Vaccine Ingredients
Beta-propiolactone

Chemical Analysis

Search

Beta-propiolactone: C3H4O2 An attenuating agent

The vapor is very irritating and the liquid form is carcinogenic. Propiolactone is "reasonably expected to be a human carcinogen." (IARC 1999)Recognized - carcinogen, Suspected - gastrointestinal or liver toxicant, respiratory toxicant, skin or sense organ toxicant. More hazardous than most chemicals in 3 out of 3 ranking systems. On at least 5 federal regulatory lists. Ranked as one of the most hazardous compounds (worst 10%) to humans. Propiolactone was once widely used in the manufacture of acrylic acid and its esters, but its use has been mostly phased out in favor of safer and less expensive alternatives.

Chemical descriptions:

Wikipedia.com http://en.wikipedia.org/wiki/Beta-propiolactone

National Library of Medicine: PubChem
http://pubchem.ncbi.nlm.nih.gov/summary/summary.cgi?sid=10326964

Adverse effects
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?CMD=search&DB=pubmed&term=%22Propiolactone%2fadverse%20effects%22[Mesh%20Terms%3anoexp]

Toxicity
http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?CMD=search&DB=pubmed&term=%22Propiolactone%2ftoxicity%22[Mesh%20Terms%3anoexp]

Scorecard: Pollution Information Site
http://www.scorecard.org/chemical-profiles/summary.tcl?edf_substance_id=57%2d57%2d8

a.k.a. 2-oxatanone Propiolactone, â-propiolactone, 2-oxatanone, Propiolactone

Present in these vaccines:
Rabies Vaccine Adsorbed
Fluvirin – Influenza virus **Hide.**

Learn About
- Specific Vaccines
- Reactions / Conditions
- Vaccine Risks
- Vaccine Ineffectiveness
- Vaccine Ingredients
- How? Why?
- Authorities Speak Out
- Law / Exemptions

Communicate
- Vaccine Blog
- Receive Newsletter
- Send to a Friend
- News and Views

Contribute
- Take a Stand
- Add to the Database
- Testimonials
- Link to WAVE
- Donate

Documentation View in order of **Newest publish date**

Scientific Literature Only

1. **"Neurological complications due to beta-propiolactone (BPL)-inactivated antirabies vaccination. Clinical, electrophysiological and therapeutic aspects."**
"Seventy six patients with neuroparalytic accidents due to antirabies vaccination (ARV) with BPL vaccine were studied.... Fourteen (18.4%) patients died and 6 were autopsied. The pathological features were essentially myeloradiculopathies, with variable degree of encephalic involvement. Two showed distinct necrotising myelopathy of immune type."
Swamy HS, et al, *J Neurol Sci. 1984 Jan;63(1):111-28.* -- 1/1/1984

		TULAREMIA Date	UL	Titer	BRUCELLOSIS Date	US	Titer
Immune ... 2094-13A		3Aug59	Titer (E)	1:20	3Aug59	Titer	Neg
3094-16A	Unk	3Aug59	SK.T 0.1ml 1:1000	Neg	23Jun60	Titer	Neg
		5Aug59	0.25ml 108B	Ra	13June60	Titer	neg.
		6Aug59	0.5ml 108B	RA	13July60	Titer	NEG
		7Aug59	0.5ml 108B	La	7Nov60	Titer	1:25
		25Jan60	Titer (E)	1:40	3Jul61	Titer	1:25
		13June60	Titer (E)	1:20	15May61	Titer	Neg.
		18June60	SK.T.0.1ml 1:1000	Neg	7Aug61	Titer	NEG
		23June60	Live Vaccine #4		31Oct61	Titer	Neg
Titer (WR)	<4	14July60	Titer (E)	1:320	14May62	Titer	neg
P.C7. Titer	Neg	18July60	SK.T.0.1ml 1:1000	E+ED 15X15	29Oct62	Titer	1:25
0.1ml DP2A	Ra	7Nov60	Titer (E)	1:160	14May63	Titer	1:50
min. 0 48hrs. 0		7Nov60	SK.T.0.1ml 1:1000	E+ED 15X20	18Nov63	Titer	Neg
1.0ml DP2A	RA	6Jul61	Titer (E)	1:80	4May64	Titer	Neg.
min. 0 48hrs 0		21Jul61	SK.T.0.1ml 1:1000	E+ED 4X5	30Oct64	Titer	1:25
1.0ml DP2A	La	15May61	Titer (E)	1:80	16Nov64	Titer	neg
min. 0 48hrs. 0		15May61	SK.T 0.1ml 1:1000	Neg	24May65	Titer	neg.
Titer WR	<4	7Aug61	Titer	1:80	2Nov65	Titer.	Neg.
Titer ml	Neg	7Aug61	SK.T.0.1ml 1:1000	E+ED 12X17mm	2May66	Titer	Neg
P.C7. Titer	Neg	31Oct61	Titer	1:40	7Nov66	Titer	Neg
C7 Titer	Neg	31Oct61	SK.T.0.1ml 1:1000	E+ED 10X12mm	15May67	Titer	neg
C7 Titer	1:5	14May62	Titer	1:80	20Nov67	Titer	neg
C7 Titer	Neg	14May62	SK.T.0.1ml 1:1000	E+ED 18X20mm			
C7 Titer	Neg	29Oct62	Titer	1:160			
C7 Titer	neg	29Oct62	SK.T.0.1ml 1:1000	E+ED 6X10mm			
C7 Titer	Neg	14May63	Titer	1:80			
C7 Titer	Neg	14May63	SK.T.0.1ml 1:1000	E+ED 8X14mm			
		18Nov63	Titer	1:80			
		18Nov63	SK.T.0.1ml 1:1000	Neg			
		4May64	Titer	1:80			
		4May64	SK.T.0.1ml 1:1000	E+ED 4X6mm			
		12Oct64	Titer	1:160			
Histo		12Nov64	SK.T.0.1ml 1:1000	E+ED 4X18mm			
SK.T.0.1ml 1:100	3+3+	16Nov64	Titer	1:80			
Pos.	E+I	24May65	Titer	1:40			
SK.T.0.1ml 1:1000	20X22	24May65	SK.T.0.1ml 1:1000	E+ED 18X22mm			
Time (Histo)		2Nov65	Titer	1:80			
		2Nov65	SK.T.0.1ml 1:1000	E+ED 4X10mm			
		2May66	Titer	1:40			
		2May66	SK.T.0.1ml 1:1000	E+ED 25X34			

VEE Date			Titer
12Oct64	WR	Nas.	<10
12Oct64	ml	Neo	<1:10
27Oct64	0.5ml TC 83	[illegible]	[illegible]
16Nov64	Wearmu	Nas	160
16Nov64	ml	Nas	1:40
24May65	ml	HAI	1:160
2Nov65	Nas	ml	1:40
2May66	Nas	ml	1:20
7Nov66	NHI	mI	1:20
15May67	Nas	ml	1:40
20Nov67	Nas ml		1:10

Influenza

Date	
15Oct62	1.0ml Type A+B

PPD Date		
29Oct62	Intermediate	neg

Tetanus

Date	
31Oct61	0.5ml Toxoid
27Nov61	0.5ml Toxoid
15Sept66	0.5ml Tet Toxoid

NK DOROTHY K. S-0?

JAN FEB | APR MAY | JUL AUG

CONSENT TO INOCULATION WITH EXPERIMENTAL BIOLOGICAL PRODUCTS

It has been explained to me that it is necessary for my safety and protection to be inoculated with certain biological products approved by the Army Investigational Drug Review Board but not yet approved by the Commissioner of Food and Drugs, Department of Health, Education and Welfare. I understand that the administration of these products will provide future additional evidence of their safety and usefulness.

I hereby consent to inoculation with any or all of the following biological products to include the initial series and booster immunizations as required:

1) Venezuelan Equine Encephalomyelitis Vaccine, Live, Attenuated.
2) Live Tularemia Vaccine.
3) Anthrax Vaccine (non-viable), aluminum hydroxide adsorbed.
4) Botulinum Toxoid, Types A B C D E, aluminum phosphate adsorbed.
5) Tularemia Skin Test Antigen.
6) Rift Valley Fever Virus Vaccine.
7) Q Fever Vaccine
8) Eastern Equine Encephalomyelitis Vaccine.
9) Western Equine Encephalomyelitis Vaccine.

WITNESSES.

21 May 1965 _____ _____
(Date) (Signature) (Signature)

21 May 1965 _____ _____
(Date) (Signature) (Date)

SMUFD FORM 8 Rev.
May 65

SPECIAL PROCEDURES RECORD

Wilmington, Mass.

TULAREMIA

7 Nov 66	Titer	1:40
7 Nov 66	S.K. T. 0.1 ml 1:1000	25x24 Eden.
15 May 67	Titer	1:40
15 May 67	S.K. T. 0.1 ml 1:1000	25x30 Stfd.
26 Nov 67	Titer	1:80
26 Nov 67	Sk. T. 0.1 ml 1:1000	18x18 Stfd.

6/13/65 Temp. 97 Pulse 76
Improved: All sx subsided. Sl. headache only. No complaints.
Used 3 Darvons only. No GU sx.
P.E.: Throat - N.R.
No cervical adenopathy
Imp.: Same
Rx.: As given
Home

EXPOSURE

8/12/65 Individual had an exposure to Beta-propiolactone in Bldg. 560/
Accidental decontamination procedures without clearing individuals from the area.
(Informed this office via phone)
Lacrimation & irritation of eyes.
Rx.: Observation

9/16/65 Temp: 98.2 Pulse: 88
Rhinorrhea, clear. Pruritis of eyes
Imp.: Allergic rhinitis
Rx.: Ornade b.i.d.
Duty

6/2/66 Temp: 98.6 Pulse: 88
Sneezing - sore throat Thursday. Rhinorrhea. No cough.
P.E.: Throat - slight injected
Neck - N.R.
Imp.: Viral URI
Rx.: Emprazil
Cepacol
Duty

3/3/67 Temp.: 99.2 Pulse: 88
Cold - 2 days. Stuffy nose, rhinorrhea, yellow. Sneezing - lacrimation. Cough, productive of yellow sputum. Headache and neck ache and stiffness. Slight fever. Secretary.
P.E.: Throat - mod. pallor and edema.
No cervical adenopathy
Imp.: Coryza
Rx.: Emprazil (36)
P.E.M. (4 oz.)
Duty

3/6/67 Rx.: P.E.M. (4 oz.)
Duty

5/67 did not report for May 67 Chest X-ray & Mantoux.

1/18/65 Temp. 97.4 Pulse 80
Cold - onset 3 days. Rhinorrhea, yellow. Sore throat. Cough - non-productive. Slight headache.
Px: Throat - Mild inflam. and ed. No cerv. aden.
Imp: Coryza
Rx: Emprazil (18)
Privine HCl 0.1%
E.T.H. with codeine (4 oz.)
Duty

1/20/65 Temp. 97.4 Pulse 84
Head still stuffy. Min. cough. Marked malaise.
P.E.: Throat - mild inflammation and edema. No cervical adenopathy
Imp.: Coryza
Rx.: Emprazil (18)
Tetracycline 250 mg q.i.d. x4
Duty

5/5/65 Recheck x-ray of chest compared with film taken on 3 Sept 64 shows no significant change.

5/17/65 Temp. 100.6 Pulse 110
Chills - 4 hrs. ago. Feverish. Headache. Gen. aches, muscles. Mild nausea - no vomiting. No coryzal sx. Hoarseness (painting in 560) Secretary in Building. No cough. Sl. dizziness - 12 hrs. ago. No shots recently. Marked weakness.
P.E.: Throat - pallor & mod. edema
No cervical adenopathy
Imp.: Grippal syndrome
Rx.: Darvon comp. (18)
Home

LAB - WBC: 14,700
DIFF: N 60, Bands 15, L 22, M 3
HEMAT: 40
HGLO: 11.8
SED RATE: 21 CSR: 19
CRP: Negative

URINALYSIS - Color app: Light yellow - hazy
Reaction: 6.0
Spec. gravity: 1.009
Albumin: Neg
Sugar: Neg
Microscopic: 0-1 WBC/HPF
10-25 EPI/HPF
SEDIMENT/moderate urates
Heavy bacteria

continued 9/3/64
WBC: 7600
DIFF: N 51, L 48, E 1
SED RATE: 10
HEMAT: 42
HGLO: 12.4

9/9/64 Temp. 99 Pulse 100
Coryza-like Sx. No chills or fever.
P.E.: Throat - clear
Imp.: Coryza
Rx.: Emprazil 2 q.i.d.
Duty

10/30/64 Sore in mouth for 5 days.
P.E.: Ulceration on inner aspect of lower lip.
Imp.: Probable herpes
Disp.: $\frac{1}{2}$ H_2O_2 wash
Viscous xylocaine
Mycostab

12/11/64 Temp. 98 Pulse 96
Onset - throat soreness and thickness. Nausea. Chills, mild. No stuffy nose or rhinorrhea. Headache, front, mod.
P.E.: Throat - lymphoid hyperplas. post pharynx. Pallor and sl. edema. No cervical adenopathy.
Imp.: Incipient coryza
Rx.: Emprazil (18)
Privine HCl 0.1% ($\frac{1}{2}$ oz)
Duty

Throat culture (pred flora) Heavy growth of alpha Strept,
heavy growth of Neisseria,
Few colonies of gamma Strept.

10/24/63 continued:

WBC: 10,200
DIFF: N 68, Bands 1, L 25, M 4, E 1, Baso 1
SED RATE: 10
HEMAT: 38
HGLB: 12.1
CRP: Neg

Heterophile aggluts: No titer

10/25/63 Doing much better. Sore throat is less.
Rx.: Same
Recheck Monday
Duty

4/24/64 Temp. 98.6 Pulse 88
Non productive cough. Sl. rhinorrhea. No sore throat. Yellowish nasal drainage. No chills, fever or aches. Onset 24 hrs. Secretary - Eigelsbach.
P.E.: Throat - not remarkable
No cervical adenopathy
Imp.: Coryza
Rx.: Pbz Exp Mix (4 oz)
Emprazil
Duty

4/28/64 Pyribenzamine exp mix Disp
Sig ZI or II q 3-4 hr for cough

8/24/64 Recheck x-ray of the chest compared with film dtd 18 June 63 shows no sig. change. Kadull

9/3/64 Temp 98.2 P 80
Cough - sore throat - malaise. Some chest pain & aching.
P.E.: Chest - many fine rhonchi
Imp.: Plurisy - bronchitis
Rx.: Novahistine
Achromycin 250 mg q 4 hr
Duty

Chest X-ray Recheck x-ray of the chest compared with film taken on 24 August 1964 shows no significant change.

C.B.C. Hughes

1/17/63 Temp. 99 Pulse 72
Coughing, coryza, for 5-6 days. No chills or fever. No shots or exposures.
P.E.: Throat and chest clear
Imp.: Coryza
Rx.: Novahistine 2 tsp q.i.d.
Home

6/18/63 Recheck x-ray of the chest compared with the film taken on 25 May 62 shows no significant change.

