EXECUTIVE SUMMARY

Background

Over the past decade a growing environmental awareness has caused society to reconsider the management of solid waste. The plastics industry began to make changes in some product designs that enable the products to meet requirements for ultimate disposability. However, as industry began implementing approaches to enhance environmental attributes, questions regarding the true long-term environmental fate and effects of degradable plastics emerged.

In June 1991 a group of companies formed and funded, as part of ASTM's Institute for Standards Research, the Degradable Polymeric Materials Program, in order to build a comprehensive understanding of the performance of these materials in waste treatment processes and to develop a progressive scheme to evaluate materials and products. This group included:

Cargill	Dow Chemical	DuPont
Eastman Chemical	Ecochem	Exxon Chemical
Kimberly-Clark	Mobil Chemical	Novamont
Novon International	Procter & Gamble	US Army Natick
Zeneca Bioproducts	National Corn Growers Association	
Association of the Nonwovens Fabrics Industry (INDA)		

As the most promising of the positively-viewed treatment processes is aerobic composting, the bulk of the work conducted under the ISR program concentrated on providing information under composting conditions. The ISR Advisory Committee established their mission to provide the basis for the scientific substantiation of disposability statements for degradable polymeric materials. The scope of the program was to determine the behavior of degradable polymeric materials in real disposal systems, and how those results correlate with laboratory results, in order to assure that such materials are safe for disposal and effectively degraded.

The ISR program in conjunction with the ASTM subcommittee D20.96 on Degradable Plastics have written the Standard Guide to Assess the Compostability of Environmentally Degradable Plastics. The strategy uses a tiered approach and allows a systematic assessment of the compostability of environmentally degradable plastic products. The three tiers are:

Tier 1: Rapid Screening Tests
Tier 2: Laboratory- and Pilot-Scale Composting Assessment
Tier 3: Field/Full-Scale Assessment

The tiers progress from the lower-cost, rapid screening of polymeric materials and other organic components to relatively long-term, more complex, higher-cost

evaluations. This report demonstrates the use of the tiered approach by the ISR program, and reports the information learned by the ISR-initiated work as well as the data contributed to or obtained by the program.

Results and Conclusions

The laboratory-scale ASTM D 5338 Controlled Composting test gave comparable results to the results obtained in the full-scale tests. The respirometric composting test ASTM D 5929, however, was too low in biodegradation potential and/or duration to be representative for full-scale composting. The MBI and P&G pilot tests obtained results that were mostly consistent with the results of the full-scale tests, and these protocols will be merged into an ASTM standard test method. The procedure applied in the RECOMP II full-scale test is considered to be a valuable test procedure, and will be developed into an ASTM standard practice.

Comparing the results obtained for the same material at each scale shows that for all materials compared, without exception, the degradation results obtained in a higher-level test equaled or exceeded those obtained in a lower-level test. This means, for example, that the laboratory-scale ASTM D 5338 was more conservative than the pilot-scale P&G test which in turn was more conservative than the full-scale RECOMP II test. This observation has important ramifications with regard to environmental claims based upon laboratory and pilot tests. In order to provide valid and useful information, a full-scale test must be very well planned and executed, while the logistics of conducting a test at that scale can be extremely difficult. Furthermore, the full-scale information cannot stand alone, but must be supported by tier 2 results. On the other hand, the full-scale test might not provide any further knowledge on the performance of a material than the laboratory and pilot tests together developed. The full-scale tests can, however, provide verification of results obtained at tier 2.

The overriding observation regarding the conduct of tests at any scale is the importance of the temperature and duration of the test. Temperatures must be maintained in the thermophilic range, preferably above 50 ^{o}C, in order to provide maximum microbial activity. The test must also last long enough to reach steady state in terms of material biodegradation.

Other specific conclusions from the ISR work include:

* The 3 major parameters of compostability - mineralization, weight loss and disintegration - are not identical and the results sometimes diverge. Care must be taken in comparing these, and in establishing compostability.

* For ecotoxicity tests to be valid for a specific material, the compost must have been generated using only that test material. The sample may not

be combined with other biodegradable plastics. Likewise, the compost quality results should be relative to the same compost generated without the test material. In the tests commissioned by ISR no significant effects could be seen from the test materials included.

* Disintegration should be measured quantitatively using weight loss and sieving procedures. Vague observations based upon visual and tactile perceptions should be omitted.

* Benchmark criteria must be established to validate the test results. This can be achieved by defining temperature and duration requirements, pass levels for reference materials, and compost quality standards.

* In anaerobic tests the absence of oxygen can give results which are totally different from results obtained under aerobic conditions.

On the basis of the results obtained in the various ISR tests the following comments can be made with regard to the purpose and importance of each tier of the proposed ASTM strategy:

- Tier 1: screening of components; development of initial test material; be careful not to be too conservative and exclude materials which under true composting conditions do degrade.

- Tier 2: evaluation and eventual proof of true compostability of test material; results obtained are valid for full-scale conditions.

- Tier 3: provides demonstration and confirmation of compostability, however, this tier should not become mandatory to demonstrate compostability. The tier 3 information can not stand alone. It must be supported by data from tier 2.

In conclusion, the proposed Standard Guide to Assess the Compostability of Environmentally Degradable Plastics provides a systematic approach to determining the compostability of a plastic or any other material which could enter the municipal solid waste stream. The scheme is cost effective because information is generated from lower level, less expensive tests to higher level, more expensive ones. The strategy covers the three aspects of compostability: biodegradability, ecotoxicity, and composting processability (the mechanical behavior of the material in a compost process).

The ISR program has generated information on the performance of a set of materials which can be used in comparing the performance of newly developed materials. Finally, the program has validated tests methods which can be used

to generate the evidence needed to support environmental claims. Test methods and practices have been and are under development for all 3 tiers, specifically, practices for conducting pilot and full-scale tests.

This body of work should prove useful both to the material developer who has entered the field of biodegradable plastics and who needs direction on how to generate the information required to meet their product development and marketing goals. This work should also prove useful to regulators and government agencies who find themselves in the position of evaluating environmental claims.