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Number of Images	23	
Descripton Notes		

M77

H E R B I C I D E   O R A N G E

DISPOSAL OF 2.3 MILLION GALLONS OF DEFOLIANT

PROJECT ASSIGNED TO AF LOGISTICS COMMAND

USAF OEHL RESPONSIBLE FOR:

- EVALUATING METHODS OF DISPOSAL
- PREPARING ENVIRONMENTAL STATEMENT
- COMPREHENSIVE DURING DISPOSAL/RECLAMATION

METHODS OF DISPOSAL

CONSIDERED-REJECTED

CAUSES FOR REJECTION

- ECOLOGICAL DANGERS
- TIME
- COST
- LOCATION OF SITE (FACILITY)
- ADVERSE POLITICAL REACTION

M78

METHODS

RETURN TO MANUFACTURERS:

SEVEN MANUFACTURERS REFUSED TO ACCEPT MATERIAL

- REPROCESSING CAPABILITY NOT AVAILABLE
- CAPITAL INVESTMENT COST - EXCESSIVE
- LEAD TIME - 18 MONTHS MINIMUM

DEEP (INJECTION) WELL DISPOSAL:

- ECOLOGICAL RISK (MIGRATION)
- LOSS OF CONTROL OVER MATERIAL
- MINIMAL DATA ON DEGRADATION AT PRESSURES AND TEMPERATURES ENCOUNTERED
- APPROVAL BY REGULATORY AGENCIES - ACTIONS VARIABLE, UNCLEAR

METHODS (CONT'D)

FRACTIONATION:

- ESSENTIALLY A DISTILLATION PROCESS
- FRACTIONATION EFFICIENCIES OF 90-95% CLAIMED
- HOWEVER, FATE OF TCDD UNKNOWN
- EMISSIONS TO ENVIRONMENT UNKNOWN
- EXTENSIVE RESEARCH REQUIRED
    - TIME
    - COST

NO DISPOSAL ACTION:

- "LAST RESORT"
- SEMI-PERMANENT STORAGE
- ADVANTAGES:
  - ELIMINATE COST OF REDRUMMING
  - ADVANCES IN TECHNOLOGY WOULD OCCUR
- DISADVANTAGES:
  - COST OF CONSTRUCTION OF TANKAGE, IF REQUIRED
  - COST OF TRANSPORTATION TO STORAGE SITE, IF TANKAGE CURRENTLY AVAILABLE
  - "ORANGE" STILL "ON HAND"

20 METHODS (CONT'D)

21 BURIAL IN UNDERGROUND NUCLEAR TEST CAVITIES:

MAJOR RESEARCH REQUIRED

- TIME
- COST

22 SLUDGE BURIAL:

- NO AVAILABLE COMMERCIAL FACILITIES
- TIME
- COST OF RESEARCH EFFORT
- TIME FOR DEGRADATION -- 10-25 YEARS
- MONITORING REQUIRED
- DEVELOPMENT OF SUITABLE STRAIN(S) OF BACTERIA

M79

ORANGE HERBICIDE DISPOSAL HIGHLIGHTS

1940s	PHENOXYACETIC ACIDS DEVELOPED AS HERBICIDES
1960 - 61	HERBICIDE ORANGE DEVELOPED FOR DOD
1962 - 69	HO USED IN VIET NAM AS DEFOLIANT
1969 - 70	TCDD IN 2,4,5-T TERATOGENIC
APR 1970	DOD SUSPENDS USE OF HO
OCT 1971	AFLC DESIGNATED OPR FOR DISPOSAL
APR 1972	VIET NAM STOCKS MOVED TO JOHNSTON ATOLL CONUS STOCKS REMAIN AT NCBC