10/22/ Temp. 97.6 Pulse 80
Sore throat - onset P.M. of 10-21-63. No coryzal symptoms. No chills or fever No aches.
P.E.: Throat - pallor - no exudate - mod edema
Cerv nodes - ant - enlarged, non tender
Imp.: Incipient coryza
Rx.: Darvon compound I or II q 6 hr (10)
Tracinets q 3 hr (12)
Warm salt water gargle
Duty

Throat culture (for beta strept)

Heavy alpha strept, heavy neisseria, mod gamma strept

10/23/63 Temp. 98 Pulse 76
Sore throat - aching and tightness in the throat.
P.E.: Throat - sl red
Imp.: Viral pharyngitis
Rx.: Same
Duty

10/24/63 Temp. 98.4 Pulse 84
Sore throat, nausea, vomited one time. No chills or fever, but cough.
P.E.: Throat-red vesicles
Imp.: Viral pharyngitis
Rx.: Achromycin 250 mg q 6 hr
Novahistine
Home

8/6/62
LAB TESTS RUN:

WBC 4,800
DIFF N 39, Bands 4, L 56, M 1
HEMAT 40
HGLO 12.9
TOTAL RBC 4,300,000

8/7/62 Will consider a repeat RBC and HGLO as well as WBC, etc., in about 2 weeks.

8/21/62 In for repeat blood count. Has been feeling fairly well - except for persistent tiredness.
Rx.: No Rx.
Duty

LAB: WBC 6,750
DIFF N 35, Bands 2, L 61, Mono 2
HEMAT 40
HGLO 12.3
TOTAL RBC: 3.95

8/24/62 Feeling of tiredness may be due to borderline(?) anemia or mild case of infectious mononucleosis
Imp: Borderline anemia
Rx.: Ferrosquels
Duty
LAB: Heterophile Aggluts: NEGATIVE

9/7/62 No significant change.
Rx.: Continue medication as given by Dr. Hughes "Ferrosquels?"
Will obtain repeat RBC, Hglo, Hemat in about 3 weeks.
Duty

9/14/62 Rx.: Ferrosquels #30
Sig. T. b.i.d.

2/1/60 cont. Imp: [illegible] Cold
Rx: Neosynephrine 0.5%
Novahistine with APC q.i.d. x5 days
Cheracol with Codeine 5 cc. q 3 hrs. p.r.n.
Return two days follow-up.
Duty

LAB:

WBC	12,250
DIFF	N 61, L 22, M 2, E 1, Baso 2, Bands 12
SED. RATE	9
HEMAT	42
CRP	Negative

Chest film (PA): Recheck x-ray of the chest compared with the film taken on 25 August 1959 shows no significant change.

2/4/60 Temp. 98.6 Pulse 92
Much improved. Afebrile. Only complaint today is constipation for past five days. Also states that IMD advised "blood counts" be taken 3-4 times a year to check on iron deficiency anemia.
Rx: MOM 30 cc. H.S. p.r.n.
Duty

LAB:

RBC	4.65
HGLO	13.5
HEMAT	42%

7/28/60 Temp. 98.6 Pulse 76
Sorethroat - chest tight. Onset this A.M. Sneezing. No cough, chills or fever.
P.E. Throat - edematous palate and uvula.
Imp: Incipient Common Cold
Rx: Demazin q.i.d. x4
PAC q.i.d. x4
Duty

5/8/61 Recheck x-ray of the chest compared with the film taken 1 February 1960 shows no significant change.

5/25/62 Recheck x-ray of the chest compared with the film taken on 8 May 1961 shows no significant change.

8/6/62 Temp. 98.4 P. 88
Light- headed, dizziness this A.M. Felt well except for two severe headaches. No nausea or diarrhea. Period just being completed. Periods regular -- of normal duration and quantity. Slight onset of headachy symptoms.
P.E.: B.P. 112/78
Pulse 72 (regular)
Imp: Post-menstrual syncope
Rx.: Observe
Home

5/9/56 Temp. 98.4 Pulse 80 BP 118/80 Wt. 116
Sore throat of 3 days duration. No stuffy nose. Chills and fever 24 hours ago. Pains in chest on breathing. Tightens up at night with cough, essentially non-productive.
Working in T-110. Works with [redacted] and [redacted]. - no "hot" agents.
P.E. Throat, mildly injected. No cervical adenopathy.
Rx: - PPA 600,000 units once daily x 3.
PAC and Chlortrimeton 8-12-4-8
E.T.H. with Codeine.
Duty

5/10/56 Soreness at site of injection of pencillin - generalized eruption with itching.
P.E. DErmatitis - generalized with pruritis (penicillin reaction).
Rx: -Chlortrimeton 4 mg. q.i.d.
Duty

8/25/59 Temp. 98.8 Pulse 96
Twenty-six-year-old white female well until last night noted sudden onset of dull, aching, frontal and retrobulbar headache; generalized muscular soreness. Loose, watery stools (no melena) x6, anorexia, generalized malaise, and nausea. Also has some vague tightness of ant. chest, but no pharyngitis, cough, or S.O.B.
Is working in "hot" area now. (Bldg. 1412) Has not been exposed to classified organisms to best of patient' knowlege. No fever, chills, or emesis.
P.E. HEENT--Within normal limits.
Lungs--Clear to P&A
Imp: Gastroenteritis, viral etiology?
Rx: Kaopectate and paregoric 1:1 5 cc. after each loose B.M.
PAC tabs 1 to 2 q 4 hrs. prn
Home

LAB: WBC 9,550
DIFF N 66, L 18, M 4, E 0, Baso 1, Bands 11
SED. RATE 8
HEMAT 44

Serum for acute phase influenza:

X-ray of chest (PA & Lateral): Recheck x-ray of the chest compared with the film taken on June 24, 1959 shows no significant change.

2/1/60 Temp. 99 Pulse 88 BP. 114/68 Wt. 124
Rhinorrhea, nasal stuffiness, slight frontal headache for the past three days. Last night had dry, irritating, non-productive cough. This A.M. has "scratchy" sorethroat attributed to coughing. On clean side of Bldg. 1412 working as secretary. No known exposure to classified organisms.
P.E. ENT -- Edematous, injected nasal mucosa; serous discharge present. Pharynx N.R.
Neck -- Supple. No masses or tenderness
Lungs -- Clear to P&A

UNCLASSIFIED

HISTORY OF THE CHEMICAL WARFARE SERVICE

IN WORLD WAR II

(1 July 1940 - 15 August 1945)

REGRADED TO Unclassified
BY AUTHORITY OF ~~DA FORM 1575~~ SECARMY by THE ... 74
DATED
FROM [illegible]
By: [illegible], CDCC
Date: 18 Sep 75

BIOLOGICAL WARFARE RESEARCH
IN THE UNITED STATES

By

REXMOND C. COCHRANE

Vol. II

EA-S-1089 (71)

Historical Section
Plans, Training and Intelligence Division
Office of Chief, Chemical Corps
November 1947

C, 1 of 1, Lib.
Ft. Detrick Controls
No. 75-FDS-71

Control Approval Symbol
CG-79

UNCLASSIFIED

CHEMICAL PLANT GROWTH REGULATORS

Code letters "LN"

General. In April 1944, the project for the development of chemical agents to destroy or reduce the value of crop plants was activated at Camp Detrick, to be carried out by the Plant Research Branch, ODD. Related projects were undertaken at Beltsville, Maryland, under Dr. J. W. Mitchell of the U.S. Department of Agriculture, and at Ohio State Univers under Dr. M. S. Newman. The objectives of these investigations were to discover new chemicals which might be effective against plants and to determine the amounts of chemical required and the most feasible methods for its application for the destruction of crop plants.

A total of 1,053 different chemical compounds were examined and tested at Camp Detrick. Of these, 226 compounds were synthesized at Ohio State University and most of the rest were prepared at Camp Detrick. Of all compounds tested, the halogenated phenoxy acetic acids and their functional derivatives appeared to be best suited for military purposes.

It was demonstrated in aerial field trials held at Bushnell, Florida between February and April 1945 that complete destruction or severe injur could be accomplished against any herbaceous broadleaf crop with relative

Special Projects Division, CWS, "Plant Growth Regulators" Science, 103 (19 Apr 1946), 469-70.

H.E. Thompson, C.P. Swanson, and A.G. Norman, "New Growth-regulating Compounds. I. Summary of Growth-inhibitory Activities of Some Organic Compounds as Determined by Three Tests," Botanical Gazette, 107 (Jun 1946), 467-507.

M.S. Newman, W. Jones, and M. Renoll, "New Compounds as Plant Growth Regulators," Journal of American Chemical Society, 69 (Mar 1947), 716-23.

small amounts of selected LN agents sprayed from standard M10 chemical spray tanks mounted on tactical aircraft. _/ A recommendation for tactical use of the new crop agents was made to the General Staff in May 1945.

No thoroughly successful approach was made as a result of wartime studies for the destruction of cereal crops by chemical agents, although several compounds appeared promising.

Selection of agents. The studies made at Camp Detrick and under contract in the chemical plant growth regulators were developed from the base laid by many workers on the plant effects produced by hetero-auxin, naphthalene acetic acid, and similar or related compounds. Of the 1,052 compounds examined, only a few were studied at any length. They include:

LN-2	Para monochlorophenoxyacetic acid
LN-8	2,4-Dichlorophenoxyacetic acid
LN-14	2,4,5-Trichlorophenoxyacetic acid
LN-32	2-methyl-4-chlorphenoxyacetic acid
LN-33	isopropyl phenyl carbamate
LN-44	ethyl ester of LN-8
LN-143	normal butyl ester of LN-8
LN-155	allyl ester of LN-2
LN-379	chloride of LN-14

_/ Sp Rpt 12, Crop Destruction by Aerial Sprays. Preliminary Trials (26 Apr 45).

In the tests to determine the relative effectiveness of compounds being examined as crop-destroying agents, the common reference material used was 2,4-dichlorophenoxyacetic acid (hereafter, 2,4-D). With inhib of growth due to the use of 2,4-D designated as 100 percent, comparativ results were obtained by subjecting germinating corn seed to 20 ml. of aqueous solution of each compound to be tested, _/ and kidney-bean plan to 0.02 ml. of an aqueous solution and 0.01 ml. of an oil solution of the compound being tested.

Production. No compound tested surpassed 2,4-D in general effectiveness against a wide variety of crops and as a result, large quantiti of this agent were produced for the numerous greenhouse and field trial which were subsequently carried out. A commercial grade of the compoun purified through the ammonium or alkali metal salt by several recrystal zations from aqueous and alcoholic solutions, was prepared for the Special Projects Division by the Dow Chemical Company of Midland, Michi and the Sherwin-Williams Company.

LN-8, the wartime designation of 2,4-dichlorophenoxyacetic acid, was prepared in bulk as an acid solid (VKA), as an ammonium salt (VKS), and as a liquid (VKL). Vegetable Killer Acid, a granular powder, was

_/ The ability of 2,4-D to inhibit the elongation of the primary root of germinating corn seed provided a bio-assay method for determining unknown low concentrations of 2,4-D. C.P. Swanson, "A Simple Bio-assay Method for the Determination of Low Concentrations of 2,4-Dichlorophenoxyacetic Acid in Aqueous Solutions," Botanical Gazette, 107 (Jun 1946), 507-09.

packaged in paraffined-fiber cartons containing 200 pounds of agent, sufficient to make 500 gallons of 5-percent solution. Vegetable Killer Liquid was prepared on the basis of 24 gallons of tributyl phosphate [1] per 100 pounds of VKA, or in smaller quantities, 0.96 quart per pound of VKA. The final volume amounted to 31.75 gallons, containing 33.8 percent agent by weight or 3.15 pounds of agent per gallon. When prepa: in 55-gallon drums, 170 pounds of VKA were dissolved in 40 gallons of tributyl phosphate, to give a volume of 53 gallons of material weighing 495 pounds. [2] When VKL was ready to be used, it was diluted with dies fuel oil to make 330 gallons of a 5-percent solution of active agent.

Dissemination. The first dispersion tests were made using the M10 airplane spray tank, which held approximately 30 gallons of material. The plants used in these trials were kidney-beans, soybeans, sweet potatoes, oats, rice, and corn. On the basis of the tests, it appeared that the best oil spray was one containing 2.9 percent VKA dissolved in tributyl phosphate and diesel oil, and the best aqueous spray was one containing 2.9 percent VKS in water. [3]

[1] W.B. Ennis, Jr., H.E. Thompson, and H.H. Smith, "Tributyl Phosphate as a Solvent for Preparing Concentrated and Oil-miscible Solutions of 2,4-Dichlorophenoxyacetic Acid and Similar Substances," Science, 103 (19 Apr 1946), 476.

[2] Ltr (S), Tech Dir SPD to C Tech Dept VP, 23 Apr 45, sub: Preparation of VKA. In VP Tech Dept (SPCYF 618.34).

[3] Sp Rpt 12, p. 2.

Three trials were conducted at Granite Peak Installation in June, July and September 1945. In the first, M16 cluster adapters were teste as possible agent containers. They proved unsatisfactory due to mechan cal difficulties which appeared to be constitutional, and no assessment of the effectiveness of the dispersed material could be made. In the second series of trials, the SPD Mark 2 bomb, adapted from the M10A1 cluster container, was examined. The results with this bomb indicated that pattern size and concentration per unit area could be predicted for any given particle size if the wind speed and height of cluster opening were known. / The bomb was considered entirely successful for the purpose for which it had been designed. The third series of trials result in little information due to faulty fuses and indeterminate variations in particle sizes of the material used.

/ The formula developed by Dr. H.C. Weingartner of Division 10, NDRC, for determining the proper height of burst of VKA-loaded clusters, in order to obtain the desired grxound pattern, was: $h = \frac{645}{V} \times \frac{59.7}{0.533}$, with h = height of burst above the ground in feet, and V = mean wind from ground to height of burst in feet per second. The ground pattern obtained with this formula was 645 yards long downwind and 150 yards wide. The formula assumed a charge of 100 pounds of material per cluster, to give uniform coverage of five pounds of agent per acre. See ltr (S), Asst Tech Dir for Mun SPD to CinC GPI, 29 Jun 45, sub: Formula for Determining Proper Height of Burst of VKA Loaded Clusters (in VP Tech Dept, SPCYF 618.34). See also MTR GPI (Jul 45), pp. 1-2.

Aerial spray trials were held at Terre Haute, Indiana, and at Beaumont, Texas, using 550-gallon bomb-bay tanks in B-25's. These tan were found to be suitable for the dispersion of crop-destroying solutio While no other growth regulating compound proved superior to VKA in these tests, it was learned that the oil miscibility of esters of certa phenoxy acids, such as LN-44, made them very effective and under some circumstances might replace VKA with advantage. /

/ Sp Rpt 25, Crop Destruction by Aerial Sprays. Field Trials 1945. Vigo Plant, CWS, Terre Haute, Indiana, and Beaumont Texas. April-October 1945 (Oct 45).

