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July 19, 1979

To: Dow Cancellation Hearing Witnesses

As some of you may have heard by now, the Environmental Protection Agency issued a notice on July 9 calling for public hearings on the remaining, non-suspended uses of 2,4,5-T and silvex. After a number of legal procedural requirements are completed, this public hearing will be consolidated with the pending hearing on the previously suspended uses. While it is difficult to make accurate predictions at this time, we anticipate that the combined hearing will begin in November.

Meanwhile, we are continuing to work with many of you in the preparation of draft testimony. For your information, we have enclosed copies of the risk witness and exhibit lists filed by Dow, EPA, and USDA which will give you some idea of the scope of the risk portion of the hearing. These lists are, of course, subject to change.

With respect to the Dow witness and exhibit list, we prepared a description of your testimony based either on the draft testimony we have or on our best expectation as to what you would cover and which exhibits you would introduce. Neither the descriptions nor the potential exhibits are binding, and these will undoubtedly change as our preparation continues over the next several months.

You will also find enclosed copies of EPA's position documents on 2,4,5-T and silvex which were completed in early July. These documents set forth EPA's latest position on the issues.

We will continue to keep you advised as we learn more about the timing of the case and other matters of mutual interest. In the meantime, feel free to call me or any of the other attorneys for Dow who have been working with you should you have any questions.

Sincerely yours,

Edward W. Warren

Edward W. Warren

JUL 17 [illegible]

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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| In re: The Dow Chemical Company, et al. | FIFRA Dockets No. 415, et al. |

# RESPONDENT'S DIRECT EVIDENCE SUBMISSION ON RISKS AND PRELIMINARY STATEMENT REGARDING RISK TESTIMONY AND EVIDENCE

Dorothy E. Patton
Patricia A. Roberts
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U. S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

July 17, 1979

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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|---|---|
| In re: The Dow Chemical Company, et al. | FIFRA Dockets No. 415, et al. |

RESPONDENT'S DIRECT EVIDENCE SUBMISSION ON RISKS AND PRELIMINARY STATEMENT REGARDING RISK TESTIMONY AND EVIDENCE

Pursuant to the June 7, 1979 order of the Administrative Law Judge, respondent is submitting a list of witnesses who will testify regarding risk issues in the above-captioned cancellation proceedings.

This memorandum briefly presents respondent's preliminary plans for the presentation of direct evidence on risks. In Part I of this memorandum, respondent outlines the general nature and objectives of the testimony which the risk witnesses will present; the appended list of witnesses and exhibits provides specific details. In Part II, respondent comments on other matters relating to the list of witnesses and plans for testimony.

## I. NATURE AND PURPOSE OF TESTIMONY ON THE RISKS OF 2,4,5-T AND SILVEX

On February 28, 1979, the Administrator issued notices of intent to cancel certain registrations of the phenoxy herbicides 2,4,5-T and silvex.*/ (44 Fed. Reg. 15893; 44 Fed Reg. 15917.)

*/ The Administrator suspended the forest, rights-of-way, and pasture uses of 2,4,5-T and silvex, and the home and garden, aquatic weed control/ditch bank and commerical/ornamental turf uses of silvex ("suspended uses").

In the cancellation proceedings, respondent, as the proponent of cancellation or change in classification, has the burden of going forward to present an affirmative case for cancellation or change in classification of the registration. 40 CFR §164.80(a). However, on all issues arising in connection with the hearing, the ultimate burden of persuasion rests with the proponent of registration. 40 CFR §164.80(b).

The witnesses and exhibits listed in the attached appendix will meet respondent's burden, as to risk issues, of going forward with an affirmative case for cancellation of the suspended uses of 2,4,5-T and silvex. They will do so by testimony and evidence on three fundamental issues which provided the bases for the Administrator's decision to issue notices of intent to cancel these uses of 2,4,5-T and silvex.

First, respondent's witnesses will testify that 2,4,5-T, silvex and/or their common dioxin contaminant, TCDD, */ produce toxic effects such as tumors, fetal loss, and retarded or deformed fetal development in test animals exposed to these chemicals. These witnesses will testify that these effects are observed in several different mammalian species, including monkeys, and that monkeys and rats experience these effects at

*/ TCDD is present in commerical formulations of silvex and 2,4,5-T as a by-product of the manufacturing processes for these herbicides.

very low levels of exposure. These witnesses will also testify that concern for the health of humans who may be exposed to 2,4,5-T, silvex, and TCDD is heightened because scientists have not identified a no-adverse-effect level for TCDD in test animals, nor an exposure level at which humans are unlikely to experience adverse effects.

Second, Agency witnesses will testify that several epidemiological investigations of human populations living and working in some areas of 2,4,5-T use or other exposure show that these persons appear to be at increased risk of developing cancer or of having abnormal pregnancies. These witnesses will testify that these data are particularly important as indicators that humans who live and work in areas where 2,4,5-T and/or TCDD are present in the environment may experience effects comparable to those observed in test animals.

Third, respondent's witnesses will testify that customary and ordinary usage of 2,4,5-T and silvex creates opportunities for direct or indirect exposure to these chemicals and TCDD. Some witnesses will present data and information showing that these chemicals are distributed during or after use to routes of human exposure such as air, water, and food. Other witnesses will testify that 2,4,5-T and silvex remain in these media for a few days to several weeks, that under some environmental conditions TCDD persists for much longer periods of time, and that the amounts of TCDD may accumulate.

In sum, respondent's witnesses will testify that the occurrence of adverse effects in test animals exposed to 2,4,5-T, silvex and/or TCDD, the increased risks of cancer and adverse reproductive effects in some human populations exposed to these chemicals, and the exposure resulting from the use of these chemicals indicates that the uses of these pesticides may have adverse consequences for human health.

## II. COMMENTS ON THE WITNESS LIST AND TESTIMONY

### Revisions of the Witness List

The appended List of Witnesses and Exhibits reflects respondent's present plan for the submission of direct evidence. At this stage in these proceedings, these plans are necessarily tentative, and may change as respondent is informed of the plans of other parties and re-shapes its own plans accordingly.

Apart from changes developed in response to plans of the other parties, respondent may also add or replace witnesses in order to present information contained in the constant influx of new information which has followed the emergency suspension of 2,4,5-T and silvex. Some of the information in the letters and reports which the Agency receives from domestic and foreign sources, from professionals and the general public appears to have relevance to these proceedings. Where responent's investigations disclose that the information has a direct and useful relationship to the issues addressed by the current witness list, respondent may

revise the list to incorporate this new evidence into its hearing plans.

Oral Direct Testimony

Consistent with Judge Finch's directive, respondent intends to present its direct case through the submission of written materials. However, several witnesses have indicated that models, photographs, and other materials will assist their testimony, and these materials are listed as exhibits. Although respondent will arrange to reduce as many of these materials as possible to paper, oral testimony limited to direct references to the physical exhibits may permit a more lucid presentation of the information represented in some of these materials. Respondent intends to request permission to present a selected and limited amount of evidence of this type through oral direct testimony and will propose a mechanism to define circumstances which would justify departure from the general procedures based on written direct testimony.

Respectfully submitted,

Dorothy E. Patton

Dorothy E. Patton, Attorney
Patricia A. Roberts
Ellen Siegler
Kevin Lee

July 17, 1979

## APPENDIX

## LIST OF WITNESSES AND EXHIBITS

DR. ROY ALBERT
Carcinogen Assessment Group
Environmental Protection Agency
Washington, D.C.

Dr. Albert, Chairman of EPA's Carcinogen Assessment Group (CAG), will testify regarding the CAG's evaluation of studies showing that exposure to TCDD produces tumors in test animals. His testimony will also include the CAG review of other studies and information on the cancer-causing effects of TCDD, 2,4,5-T and silvex.

Exhibits

Van Miller, J.P., J.J. Lalich, and J.R. Allen. 1977. Increased incidence of neoplasms in rats exposed to low levels of 2,3,7,8-tetrachlordibenzo-p-dioxin. Chemosphere 6(10): 625-632.