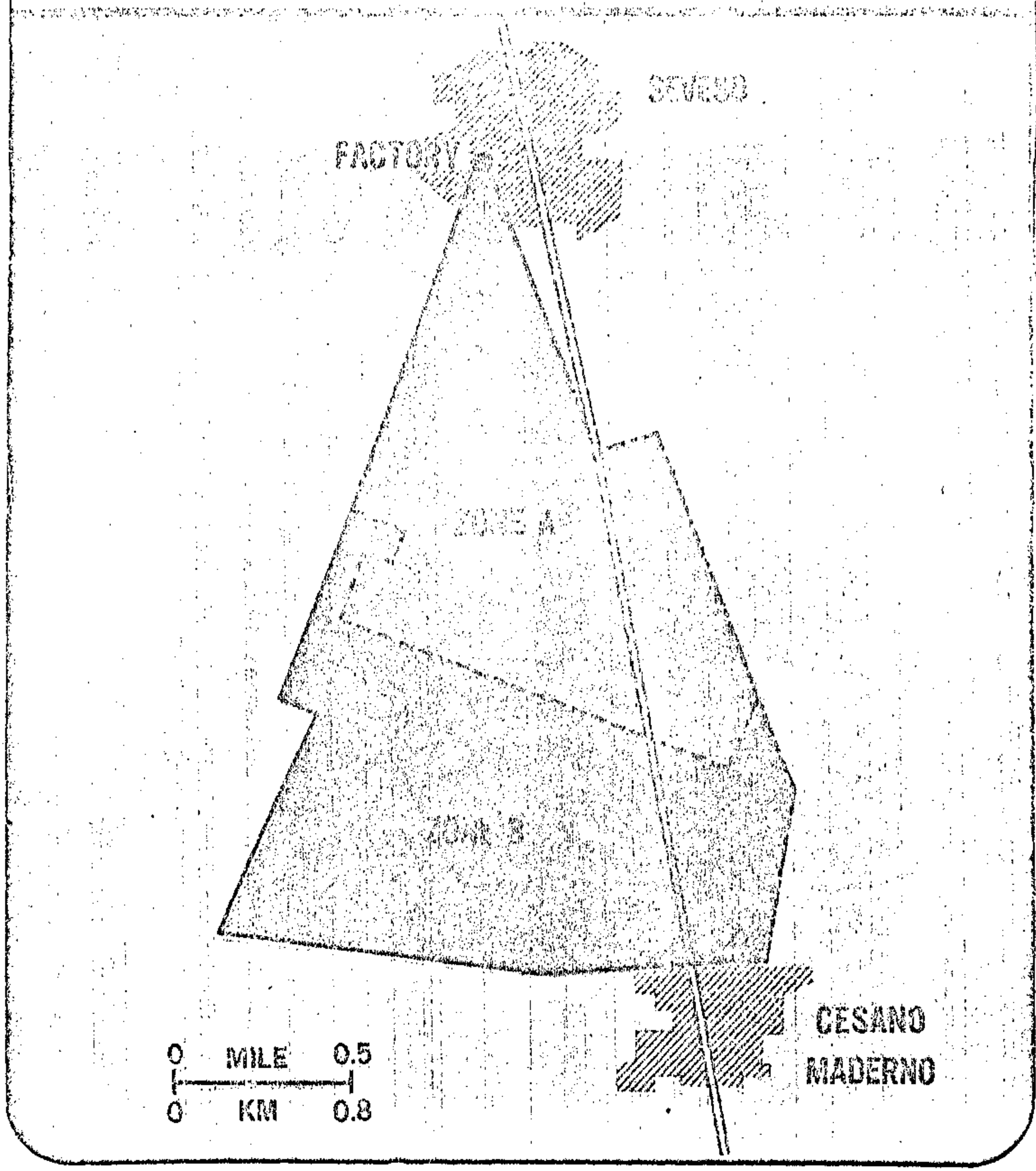
1970 - 72	EHL TECH REPORT, INCINERATION, MONITORING, ANALYTICAL PROCEDURES
JAN 1972	DRAFT ENVIRONMENTAL IMPACT STATEMENT (EIS) PREPARED BY FUELS DIVISION, KAFB
13 APR 1973	KELLY EHL DESIGNATED OPR FOR EIS PREPARATION
APR 73 - MAR 74	EHL PREPARES CANDIDATE EIS -- LAND BASED INCINERATION
MAR - MAY 74	EHL PREPARES DRAFT EIS -- INCINERATION LAND OR SEA
MAY - DEC 74	EHL PREPARES FINAL EIS -- INCINERATION AT SEA
DEC 74 - FEB 75	PUBLIC HEARINGS HELD EPA DIRECTS INVESTIGATION OF REPROCESSING

DISPOSAL HIGHLIGHTS (CONT'D)