Toxicity of phenoxyacetic acids.

Stem curvature, epinasty (downward curvature of leaves), proliferation of various plant parts, and formation of gall-l growths were found to be common responses of plants to single drops or spray applications of 2,4-D. When the compound was brought into conta with aerial portions of plants, it apparently entered by penetration c the cuticle, epidermal layer, and underlying cells of the leaves and then made its way rapidly to the stems. Experiments that were made supported the theory of upward movement of growth regulators in the xylem and possible downward movement in the phloem. / The leaves of young soybeans absorbed maximum amounts of 2,4-D within 6 hours after application. / The effect of 2,4-D was shown to be systemic in natur rather than local, even in relatively low concentrations, and in this respect it differed from other growth-regulating compounds. /

As a result of greenhouse and field trials, it was learned that a 3 percent solution of LV-8 (one pound per ten gallons of solution)in oil or water would severely injure or kill most broadleaf crops. A 5 percent solution was required for plants in the mature stages of gro Concentrations up to 15 percent had relatively little effect on any of

/ The phloem is the part of the conductive tissue which conveys the elaborated food materials from the leaves down to the stem. The xylem is the trachea tissue of plants in which water is conveyed from the roots up the stem and also furnishes mechanical support to the plant.

/ R.J. Weaver and H.R. DeRose, "Absorption and Translocation of 2,4-Dichlorophenoxyacetic Acid," Botanical Gazette, 107 (Jun 1946), 509-21.

/ C.P. Swanson, "Histological Responses of the Kidney Bean to Aqueous Sprays of 2,4-Dichlorophenoxyacetic Acid," Botanical Gazette, 107 (Jun 1946), 522-31.

the cereal crops. No spread, as the secondary infections of fungi, was possible with chemical compounds, the agent affecting only those plants it falls on. For soil contamination, applications at the rate of 5 pounds of LN-8 in granular pellet form per acre effectively killed young plants, but was ineffective against older plants. No completely satisfactory metho for destroying cereal crops was found, although the carbamates as a cla showed promise against cereals in their early stages of growth. A spra of ammonium sulfamate at the rate of 5 pounds per acre stopped all yiel of rice but only when applied at the heading stage. /

Treatment of cabbage, soybean, tomato, sweet potato, and sugar beet plants with an aqueous spray of ammonium 2,4-dichlorophenoxyacetate at various stages of growth indicated that the immature plants only were severely inhibited or killed by the agent. / Similar results were obtained when young vegetative red kidney bean, soybean, cowpea, wheat, and corn plants were grown in nutrient-solution cultures / which contained various concentrations of 2,4-D, the agent proving toxic to all plants, with the cereals slightly more resistant than the broadleaved crop plants. From these studies it appeared that when 2,4-D was pre-

/ J.W. Mitchell, "Results of Field and Greenhouse Experiments Concerning Effectiveness of LN Compounds," WRS Progress Report No. LN-1 (1 Jul 44-1 Jan 45).

/ R.J.Weaver, C.P. Swanson, W.B. Ennis, Jr., and F.T. Boyd, "Effect of Plant Growth-regulators in Relation to Stages of Development of Certain Dicotyledonous Plants," Botanical Gazette, 107 (Jun 1946), 563-68.

/ This was Hoagland's standard nutrient solution containing chemicals in the following concentrations: 0.005 M monopotassium acid phosphate, 0.001 M ammonium dihydrogen phosphate, 0.005 M calcium nitrate, 0.005 M magnesium sulphate, 0.00012 M ferric citrate, and minor elements, in distilled water to pH 6.0-6.2 with sodium

sented in nutrient cultures, it caused greater inhibition to growth of plants than was caused by equal or larger amounts of 2,4-D when applied as soil treatment. /

Irish potatoes could be killed or severely injured only by applications of LN-14. When applied to the vegetative portions of the plants in aqueous or oil sprays or to the soil, it caused pronounced stunting and distortion of vegetative growth, with marked reduction in yield and quality of tubers. LN-8 and LN-32 in oil solutions caused some reducti in yield but in aqueous solutions had no effect on either top growth or yield when applied at rates which would kill or inhibit the usual broad leaf weeds. /

Studies made on the effect of 2,4-D upon germination and seedling development of twenty-two cereal and broadleaf crops showed that this agent inhibited germination in every case, decreased the growth of youn seedlings, and caused abnormalities in the anatomy of seedlings. Notabl was the lack of specificity of 2,4-D in its inhibition of germination.

/ D.L. Taylor, "Observations on the Growth of Certain Plants in Nutrie Solutions Containing Synthetic Growth-regulating Substances. I. Some Effects of 2,4-Dichlorophenoxyacetic Acid. II. The Influence of Presentation Time," Botanical Gazette, 107 (Jun 1946), 597-619.

/ W.B. Ennis, Jr., C.P. Swanson, R.W. Allard, and F.T. Boyd, "Effects of Certain Growth-regulating Compounds on Irish Potatoes," Botanical Gazette, 107 (Jun 1946), 563-74.

/ R.W. Allard, H.R. DeRose, and C.P. Swanson, "Some Effects of Plant Growth-regulators on Seed Germination and Seedling Development," Botanical Gazette, 107 (Jun 1946), 575-83.

In quantitative studies of aqueous 2,4-D, it was shown that volume rates of 10 to 20 ml. per square yard were the most effective when appli to young kidney-bean plants. Sprays of relatively large droplet size, with average diameters between 250 and 561 u, were more effective than small droplet sprays. Maximum deposition and retention resulted under these conditions. Both larger and smaller volume rates were less effect ive than 10 to 20 ml. per square yard. [1]

Since it had been shown that it took several hours for plants to absorb maximum amounts of 2,4-D sprays, tests were made to determine to what extent rainfall would remove the agent and reduce its effectiveness When 2,4-D was applied in oil solution, an immediate heavy rain caused n diminution in plant response, but when it was applied in aqueous solutio there was a slight decrease in response. [2]

Before tributyl phosphate was accepted as the most effective co-sol for increasing the concentration of 2,4-D in aqueous or oil solutions, an investigation was made of Carbowax, a polyethylene glycol. It was found that Carbowax enhanced the action of 2,4-D on kidney-bean plants but failed to do so on soybean plants, and it was therefore abandoned. [3]

[1] H.H. Smith, "Quantitative Aspects of Aqueous-spray Applications of 2,4-Dichlorophenoxyacetic Acid for Herbicidal Purposes," Botanical Gazette, 107 (Jun 1946), 544-51.

[2] R.J. Weaver, C.P. Minarik, and F.T. Boyd, "Influence of Rainfall on the Effectiveness of 2,4-Dichlorophenoxyacetic Acid Sprayed for Herbicidal Purposes," Botanical Gazette, 107 (Jun 1946), 540-44.

[3] W.B. Ennis, Jr., and F.T. Boyd, "The Response of Kidney-bean and Soybean Plants to Aqueous-spray Applications of 2,4-Dichlorophenoxy-acetic Acid with and without Carbowax," Botanical Gazette, ~~107~~ 107 (Jun 1946), 552-59.

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/ R.J. Weaver, C.E. Minarik, and F.T. Boyd, "Influence of Rainfall on the Effectiveness of 2,4-Dichlorophenoxyacetic Acid Sprayed for Herbicidal Purposes," Botanical Gazette, 107 (Jun 1946), 540-44.

/ W.B. Ennis, Jr., and F.T. Boyd, "The Response of Kidney-bean and Soybean Plants to Aqueous-spray Applications of 2,4-Dichlorophenoxy-acetic Acid with and without Carbowax," Botanical Gazette, ~~[illegible]~~ 107 (Jun 1946), 552-59.

The most satisfactory preparation for the dispersion of 2,4-D eithe for herbicidal purposes or as a crop-destroying agent was a mixture of the agent in tributyl phosphate and oil, the co-solvent fixing the large quantities of agent in solution and the oil enhancing the inhibitory effect of the agent, probably because of its low rate of evaporation and its power of penetration of leaf cuticle. It was also demonstrated that tributyl phosphate itself had an inhibitory effect on plant growth and acted synergistically with 2,4-D to increase the action of the agent compound. /

Since 2,4-D might be used as a soil contaminant as well as a spray against growing crops, studies were made to determine the persistence of the agent in soils and their subsequent effect on crops planted in such soils. 2,4-D was nonpersistent. In greenhouse trials, high rates of 2,4-D disappeared in 8 weeks as a result of leaching due to rainfall or inactivation. In the field, it did not persist for more than 80 days. and in some instances had almost completely disappeared in 68 days. LN-32, however, was sufficiently active in soil after 68 days to be toxi to soybeans and LN-14 was only slightly less active. / In comparative tests of ammonium 2,4-dichlorophenoxyacetate on plants grown in soil cultures and in nutrient-solution cultures, approximately four to five

/ Fn. p. 414; C.P. Swanson, "Two Methods for the Determination of the Herbicidal Effectiveness of Plant Growth-regulating Substances in Oil Solution on Broadleaf Plants," Botanical Gazette, 107 (Jun 1946), 560-62.

/ H.R. DeRose, "Persistence of Some Plant Growth-regulators When Applied to the Soil in Herbicidal Treatments," Botanical Gazette, 107 (Jun 1946), 583-89.

times as much inhibition of growth occurred in solution cultures as in soil cultures, apparently due to the retention or inactivation of the agent by organic or colloid components of the soil. /

A special study was made of 2,4-D to determine its possible toxici for man. Experimental animals were administed the compound orally, par terally, and by inhalation. It was apparent that 2,4-D is a relatively nontoxic compound for mice, guinea pigs, rats, rabbits, and monkeys, al of which reacted similarly to the material. In large doses, 2,4-D is a gastric irritant but is not lethal. It was presumed on the basis of th experiments that a 75 kg. man could tolerate a dosage of 15 grams or an oral volume of 28 milligrams of agent. / Elsewhere, it was estimated that a 75 kg. man could tolerate 18 grams of agent and that 52 grams might be a lethal dose, except that man could not ingest and retain this amount of agent. It also appeared that 2,4-D is nontoxic by inhalation and is not readily absorbed by the skin. /

/ D.L. Taylor, "Observations on the Growth of Certain Plants in Nutrient Solutions Containing Synthetic Growth-regulating Substances. IV. The Amount of Growth in Soil and Solution Cultures Treated with Equal Weights of Ammonium 2,4-Dichlorophenoxyacetate," Botanical Gazette, 107 (Jun 1946), 630-32.

/ E.V. Hill and H. Carlisle, "Toxicity of 2,4-Dichlorophenoxyacetic Acid for Experimental Animals," Journal of Industrial Hygiene and Toxicology, 29 (Mar 1947), 85-95.

/ Sp Rpt 10, Toxicity of LN-8 (2-4 Dichlorophenoxyacetic Acid) for Experimental Animals (Apr 45)

Toxicity of isopropylphenylcarbamate. Unlike the halogenated phen acetic acid series which do not injure cereals greatly, isopropylphenyl carbamate (LN-33 or IPC) appeared to be a highly selective herbicide fo certain cereals, particularly when applied to the soil rather than to the plants themselves. In greenhouse studies, LN-33 severely stunted or killed seedling oats, wheat, corn, barley, and rice, and was particu effective against oats and barley. It was also highly effective agains field-grown oats and rye when applied at seeding time or to seedling plants, completely prevented the germination of buckwheat, and killed field-grown winter rye. It was ineffective as an inhibitor of growth in such broadleaf plants as soybeans, kidney beans, radishes, turnips, and sugar beets. /

The low solubility of LN-33 in water made aqueous sprays impractica and the agent was entirely insoluble in oil. However, it could be dissolved in tributyl phosphate and this solution was oil miscible. It could not be shown that oil sprays produced any of the effects seen in soil treatment, except on winter rye.

It had been shown that in greenhouse studies, 2,4-D inhibited germi ation and decreased the growth of young seedlings not only of broadleaf plants but of cereal plants as well. The behavior of LN-33 was quite

/ R.W. Allard, W.B. Ennis, Jr., H.R. DeRose, and R.J. Weaver, "The Action of Isopropylphenylcarbamate Upon Plants," Botanical Gazette, 107 (Jun 1946), 589-96.
W.B. Ennis, Jr., "Some Effects of O-Isopropyl N-Phenyl Carbamate Upon Cereals," Science, 105 (24 Jan 1947), 95.

different in that it prevented the establishment of cereals at rates which had no effect upon broadleaf species, although buckwheat, a dicotyledonous species, responded like a cereal.

When 2,4-D and the carbamate were mixed and applied to both broadleaf and cereal plants, the seedlings of both types were affected, but each by its type specific agent. LN-8 and LN-33 did not appear to be complementary in action. / A number of cereals were grown in nutrient-solution cultures to which several phenoxyacetic acids and LN-33 were added, in a comparison of relative toxicities. In concentrations as low as 0.25 to 1 ppm, all agents were highly active in inhibiting growth of plants in nutrient cultures. Although there was no difference in the toxicity of LN-8 and LN-33, the appearance of the plants differed. LN-8 treatments resulted in parts of shoots withering or dying; LN-33 treatments arrested growth of the shoot, but it remained alive, becoming dark green and very leathery. /

LN-33 apparently disappeared from the soil within 60 days after treatment, and in this respect was of equal or even less persistence than LN-8. /

/ "Some Effects of Plant Growth-regulators...," Botanical Gazette, 107 (Jun 1946), 582-3.

/ D.L. Taylor, "Observations on the Growth of Certain Plants in Nutrient Solutions Containing Synthetic Growth-regulating Substances. III. The Relative Toxicity of Isopropylphenylcarbamate and Some Phenoxyacetic Acid Derivatives to Some Cereals," Botanical Gazette, 107 (Jun 1946), 620-29.

/ "Persistence...," Botanical Gazette, 107 (Jun 1946), 583.

Supplementary field studies. In the preliminary spray trials conducted at Bushnell, Florida, in April 1945 (Cf. Sp Rpt 12), it was found that the spray drift in these trials produced injury in many species of natural vegetation even at substantial distances from the target area. All herbaceous broadleaf crop plants which were subjected even to minisc applications of the spray were severely damaged. /

A year after the aerial sprays of annual and perennial vegetation with 2,4-D in tributyl phosphate and oil at Terre Haute (Cf. Sp Rpt 25), a survey was made to determine whether sufficient agent persisted in the soil to affect succeeding crops, and to determine residual effects upon trees and shrubs in the area. The concentrations which had been used, ranging from 1 to 15 percent, were found to have been insufficient to contaminate the soil or to affect subsequent growth of weeds or of corn and soybeans planted the next year.

