ENVIRONMENTAL ASSESSMENT REPORT

1. **DATE:** May 10, 2000

2. **NAME OF NOTIFIER:** Shell Chemical Company
   Division of Shell Oil Company

3. **ADDRESS:** P. O. Box 4320
   Houston, TX 77210

4. **DESCRIPTION OF THE PROPOSED ACTION:**

Description of the requested approval:
The food-contact notification proposes a clearance for polymers of carbon monoxide, ethylene, and 0 to 8 mole percent propylene which will be acceptable as components of food contact articles.

Current market forecasts indicate that the major initial use for the subject polymers in contact with food will be in the manufacture of articles intended for repeated-use in food processing establishments, including belts, hoses, and pipes used in food conveyance. The market for the polymers projected to the year 2000 is in the range of

To the extent a market for the polymers in single-service food packaging is realized in the future, the main market targeted is multi-layer flexible refrigerated packaging for meat, cheese and vegetable wrap. In this market, the polymer is expected to compete with EVOH in a PE/adhesive/EVOH/adhesive/PE structure. A smaller market potential could be in reheatable or microwaveable rigid retort food packaging but since the filing of the original petition, this market appears unlikely to materialize for polyketone polymers. In this application, the polymer would be expected to compete with EVOH in PP/adhesive/EVOH/adhesive/PP structures. To the extent a market does develop for carbon monoxide copolymers in these containers, the polymers are expected initially to be used in place of the EVOH layer in multilayered PP retort containers rather than replacing the entire package construction. It is possible that the use of carbon monoxide copolymers might evolve to replace the inner three layers of the container so the structure, from food-contact surface outward, would be: polyketone/adhesive/PP. The function of the EVOH in these structures is to provide oxygen barrier and extend the shelf life of the product. In flexible refrigerated food packaging, the food products are typically sold in the deli section and used at home until consumed. The microwaveable retort containers are designed for single use but some people reuse the empty containers for refrigerator storage of leftovers. Our forecasted sales of polyketone into these food contact applications by the year 2000 is in the range of or less.

Because the polymers have improved barrier properties, higher heat distortion temperatures and processability than the competitive materials above, we expect that polyketones may compete favorably in these market niches. In other food-packaging areas, such as ready to eat foods, the competition with lower cost existing polyethylene, polypropylene and polystyrene polymers is not attractive. Thus, polyketones are not expected to enter such markets.

Description of location produced:
In accordance with FDA's recently revised environmental impact regulations, it is not ordinarily necessary to provide information regarding environmental introductions resulting from the production of FDA-regulated substances. (62 *Fed. Reg.* 40570; July 29, 1997.) In the present case, no extraordinary circumstances apply to the manufacture of polyketone that suggest an environmental risk. Consequently, information regarding the manufacturing site is not included here.

Description of the locations used/disposal after use:
The fabrication of food contact articles from the polymer will be done in existing equipment used in current fabrication of repeated-use articles and food packaging materials. No significant change in manufacturing practices will need to be made.

The repeated-use food contact articles manufactured from polymers will be used in food processing facilities. The food packaging material produced from these polymers will be used in households or offices. The rigid packaging may in some instances be reused as a utility container due to its durability.

Disposal Patterns:
Food-contact articles produced from the subject polymer will be utilized in patterns corresponding to the national population density and will be widely distributed across the country. Therefore, it is anticipated that disposal will occur nationwide. The disposal options for food contact articles containing polymers are the same as for other such materials: thus, polymer may be placed in land disposal sites, incinerated, or recycled (where possible) in commingled plastics streams. According to current Environmental Protection Agency (EPA) projections, it is expected that about 80% of the materials will ultimately be deposited in land disposal sites, or to some extent recycled, and about 20% will be incinerated. The waste generated will be primarily in the form of household waste with a small amount ending in commercial and office waste. The food packaging materials would typically be disposed of in municipal solid waste collections at households or in office collections.

The types of environments present at and adjacent to these expected disposal locations are the same as for the disposal of other food contact materials currently in use. Environments potentially affected by disposal would include watersheds or groundwater impacted by release of leachate from land disposal sites and areas subject to air emissions from landfills and incineration sites. No special circumstances concerning the environment surrounding the disposal of the articles are expected.

5. IDENTIFICATION OF CHEMICAL SUBSTANCES THAT ARE THE SUBJECT OF THE PROPOSED ACTION.

Technical Name/CAS No.