Kociba, R.J., D.G. Keyes, J.E. Beyer, R.M. Carreon, C.E. Wade, D.A. Dittenber, R.P. Kalnins, L.E. Frauson, C.N. Park, S.D. Barnard, R.A. Hummel, and C.G. Humiston. 1978. Results of a two-year chronic toxicity and oncogenicity study of 2,3,7,8-tetrachlordibenzo-p-dioxin in rats. Toxicol. Appl. Pharmacol. 46: 279-303.

Wogan, Paglialunga and Newberne. 1974. Carcinogenic Effects of low Dietary Levels of Aflafoxin B in rats. Food Cosmet. Toxicol. 12: 681-685.

Affidavit of Robert H. Harris, July 12, 1978. 2,4,5-T RPAR Rebuttal Submission 30000/26: #2392.

Letter from Thomas E. Fischetti, National Cancer Institute, to Dr. Elizabeth Anderson, EPA. January 21, 1979. NCI Bioassay of TCDD, Preliminary Animal Pathology Report.

Risk Assessment for 2,4,5-T and TCDD. February 23, 1979. Carcinogen Assessment Group. Summary and Conclusions (Draft)

Albert, R. E., R. E. Train, and E. Anderson. 1977. Rationale Developed by the Environmental Protection Agency for the Assessment of Carcinogenic Risk. J. Natl. Cancer Inst. 58(2): 1537-1541.

* * *

DR. ROBERT SQUIRE
Johns Hopkins University
Baltimore, Maryland

Dr. Squire, the veterinary pathologist who reviewed the oneogencity studies for the Clement Report, will testify regarding the methodology, data, and general findings upon which the oncogenicity analysis in the Clement Associates' Report on "Exposure, Toxicity and Risk Assessment of 2,4,5-T/TCDD" is based.

Exhibits

Clement Associates. 1979. Exposure, Toxicity and Risk Assessment of 2,4,5-T/TCDD. Oncogenicity.

Muranyi-Kovacs, I.G. Rudali, and J. Imbert. 1976. Bioassay of 2,4,5-trichlorphenoxyacetic acid for Carcinogenicity in mice, Br. J. Cancer 33:626-633.

Innes, J.R.M., B.M. Ulland, M.G. Valerio, L. Petrucelli, L. Fishbein, E.R. Hart, A.J. Pallotta, R.R. Bates, H.L. Falk, J.J. Gart, M. Klein, I. Mitchell, and J. Peters. 1969. Bioassay of pesticides and industrial chemicals for tumorigenicity in mice: a preliminary note. J. Natl. Cancer Inst. 42:1101-1114.

Toth, et.al. 1979, Carcinogenicity testing of herbicide 2,4,5-trichlorophenoxyethanol containing dioxin and of pure dioxin in Swiss Mice. Nature 278:548-549.

Kociba, R.J., D.G. Keyes, J.E. Beyer, R.M. Carreon, C.E. Wade, D.A. Dittenber, R.P. Kalnins, L.E. Frauson, C.N. Park, S.D. Barnard, R.A. Hummel, and C.G. Humiston. 1978. Results of a two-year chronic toxicity and oncogenicity study of 2,3,7,8-tetrachlordibenzo-p-dioxin in rats. Toxicol. Appl. Pharmacol. 46: 279-303.

Kociba, Keyes, Lisowe, Kaluius September 27, 1978. Results of Two Year Chronic Toxicity and Oncogenic Study of Rats Ingesting Diets containing 2,4,5-Trichlorophenoxyacetic Acid (2,4,5-T). Dow Chemical Company. (CONFIDENTIAL.)

Van Miller, J.P., J.J. Lalich, and J.R. Allen. 1977. Increased incidence of neoplasms in rats exposed to low levels of 2,3,7,8-tetrachlorodibenzo-p-dioxin. Chemosphere 6(10): 625-632.

* * *

DR. KIM HOOPER
Department of Biochemistry
University of California, Berkeley

DR. ROBERT HARRIS
Environmental Defense Fund
Washington, D.C.

Dr. Hooper and Dr. Harris will testify about their analysis (with Dr. Bruce Ames) of the relative strengths of various chemicals as animal carcinogens. Their testimony will include analyses identifying TCDD as one of the most potent carcinogens known.

EXHIBITS

Chart: Potency Scale for Chemical Carcinogens

Affidavit of Dr. Robert Harris, July 12, 1978. 2,4,5-T RPAR Rebuttal Submission 30000/26: #2392.

Manuscript (in preparation)

* * *

DR. HENRY SPENCER
Office of Pesticide Programs
Environmental Protection Agency
Washington, D.C.

Dr. Spencer will testify that Agency analysis of studies in test animals indicates that exposure to 2,4,5-T, silvex and/or TCDD results in adverse reproductive effects. He will discuss the Agency's approach to evaluating the quality of studies, the conclusions reached by toxicologists, and the applicability of these conclusions to evaluating potential human risks.

Exhibits

Decision and Emergency Order Suspending Certain Uses of 2,4,5-Trichlorophenoxyacetic Acid (2,4,5-T), 44 FR 15874 (March 15, 1979); Decision and Emergency Order Suspending Certain Uses of 2-(2,4,5-Trichlorophenoxy) propionic Acid (Silvex), 44 FR 15897 (March 15, 1979).

Rebuttable Presumption Against Registration and Continued Registration of Pesticide Products Containing 2,4,5-T, 43 FR 17116 (April 21, 1978).

Moore, J.A. 1978. Toxicity of 2,3,7,8-Tetrachlorodibenzo-para-Dioxin. In: C. Ramel (ed.), Chlorinated Phenoxy Acids and Their Dioxins. Ecol. Bull. (Stockholm) 27: 134-144.

Allen, J.R. et al. 1977. Morphological Changes in Monkeys Consuming A Diet Containing Low Levels of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin. Food Cosmet. Toxicol. 15: 401-410.

McNulty, Wilbur P. Communications to EPA dated July 27, 1978 and January 29, 1979.

Smith, F.A. et al. 1977. Three-generation Reproduction Study of Rats Ingesting 2,3,7,8-Tetrachlorodibenzo-p-dioxin. Toxicol. Appl. Pharmacol. 41: 201. [Dow Confidential Study.]

Schantz. S.L., Barsotti, D.A. and Allen, J.R. 1979. Toxicological Effects Produced in Nonhuman Primates Chronically Exposed to Fifty Parts per Trillion 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD). Abstract of paper presented at the Eighteenth Annual Meeting of the Society of Toxicology on March 11-15, 1979. Personal communications.

Smith, F.A. et al. 1977. Three-generation Reproduction Study of Rats Ingesting 2,4,5-trichlorophenoxyacetic Acid in the Diet. Toxicol. App. Pharmacol 45: 293. [Dow Confidential Study.]

Thompson, et al. 1973. Teratology and Postnatal Studies in Rats Treated Orally with 2-(2,4,5-Trichlorophenoxy)propionic Acid (Silvex) and 2-(2,4,5-Trichlorophenoxy)propionic Acid, Propylene Glycol Butyl Ether Esters (Silvex-PGBE). Dow Chemical, U.S.A. (EPA Pesticide Petition No. 8F0675). (CONFIDENTIAL.)

International Agency for Research on Cancer. 1978. Long-term Hazards of Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans.

Allen, J.R., Barsotti, D.A. and Van Miller, J.P. 1977. Reproductive Dysfunction in Nonhuman Primates Exposed to Dioxins. Toxicol. Appl. Pharmacol. 41: 177.

Leuschner, F. 1978. Chronic Oral Toxicity of 2,4,5-T, Batch No. 503, Control No. 153574 B-Short '2,4,5-T' in a reproduction study covering three generations of Sprague-Dawley rats. Laboratorium fur Pharmakologies und Toxikologies. (CONFIDENTIAL.)

Barsotti, D.A., Abrahamson, L.J. and Allen, J.R. 1979. Hormonal Alterations in Female Rhesus Monkeys Fed a Diet Containing 2,3,7,8-Tetrachlorodibenzo-p-dioxin. Bull. Environ. Contam. Toxicol. 21: 463-469.

