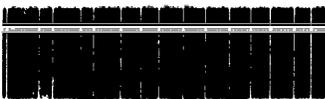


CODING FORMS FOR SRC INDEXING

Microfiche No.		CTS0001106	
New Doc ID	FYI-OTS-0794-1106	Old Doc ID	
Date Produced	05/17/88	Date Received	07/14/94
		TSCA Section	FYI
Submitting Organization		GREAT LAKES CHEM CORP	
Contractor			
Document Title		INITIAL SUBMISSION: LETTER FROM GREAT LAKES CHEM CORP TO USEPA REGARDING ITC REQUEST FOR INFORMATION ON BROMINATED FLAME RETARDANTS (53 FR 5466) WITH ATTACHMENTS, DATED 05/17/88	
Chemical Category		BROMINATED FLAME RETARDANTS	



Great Lakes
Chemical Corporation



WT-94-0116
INET 07/14/94

74I-0794-00106

P.O. BOX 2800 • HIGHWAY 88 N.W. • WEST LAFAYETTE, INDIANA 47906 • PHONE: 317-483-2511 • TELEX: 27-9428 • CABLE: GLARCHEN LAFAYETTE

May 17, 1988

Executive Secretary
Interagency Testing Committee (TS-792)
Environmental Protection Agency
401 M Street SW
Washington, DC 20460



84940000189

REC'D
MAY 23 1988
DHR/Smk

Re: ITC Request for Information on
Brominated Flame Retardants
(53 FR 5466)

Dear Sir:

Great Lakes Chemical Corporation is a manufacturer of the following chemicals which were listed in the subject notice:

CAS No.	Chemical Name
1163195	Decabromodiphenyl oxide - Walker
3194556	Hexabromocyclododecane - Hudson/Walker
32534819	Pentabromodiphenyl oxide - Walker
32536520	Octabromodiphenyl oxide - Walker
37853591	→ 1,2-Bis(2,4,6-tribromophenoxy)-ethane - Mishra/Walker

For each of these chemicals the following information is enclosed:

Product Information Sheet
Material Safety Data Sheet
Toxicity Data Summary

Also enclosed is a summary of uses and markets for the brominated diphenyl oxides. This summary was presented to EPA in a meeting April 21, 1988.

Copies of any of the studies referenced on the Toxicity Data Summary can be provided on request.

To our knowledge, bromochloromethane (CAS 74975) is not manufactured or used as a flame retardant or for any other purpose.

Sincerely,

David L. McAllister

David L. McAllister
Director, Research Services

DLM:sb:214
Enclosures

cc: K. A. Hughes
D. L. McFadden

912
MAY 14 9 16 AM '88
RECEIVED
GPT/BIC

0 0 0 3 4

Product Information



Flame Retardant Chemicals

July 15, 1981

Effective:
Supersedes:

BIS(TRIBROMOPHENOXY)ETHANE GREAT LAKES FF 680

APPLICATIONS

FF 680, a proprietary flame retardant, is a white, crystalline powder. High bromine content and excellent thermal stability make this material an outstanding flame retardant for many thermoplastic and thermoset systems. FF 680 is an efficient flame retardant for those applications where thermal stability at high processing temperatures is important. FF 680 has a good ultraviolet light stability making it an ideal candidate for light stable applications.

PHYSICAL PROPERTIES

See price information bulletin for specifications.

Bromine, %	70.0
Melting range, °C	223-225
Density, g/ml	2.58
Bulk density, lb/ft ³	46.7
Vapor pressure, mm Hg, at	
170°C	1.9 x 10 ⁻³
190°C	1.1 x 10 ⁻²
210°C	3.5 x 10 ⁻²
220°C	4.9 x 10 ⁻²

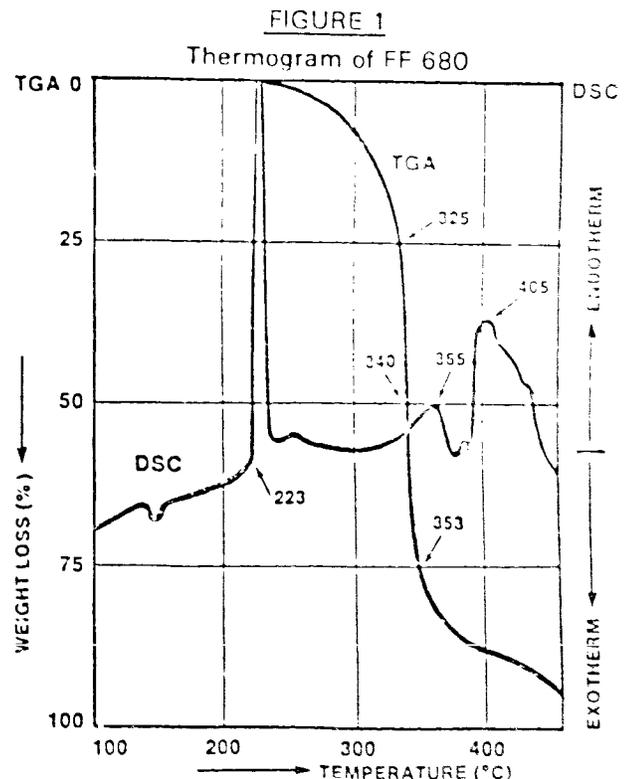
Solubility:

Boiling dichlorobenzene, p-xylene
perchloroethylene Soluble
At ambient temperature in water, acetone,
benzene, carbon tetrachloride, chloroform,
cottonseed oil, dichloroethane, dimethyl-
formamide, hexane, methanol, perchloro-
ethylene, Stoddard solvent insoluble

Thermal Properties

The thermal behavior of FF 680 as determined by thermogravimetric (TGA) and differential scanning calorimetric (DSC) analysis is presented in Figure 1. The flame retardant was heated in air at a rate of 20°C/min from room temperature to 500°C.

The major endotherm beginning at 223°C represents the melting of the compound.



Thermogravimetric analysis shows that a one percent weight loss occurs at 244°C.

Toxicological Information

The acute oral LD₅₀ of FF 680 for male rats was found to be greater than 10 g/kg of body weight.

The acute dermal LD₅₀ for rabbits was greater than 10 g/kg of body weight.

Skin and eye irritation studies using albino rabbits produced no irritative effects.

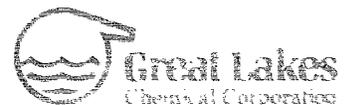
Within the meaning of the Federal Hazardous Substances Act as amended January 1971, FF 680 is non-toxic orally, non-toxic dermally, and is not a skin or eye irritant.

OVER

The information supplied is presented in good faith and has been derived from sources believed to be reliable. Since conditions of use are beyond our control, all risks are assumed by the user. No representation is expressed or implied and nothing herein shall be construed as permission or recommendation to practice a patented invention without a license.

P.O. Box 2200, Highway 52 N.W., West Lafayette Indiana 47906

Phone: 317-463-2511 Telex: 27-9428 Cable: GLACHEM Lafayette



Subacute feeding studies conducted on white rats with FF 680 showed the following

- 1) Minimal effect on body weight and organ weight.
- 2) Minimal chemical and histopathological effects.
- 3) Low accumulation of FF 680 in liver, fat, and muscle tissue. The small amounts that accumulated rapidly decreased on withdrawal of feed containing FF 680.

HANDLING PRECAUTIONS

FF 680 is stable under normal storage conditions. It does not cake nor is it affected by exposure to atmospheric moisture.

Even though FF 680 is not toxic orally or dermally and is not a skin or eye irritant within the meaning of the Federal Hazardous Substances Act, as amended January 1971, it is recommended that prolonged skin contact, eye exposure, and inhalation of dust be avoided. If contact with the skin occurs, exposed areas should be washed with soap and water. Protective gloves, chemical safety glasses and dust masks should be worn. Smoking and eating should be avoided, when handling the product.

0 0 0 5



Great Lakes
Chemical Corporation

MATERIAL SAFETY DATA SHEET

EMERGENCY TELEPHONE (501) 862-5141

IDENTITY - Great Lakes FF-680
1,2-Bis(tribromophenoxy)-ethane

SECTION I - PRODUCT INFORMATION

MANUFACTURER'S NAME - GREAT LAKES CHEMICAL CORPORATION

TELEPHONE NUMBER FOR INFORMATION - (317) 463-2511

CAS REGISTRY NO. - 37853-59-1

DATE PREPARED - 8/86

FORMULA - $C_{14}H_8Br_6O_2$

SUPERCEDES - 2/85

CHEMICAL FAMILY - Brominated aryl alkylene ether

PREPARED BY - Research Services Department
Great Lakes Chemical Corporation
West Lafayette, Indiana 47906

SECTION II

HAZARDOUS COMPONENTS (Specify Chemical Identity: Common Name(s))

<u>COMPONENT</u>	<u>OSHA PEL</u>	<u>ACGIH TLV</u>	<u>Other Limits Recommended</u>	<u>% (optional)</u>
1,2-Bis(tribromophenoxy)-ethane (Nuisance dust levels)	15 mg/m ³	10 mg/m ³	Not estbl.	100

GLCC Product Code: 505

GREAT LAKES CHEMICAL CORPORATION

P.O. Box 9000, West Lafayette, Indiana 47906

0 0 0 6

=====

SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point	Not Available
Specific Gravity (water = 1)	2.58
Vapor Pressure (mm Hg.)	Not Available
Melting Point	433-437°F (223-225°C)
Vapor Density (AIR=1)	Not Available
Evaporation Rate	Not Available
(Butyl Acetate = 1)	
Solubility in Water	Insoluble
Appearance and Odor	White crystalline powder

=====

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used)	Not Applicable
Flammable Limits	Not Applicable
LEL	Not Applicable
UEL	Not Applicable

Extinguishing Media

All conventional extinguishing media are suitable

Special Fire Fighting Procedures

Wear self-contained breathing apparatus

Unusual Fire and Explosion Hazards:

Combustion in the presence of other fuels may release hydrogen bromide or other toxic gases.

=====

SECTION V - REACTIVITY DATA

Stability Stable X Unstable

Conditions to Avoid: None

Incompatibility (Materials to Avoid)

None known

Hazardous Decomposition or Byproducts

Hydrogen bromide or other toxic gases

Hazardous Polymerization

May Occur Will Not Occur

Conditions to Avoid: None

SECTION VI - HEALTH HAZARD DATA

Route(s) of Entry:

Inhalation? Yes Skin? No Ingestion? Yes

Health Hazards (Acute and Chronic):

Acute oral LD₅₀ for rats is greater than 10 g/kg. The acute dermal LD₅₀ for rabbits is greater than 2 g/kg. Great Lakes FF-680 is not a primary skin irritant and not a primary eye irritant. No test animal deaths occurred during a four hour acute inhalation exposure and 14 day post-exposure period to FF-680 at the maximum concentration employed of 36.68 mg/l. In a 90-day dietary study, no treatment related changes were observed in animals fed 0.1 or 1.0% FF-680. At 10%, minimal liver cell enlargement was observed. Acute health hazard is the potential for eye or skin irritation. Tests in laboratory animals indicate a potential for liver damage from chronic extremely high oral exposure.

Carcinogenicity:

NTP? No IARC Monographs? No OSHA Regulated? No

Signs and Symptoms of Exposure

Contact may cause eye or skin irritation.

Medical Conditions Generally Aggravated by Exposure

None reported. Existing dermatitis may be aggravated by exposure.

Emergency and First Aid Procedures

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get prompt medical attention if irritation occurs. In case of contact, wash exposed skin with soap and water.

SECTION VII - PRECAUTIONS FOR SAFE HANDLING AND USE

Steps To Be Taken in Case Material is Released or Spilled

Vacuum up spill to minimize dust in the air and place in a suitable, labelled container for disposal. Avoid skin or eye contact and inhalation of dust.

Waste Disposal Method

Dispose of waste in an approved chemical incinerator equipped with a scrubber or in a chemical landfill as approved by current laws and regulations.

Precautions to be Taken in Handling and Storing

Use reasonable care to avoid skin and eye contact. Avoid breathing dusts. Wash contaminated clothing before reuse. Store in dry, well-ventilated area. Avoid overheating.

Other Precautions

None

SECTION VIII - CONTROL MEASURES

Respiratory Protection

Wear NIOSH approved dust respirator where dusting occurs.

Ventilation

Local Exhaust - Use to minimize dusting Special - None

Mechanical - Use for general area control Other - None

Protective Gloves - Neoprene

Eye Protection - Safety glasses

Great Lakes Chemical Corporation
MSDS - Great Lakes FF-630 1,2-Bis(tribromophenoxy)-ethane
page 5

Other Protective Equipment - Wear body covering clothing

Work/Hygiene Practices - Wash thoroughly after handling

Information on this form is furnished solely for the purpose of compliance with OSHA's Hazard Communication Standard, 29CFR 1910.1200 and shall not be used for any other purpose.

DLMcF/db:90

observed for two weeks. No deaths were observed and body weight gains were normal.

Primary Skin Irritation

The test material was applied to two areas on each of six albino rabbits, one abraded area and one intact area, in the amount of 0.5 g. per area. The treated areas were covered with gauze patch and tape. After 24 hours, the coverings were removed and the degree of erythema and edema were scored. A second reading was taken at 72 hours. The average of the two readings was taken as the score. The primary irritation index was determined to be zero for both abraded and unabraded skin.

Eye Irritation

The eyes of six New Zealand albino rabbits were examined. A 0.1 g. sample was instilled into an eye of each rabbit. The eyes were unwashed. Eye examinations for irritation were made at 24, 48, and 72 hours following application. No irritation was observed at any of the examination periods and the irritation index was determined to be 0.0.

Acute Inhalation

A Wright Dust Feeder was used to develop a calculated atmospheric concentration of 36.68 mg./l. of the micronized test material. Five male and five female rats of the Spartan strain were exposed for four hours to the test atmosphere. Signs observed during the exposure period included increase^d followed by decreased motor activity, eye squint, erythema, slight dyspnea, slight bradypnea, salivation and nasal porphyrin discharge. At 24 hours and the duration of the observation period, all rats appeared normal, with the exception of one rat that exhibited nasal porphyrin discharge on days seven and eight. All rats exhibited normal body weight gains. No compound related findings were observed at necropsy following the observation period. Three rats were observed to have greyish foci in the lungs, which were not considered significant in rats of this age and strain.

Twenty-Eight Day Feeding Study

The test material was added to the diet of male weanling rats for 28 days at 100 and 1000 p.p.m. Average body weight gains were somewhat less than average control gains. Average organ weights were less than controls for both the 100 and 1000 p.p.m. dosages. The lack of clinical and histopathological effects indicated the effects noted were minimal. Data on body weight gain and food consumption during the withdrawal periods of 6, 12, and 18 weeks showed a recovery in those instances where differences between control and test groups were noted during the test feeding period. This indicated the body weight effect was the result of palatability

or a minimal reversible or transient toxic effect. Tissue residue data determined by neutron activation for groups receiving the test material indicated moderate residues in muscle, liver, and fat at the beginning of withdrawal and much lower residues in all tissues at the two weeks withdrawal. After six weeks withdrawal, all residues were markedly reduced or negative in all tissues except the fat tissue which still had a low level residue. The 12 and 18 week average withdrawal values for liver and muscle are zero while the fat tissue residue values are much lowered over the six week withdrawal period.

Fourteen Day Range Finding Feeding

In a 14 day range finding study in Charles River CD rats, the test material was fed in the diet at dosage levels of 0.5, 1.0, 5.0 and 10.0 percent. Five male and five female rats were used at each dosage level. No changes considered compound related were seen in general behavior, appearance, body weights, or food consumption. One rat at the 5.0 percent dosage level died during study. No compound related gross pathologic lesions were observed at necropsy in any rats.

Twenty-Eight Day Feeding Study

Twenty-five male and 25 female Charles River CD rats were fed a diet containing 1000 p.p.m. of the test material for 28 days. Twenty-five male and 25 female rats were used as controls. No changes considered to be compound related were seen in general behavior or appearance, body weight, food consumption or survival. Slight increases in bromine content were found in the fat samples from the treated rats following four weeks of compound administration. There was a reduction in the bromine content of the fat samples of treated rats at each analysis period during withdrawal. After 18 weeks of withdrawal, the bromine content of fat from treated rats was considered to be within normal limits.