Carbon monoxide-ethylene-propylene terpolymer
(Chemical Abstracts Service Registry No. 88995-51-1)

Carbon monoxide-ethylene copolymer
(Chemical Abstracts Service Registry No. 111190-67-1)

Molecular Weight:

The number average molecular weight is:

30,000 [relative to poly(methyl methacrylate) (PMMA)]

Low molecular weight polymer fractions (estimate):

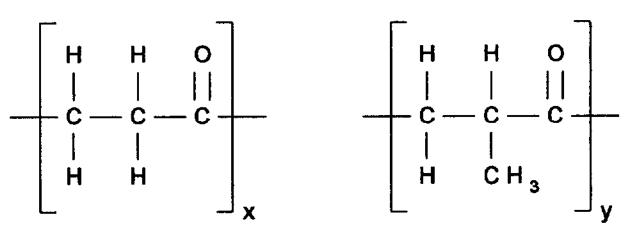
≤ 10,000 g/mole	7.5%
< 5,000 g/mole	3.0%
< 2,000 g/mole	0.3%

Empirical Formula: Not available

Molecular Formula:

$-(C_3H_4O)_m-(C_4H_6O)_{(0-0.08)m}$

Structural Formula:



Physical description: White to off-white solid

Additives:
The following adjuvants may be used typically with a total concentration of 0.5 to 1.5% polymer weight. Not all adjuvants will be used in each formulation; rather, the list below is representative of the additives being considered for use in the polymer in food contact.

Impurities:
Residual impurities may be

Analytical tests indicate that typical residual levels in water are as follows when the polymer is subjected to two hours of heating at 250°F followed by 120°F for ten days:

Catalyst metallic component	not detectable (< 25 ppb)
Organophosphine ligand	25 - 150 ppb (in fsl extract)
Trifluoroacetic acid salts	< 100 ppb
Methanol	≤ 800 ppm

Catalysts are defined in CBI table

Unreacted raw materials/process chemicals:
Theoretical maximum levels calculated for all catalyst components in the polymer are less than 20 ppm. Methanol, a process solvent, has an established maximum specification of 800 ppm in the polymer.

6. INTRODUCTION OF SUBSTANCES INTO THE ENVIRONMENT.

Food contact article fabrication:
In the fabrication of food contact articles, adequate emission controls currently in place under federal and state statutes will prevent the unlawful entry of any contaminants into the environment. The methods used to produce the food contact articles may include extrusion film processes (cast, oriented, etc.), injection molding, blow molding, and thermoforming.

Most of the molding processes include heating the polymer in a closed extruder barrel until it is molten. It is extruded or injected from the barrel and subsequently solidified into the desired shape. We estimate the quantity of air emissions that would enter the environment from the article manufacturing process to be negligible and not different from existing polyolefin processing. The "typical" injection molder will have five to thirty machines and process one to ten million pounds per year of polymer using twenty to fifty employees.

The wastes in the production of food contact articles are expected to be well below 0.5%. Scraps, runners, sprues, and the like are normally reground and reused. No other significant forms of waste are envisioned.

Disposal in landfill:
Migration data from the chemistry testing has been employed to estimate the theoretical maximum environmental contribution of the components that may leach from the containers. This estimate is very conservative in that it uses data developed from very extreme exposures (i.e., 250°F exposure) whereas landfills are usually at ambient temperatures. The calculations assume that the migration level will be the same under much less extreme environmental conditions and use the total polymer production for this application as the source for leachate. The maximum annual contribution is given below. The calculations are summarized in the attached confidential table.

Migrant	Theoretical Maximum Contribution in U.S.
Oligomers of polymer	14,400 pounds
Methanol	11,300 pounds
Catalyst component 1	100 pounds
Catalyst component 2	70 pounds
Catalyst component 3	5 pounds

These values clearly represent exaggerative estimates of actual leachate amounts in view of EPA regulations governing municipal solid waste landfills. EPA's regulations require new municipal solid-waste landfill units and lateral expansions of existing units to have composite liners and leachate collection systems to prevent leachate from entering ground and surface water, and to have ground-water monitoring systems. 40 C.F.R. Part 258. Although owners and operators of existing active municipal solid waste landfills that were constructed before October 9, 1993 are not required to retrofit liners and leachate collection systems, they are required to monitor groundwater and to take corrective action as appropriate.