* * *

DR. K. DIANE COURTNEY
Health Effects Research Laboratory (EPA)
Research Triangle Park, North Carolina

Dr. Courtney, a teratologist with numerous publications on the adverse reproductive effects of TCDD and phenoxy herbicides, will testify that adverse fetotoxic effects, such as growth retardation, birth defects and fetal loss occur in test animals exposed to 2,4,5-T, silvex and TCDD. In addition, Dr. Courtney will testify that in the case of TCDD, these effects have been observed at the lowest dose levels tested, and she will relate these effects to basic concepts of fetal toxicity, including the significance of animal "no effect levels" for evaluating the risk potential of TCDD.

Exhibits

Mrak, E.M, 1969. Report of the Secretary's Commission on Pesticides and Their Relationship to Environmental Health. USHEW, pp. 665-675.

Courtney, K.D., Gaylor, D.W., Hogan, M.D., Falk, H.L., Bates, R.R. and Mitchell, I. 1970. Teratogenic Evaluation of 2,4,5-T. Science 168: 864-866.

Courtney, K.D. and Moore, J.A. 1971. Teratology Studies with 2,4,5-Trichlorophenoxyacetic Acid and 2,3,7,8-Tetrachlorodibenzo-P-dioxin. Toxicol. Appl. Pharmacol. 20: 396-403.

Roll, R. 1971. Untersuchungen uber die teratogene Wirkung von 2,4,5-T bei Mausen. Fd. Cosmet. Toxicol. 9: 671-676.

Neubert, D. and Dillmann, I. 1972. Embryotoxic Effects in Mice Treated with 2,4,5-Trichlorophenoxyacetic Acid and 2,3,7,8-Tetrachlorodibenzo-p-Dioxin. Naunyn-Schmiedeberg's Arch. Pharmacol. 272: 243-264.

Courtney, D.K. 1977. Prenatal Effects of Herbicides: Evaluation by the Prenatal Development Index. Arch. Env. Contam. Toxicol. 6: 33-46.

Nelson, C.J. and Holson, J.F. 1978. Statistical Analysis of Teratologic Data: Problems and Advancements. J. Env. Path. Toxicol. 2: 187-199.

Gaines, T.B., Holson, J.F., Nelson, C.J. and Schumacher, H.J. 1975. Analysis of Strain Differences in Sensitivity and Reproducibility of Results in Assessing 2,4,5-T Teratogenicity in Mice. Tox. Appl. Pharmacol. 33: 174.

Emerson, J.L., Thompson, D.J., Strebing, R.J, Gerbig, C.G. and Robinson, V.C. 1971. Teratogenic Studies on 2,4,5-Trichlorophenoxyacetic Acid in the Rat and Rabbit. Fd. Cosmet. Toxicol. 9: 395-404.

Sparschu, G.L., Dunn, F.L., Lisowe, R.W. and Rowe, V.K. 1971. Study of the Effects of High Levels of 2,4,5-Trichlorophenoxyacetic Acid on Foetal Development in the Rat. Fd. Cosmet. Toxicol. 9: 527-530.

Fytizas-Danielidou, R. 1971. Action de L'Herbicide 2,4,5-T (Acide Trichlorophenoxyacetique) sur des Rats Blancs, Pendant la Periode de la Gestation. Annls. Inst. Phytopath. Benaki N.S. 10: 148-154.

Khera, K.S. and McKinley, W.P. 1972. Pre-and Postnatal Studies on 2,4,5-Trichlorophenoxyacetic Acid, 2,4-Dichlorophenoxyacetic Acid and Their Derivatives in Rats. Toxicol. Appl. Pharmacol. 22: 14-28.

Collins, T.F.X. and Williams, C. H. 1971. Teratogenic Studies with 2,4,5-T and 2,4-D in the Hamster. Bull. Env. Contam. Toxicol. 6: 559.

Dougherty, W.J., Herbst, M. and Coulston, F. 1975. The Non-Teratogenicity of 2,4,5-Trichlorophenoxyacetic Acid in the Rhesus Monkey. Bull. Env. Contam. Toxicol. 13: 477-482.

Dougherty, W.J., Coulston, F. and Goldberg, L. 1976. The Evaluation of the Teratogenic Effects of 2,4,5-Trichlorophenoxyacetic Acid in the Rhesus Monkey. Env. Qual. Safety 5: 89-96.

Wilson, J. G. 1972. Abnormalities of Intrauterine Development in Non-Human Primates. Acta Endocrinol. (Suppl.) 166: 261-292.

Smith, F.A., Schwetz, B.A. and Nitschke, K.D. 1976. Teratogenicity of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin in CF-1 Mice. Toxicol. Appl. Pharmacol. 38: 517-523.

Courtney, K.D. 1976. Mouse Teratology Studies with Chlorodibenzo-P-Dioxins. Bull. Env. Contam. Toxicol. 16: 674.

Sparschu, G.L., Dunn, F.L. and V.K. Rowe 1971. Study of the Teratogenicity of 2,3,7,8-Tetrachlorodibenzo-p-dioxin in the Rat. Fd. Cosmet. Toxicol. 9: 405-412.

Khera, K.S. and Ruddick, J.A. 1973. Polychlorodibenzo-p-dioxins: Perinatal Effects and the Dominant Lethal Test in Wistar Rats. Adv. in Chem. 120: 70-84.

Allen, J.R. et al. 1977. Morphological Changes in Monkeys Consuming a Diet Containing Low Levels of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin. Fd. Cosmet. Toxicol. 15: 401-410.

Schantz, S.L. Barsotti, D.A. and Allen, J.R. 1979. Toxicological Effects Produced in Nonhuman Primates Chronically Exposed to Fifty Parts per Trillion 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD). Abstract of paper presented at the Eighteenth Annual Meeting of the Society of Toxicology on March 11-15.

McNulty, Wilbur P. Communications to EPA, dated July 27, 1978 and January 29, 1979.

Murray, F.J. et al. 1978. Three Generation Reproduction Study of Rats Ingesting 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD). Dow Chemical, U.S.A.. (CONFIDENTIAL)

Leuschner, F. 1978. Chronic Oral Toxicity of 2,4,5-T, Batch No. 503, Control N. 153574 B-Short '2,4,5-T' in a reproduction study covering three generations of Sprague-Dawley rats. Laboratorium fur Pharmakologie und Toxikologie. (CONFIDENTIAL.)

Smith, F.A. et al. 1978. Three-generation Reproduction Study of Rats Ingesting 2,4,5-Trichlorophenoxyacetic Acid in the Diet. Dow Chemical, U.S.A. (CONFIDENTIAL)

Allen, J.R., Barsotti, D.A. and Van Miller, J.P. 1977. Reproductive Dysfunction in Nonhuman Primates Exposed to Dioxins. Toxicol. Appl. Pharmacol. 41: 177.

Courtney, K.D. 1970. 2,4,5-T in the Rat: Excretion Pattern, Serum Levels, Placental Transport, and Metabolism. Pesticide Symp. 6-7th Int-American Conf. on Toxicol. and Occup. Med., pp. 277-283. Halos and Assoc., Miami, FL.

Courtney, K.D., Ebron, M.T. and Tucker, A.W. 1977. Distribution of 2,4,5-Trichlorophenozyacetic Acid in the Mouse Fetus. Toxicol. Letters 1: 103-108.

Courtney, K., Putman, J.P. and Andrews, J.E. 1978. Metabolic Studies with TCDD (Dioxin) Treated Rats. Arch. Environ. Contam. Toxicol. 7: 385-396.

Smith, F.A. et al. 1977. Three-generation Reproduction Study of Rats Ingesting 2,3,7,8-tetrachlorodibenzo-p-dioxin. Toxicol. Appl. Pharmacol. 41: 201.

Smith, F.A. et al. 1977. Three-generation Reproduction Study of Rats Ingesting 2,4,5-trichlorophenoxyacetic Acid in the Diet. Toxicol. App. Pharmacol. 45: 293.