FEB 75 - JUL 76	REPROCESSING STUDIES	
	OCT - NOV 75	ACI INCINERATOR FAILS
	JAN - FEB 76	ACI INCINERATOR FAILS
	JUNE 76	ADSORPTION PROVEN
SEP - OCT 76	EHL PREPARES AMENDMENT TO EIS	
NOV - DEC 76	PILOT PLANT CYLINDERS MOVED TO JOHNSTON ISLAND	
DEC 76	MOA BETWEEN AF AND DLA SIGNED	
JAN - FEB 77	EHL PREPARING REVISED AMENDMENT TO EIS	

DISPOSAL HIGHLIGHTS (CONT'D)

FEB 75 - JUL 76	REPROCESSING STUDIES		
	OCT - NOV 75	ACI INCINERATOR FAILS	
	JAN - FEB 76	ACI INCINERATOR FAILS	
	JUNE 76	ADSORPTION PROVEN	
SEP - OCT 76	EHL PREPARES AMENDMENT TO EIS - PROPOSED REPROCESSING		
NOV - DEC 76	PILOT PLANT CYLINDERS MOVED TO JOHNSTON ISLAND		
MAR 77	DECISION TO INCINERATE/NOT REPROCESS		
APR 77	EPA ISSUED RESEARCH INCINERATION PERMIT		
JUL 77	RESEARCH INCINERATION UNDERWAY		


FACTORY
CESANO
MADERNO
0 MILE 0.5
0 KM 0.8

D I S P O S I T I O N

DESTRUCTION

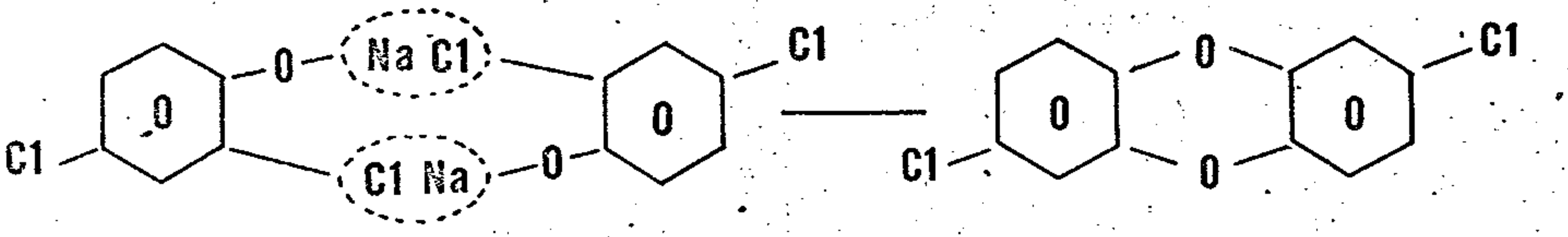
1. INCINERATE AT SEA
2. INCINERATE AT JOHNSTON ISLAND
3. CONVENTIONAL INCINERATION IN CONUS
4. DEEP (INJECTION) WELL DISPOSAL
5. BURIAL, NUCLEAR TEST CAVITIES
6. SLUDGE BURIAL
7. MICROBIAL REDUCTION
8. FRACTIONATION
9. CHLORINOLYSIS
10. SOIL BIODEGRADATION