Ninety Day Subacute Oral Toxicity

A 90 day subacute oral toxicity study was conducted in which groups of albino rats were fed dietary concentrations of 0, 0.1, 1.0 or 10.0 percent of the test material. The body weights and body weight gains among the test groups compared favorably with those of the control groups. The average food consumption among the test groups compared favorably with those of the control group. Fourteen animals died during the study. Eleven deaths occurred immediately after the collection of blood. The cause of death was not determined for the other three rats. Gross pathologic examination of these animals did not reveal any correlation between death and exposure to the test material. No abnormal behavioral reactions were noted among any of the animals in the study. The results of the hematologic studies conducted revealed no changes related to the test material. Slight changes were noted in the serum alkaline

phosphatase activity were similar (not females) fed 10.0 percent test material at 40 and 60 days of testing. Evaluation of lower test groups at 60 days revealed values which were similar to those of the controls. No other significant changes were noted in other clinical blood chemistry studies. Urinalyses conducted during the study were similar for both test and control animals. No gross pathological changes related to treatment were observed. Statistical analysis conducted on absolute organ weights and ratios revealed no treatment related changes. Histopathological examination of test animals fed 10 percent test material revealed treatment related liver changes among most animals in this group. The lesion consisted of either focal or multifocal enlargement (hypertrophy) of hepatocytes located within the centrilobular to midzonal regions of affected liver lobules. The severity was scored as minimal and the incidence was higher among male test animals. No treatment related changes were observed among animals fed either 0.1 or 1.0 percent.

Twenty-Eight Day Dermal Toxicity Study

The test compound was applied at dosage levels of 50, 500 and 5,000 mg./kg./day, five days each week, for a total of four weeks to New Zealand white rabbits. Three male and three female rabbits were used at each dosage level. A control group of three male and three female rabbits received normal saline. No compound related clinical signs were seen during the study period. No deaths occurred during the study. The skin irritation observed was limited to very slight to slight erythema which was observed in both the control and treated groups. One rabbit at the 5,000 mg./kg./day dosage level exhibited very slight to moderate erythema. No significant difference was noted in the degree of erythema observed when comparing the observations made prior to and following each daily dermal application. The erythema observed was considered attributable to the control vehicle (normal saline) and not to the application of the test material. Changes in body weight which occurred during the study were not attributed to compound administration. No compound related changes were seen in the hematological, biochemical, or urinalysis studies conducted at 14 and 28 days. No compound related gross or microscopic pathologic lesions or variations in organ weights were noted in any rabbits from the experimental groups.

Modified Draize Multiple Insult Test in Humans

Fifty male human volunteer subjects were used to examine the irritation and contact sensitization potential of the test material. No evidence of irritation was seen during the sensitizing phase of the study. Following the challenge dose, one subject showed a delayed response which appeared clinically to be a type of irritation. A second challenge dose given this person, gave completely negative results, indicating that contact sensitization had not occurred in this subject. The test compound produced no significant irritation

and gave no evidence of contact sensitization in the 45 persons who completed the study.

Twenty-One Day Inhalation

In a 21 day inhalation study, albino rats were exposed to the test material at atmospheric concentrations of five and 20 mg./l. The exposure lasted four hours daily, five days each week, for three weeks. A control group of rats was exposed only to air in the test chamber. Clinical observations during the study period did not reveal any significant compound related findings. No deaths occurred in either the control or treated groups during the study period. No compound related changes in body weight or food consumption occurred during the study. Hematological, biochemical and urinalysis studies obtained at 20 days did not exhibit changes which were considered related to compound application. No compound related gross pathological lesions or variations in organ weight were observed. Microscopically, most rats from the two experimental groups had scattered foci of foamy alveolar macrophages in their lungs; these foci were considered compound related.

Acute Inhalation Toxicity After Pyrolysis

An inhalation study was performed with the pyrolysis products from a mixture of ABS, FF-680, and antimony oxide. Albino rats were exposed to the pyrolysis products at a temperature of 68-69°F with an airflow of ten l./min. No deaths occurred during the four hour exposure period or during the subsequent 14 day period of observation. Signs noted during the exposure period included decreased motor activity, eye squint, slight dyspnea, and ocular porphyrin discharge. At 24 hours, eye squint and ocular porphyrin discharge were observed in several rats. From 48 hours through 14 days, most rats appeared normal. Signs that were observed included one or two rats exhibiting soft stool at 48 hours and 8, 10, 12, 13, and 14 days; one rat exhibiting respiratory congestion at 8, 9, 12, and 13 days; and one rat exhibiting ocular lesions from 48 hours through seven days. All rats exhibited normal body weight gains during the study period. The percent weight loss of compound in the flask, after pyrolysis, at four hours was calculated to be 2.45 percent of 100.02 grams of starting material. Necropsy findings observed at terminal necropsy conducted at 14 days revealed one of ten rats showing scattered grey foci in the lungs and one of ten rats which showed congestion of the lungs.

Acute Heated Vapor Inhalation Toxicity Study with Granulated FF-680 Containing Television Rings

Vapor was generated by passing a stream of clean, dry air over granulated television rings containing FF-680 heated to 135°C. The air-vapor mixture was then introduced into the exposure chamber for four hours. The ten rats were exposed to an average particulate matter concentration of 0.228 mg./l. of air. The

... and later analyses. There were no significant differences observed during the exposure or the 14-day post-exposure period. The average body weight gain was 17% of normal limits. Necropsy did not show any gross pathological alterations that were attributable to the effects of the test material.

Pilot Teratology

The test material was administered by gavage at 3, 100, 300, 1,000, 3,000, and 10,000 mg./kg./day to pregnant rats from gestation day six through day 15. A control group received the vehicle, corn oil at 25 mg./kg./day. The rats were sacrificed on gestation day 20 and uterine contents examined for viable and nonviable fetuses, early and late resorptions, and total implantations. There were no effects attributable to treatment at dosage levels of 10,000 mg./kg./day or less in pregnant rats.

Teratology

Test material was given orally by gavage to pregnant Charles River CD rats at dosage levels of 100, 1,000, and 10,000 mg./kg./day from day six through day 15. The rats were sacrificed on gestation day 20. There were no biologically meaningful differences in the mean number of viable and nonviable fetuses, early or late resorptions, corpora lutea, male to female ratio or mean fetus body weights between the treated and untreated groups. Fetal malformations and variations were comparable for the treated and control groups.

Tissue Residue Accumulation/Depletion

A tissue residue accumulation/depletion study was conducted upon groups of albino rats fed either zero or 1,000 p.p.m. of the test material. Five males and five females from each group were sacrificed 4, 8, 12, 16, 20, or 24 weeks of testing. The same number of animals were removed from test diet at 24 weeks and allowed 2, 4, 9 1/2, 12, 16, or 56 week recovery periods prior to sacrifice. Body weight and body weight gains among test animals compared favorably to those of the controls during both the test and recovery periods. The food intake of treated animals was similar to that of control animals. No clinical symptoms or treatment related deaths occurred during the study. Analysis of fat samples among test animals revealed a ten to 20% increase in bromine concentration throughout the 24 week test period when compared to controls. Although a slight reduction in bromine was noted after 12 weeks of recovery, bromine was present in fat samples, at about four times controls, at the final recovery period sacrifice. Bromine concentrations of both liver and kidney samples were approximately two to three times controls during the test period. After two and four weeks of recovery, the bromine levels for the liver and kidneys, respectively, were nearly similar to those of the controls. Analysis of brain

samples showed bromine concentrations up to two times controls during the 24 week test period. After two weeks of recovery, the values were similar to those of the controls.

¹⁴C-Biodegradation

Radioisotope-tagged test material was exposed to microorganisms derived from fresh settled sewage and garden soil in a shake flask system. The extent of total degradation was monitored by measuring the amount of ¹⁴CO₂ liberated due to degradation of the labeled test material by the microorganisms present. Three different concentrations of ¹⁴C-labeled test material in microbial media were prepared (1.0 and 0.01 percent, and 1.0 p.p.m.). Incubation of the 0.01 and 1.0 percent tests was terminated after 211 days or 30 weeks; from the 1 p.p.m. test a final sample was obtained at 183 days (26 weeks). Degradation was evident in all test samples but the rate was considered low. Total recoveries of 1.11 and 0.53 percent of the initially applied ¹⁴C-activity were obtained from the 0.01 percent and 1.0 percent test groups. In the one part of the ¹⁴C-labeled test compound per million parts of media group, the total ¹⁴C-activity recovered during 183 days of incubation amounted to 1.41 percent of the total ¹⁴C applied. Inhibition of the growth rate of the microbial population in the presence of the test material at the 1.0 percent level may have been responsible for a reduced ¹⁴CO₂ evolution.

Mutagenicity Testing - Ames Test

The test material was evaluated for mutagenic potential utilizing the Ames test employing both Salmonella and Saccharomyces microorganisms at dosage levels of 0.25 µg., 0.5 µg., 5 µg., and 50 µg./plate. The solvent was dimethylsulfoxide. In the absence or presence of the rat liver activation system, this material did not demonstrate mutagenic activity. The test material was not considered mutagenic under the test conditions.

96-Hour Static Aquatic Bioassay

Bluegill fish were used as a test species in a 96-hour static aquatic bioassay. A single introduction of the test material was made and the toxicity evaluated at 24 hour intervals for a total of 96 hours. The concentrations tested were 464, 681, 1000, 1470, 2150, and 3160 mg./l. of water. Abnormal behavioral patterns observed were swimming in side position, staying at the bottom, and lying at the bottom. The acute toxicity (TL₅₀) at 24 hours was greater than 3160 mg./l., at 48 hours the TL₅₀ was 1977 mg./l. and at 96 hours the TL₅₀ was 1531 mg./l.

Rainbow Trout were used as a test species in a 96-hour static aquatic bioassay. The test procedure and concentrations were the same as the test with Bluegill fish. The acute toxicity (TL₅₀) at 24 hours was greater than 3160 mg./l., at 48 hours the TL₅₀ was 2612 mg./l. and at 96 hours the TL₅₀ was 1410 mg./l.

LD₅₀ (48 hours) for orange-red killifish was determined to be

Partition Coefficient

Radioisotope-labeled test material was used for determining the partition coefficient in an n-octanol/water system. The partition coefficient was 1.373.

Photolysis

Radioisotope-labeled test material applied to silica gel surfaces was irradiated with UV light. The test material was degraded rapidly and followed a biphasic curve. The initial degradation half-life was 0.4 day. After one day of exposure, the degradation then entered the second phase with a half-life of about 1.7 days. After ten days, 37 percent of applied ¹⁴C was recovered. Some of the test material and degradation products were probably volatilized from the plate surface. At least four degradation products were detected by TLC analysis including 2-(2',4',6'-tribromophenoxy)ethanol. The degradation products appeared to be transitory.

¹⁴C-Pharmacokinetics

Rats were given a single oral dose of the test material. Eighty percent of the radioactivity was excreted in feces and five percent was eliminated via urine, within 96 hours. The maximum residue after ten days for fat was 0.34 p.p.m. The maximum residue for other tissues was 0.05 p.p.m. Test material concentration in the blood peaked to 0.58 p.p.m. at 24 hours after dosing and gradually decreased to 0.150 p.p.m. at 96 hours. The rate of elimination in urine appears to be proportional to the concentration in the blood. The tissue residues indicate the material is poorly absorbed in the rat gut and does bioaccumulate in the fat.

¹⁴C-Water Solubility

Excess ¹⁴C-labeled test compound in distilled water was shaken in a water bath at 35°C overnight. After centrifugation (12,000 X G) at 15°C, 25°C, or 35°C for one hour, water solubility was determined by radioassay. The average solubility (p.p.m.) of duplicate experiments at 15°C, 25°C, and 35°C respectively were 0.16, 0.20, and 0.08.

W/RCF/lkb
11/81

Product Information

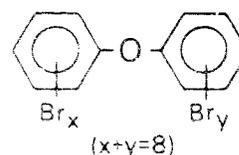


Flame Retardant Chemicals

Effective September 15, 1987
 Superseded February 16, 1981

GREAT LAKES DE-79™

DE-79™ is a highly brominated diphenyl oxide based flame retardant with a melting range that offers unique processing and product performance.



DI-BROMODIPHENYL OXIDE

APPLICATIONS

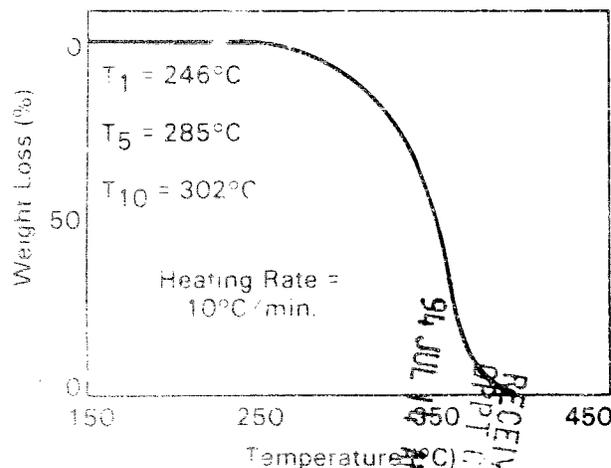
DE-79 is recommended as an additive flame retardant for ABS, Nylon, Polycarbonate, and Polyester Thermoplastic Polymers. The solubility of DE-79 in numerous organic systems makes it suitable as an additive for unsaturated polyesters and epoxy thermoset resins. Specific recommendations for DE-79 loading levels may be found in the product use bulletins.

PHYSICAL PROPERTIES

See price information bulletin for specifications

Formula weight	801
Appearance	Off white powder
Melting Range	70-150°C
Specific Gravity	2.6
Organic Bromine Content (Theoretical)	79%

Thermogravimetric Analysis (TGA)



Solubility in 25 ml of 100% solvent

Water	0.1	Benzene	20
Chloroform	0.2	Styrene	25
Methanol	0.5	Methyl Ethyl Ketone	4
Acetone	1.0	Acetone	2



Great Lakes
 Chemical Corporation

TOXICOLOGICAL INFORMATION

The potential of DE-79 for eye injury or intoxication by ingestion, eye or skin contact is believed to be low. The oral LD₅₀ for rats has been found to be greater than 500 mg/kg of body weight. Dermal LD₅₀ for rabbits is greater than 2000 mg/kg. Repeated inhalation of dust should be avoided. The LC₅₀ of DE-79 for rats is greater than 60 mg/liter.

DE-79 is not mutagenic in a series of bioassays employing salmonella and saccharomyces indicator organisms both directly and with liver activation. Chronic over-exposure may result in liver effects and a potential for developmental effects.

A complete summary of toxicity data is available upon request.

HANDLING PRECAUTIONS

The following are general precautionary measures which should be followed for DE-79. Excessive exposure to the product should be avoided or prevented by the use of appropriate personal protective equipment. The use of safety glasses with shields, rubber gloves, and dust respirators is recommended. Suitable ventilation in the work place is recommended as a standard practice. Contaminated clothing should be washed before reuse.

DE-79 is not hazardous under the Federal Hazardous Substances Act and is not a hazardous waste under the Resource Conservation and Recovery Act.

FIRST AID RECOMMENDATIONS

1. For eye exposure to DE-79, flush for several minutes with fresh water. If ill effects continue, get medical attention.
2. For skin exposure, wash with soap and water repeating the process a number of times until traces of product are removed.
3. For excess exposure to dust if breathing difficulties occur, move person to fresh air and obtain medical attention.
4. If large amounts of DE-79 are swallowed, get medical attention.



Great Lakes
Chemical Corporation

MATERIAL SAFETY DATA SHEET

EMERGENCY TELEPHONE (201) 862-5141

IDENTITY - Great Lakes DE-79TM
Octabromodiphenyl Oxide

SECTION I - PRODUCT INFORMATION

MANUFACTURER'S NAME - GREAT LAKES CHEMICAL CORPORATION

TELEPHONE NUMBER FOR INFORMATION - (317) 463-2511

CAS REGISTRY NO. - 32536-52-0;
68928-79-0;
68928-80-3

DATE PREPARED - 9/86

FORMULA - C₁₂H₂Br₈O

SUPERCEDES - 6/85

CHEMICAL FAMILY - Brominated diphenyl oxide

PREPARED BY - Research Services Department
Great Lakes Chemical Corporation
West Lafayette, Indiana 47906

SECTION II

HAZARDOUS COMPONENTS (Specify Chemical Identity: Common Name(s))

<u>COMPONENT</u>	<u>OSHA PEL</u>	<u>ACGIH TLV</u>	<u>Other Limits Recommended</u>	<u>% (optional)</u>
Heptabromodiphenyl oxide				
Octabromodiphenyl oxide	15 mg/m ³	10 mg/m ³	0.25 mg/m ³	100
Nonabromodiphenyl oxide				

(Nuisance dust levels)

GLCC Product Code: 525

GREAT LAKES CHEMICAL CORPORATION
P.O. Box 2200 · Highway 52 NW · West Lafayette, Indiana 47906

SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point	Not available
Specific Gravity (water=1)	Approx. 2.76
Vapor Pressure (mm Hg.)	Not available
Melting Point	167-257 ^o F
Vapor Density (AIR=1)	Not available
Evaporation Rate (Butyl Acetate = 1)	Not available
Solubility in Water	Negligible
Appearance and Odor	Off white beads with no odor

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used)	Not applicable
Flammable Limits	Not applicable
LEL	Not applicable
UEL	Not applicable

Extinguishing Media

All conventional media are suitable

Special Fire Fighting Procedures

Wear self-contained breathing apparatus

Unusual Fire and Explosion Hazards:

Combustion in the presence of other fuels may result in the release of hydrogen bromide and/or bromine vapors.