Waste to Energy:
The plastic does not contain heavy metals, halogens or any other element at levels that would compromise its ability to be used as an energy source. It is expected to be a good fuel source in waste to energy plants.

7. FATE OF EMITTED SUBSTANCES IN THE ENVIRONMENT

The environments present at and adjacent to the disposal locations are the same as for the disposal of any other retail food packaging material in current use. Therefore, there are no special considerations concerning the environment surrounding the disposal sites of these polymers.

(a) Air

The polymers which are the subject of this notification are not volatile. The materials present in the polymer are bound in the polymer matrix and would not be released into the atmosphere under normal environmental conditions.

(b) Freshwater, estuarine, and marine ecosystems:

The polymers which are the subject of the present notification will not be in contact with fresh water, estuarine, or marine ecosystems. At ambient temperatures there is no significant migration predicted from the polymers. Thus, disposal of the polymer will not contribute any significant contaminants to this ecosystem.

If the leachates, identified above, were to leach into the water, they would be present in such extremely low concentrations that there would be no consequence of their presence.

(c) Terrestrial ecosystems

The polymers that are the subject of the present notification will be disposed of in landfills, converted to energy through incineration, or recycled in commingled plastics streams, and will not become a significant part of the terrestrial ecosystems.

The unstabilized polymer undergoes photodegradation. Tests were conducted in Houston, Texas and South Florida to determine the extent of degradation under normal ultraviolet conditions. Drop strength or tensile properties were the most sensitive measurements of degradation. The UV damage arises from exposure to sub-325 nm wavelengths according to observations with cut-off filters. By pigmenting the containers, we expect the polymer to have shelf life well over six months based on testing conducted in full outdoor sun of containers pigmented with carbon black. Most window glass filters the range of UV which damages the polymer.[1] Moreover, the polymers will not be subject to photodegradation upon disposal because the specific end-use applications covered in this Notification are not frequently littered.

Work conducted to support non-notified applications for the polymer indicate that the material is inert in the environment. After soil burial for six (6) months, and incubation for three to four weeks under highly challenging conditions of high humidity, temperature and concentration of polymer-degrading organisms, there was negligible biodeterioration of the polymers or the Nylon 6.6 or polypropylene controls.[2]

The polymer does not support microbial growth nor does it degrade at any perceptible rate in underground burial. There will not be an adverse contribution to the terrestrial ecosystem from any materials contained in these polymers.

8. ENVIRONMENTAL EFFECTS OF RELEASED SUBSTANCES

Polymer:
The polymer was tested to determine its mammalian toxicity. These tests are summarized in Section E. The polymer was practically non-toxic in acute oral, dermal and inhalation tests; it did not cause skin irritation or sensitization. It was not mutagenic in bacterial assays.

Oligomers:
Mammalian testing on the oligomers extracted from the polymer are summarized in Section E. In acute lethality tests by the oral and dermal route the material was not toxic at doses of 5,000 mg/kg in oral tests in rats and 2,000 mg/kg in dermal tests in rabbits. It was not irritating to the skin or a sensitizer. There was corrosion seen in the eyes of rabbits when tested but this was believed to be an effect of the methanol solvent used in the extraction of the oligomers from the polymer. The oligomer extract was not mutagenic in a battery of mutagenicity studies both with and without metabolic activation.

There are no available environmental tests on the oligomers but the contribution to any individual environment is not predicted to be significant. From the mammalian and mutagenicity testing, the materials appear to be rather inert biologically.

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[1] Weinkauf, D. H., et al, "UV Light Stability of Thermoplastic Polymer: South Florida Test Service, tab 57.

[2] Battersby, N.S., "(: An Assessment of Biodeterioration", SBRG.90.220, 1990, tab 55. Methods used in the soil burial studies were generally based on published studies found in the Reference section of the report. Resistance to fungi and bacteria studies were based on ASTM G21-70 and G22-76 methods. These methods also represented the closest standard methods available for the growth on polymers in liquid culture studies. The ASTM methods were followed or adopted as appropriate. Where no applicable standard methods were available, detailed test procedures are described in the study report.

Methanol:
Methanol is a naturally occurring component of many fruits, vegetables, coffee, and nuts ranging in concentration from 20 to 2,000 parts per million.[3 4] The levels of methanol in these items is greater than the amount that will be contributed from its presence in these polymers, where most of it is bound in the matrix. There should be no additional significance to the very low incremental increase in methanol in landfills that may occur from the food contact use of the polymer.