It was reported that in the 1945 trial, catalpa, wild cherry, willo and sumac had been killed or seriously injured by a single aerial application. Black oak, persimmon, elm, and sassafras were less seriously injured. Elm, white ash, sweet gum, and black walnut trees were killed or seriously injured by repeated spray applications. Hickory, persimmon sugar maple, apple, and oak trees were less seriously injured by repeate/applicati

/ Sp Rpt 14, The Effect of VKA and VKS on Natural Vegetation. Preliminary Trials (17 Jun 45).

/ Sp Rpt 78, Observations on the Permanent Effects of Aerial Plant Growth Inhibitory Sprays Upon Natural Vegetation (Aug 46), p. 7.

Spray trials were carried out in India with 2,4-D in tributyl phosphate and diesel oil. Field plantings of such major crops as sweet potato, taro, and tapioca were destroyed, but reductions in the yield of rice were accomplished only with spray at the time of flowering. Thi was essentially in agreement with findings at Camp Detrick. The yam, another important food item, was not appreciably affected by 2,4-D. Semi-cultivated staples, including the coconut, banana, papaya, breadfru pineapple, cashew, mango, pepper, jackfruit, ash gourd, and areca nut, which are considered the jungle garden crops, were not affected by 5 percent concentrations of LN-32 (2-methyl-4-chlorophenoxyacetic acid) distributed by aircraft.

The growth-inhibiting activity of LN agents applied to the soil was completely lost in 5 weeks under tropical conditions, probably as a resu of leaching or dissolution due to rainfall. /

/ Sp Rpt 64, Destruction of Tropical Crops with Growth-inhibiting Agents. Chemical Defense Research Establishment, Cannanore and Kumbla, South India, May 1945-February 1946 (Aug 46).

In a postwar study of the herbicidal action of 2,4-D on on obnoxiou aquatic plants at the Fisheries Experimental Station at Leetown, West Virginia, it was learned that this compound could be used to control such plants as the cattail, spikerush, bulrush, burreed, willow, and waterweed. Concentrations ranging from 1 to 15 percent 2,4-D were used, in water and kerosene solutions, with tributyl phosphate and triethanola as co-solvents. Repeated applications by spray were necessary in order to eradicate the water plants, due to the continual loss of compound through such factors as seepage, adsorption, and microbial decomposition

/ E.W. Surber, C.E. Minarik, and W.B. Ennis, Jr., "The Control of Aquatic Plants with Phenoxyacetic Compounds," Progressive Fish-Culturist (Jul 1947), 143-50.

Plans to use the LN chemicals on Japanese crops. "It all started when the Army Air Forces wanted some way to mark target areas in the jungle. The Chemical Corps gave them a compound which, when sprayed ov the target, left a clear and unmistakable mark in the forest canopy because it first discolored and then blighted all leafy vegetation in i path. Next, the Air Forces wanted a material to destroy food crops in the Jap-held islands in the Southwest Pacific. We had driven the Japs back from the beaches in many of these islands, but we hadn't been able to break their resistance entirely. They had fled in bands into the interior of the islands, from which it was not practicable to drive the with the forces we had available. They were able to hold out in interi strongholds on Rabaul and similar islands because they were able to sustain themselves out of gardens which they set out in the clearings. If we could not send clean-up troops against these forces, we could sta them out into the open. When I was in New Guinea in 1944, General Kenn was asking for some way to destroy these gardens. His planes went out on frequent missions to spray them with crude oil and crank case drainir but these materials were not very effective. The Chemical Corps was asked to solve the problem."

By early 1945 the status of production and field testing of the new plant growth regulators had progressed to the point where fairly detaile plans could be made for their use in the destruction of crops, not only in the bypassed islands but also in the home islands of Japan itself. In March 1945, General Porter, then Chief of the Chemical Warfare Ser

/ From an article on byproducts of Chemical Corps wartime research prepared in Sep 1947 for possible publication by Maj.Gen. Alden H. Waitt, who, at the time he writes of, was Asst C CWS for Materiel.

the Chief, CWS, wrote to the Commanding General, Army Air Forces, that the Chemical Warfare Service was prepared to supply the necessary VX and to provide technical personnel to assist in the training of an AAF unit organized to undertake the mission. Without such training, he stated, there was grave danger that these operations might be wasteful or even ineffective. /

Meanwhile, the War Department was questioning the legality of employing the LW compounds against the enemy, lest it be construed as an instrument of either chemical or biological warfare. The Steering Committee of the USBWC, meeting with Mr. Merck in April 1945, expressed the opinion that the growth regulating chemicals were not biological warfare agents. / When the question was submitted to the Judge Advocate General for his opinion, he reported, "...the use of chemical agents whether in the form of a spray, powder, dust, or smoke, to destroy cultivations or retard their growth, would not violate any rule of international law prohibiting poison gas, upon condition, however, that such chemical do not produce poisonous effects upon enemy personnel, either from direct contact, or indirectly from ingestion of plants and vegetables which ha

/ Ltr (TS), C CWS to CG AAF, 28 Apr 45, sub: Destruction of Gardens of Isolated Japanese Garrisons in SWP and POA.

/ Memo (TS), G.W. Merck Spec Asst to SW for SW, 25 Apr 45, sub: Destruction of Crops by LW Chemicals. This memo atchd to Minutes of Meeting of USBWC Steering Committee, 25 Apr 45.

been exposed thereto." /

This ruling resulted in the study made of the toxicity of 2,4-D for man (Cf. Sp Rpt 10), and in a letter to ASF, the Chief, CWS, reporte that the degree of toxicity of 2,4-D was negligible. A man could tolera a single dose of one-half ounce of active agent. In terms of the rate of application proposed (one pound per acre), an individual would have to consume the vegetation of approximately 100 square yards or one-thirt second of an acre in order to approach a toxic dose. This computation implied that all of the material sprayed over the field was intercepted by the vegetation and persisted on it until consumed. /

The nature of the agent which it was proposed to use against the enemy was described for the Secretary of War by his Special Assistant. The chemical, 2,4-dichlorophenoxyacetic acid, he reported, is a commerci chemical manufactured by ordinary synthetic methods. It is not made frc living organisms or by any biological process and it is not a living organism. The chemical in diesel oil solution, when sprayed from planes

/ Memo (TS), JAG for SW Att Mr. George Merck C USEWC, 5 Mar 45, sub: Destruction of Crops by Chemicals. SPJGW 1945/164. Quoted in this memo was the resolution recommended for adoption by the advisory committee of the American delegates at the 1921 Washington Arms Conference: "Resolved, that chemical warfare, including the use of gases, whether toxic or non-toxic, should be prohibited by international agreement, and should be classed with such unfair methods of warfare as poisoning wells, introducing germs of disease, and other methods that are abhorrent in modern warfare." (Conference on the Limitation of Armament, Washington, 12 Nov 21-6 Feb 22, p. 732.) Also quoted was the League of Nations protocol of 1925 outlawing bacteriological methods of warfare, which protocol the U.S. did not ratify but by which it felt morally bound. See Manley O. Hudson, ed., International Legislation (Washington, 1931), III, 1670.

/ Memo (TS), C CWS for CG ASF, 15 Mar 45, sub: Weekly Progress Report on LN-8. SPCWV 400.112.

at treetop level, would cause vegetation in truck gardens to wither at the end of a short period or, when not destroyed, to stop growing. In powder form the same substance, when applied to irrigation and paddy fields in amounts as little as one pound per acre, would dissolve in the impounded water and produce a slower but equally devastating result. Rice when so treated shows no perceptible change for some days and the amount of chemical present in the water about its roots would be so negligible an amount as to defy ordinary analysis. In the course of a few weeks, however, the rice plants grow sere and weak in the roots. The great majority of them fall over and the growth of those still livir is so retarded that they produce no rice. _/

In spite of these reports and studies, the chemical plant growth regulator was not used. In a report from the Joint Staff Planning Committee in collaboration with the Joint Logistics Committee late in May 1945, it was decided that the subject of large scale use of LN-8, either as VKA, VKL, or VKS, against Japanese rice crops would be tabled for restudy in January 1946. No attempt was to be made to use the agent against the Japanese main islands in 1945./ This appears to have been the final decision.

_/ Memo (TS), J.P. Marquand and G.W. Merck for SW, 3 May 45, no sub, no file. In files NDD, WDSS (?).

_/ Directive JCS 1371/1 (TS), 1 Jun 45, sub: Policy on the Use of Chemical Agents for the Destruction of Japanese Food Crops. In SPD OC CWS.

CHEMICAL DEFOLIANTS

General. The objectives of the defoliation project carried out by C Division were to determine the effectiveness of certain chemical agen in solution for marking, defoliating, or increasing the inflammability of forest vegetation and to ascertain techniques of distribution from tactical aircraft using standard chemical tanks. As a result of the investigation, discoloration and defoliation of forest vegetation by tw chemical compounds was successfully accomplished. It was determined, however, that leaf discoloration occurred too slowly to be of general tactical value in target marking, and that the inflammability of treate foliage was not enhanced by either of the chemical compounds selected.

Selection of agents. Preliminary static trials were held at the AAF Tactical Center at Orlando, Florida, in March and April 1944. Saturated solutions of ammonium thiocyanate, zinc chloride, sodium nitri sodium arsenite, sodium fluoride, and dinitro-ortho-cresol in oil were compared in these tests. The first two solutions proved to be the best agents for causing rapid leaf discoloration and defoliage, with ammonium thiocyanate slightly superior because it turned leaves a bright red with 48 hours whereas zinc chloride acted in 2 to 3 days, turning leaves to a yellowish brown color. Defoliation was initiated 3 to 4 days after treatment and was complete in approximately 10 days. Recovery of trees, marked by the appearance of new leaf buds, required 3 weeks or more afte

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Appendix IV to Annex E

Biological Field Testing
(Chronological Listing)

Abbreviations

UA	Unavailable.
BG	Bacillus globigii (Bacillus subtilis var niger).
SM	Serratia marcescens.
AF	Aspergillus fumigatus.
EC	Escherichia coli.
FP	Fluorescent particle.
LP	Lycopodium Spores.
SO_2	Sulfur Dioxide.

TABLE 3

FIELD TESTING
NON-BIOLOGICAL SIMULANTS/AIR DIFFUSION
INVOLVING PUBLIC DOMAIN

LOCATION OF TEST	DATE(s) OF TEST	SIMULANT/AGENT USED
Harpers Lake, CA (Mojave Desert)	18 - 19 Aug 1949	Soap Bubbles
South Carolina, Georgia Coast	Mar - Apr 1952	FP
Minneapolis, MN St. Louis, MO	15 Jan - 24 Mar 1953	FP
Rosemont, MN	Sep - Oct 1953	FP and Lycopodium spores
San Francisco Bay, Redwood City, CA	21 and 26 Mar 1956	FP SO_2
Continental U. S. East of Rocky	30 Nov 1957 6 Feb 1958 25 Apr 1958 20 Mar 1958	FP
North Central Texas	1959 - 1960 Test No. Date A-1 13 Aug A-2 15 Aug A-3 18 Aug A-4 2 Oct A-5 5 Oct A-6 7 Oct A-7 9 Oct A-8 12 Oct A-9 10 Feb A-10 12 Feb A-11 15 Feb A-12 19 Feb A-13 22 Feb	FP FP
Vanderburg AFB, CA	Jun - Aug 1961 Feb, Mar, and Jun 1962	FP
Cape Kennedy, FL	May, Jun 1961, Jan - Mar 1962	FP
NE Oklahoma, Corpus Christi, TX, E Washington and SW Nevada	Summer 1962	FP

LOCATION OF TEST	DATE(s) OF TEST	SIMULANT/AGENT USED
St. Louis, MO	May - Sep 1963 Apr - Oct 1964 Mar 1965	FP
Dugway Proving Ground, UT	17 - 21 May and 15 Aug 1963 4 Sep 1963	FP FP
Chippewa National Forest, MN	Jan - Aug 1964	FP
San Francisco, CA	Mar 64 - Mar 1968	FP
Wambaw Swamp Francis Marion National Forest, SC	Jun - Aug 1964	FP
Fort Wayne, IN	29 Jul 1964 - 5 Feb 1966	FP
Victoria, TX	Jul - Aug 1965 Jul - Aug 1965 9 - 29 Jul 1966	LP, FP LP, FP Glass beads & fluorescent tagged cork
Oceanside, CA	Jun - Jul 1967	FP
Searcy, AR	Sep 1967 - May 1968	FP
East Central Texas	1967	Glass beads, fluorescent tagged ground cork
Charles Lathrop Pack Demonstration Forest of the University of WA	Nov 1968	FP
Cambridge, MD	Aug - Nov 1969	FP

TABLE 6

BIOLOGICAL FIELD TESTING
ANTI-CROP
PATHOGENIC AGENT
NOT INVOLVING PUBLIC DOMAIN

LOCATION OF TEST	DATE(s) OF TEST	SIMULANT/AGENT USED
Dugway Proving Ground, UT	18 Feb - 27 May 1952	Wheat Rust Spores
	12 Sep 52 - 26 May 53	Stem Rust of Wheat
	21 Jul - 24 Sep 53	Wheat Stem Rust
(Crop Grd #5)	12 Nov 53 - 16 Dec 53	Stem Rust Wheat
	Apr - Aug 1954	Wheat Rust
	14 Oct 54	Wheat Stem Rust
Avon Park AFB, Avon Park, Florida Bombing Range	Nov - Dec 1954	Wheat & Rye Stem Rust
ACmlC Rosemount Research Lab, Rosemount, MN	12 Jul 1955	Wheat stem rust (killed spores)
Belleglade & Ft Pierce, FL	Apr 1, May 1, Jun 1, & Jul 1, 1956 & 1957	Rice blast

TABLE 5

BIOLOGICAL FIELD TESTING
ANTI-CROP
PATHOGENIC AGENT
INVOLVING PUBLIC DOMAIN

LOCATION OF TEST	DATE(s) OF TEST	SIMULANT/AGENT USED
South Carolina - Georgia Coast	Nov & Dec 1952	Dyed Lycopodium Spores Seed-dyed Cereal Rust Spores
Morris, Waseca, Le Sueur, Crookston, Duluth, & Rosemount, MN	May 1953	
Crookston, MN; Rosemount, MN; Rapid City, MN	Rosemount - 5,7 Jun 1955; Rapid City - 3 Jun 1956; Crookston 19 Jun 1956	Wheat Stem Rust
Intersection of US Highways 60 and 441, Yeehaw Junction, Florida	15, 18, 19, 20, 24, 27 Nov & 1 Dec 1956	Wheat Stem Rust
Hays, Kansas	7 May 1960	Wheat Stem Rust
Experimental Station, Beaumont, TX	Summer 1959	Rice blast
Langdon, North Dakota	12 Jun 1960	Wheat Stem Rust
Yeehaw Junction, FL	Nov, Dec 1968	Wheat Stem Rust

TABLE 5A

(UNSUBSTANTIATED)
BIOLOGICAL FIELD TESTING
ANTI-CROP
BIOLOGICAL AGENTS
INVOLVING PUBLIC DOMAIN

LOCATION OF TEST	DATE(s) OF TEST	SIMULANT/AGENT USED
Edgewood Arsenal, MD	1949-50	TX or TX simulant
Crookston, MN	1964	TX
Avon Park AFB, FL	1954-1957 1960 1964	Cereal Stem rust spores None LX Helminthosporium oryzae
Casselton, ND	1964	TX
Crookston, MN	1956-57	
Stillwater, OK	1963-67	TX
Hayes, KS	1960, 64, 65	TX
Lincoln, NEB	1964-65	TX
Rosemount, MN	1955, 57, 64	TX
Langdon, ND	1960, 64	TX
Crowley, LA	1963, 64, 68, 69	LX and Helminthosporium oryzae
Avon Park AFB, FL	1 Apr 1965 - 31 Oct 1965	LX

Congressional Record: November 10, 1999 (Senate)
Page S14533-S14571

STATEMENTS ON INTRODUCED BILLS AND JOINT RESOLUTIONS

By Mrs. FEINSTEIN:

S. 1902. A bill to require disclosure under the Freedom of Information Act regarding certain persons and records of the Japanese Imperial Army in a manner that does not impair any investigation or prosecution conducted by the Department of Justice or certain intelligence matters, and for other purposes; to the Committee on the Judiciary.