SECTION V - REACTIVITY DATA

<u>Stability</u>	Unstable <u> </u>	Conditions to Avoid: None
	Stable <u> x </u>	

Product Information



Flame Retardant Chemicals

Effective: 2-81
Supersedes:

DE-79-1

PRODUCT USE

DE-79™

THE THERMOPLASTIC APPLICATIONS

The unique properties of DE-79™, relatively low melting range, good thermal stability, and high bromine content, make this flame retardant an excellent choice for many thermoplastic systems. DE-79 melts under normal compounding conditions and thus is easily blended into a molten plastic rather than having to be dispersed as solid particles. Generally improved impact strength of the FR plastic system results when DE-79 is used. Below are suggested loading levels for DE-79 in specific thermoplastics for which it is recommended. Modification of these loadings may be necessary if other additives are used to alter the polymer system's physical properties.

POLYMER SYSTEM	FR PERFORMANCE TESTS	RECOMMENDED STARTING LEVELS	
		DE-79 (%)	Sb ₂ O ₃ (%)
ABS	UL 94 V-0 @ 1/8"	14.8	2.5
	UL 94 V-0 @ 1/16"	14.2	7.1
Nylon 6/6	UL 94 V-0 @ 1/8"	12.4	2.6
Polycarbonate	UL 94 V-0 @ 1/16"	10.7	-0-
PBT (Unfilled)	UL 94 V-0 @ 1/16"	10.9	5.4
Styrene Maleic Anhydride (SMA)	UL 94 V-0 @ 1/16"	12.0	4.0

Because DE-79 is a low melting flame retardant, in some systems a plasticizing of the compound FR plastic may result. The use of a combination of DE-79 with the higher melting DE-83R can balance the desired physical properties of the plastic. On the back of this page are recommended combinations and loading levels for some specific polymer systems.

The information supplied is presented in good faith and has been derived from sources believed to be reliable. Since conditions of use are beyond our control, all risks are assumed by the user. No representation is expressed or implied, and nothing herein shall be construed as permission or recommendation to practice a patented invention without a license.

P.O. Box 2200, Highway 52 N.W., West Lafayette, Indiana 47906

Phone: 317/463-2511, Telex: 27-9426, Cable: GLAKCHEM Lafayette



0 0 2 3

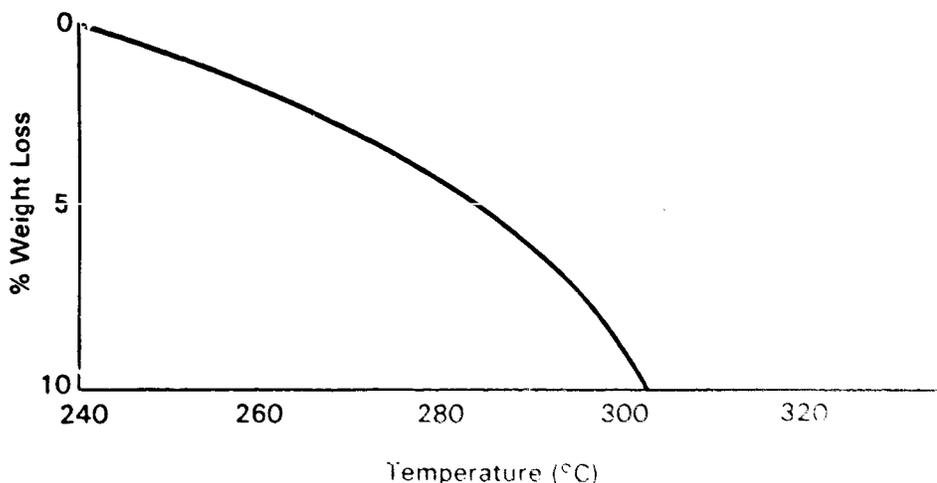
POLYMER SYSTEM	FR PERFORMANCE TEST	RATIO OF DE-79/DE-83R	RECOMMENDED STARTING LEVELS	
			BLEND (%)	Sb ₂ O ₃ (%)
ABS	UL 94 V-0 @ 1/16"	1/2	16.7	5.5
PBT (Unfilled)	UL 94 V-0 @ 1/32"	3/1	9.7	3.6
		1/1	9.8	3.6
		1/3	9.9	3.6
		1/3	9.9	3.6
PBT (30% glass filled)	UL 94 V-0 @ 1/32"	1/3	9.9	3.6
Nylon 6/6	UL 94 V-0 @ 1/32"	1/1	9.8	4.6

THERMOPLASTIC COMPOUNDING

The efficiency of flame retardant systems is highly dependent upon uniform dispersion of DE-79 and antimony trioxide. This is typically accomplished by dry blending the components followed by processing above the polymer melt temperatures in a Banbury mixer. Specific time/temperature conditions can depend upon the polymer's physical properties, but must remain significantly below the point at which thermal degradation of DE-79 begins. Below are detail TGA data for DE-79 and an expanded scale profile curve up to 10% weight loss.

THERMOGRAVIMETRIC ANALYTICAL DATA — DE-79

Weight Loss, %	1	5	10	25	50	75	95	98	99
Temperature, °C	246	285	302	327	348	362	373	375	420



Flame retardants, fire retardants, or similar expressions are not to be used interchangeably with such terms as non-burning or self-extinguishing. Descriptive expressions like flame retardant are used for a class of chemicals, such as those described in this and other Great Lakes literature, which are incorporated into plastic compounds, allowing the resin to satisfy certain laboratory tests as defined by flammability safety regulations or codes.

Incompatibility (Materials to Avoid)

None known

Hazardous Decomposition or Byproducts

Hydrogen bromide and/or bromine

Hazardous Polymerization

May Occur Will Not Occur x

Conditions to Avoid: None

SECTION VI - HEALTH HAZARD DATA

Route(s) of Entry:

Inhalation? yes Skin? no Ingestion? yes

Health Hazards (Acute and Chronic):

Acute oral LD₅₀ (rat) is greater than 5000 mg/kg, dermal LD₅₀ (rabbit) is greater than 2000 mg/kg, inhalation LD₅₀ (rat) is greater than 60 mg/l. In a 90-day feeding study at 100, 1000, and 10,000 ppm, liver and thyroid effects were observed. Thyroid hyperplasia was reversible upon compound withdrawal. Hepatocytomegaly declined upon compound withdrawal. Developmental effects have been reported by another company for octabromodiphenyl oxide at 25 mg/kg/day in a teratology study. The NOEL is reported to be 2.5 mg/kg/day. A range-finding teratology study with DE-79 indicates a potential for fetotoxicity as evidenced by reduced body weight at a dosage level of 50 mg/kg/day. The NOEL is 25 mg/kg/day. Chronic overexposure may result in liver effects and a potential for developmental effects.

Carcinogenicity:

NTP? no IARC Monographs? no OSHA Regulated? no

Signs and Symptoms of Exposure

No known signs or symptoms of exposure

Medical Conditions Generally Aggravated by Exposure

None reported

Emergency and First Aid Procedures

Eyes: Flush with water. Get medical attention. Skin: Wash with soap and water. Ingestion: Get medical attention. Inhalation: Remove person to fresh air. Get medical attention.

=====

SECTION VII - PRECAUTIONS FOR SAFE HANDLING AND USE

Steps To Be Taken in Case Material is Released or Spilled

Sweep-up and use material when possible. Collect in labelled containers for disposal. Wear protective equipment.

Waste Disposal Method

Dispose of waste in an approved chemical incinerator or in an approved chemical landfill as allowed by current laws and regulations.

Precautions to be Taken in Handling and Storing

Store in dry, well ventilated area. Avoid overheating.

Other Precautions

None

=====

SECTION VIII - CONTROL MEASURES

Respiratory Protection

Wear NIOSH approved dust respirator if dusting occurs.

Ventilation

Local Exhaust - Use to maintain dust below TLV

Mechanical - Use for general area control

Special - None

Other - None

Protective Gloves - Desirable if skin contact likely

Eye Protection - Safety glasses

00025

Great Lakes Chemical Corporation

MSDS - DE-79TM

Octabromodiphenyl Oxide

page 5

Other Protective Equipment - Wear clean, body-covering clothing

Work/Hygienic Practices - Wash thoroughly after handling

=====

Information on this form is furnished solely for the purpose of compliance with OSHA's Hazard Communication Standard, 29CFR 1910.1200 and shall not be used for any other purpose.

DLMcF/db:46



TOXICITY DATA

NEW YORK 200 • MONROE 2828 • WEST LAFAYETTE, INDIANA 47906 • PHONE: 317-463-2611 • TELEX: 27-9428 • CABLE: GLAKCHEM LAFAYETTE

OCTABROMODIPHENYL OXIDE (DE-79)

SUMMARIES OF TOXICITY DATA

Acute Oral. Male Charles River CD rats were fasted overnight and then treated by intubation with octabromodiphenyl oxide at rates of 50, 500 or 5,000 mg./kg. suspended in corn oil. No rats died during a subsequent 14-day observation period; all rats in all dose levels exhibited normal weight gains. These test results indicate that octabromodiphenyl oxide is not a toxic material by the oral route of administration.

Acute Dermal. Octabromodiphenyl oxide was applied to the closely clipped abraded and unabraded skin of male and female albino rabbits at concentrations of 200 or 2,000 mg./kg. for 24 hours. During a subsequent 14-day observation period none of the rabbits died, and all exhibited normal weight gains. These test results indicate that octabromodiphenyl oxide is not a toxic material by the dermal route of administration.

Primary Skin Irritation. Octabromodiphenyl oxide was applied to the closely clipped and abraded and unabraded skin of male and female albino rabbits at a dosage of 500 mg. The area was then wrapped and occluded with a gauze bandage and Saran Wrap. After 24 hours, the wrappings were removed, and the rabbits' backs were washed with tepid water and examined for irritation. The examination was repeated at 72 hours. One rabbit showed very slight erythema at 72 hours; the remaining rabbits exhibited neither erythema nor edema at either examination time. These results indicate that octabromodiphenyl oxide is not a primary skin irritant.

Acute Inhalation. Male and female Charles River CD rats were exposed for one hour to concentrations of 2 or 60 mg./l. of octabromodiphenyl oxide in air. The physical nature of the compound precluded administration at higher than the 60 mg./l. dose level. During exposure, the rats were continuously observed for pharmacodynamic and/or toxic signs. Rats at the 2 mg./l dosage exhibited decreased motor activity, erythema, and eye squint during exposure. Upon termination and during the subsequent 14-day observation period, all rats survived, appeared normal, and exhibited normal body weight gains. Rats at the 60 mg./l. dosage exhibited decreased motor activity, erythema, eye squint, and tachypnea during exposure. Signs were the same on termination except for the addition of salivation in one rat. During the subsequent 14-day observation period, all rats appeared normal except for one which exhibited salivation on the fifth and seventh days; no mortalities were noted. These test results indicate that octabromodiphenyl oxide is not a highly toxic substance by the inhalation route of administration.

The information supplied above is presented in good faith and has been derived from sources believed to be reliable. However, no warranty, express or implied, is extended regarding its accuracy or the results to be obtained from its use. Since variability of use may occur, control of risks are assumed by the user.

Acute Eye Irritation. Single applications of 100 mg. octabromodiphenyl oxide were made into the conjunctival sac of the right eye of three male and three female New Zealand white rabbits. Examinations for ocular irritation were made at 24, 48, 74 hours, and seven days. At 72 hours, sodium fluorescein and ultraviolet light were used to check for corneal damage. Irritative findings were scored according to the method of Draize. A very slight discharge was noted from the eyes of two rabbits at 24 hours, and a very slight redness was noted in the eye of one rabbit at 48 hours. There were no other signs of ocular irritation or corneal damage. These test results indicate that octabromodiphenyl oxide is not an eye irritant.

Fourteen-Day Inhalation. Charles River CD rats were exposed to a micronized dust of octabromodiphenyl oxide introduced into an inhalation chamber at nominal concentrations of 1.2, 12, 120 and 1200 mg./cu.m. for eight hours per day for 14 consecutive days. Actual airborne dust concentrations during period of chemical introduction determined by air sampling ranged from 15-45% of the nominal values. It was not possible to measure the extent to which oral exposures to the chemical occurred as a result of ingestion by preening or in any other fashion. There were five male and five female rats in each dose group and in a control group. The rats were observed daily for ocular and nasal irritation, respiratory distress, and any pharmacotoxic signs before and immediately after the eight-hour exposure. Individual body weights were recorded periodically before compound administration and at 1, 7, 13, and 14 days during exposure. Blood and urine samples were obtained for analysis from all rats of the 120 and 1200 mg./cu.m. dosage groups and all controls after the 13th day of exposure. Hematological studies included hemoglobin, hematocrit, erythrocyte count and total and differential leucocyte counts. Biochemical studies performed included glucose, urea nitrogen, serum glutamic, oxalacetic, and pyruvic transaminase activities, and serum alkaline phosphatase activity. Urinalysis studies performed included measurement of volume, pH, specific gravity, description, color and appearance, qualitative tests for albumin, glucose, bilirubin, and occult blood, and microscopic examination of the sediment.

Following the 14th day of exposure, all rats were necropsied and analyses of bromide were done on sections of lung, fat, and liver tissues. Organs and tissues were examined for gross abnormalities and fresh weights were taken on lungs, spleen, liver, kidneys, heart and brain. The adrenals, thyroid/parathyroid, and pituitary were weighed after fixation. Histopathological examinations of formalin fixed, and hematoxylin and eosin stained paraffin sections of liver from the 1.2, 12, and 120 mg./cu.m. dosage levels were also examined histopathologically.

No animals died during the test period nor were there any changes in appearance or general behavior in the 1.2 or 12 mg./cu.m. dosage groups. By the end of the eight-hour exposure period, all animals in the 1200 mg./cu.m. dosage group and occasionally the animals in the 120 mg./cu.m. dose group exhibited a fast breathing pattern that disappeared by the morning following exposure. Neither body weights nor food consumption in any dose group were significantly different

in the following histological studies the rats were generally fed until they were attributed to trauma or other causes. There were no differences of significance in morphology, biochemistry, or urinalysis of any dose group compared to control animals. There was a slight elevation of bromide excretion observed for Charles River CD rats in the test laboratory. The concentrations of bromide in the lung and the fat of all exposed rats were significantly higher than the control values on a dose-related basis. The bromide concentrations in the liver tissues were also significantly higher than the control values except at the 1.2 mg./cu.m. dose level. Average bromide concentrations in lung and fat ranged from about 1.5 to 12.5 times as high as those of livers. Statistically significant variations in sex group mean weights occurred in liver, kidney, brain, and adrenal glands in one or more treated groups, the biological significance of which is unknown. With the exception of the increase in liver weights among male and female rats in the upper three dose levels, these organ weight variations were not accompanied by morphologic changes which were considered compound related. At necropsy no compound related gross pathologic lesions were observed in any of the rats at any dose level. Compound-related liver effects were seen histopathologically in rats at 12, 120, and 1200 mg./cu.m. dosage levels. The liver effects in the 12 mg./cu.m. dose level consisted of very slight to slight, focal to multifocal cytoplasmic enlargement of the hepatocytes accompanied by focal acidophilic degeneration of individual and small groups of liver cells. The liver effects in the upper two doses were similar to the above with the exception that the enlargement of the hepatocytes were multifocal to diffuse in distribution and focal, small to large areas of hepatocellular necrosis of very slight to marked degree, were existent, especially in the highest dose level. The enlargement of the hepatocytes and occasionally the areas of necrosis of hepatocytes were usually observed in the centrilobular regions of the affected liver lobule. The relative severity of the above effects was slightly more pronounced among the male test animals. Other changes noted in the liver and other tissues were considered unrelated to treatment and were present in most instances among the control and test animals.

Twenty-eight Day Feeding. Charles River CD rats were fed at dietary dosage levels of 100 and 1000 ppm for 28 days. There were 10 male and 10 female rats in each dose group and in a control group fed only the basal diet. The rats were observed daily during the feeding period for changes in behavior and appearance. Body weights and sex group feed consumptions were recorded weekly. At the conclusion of the 28-day feeding period, all rats were sacrificed for gross pathological examination and for histopathological examination of liver, kidney, and thyroid tissues. Liver tissues pooled by sex and dose group were analyzed for bromine content.

In none of the tests did rats die, nor were there changes noted in behavior or appearance of any of the rats during the feeding period. Feed consumption and body weight gains were similar for control and treatment groups. Absolute and relative liver weights were statistically significantly increased for female rats at the 1000 ppm

dietary level and for both male and female rats at the 1000 ppm dietary level. Other organ weight variations noted but believed to be of doubtful biological significance were increases in the absolute kidney weights of females at the 1000 ppm dietary level and in the absolute adrenal weights of females at the 100 ppm dietary level. No compound-related gross pathological lesions were noted in any rats from any group. Compound-related histopathological liver lesions were observed in rats from both 100 ppm and 1000 ppm dietary level groups. They consisted of enlarged centrilobular and midzonal liver parenchymal cells in which the cytoplasm had large areas of finely granular "ground glass" appearance and frequently contained eosinophilic "round bodies." These liver lesions occurred more frequently and with greater severity in males; their incidence and severity were dose-related. Several rats from the 1000 ppm dietary level had a slight to moderate hyperplasia of the thyroid but whether the change was compound-related or only represented a somewhat greater degree of normal morphological variation than occurred in the control rats could not be determined. Dose-related increases in bromide levels of liver tissues were noted in pooled tissues from both male and female rats and ranged from about 6 to about 137 times the levels found in the control groups.