Thompson, et al. 1973. Teratology and Postnatal Studies in Rats Treated Orally with 2-(2,4,5-Trichlorophenoxy)propionic Acid (Silvex) and 2-(2,4,5-Trichlorophenoxy)propionic Acid, Propylene Glycol Butyl Ether Esters (Silvex-PGBE). Dow Chemical, U.S.A. (EPA Pesticide Petition No. 8F0675). (CONFIDENTIAL.)

Moore, J.A. and Courtney, K.D. 1971. Teratology Studies with the Trichlorophenoxyacid Herbicides, 2,4,5-T and Silvex. Teratology 4: 236.

Woo, D.C. and Hoar, R.M. 1972. "Apparent Hydronephrosis" as a Normal Aspect of Renal Development in Late Gestation of Rats: The Effect of Methyl Salicylate. Teratology 6: 191-196.

Highman, B., Gaines, T.B., and Schumacher, H.R. 1977. Retarded Development of Fetal Renal Alkaline Phosphatase in Mice Given 2,4,5-Trichlorophenoxyacetic Acid. J. Toxicol. Env. Health 2: 1007-1018.

Saxen. L 1970. The Determination and Differentiation of the Metanephric Nephron. Proc. 4th Int. Congr. Nephrol., 1969. Ed. N. Alwall. Vol. 1, pp. 29-38, Karger, N.Y.

Saxen, L. 1977. Abnormal Cellular and Tissue Interactions. In: Handbook of Teratology. Eds. Wilson, J.G. and Frasner, F.C. Vol. 2, pp. 171-198, Plenum, N.Y.

Trasler, D.G. and Fraser, F.C. 1977. Time-position Relationship, with Particular Reference to Cleft lip and Cleft palate. In: Handbook of Teratology. Eds. Wilson, J.G. and Fraser, F.C. Vol. 2, pp. 271-292, Plenum, N.Y.

Coulombre, A.J. and Clulombre, J.L. 1977. Abnormal Organogenesis in the Eye. In: Handbook of Teratology. Eds. Wilson, J.G. and Fraser, F.C. Vol. 2, pp. 329-342, Plenum, N.Y.

Monie, I.W. 1977. Abnormal Organogenesis in the Urinary Tract. In: Handbook of Teratology. Eds. Wilson, J.G. and Fraser, F.C. Vol. 2, pp. 365-390, Plenum, N.Y.

Kimbrough, R.D., Carter, C.D., Liddle, J.A., and Cline, R.E. 1977. Epidemiology and Pathology of a Tetrachlorodibenzodioxin Poisoning Episode. Arch. Env. Health March/April: 77-86.

Carter, C.D., Kimbrough, R.D., Liddle, J.A., Cline, R.E., Zack, M.M., Barthel. W.F., Koehler, R.E., and Phillips, P.E. 1975. Tetrachlorodibenzidioxin: An accidental poisoning episode in horse arenas. Science 188: 738-740.

* * *

DR. JAMES R: ALLEN
University of Wisconsin Medical Center
Department of Pathology & Regional Primate Research Center
Madison, Wisconsin

DR. WILBUR P. MCNULTY
Oregon Regional Primate Research Center
Beaverton, Oregon

Drs. Allen and McNulty will testify that exposure to low levels of TCDD results in an increased incidence of abortions and other toxic effects in rhesus monkeys. They will testify that the adverse effects of TCDD in monkeys are indicators of potential human risks, because of the similarities between these subhuman primates and man.

Exhibits (ALLEN)

Allen, J.R. et al 1977. Morphological Changes in Monkeys Consuming a Diet Containing Low Levels of 2,3,7,8-Tetrachlorodibenzo-p-dioxin. Food Cosmet. Toxicol. 15: 401-410.

Barsotti, D.A., Abrahamson, L.J. and Allen, J.R. 1979. Hormonal Alterations in Female Rhesus Monkeys Fed a Diet Containing 2,3,7,8-Tetrachlorodibenzo-p-dioxin. Bull. Environ. Contam. Toxicol. 21: 463-469.

Allen, J.R., Barsotti, D.A. and Van Miller, J.P. 1977. Reproductive Dysfunction in Nonhuman Primates Exposed to Dioxins. Toxicol. Appl. Pharmacol. 41: 177.

Allen, J.R. and Van Miller, J.P. 1978. Health Implications of 2,3,7,8-Tetrachlorodibenzo-p-dioxin Exposure in Primates. In: K.R. Rao (ed.), Pentachlorophenol - Chemistry, Pharmacology, and Environmental Toxicology, Plenum Press, New York, pages 375-377.

Schantz, S.L., Barsotti, D.A. and Allen, J.R. 1979. Toxicological Effects Produced in Nonhuman Primates Chronically Exposed to Fifty Parts per Trillion 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD). Abstract of paper presented at the Eighteenth Annual Meeting of the Society of Toxicology on March 11-15, 1979. Personal Communications to EPA.

Exhibits (MCNULTY)

Allen, J.R., Barsotti, D.A. and Van Miller, J.P. 1977, Reproductive Dysfunction in Nonhuman Primates Exposed to Dioxins. Toxicol. Appl. Pharmacol. 41: 177.

Allen, J.R. and Van Miller, J.P. 1978. Health Implications of 2,3,7,8-Tetrachlorodibenzo-p-dioxin Exposure in Primates. In: K.R. Rao (ed.), Pentachlorophenol - Chemistry, Pharmacology, and Environmental Toxicology, Plenum Press, New York, pages 375-377.

McNulty, Wilbur P. 1977. Toxicity of 2,3,7,8-Tetrachlorodibenzo-p-dioxin for Rhesus Monkeys: Brief Report. Bull. Environ. Contam. Toxicol. 18: 108-109.

McNulty, Wilbur P. Personal Communications to EPA dated July 27, 1978 and January 29, 1970.

Schantz, S.L., Barsotti, D.A. and Allen, J.R. 1979. Toxicological Effects Produced in Nonhuman Primates Chronically Exposed to Fifty Parts per Trillion 2,3,7,8-Tetrachlordibenzo-p-dioxin (TCDD). Abstract of paper presented at the Eighteenth Annual Meeting of the Society of Toxicology on March 11-15, 1979.

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DR. JOSEPH F. HOLSON
National Center for Toxicological Research (HEW)
Jefferson, Arkansas

Dr. Holson will testify regarding the importance of study design for detecting animal teratologic effects occurring at low doses, particularly factors such as test group size and strain. His testimony will include data from his

studies using 2,4,5-T which indicate that because of variability among different animal strains and among replicates of the same strain, "negative" results obtained at low doses in small groups of experimental animals are not always reliable.

Exhibits

Nelson, C.J. and Holson, J.F. 1978. Statistical Analysis of Teratologic Data: Problems and Advancements. J. Environ. Path. Toxicol. 2: 187-199.

Unpublished data collected in connection with the above study.

Gaines, T.B., Holson, J.F., Nelson, C.J. and Schumacher, H.J. 1975. Analysis of Strain Differences in Sensitivity and Reproducibility of Results in Assessing 2,4,5-Teratogenicity in Mice. Tox. Appl. Pharm. 33: 174.

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DR. JOHN A. MOORE
National Institute of Environmental Health Sciences (HEW)
Research Triangle Park, North Carolina

Dr. Moore will testify that exposure to very low levels of TCDD suppresses normal immulogical responses of test animals, thereby increasing susceptibility to some infectious agents. He will discuss the nature of the changes, their impact on the health of the animal, and the implications of these changes for human health effects.

Exhibits

Faith, R.E., and Moore J.A. 1977. Impairment of Thymus-Dependent Immune Functions by Exposure of the Developing Immune System to 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD). J. Toxicol. Environ. Health 3: 451-464.

Thigpen, J.E., Faith, R.E., McConnell, E.E., and Moore, J.A. 1975. Increased susceptibility to bacterial infection as a sequela of exposure to 2,3,7,8-tetrachlorodibenzo-p-dioxin. Infect. Immu. 12: 1319-1324.

