI and MDI are used to make a number of different types of polyurethane products that are used by consumers ranging from foams for insulation, foam cushions, and sealants. In products such as cushions, the diisocyanates are cured, meaning that they are not reactive. It is unlikely that consumers would be exposed to diisocyanates from cured products. However, you can be exposed to TDI in the air from uncured polyurethane products such as adhesives, sealants, coatings, paints, craft materials, and insulating foams. The percentage of monomeric isocyanates in pre-polymer products is low (generally <5% for consumer products). Consumer products that contain low levels of diisocyanates warn against dermal exposure and recommend use of protective gloves. Workers involved in the manufacture of cured and uncured polyurethane products or involved in other industries using uncured diisocyanates may be exposed to higher levels. You are unlikely to be exposed to TDI or MDI in food or water.

HOW CAN TDI AND MDI ENTER AND LEAVE MY BODY?

When you breathe air containing TDI or MDI, some will enter your body through your lungs, but there is limited information on how much and how fast these compounds enter the body. TDI may enter your body through the digestive tract if you ingest it. There are no data on whether MDI will enter your body after ingestion. If your skin comes in contact with TDI or MDI, it is possible that a small amount may enter the body through the skin.

Once TDI or MDI enters your body, it reacts with large molecules, called macromolecules to form TDI- or MDI-conjugates. These conjugates are widely distributed throughout the body. TDI or MDI can also be reactive with itself to form compounds called polyureas, which are not absorbed. TDI and MDI conjugates and polyureas primarily leave the body in the feces; a small amount also leaves the body in the urine.

HOW CAN TDI AND MDI AFFECT MY HEALTH?

The health effects of TDI and MDI depend on how much you are exposed to and the length of that exposure. Respiratory effects, including a decrease in lung function, have been reported in workers exposed to TDI or MDI. Some workers have become sensitized to TDI and/or MDI; they are particularly sensitive to the toxicity of TDI and MDI and may experience adverse effects at much lower concentrations than the concentrations that may affect non-sensitized individuals. Asthma and symptoms of asthma, such as wheezing and shortness of breath, have been observed in some individuals who are particularly sensitive to the toxicity of TDI and MDI.

An excess of lung cancer has been observed in some workers at a polyurethane foam manufacturing plant. However, it is not known if exposure to TDI was the cause. A study in animals exposed by gavage to TDI reported increases in tumors in the pancreas, mammary gland, and liver. The Department of Health and Human Services (HHS) considers TDI as reasonably anticipated to be a human carcinogen and the International Agency for Research on Cancer has classified TDI as possibly carcinogenic to humans. EPA has not classified the carcinogenicity of TDI.

There are limited data to determine whether exposure to MDI can cause cancer. An animal study reported an increase in lung tumors in rats exposed by inhalation to polymeric MDI. The exposure levels tested in this study are much higher than concentrations found in work environments. IARC has determined that MDI is not classifiable as to its carcinogenicity in humans. EPA notes that the carcinogenicity of MDI cannot be determined, but there is suggestive evidence that raises concern for carcinogenic effects.

See Chapters 2 and 3 for more information on health effects of TDI and MDI.

HOW CAN TDI AND MDI AFFECT CHILDREN?

This section discusses potential health effects of TDI and MDI exposure in humans from when they’re first conceived to 18 years of age.

We do not have any information on the effects of TDI or MDI in children. We expect that the effects in children will be similar to those seen in adults; exposure to TDI or MDI in the air could result in lung effects. A delay in bone growth has been observed in offspring of animals exposed to high levels of TDI in air that also caused decreases in body weight gain or respiratory effects in the mothers. Exposure to

high levels of MDI in air during gestation also resulted in bone effects in the offspring; the MDI concentration causing these effects also resulted in decreased food consumption in the mothers.

HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO TDI AND MDI?

If your doctor finds that you have been exposed to significant amounts of TDI or MDI, ask whether your children might also be exposed. Your doctor might need to ask your state health department to investigate. You may also contact the state or local health department with health concerns.

You are unlikely to be exposed to TDI and MDI from food, drinking water, contaminated groundwater, or soil.

TDI and MDI are used to make many products; however, most of these products are cured and should not have unreacted diisocyanates remaining in them. Primary users and bystanders should be made aware of the potential risks and appropriate precautions to take when uncured TDI or MDI products (such as spray foam or sealants) are being used because use of these professional products can result in exposure to TDI or MDI. Always follow the manufacturers' instruction or product labels when using these products. Wear personal protective equipment (chemical resistant goggles/gloves/ clothing) to prevent direct contact with skin and eyes.

ARE THERE MEDICAL TESTS TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO TDI OR MDI?

TDI and MDI exposures can be measured in blood and urine by hydrolyzing the TDI and MDI reaction products to the corresponding diamine. However, the detection of the diamine products cannot predict the kind of health effects that might develop from that exposure. Because TDI and MDI reaction products leave the body fairly rapidly (within hours or days), the tests need to be conducted soon after exposure. For more information on the reaction products of TDI and MDI and on tests to detect these substances in the body, see Chapters 3 and 7.

WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the

Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but are not enforceable by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed as "not-to-exceed" levels; that is, levels of a toxic substance in air, water, soil, or food that do not exceed a critical value usually based on levels that affect animals; levels are then adjusted to help protect humans. Sometimes these not-to-exceed levels differ among federal organizations. Different organizations use different exposure times (e.g., an 8-hour workday or a 24-hour day), different animal studies, or emphasize some factors over others, depending on their mission.

Recommendations and regulations are also updated periodically as more information becomes available. For the most current information, check with the federal agency or organization that issued the regulation or recommendation.

OSHA has set a legal ceiling limit of 0.02 parts per million (ppm) for TDI and MDI in air; these are "not-to-exceed" levels. NIOSH has set a recommended limit of 0.005 ppm for monomeric 4,4'-MDI in air for workers exposed 10 hours/day during a 40 hour/day workweek. The EPA has not recommended any drinking water guidelines for TDI or MDI.

WHERE CAN I GET MORE INFORMATION?

If you have any questions or concerns, please contact your community or state health or environmental quality department, or contact ATSDR at the address and phone number below. You may also contact your doctor if experiencing adverse health effects or for medical concerns or questions. ATSDR can also provide publicly available information regarding medical specialists with expertise and experience recognizing, evaluating, treating, and managing patients exposed to hazardous substances.

- Call the toll-free information and technical assistance number at 1-800-CDCINFO (1-800-232-4636) or

- Write to:

  Agency for Toxic Substances and Disease Registry
  Division of Toxicology and Human Health Sciences
  1600 Clifton Road NE
  Mailstop F-57
  Atlanta, GA 30329-4027

Toxicological profiles and other information are available on ATSDR's web site: http://www.atsdr.cdc.gov.