Twenty-eight Day Feeding. This study was done in conjunction with the 90-day feeding study summarized below. Charles River DC rats were fed at dietary dose levels of 100, 1,000, or 10,000 ppm of octabromodiphenyl oxide for 28 days. There were 10 male and 10 female rats in each group; 35 male and 35 female rats from the 90 day feeding study served as controls. The rats were observed daily during the feeding period for changes in behavior or appearance. Body weights and sex group feed consumptions were recorded weekly. Hematology, biochemical and urinalysis studies were performed during the fourth week of animal feeding. At the conclusion of the study five rats/sex/dose were sacrificed for gross pathological examination and for histopathological examination of selected tissues. The remaining five rats/sex/dose were maintained on normal diets for four weeks of compound withdrawal and then were sacrificed for equivalent examinations. Liver tissues of each individual animal in each group were analyzed for bromide content.

In none of the dose groups did rats die, nor were there changes noted in behavior or appearance of any of the rats during the feeding period. Body weights and feed consumption were slightly lower than control animals for some rats of the 1,000 ppm and 10,000 ppm dose level groups when compared to control rats. Hematology results were comparable to controls at all dose levels, however, urea nitrogen levels were slightly elevated for one or two male rats and most female rats at the 10,000 ppm dose level. At necropsy, observed gross changes which may have been compound related were limited to the livers of some rats in the 10,000 ppm dose group. These changes included brownish discoloration and accentuated lobulation of the liver. Increases in absolute and/or relative liver weights occurred in rats at the 1,000 and 10,000 ppm dose levels. Other organ weight variations were noted but, while statistically significant, occurred in a random pattern or appeared to be related to decreased body weights at the 1,000 and 10,000 ppm levels, and, therefore, were not considered organ specific effects.

of compound administration. Compound-related effects were observed in the liver of rats from all three dose levels. These liver effects were characterized by enlargement of hepatocytes, principally those in the central and midzonal portion of the liver lobules. These cells exhibited a change which gave the cytoplasm a "ground-glass" appearance. In addition, at the 10,000 ppm dose level, many livers exhibited vacuolation of centrolobular hepatocytes and several exhibited necroses of scattered individual hepatocytes. Following four weeks of compound withdrawal microscopic liver effects which were considered compound related were observed in rats from the 100 ppm level. The same cytoplasmic change described above was seen in two male rats from the 1,000 ppm dose and five male rats from the 10,000 ppm dose but was somewhat reduced in severity as compared to that observed in rats sacrificed immediately following four weeks of compound administration. Additional compound related liver effects were limited to necroses of scattered individual hepatocytes in a female from the 10,000 ppm level and the occurrence of intracytoplasmic hyaline inclusions in a male from the same group. A dose related increase in liver bromide levels was seen for rats in all treated groups after four weeks of compound administration, but those bromide levels dropped rapidly during the four weeks of compound withdrawal. Although there still was a dose related increase for all treated rats as compared to control animals, the bromide levels of rats at the 100 ppm dietary level approached those of the control rats at the end of the four week withdrawal period.

Ninety Day Feeding. Charles River CD rats were fed at dietary dosage levels of 100, 1,000 or 10,000 ppm for up to 13 weeks. There were 35 male and 35 female rats in each dose group and in a control group fed only the basal diet. The rats were observed daily during the feeding period for changes in behavior and appearance. Body weights and sex group feed consumptions were recorded weekly. Blood and urine samples were obtained for analysis from five rats/sex/group at one, two and three months of study. Hematological studies included hemoglobin, hematocrit, erythrocyte count and total and differential leucocyte counts. Biochemical studies performed included glucose, urea nitrogen, serum glutamic, oxalacetic, and pyruvic transaminase activities, and serum alkaline phosphatase activity. Urinalysis studies performed included measurement of volume, pH and specific gravity, description of color and appearance, qualitative tests for albumin, glucose, bilirubin and occult blood, and microscopic examination of the sediment.

Analyses of bromide as well as gross pathology and histopathology were conducted on liver specimens obtained from five rats/sex/group sacrificed at the following intervals: After 13 weeks of compound administration and after 13 weeks of compound administration followed by eight weeks, six months, or one year of compound withdrawal.

Two control rats, two rats at the 100 ppm dose level, one rat at the 1,000 ppm dose level, and one rat at the 10,000 ppm dose level died during the 13 weeks of compound administration. All of these rats died after collection of blood for clinicopathology.

This information is provided for your information and is not intended to be used for any other purpose. It is the property of the company and should be kept confidential.

At the 100 ppm dose level died during the compound withdrawal period due to hemorrhage possibly resulting from injury. One rat at the 100 ppm dose level died during the compound withdrawal period due to brain hemorrhage possibly resulting from injury. It is believed none of these deaths were compound related.

Results of the 100 ppm Dietary Feeding. At the 100 ppm dosage level of octabromodiphenyl oxide no pharmacodynamic or toxic signs were observed in the animals. Neither body weights nor food consumption were significantly different from controls. There were no differences of significance in the hematology, biochemistry or urinalysis of this dose group when compared to control animals. A dose related increase in liver bromide levels was seen after 13 weeks of compound administration. The liver bromide levels dropped rapidly during eight weeks of compound withdrawal after which mean levels were approximately twice those of controls. After six months and one year of compound withdrawal, the liver bromide levels of the treated rats were very close to but slightly higher than those of the control animals. The only organ weight effects noted for this dose group were increases in absolute and/or relative liver weights observed at the end of the 13 week feeding period but not in rats sacrificed following the compound withdrawal periods. At necropsy no gross changes were observed in animals at this dose level and any time of sacrifice. Compound related liver effects were seen microscopically in 4 of 10 rats in this dose level. These effects consisted of the "ground glass" cytoplasmic changes and were the only compound related liver changes noted at this dose. Other tissues examined from rats at all sacrifice times were considered free of compound related histopathological effects.

Results of the 1,000 ppm Dietary Feeding. At the 1,000 ppm dosage level of octabromodiphenyl oxide no pharmacodynamic or toxic signs were observed in the animals. Female rats at this dose gained less weight but consumed approximately equivalent amounts of food when compared to controls during the 13 weeks of compound administration. There were no differences of significance in the hematology, biochemistry or urinalysis of this dose group when compared to control animals. A dose related increase in liver bromide levels was seen for rats in this treated group after 13 weeks of compound administration. The liver bromide levels dropped rapidly during eight weeks of compound withdrawal and continued to decline through succeeding withdrawal periods until at the end of one year of compound withdrawal the liver bromide levels were a fraction of their peak values but still remained higher than those of the controls. The only organ weight effects noted for this dose group were increases in absolute and/or relative liver and thyroid weights observed at the end of the 13 week feeding period but not in rats sacrificed following the compound withdrawal periods. Other organ weight variations, while statistically significant, occurred in a random pattern or appeared to be related to decreased body weights at the 1,000 ppm dose level, and were not considered organ specific effects of compound administration. At necropsy no gross changes or lesions to have been compound related were noted in rats at any sacrifice time. Compound related liver effects were seen histopathologically in all rats sacrificed from this dose level following 13 weeks of compound administration and in one rat

... of compound withdrawal. These ... "ground glass" cytoplasmic changes ... Kupffer cells and/or ... following eight weeks of compound ... following six months of compound withdrawal many rats ... exhibited compound related histopathological changes ... characterized by centrilobular hepatocyte and midzonal vacuolation, ... granular "ground glass" appearance of hepatocyte cytoplasm ... and hyaline intracytoplasmic inclusions in hepatocytes. ... hyperplastic nodule was observed in one rat at this dose and withdrawal period. Several rats at the 1,000 ppm dose following one year of compound withdrawal had vacuolation of hepatocytes with vacuoles containing a pale proteinaceous fluid. No hepatic hyperplastic nodules or neoplasms were seen in rats sacrificed after one year of compound withdrawal.

Results of the 10,000 ppm Dietary Feeding. At the 10,000 ppm octabromodiphenyl oxide dosage pale coloration of the eyes was noted for one female rat during weeks 10-13 of compound administration and general paleness was noted for another female rat during weeks 12 and 13. Female rats at this dose gained less body weight when compared to the controls during the 13 weeks of compound administration and continued to show lower body weight gains during the compound withdrawal period while consuming less food than any other group. A few male rats at this dose exhibited low normal erythrocyte counts and a few female rats showed slight to moderate decreases in hemoglobin, hematocrit and erythrocytes at two months of study. One female rat showed hypochromasia, polychromasia and anisocytosis of the erythrocytes. At three months of study, slight to marked decreases in hemoglobin, hematocrit and erythrocytes were seen for most of the female rats at this dose. Glucose values for male and female rats at this dose were slightly lower than those of the controls at all intervals of analysis. Orange coloration of the urine was noted for one to nine female rats during weeks 13-39 of study; dark amber coloration of the urine for one female at two months of study and a red coloration was also noted for two females at three months of study. A dose related increase in liver bromide levels was noted after 13 weeks of compound administration. The bromide levels dropped rapidly during eight weeks of compound withdrawal and continued to decline through succeeding withdrawal periods until at the end of one year of compound withdrawal the liver bromide levels were a fraction of their peak values but still remained higher than those of controls. A statistically significant increase in mean liver and kidney weights in male rats may have been compound related and were observed at all sacrifice times. Increases in group mean absolute and relative thyroid weights were also noted after 13 weeks of compound administration, and after eight weeks of compound withdrawal that were considered compound related. Other organ weight variations were noted but, while statistically significant, occurred in a random pattern or appeared to be related to decreased body weights at the 10,000 ppm dose level and, therefore, were not considered organ specific effects of compound administration. At necropsy, gross changes which may have been compound related were limited to livers and kidneys of rats at this dose sacrificed after 13 weeks of compound administration.

These changes include accentuated lobulation and yellowish mottling of the livers and brownish discoloration of liver and kidneys. Other gross pathologic effects observed in these rats were considered spontaneous and unrelated to treatment. Following one year of compound withdrawal all remaining rats were sacrificed and no gross pathologic effects which were considered compound related were seen at this dose level. Following 13 weeks of administration compound related liver effects were seen histopathologically in all rats sacrificed at this dose level. These liver effects consisted of the "ground glass" cytoplasmic changes described previously. Hepatocyte cytoplasmic vacuolation, which probably represents fatty degeneration, occurred in a number of rats at this dose. Necrosis of scattered parenchymal cells or of centrilobular cells, centrilobular fibrosis and a greenish pigment in Kupffer cells and hepatocytes also occurred in some rats and were considered compound related. Histopathological kidney changes, characterized by the occurrence of small to moderate numbers of cortical tubules, considered to represent regenerative tubules, were concluded to be compound related. One rat had a severe tubular nephrosis while another exhibited focal mineralization of cortical tubules. Cellular changes in the thyroid were probably compound related and were observed in animals sacrificed after 13 weeks of compound administration. Following eight weeks, six months or one year of compound withdrawal similar histopathological observations were noted as above but with decreasing frequency. A hyperplastic nodule of the liver was noted in one rat each from the eight week and six month compound withdrawal groups. No hepatic hyperplastic nodules or neoplasms were seen in rats sacrificed after one year of compound withdrawal.

Mutagenicity. Octabromodiphenyl oxide was examined for mutagenic activity at a number of concentrations in a series and in vitro microbial assays employing Salmonella and Saccharomyces indicator organisms both directly and in the presence of liver microsomal enzyme preparations from Arochlor-induced rats. The results of the tests, whether in the presence or absence of the rat liver activation system, were all negative. Octabromodiphenyl oxide was judged not mutagenic under these test conditions.

Unscheduled DNA Synthesis Assay. The purpose of this assay is to indicate the ability of a test material to induce DNA damage in mammalian cells. In the test, monolayers of WI-38 human fibroblast cells are exposed to the test material in the presence of radiolabeled thymidine. After a period of cell growth to allow for unscheduled DNA synthesis incorporating the radiolabeled thymidine, the cells are harvested and thymidine uptake and cell viability are determined. An increase above the normal background rate of radioactively labeled thymidine in the harvested cells, without the appearance of severe toxicity to the cells, indicates that the test material has the potential to induce DNA damage in mammalian cells. Octabromodiphenyl oxide was tested at five concentrations ranging from 50 to 300 ug/ml. in the presence and in the absence of metabolic activation and did not cause an increase in unscheduled DNA synthesis. Positive and negative controls confirmed the sensitivity of the system. Octabromodiphenyl oxide was not found to be mutagenic in this assay.

In Vitro Sister Chromatid Exchange in Chinese Hamster Ovary

The purpose of this assay is to determine the ability of the test material to induce sister chromatid exchanges (SCEs). Sister chromatid exchanges represent the interchange of DNA between chromatids which are the replication products of a chromosome. These exchanges presumably involve DNA breakage and reunion, although the molecular basis of SCE formation and the biological significance of the exchanges is not understood. In the test, Chinese Hamster ovary cells were exposed to five concentrations of octabromodiphenyl oxide; 750, 250, 75, 25, and 7.5 ug./ml. of DMSO for two hours in the presence and in the absence of metabolic activation. The exposure period was followed by a 24 hour expression period. After treatment with colcemid and staining, fifty cells in the metaphase stage of mitosis were scored whenever possible at each dose level for the number of sister chromatid exchanges. No statistically significant increase in the number of exchanges per chromosome or the number of exchanges per cell was seen at any of the levels tested, either with or without metabolic activation. Octabromodiphenyl oxide was not found to be mutagenic in this assay.

Range-Finding Teratology Study in Rats. Potential maternal and embryotoxic effects were evaluated in this study. Female rats were dosed daily by gavage from days 6 through 15 of gestation with 2.5, 10.0, 15.0, 25.0 and 50.0 mg./kg./day of DE-79. All animals survived gestation day 20 when they were sacrificed. No compound related effects were observed at 2.5, 10.0 and 15.0 mg./kg./day. At 25.0 mg./kg./day increased serum bromide levels were observed. Mean maternal body weight gain was statistically reduced in the 50.0 mg./kg./day group during gestation. Days 16-20 partially due to increased number of late resorptions and statistically reduced mean fetal weight. The cholesterol level was slightly increased in the 50.0 mg./kg./day group. No compound related macroscopic or microscopic findings were observed in the liver or kidney tissues. No effects on organ weights were observed.

The malformations and developmental variations observed in the 50.0 mg./kg./day group are commonly associated with maternal toxicity. Fetal anasarca and bent limb bones were observed at the 50.0 mg./kg./day level. Mean fetal body weight and increased postimplantation loss due to late resorptions was also observed at this level but not at a statistically significant level compared to controls. Reduced ossification of the skull, various bones unossified and two instances of bent ribs were also noted at this dose level. Bent limb bones and bent ribs are a reversible pathologic finding related to retarded ossification due to maternal toxicity. The fetal findings at the highest dose level were considered by the performing laboratory to be a result of maternal toxicity rather than a teratogenic effect.

DLNoA/vkm
3/19/87

Product Information

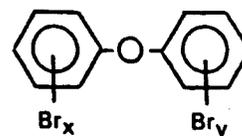


Flame Retardant Chemicals

Effective: April 15, 1981
Supersedes: September 2, 1980

GREAT LAKES DE-71™

DE-71, PENTABROMODIPHENYL OXIDE, is a high viscosity liquid flame retardant containing 71% aromatic bromine. It offers thermal stability and product compatibility for many thermosetting and thermoplastic resin systems.



$$(x + y = 5)$$

PENTABROMODIPHENYL OXIDE

APPLICATIONS

DE-71 is recommended as an additive flame retardant for unsaturated polyester, rigid and flexible urethane foams, epoxies, laminates, adhesives, and coatings. DE-71 is readily soluble in styrene, polyols, phosphates, Freon 11, and isocyanates, for blending into the polymer systems. Specific formulation recommendations for DE-71 may be found in the product use bulletins.

PHYSICAL PROPERTIES

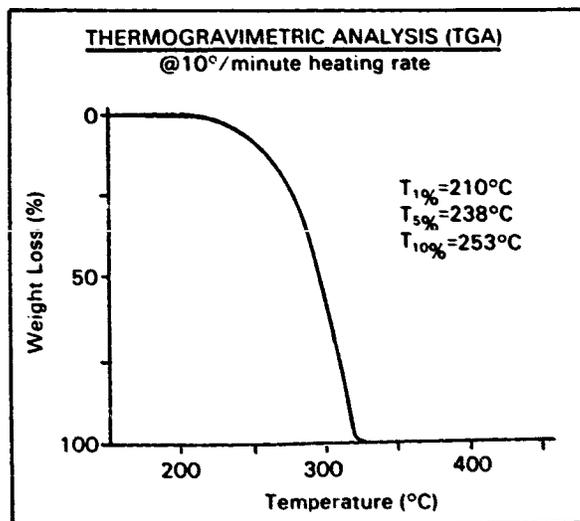
See price information bulletin for specifications.