Vos, J.G., and Moore, J.A. 1974, Suppression of cellular immunity in rats and mice by maternal treatment with 2,3,7,8-tetrachlorodibenzo-p-dioxin. Int. Arch. Allergy Appl. Immunol. 47: 777-794.

Vos, J.G., Moore, J.A., and Zinkl, J.G. 1973. Effect of 2,3,7,8-tetrachlorodibenzo-p-dioxin on the immune system of laboratory animals. Environ. Health Perspec. 5: 149-162.

Faith, R.E., and Luster, M.I. 1978. Investigations on the Effects of 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) on Parameters of Various Immune Functions. Annals N.Y. Acad. Sci. (In press).

Vos, J.G. 1977. Immune Suppression as Related to Toxicology. CRC Critical Reviews in Toxicology 5: 67-101 at 81-83.

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DR. GEORGE STREISINGER
Institute of Molecular Biology
University of Oregon,
Eugene, Oregon

Dr. Streisinger, a biologist and member of the National Academy of Sciences, will testify regarding the relationship between the TCDD exposure levels which produce acute and chronic effects in test animals and the TCDD exposure which humans may experience. Dr. Streisinger's testimony will include discussion of the risks to humans associated with exposure to TCDD.

Exhibits

Allen, J. R. and L.A. Carstens, 1967. Light and electron microscopic observations in Macaca mulatta monkeys fed toxic fat. American Journal of Veterninary Research 28: 1513-1526.

Ames, B.N., W.E. Durston, E. Yamasaki and F.D. Lee, 1973. Carcinogens are mutagens: A simple test system combining liver homogenates for activation and bacteria for detection. Proc. Nat. Acad. Sci., U.S.A. 70: 2281-2285.

BEIR report, 1972. The effects on populations of exposure to low levels of ionizing radiation. Report of the Advisory Committee on the Biological Effects of Ionizing Radiations, National Academy of Sciences - National Research Council. Publication of the Environmental Protection Agency, U.S. Government Printing Office, Washington, D.C.

Commoner, B. and R.E. Scott, 1976. U.S. Air Force Studies on the stability and ecological effects of TCDD (Dioxin): An evaluation relative to the accidental dissemination of TCDD at Seveso, Italy. Center for the Biology of Natural Systems (Washington University) Publication, November 13, 1976.

Drake, J.W., 1970. The molecular basis of mutation. Holden-Day, Inc. San Francisco.

Kearney, P.C., E.A. Wollson, A.R. Isensee and C.S. Helling, 1973. Tetrachlorodibenzo-dioxin in the environment: sources, fate and decontamination. Environmental Health Perspectives 5:

Kociba, J.J., P.A. Keller, C.N. Park and P.J. Gehring, 1976. 2,3,7,8-Tetrachlordibenzo-p-dioxin (TCDD): Results of a thirteen week oral toxicity study in rats. Toxicol. Appl. Pharmacol. 35: 553-574.

Maher, V.M. and J.E. Wessel, 1975. Mutations to azaguanine resistance induced in cultured diploid human fibroblasts by the carcinogen, N-acetoxy-2-acetylaminofluorine. Mutation Research 28: 277-284.

McCann, J., E. Choi, E. Yamasaki and B. Ames, 1975. Detection of carcinogens as mutagens in the Salmonella/microsome test: Assay of 300 chemicals. Proc. Nat. Acad. Sci., U.S.A. 72: 5135-5139.

O'Keefe, P., 1976. Testimony, Civil No. 76-438 In the U.S. District Court for the District of Oregon.

Plewa, M.J. and J.M. Gentile, 1975. A maize-microbe bioassay for the detection of proximal mutagenicity of agricultural chemicals. Maize Genetics Cooperation News Letter 49: 40-43.

Plewa, M.J. and J.M. Gentile, 1976. Mutagenicity of atrazine: a maize-microbe bioassay. Mutation Research 38: 287-292.

Rose, J.Q., J .C. Ramsey, T.H. Wentzler, R.A. Hummel and P.J. Gehring, 1976. The fate of 2,3,7,8-Tetrachlorodibenzo-p-dioxin following single and repeated oral doses to the rat. Toxicol. Appl. Pharmacol. 36: 209-229.

Train, R., 1976. Quoted in: Environmental Reporter 6: 1457.

Schwetz, B.A., J.M. Norris, G.L. Sparschu, V.K. Rowe, P.J. Gehring, J.L. Emerson and E.G. Gerbig, 1973. Toxicology of chlorinated dibenzo-p-dioxins. Environmental Health Perspectives 5: 87-99.

Yoder, J., M. Watson and W.W. Benson, 1973. Lymphocyte chromosome analysis of agricultural workers during extensive occupational exposure to pesticides. Mutation Res. 21: 335-340.

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RENATE KIMBROUGH, M.D.
Center for Disease Control (HEW)
Atlanta, Georgia

Dr. Kimbrough will testify on an epidemiologic and laboratory investigation of the consequences of exposure to a salvage oil contaminated with TCDD. She will testify that horses and other animals developed toxic symptoms.

Exhibits

Kimbrough, R.D., C. Carter, J.A. Liddle, R.E. Cline, P.E. Phillips. 1977. Epidemiology and pathology of a tetrachlorodibenzodioxin poisoning episode. Arch. Environ. Health 32(2): 77.

Kimbrough, R.D., C. Carter, J.A. Liddle, R.E. Cline, M.M. Zack, Jr., W.E. Barthel. 1975. Tetrachlorodibenzodioxin: An Accidental Poisoning Episode in Horse Arenas. Science 188: 738-740.

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OLAV AXELSON; M.D.
Department of Occupational Medicine
Regional Hospital
Linkoping, Sweden

Dr. Axelson, an occupational epidemiologist, will testify on his studies of Swedish railroad workers exposed to herbicides. His testimony will include recent results which tend to strengthen earlier data suggesting that the cancer risk is elevated for workers exposed to 2,4,5-T.

Exhibits

Axelson, O. and Sundell L. 1974. Herbicide exposure, mortality and tumor incidence. An epidemiological investigation on Swedish railroad workers. Sc and J Work Environ. Health II: 21-28.

Axelson O. 1978. Letter: Aspects on confounding in occupational health epidemiology. Sc and J Work Environ. Health 4: 85-89.

Axelson, O. June, 1978. A review on Swedish epidemiologic studies with relation to chlorinated dibenzodioxins. Working paper presented at the National Institute of Environmental Health Sciences and International Agency for Research on Cancer Conference on the Long-term Hazards of Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans, Lyon, France.

Axelson, O. Manuscript (in preparation) [follow-up of railroad workers study]

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R. FRENTZEL-BEYME, M.D.
Institute fur Dokimentatiun, Infumatiun and Statistics
Deutsches Kresbfurschungs zentreun Inu Neuenheines Feld
Heidelberg, Germany

Dr. Frentzel-Beyme, an epidemiologist for the West German government, will testify on the results of his 25-year follow-up of workers exposed to TCDD during and after an explosion in a trichlorophenol plant in Ludwigshafen. His testimony will include data showing an excess of cancer which corresponds closely to findings of an elevated cancer incidence among Swedish railroad workers exposed to 2,4,5-T.

Exhibits

Thiess, A.M. and Frentzel-Beymer R. 1977. Mortality of persons exposed to dioxin after an accident which occurred in the BASF on 13th November, 1953. Paper presented at MEDICHEM Congress V. San Francisco, September 5-9, 1977.

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DR. JACK GRIFFITH
Office of Pesticide Programs
Environmental Protection Agency
Washingon, D.C.

Dr. Griffith, coordinator of EPA's investigation of miscarriages in Alsea, Oregon, will testify regarding the origin, design, conduct and significance of the Alsea study. His testimony will include data and analyses relating the use use of 2,4,5-T for forest management to a subsequent increased incidence of spontaneous abortions.

Exhibits

Letter from Bonnie Hill of Alsea, Oregon. 1978. 2,4,5-T RPAR Rebuttal Submission 30000/26: #363.