Japanese Imperial Army Disclosure Act of 1999

Mrs. FEINSTEIN. Mr. President, I rise today to introduce the Japanese Imperial Army Disclosure Act of 1999.

This legislation will require the disclosure under the Freedom of Information Act classified records and documents in the possession of the U.S. Government regarding chemical and biological experiments carried out by Japan during the course of the Second World War.

Let me preface my statement by making clear that none of the remarks that I will make in discussing this legislation should be considered anti-Japanese. I was proud to serve as the President of the Japan Society of Northern California, and I have done everything I can to foster, promote, and develop positive relations between Japan, the United States, China, and other states of the region. The legislation I introduce today is eagerly sought by a large number of Californians who believe that there is an effort to keep information about possible atrocities and experiments with poisonous gas and germ warfare from the pubic record.

One of my most important goals in the Senate is to see the development of a Pacific Rim community that is peaceful and stable. I have worked towards this end for over twenty years. I introduce this legislation to try to heal wounds that still remain, particularly in California's Chinese-American community.

This legislation is needed because although the Second World War ended over fifty years ago--and with it Japan's chemical and biological weapons experimentation programs--many of the records and documents regarding Japan's wartime activities remain classified and hidden in U.S. Government archives and repositories. Even worse, according to some scholars, some of these records are now being inadvertently destroyed.

For the many U.S. Army veteran's who were subject to these

experiments in POW camps, as well as the many Chinese and other Asian civilians who were subjected to these experiments, the time has long since passed for the full truth to come out.

According to information which was revealed at the International Military Tribunal for the Far East, starting in 1931, when the so-called "Mukden incident" provided Japan the pretext for the occupation of Manchuria, the Japanese Imperial Army conducted numerous biological and chemical warfare tests on Chinese civilians, Allied POWs, and possibly Japanese civilians as well.

Perhaps the most notorious of these experiments were carried out under General Ishii Shiro, a Japanese Army surgeon, who, by the late 1930's had built a large installation in China with germ breeding facilities, testing

grounds, prisons to hold the human test subjects, facilities to make germ weapons, and a crematorium for the final disposal of the human test victims. General Ishii's main factory operated under the code name Unit 731.

Based on the evidence revealed at the War Crimes trials, as well as subsequent work by numerous scholars, there is little doubt that Japan conducted these chemical and biological warfare experiments, and that the Japanese Imperial Army attempted to use chemical and biological weapons during the course of the war, included reports of use of plague on the cities of Ningbo and Changde.

And, as a 1980 article by John Powell in the Bulletin of Concerned Asia Scholars found,

> Once the fact had been established that Ishii had used Chinese and others as laboratory tests subjects, it seemed a fair assumption that he also might have used American prisoners, possibly British, and perhaps even Japanese.

Some of the records of these activities were revealed during the Tokyo War Crimes trials, and others have since come to light under Freedom of Information Act requests, but many other documents, which were transferred to the U.S. military during the occupation of Japan, have remained hidden for the past fifty years.

And it is precisely for this reason that this legislation is needed: The world is entitled to a full and compel record of what did transpire.

Sheldon Harris, Professor of History Emeritus at California State university Northridge wrote to me on October 7 of this year that:

> In my capacity as an academic Historian, I can testify to the difficulty researchers have in unearthing documents and personal testimony concerning these war crimes * * *. Here in the United States, despite the Freedom of Information Act, some archives remain closed to investigators * * *. Moreover, "sensitive documents--as defined by archivists and FOIA officers--are at the moment being destroyed.

Professor Sheldon's letter goes on to discuss three examples of the destruction of documents relating to chemical and biological warfare experiments that he is aware of: At Dugway Proving Grounds in Utah, at Fort Detrick in Maryland, and at the Pentagon.

This legislation establishes, within 60 days after the enactment of the act, the Japanese Imperial Army Records Interagency Working Group, including representation by the Department of State and the Archivist of the United States, to locate, identify, and recommend for declassification all Japanese Imperial Army records of the United States.

This Interagency Work Group, which will remain in existence for three years, is to locate, identify, inventory, recommend for classification, and make available to the public all classified Imperial Army records of the United States. It is to do so in coordination with other agencies, and to submit a report to Congress describing its activities.

It is my belief that the establishment of such an Interagency Working Group is the best way to make sure that the documents which need to be declassified will be declassified, and that this process will occur in an orderly and expeditious manner.

This legislation also includes exceptions which would allow the Interagency Working Group to deny release of records on the basis of: 1. Records which may unfairly invade an individual's privacy; 2. Records which adversely affect the national security or intelligence capabilities of the United States; 3. Records which might "seriously or demonstrably impair relations between the United States and a foreign government"; and, 4. Records which might contribute to the development of chemical or biological capabilities.

My purpose in introducing this legislation is to help those who were victimized by these experiments and, with the adage "the truth shall set you free" in mind, help build a more peaceful Asian-Pacific community for the twenty-first century.

First, the declassification and release of this material will help the victims of chemical and biological warfare experimentation carried out by the Japanese Army during the Second World War, as well as their families and descendants, gain information about what occurred to them fifty years ago. If old wounds are to heal, there must be a full accounting of what happened.

Second, and perhaps just as importantly, this legislation is intended to create an environment of honest dialogue and discussion in the Asia-Pacific region, so that the countries and people of the region can move beyond the problems that have plagued us for the past century, and work together to build a peaceful and prosperous Asian-Pacific community in the next century.

If the countries of Asia are to build a peaceful community it is necessary that we deal fully, fairly, and honestly with the past. It is only by doing so that we can avoid repeating the mistakes of the past and build a more just world for the future.

Indeed, as Rabbi Abraham Cooper has remarked, "Since the end of World War II, professed neutral nations like Sweden and Switzerland have had the courage to take a painful look back at their World War II record; can Japan be allowed to do anything less?"

I hope that my colleagues will join me in support of this legislation.

Mr. President, I ask unanimous consent that the October 7 letter by Professor Harris and an article outlining some of the scholarly research on this issue: "Japan's Biological Weapons: 1930-1945," by Robert Gromer, John Powell, and Burt Roling be printed in the Record.

There being no objection, the material was ordered to be printed in the Record, as follows:

Granada Hills, CA,

October 7, 1999.

Hon. Senator Dianne Feinstein,
Hart Senate Office Building, Washington, DC.

Dear Senator Feinstein: Several Asian American activists organizations in California, and organizations representing former Prisoners of War and Internees of the Japanese Imperial Army, have indicated to me that you are proposing to introduce legislation into the United States Senate that calls for full disclosure by the United States Government of records it possesses concerning war crimes committed by members of the Japanese Imperial Army. I endorse such legislation enthusiastically.

My support for the full disclosure of American held records relating to the Japanese Imperial Army's wartime crimes against humanity is both personal and professional. I am aware of the terrible suffering members of the Imperial Japanese Army imposed upon innocent Asians, prisoners of war of various nationalists and civilian internees of Allied nations. These inhumane acts were condoned, if not ordered, by the highest authorities in both the civilian and military branches of the Japanese government. As a consequence, millions of persons were killed, maimed, tortured, or experienced acts of violence that included human experiments relating to biological and chemical warfare research. Many of these actions meet the definition of "war crimes" under both the Potsdam Declaration and the various Nuremberg War Crimes trials held in the post-war period.

I am the author of "Factories of Death, Japanese Biological Warfare, 1932-45, and the American Cover-up" (Routlege: London and New York; hard cover edition 1994; paperback printings, 1995, 1997, 1998, 1999). I discovered in the course of my research for this book, and scholarly articles that I published on the subject of Japanese biological and chemical warfare preparations, that members of the Japanese Imperial Army Medical Corps committed heinous war crimes. These included involuntary laboratory tests of various pathogens on humans--Chinese, Korean, other Asian nationalities, and Allied prisoners of war, including Americans. Barbarous acts encompassed live vivisections, amputations of body parts (frequently without the use of anesthesia), frost bite exposure to temperatures of 40-50 degrees Fahrenheit below zero, injection of horse blood and other animal blood into humans, as well as other horrific experiments. When a test was completed, the human experimented was "sacrificed", the euphemism used by Japanese scientists as a substitute term for "killed."

In my capacity as an academic Historian, I can testify to the difficulty researchers have in unearthing documents and personal testimony concerning these war crimes. I, and other researchers, have been denied access to military archives in Japan. These archives cover activities by the Imperial Japanese Army that occurred more than 50 years ago. The documents in question cannot conceivably contain information that would be considered of importance to "National Security" today. The various governments in Japan for the past half century have kept these archives firmly closed. The

fear is that the information contained in the archives will embarrass previous governments.

Here in the United States, despite the Freedom of Information Act, some archives remain closed to investigators. At best, the archivists in charge, or the Freedom of Information Officer at the archive in question, select what documents they will allow to become public. This is an unconscionable act of arrogance and a betrayal of the trust they have been given by the Congress and the

[[Page S14543]]

President of the United States. Moreover, "sensitive" documents--as defined by archivists and FOIA officers--are at the moment being destroyed. Thus, historians and concerned citizens are being denied factual evidence that can shed some light on the terrible atrocities committed by Japanese militarists in the past.

Three examples of this wanton destruction should be sufficiently illustrative of the dangers that exist, and should reinforce the obvious necessity for prompt passage of legislation you propose to introduce into the Congress:

1. In 1991, the Librarian at Dugway Proving Grounds, Dugway, Utah, denied me access to the archives at the facility. It was only through the intervention of then U.S. Representative Wayne Owens, Dem., Utah, that I was given permission to visit the facility. I was not shown all the holdings relating to Japanese medical experiments, but the little I was permitted to examine revealed a great deal of information about medical war crimes. Sometimes after my visit, a person with intimate knowledge of Dugway's operations, informed me that "sensitive" documents were destroyed there as a direct result of my research in their library.

2. I conducted much of my American research at Fort Detrick in Frederick, Md. The Public Information Officer there was extremely helpful to me. Two weeks ago I telephoned Detrick, was informed that the PIO had retired last May. I spoke with the new PIO, who told me that Detrick no longer would discuss past research activities, but would disclose information only on current projects. Later that day I telephoned the retired PIO at his home. He informed me that upon retiring he was told to "get rid of that stuff", meaning incriminating documents relating to Japanese medical war crimes. Detrick no longer is a viable research center for historians.

3. Within the past 2 weeks, I was informed that the Pentagon, for "space reasons", decided to rid itself of all biological warfare documents in its holdings prior to 1949. The date is important, because all war crimes trials against accused Japanese war criminals were terminated by 1949. Thus, current Pentagon materials could not implicate alleged Japanese war criminals. Fortunately, a private research facility in Washington volunteered to retrieve the documents in question. This research facility now holds the documents, is currently cataloguing them (estimated completion time, at least twelve months), and is guarding the documents under "tight security."

Your proposed legislation must be acted upon promptly. Many of the victims of Japanese war crimes are elderly. Some of the victims pass away daily. Their suffering should receive recognition and some compensation. Moreover, History is being cheated. As documents disappear, the story of war crimes committed in the War In The Pacific becomes increasingly difficult to describe. The end result will be a distorted picture of reality. As an Historian, I cannot accept this inevitability without vigorous protest.

Please excuse the length of this letter. However, I do hope that some of the arguments I made in comments above will be of some assistance to you as you press for passage of the proposed legislation. I will be happy to be of any additional assistance to you, should you wish to call upon me for further information or documentation.

Sincerely yours,

Sheldon H. Harris,

Professor of History emeritus,
California State University, Northridge.

"I can't just sit idly by and read a newspaper account that says: 'We are bringing in anthrax-laced scrub suits or letters to be destroyed,'" she said. "I mean, come on, this is not something that people are comfortable with. And if they are to be comfortable with it, we have to have the information in advance."

She also asked Fort Detrick for daily updates on the Area B-11 clean-up. And she assigned a city official to sit on the fort's Restoration Advisory Board, a group of citizens the Army regularly updates on the clean-up and other base activities.

The mayor assigned Dan Patton, the city's coordinator of health and safety, to the board.

Ms. Mitchell said the Army recognized the importance of good communications with City Hall. "That's one of the reasons we thought it was important to have someone from the city sitting on the Restoration Advisory Board," she said.

The board meetings are open to the public, and Ms. Mitchell said she didn't know why city officials have not attended in the past.

"We do try to make that effort so everybody does know what is going on," Ms. Mitchell said. "The intent is to be open."

As for daily updates on the cleanup, Ms. Mitchell said they were available to everyone at a Web site about the cleanup (www.armymedicine.army.mil/detrick/areab/summary.cfm).

The invitation to the Web site did not satisfy Ms. Dougherty.

"It's not sufficient for our purposes," she said. "There are things that Fort Detrick is not prepared or willing to share with the general public that the public safety community needs to know about."

Information supplied to City Hall would not necessarily be disseminated to the general public, Ms. Dougherty said.

"This might seem like an insignificant issue to the people at the fort, but it is not insignificant to the people who live in Frederick," she said.

Residents have told Ms. Dougherty they fear health risks from the base, but the city can't calm the public without the right information, she said.

"There must not be a huge health concern because people that work at the fort generally live here. But let's be sure we are communicating the details to the neighborhood," Ms. Dougherty said.

"You will never convince a grandmother that her grandsons didn't get the flu ... because of something that is being burnt at Fort Detrick. But, scientifically speaking, I'm willing to listen," she said.

"The important thing is that we know what's coming in and that we know in advance so our public education campaign can be prepared," Ms. Dougherty said.