Formula Weight:	564.7
Appearance:	Viscous Amber Liquid
Bromine Content, %:	69-72
Color, Gardner, max:	12
Acidity, mg. KOH/g. max:	0.25
Volatiles, 1 hr at 105°C, %, max:	0.1
Iron, ppm, max:	10
Specific gravity:	2.27
gm/m. @ 25°C:	(approx. 19.0 lbs/gal)

Solubility at 25°C (g/100g solvent)

Water	< 0.1	Freon 11	C
Methanol	1	Polyol	C
Methylene Chloride	C	Styrene	C
Toluene	C	Methyl Ethyl Ketone	C
Diethylphthalate	> 100	Triethyl Phosphate	C

C = Complete solubility



The information supplied is presented in good faith and has been derived from sources believed to be reliable. Since conditions of use are beyond our control, all risks are assumed by the user. No representation is expressed or implied, and nothing herein shall be construed as permission or recommendation to practice a patented invention without a license.

P.O. Box 2200, Highway 52 N.W., West Lafayette, Indiana 47906

Phone: 317/463-2511, Telex: 27-9426, Cable: GLAKCHEM Lafayette



TOXICOLOGICAL INFORMATION

The potential for eye injury or intoxication by ingestion, eye or skin contact is believed to be relatively low. Repeated inhalation of vapors may be hazardous and should be avoided.

The oral LD₅₀ value for rats has been found to be greater than 1000 mg/kg of body weight. Dermal LD₅₀ for rabbits is greater than 2000 mg/kg, and the inhalation LC₅₀ for rats is greater than 200 mg/L.

DE-71 is determined to be not mutagenic in a series of bioassays employing salmonella and saccharomyces indicator organisms both directly and with liver activation.

A complete summary of toxicological data is available upon request.

HANDLING PRECAUTIONS

Opportunities for long-term chronic exposure should be limited. Repeated inhalation of vapors may be hazardous and should be avoided.

The use of safety glasses and protective gloves is recommended. Wash any contaminated areas with soap and water.

Store in a dry, well ventilated area. Avoid overheating.

FIRST AID PRECATUIONS

1. For eye exposure to DE-71 vapors, flush for several minutes with fresh water. If ill effects persist, get medical attention.
2. For skin exposure, wash with soap and water, repeating the process a number of times until traces of product are removed.
3. For excess exposure to vapors, remove person to fresh air and obtain medical attention.
4. If large amounts of DE-71 are swallowed, induce vomiting and seek medical attention.

Flame Retardant Chemicals



Product Information

December 1, 1981

DE-71-2

Effective:
Supersedes:

PRODUCT USE DE-71 FOR WOOD TREATMENT

DE-71 is an efficient liquid organic bromine compound that can be blended with a wide variety of organic solvents, including triethyl phosphate, trichloroethane, methylene chloride, and trichlorofluoromethane to prepare flame retardant wood treatments. DE-71 is readily soluble in chlorinated solvents. Concentrations of 75% DE-71 yield solutions which can be applied by brush. 60-50% solutions are recommended for spray applications. A coverage rate of 3-5 gms./sq. ft. will significantly reduce the flame spread.

Potential applications for DE-71 solutions include dimensional lumber, shakes and shingles.

DE-71 APPLIED TO DOUGLAS FIR *

<u>FR Treatment†</u>	<u>Treatment Level gms./sq. ft.</u>	<u>Burn Rate, 50% O₂ ** in/min.</u>
Untreated	---	3.1 - 4.5
DE-71	3	1.0 - 1.9

* Douglas Fir (2 - 13% H₂O).

** Downward Vertical Burn Rate, Ref. "A Small-Scale Test for Evaluating the Surface Flame Propagating Properties of Polymers", E. R. Larsen, Proc. 30th Annual Technology Conference, SPI Reinforced Plastics Div.

KAH:psf

The information supplied is presented in good faith and has been derived from sources believed to be reliable. Since conditions of use are beyond our control, all risks are assumed by the user. No representation is expressed or implied, and nothing herein shall be construed as permission or recommendation to practice a patented invention without a license.

R.O. Box 2200, Highway 52 N.W., West Lafayette, Indiana 47906

Phone: 317/463-2511, Telex: 27-9428, Cable: GLAKCHEM Lafayette



0 0 3 9

Product Information



Flame Retardant Chemicals

Effective: April 15, 1981
Supersedes:

DE-71-1

PRODUCT USE

DE-71 IN UNSATURATED POLYESTER

DE-71 is a most effective FR for unsaturated polyester (UPE) resins. DE-71 is a high viscosity liquid that is readily soluble in styrene. It mixes well with Alumina Trihydrate, glass reinforcement, and other fillers including Great Lakes DE-83R.

<u>POLYMER</u>	<u>FR PERFORMANCE</u>	RECOMMENDED STARTING LEVELS	
		DE-71 (PHR)	Sb ₂ O ₃ (PHR)
Aropol 7241 ¹ (25% GR Laminate)	UL 94 V-0 & 5V @ 1/16"	15.3	3.0
	UL 94 V-0 & 5V @ 1/8"	15.2	2.0
	O.I. of 27%		
Aropol 7241 (20% GR Laminate +100 PHR ATH)	UL 94 V-0 & 5V @ 1/16"	7.5	1.5
	UL 94 V-0 & 5V @ 1/8"	5.9	1.0
	O.I. of 35%		
Aropol 7241 (25% GR Laminate)	UL 94 V-0 & 5V @ 1/8" O.I. of 27%	FR-701 (PHR)	Sb ₂ O ₃ (PHR)
		18.0	0

ATH =Alumina Trihydrate

¹ Aropol 7241 polyester resin supplied by Ashland Chemical

The information supplied is presented in good faith and has been derived from sources believed to be reliable. Since conditions of use are beyond our control, all risks are assumed by the user. No representation is expressed or implied, and nothing herein shall be construed as permission or recommendation to practice a patented invention without a license.

P.O. Box 2200, Highway 52 N.W., West Lafayette, Indiana 47906

Phone: 317/463-2511, Telex: 27-9428, Cable: GLAKCHEM Lafayette



Product Information



Flame Retardant Chemicals

Effective: **January 1983**
Supersedes:

DE-71-3

PRODUCT USE

DE-71 IN POLYETHYLENE COPOLYMERS

DE-71 is an effective flame retardant for polyethylene copolymers. It offers excellent thermal stability, cost performance, and compatibility. DE-71 does not bloom or plate-out on extruder dies or screws. For most copolymers, 20-25% of DE-71 is sufficient for a V-0 rating in UL-94. Antimony synergists should be used in a ratio of 1 to 2, antimony oxide to brominated flame retardant.

Tables I and II show the results of an evaluation of DE-71 in a polyethylene copolymer resin.

TABLE I

COMPOSITION	FR CONC. %	MELT FLOW g/10 min.	TENSILE		BLOOM**
			STRENGTH, psi	ELONGATION, %	
Base Resin*	---	3.4	1270	425	None
DE-71/Sb ₂ O ₃	21/11	11.6	980	470	None
Dechlorane+ 515/Sb ₂ O ₃	21/11	3.8	1010	205	Heavy
Pyrochek 77B/Sb ₂ O ₃	21/11	4.4	1300	440	None
Saytech BT-93/Sb ₂ O ₃	21/11	3.3	1240	370	None

TABLE II

COMPOSITION	FR CONC. %	UL - 94***		OXYGEN INDEX
		1/16 in.	1/8 in.	
Base Resin*	---	Fail	Fail	18.5
DE-71/Sb ₂ O ₃	21/11	V-2 (4.1)	V-0 (1.1)	29.0
Dechlorane+ 515/Sb ₂ O ₃	21/11	V-2 (12.5)	V-0 (1.4)	24.5
Pyrochek 77B/Sb ₂ O ₃	21/11	V-2 (1.0)	V-0 (0)	28.0
Saytech BT-93/Sb ₂ O ₃	21/11	V-2 (0.7)	V-0 (0)	26.0

*Polyethylene copolymer, wire jacketing compound.

**48 hrs. @ 150°F.

***Rating (average burn time, secs.)

The information supplied is presented in good faith and has been derived from sources believed to be reliable. Since conditions of use are beyond our control, all risks are assumed by the user. No representation is expressed or implied, and nothing herein shall be construed as permission or recommendation to practice a patented invention without a license.

P.O. Box 2200, Highway 52 N.W., West Lafayette, Indiana 47906

Phone: 317/463-2511, Telex: 27-9428, Cable: GLAKCHEM Lafayette





Great Lakes
Chemical Corporation

MATERIAL SAFETY DATA SHEET

EMERGENCY TELEPHONE (501) 862-5141

IDENTITY - Great Lakes DE-71
Pentabromodiphenyl oxide

SECTION I - PRODUCT INFORMATION

MANUFACTURER'S NAME - GREAT LAKES CHEMICAL CORPORATION

TELEPHONE NUMBER FOR INFORMATION - (317) 463-2511

CAS REGISTRY NO. - 32534-81-9

DATE PREPARED - 8/86

FORMULA - $C_{12}H_5Br_5O$

SUPERCEDES - 10/35

CHEMICAL FAMILY - Brominated diphenyl ether

PREPARED BY - Research Services Department
Great Lakes Chemical Corporation
West Lafayette, Indiana 47906

SECTION II

HAZARDOUS COMPONENTS (Specify Chemical Identity: Common Name(s))

COMPONENT	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Tetrabromodiphenyl oxide				
Pentabromodiphenyl oxide	Not estbl.	Not estbl.	Not estbl.	> 97
Hexabromodiphenyl oxide				
Lower brominated diphenyl oxides				< 1
Higher brominated diphenyl oxides				< 2

GLCC Product Code: 550

=====

SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point	Not Available
Specific Gravity (water = 1)	2.28 at 25°C
Vapor Pressure (mm Hg.)	9.3 at 22°C
Melting Point	Not Available
Vapor Density (AIR=1)	Not Available
Evaporation Rate (Butyl Acetate = 1)	
Solubility in Water	Less than 0.1 g/100 c.c. at 25°C
Appearance and Odor	Clear, amber, dense, very viscous liquid

=====

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used)	None
Flammable Limits	Not Available
LEL	Not Available
UEL	Not Available

Extinguishing Media

Dry powder, carbon dioxide, Halon, foam, water fog.

Special Fire Fighting Procedures

Wear self-contained breathing apparatus

Unusual Fire and Explosion Hazards:

Combustion in the presence of other fuels may result in the release of hydrogen bromide and/or bromine.

=====

SECTION V - REACTIVITY DATA

Stability Stable X Unstable

Conditions to Avoid: None

Incompatibility (Materials to Avoid)

None known

Hazardous Decomposition or Byproducts

Hydrogen bromide and/or bromine

Hazardous Polymerization

May Occur Will Not Occur

Conditions to Avoid: None

SECTION VI - HEALTH HAZARD DATA

Route(s) of Entry:

Inhalation? Yes Skin? No Ingestion? Yes

Health Hazards (Acute and Chronic):

Oral LD₅₀ (rats) = 6200 mg/kg; dermal LD₅₀ (rabbits) >2000 mg/kg. DE-71 is not a primary skin irritant, but is a slight eye irritant. Acute inhalation (rats) at 200 mg/l not toxic. Liver cell enlargement and thyroid hyperplasia were observed in a 90-day oral study in rats. Upon compound withdrawal, thyroid hyperplasia was reversible; necrosis was observed in some enlarged liver cells. In a 30-day oral study in rats, no compound related liver or thyroid effects were observed at 1 mg/kg. Acute health hazard is considered to be the potential for eye irritation. Chronic health hazard is the potential for liver damage from chronic over exposure.

Carcinogenicity:

NTP? No IARC Monographs? No OSHA Regulated? No

Signs and Symptoms of Exposure

Eye irritation may occur from contact.

Medical Conditions Generally Aggravated by Exposure

None reported

Emergency and First Aid Procedures

Ingestion: Induce vomiting unless victim is unconscious; obtain medical assistance immediately. Skin: Wash with soap and water. Eyes: Flush for 15 minutes with water; obtain medical assistance. Inhalation: Remove victim to fresh air; administer artificial respiration if necessary; obtain medical assistance. Clothing: Wash contaminated clothing before re-use.

SECTION VII - PRECAUTIONS FOR SAFE HANDLING AND USE

Steps To Be Taken in Case Material is Released or Spilled

Collect spill and place in suitable labelled containers for disposal. Wash contaminated area with copious amounts of soap and water.

Waste Disposal Method

Dispose of waste in a chemical incinerator equipped with a scrubber as allowed by current laws and regulations.

Precautions to be Taken in Handling and Storing

Avoid skin and eye contact. Avoid breathing vapors. Wash contaminated clothing before reuse. Store in dry, well-ventilated area. Avoid overheating.

Other Precautions

None

SECTION VIII - CONTROL MEASURES

Respiratory Protection

Wear NIOSH approved organic vapor canister gas mask during open handling where local exhaust is not available.

Ventilation

Local Exhaust - Use local exhaust and closed handling system. Special - None

Mechanical - Use for general area control Other - None

Protective Gloves - Rubber or plastic

Eye Protection - Safety glasses with side shields

Other Protective Equipment - Wear clean, body-covering clothing

Work/Hygienic Practices

Wash thoroughly after handling

=====

Information on this form is furnished solely for the purpose of compliance with OSHA's Hazard Communication Standard, 29CFR 1910.1200 and shall not be used for any other purpose.

DLMcF/db:92

2

PENTABROMODIPHENYL OXIDE

SUMMARY OF TOXICITY DATA

Acute Oral. Groups of five Charles River CD male albino rats were fasted overnight and then dosed with 50, 500, or 5000 mg./kg. of pentabromodiphenyl oxide. The compound was administered in corn oil by intubation at concentrations permitting a total dose of 10 ml./kg. at all dose levels. The rats were then observed for mortality and body weight gains for 14 days. Those treated at the 50 or 500 mg./kg. dosage levels survived the observation period and exhibited normal body weight gains. Four of the five rats dosed at 5000 mg./kg. died within five days of compound administration. The remaining rat at this dose survived the observation period and exhibited normal body weight gains. These test results indicate that pentabromodiphenyl oxide is a toxic but not highly toxic substance by the oral route of administration.

Acute Oral LD₅₀. Groups of five male and five female Wistar strain rats were fasted overnight and then dosed with 2400, 4800, 6048, 7621, or 9600 mg./kg. of pentabromodiphenyl oxide. The compound was administered by intubation diluted to 80% w/v in maize oil. A formulation of 80% w/v water in maize oil, sonicated to form a suspension, served as a control at each dose level. The rats were then observed for mortality for 44 days. Body weights were recorded weekly. A post-mortem examination was performed on all animals dying during the observation period and those sacrificed at the end of the observation period. Those treated at the 2400 mg./kg. dose exhibited no signs of intoxication but a slower weight gain than controls was noted. Rats treated at 4800 mg./kg. exhibited slight diarrhea within 24 hours of dosing followed by two to three days of fewer faeces than produced by controls. Rats of this dose also exhibited slower weight gain up to 32 days of observation then increased at the same rate as controls. No rats at these lower two dose rates died during the observation period. Females at 4800 mg./kg. and higher doses exhibited piloerection and reduced activity within a few hours of dosing, followed by clonic persistent tremors of the fore limbs, together with a red staining around the nose and eyes. Also a continual chewing movement of the jaws was noted. In those animals which subsequently died, these signs increased in severity up to the time of death. Post-mortem examination of those animals dying during the observation period revealed pale enlarged necrotic livers in all cases and multiple small ulcerations of the gastric mucosa in many cases. Post-mortem examination of the survivors showed slightly mottled livers, the extent of which increased with dose level. The acute oral LD₅₀ for males was 7150 mg./kg. with 95% confidence limits of 6802 to 8081 mg./kg. of pentabromodiphenyl oxide. The acute oral LD₅₀ for females was 5000 mg./kg. with

the confidence limits of 5276 to 5364 mg./kg. of pentabromodiphenyl oxide. The confidence limits of 5280 mg./kg. with 95% confidence limits of 5391 to 5364 mg./kg. of pentabromodiphenyl oxide. However, data for clinical signs, weight gain and post-mortem examination indicate that some toxic effects are present with doses as low as 2400 mg./kg.