PRODUCT RECOVERY

1. USE, ISOLATED AREAS, CONUS
2. USE, AFTER TCDD REMOVAL
3. RETURN TO MANUFACTURERS
4. NO DISPOSAL ACTION

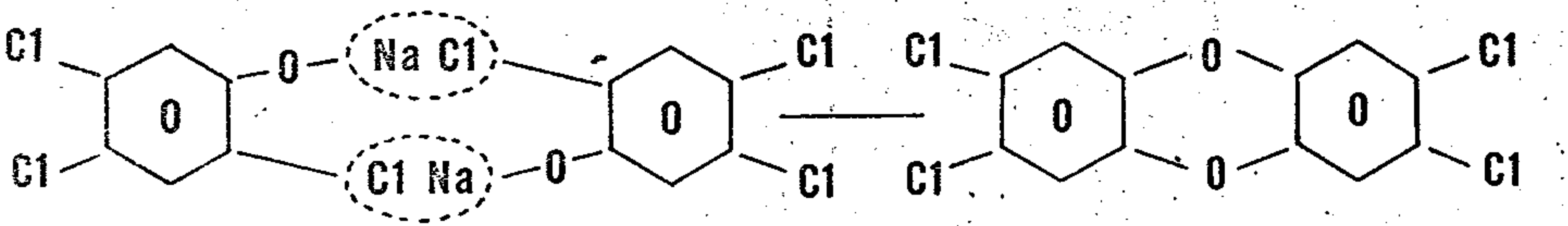
FIGURE 2

FORMATION OF DIBENZO-P-DIOXINS
FROM THE CORRESPONDING CHLOROPHENOLS



2,4-dichlorophenol

2,7-dichlorodibenzo-p-dioxin



2,4,5-trichlorophenol

2,3,7,8-tetrachlorodibenzo-p-dioxin

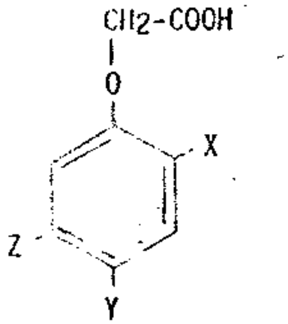
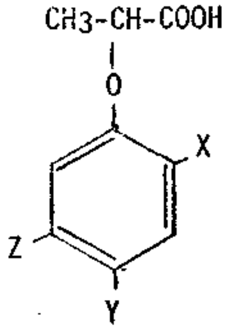
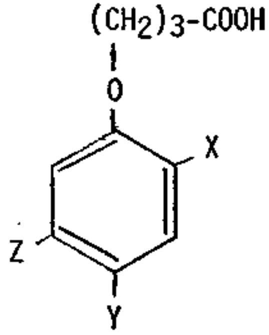
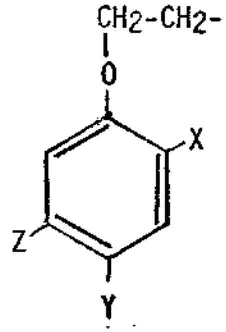
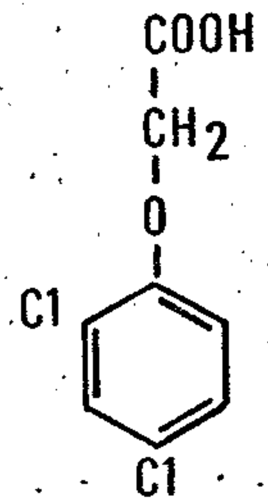
ACETIC ACID	PROPIONIC ACID	BUTYRIC ACID	PHENOXYETHYL ESTER
			
MCPA [(4-Chloro-o-tolyl)-oxy] acetic acid $X-CH_3$ Y=Cl Z=H	MCPP, Mecoprop 2-[(4-Chloro-o-tolyl)-oxy] propionic acid $X=CH_3$ Y=Cl Z=H	MCPB 4-[(4-Chloro-o-tolyl)-oxy] butyric acid $X=CH_3$ Y=Cl Z=H	$-O-SO_2-O-Na$ MCPES 2-[(4-Chloro-o-tolyl)-oxy] ethyl sodium sulfate $X=CH_3$ Y=Cl Z=H
2,4-D (2,4-Dichlorophenoxy)-acetic acid X,Y=Cl Z=H	2,4-DP, Dichlorprop 2-(2,4-Dichlorophenoxy)-propionic acid X,Y=Cl Z=H	2,4-DB 4(2,4-Dichlorophenoxy)-butyric acid X,Y=Cl Z=H	$-O-SO_2-O-Na$ Sesone 2-(2,4-Dichlorophenoxy) ethyl sodium sulfate X,Y=Cl Z=H
2,4,5-T (2,4,5-Trichloro-phenoxy)-acetic acid X,Y,Z=Cl	Silvex 2-(2,4,5-Trichlorophenoxy)-propionic acid X,Y,Z=Cl	2,4,5-TB 4-(2,4,5-Trichlorophenoxy)-butyric acid X,Y,Z=Cl	$-O-SO_2-O-Na$ 2,4,5-TES 2-(2,4,5-Trichlorophenoxy) ethyl sodium sulfate X,Y,Z=Cl