Catalyst components:
There is no significant contribution of the catalysts to the terrestrial ecosystem or any known harm from these materials. As shown in Item 6 above, the maximum predicted environmental contributions of all polyketone catalyst components in the entire U.S. is less than 200 pounds based on testing conducted under extreme conditions not typical to landfills or terrestrial environments.

Mammalian testing has been conducted on the catalyst component 1 (see CBI table for identification). Tests indicate that there is no significant toxicity associated with this material. In acute testing, the material was not lethal at doses of 5,000 mg/kg orally in rats, 2,000 mg/kg dermal in rabbits, and 2 mg/L by inhalation to rats. It was not irritating to the skin or a skin sensitizer. It was only slightly irritating to the eyes. It caused only a slight liver weight increase at 1,000 mg/kg/day in a 28-day rat study with no effects at the 350 mg/kg/day dose. There was no indication of mutagenicity in a battery of tests both with and without metabolic activation.

9. USE OF RESOURCES AND ENERGY

Energy content of polymer:

polymer has a low energy content when compared to other common polymers such as polypropylene and polyethylene. The reason for this is that the polymer is composed of 50:50 carbon monoxide/ethylene ratio for the copolymer or a 50:42:8 ratio for the terpolymer. Carbon monoxide has a very low BTU/lb energy content. The following table shows that the energy savings are very significant at approximately 35% when compared to straight ethylene or propylene. The values for each of the polymers listed reflect the energy stored in each polymer that can be released on consumption (not the amount of energy that is needed to produce the polymer).

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[3] Lund, Eric D., et al, "Methanol, Ethanol, and Acetaldehyde Contents of Citrus Products", J Agric Food Chem, 29: 361-366, tab 58.

[4] Kavet R. and Nauss K.M., The Toxicity of Inhaled Methanol Vapors. CRC Critical Reviews in Toxicology 21, 21-50, tab 59.

Caloric Value, 60 deg F

	BTU/lb
Ethylene	21,713
Carbon monoxide	4,359
Carbon monoxide/ethylene (50/50)	13,036
Propylene	20,142
Polyethylene	19,990
Polypropylene	19,850

The energy content of the terpolymer containing up to 8 mole-percent propylene is expected to be the same as, or slightly less than, that of the carbon monoxide/ethylene (50/50) copolymer given above. The amount of energy used to polymerize these monomers is small and essentially the same as compared to the energy content of the monomers. The amount of energy used in transportation and distribution is also small and similar to other polymers.

Polymer production:

Land:
No additional land will be required, as the new plant will be located on the existing site of Shell Nederland Chemie at Moerdijk.

Raw materials:

Per ton of polymer:	0.51	ton carbon monoxide
	0.42 - 0.51	ton ethylene
	0 - 0.08	ton propylene

Energy:

Steam:	5,753.5 BTU/lb
Electricity:	2,140.1 BTU/lb
Cooling:	minimal

Waste treatment/incineration aqueous stream: minimal

According to the Franklin Associates in a study which measured the cradle to grave energy, air and water pollution, and solid waste, plastic beverage containers are favored. They studied PET, glass and aluminum and found that plastics consume less energy, generate less air and water pollution and create less solid waste. Though they did not use the notified polymer specifically, based on the chemistry of this polymer, we would expect it to be even less energy intensive than the PET used in their study.[5]

There are no threatened or endangered species at the site of production or nearby which would be harmed by the manufacturing operations for this polymer.

[5] Franklin Associates, "Comparative Energy and Environmental Impacts for Soft Drink Delivery Systems", March 1989, tab 56.

Finished article fabrication

The manufacturing plants which will use this polymer to produce food contact articles are currently in existence, and this material will serve as a replacement for materials currently used in these plants. There is no net increase in the use of natural resources and energy from substitution at the plant. Indeed, in some applications, a net reduction in resource consumption is likely considering the relative weights of polyketone articles vs. the materials these containers will replace. For example, an 8-ounce steel can with an estimated weight of 38 grams is approximately 2.5 to 3.8 times the weight of the same volume container produced from the subject polymers. (See Table 1 below for typical polyketone container mass and capacity information.)

Disposal

Information on potential markets for polyketones in repeated-use and single-service food-contact applications is set forth in Table 1 attached to this Environmental Assessment. polymers will not adversely affect recycling programs currently available to other polymers for the following reasons. Initially, polyketone polymers are expected to be used primarily or exclusively in the production of articles intended for repeated use, primarily for use in food conveyance in food processing facilities. At the end of their useful life, such articles will be disposed of by the same means currently used to dispose of other similar articles; the replacement of other materials by polyketones is expected to have no environmental impact.