Acute Dermal. Pentabromodiphenyl oxide was applied to the closely clipped intact or abraded skin of groups of two male and two female New Zealand white rabbits at concentrations of 200 or 2000 mg./kg. The area was occluded and wrapped for 24 hours after which wrappings were removed and the rabbits' backs were washed with tepid water. The rabbits were then observed for 14 days for mortality. No rabbits died during the study. At the 200 mg./kg. dose females exhibited normal body weight gains. One male at this dose exhibited about 3% weight loss while the other male rabbit exhibited approximately 24% weight loss, but the latter was attributable to injuries sustained in stock confinement. At the 2000 mg./kg. dose three of four rabbits exhibited body weight gains while one female lost about 5% original weight. These test results indicate that pentabromodiphenyl oxide is not a toxic substance by the dermal route of administration.

Primary Skin Irritation. Pentabromodiphenyl oxide was applied to the closely clipped intact or abraded skin of groups of three male and three female New Zealand white rabbits at a dose of 0.5 milliliter (approximately 1135 mg.). The area was occluded and wrapped. After 24 hours the wrappings were removed and the rabbits' backs were washed with tepid water and examined for irritation. The examination was repeated at 72 hours following application. At 24 and 72 hours very slight to no erythema was noted; no edema was seen at either observation time. These test results indicate that pentabromodiphenyl oxide is not a primary skin irritant.

Acute Inhalation. Groups of 10 male and 10 female Charles River CD rats were exposed in a sealed container for one hour to an aerosol mist of pentabromodiphenyl oxide mixed with corn oil at concentrations of 2 or 200 mg./l. of air and subsequently observed for 14 days. No rats died during administration or during the 14 day observation period. The rats at the 2 mg./l. dose exhibited increased, followed by decreased, motor activity, erythema, and eye squint during exposure and for 24 hours thereafter. From 24 hours after exposure and to the end of the 14 day observation period all rats at this dose appeared normal and exhibited normal body weight gains. During exposure rats at the 200 mg./l. dose exhibited the same signs as at the lower dose and also lacrimation, salivation, and tachypnea. At 24 and 48 hours two rats exhibited nasal congestion. At 72 hours following administration one rat displayed respiratory congestion. From 4 to 14 days after administration all rats at this dosage appeared normal and exhibited normal body weight gains. These test results indicate that pentabromodiphenyl oxide is not a toxic substance by the inhalation route of administration.

Acute Eye Irritation. Single applications of 0.1 milliliter of pentabromodiphenyl oxide were instilled into the cupped conjunctival

Pentabromodiphenyl Oxide

... of the right eye of three male and three female New Zealand white rabbits. Examinations were made for ocular irritation at 24, 48, and 72 hours and at seven days; sodium fluorescein and ultra-violet light were used at the 72 hour examination to assess possible corneal injury. Irritative findings were scored according to the method of Draize. At 24 hours all rabbits exhibited slight redness, slight to very slight chemosis, and slight discharge of the conjunctivae. These symptoms subsided with time; four animals exhibited these symptoms at 48 and 72 hours. At seven days slight alopecia around the lower eyelid in two of six animals, very slight to normal redness, very slight to normal chemosis and slight to normal discharge of the conjunctivae were noted. No irritation of the iris was exhibited at any time. Examination at 72 hours revealed slight evidence of corneal damage in one of the six animals only. These test results indicate that pentabromodiphenyl oxide is a possible eye irritant.

Twenty-eight Day Feeding. Charles River CD rats were fed at dietary dosage levels of 100 or 1000 ppm of pentabromodiphenyl oxide dissolved in corn oil for 28 days. There were 10 male and 10 female rats in each dose group and in a control group fed only the basal diet. The rats were observed daily during the feeding period for changes in behavior and appearance. Body weights and sex group feed consumptions were recorded weekly. At the conclusion of the 28-day feeding period all rats were sacrificed for gross pathological examination and for histopathological examination of liver, kidney, and thyroid tissues.

In none of the tests did rats die, nor were there changes noted in behavior or appearance of any of the rats during the feeding period. Feed consumption and body weight gains were similar for control and treatment groups. Absolute and relative liver weights were statistically significantly increased for male and female rats at the 1000 ppm dietary level, and increases in the mean relative liver weights of females were found at the 100 ppm dose rate. Other organ weight variations which were statistically significant but of doubtful biological significance included decreases in mean absolute and relative pituitary weights and decreases in absolute adrenal weights in females at 1000 ppm and increases in mean absolute and relative kidney weights in females at the 100 ppm dose level. No compound related gross pathological lesions were noted in any rats from any group. Compound related histopathologic liver lesions were observed in rats from the 100 and 1000 ppm dietary level groups. The lesions consisted of enlargement of centrilobular and mid-zonal liver parenchymal cells. The cytoplasm of the enlarged cells had large areas with a finely granular "ground glass" appearance. Frequently, eosinophilic "round bodies" also were present in the cytoplasm

(over)

... usually had a dense eosinophilic ... eosinophilic central por- ... more frequently and with greater ... and with a dosage related order of incidence and sever-

Several rats from the 100 and 1000 ppm feeding levels of pentabromo- diphenyl oxide had slight to moderate hyperplasia of the thyroid, how- ever, several rats from the control group also had thyroids which could almost be considered hyperplastic. In thyroids which were designated as hyperplastic, most follicles were very small, devoid of colloid and lined by basophilic columnar follicular epithelium. Whether the thyroid change noted in the above groups was compound related or only represented a somewhat greater degree of normal morphological variation than occurred in the control rats could not be determined.

All other microscopic lesions observed in tissues from rats from the experimental groups were considered spontaneous and unrelated to treat- ment.

Dose related increases in bromide levels of liver tissues were noted in pooled tissues from both male and female rats and ranged from about 6 to about 12 times the levels found in control groups.

90-day Dietary Study in Rats: Pentabromodiphenyl oxide (DE-71) was given in the diet to three groups of 30 male and 30 female CD® Sprague Dawley rats. Dosage levels of 0, 2, 10, and 100 mg./kg./day were used. Ten rats per sex per level were sacrificed at the end of 4 weeks. Ten animals per sex at each level were sacrificed at the end of the 90-day feeding period. Five animals per sex per level were sacrificed after a 6-week recovery period and the remaining animals were sacrificed after a 24-week recovery period.

No compound-related mortality or clinical effects were observed. Decreases in body weights for high dose males and females and decreases in food consumption for high dose females appeared to be dose-related.

Hematology parameters were normal. Liver function assays were nor- mal except for increased serum cholesterol values for high dose animals of both sexes at weeks 4 and 13 when they were determined.

Triiodothyronine (T_3) levels were normal at 4 and 13 weeks. Tetra- iodothyronine (T_4) levels were decreased in the mid and high dose groups, although not in a dose-dependent manner. There was also an increase in serum bromide levels for the mid and high dose groups of both sexes at week 4 and for the high dose groups at week 13. The values at week 13 were slightly less than at week 4. The decrease in T_4 levels may be re- lated to the increase in serum bromide levels. The thyroid gland may have responded to the bromide as iodide and as a result reduced the T_4 levels.

There were compound-related increases in liver and urine porphyrins for the high dose males and females. The levels were increased 2 to 3 times the control values at 13 weeks for males. Urine porphyrin levels were 13 times higher than controls for high dose females and liver por- phyrins were almost 400 times that of controls.

Pentabromodiphenyl Oxide

Compound-related increases in tissue bromine levels were noted in all tissues for males and females at the low and high dose levels, the mid dose groups bromine levels were not determined. After a 6-week recovery period, the bromine levels for all tissues were decreased from the 13 week levels, but were still above control levels. After the 24 week recovery period many of the tissues had bromine levels only somewhat elevated when compared to controls. In the high dose group after 24 weeks bromine levels were elevated for all tissues.

No compound-related macroscopic changes were noted at necropsy. Compound-related increases in absolute liver weight and liver weight relative to body weight were observed in the mid and high dose groups. At the 6-week recovery period, only high dose animals had slightly elevated absolute liver weights and elevated liver to body weight ratios. After 24 weeks of recovery, liver weights and ratios were in the normal range for all dose levels.

Microscopic examination of the liver and thyroid gland revealed compound-related changes. No other tissues showed compound-related changes. The liver changes were diagnosed as hepatocytomegaly and the thyroid changes as hyperplasia. Hepatocytomegaly is characterized as increases in the size of individual liver cells. Hyperplasia is an increase in the number of cells. The thyroid hyperplasia was a reversible effect and was not reported for any dosage level after the 24 week recovery phase. The hepatocytomegaly, however, was not completely reversible. Very slight to slight hepatocytomegaly was observed in mid dose males and high dose males and females. No hepatocytomegaly was observed in the low dose animals after 24 weeks. Necrosis of individual liver cells was observed for females at all dosage levels after 24 weeks recovery. At the lowest dosage level of 2 mg./kg., the only compound-related effect observed after 24 weeks recovery was very slight to slight liver cell degeneration and necrosis in females. No compound-related histopathologic effects were observed in low dose males after 24 weeks recovery.

Mutagenicity. Pentabromodiphenyl oxide was examined for mutagenic activity at a number of concentrations in a series of in vitro microbial assays employing Salmonella and Saccharomyces indicator organisms both directly and in the presence of liver microsomal enzyme preparations from Arochlor-induced rats. The results of the tests whether in the presence or absence of the rat liver activation system were all negative. Pentabromodiphenyl oxide was judged not mutagenic under these test conditions.

7/21/77
Rev. 11/84

Product Information

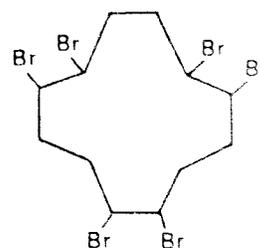
Flame Retardant Chemicals



Effective April 15, 1981
Supersedes April 11, 1973

GREAT LAKES CD-75P™

CD-75P, HEXABROMOCYCLODODECANE, is a highly brominated cyclo-aliphatic flame retardant. It provides excellent performance at low loading levels with a minimum effect on polymer properties.



HEXABROMOCYCLODODECANE

APPLICATIONS

CD-75P is recommended as an additive flame retardant for thermoplastic and thermosetting polymers. It is the product of choice for EPS (expanded polystyrene foam) and other styrene based resin systems. CD-75P is also used in textile treatments, latex binders, adhesives, unsaturated polyesters, and coatings. For specific formulations, refer to product use bulletins.

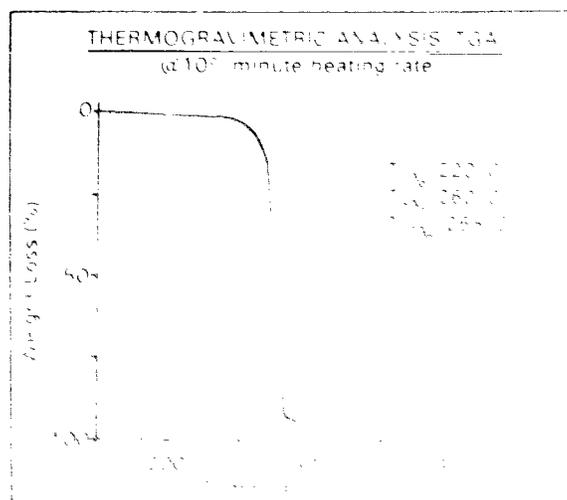
PHYSICAL PROPERTIES

See price information bulletin for specifications.

Formula weight:	641.7
Appearance:	white powder
Melting Range °C:	185-195
Assay, HPLC, %:	90
Bromine Content, %:	
Theoretical:	75
Color, APHA:	60
Volatiles, 2 hr at 110°C, %:	1

Solubility at 25°C (g/100g solvent):

Water	0.1	Toluene	10
Methanol	1	Methylene Chloride	10
Methylene Chloride	4	Styrene	10



The information supplied is presented in good faith and has been believed to be correct at the time of publication. Conditions of use are beyond our control. ANALYSIS AND ASSAY METHODS ARE SUBJECT TO CHANGE WITHOUT NOTICE AND NOTHING HEREIN SHALL BE CONSTRUED AS PERMISSION TO REPRODUCE OR TRANSMIT IN ANY FORM OR BY ANY MEANS WITHOUT LICENSE.

P.O. Box 2200, Highway 52 N.W., West Lafayette, Indiana 47906

TOXICOLOGICAL INFORMATION

Literature values indicate CD-75P has a low order toxicity. The oral LD₅₀ value for rats is greater than 10,000 mg/kg of body weight. Dermal LD₅₀ in rabbits is greater than 20,000 mg/kg and inhalation LC₅₀ in rats is greater than 202 mg/liter.

HANDLING PRECAUTIONS

Though CD-75P is not considered hazardous under the Federal Hazardous Substance Act, safe handling procedures should be followed when working with this fire retardant. Excessive exposure to the product should be avoided or prevented by the use of appropriate protective equipment. The use of safety glasses with side shields, rubber gloves, and dust respirator is recommended. Suitable ventilation in the work place is recommended. Contaminated clothing should be washed before reuse. Smoking and eating should not be allowed when handling the product.

FIRST AID RECOMMENDATIONS

1. For eye exposure to CD-75P, flush eyes for several minutes with fresh water. If ill effects occur, get medical attention.
2. For skin exposure, wash with soap and water repeating the process a number of times until traces of product are removed.
3. For excess exposure to dust or vapors from over heating, remove person to fresh air and obtain medical attention.
4. If large amounts are swallowed, drink one or two glasses of water and induce vomiting. Seek medical attention.



Great Lakes
Chemical Corporation

MATERIAL SAFETY DATA SHEET

EMERGENCY TELEPHONE (501) 862-5141

IDENTITY - Great Lakes CD-75P

SECTION I - PRODUCT INFORMATION

MANUFACTURER'S NAME - GREAT LAKES CHEMICAL CORPORATION

TELEPHONE NUMBER FOR INFORMATION - (317) 463-2511

CAS REGISTRY NO. - 3194-55-6

DATE PREPARED - 6/87

FORMULA - $C_{12}H_{18}Br_6$

SUPERCEDES - 7/86

CHEMICAL FAMILY - Cyclic alkyl bromide

PREPARED BY - Research Services Department
Great Lakes Chemical Corporation
West Lafayette, Indiana 47906

SECTION II

HAZARDOUS COMPONENTS (Specify Chemical Identity: Common Name(s))

<u>COMPONENT</u>	<u>OSHA PEL</u>	<u>ACGIH TLV</u>	<u>Other Limits Recommended</u>	<u>% (optional)</u>
Hexabromocyclo- dodecane	15 mg/m ³ (Nuisance dust levels)	.10 mg/m ³	Not estbl.	100

GLCC Product Code: 521

GREAT LAKES CHEMICAL CORPORATION
P.O. Box 2200 . Highway 52 NW . West Lafavetta. Indiana 47906

SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point	Decomposes
Specific Gravity (water=1)	2.24
Vapor Pressure (mm Hg.)	Not Available
Melting Point	19°C; 374°F
Vapor Density (AIR=1)	22
Evaporation Rate	Not Available
(Butyl Acetate = 1)	
Solubility in Water	Insoluble
Appearance and Odor	Off-white powder with characteristic odor.

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used)	Not Applicable
Flammable Limits	Not Applicable
LEL	Not Applicable
UEL	Not Applicable

Extinguishing Media

All conventional media suitable

Special Fire Fighting Procedures

Wear self-contained breathing apparatus

Unusual Fire and Explosion Hazards:

This product decomposes under fire conditions to produce hydrogen bromide

SECTION V - REACTIVITY DATA

Stability Stable x Unstable

Conditions to Avoid: None

11155

Incompatibility (Materials to Avoid)

None known

Hazardous Decomposition or Byproducts

Combustion may produce hydrogen bromide or other toxic gases

Hazardous Polymerization

May Occur Will Not Occur x .

Conditions to Avoid: None

SECTION VI - HEALTH HAZARD DATA

Route(s) of Entry:

Inhalation? yes Skin? no Ingestion? yes

Health Hazards (Acute and Chronic):

Acute oral LD₅₀ for rats is greater than 10 g/kg. The acute dermal LD₅₀ for rabbits is greater than 10 g/kg. The product is a minimal skin irritant (Draize score 0.1) and mild eye irritant in tests with rabbits. No test animal deaths occurred during a one hour acute inhalation exposure and 14 day post exposure period to CD-75P at the maximum concentration employed of 202 mg/l. Other than the potential for mild eye irritation no acute or chronic health effects are known.

Carcinogenicity:

NTP? no IARC Monographs? no OSHA Regulated? no

Signs and Symptoms of Exposure

Eye contact may cause mild eye irritation

Medical Conditions Generally Aggravated by Exposure

None reported

Emergency and First Aid Procedures

Eyes: Flush with water for 15 minutes. Get medical attention. Skin: Wash with soap and water. Inhalation: Remove person to fresh air. Get medical attention. Ingestion: Get medical attention.

SECTION VII - PRECAUTIONS FOR SAFE HANDLING AND USE

Steps To Be Taken in Case Material is Released or Spilled

Sweep up and place in suitable labelled container for disposal. Avoid dust inhalation.

Waste Disposal Method

Dispose of waste in an approved chemical incinerator equipped with a scrubber or in a chemical landfill as approved by current laws and regulations.

Precautions to be Taken in Handling and Storing

Store in a dry, well-ventilated area. Avoid overheating.