EPA. 1979. Report of Assessment of a Field Investigation of Six-year Spontaneous Abortion Rates in Three Oregon Areas in Relation to Forest 2,4,5-T Spray Practices.

Report of the Consultative Council on Congenital Abnormalities in the Yarram District. March, 1978. J.E. Aldred, Chairman.

Mac Mahon, Brian and Pugh, Thos. F. 1970. Epidemiology: Principles and Methods. Department of Epidimiology, Harvard University School of Public Health. Little, Brown and Co., Boston.

Field, Barbara and Kerr, Charles. 1979. Herbicide Use and Incidence of Neural-Tube Defects. Lancet, June 23, 1979, p. 1341.

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DR. ROBERT DUNCAN
Department of Epidemiology & Public Health
University of Miami School of Medicine
Miami, Florida

Dr. Duncan, Director of the Medical School's Division of Biostatistics and biostatistician for the Alsea Report, will testify regarding the statistical methods and analyses which underlie the EPA's report showing a seasonal increase in the incidence of miscarriages in relation to the use of 2,4,5-T in Alsea, Oregon. His testimony will include data and analyses which supplement the February 28, 1979 Report.

Exhibits

EPA. 1979. Report of Assessment of a Field Investigation of Six-year Spontaneous Abortion Rates in three Oregon areas In Relation to Forest 2,4,5-T Spray Practices.

H.O. Lancaster. 1949. The Derivation and Position of $X^2$ in Certain Discrete Distributions. Biometrike 36: 117.

Anderson, T.W. 1970. The Statistical Analysis of Time Series. John Wiley & Sons, Inc. Pp. 56-60, 92-115, and 18-321.

Supplementary comment and analyses on the Analysis of Variance.

Supplementary comment and analysis of spontaneous abortions on a month-by-month basis.

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DR. JOHN DAVIES
Department of Epidemiology & Public Health
University of Miami School of Medicine
Miami, Florida

Dr. Davies, Professor of Epidemiology and member of EPA's Scientific Advisory Panel, will testify on his review of the Alsea study.

Exhibits

Dr. Davies' exhibits will be identified in a later submission.

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MR. RONALD THOMAS
Office of Pesticide Programs
Environmental Protection Agency
Beltsville, Maryland

Mr. Thomas will testify that analyses of the technical grade 2,4,5-T and silvex used to manufacture commercial formulations show that these pesticide products contain measurable amounts of TCDD.

Exhibits

Buser, H. and Bosshardt, H. 1974. Determination of 2,3,7,8-TCDD at ppb Levels in Technical Grade 2,4,5-T in 2,4,5-T Alkylester and 2,4,5-T Amine Salt Herbicide Formulations by Quadrapole Massfragmentography. J. Chrom. 90: 71-77.

Dow Chemical Company. Method ML-AM-75-34 Determination of TCDD in 2,4,5-T and Related Materials. Applicable to 2,4,5-T, Silvex and Chlorinated Phenols (unpublished).

Monalvo, J.G., Ryan, J.F. and Flagg, R. Analysis of Technical Grade Pesticides for TCDD at the ppb Level. EPA Project No. 68-01-3981. Physical Engineering Sciences Division, Gulf South Research Institute, New Orleans, Louisiana.

Tore-Ramstad, Mahle, N.H. and Matalon, R. 1977. Automated Cleanup of Herbicides by Adsorption Chromatography for Determination of 2,3,7,8-TCDD. An. Chem. 49:

Woolson, E.A., Thomas, R.F. and Ensor, P.D.J. 1972. Survey of Polychlorodibenzo-p-dioxin Content in Selected Pesticides. J. Ag. Fd. Chem. 20: 2.

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DR. MORTON BEROZA

Dr. Beroza will testify on the environmental fate of 2,4,5-T, silvex and TCDD in soil, water and plant or animal tissue. Based on his analysis of the studies in this area, he will testify that there is a significant potential for human exposure to each of these chemicals.

Exhibits

Clements Associates, Inc. 1979. Exposure, Toxicity, and Risk Assessment of 2,4,5-T/TCDD. Volume 1, Chapter 1.

Nash, R.G., M.L. Beall, Jr. 1978. Environmental Distribution of 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) Applied with Silvex to Turf in Microagroeco-systems. U.S. Environmental Protection Agency. EPA-LAG-D6-0054; ARS 173 EPA 1001-704.

Jensen, D.J., R.A. Hummel, N.H. Mahle, C.W. Kocher. 1978. A Residue Study on Beef Cattle Consuming 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD). Unpublished. The Dow Chemical Company. (CONFIDENTIAL)

Jensen, D.J., R.A. Hummel, H.S. Higgins, L. Lamparski, E. Madrid. 1978. A Residue Study on Sheep Consuming 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD). Unpublished. The Dow Chemical Company. (CONFIDENTIAL).

Jensen, D.J., R.A. Hummel, H.S. Higgins, L. Lamparski, E.T. Madrid. 1978. Secretion of TCDD in Milk and Cream Following the Feeding of TCDD to Lactating Dairy Cows. Unpublished. The Dow Chemical Company. (CONFIDENTIAL)

Fries, G.F., G.S. Marrow. 1975. Retention and Excretion of 2,3,7,8-Tetrachlorodibenzo-p-dioxin by Rats. J. Agr. Fd. Chem. 23(2): 265-269.

Helling, C.S., A.R. Isensee, E.A. Woolson, P.D.J. Ensor, G.E. Jones, J.R. Plimmer, and P.C. Kearney. 1973. Chlorodioxins in pesticides, soils, and plants. J. Environ. Quality 2(2): 171-178.

Kearney, P.C., E.A. Woolson, and C. P. Ellington, Jr. 1972. Persistence and metabolism of chlorodioxins in soils. Environ. Sci. Technol. 6(12): 1017-1019.

Isensee, A.R., and G.E., Jones 1975. Distribution of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in aquatic model ecosystem. Environ. Sci. Technol. 9(7): 668-672.

Shadoff, L.A., R. A. Hummel, L. Lamparski, and J. H. Davidson. 1977. A search for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in an environment exposed annually to 2,4,5-trichlorophenoxyacetic acid ester (2,4,5-T) herbicides. Bull. Environ. Contam. Toxicol. 18: 478-485.

Isensee, A.R., and G.E. Jones. 1971. Absorption and translocation of root and foliage applied 2,4-dichlorophenol, 2,7-dichlorodibenzo-p-dioxin and 2,3,7,8-tetrachlorodibenzo-p-dioxin. J. Agri. Food Chem. 19(6): 1216-1214.

U.S. Environmental Protection Agency. 1977. Dioxin Working Group, Dioxin: position document. (Draft-unpublished.)

Leng, M.L. 1972. Residues in milk and meat and safety to livestock from the use of phenoxy herbicides in pasture and rangeland. Down to Earth 28(1): 12-20.

Morton, H.L, E.D. Robinson, and R. E. Meyer, 1967. Persistence of 2,4-D, 2,4,5-T, and dicamba in range forage grasses. Weeds 15(3): 268-271.

Shafik, M.T., H. C. Sullivan, and H. F. Enos. 1971. A method for determination of low levels of exposure to 2,4-D and 2,4,5-T. Intntl. J. Environ. Anal. Chem. 1: 23-33.

Gehring, P.J., C.G. Kramer, B.A. Schwetz, J.Q. Rose, and V.K Rowe, 1973. The fate of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) following oral administration to man. Toxicol. Appl. Pharmacol. 26: 352-361.

Kocher, C.W., N.H. Mahle, R.A. Hummel, L.A. Shadoff, and M.E. Getzendaner. 1978. A search for the presence of 2,4,7,8-tetrachlorodibenzo-p-dioxin in beef fat. Bull. Environ. Contam. Toxicol. 19(2): 228-236.

Bovey, R.W. et al. 1974. Occurrence of 2,4,5-T and Picloram in Surface Run-off Water in the Blacklands of Texas. J. Environ. Quality 3: 61-64.