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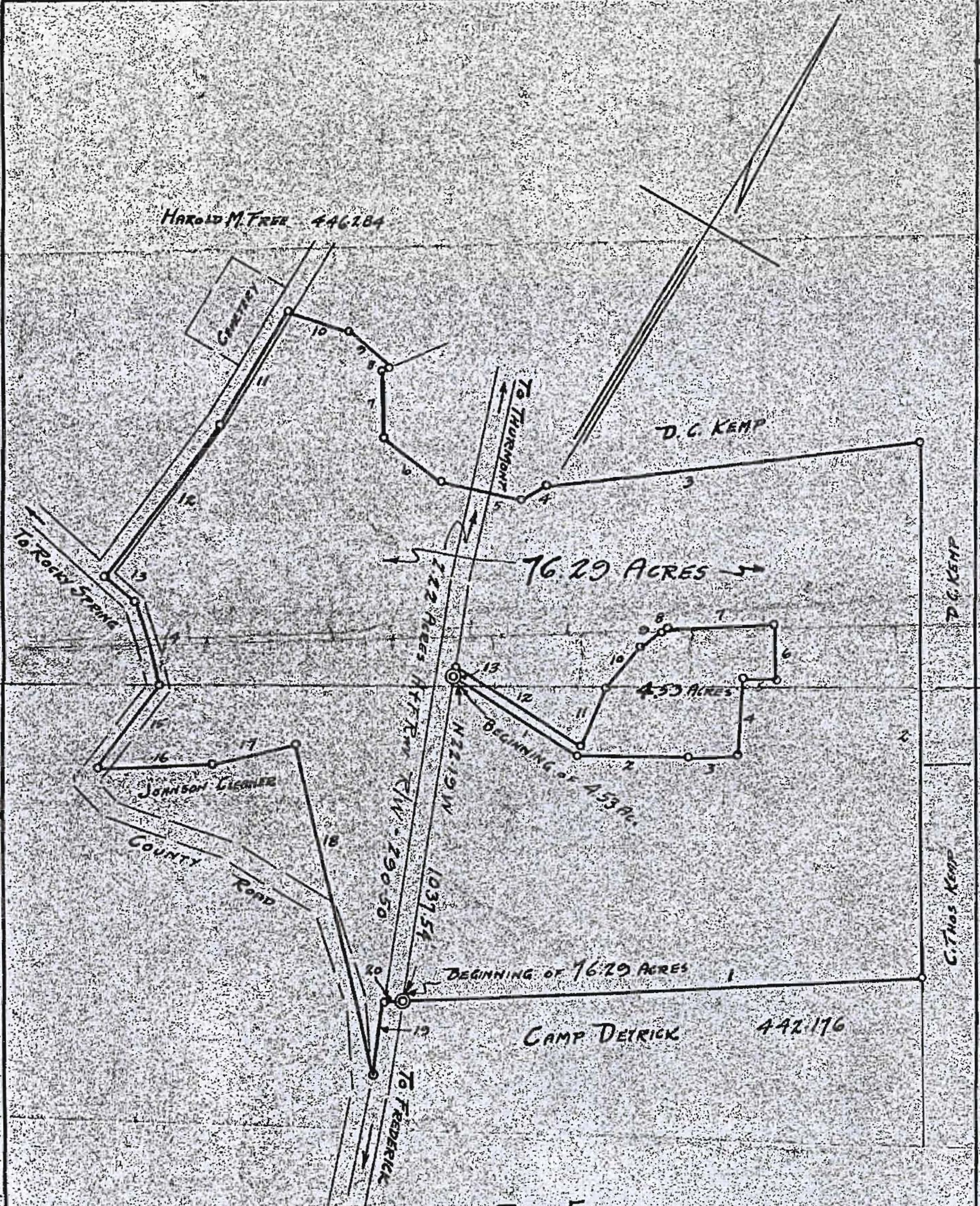
samiller@fredericknewspost.com

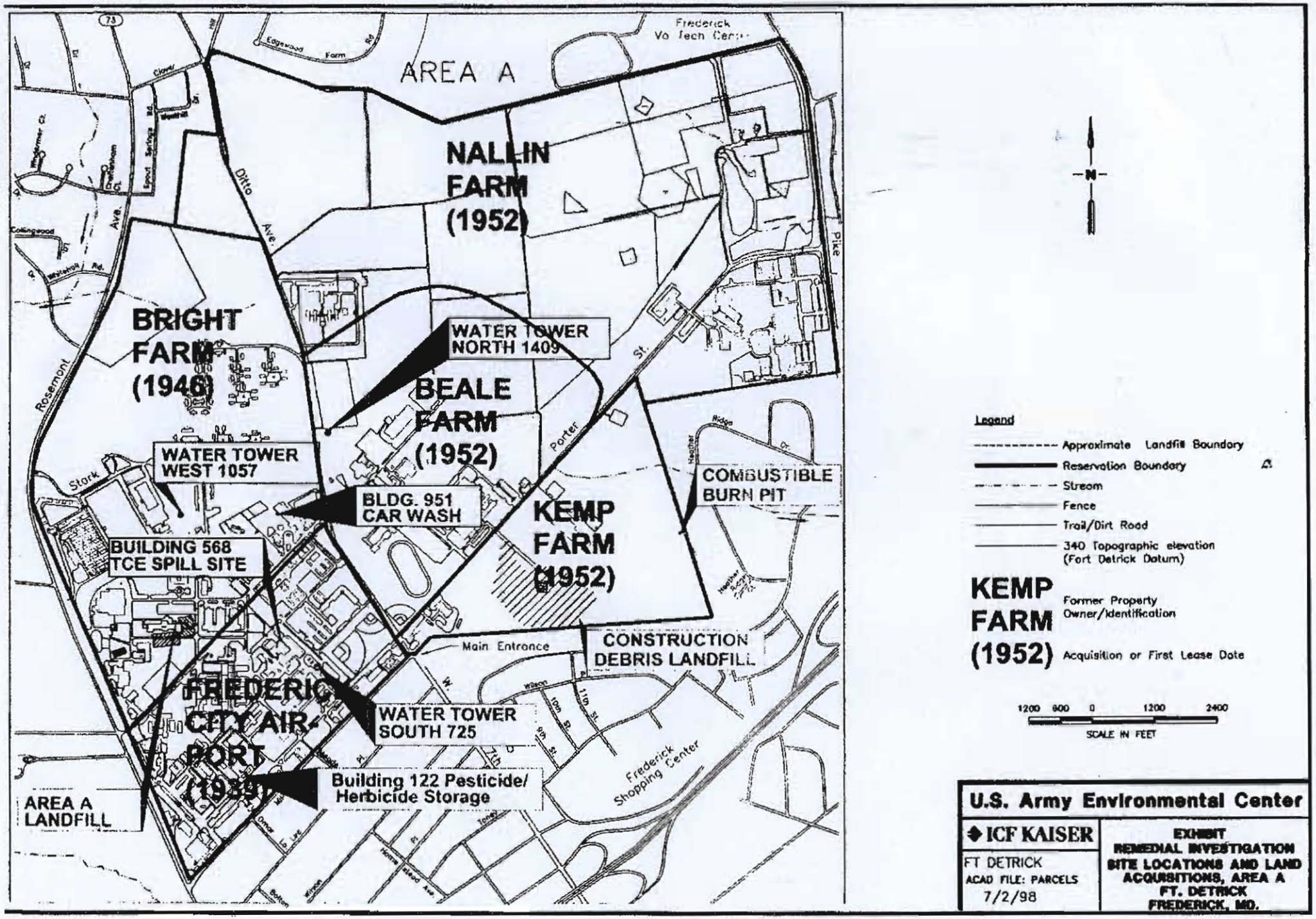


PLAT OF THE REAL ESTATE OF

ROBERT S. BRIGHT, DECEASED
FREDERICK CO., MARYLAND

SCALE:- 1" = 400' AUG. 14, 1945

FRANK W. ROTHENHOEFER
COUNTY SURVEYOR



AUTHORIZATION FOR RELEASE OF PROPERTY AND INFORMATION

I Virginia Ann Gaver hereby give my permission to The Kristen Renee Foundation to use the photos of myself, my husband Ralph Gaver, and/or any other photos I choose to provide them, for the Foundation's use in any manner it deems appropriate in accordance with the cancer cluster and groundwater contamination investigation on behalf of myself, my family and other residents.

I also give them permission, release and hold KRF harmless and able to use my personal or family medical information and any other information I choose to provide them including all paper, electronic, video belonging to me that I choose to release.

Signed:

Virginia Ann Gaver / Virginia Ann Gaver Date: 10-13-10
(Sign and Print Name)

Witnessed by:

_____ Date: _____
(Sign and Print Name)


NAPA


NAPA

D-1. Waste Management

I. Scope

Procedures covered here are:

1. Storage and disposal of chemical waste;
2. Storage and disposal of radioactive wastes;
3. Recycling of chemicals, office materials and pipette tip trays;
4. Use of silver recovery units for photo-processing equipment.

More information can be found at http://home.ncifcrf.gov/ehs/ehs.asp?id=66 or by phoning x 1451.

These procedures apply to all facilities, including off-site, of the NCI-Frederick, including government owned and operated as well as government owned and contractor operated. Specific requirements for the management of other solid wastes are more fully explained in other chapters of this manual.

II. Purpose

This section summarizes the responsibilities, requirements, and instructions for the management of solid wastes generated at the NCI-Frederick including biohazardous, chemical, radiological, and mixed wastes.

III. Definitions

Medical Waste - At the NCI-Frederick, medical waste includes special medical waste as defined by COMAR 10.06.06.02, and other laboratory items which may be perceived by the public as medical waste, such as pipettes, culture tubes/flasks, etc.

Mixed Waste - Hazardous waste that also contains low-level radioactive waste as defined in Maryland Environmental Article §7-201.

Radioactive Waste - Solid, liquid or gaseous materials from nuclear operations that are radioactive or become radioactive and for which there is no further use.

Hazardous Waste - A solid, liquid, or gas that is no longer suited for its intended purpose and that is ignitable, corrosive, toxic, reactive, or listed by the United States Environmental Protection Agency (EPA) in 40 CFR 261, or the Maryland

Department of the Environment (MDE) in COMAR 26.13. In general, excess or spent hazardous material to be disposed of or recycled is considered hazardous waste.

Satellite Accumulation Point - A point at or near any point of generation where wastes initially accumulate, which is under control of the operator of the process generating the waste, and where as much as 55 gallons of hazardous waste or one quart of acutely hazardous waste is collected in containers. Lab benches with waste jugs or solvent cans are Satellite Accumulation Points.

Sharps - Syringe, needle, surgical instrument, or other article that has cut punctured human skin or come in contact with a known infectious agent.

Solid Waste - Any discarded material as defined by COMAR 26.13.02.02 which is not otherwise excluded from regulation. Solid waste includes the following:

1. Garbage, refuse, or sludge.

2. Solid, liquid, semi-solid, or contained gaseous material which is abandoned, recycled, or considered inherently waste-like.

Solid waste does not include the following:

1. Industrial wastewater discharges subject to regulation under Section 402 of the Clean Water Act, as amended.

2. Radioactive source, special nuclear or byproduct material as defined by the Atomic Energy Act of 1954.

Special Medical Waste - waste that contains anatomical material; blood; blood soiled articles; contaminated material; microbiological laboratory waste; or sharps, see COMAR10.06.06.02.

IV. Responsibilities

A. Supervisors are responsible for enforcing the requirements and practices contained in this procedure, and ensuring that all wastes generated as a result of activities under their supervision are properly segregated, labeled, containerized, and transferred.

B. Employees are responsible for understanding and complying with all policies governing management of wastes generated by their activities while working at the NCI-Frederick.

C. U.S. Army Garrison, Fort Detrick (USAG), through an Interdepartmental Support Agreement, is responsible for the transportation, incineration and land filling of all solid wastes (except hazardous wastes) generated by activities at the NCI-Frederick.

D. Facilities Maintenance and Engineering (FME) is responsible for collecting solid wastes (except hazardous wastes, radioactive wastes and special medical wastes) from the NCI-Frederick campus and placing these wastes in designated containers for pickup by either the USAG or the Environment, Health and Safety Program (EHS).

E. EHS is responsible for policies and procedures for the classification, handling, and disposal of solid, medical, radioactive, and hazardous wastes generated at the NCI-Frederick.

V. Procedures

A. Medical Waste

1. All medical waste, including autoclaved waste, red bagged material, broken glass boxes, and biomedical waste boxes shall be placed in a gray medical waste cart. Never use any dumpster for disposal of medical waste, including needles, other sharps, animals or pathological waste. Never leave medical waste or bags of medical waste on the ground.

a. Biomedical waste containers, NCI-F Warehouse item number 66401506 are recommended for the disposal of medical waste. These are designed to be used one time and are not to be reused. They provide adequate protection for the personnel handling the waste and clearly identify the waste as medical. Material which is to be autoclaved should be placed in polypropylene bags, item numbers SPWH-81051031 (30" x 36") or SPWH-81051033 (12" x 24"). Red-tinted bags may also be used for non-infectious laboratory waste. Two sizes are available (SPWH-81050124 (24" x 24") and SPWH-81050122 (36" x 48")). All are available and stocked in the warehouse.

NOTE: Medical waste containers and biomedical waste boxes must not be filled past the fill line. Red bagged waste must be put in medical waste carts. Red bags used in small administrative trash cans are not recommended.

b. Animals and other pathological waste should be properly packaged in a leakproof container, preferably black or red-tinted poly bags, and placed in the designated ANIMAL cart before 10 a.m. Monday – Friday. Animal carts can be requested from the USAG by calling 9-619-2323. Animal bedding should also be properly packaged and put in the medical waste carts. Under no circumstances, should you leave animal wastes in a cart on a Friday afternoon in July.

c. Used needles and syringes must be kept in a red sharps container for disposal. Two sizes of sharps containers (SPWH-66401505 (5 gal.) and SPWH-66401504 (9.5 qt.)) are stocked in the warehouse and shall be used for the disposal of needles and syringes. These containers shall be sealed when three-fourths full and lab personnel must place them in a gray medical waste cart outside the building (NOTE: FME service workers do not handle needles and syringes).

d. Other sharps, including scalpels, razor blades, broken glass, glass pipettes and other items which may penetrate human skin, must be placed in a rigid puncture-resistant container and handled as medical waste. Lab personnel are responsible for placing any full rigid puncture-resistant containers in a medical waste cart with the other medical waste. Custodial staff are not authorized to handle sharps containers.

e. Lab personnel must disinfect all potentially infectious liquid wastes before discharge into any drain. Sodium hypochlorite solution, e.g. CLOROX bleach, is recommended: add one part bleach to nine parts waste for a final solution 1:10 bleach to waste. Allow the bleach-waste mixture to sit for a minimum of 30 minutes before pouring the liquid down the drain. Other liquid disinfectants may be used with prior approval of EHS. Call Biological Safety for guidance at x1451.

B. Chemical Waste

1. Chemical wastes should be stored for collection by Waste Management in containers as hazardous wastes. The containers must have a waste tag attached with the building, room, center number, and contents identified.