Other Precautions

None

SECTION VIII - CONTROL MEASURES

Respiratory Protection

Wear NIOSH approved dust respirator where dusting occurs

Ventilation

Local Exhaust - Use to maintain dust below TLV

Mechanical - Use for general area control

Special - None Other - None

Protective Gloves - Neoprene gloves desirable if skin contact likely

Eye Protection - Safety glasses

Other Protective Equipment - None normally required

Work/Hygienic Practices - Wash after handling

Information on this form is furnished solely for the purpose of compliance with OSHA's Hazard Communication Standard, 29CFR 1910.1200 and shall not be used for any other purpose.

DLMcF/jg:81

SUMMARIES OF TOXICITY DATA

Acute Oral

Five male and five female rats of the Charles River CD strain were dosed at a level of 10,000 mg./kg. of body weight. The test material was suspended in corn oil and administered orally by gavage. None of the ten rats died during the 14-day observation period. Pharmacotoxic signs observed in some rats were hypoactivity, corneal opacity, and ptosis in males and diarrhea and hypoactivity in females.

Six groups of five Dublin strain rats were dosed by stomach tube at levels of 0.215, 0.464, 1.00, 2.15, 4.64, and 10.0 g./kg. of body weight. At the end of a 14-day holding period, the rats were weighed and sacrificed. There were no deaths at any dosage level and average body weight gain was within normal limits.

Acute Dermal

A single dose of the test compound was applied at a dosage level of 20,000 mg./kg. of body weight with 0.9 percent saline as a wetting agent to the clipped and abraded skin of two male and two female New Zealand albino rabbits. The rabbits were observed at 24 hours and daily thereafter for a total of 14 days. None of the rabbits died during the observation period. One male rabbit showed signs of diarrhea on Days 12 through 14 and one female showed signs of diarrhea on Day 9.

Four groups of four albino rabbits were clipped of abdominal fur. The abdominal skin of two rabbits in each group was abraded and for the remaining two rabbits remained intact. The sample was applied as a paste with corn oil at dosage levels of 1.00, 2.15, 4.64, and 10.0 g./kg. of body weight. After the rabbits were exposed for 24 hours, they were observed for 14 days. No deaths occurred during the observation period. All rabbits gained weight during the 14-day holding period.

Primary Skin Irritation

Three male and three female New Zealand albino rabbits were clipped of back hair and the skin of three rabbits was abraded. The test material was applied as a paste with saline at a dosage level of

The eyes of six New Zealand albino rabbits were covered with gauze and occluded for 24 hours. After 24 hours the bandages were removed and the eyes were examined for skin irritation. The examinations were repeated at 48, and 72 hours. A low value of erythema was observed on the intact skin of one female rabbit initially and at 24 and 48 hours, and on one female at 24 hours. No erythema or edema was observed at any time on the abraded skin of any of the rabbits. The test material was considered minimally irritating but not a primary skin irritant. The irritation score was 0.1.

A sample of 500 mg. of test material was applied to an intact-skin area and an abraded-skin area on each of six albino rabbits. After the 24 hour exposure, the rabbits were examined and again two days later (72-hour reading). Three rabbits exhibited slight erythema at 24 hours on abraded areas. No irritation was observed on intact skin at any time for any of the rabbits. The primary irritation index was calculated to be 0.13.

Eye Irritation

The eyes of six New Zealand albino rabbits were examined. A 100 mg. sample was instilled into the right eye of each rabbit. The eyes were unwashed. Eye examinations for irritation were made at 24, 48, and 72 hours and at seven days following application. Very slight to slight redness was observed in the conjunctivae of some rabbits at 48 and 72 hours, very slight chemosis was observed in one rabbit at 48 and 72 hours, very slight to slight discharge was observed in some rabbits at 24, 48, and 72 hours. All eyes were normal at seven days. The test material was classified as mildly irritating to the eye, but not a primary eye irritant.

A sample of 100 mg. of test material was instilled into the left eye of each of six albino rabbits. Examinations were made at 24, 48 and 72 hours following application. Two rabbits showed no irritation at any time. The four remaining rabbits showed mild conjunctival erythema at the 24-hour observation. With an additional 24 hours, the erythema observed in three of these rabbits subsided completely. The remaining rabbit continued to show mild conjunctival erythema during the remainder of the 72-hour period.

Acute Inhalation

The dust atmosphere of the compound was generated by dispersing the powder at a calculated rate with a specially constructed dust generator. A total of 339.65 g. of the powder was disseminated during the four hour exposure period. The rate of the powder disseminated was calculated to be 1.415 g./min. The total chamber airflow was seven l./min. and the chamber dust concentration was calculated to be 202.14 mg./l. Five male and five female Charles River CD rats were exposed to the test atmosphere. The immediate response of the rats to the atmosphere was an increase in preening. After ten minutes of exposure,

... 30 minutes after the ini-
... to the bed of the four hour period, the rats
... of breath. During the 14-day observa-
... appeared normal. No deaths occurred during the
... observation periods. No latent adverse effect was ob-
... after the exposure.

... male Dublin albino rats were exposed to the test material in an
... chamber for one hour at a calculated concentration of 130
.../l. Fifteen minutes following initiation of the exposure, the
... showed intermittent preening and were moderately active. Fif-
... minutes later, the rats continued to show intermittent preening
... and appeared slightly depressed. During the remainder of the expo-
... the chamber was too dusty to permit satisfactory observation
... of the animals. On removal from the chamber, the rats appeared
... slightly depressed and one showed slight salivation. No deaths
... occurred during the exposure period or during the 14-day observation
... period. Body weight gain was normal during the period.

Mutagenicity Testing - Ames Test

The test material was evaluated for mutagenic potential utilizing
the Ames test employing Salmonella typhimurium bacteria. Dosages
ranged from 25 to 250 µg./10 µl. of dimethylsulfoxide solvent/plate.
The highest concentration that could be dissolved was 250 µg./10 µl.
In the absence or presence of the rat liver activation system, this
material did not demonstrate mutagenic activity. The test material
was not considered mutagenic under these test conditions.

96-Hour Static Aquatic Bioassay

Bluegill sunfish, Lepomis macrochirus Rafinesque were used as the
test species in the bioassay. Test material concentrations ranged
from 10.0 to 100.0 mg./l. and observations were made at 24, 48, and
96 hours. The LC₅₀ could not be determined due to the lack of deaths.
Abnormal behavior was not observed during the test.

Pilot Cataractogenic Study in Chicks

The test material was administered in the diet of chicks (3/sex/
level) at dietary levels of 0.075, 0.15, 0.30, 0.60, and 1.20 per-
cent. A control group was fed the chick starter ration. No changes
considered to be related to the compound were seen in general be-
havior or appearance during the 17-day feeding study. No cataract
formation was observed in any of the chicks and none of the animals
died during the study.

Cataractogenic Study in Chicks

The test material was administered in the diet to ten male and ten
female chicks at dosage levels of 1.0 and 1.5 percent. The study

... feeding control group which received chick starter feed ... positive control group fed 0.3 percent of 2,4-dinitrophenol ... The eyes of the chicks were checked daily. No cataracts were noted in any of the chicks with treated or negative control groups. Very faint anterior cortical cataracts were noted in one or two chicks in the positive control group. One chick at the 1.0 percent dietary level died (possibly compound related) and seven of eight chicks in the positive control group died as a result of malnutrition (diet rejection). No gross pathologic lesions which were considered due to test material feeding were seen at necropsy in any chicks from the two dosage level groups. No compound related microscopic ocular lesions were seen in the eyes of any chicks from either treated group.

Biodegradation

The biodegradability of the test material was investigated by analyzing the benzene extracts of hexabromocyclododecane representing zero, one, five and seven days exposure to bacterial medium. About half of the test material had biodegraded after 15 days exposure.

Hydrolysis

One gram samples of test material were placed in each of nine bottles containing 30 ml. of distilled water. The bottles were tightly capped and put on a shaker. Samples were taken twice weekly and the water tested for pH and bromide ion. After 39 days, no bromide ions were detected in any of the samples. The detection limit for bromide ion was 200 p.p.m. No significant trend was observed in the pH measurements. No significant hydrolysis occurred under the conditions of this test.

Partition Coefficient

The partition coefficient may indicate the bioaccumulation potential of a chemical in aquatic environments. The n-octanol/water partition coefficient for the test material was determined as 1482 using radio-labeled material.

Solubility

Water solubility of a chemical may be related to its absorption and leachability and bioaccumulation in aquatic organisms. Radiocarbon labeled test material samples in distilled water were shaken overnight at 15, 25, and 35°C. The samples were centrifuged for one hour and solution samples were taken for radioassay. Water solubility of the test material was approximately 0.008 p.p.m. and not sensitive to water temperature.

Product Information



Flame Retardant Chemicals

Effective: April 15, 1981
Supersedes: September 2, 1980

GREAT LAKES DE-60F™

PENTABROMODIPHENYL OXIDE
(DE-71)/AROMATIC PHOSPHATE
BLEND

DE-60F, PENTABROMODIPHENYL OXIDE BLEND, is a lower viscosity blend of DE-71, Pentabromodiphenyl Oxide, and an aromatic phosphate. The blend offers 60% aromatic bromine in an easily pourable liquid form.

APPLICATIONS

DE-60F is recommended as an additive flame retardant for rigid and flexible urethanes, epoxies, laminates, unsaturated polyesters, and plasticized PVC compounds. DE-60F is readily soluble in styrene, polyols, Freon 11, and isocyanates. The aromatic phosphate improves viscosity for handling and adds phosphorous synergist for enhanced flame retardancy. Specific formulation recommendations are available in product use bulletins.

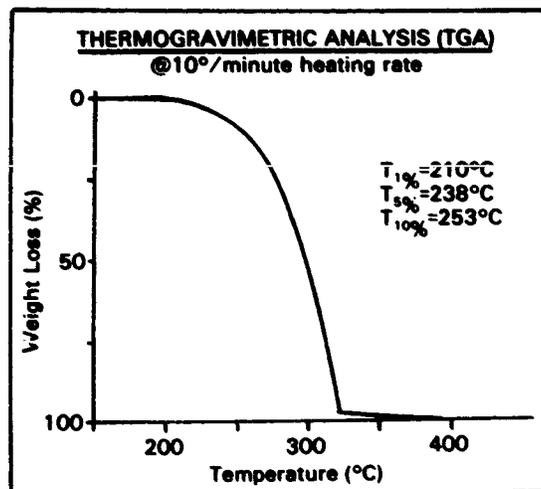
PHYSICAL PROPERTIES

DE-71 Content:	85%
Aromatic phosphate:	15%
Appearance:	Amber Liquid
Bromine Content, %, Theoretical:	59-61
Phosphorous Content, %, Theoretical:	1.1-1.4
Acidity, mg. KOH/g, max:	0.25
Volatiles, 1 hr at 105°C, 5, max:	0.20
Iron, ppm, max:	10
Specific gravity, gm/ml at 25°C:	1.95 (approx. 16.4 lb.gal)

Solubility @ 25°C (g/100g solvent)

Water	0.1	Freon 11	C
Methanol	1	Polyol	C
Methylene Chloride	C	Styrene	C
Toluene	C	Methyl Ethyl Ketone	C
Diocetylphthalate	100	Triethyl Phosphate	C

C = Complete solubility



The information supplied is presented in good faith and has been derived from sources believed to be reliable. Since conditions of use are beyond our control, all risks are assumed by the user. No representation is expressed or implied, and nothing herein shall be construed as permission or recommendation to practice a patented invention without a license.

P.O. Box 2200, Highway 52 N.W., West Lafayette, Indiana 47906

Phone: 317/463-2511, Telex: 27-9428, Cable: GLAKCHEM Lafayette



Great Lakes
Chemical Corporation

TOXICOLOGICAL INFORMATION

The potential for eye injury or intoxication by ingestion, eye or skin contact is believed to be relatively low. Repeated inhalation of vapors may be hazardous and should be avoided.

The oral LD₅₀ value for rats has been found to be greater than 1000 mg/kg of body weight. Dermal LD₅₀ for rabbits is greater than 2000 mg/kg, and the inhalation LC₅₀ for rats is greater than 200 mg/L.

DE-60F is determined to be not mutagenic in a series of bioassays employing salmonella and saccharomyces indicator organisms both directly and with liver activation.

A complete summary of toxicological data is available upon request.

HANDLING PRECAUTIONS

Opportunities for long-term chronic exposure should be limited. Repeated inhalation of vapors may be hazardous and should be avoided.

The use of safety glasses and protective gloves is recommended. Wash any contaminated areas with soap and water.

Store in a dry, well ventilated area. Avoid over heating.

FIRST AID RECOMMENDATIONS

1. For eye exposure to DE-60F vapors, flush for several minutes with fresh water. If ill effects persist, get medical attention.
2. For skin exposure, wash with soap and water, repeating the process a number of times until traces of product are removed.
3. For excess exposure to vapors, remove person to fresh air and obtain medical attention.
4. If large amounts of DE-60F are swallowed, induce vomiting and seek medical attention.

0064

Product Information



Flame Retardant Chemicals

June, 1981

Effective:
Supersedes:

PRODUCT USE

DE-60F EMULSION

DE-60F (PENTABROMODIPHENYL OXIDE BLEND) can be readily made into a stable emulsifiable concentrate which can be further diluted with water. The emulsion of DE-60F provides a low viscosity flame retardant for use in a variety of water based systems. Typical application areas include adhesives, coatings, SBR-latex, fabric treatments and wood products.

CONCENTRATE:

DE-60F	90 or (92 parts)
BASF Pluronic L-64 (non-ionic)	10 parts
or GAF GAFAC RE-610 (ionic)	(8 parts)

EMULSION:

1. Charge 5 parts of DE-60F concentrate and 1 part (by weight) of water to a mixing tank. Agitate thoroughly.
2. Add additional volume of water to obtain desired concentration.

The Concentrate has an excellent shelf life. The emulsion should be kept for only 24-48 hours.

The information supplied is presented in good faith and has been derived from sources believed to be reliable. Since conditions of use are beyond our control, all risks are assumed by the user. No representation is expressed or implied, and nothing herein shall be construed as permission or recommendation to practice a patented invention without a license.

P.O. Box 2200, Highway 52 N.W., West Lafayette, Indiana 47906

Phone: 317/463-2511, Telex: 27-9428, Cable: GLAKCHEM Lafayette





MATERIAL SAFETY DATA SHEET

EMERGENCY TELEPHONE (501) 862-5141

IDENTITY - Great Lakes DE-60F

=====

SECTION I - PRODUCT INFORMATION

MANUFACTURER'S NAME - GREAT LAKES CHEMICAL CORPORATION

TELEPHONE NUMBER FOR INFORMATION - (317) 463-2511

CAS REGISTRY NO. - 32534-81-9

DATE PREPARED - 8/86

FORMULA - Trade secret mixture

SUPERCEDES - 3/86

CHEMICAL FAMILY - Mixture of pentabromodiphenyl oxide and aromatic phosphate

PREPARED BY - Research Services Department
Great Lakes Chemical Corporation
West Lafayette, Indiana 47906

=====

SECTION II

HAZARDOUS COMPONENTS (Specify Chemical Identity: Common Name(s))

<u>COMPONENT</u>	<u>OSHA PEL</u>	<u>ACGIH TLV</u>	<u>Other Limits Recommended</u>	<u>% (optional)</u>
Pentabromodiphenyl oxide	Not estbl.	Not estbl.	Not estbl.	85
Aromatic phosphate	Not estbl.	Not estbl.	Not estbl.	15

GLCC Product Code: 551

GREAT LAKES CHEMICAL CORPORATION
P.O. Box 2200 · Highway 52 NW · West Lafayette, Indiana 47906

=====

SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point	Not Available
Specific Gravity (water = 1)	1.95 at 25°C
Vapor Pressure (mm Hg.)	Not Available
Melting Point	Not Available
Vapor Density (AIR=1)	Not Available
Evaporation Rate	Not Available
(Butyl Acetate = 1)	
Solubility in Water	Very low
Appearance and Odor	Clear amber, dense liquid with no odor

=====

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Flash Point (Method Used)	None
Flammable Limits	Not Available
LEL	Not Available
UEL	Not Available

Extinguishing Media

Dry powder, carbon dioxide, Halon, foam, water fog.

Special Fire Fighting Procedures

Wear self-contained breathing apparatus.

Unusual Fire and Explosion Hazards:

Combustion in the presence of other fuels may result in the release of hydrogen bromide, bromine and/or other irritating vapors.

=====

SECTION V - REACTIVITY DATA

Stability Stable X Unstable

Conditions to Avoid: None

Incompatibility (Materials to Avoid)

None known

Hazardous Decomposition or Byproducts

Hydrogen bromide and/or bromine, or other toxic gases.