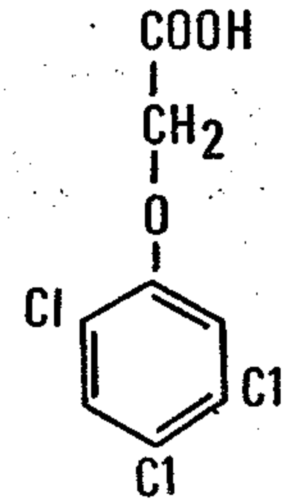
TABLE 1

COMMON PHENOXYALKANOIC ACID HERBICIDES



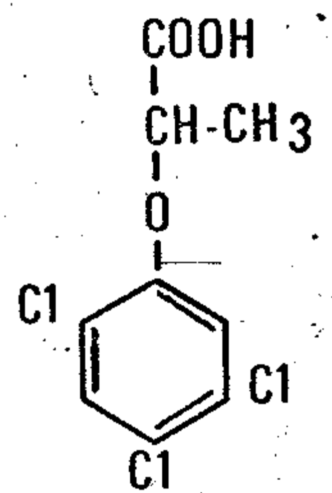
24D

2,4-dichlorophenoxyacetic acid



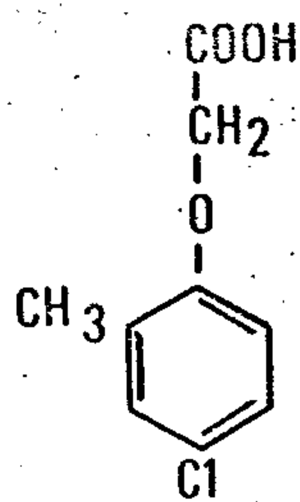
2,4,5-T

2,4,5-trichlorophenoxyacetic acid



Silvex

2-(2,4,5-trichlorophenoxy)-propionic acid

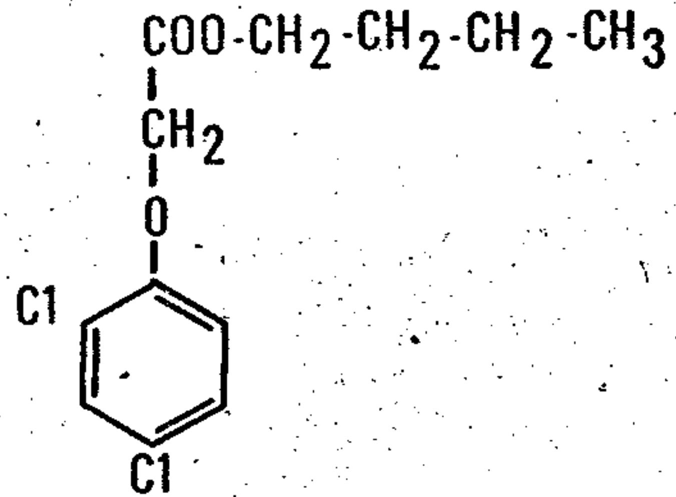


MCPA

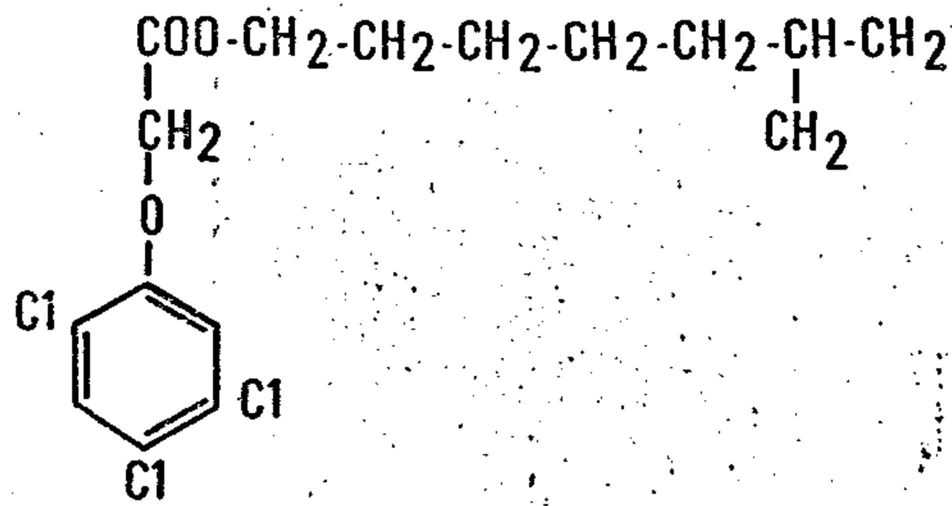
2-methyl-4-chlorophenoxyacetic acid

TABLE 2

ESTERS OF 2,4-D AND 2,4,5-T



n-butyl ester of 2,4-dichlorophenoxyacetic acid



iso-octyl ester of 2,4,5-trichlorophenoxyacetic acid

TABLE 3

FORMULATION OF HERBICIDE ORANGE

(BY VOLUME)