Dobbs and Grant. 1979. Photolysis of Highly Chlorinated Dibenzo-p-dioxins by Sunlight. Nature 278: 163-165.

Kociba, R.J. et al. 1978. Results of a Two-Year Chronic Toxicity and Oncogenicity Study of 2,3,7,8-Tetrachloro-dibenzo-p-Dioxin in Rats. Tox. Appl. Pharm. 46: 279-303.

Meselson, M. 1978. Draft Final Report - TCDD Analysis in Environmental Samples. Submitted as part of 2,4,5-T RPAR rebuttal of the Environmental Defense Fund (30000/26: #1021).

Young, A. et al. 1978. The Toxicology, Environmental Fate and Human Risk of Agent Orange and Its Associated Dioxin. Submitted as part of 2,4,5-T RPAR rebuttal of the United States Air Force (30000/26: #2531).

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DR. FREDERICK W. KUTZ
Office of Pesticide Programs
Environmental Protection Agency
Washington, D.C.

Dr. Kutz will testify that EPA and other federal monitoring programs indicate that 2,4,5-T and silvex are present in water, air, human urine and other media in some locales. He will give a brief overview of the analytical methodologies involved, and will discuss the results of past and present monitoring projects, the reliability of these results, and the implications of the results for human exposure potential.

Exhibits

Kutz, F.W. 1979. Summary of Federal Monitoring Program Data on 2,4,5-T, Silvex, and TCDD. Memorandum to Robert Brown, March 22, 1979.

Kutz, F.W., A.R. Yobs and H.S.C. Yang. 1976. National pesticide monitoring programs. In: Air Pollution from Pesticides and Agricultural Processes, CRC Press, Cleveland, Chapter 4, pp. 95-136.

Kutz, F.W. 1978. Human and environmental monitoring for herbicides used in forestry. Proc. Symposium on the Use of of Herbicides in Forestry, U.S. Environmental Protection Agency, pp. 83-86.

Scifres, C.J., H.G. McCall, R. Maxey and H. Tai. 1977. Residual properties of 2,4,5-T and picloram in sandy rangeland soil. J. Environ. Quality 6: 36-42.

Shafik, T.M., H.C. Sullivan and H.R. Enos. 1971. A method for determination of low levels of exposure to 2,4-D and 2,4,5-T. Intern. J. Environ. Anal. Chem. 1: 23-33.

Shafik, T.M., H.C. Sullivan and H.R. Enos. 1973. Multiresidue procedure for halo-# and nitrophenols. Measurement of exposure to biodegradable pesticides yielding these compounds as metabolites. J. Agr. Food Chem. 21: 295-298.

Goerlitz, D.F. and E. Brown, 1972. Methods for analysis of organic substances in water. In: Techniques of Water Resources Investigations of the U.S. Geologic Survey, Chapter 3.

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MR. THOMAS DIXON
Office of Toxic Substances
Environmental Protection Agency

Mr. Dixon will testify regarding water monitoring reports that disclose the presence of silvex and 2,4,5-T in rivers, streams, lakes and other water sources. Mr. Dixon's testimony will include a report of EPA's investigation of the sampling procedures and the analytical methods upon which these monitoring reports are based.

Exhibits

Mr. Dixon's exhibits will be identified in a subsequent pleading.

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DR. WILLIAM UPHOLT
Office of Toxic Substances (Emeritus)
Environmental Protection Agency
Washington, D.C.

Dr. Upholt will testify on the origin and nature of the Dioxin Implementation Plan (DIP), a collaborative effort between EPA and other institutions to develop and apply chemical methods for the measurement of TCDD in environmental samples. His testimony will provide information on the Agency's approach to monitoring TCDD as background for the analytical data to be presented by subsequent EPA witnesses.

Exhibits

EPA. 1975. Dioxin Implementation Plan. February.

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DR. AUBRY DUPUY
Office of Pesticide Programs
Environmental Protection Agency
Bay St. Louis, Mississippi

Dr. Dupuy will testify on the collection and preparation of the environmental samples and standards used in the Dioxin Implementation Plan. He will discuss the coding of the samples and the distribution of them to the analytical laboratories participating in the plan.

Exhibits

Harless, R.L., Oswald, E.O., Wilkenson, M.K., Dupuy, A.E., McDaniels, D.D. and Tai, H. 1979. Sample Preparation Procedures and Gas Chromatography Mass-spectrometric Methods of Analysis for 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) Residues.

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DR. MICHAEL L. GROSS
Department of Chemistry
University of Nebraska
Lincoln, Nebraska

Dr. Gross, a participant in the DIP, will testify that measurable amounts of TCDD are present in human, animal and environmental samples from some locales. He will discuss the analytical methodology involved, and results obtained in analyses done as part of the Dioxin Implementation Plan. In addition, he will discuss the results of other TCDD monitoring projects in which he has been involved.

Exhibits

EPA. 1978. Draft Status Report of the Dioxin Implementation Plan. February.

EPA. 1978. Status Report-Dioxin Implementation Plan-Human Milk and Urine Study for 2,3,7,8-TCDD - Pacific Northwest Study. October.

EPA. 1979. Interlaboratory Validation Study for Dioxin. January.

Gross, M.L. 1979. Monthly Reports to EPA on Analyses of Mothers' Milk, Water and Water Sediment.

Kimble, B.J. and Gross, M.L. 1979. TCDD Quantitation in Stack-Collected Coal Fly Ash. Science (submitted for publication).

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DR. RAPLH C. DOUGHERTY
Department of Chemistry
Florida State University
Tallahassee, Florida

Dr. Dougherty will testify that his mass spectrometric analyses of human and environmental samples indicate that TCDD and other organochlorine compounds are contaminants in the environment.

Exhibits

Dougherty, R.C. and Piotrowska, K. 1976. Screening by Negative Chemical Ionization Mass Spectrometry for Environmental Contamination with Toxic Residues: Application to Human Urines. Proc. Natl. Acad. Sci. 6: 1777-1781.

Dougherty, R.C. and Piotrowska, K. 1976. Multiresidue Screening by Negative Chemical Ionization Mass Spectrometry of Organic Polychlorides. J. Ass. Offic. Anal. Chem. 59: 1023.

Dougherty, R.C. and Hett. 1978. Applications to Environmental Mass Spectrometry. In: K.R. Rao (ed.), Pentachlorophenol - Chemistry, Pharamcology, and Environmental Toxicology, Plenum Press, New York, p. 339.

Dougherty, R.C. et al. 1979. Negative Chemical Ionization Study: Human and Food Chain Contamination with Xenobiotics. Environ. Health Perspec. (in press).

Kimble, B.J. and Gross, M.L. 1979. TCDD Quantitation in Stack-Collected Coal Fly Ash. Science (submitted for publication).

Dow Chemical Company. 1978. The Trace Chemistries of Fire - A Source of and Routes for the Entry of Chlorinated Dioxins into the Environment. Unpublished.

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DR. MATTHEW MESELSON
Department of Biochemistry
Harvard University
Cambridge, Massachusetts

Dr. Meselson, a participant in the Dioxin Implementation Plan, will testify that TCDD is present in environmental samples such as beef fat. His testimony will include an evaluation of the implications of these findings for human health.

Exhibits

Baughman, R. and Meselson, M. 1973. An improved analysis for 2,3,7-8-tetrachlorodibenzo-p-dioxin. In: Advances in Chemistry Ser. 120 ("Chlorodioxins--Origin and Fate") E. Blair, Ed., American Chemical Society, Washington, D.C., pp. 92-104.

Baughman, R. and Meselson, M. 1973. An analytical method of detecting TCDD (Dioxin): Levels of TCDD in samples from Vietman. Environmental Health Perspectives, 5: 27-35. [DHEW Publication No. (NIH) 74-218].

O'Keefe, P.W., Meselson, M., and Baughman, R.W. 1978. A neutral cleanup procedure for 2,3,7,8-tetrachlorodibenzo-p-dioxin residues in bovine fat and milk. Journal of the Association of Official Analytical Chemists (in press).