Hazardous Polymerization

May Occur Will Not Occur

Conditions to Avoid: None

SECTION VI - HEALTH HAZARD DATA

Route(s) of Entry:

Inhalation? Yes Skin? No Ingestion? Yes

Health Hazards (Acute and Chronic):

Pentabromodiphenyl oxide: oral LD₅₀ (rats) is equal to 6200 mg/kg; dermal LD₅₀ (rabbits) is greater than 2000 mg/kg. Not a primary skin irritant, slight eye irritant. Acute inhalation (rats) at 200 mg/l not toxic. Liver cell enlargement and thyroid hyperplasia were observed in a 90-day oral study in rats. Upon compound withdrawal, thyroid hyperplasia was reversible, necrosis was observed in some enlarged liver cells. In a 30-day oral study in rats with pentabromodiphenyl oxide, no compound related liver or thyroid effects were observed at 1 mg/kg. Acute health hazard is considered to be the potential for eye irritation. Chronic health hazard is the potential for liver damage from chronic overexposure. Aromatic phosphate: oral LD₅₀ (rats) is greater than 15 g/kg. The dermal LD₅₀ is greater than 7 g/kg. Aromatic phosphate is a slight eye and skin irritant. The compound is toxic by inhalation, at 3 mg/l, 3 of 5 rabbits died after a 6 hour exposure. Not mutagenic in the Ames test. No signs of neurotoxic or teratogenic effects in animal studies. Aromatic phosphate is used as a food additive.

Carcinogenicity:

NTP? No IARC Monographs? No OSHA Regulated? No

0068

Signs and Symptoms of Exposure

Eye and skin irritation may occur upon contact.

Medical Conditions Generally Aggravated by Exposure

None reported. Existing dermatitis may be aggravated by exposure.

Emergency and First Aid Procedures

Ingestion: Induce vomiting unless victim is unconscious; obtain medical assistance immediately. Skin: Wash with soap and water. Eyes: Flush for 15 minutes with water; obtain medical assistance. Inhalation: Remove victim to fresh air; administer artificial respiration if necessary; obtain medical assistance. Clothing: Wash contaminated clothing before reuse.

SECTION VII - PRECAUTIONS FOR SAFE HANDLING AND USE

Steps To Be Taken in Case Material is Released or Spilled

Collect spill and place in suitable, labelled container for disposal. Wash contaminated area thoroughly with soap and water.

Waste Disposal Method

Dispose of waste in a chemical incinerator equipped with a scrubber as approved by current laws and regulations.

Precautions to be Taken in Handling and Storing

Store in dry, well ventilated area. Avoid overheating. Use reasonable care to avoid skin and eye contact. Do not inhale vapors.

Other Precautions

None

SECTION VIII - CONTROL MEASURES

Respiratory Protection

Wear NIOSH approved organic vapor canister gas mask during open handling where local exhaust is not available.

0069

Ventilation

Local Exhaust - Use local exhaust and closed handling system.

Special - None

Mechanical - Use for general area control Other - None

Protective Gloves - Rubber or plastic

Eye Protection - Safety glasses with side shields

Other Protective Equipment - Wear clean, body-covering clothing.

Work/Hygenic Practices - Wash thoroughly after handling.

=====
Information on this form is furnished solely for the purpose of compliance with OSHA's Hazard Communication Standard, 29CFR 1910.1200 and shall not be used for any other purpose. Use or dissemination of all or any part of this information for any other purpose may result in a violation of law or constitute grounds for legal action.

DLMcF/db:104

April 21, 1988

BFRIP RESPONSES TO "ECONOMIC ASSESSMENT" QUESTIONS
SUBMITTED BY U.S. EPA

I. **Where are brominated diphenyl ethers used?**

Brominated diphenyl ethers are recommended for use in the following resins:

ABS
acrylic
cellulose acetate
epoxy
nitrile
phenolic
polycarbonate
thermoset polyester
polyethylene
polypropylene
polystyrene
polyvinyl acetate
polyvinyl chloride
polyurethane
polybutylene terephthalate
polyethylene terephthalate
nylon

A. For the above resins:

1. Which of these resins actually use deca-, octa-, or pentabromodiphenyl oxide?

RESIN	Use of Brominated DPE */		
	DECA	OCTA	PENTA
ABS		X	
epoxy	X		
phenolic	X		
thermoset polyester	X		
polyethylene	X		
polypropylene	X		
polystyrene	X		
polyurethane			X
polybutylene terephthalate	X		
nylon	X		

*/ X = Use
Individual BFRIP members may have different specific responses, depending upon their definition of a use as non-existent or de minimis.

2. Of the resin types containing brominated diphenyl ethers, how many pounds are produced annually?

RESIN	1987 ^{*/} RESIN SALES (MM LBS)	VOLUME OF RESIN CONTAINING BROMINATED DPE (MM LBS)	%CONC. OF Br DPE	BROMINATED DPE (MM LBS)
ABS	1,194			
epoxy	404			
phenolic thermoset	2,764			
polyester	1,315			
polyethylene	17,323			
polypropylene	6,472			
polystyrene	4,857			
polyurethane	2,681			
polybutylene terephthalate	1,800			
nylon	471			

3. Of those resins in number 2, how many pounds produced are of flame retarded grades?

This information is not publicly available. Individual BFRIP member companies have proprietary estimates. However, approximately 1% of the total resin volume contains brominated DPEs.

4. How many pounds of the flame retarded grades of each resin type use decabromodiphenyl oxide? How many pounds use octabromodiphenyl oxide? How many pounds use pentabromodiphenyl oxide?

This information is not publicly available. Individual BFRIP member companies have proprietary estimates.

^{*/} Source: Modern Plastics, Vol. 65, No. 1, Jan. 1988, p. 95.
M = 1,000
MM = 1,000,000

-3-

5. At what concentrations are the diphenyl ethers used in each resin?

This information is not publicly available. Individual BFRIP member companies have proprietary estimates.

B. For what specific product components (e.g., housings, electrical connectors, distributor caps) and final products (e.g. televisions, mixers, automobiles) are the resins containing diphenyl ethers used? How many pounds of each resin type containing diphenyl ethers is used for each of these products?

As to specific product components, see the chart below. The pounds used for each application are not publicly available. In consumer products, resins containing brominated DPES are typically used in interior parts, minimizing the potential for public exposure. The incorporation of the brominated DPES into the polymer matrix further reduces the possibility for exposure.

<u>RESIN</u>	<u>PRINCIPAL APPLICATIONS</u>	<u>EXAMPLES OF FINAL PRODUCTS</u>
ABS	Molded parts	Interior parts of cars, TVs, Small appliances, Business machines
epoxy	Circuit boards, Protective coatings	Computers, Ship interiors, Electrical parts
phenolic	Printed circuit boards	Electronic parts
thermoset polyester	Circuit boards, Coatings	Electrical equipment, Coatings for chemical processing plants, Marine applications
polyethylene	Cross linked wire and cable, Foam tubing, Weather protection and moisture barriers	Power cable, Building, Shipboards, Automotive

polypropylene	Conduits, Electronic devices	TV, Electro- mechanical, Under- ground junction boxes, Electrical parts
polystyrene	TV cabinets and back covers, Electrical appliance housings	TVs, Computers, Electrical appliances, Smoke detectors, VCRs
poly- urethane	Cushioning materials, Packaging, Padding	Interior components of furniture, Transportation
polybutylene terephthalate	Electrical connectors and components	Stereos, Computers, Business machines, Military electronics
nylon	Electrical connectors, Automotive interior parts	Computers, Appliances, Transportation

II. Who are the users of brominated diphenyl ethers?

A. How many firms buy brominated diphenyl ethers?

The total number of U.S. users for these products is estimated to be between 200-300, with the great majority of these purchasing less than 100M lbs. per year. Ninety percent of the total consumption can be accounted for by twenty-five users.

1. **How many of these are resin compounders? How many pounds of diphenyl ethers might a compounder use in a year?**

Approximately 150 are compounders. The very largest of these consume about 1MM lbs. per year. The vast majority buy less than 100M lbs. per year. The very smallest use a few thousand pounds.

2. **How many of these are extruders/molders/foam blowers who do their own resin compounding? How many pounds of diphenyl ethers might each use in a year? What products do they make?**

There are approximately 20-30 foam producers, 30-50 extruders, and 40-60 molders who do their own resin compounding. There are no million pound per year users in this category. Most use under 100M lbs. per year. Flexible foam manufacturers are the largest group in this category. The foams are intended for furniture and other cushioning uses. Extrusion products include wire and cable, paper/plastic/foil laminates, & adhesive tape. Molding applications include business machine housings, automotive interior parts, and small appliance housings.

3. **How many of these are resellers?**

There are no resellers.

III. What are the likely substitutes for brominated diphenyl ethers?

- A. **What do you believe are the best substitutes for each of the brominated diphenyl ethers in each resin system?**

1. **How do the substitutes compare with diphenyl ethers in terms of flame retardant properties?**

April 21, 1988

-6-

2. **How do the substitutes compare with diphenyl ethers in terms of plastic properties (i.e., are there any impacts on resin performance when the flame retardant is changed)?**

There are over 20 different flame retardant chemical molecules now manufactured commercially. There are available chlorinated flame retardants and a variety of phosphorus and phosphorus/halogen based materials. No flame retardant chemical is totally satisfactory for a particular use. All have technical deficiencies which require the end user to make some compromises in performance. The primary challenge is finding a flame retardant which is both effective as a flame retardant and does not affect key strength properties, aging and processing characteristics, esthetics of the product or significantly increase the cost. It is in these areas that most substitutes fall short. For instance a designer may have to compromise his impact strength or tolerate a lower heat distortion temperature to retain the original appearance or color stability of the resin system. Of course, cost compromises are also a factor.

Decabrom is a very efficient flame retardant, has good thermal stability, low toxicity, and relatively low cost.

Octabrom is high in bromine content, has excellent retention of properties and is thermally stable.

Pentabrom has excellent thermal stability and less tendency to smolder, compared to alternatives used in flexible polyurethane foams.

- IV. **What would be the impacts on production facilities of a transition from the use of brominated diphenyl ethers to the use of other flame retardants?**

The impact will vary depending upon the type of equipment available to the producer. It will also depend upon the specific flame retardant in question and the nature of the chemical used as a substitute.

- A. **What is the feasibility of shifting current production facilities used to manufacture brominated diphenyl ethers to the production of substitutes?**

April 21, 1988

-7-

1. **What process/equipment change would be necessary?**

Production facilities for the brominated DPE's are for the most part dedicated and designed specifically for the process and physical form of these products. The closer a substitute is to the brominated DPE's, the less will be the capital cost to modify the facilities. At a minimum, a new substitute would require re-piping, possible change in controls, changes in materials of construction in auxiliaries, or changes in driers, solvent recovery, etc. In many cases a new plant may have to be constructed. Generally some individual pieces of equipment can be used in manufacture of another chemical, but a redesign of a plant is necessary.

2. **What would be the cost of making these changes?**

A specific answer is not possible. Generally the cost is high to convert a manufacturing facility for production of a different chemical. Assuming very minor plant changes, setting up a permanent production capability for a substitute product would likely cost \$1MM-3MM. Major modifications to accommodate a substitute product could amount to \$5MM-10MM. A new grass roots plant for a substitute product of moderate complexity would cost between \$10MM-15MM. However, these costs do not include new product development costs, which includes extensive toxicological testing. These costs can add an additional \$2MM-5MM to the capital investment.

3. **How long would it take to make these changes?**

Timing to complete minor modifications would be 6-9 months, major modifications 9-14 months and grass roots plant 1 to 2 years. Product development activity could add another 2-3 years.

B. **What machinery changes may be necessary for resin compounders as a result of resin reformulations? What would be the costs and time involved in making these changes?**

The answer to this question is generally beyond our expertise, but estimates of machinery changes for compounders might serve as an example.

April 21, 1988

-8-

Examples of Minor Changes

- a. Heating Capacity For Extruder
- b. Changing Screw \$20M-50M
- c. Modification Of Take-Off Equipment

Example of Major Changes

- a. New Pelletizer
- b. Conversion To Other Extruder \$100M-1.5MM

- C. What machinery changes may be necessary for extruders/molders/foam blowers as a result of resin reformulations? What would be the costs and time involved in making these changes?

The answer to this question is generally beyond our expertise, but estimates of machinery changes for molders might serve as an example.

Example Of Minor Changes

- a. Screw Design
- b. New Mold \$20M-50M

Examples Of Major Changes

- a. New Materials Of Construction - Molding Machine \$500M-10MM
- b. New Molding Machine

- D. Would any interruptions in the production of end products result from the replacement of diphenyl ethers with other flame retardants?

Yes. The time for the reformulation, testing and regulatory approval as well as availability of flame retardant production equipment would vary from application to application. Given sufficient lead time, an orderly change could be made within 2-5 years without interruptions.

- V. What would be the cost of reformulating resin products to switch from brominated diphenyl ethers to other flame retardants?

The complex process of reformulating flame retardant plastics involves technical cooperation at all levels of the industry: flame retardant producers, polymer producers

April 21, 1988

-9-

and compounders, molders, and end users. Not only must the end use meet other performance standards (as outlined in Appendix A), but it must comply with a variety of regulatory requirements.

BFRIP does not have information on the costs of reformulating the broad range (and number) of resin products. Further, the following presents a general perspective on the difficulties involved in estimating such costs.

The Recognized Component Directory, a publication from UL, gives some insight into the type and scope of testing that is done on plastic materials. A discussion beginning on page 1017 describes the type of testing that is done, and the book then continues for more than 500 pages, giving the details of test results obtained on many thousands of grades and compositions of plastics. This testing is done at the expense of resin manufacturers and compounders, in order that their customers may know a given plastic is suitable for the intended application. Of course, many of the plastics listed in that book are not flame retarded, and many of the flame retardant grades do not contain brominated diphenyl ethers. On the other hand, a great many of them do contain the chemicals in question.

In another UL publication. The Building Materials Directory, are shown some test methods and results on building materials and assemblies. For example note the report on roofing systems beginning on page 389. Our understanding is that a change in any component of the systems would require retesting of the entire combination. This illustrates the complexity and difficulty in understanding the costs associated with reformulation of a seemingly minor component.

- A. How many total resin products are there currently on the market containing brominated diphenyl ethers which might require reformulation?

BFRIP estimates that there are in the range of 500-1000 such resin products.

- B. What would be the R&D costs per reformulation?

See the general discussion above.

- C. What would be the costs of obtaining UL and other approvals for reformulated products?

Costs for UL-94 approval card are \$75,000-\$100,000.

April 21, 1988

-10-

- D. How much time would it take to reformulate the products and make them available for purchase? How much work has already been done in reformulating resins products to replace diphenyl ethers.

It is estimated that three years are required to develop a new FR polymer formulation before it becomes commercially available. This refers to replacements by known FR molecules, which can be produced on existing production equipment having sufficient capacity. The need to build a new production unit extends the period by at least another year.

In the case of a new molecule, it is estimated that 6-8 years are needed to reach the commercial stage.

These estimates are based on the assumption that no changes are made in the required FR standard.

- VI. What information do you have on brominated diphenyl ethers in Germany?

Use of the brominated diphenyl ethers in Germany continues. BFRIP understands that the German industry has replaced approximately 20% of brominated diphenyl ethers. To the extent that changes have been made, the replacement products are higher cost materials.

The rate of substitution has been slower than originally anticipated. It appears that both the German industry and government have agreed that it is not necessary to make a precipitous withdrawal of these chemicals. Instead, they have decided on a course of further research to better define what, if any, problem exists.

- A. What substitutes are being used by the German industry?

Refer to general discussion above.

- B. Do the U.S. brominated diphenyl ethers, importers/manufacturers or their European subsidiaries export to Germany? What substitutions have been made?

Yes. Refer to general discussion above.

April 21, 1988

-11-

VII. What sort of inventories are kept of flame retardants and resins?

- A. How much of an inventory of brominated diphenyl ethers is kept by the flame retardant manufacturers at any one time? How much is kept by resin compounders (i.e., how many weeks' supply)?

Flame retardant manufacturers normally keep about 30 to 90 days ~~days~~ of sales on hand. We estimate that the resin manufacturers keep approximately 30 days of sales on hand.

- B. How much of an inventory of the potential substitutes for brominated diphenyl ethers is kept at any one time?

Because the potential substitutes are not fully commercial, inventories would be expected to be limited.

- C. How much of an inventory of compounded resins containing diphenyl ethers is kept by resin compounders and by their customers at any one time?

This information is not available to BFRIP.

APPENDIX A

CRITERIA FOR SELECTING A FLAME RETARDANT

- IS IT EFFECTIVE?
- COST/EFFECTIVENESS
- HEAT STABILITY
- PERMANENCE
- EFFECT ON PHYSICAL PROPERTIES
- BLOOM/PLATE OUT
- LIGHT STABILITY
- COLOR
- ELECTRICAL "PURITY"
- SMOKE GENERATION
- LIQUID vs. SOLID
- REACTIVE vs. ADDITIVE
- COMPATABILITY WITH PLASTIC
- EFFECT ON MOLDABILITY OF PLASTIC
- SURFACE EFFECTS/APPEARANCE