2. Waste is legally defined as hazardous waste in either of two ways:

   - the waste may be specifically listed as hazardous by the EPA or the MDE ("listed hazardous waste"). Listed hazardous wastes generated on a recurring basis at the NCI-Frederick are identified in Table D-1-2 and D-1-3. Or
   - the waste may exhibit one of four hazardous characteristics as defined by the EPA or the MDE ("characteristic hazardous waste"). If you are unsure about any waste material, contact the EHS at x1451.

   The four characteristics are:

   Ignitable - includes any liquid with a flash point less than 140°F (60°C), as well as any oxidizers, flammable solids, and flammable gases. Examples: methanol, ethanol, acetonitrile, hexanes and liquid scintillation cocktails containing xylene, toluene or pseudocumene.

   Note: wastes containing 10% or more of common solvents such as methanol or ethanol have a flash point below 140°F and are ignitable hazardous waste.

   Corrosive - includes any aqueous liquid with a pH ≤2 or ≥12.5, and any liquid which corrodes steel faster than the designated rate. Examples: Cell lysis buffers, Spor-Klenz, cleaning products or disinfectants containing hydrochloric acid or sodium hydroxide.

   Reactive - includes explosives, metal cyanides or sulfide-bearing wastes, and materials which, when mixed with water, react violently or generate flammable or toxic gases. Examples: azo compounds, di or tri-nitro compounds, sodium hydride, hydrogen sulfide, sodium cyanide, sodium or potassium metal.

Toxic - includes wastes which, under specified test conditions, yield an extract containing any of the compounds in Table D-1-1 in excess of their regulatory levels. As an example, note that as little as 2 drops of chloroform dissolved in 20 L of waste must be handled as hazardous waste. Examples: salts of mercury, lead or silver, chloroform, epinephrine, nicotine, phenol and sodium azide.

The basic rules for managing chemical wastes generated at the NCI-Frederick are:

a. Never pour hazardous wastes down the drain. Call EHS (x5718) if you are not certain whether a waste is suitable for drain disposal.

b. Pour solvents and flammable wastes into red (or white) safety cans which are available from EHS (x5718).

c. Whenever possible, segregate halogenated and non-halogenated solvent wastes. Common halogenated solvents include methylene chloride, chloroform, freons, and trichloroethylene. Common non-halogenated solvents include methanol, isopropanol, acetonitrile, toluene, and xylene.

d. The following is a partial list of waste streams that shall not be co-mingled with other wastes in the same container because of incompatibilities and/or disposal/recycling requirements[1]:

   Oils (vacuum pump)

   Flammable liquids (isopropyl alcohol, ethanol, kerosene, methyl ethyl ketone, acetone, ether, methanol, toluene, xylene, etc.)

   Halogenated solvents[2] (methylene chloride, 1,1,1 - Trichloroethane, chloroform, freons, trichloroethylene)

   Oxidizers (>40% nitric acid, ammonium nitrate, uranyl nitrate, chromic acid, ammonium persulfate, periodic acid, etc.)

Poisons (mercury, arsenic, etc.)

Organic acids (acetic acid, formic acid, etc.)

Inorganic acids (hydrochloric acid, sulfuric acid, hydrofluoric acid, etc.)

Mixed waste [3] (phenol/chloroform mixtures or pump oil contaminated with ^{3}H, ^{14}C, ^{32}P, etc., scintillation fluids containing more than 0.05 µCi/gram of ^{3}H or ^{14}C, scintillation fluids containing isotopes other than ^{3}H or ^{14}C, etc.)

Note 1: Further segregation within the above waste streams may be required because of chemical incompatibilities. If uncertain as to waste collection and storage requirements, contact Waste Management at x5718.

Note 2: Flammable solvents, halogenated solvents, and organic acids shall be segregated to the extent practicable to minimize recycling or disposal costs.

Note 3: Avoid generating mixed waste by substituting non-regulated chemicals and solvents, using non-radioactive assay techniques, and properly identifying and separating chemical and radioactive wastes.

e. Attach a completed "NCI-Frederick Hazardous Waste Disposal Summary Sheet" (Exhibit D-1-2) to each waste container. This sheet contains the following required information:

i. On-site generator's name, building and room number, telephone extension, and center number;

ii. Satellite accumulation start date (i.e., date waste is first added to the container at a satellite accumulation point); and container size (e.g. 20 liters).

iii. Waste contents: each time waste is added to the container, list the following information:

(a) chemical name(s);

(b) amount added to the container;

(c) initials of person adding waste to the container;

Note: Sheets are available from EHS, x 1451

f. Waste containers must be closed at all times unless waste is being added to the container. Check containers regularly to make sure that they are not leaking. If containers are found to be leaking, immediately notify EHS at x1451 or call x911.

g. Leave at least 3 inches of head space in any hazardous waste drum containing liquid.

h. Hazardous wastes are picked up weekly. Call EHS at x5718 to arrange for pickup. All wastes shall be properly identified. Check the Material Safety Data Sheet (MSDS) to identify hazardous components in products such as batteries, maintenance and cleaning products, and photographic chemicals. Many of these must be disposed of as hazardous waste.

I. Never place hazardous wastes in the trash. If not hazardous waste, burnable items (e.g., benchtop liners, pipet tips) minimally contaminated with carcinogens should be double-bagged and placed in the medical waste carts for pickup by the Army and incineration.

Note: contact EHS for approval before using this disposal method.

j. Dilute aqueous solutions of many carcinogens, such as ethidium bromide, may be poured into special one gallon plastic containers packed with absorbent material, which are available from the warehouse, (SWPH# 81151082 for jugs, and SWPH# 81151081 for powersorb). Fill until the first free liquid can be seen at the bottom of the container. When free liquid is just visible, the container shall be capped, placed in a plastic bag, labeled “Caution - Chemical Carcinogen", and placed in a medical waste cart for incineration by USAG personnel. Stock solutions, undiluted carcinogens, and any

regulated hazardous wastes must be disposed of through EHS. Call Waste Management at x5718.

Note: contact EHS for approval before using this disposal method.

k. Empty chemical bottles should be rinsed before disposal as non-contaminated trash. Empty bottles with residues of acutely hazardous or "P-listed" chemicals (Table D-1-4) must be disposed of as hazardous waste, or the bottle must be triple-rinsed with water, detergent or an appropriate solvent, and the rinsate must be collected for disposal as hazardous waste. Examples of “P-listed" chemicals include cyanides, sodium azide, and epinephrine. Note that in Maryland, wastes containing as little as 500 ppm of polychlorinated biphenyls are considered acutely hazardous, and container residues must be disposed of as hazardous waste.

l. Do Not mix radioactive and chemical wastes. Disposal of such mixtures may be impossible, extremely difficult, or expensive.

C. Radiological Waste

1. This includes those solid and liquid wastes with measurable quantities of radiation. EHS personnel will pick up radioactive wastes. For questions or to arrange for pickup call x1384.

a. Solid Radioactive Waste - shall be segregated whenever possible, based on the isotopic half-life as follows:

i. Class 1: isotopes with a half-life less than 15 days (e.g., ^{32}P, ^{111}In).

ii. Class 2: isotopes with a half-life of from 15 to 100 days (e.g., ^{33}P, ^{51}Cr, ^{125}I).

iii. Class 3: isotopes with a half-life greater than 100 days (e.g., ^{3}H, ^{14}C, ^{63}Ni).

Each class of waste will be placed into separate, clear, plastic bags, which are labeled to indicate each name, date, program number, isotope and associated activity. The labels

(SPWH # 66401279) are available from the warehouse. The bags are then placed into the 30-gallon solid waste drums labeled and supplied by EHS.

b. Radioactive Animal Carcasses - Animal carcasses or animal parts containing radioisotopes shall be segregated and sealed in polyethylene bags. These bags must be properly labeled to include the name, date, program number, isotope(s), number of animals, and total activity using label SPWH # 66401279, available from the Warehouse. The animal carcasses must be hard frozen for pickup.

c. Scintillation Vials – Return used LS vials to the compartmentalized cardboard containers (flats) or double bag after separation into the following groups:

i. Tritium (^{3}H) and carbon (^{14}C): vials containing less than 0.05 microcuries/gram of fluid (3×10^{4} cpm/ml fluid) are may be placed with background vials. Tritium (^{3}H) and carbon (^{14}C) vials containing greater than an average of 0.05 microcuries/gram of fluid must be kept separate from all other LS vials.

If unsure, call Waste Management x1384 for help.

ii. Phosphorus (^{32}P), and iodine (^{131}I) vials may be mixed together and will be disposed of as radioactive waste.

iii. All other isotopes with a half-life of less than 100 days, such as sulfur (^{35}S), chromium (^{51}Cr), selenium (^{75}Se), and iodine (^{125}I) may be mixed together and will be disposed of as radioactive waste.

Label each group of waste with a dry waste tag to indicate name, date, program number, isotope, and associated activity. Also label with the "NCI-Frederick Hazardous Waste Disposal Summary Sheet" to identify all chemicals and/or scintillation cocktails present. Avoid generation of mixed waste by using non-hazardous cocktails whenever possible. Contact Waste Management or Radiation Safety at 1451 for a list of non-hazardous cocktails.

d. Liquid Radioactive Waste

Mixed Wastes. Liquids that are both radioactive AND hazardous (flammable, corrosive, toxic or reactive - or listed wastes) are especially expensive to dispose. Carboys containing chemicals such as ethanol, methanol greater than 5% and/or containing any F-listed chemicals (Table D-1-2), and/or any toxic chemicals (Table D-1-1) will be considered mixed waste and must be kept separate from the aqueous radioactive carboys.

Please contact Waste Management (x 5718) if you believe you will be generating this type of waste.

ii. Aqueous radioactive waste: Lab personnel should carefully place liquid waste into a radioactive waste carboy inside a steel secondary container and log the volume and activity on the contents sheet.

Segregate aqueous wastes by isotope. Never mix isotopes within a waste carboy.

If your lab generates aqueous ^{32}P waste routinely, please contact Waste Management x1384 and we will be happy to include you in the Liquid Decay program.

The total activity per carboy should not exceed the following levels per isotope listed:

Carbon (^{14}C)	3 millicuries
Tritium (^{3}H)	10 millicuries of each
Sulfur (^{35}S)	4 millicuries
Iodine (^{125}I)	1 millicuries
Chromium (^{51}Cr)	1 millicuries
Phosphorus (^{33}P)	1 millicurie
Phosphorus (^{32}P)	1 millicurie
Indium (^{111}In)	1 millicurie

For high activity, low volume waste (>1-10 mCi) such as source vials or reagents, store the waste in the

original container or vial and place in a bag with a waste tag. Call Waste Management at x1384 for pickup.

D. Ordinary Office and Lunchroom Trash (Non- Laboratory, Non-Medical, Non-Hazardous, Non-Radioactive)

1. Burnable waste includes most materials from non-laboratory work areas, including offices, lunch rooms and meeting rooms.

- Please recycle paper, cardboard, soda cans , soda bottles at base drop-off locations which can be found at: http://home.ncifcrf.gov/ehs/recycling/

- Toner or ink cartridges, fluorescent light bulbs and batteries – please call waste management at x5718.

Please be aware that although the trash in the burnable dumpsters are usually incinerated, there are times when it is taken directly to the Fort Detrick landfill by the Army. Therefore, laboratory wastes must never be placed in any dumpster, even the ones designated as "Burnable".

2. Non-burnable waste includes scrap metal, aluminum cans, glass, etc. Many of these items can be recycled. Call the Fort Detrick Recycling Center for information on the recycling program at 9-619-2323.

3. Waste generated off the NCI-Frederick should not be brought onto Fort Detrick for disposal. The only exception is material that can be recycled by the USAG recycling program. Any questions about what materials can be recycled should be directed to Waste Management at x5718 or the USAG Recycling Center at 9-619-2323.

Note: Do Not use a red bag for office/lunch room trash or recycling items. Red bags are only for medical or laboratory waste.

E. Waste Minimization

1. The NCI-Frederick is required to minimize hazardous waste generated. Useful waste minimization techniques include:

a. Substitution of less hazardous products. For example, replace mercury thermometers with non-mercury alternatives available from the supply warehouse. Replace flammable and potentially toxic scintillation counting fluids with environmentally friendly alternatives available from the central supply warehouse.

b. Ordering chemicals in minimum quantities. Excessive chemical orders represent a significant waste of resources. Some vendors have begun offering smaller-size packages to reduce waste, enhance safety, and avoid problems associated with storage and contamination.

c. Checking the surplus chemical listing before ordering chemicals. EHS provides a list of surplus chemicals available at no cost. Most surplus chemicals are in unopened containers, and a list is circulated every other month. Contact EHS at x5718 or check online at http://web.ncifcrf.gov/campus/safety/avail/index.stm for updated surplus inventory lists.

d. Recovering and reusing chemicals. Many solvents can be redistilled and reused, and the procedure is economical for medium to large scale processes. Contact waste management, x5718, for more details.

e. Using silver-recovery units on all photographic processing equipment. These units recover significant amounts of silver – an EPA hazardous waste - which would otherwise be released into the environment. Call EHS (x5718) if you use a chemical photo processor that does not have a silver recovery unit.

f. Order compressed gases from vendors that offer returnable cylinders. Non-returnable cylinders such as lecture bottles may incur significant disposal costs.

g. Maintenance products used for degreasing operations and spray paints containing environmentally friendly chemicals should be used instead of degreasers containing halogenated solvent.

VI. References

Fort Detrick Regulation 385-4 - Management of Medical Waste, Section D-1
Health, Safety and Environmental Compliance Program Manual - Hazardous Waste Disposal
Fort Detrick Regulation 200-7 “Sanitary Sewer Disposal”
Waste Minimization SOP
COMAR 26.13 Disposal of Controlled Hazardous Substances
COMAR 10.06.06 Handling, Treatment, and Disposal of Special Medical Waste
40 CFR 260: Hazardous Waste Management System, General
40 CFR 261: Identification and Listing of Hazardous Waste
40 CFR 262: Standards Applicable to Generators of Hazardous Waste
Executive Order 13148: Federal Compliance With Right-to-Know Laws and Pollution Prevention Requirements.
NCI-Frederick Pollution Prevention Plan
Maryland Environment Article, Title 7, Subtitle 2 - Controlled Hazardous Substances

Exhibit D-1-1
Waste Management Guide

Waste Type	Method Of Disposal	Comments
Potentially infectious material, i.e. blood, serum, bacterial cultures, viral cultures, etc.	Disinfect using appropriate chemical or autoclave. Put in biomedical waste box or red-tinted bag. Put in medical waste cart.	For autoclaving, use autoclave bag (not red-tinted bag). All waste from BSL-3 labs must be disinfected or autoclaved before removal from lab.
Other laboratory waste, i.e, gloves, gowns, culture tubes, petri plates, pipettes, vials, animal bedding, etc.	Biomedical waste container, broken glass boxes, or red-tinted bags available from warehouse. Place in medical waste cart.	Red-tinted plastic bags must not be used for materials which may puncture bag.
Needles and syringes	Special sharps container available from warehouse, container stays in lab until ready for pickup. Put in medical waste cart outside the building.	Seal sharps containers when three-fourths full.
Animals, pathological waste	Place in bags and put in designated animal carts before 10 a.m. Monday - Friday.	Call 9-619-2323 for pickup.
Chemical waste[1]	Place in appropriate containers available from waste management or in DOT-specification drum.	Attach NCI-Frederick Hazardous Waste Summary Sheet to each container. Call EHS, X5718 for pickup.
Radioactive waste[2]	Place in appropriate container.	Call EHS, X1384 for pickup.
Non-medical waste, burnable, i.e. paper products, food items, and Styrofoam.	Office trash cans or other appropriate container.	Place in burnable dumpster unless it can be recycled.
Recycling Non-burnable, scrap metal, building materials, paper, cardboard, etc.	Place in appropriate recycling containers.	Call the Army Recycling Center (619-2323) with questions about recycling.