Moreover, based on the expected end-use applications, as described in Item 4 above, food-contact articles produced from polyketones will be readily distinguishable from PET beverage bottles and HDPE milk jugs and, thus, are not expected to be collected with these articles for purposes of recycling. Consequently, there will be no impact on recycling programs for these materials.

In addition, there will be no adverse impact on the stability of articles made from commingled plastic waste for the following reasons: a) The anticipated market volume for polymers in food packaging applications is extremely low, as shown in the Confidential Business Information table provided with this EA, compared to the general plastics recycling stream; thus, the level of polyketone in articles manufactured from commingled plastics will be correspondingly low. It is highly unlikely that the presence of minute levels of polyketone would adversely affect the properties of these articles; b) The main packaging applications targeted for polyketone are multilayer structures which are not currently recycled to a significant extent; thus, only a small fraction of food packaging materials produced from polyketone would be likely to be present in mixed plastics recycling streams; and, c) In the case of recycled items such as plastic lumber, manufacturers with stringent requirements for performance properties and consistency, such as lumber makers, are trending toward extrusion of sorted plastics, particularly HDPE, and away from commingled plastics.[6] While sorting of used articles may likely be the predominant method of sorting, automated sorting by density differences should also be efficient (densities, g/cc: HDPE <0.99; polymer = 1.20 - 1.28).

While unprotected polymers do exhibit photodegradation, this is not expected to be manifested in commingled articles. Commingled plastic compounds typically include fillers, UV absorbing pigments such as carbon black or titanium dioxide (TiO_2), or reinforcing agents such as chopped glass fibers. Experience with polymers has shown that these agents are, indeed, stabilizing towards the adverse effect of UV. Screening pigments, coatings or absorbing additives provide effective stabilization. This is especially true in thick sections such as encountered in lumber applications. Outdoor durability has further been demonstrated in polymers which after molding into automotive fenders and painted show excellent ductility after more than 6 years of outdoor exposure in South Florida[7].

10. MITIGATION MEASURES

No potential adverse environmental impact is associated with the proposed action.

11. ALTERNATIVES TO THE PROPOSED ACTION

No potential adverse environmental impacts have been identified with the proposed action.

12. LIST OF PREPARERS

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[6] Plastics Technology, "Plastic Lumber Gets Some Respect", August, 1996, p. 34-39. (Copy provided as Attachment A.)

[7] Shell ongoing, unpublished study. (Memorandum summarizing study is provided as Attachment B.)

13. CERTIFICATION:

The undersigned certifies that the information presented is true, accurate, and complete to the best of the knowledge of the firm or agency responsible for preparation of the environmental assessment.

Date: May 10, 2000

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Counsel for the Notifier

TABLE 1

INFORMATION ON POTENTIAL FOOD-CONTACT USES FOR POLYKETONES

Description of the food-contact articles and food applications affected by the proposed action				
Articles to be made with packaging containing the subject additive	**Types of food applications**	**Amount of food container will hold**	**Container mass**	**Type of packaging currently used for these applications**
Articles intended for repeated-use in food processing establishments, including belts, hoses, and pipes	n/a	n/a	n/a	n/a
Multilayer flexible packaging for refrigerated products	meat	1 lb - 20 lb	5 g - 26 g	PE/adhesive/EVOH/ adhesive/PE structures[8]
	cheese	1 lb - 40 lb	3 g - 22 g	PE/adhesive/EVOH/ adhesive/PE structures[8]
	vegetables	0.5 lb - 3 lb	4 g - 10 g	PE/adhesive/EVOH/ adhesive/PE structures[8]
Reheatable or microwavable rigid retort packaging	see confidential information in Section C of this notification	0.5 lb	10 - 15 g	Cans and structures with PP/adhesive/ EVOH/adhesive/PP layers[9]

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[8] PE/adhesive/EVOH/adhesive/PE is an abbreviation for polyethylene/adhesive/ethylene-vinyl alcohol copolymer/adhesive/polyethylene.

[9] PP/adhesive/EVOH/adhesive/PP is an abbreviation for polypropylene/adhesive/ethylene-vinyl alcohol copolymer/adhesive/polypropylene.