N-BUTYL ESTER OF 2,4-D $C_{12}H_{14}Cl_2O_2$	49.40%
NORMAL BUTYL 2,4-DICHLOROPHENOXYACETATE	
FREE ACID OF 2,4-D	0.13%
N-BUTYL ESTER OF 2,4,5-T $C_{12}H_{14}Cl_3O_3$	48.75%
NORMAL BUTYL 2,4,5-TRICHLOROPHENOXYACETATE	
FREE ACID OF 2,4,5-T	1.00%
INERT INGREDIENTS (BUTYL ALCOHOL, ESTERS, ETC.)	0.62%

* ALTERNATE FOR NB 2,4,5-T IS ISO-OCTYL 2,4,5-T,TRICHLOROPHENOXYACETATE $C_{16}H_{21}Cl_3O_3$

PHYSICAL, CHEMICAL AND TOXICOLOGICAL PROPERTIES OF ORANGE

1. MOLECULAR WEIGHTS:

	NB 2,4-D	277.15
	NB 2,4,5-T	311.60
	IO 2,4,5-T (IO)	367.71

2. SPECIFIC GRAVITY ($20^o/20^o$): 1.275 - 1.295

3. VISCOSITY, CENTIPOISE (23^oC): 43

4. FREEZING POINT: 45^oF

5. FLASH POINT: 295^oF

6. VAPOR PRESSURE: 3.6×10^{-4} MM HG (35^oC)

PHYSICAL, CHEMICAL AND
TOXICOLOGICAL PROPERTIES OF ORANGE
(CONTINUED)

7. FORMULATION WEIGHT (LBS/GAL): ~~8.33~~ 10.7

8. SOLUBILITY IN WATER: INSOLUABLE

9. CORROSIVENESS: NONCORROSIVE TO MOST METALS.

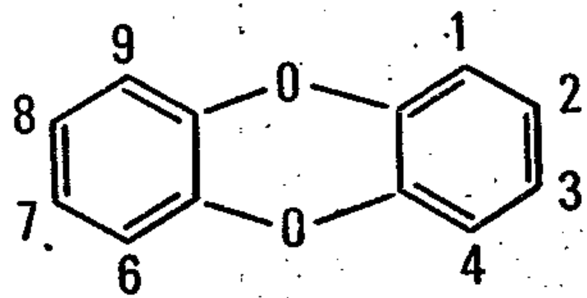
   DELETERIOUS TO SOME PAINTS, NATURAL RUBBER, AND NEOPRENE. TEFLON, VITON, POLYETHYLENE AND BUTYL RUBBER ARE RESISTANT.