[1] Specific instructions for the packaging and disposal of chemical waste can be obtained by calling EHS at X5718

[2] Specific instructions for the packaging and disposal of radioactive wastes can be obtained by calling EHS at X1384

Exhibit D-1-2
NCI-Frederick Hazardous Waste Disposal
Summary Sheet

Print Your Name:_____

Bldg. & Room:_____ Department:_____

Center No:_____ Satellite Accumulation Start Date:_____

INSTRUCTIONS:

- Please fill out one Summary Sheet for each container of waste.
- Accurately summarize the container contents as they are added to the container.
- Amounts must be in liters or kilograms.
- Use proper chemical names and write neatly. DO NOT use chemical formulas, structures, or abbreviations.
- Container must be closed when not in use.
- Attach multiple sheets if more room is needed.

Chemical Waste pickups are on Wednesday mornings. To schedule a pickup, call Waste Management at X5718, or e-mail to chemwaste@ncifcrf.gov.

Container Summary:

Chemicals	Amounts (Liter/ Kilogram)
Example: Ethyl Acetate	3.5 liters
Total Amount	

Table D-1-1
Maximum Concentration Of Contaminants For The
Toxicity Characteristic

EPA HW No.[1]	Contaminant	CAS No.[2]	Regulatory Level (mg/L)
D004	Arsenic	7440-38-2	5.0
D005	Barium	7440-39-3	100.0
D018	Benzene	71-43-2	0.5
D006	Cadmium	7440-43-9	1.0
D019	Carbon tetrachloride	56-23-5	0.5
D020	Chlordane	57-74-9	0.03
D021	Chlorobenzene	108-90-7	100.0
D022	Chloroform	67-66-3	6.0
D007	Chromium	7440-47-3	5.0
D023	o-Cresol	95-48-7	[4]200.0
D024	m-Cresol	108-39-4	[4]200.0
D025	p-Cresol	106-44-5	[4]200.0
D026	Cresol		[4]200.0
D016	2,4-D	94-75-7	10.0
D027	1,4-Dichlorobenzene	106-46-7	7.5
D028	1,2-Dichloroethane	107-06-2	0.5
D029	1,1-Dichloroethylene	75-35-4	0.7
D030	2,4-Dinitrotoluene	121-14-2	[3]0.13
D012	Endrin	72-20-8	0.02
D031	Heptachlor (and its epoxide)	76-44-8	0.008
D032	Hexachlorobenzene	118-74-1	[3]0.13
D033	Hexachlorobutadiene	87-68-3	0.5
D034	Hexachloroethane	67-72-1	3.0
D008	Lead	7439-92-1	5.0
D013	Lindane	58-89-9	0.4
D009	Mercury	7439-97-6	0.2
D014	Methoxychlor	72-43-5	10.0
D035	Methyl ethyl ketone	78-93-3	200.0
D036	Nitrobenzene	98-95-3	2.0
D037	Pentrachlorophenol	87-86-5	100.0
D038	Pyridine	110-86-1	[3]5.0
D010	Selenium	7782-49-2	1.0
D011	Silver	7440-22-4	5.0
D039	Tetrachloroethylene	127-18-4	0.7
D015	Toxaphene	8001-35-2	0.5
D040	Trichloroethylene	79-01-6	0.5
D041	2,4,5-Trichlorophenol	95-95-4	400.0
D042	2,4,6-Trichlorophenol	88-06-2	2.0
D017	2,4,5-TP (Silvex)	93-72-1	1.0
D043	Vinyl chloride	75-01-4	0.2

[1]Hazardous waste number.
[2]Chemical abstracts service number.
[3]Quantitation limit is greater than the calculated regulatory level. The quantitation limit therefore becomes the regulatory level.
[4]If o-, m-, and p-Cresol concentrations cannot be differentiated, the total cresol (D026) concentration is used. The regulatory level of total cresol is 200 mg/l.

Table D-1-2
Hazardous Wastes From Non-Specific Sources

EPA hazardous waste No.	Hazardous waste
F001	The following spent halogenated solvents used in degreasing: Tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and chlorinated fluorocarbons; all spent solvent mixtures/blends used in degreasing containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures
F002	The following spent halogenated solvents: Tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, ortho-dichlorobenzene, trichlorofluoromethane, and 1,1,2-trichloroethane; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those listed in F001, F004, or F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.
F003	The following spent non-halogenated solvents: Xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, and methanol; all spent solvent mixtures/blends containing, before use, only the above spent non-halogenated solvents; and all spent solvent mixtures/blends containing, before use, one or more of the above non-halogenated solvents, and, a total of ten percent or more (by volume) of one or more of those solvents listed in F001, F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.
F004	The following spent non-halogenated solvents: Cresols and cresylic acid, and nitrobenzene; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.
F005	The following spent non-halogenated solvents: Toluene, methyl ethyl ketone, carbon disulfide, isobutanol, pyridine, benzene, 2-ethoxyethanol, and 2-nitropropane; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, or F004; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.
F027	Discarded unused formulations containing tri-, tetra-, or pentachlorophenol or discarded unused formulations containing compounds derived from these chlorophenols.[1] (This listing does not include formulations containing Hexachlorophene synthesized from prepurified 2,4,5-trichlorophenol as the sole component).

[1] Compounds derived from chlorophenols include tetra-, penta-, and hexachlorodibenzo-*p*-dioxins; tetra-, penta-, and hexachlorodibenzofurans; and tri-, tetra-, and pentachlorophenols and their chlorophenoxy derivative acids, esters, ethers, amine and other salts.

Table D-1-3
U-Listed Hazardous Wastes

Hazardous waste No.	Chemical abstracts No.	Substance
U394	30558-43-1	A2213
U001	75-07-0	Acetaldehyde (I)
U034	75-87-6	Acetaldehyde, trichloro-
U187	62-44-2	Acetamide, N-(4-ethoxyphenyl)-
U005	53-96-3	Acetamide, N-9H-fluoren-2-yl-
U240	194-75-7	Acetic acid, (2,4-dichlorophenoxy)-, salts & esters
U112	141-78-6	Acetic acid ethyl ester (I)
U144	301-04-2	Acetic acid, lead(2+) salt
U214	563-68-8	Acetic acid, thallium(1+) salt
see F027	93-76-5	Acetic acid, (2,4,5-trichlorophenoxy)-
U002	67-64-1	Acetone (I)
U003	75-05-8	Acetonitrile (I,T)
U004	98-86-2	Acetophenone
U005	53-96-3	2-Acetylaminofluorene
U006	75-36-5	Acetyl chloride (C,R,T)
U007	79-06-1	Acrylamide
U008	79-10-7	Acrylic acid (I)
U009	107-13-1	Acrylonitrile
U011	61-82-5	Amitrole
U012	62-53-3	Aniline (I,T)
U136	75-60-5	Arsinic acid, dimethyl-
U014	492-80-8	Auramine
U015	115-02-6	Azaserine
U365	2212-67-1	H-Azepine-1-carbothioic ajvw¿
U010	50-07-7	Azirino[2',3':3,4]pyrrolo [1,2-a]indole-4,7-dione, 6-amino-8-[(aminocarbonyl)oxy]methyl]-1,1a,2,8,8a,8b-hexahydro-8a-methoxy-5-methyl-, [1aS-(1aalpha, 8beta,8aalpha,8balpha)]-
U280	101-27-9	Barban.
U278	22781-23-3	Bendiocarb.
U364	22961-82-6	Bendiocarb phenol.
U271	17804-35-2	Benomyl.
U157	56-49-5	Benz[j]aceanthrylene, 1,2-dihydro-3-methyl-
U016	225-51-4	Benz[c]acridine
U017	98-87-3	Benzal chloride
U192	23950-58-5	Benzamide, 3,5-dichloro-N-(1,1-dimethyl-2-propynyl)-
U018	56-55-3	Benz[a]anthracene
U094	57-97-6	Benz[a]anthracene, 7,12-dimethyl-
U012	62-53-3	Benzenamine (I,T)
U014	492-80-8	Benzenamine, 4,4'-carbonimidoylbis [N,N-dimethyl-
U049	3165-93-3	Benzenamine, 4-chloro-2-methyl-, hydrochloride

Table D-1-3
U-Listed Hazardous Wastes

Hazardous waste No.	Chemical abstracts No.	Substance
U093	60-11-7	Benzenamine, N,N-dimethyl-4-(phenylazo)-
U328	95-53-4	Benzenamine, 2-methyl-
U353	106-49-0	Benzenamine, 4-methyl-
U158	101-14-4	Benzenamine, 4,4'-methylenebis[2-chloro-
U222	636-21-5	Benzenamine, 2-methyl-, hydrochloride
U181	99-55-8	Benzenamine, 2-methyl-5-nitro-
U019	71-43-2	Benzene (I,T)
U038	510-15-6	Benzeneacetic acid, 4-chloro-alpha-(4-chlorophenyl)-alpha-hydroxy-, ethyl ester
U030	101-55-3	Benzene, 1-bromo-4-phenoxy-
U035	305-03-3	Benzenebutanoic acid, 4-[bis(2-chloroethyl)amino]-
U037	108-90-7	Benzene, chloro-
U221	25376-45-8	Benzenediamine, ar-methyl-
U028	117-81-7	1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
U069	84-74-2	1,2-Benzenedicarboxylic acid, dibutyl ester
U088	84-66-2	1,2-Benzenedicarboxylic acid, diethyl ester
U102	131-11-3	1,2-Benzenedicarboxylic acid, dimethyl ester
U107	117-84-0	1,2-Benzenedicarboxylic acid, dioctyl ester
U070	95-50-1	Benzene, 1,2-dichloro-
U071	541-73-1	Benzene, 1,3-dichloro-
U072	106-46-7	Benzene, 1,4-dichloro-
U060	72-54-8	Benzene, 1,1'-(2,2-dichloroethylidene)bis [4-chloro-
U017	98-87-3	Benzene, (dichloromethyl)-
U223	26471-62-5	Benzene, 1,3-diisocyanatomethyl-(R,T)
U239	1330-20-7	Benzene, dimethyl-(I,T)
U201	108-46-3	1,3-Benzenediol
U127	118-74-1	Benzene, hexachloro-
U056	110-82-7	Benzene, hexahydro-(I)
U220	108-88-3	Benzene, methyl-
U105	121-14-2	Benzene, 1-methyl-2,4-dinitro-
U106	606-20-2	Benzene, 2-methyl-1,3-dinitro-
U055	98-82-8	Benzene, (1-methylethyl)-(I)
U169	98-95-3	Benzene, nitro-
U183	608-93-5	Benzene, pentachloro-
U185	82-68-8	Benzene, pentachloronitro-
U020	98-09-9	Benzenesulfonic acid chloride (C,R)
U020	98-09-9	Benzenesulfonyl chloride (C,R)
U207	95-94-3	Benzene, 1,2,4,5-tetrachloro-
U06	50-29-3	Benzene, 1,1'-(2,2,2-trich[illegible]
U247	72-43-5	Benzene, 1,1'-(2,2,2-trichloroethylidene)bis [4- methoxy-

Table D-1-3
U-Listed Hazardous Wastes

Hazardous waste No.	Chemical abstracts No.	Substance
U023	98-07-7	Benzene, (trichloromethyl)-
U234	99-35-4	Benzene, 1,3,5-trinitro-
U021	92-87-5	Benzidine
U202	181-07-2	1,2-Benzisothiazol-3(2H)-one, 1,1-dioxide, & salts
U364	22961-82-6	1,3-Benzodioxol-4-ol, 2,2-dimethyl-,
U278	22781-23-3	1,3-Benzodioxol-4-ol, 2,2-dimethyl-, methyl carbamate.
U203	94-59-7	1,3-Benzodioxole, 5-(2-propenyl)-
U141	120-58-1	1,3-Benzodioxole, 5-(1-propenyl)-
U090	94-58-6	1,3-Benzodioxole, 5-propyl-
U367	1563-38-8	7-Benzofuranol, 2,3-dihydro-2,2-dimethyl-
U064	189-55-9	Benzo[rst]pentaphene
U248	181-81-2	2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-phenyl-butyl)-, & salts, when present at concentrations of 0.3% or less
U022	50-32-8	Benzo[a]pyrene
U197	106-51-4	p-Benzoquinone
U023	98-07-7	Benzotrichloride (C,R,T)
U085	1464-53-5	2,2'-Bioxirane
U021	92-87-5	[1,1'-Biphenyl]-4,4'-diamine
U073	91-94-1	[1,1'-Biphenyl]-4,4'-diamine, 3,3'-dichloro-
U091	119-90-4	[1,1'-Biphenyl]-4,4'-diamine, 3,3'-dimethoxy-
U095	119-93-7	[1,1'-Biphenyl]-4,4'-diamine, 3,3'-dimethyl-
U401	97-74-5	Bis(dimethylthiocarbamoyl) sulfide.
U400	120-54-7	Bis(pentamethylene)thiuram tetrasulfide.
U225	75-25-2	Bromoform
U030	101-55-3	4-Bromophenyl phenyl ether
U128	87-68-3	1,3-Butadiene, 1,1,2,3,4,4-hexachloro-
U172	924-16-3	1-Butanamine, N-butyl-N-nitroso-
U031	71-36-3	1-Butanol (I)
U159	78-93-3	2-Butanone (I,T)
U160	1338-23-4	2-Butanone, peroxide (R,T)
U053	4170-30-3	2-Butenal
U074	764-41-0	2-Butene, 1,4-dichloro-(I,T)
U143	303-34-4	2-Butenoic acid, 2-methyl-, 7-[[2,3-dihydroxy-...2-(1-methoxyethyl)-3-methyl-1-oxobutoxy]methyl]-...2,3,5,7 a-tetr€— ester,...[1S-[1alpha(Z),7(2S*,3R*),7aalpha]]-
U031	71-36-3	n-Butyl alcohol (I)
U392	2008-41-5	Butylate.
U136	75-60-5	Cacodylic acid
U032	13765-19-0	Calcium chromate