10. RELATIVE TOXICITY: LOW

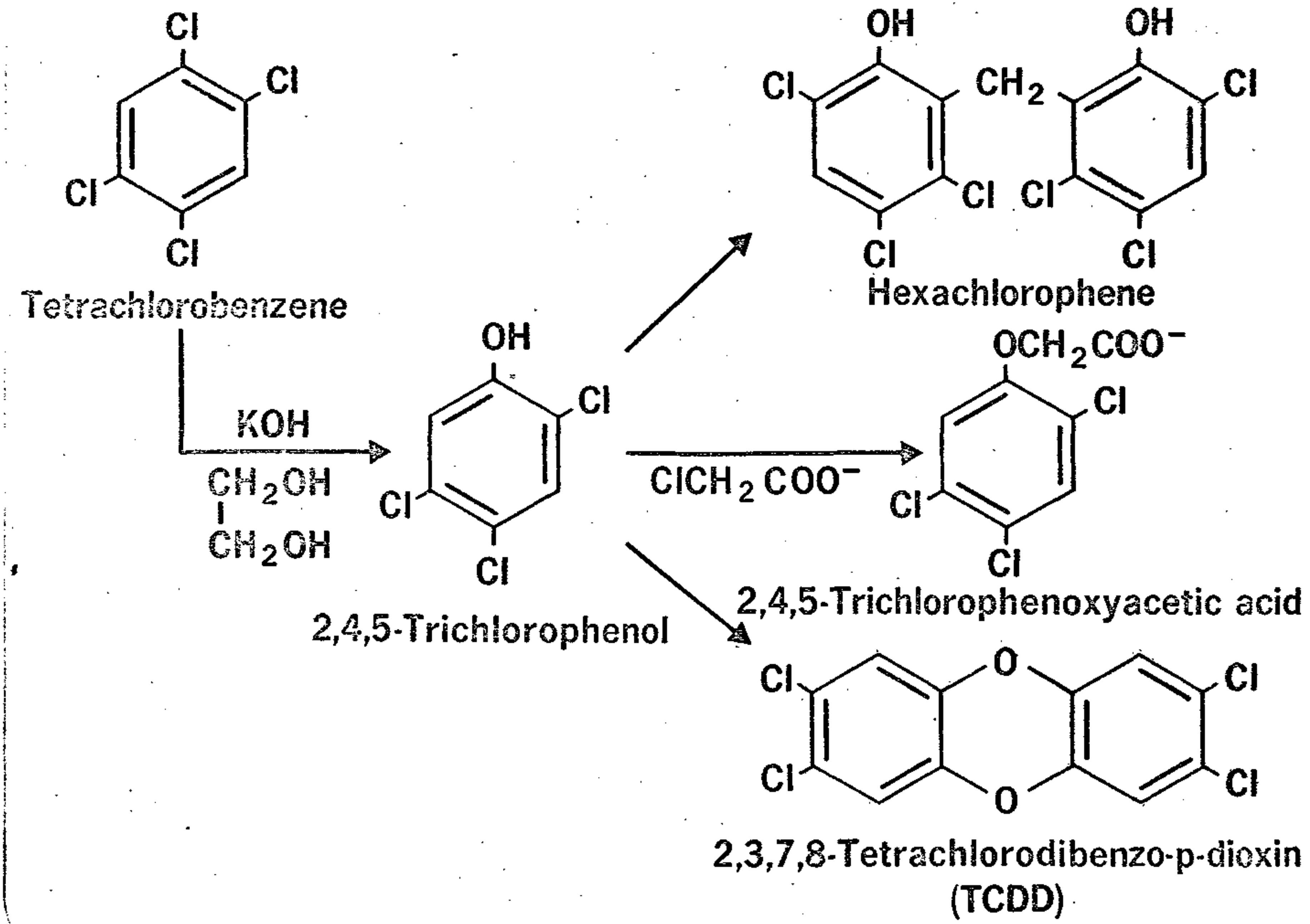
11. DIOXIN CONTENT: <1 TO 47 PPM (KNOWN TO EXIST IN AIR FORCE STOCKS)

FIGURE 1

STRUCTURE OF DIBENZO-P-DIOXINS



FORMATION OF 2,3,7,8, - Tetrachlorodibeno - p - dioxin



M 77

2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN
(TCDD)

Melvin

PHYSICOCHEMICAL PROPERTIES

MOLECULAR WEIGHT - 321.97

MELTING POINT - 303 - 305^{o}C

DECOMPOSITION TEMPERATURE - 800^{o}C

SOLUBILITIES (GMS/.00 GMS)

- O-DICHLOROBENZENE - 0.14
- CHLOROBENZENE - 0.07
- BENZENE - 0.06
- ACETONE - 0.01

ORAL TOXICITY - GENERAL

CLASS	ACUTE ORAL TOXICITY LD50, mg/kg OF BODY WEIGHT	LETHAL DOSAGE FOR 150 lb MAN
HIGHLY TOXIC	50 AND BELOW	FEW DROPS TO 1 TEASPOON
MODERATELY TOXIC	50 TO 500	1 TEASPOON TO 1 OUNCE
MILDLY TOXIC	500 TO 5,000	1 OUNCE TO 1 PINT OR POUND
NONTOXIC	ABOVE 5,000	1 PINT TO OVER 1 QUART