For a collection of papers on various aspects of the environment toxicology of TCDD, see Environmental Health Perspectives, Volume 5, 1973. [DHEW Publication No. (NIH) 74-218].

Baughman, R.W. 1974 terachlordibenzo-p-dioxins in the Environment. High resolution mass spectrometry at the picrogram level. Ph.D. Thesis, Department of Chemistry, Harvard University, Cambridge, Massachusetts.

Allen, J.R. and Carstens, L.A. 1967. Light and electron microscopic observations in Macaca mulatta monkeys fed toxic fat. Am. J. Vet. Res. 28: 1513-1526. [The TCDD concentration in the toxic fat used in these experiments was not known at the time. In 1974 we determined it to be 3 ppm by high resolution mass spectrometry. However, this value must be viewed as only approximate due to the possibility of sample heterogeneity.]

Allen, J.R., Barsotti, D.A., Van Miller, J.P., Abrahamson, L.J., and Lalich, J.J. 1977. Morphological changes in monkeys consuming a diet containing low levels of 2,3,7,8-tetrachlorodibenzo-p-dioxin. Food Cosmet. Toxicol. 15: 401-410.

Van Miller, J.P., Lalich, J.J., and Allen, J.R. 1977. Increased incidence of neoplasms in rats exposed to low levels of 2,3,7,8-tetrachlorodibenzo-p-dioxin. Chemosphere 10: 625-632.

DR. ARTHUR GALSTON
Yale University
New Haven, Connecticut

Dr. Galston will testify regarding the human health consequences of prolonged or temporary exposure to dioxins such as TCDD. His testimony will include information on the production and environmental distribution of 2,4,5-T, related human health effects, and the implications of these findings for policy decisions.

Exhibit

Allen, J.R., D.A. Barsotti, J.P. Van Miller, L.J. Abrahamson, and J.J. Lilach. 1977. Morphological changes in monkey consuming a diet containing low levels of 2,3,7,8-tetrachlorodibenzo-p-dioxin. Food Cosmet. Toxicol. 15: 401-410.

Allen, J.R., and L.A. Carstens. 1967. Light and electron microscopic investigations in Macaca mulatta monkeys fed toxic fat. Am. J. Vet. Res. 28: 1513-1526.

Baughman, R. and M. Meselson. 1973. Analytical method for detecting TCDD (dioxin): levels of TCDD in samples from Vietnam. Environ. Health Perspect. 5: 27-35.

Clark, D.E., J.S. Palmer, R.D. Radcleff, H.R. Crookshank, and F.M. Farr. 1975. Residues of chlorophenoxy acid herbicides and their phenolic metabolites in tissues of sheep and cattle. J. Agric. Food Chem. 23(3): 571-578.

Crosby, D.G., and A.S. Wong. 1973. Photodecomposition of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) in water. J. Agric. Food Chem. 21(6): 1052-1054.

Dougherty, R.C. and K. Piotrowska. 1976. Screening by negative chemical ionization mass spectrometry for environmental contamination with toxic residues: application to human urines. Proc. Natl. Acad. Sci. USA 75(6): 1977-1781.

Environmental Health Perspectives. 1973. Experimental Issue No. 5, 1-313. U.S. Department of Health, Education and Welfare, NIEHS, Research Triangle Park, N.C.

Environmental Protection Agency (EPA). 1978. Rebuttable presumption against registration and continued registration of pesticide products containing 2,4,5-T. Fed. Reg. 43(78): 17116-17157.

Fitzgerald, C.H., C.L. Brown, and E.G. Beck. 1967. Degradation of 2,4,5-trichlorophenoxyacetic acid in wood plants. Plant Physiol. 42: 459-460.

Grunow, W., and C. Bohme. 1974. Metabolism of 2,4,5-T and 2,4-D in rats and mice. (Translated from German) Arch. Toxicol. 32: 217-225.

Helling, C.S., A.R. Isensee, E.A. Woolson, P-D.J. Ensor, G.E. Jones, J.R. Plimmer, and P.C. Kearney. 1973. Chlorodioxins in pesticides, soils, and plants. J. Environ. Qual. 2(2): 171-178.

Isensee, A.R., and G.E. Jones. 1971. Absorption and translocation of root foliage applied 2,4-dichloropheno, 2,7-dichlorodibenzo-p-dioxin and 2,3,7,8-tetrachlorodibenzo-p-dioxin. J. Agric. Food Chem. 19(6): 1210-1214.

Isensee, A.R., and G.E. Jones. 1975. Distribution of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in aquatic model ecosystem. Environ. Sci. Technol. 9(7): 668-672.

Johnson, J.E. 1971. The public health implications of widespread use of the phenoxy herbicides and picloram. BioScience 21(7): 899-905.

Kearney, P.C., E.A. Woolson, and C.P. Ellington, Jr. 1972. Persistence and metabolism of chlorodioxins in soils. Environ. Sci. Technol. 6(12): 1017-1019.

Kearney, P.C., E.A. Woolson, A.R. Isensee, and C.S. Helling. 1973. Tetrachlorodibenzodioxin in the environment: sources, fate, and decontamination. Environ. Health Perspect. 5: 273-277.

Lang. A., ed. 1974. Effects of Herbicides in South Vietnam. Summary and Conclusions. National Academy of Sciences, Washington, D.C.

Leng, M.L. 1972. Residues in milk and meat and safety to livestock from the use of phenoxy herbicides in pasture and rangeland. Down to Earth 28(1): 12-20.

Meselson, M., P. O'Keefe, and R. Baughman. 1978. The Evaluation of Possible Health Hazards from TCDD in the Environment. Symposium on the use of herbicide in forestry, Arlington, VA. 21-22 February.

Meselson, M.S., A.H. Westing, and J.D. Constable. 1972. Background material relevant to presentations at the 1970 meeting of the AAAS. U.S. Congr. Rec. 118: 6807-6813.

Mark, E. 1969. Report of the Secretary's commission on pesticides and their relationship to environmental health. In: Teratogenicity of Pesticides, U.S. Department of Health, Education and Welfare, Washington, D.C., Ch. 18.

Muranyi-Kovacs, I., G. Rudali, and J. Imbert. 1976. Bioassay of 2,4,5-trichlorphenoxyacetic acid for carcinogenicity in mice. Br. J. Cancer 33: 626-633.

Norris, L.A. 1966. Degradation of 2,4-D and 2,4,5-T in forest litter. J. Forest. 64(7): 475-476.

O'Keefe, P.W., M. Meselson, and R.W. Baughman. 1978. A neutral cleanup procedure for 2,3,7,8-Tetrachlorodibenzo-p-dioxin residues in bovine fat and milk. J. Assoc. Off. Anal. Chem. (in press).

Shadoff, L.A., R.A. Hummel, L. Lamparski, and J.H. Davidson. 1979. A search for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in an environment exposed annually to 2,4,5-trichlorophenoxyacetic acid ester (2,4,5-T) herbicides. Bull. Environ. Contam. Toxicol. (in press).

Shafik, M.T., H.C. Sullivan, and H.F. Enos. 1971. A method for determination of low levels of exposure to 2,4-D and 2,4,5-T. Int. J. Environ. Anal. Chem. 1: 23-33.

Sharpee, K. 1973. Microbial degradation of Phenoxy Herbicides in Culture, Soil, and Aquatic Ecosystems. Ph.D. Thesis. University Microfilms, Ann Arbor, Michigan.

Smith, R.J. 1978. Dioxins have been present since the advent of fire, say, DOW. Science 202: 1166-1167.

Tung, T.T., T.T. An. N.D. Tam. P.H. Phiet, N.N. Bang, T.T. Bach, H. Van Son, K.D. Son. 1973. Le cancer primaire du foie au Vietnam. Chirurgie 99: 427-436.

Van Miller, J.P., J.J. Lalich, and J.R. Allen. 1977. Increased incidence of neoplasms in rats exposed to low concentrations of 2,3,7,8-tetrachlorodibenzo-d-dioxin. Chemosphere 10: 625-632.

Westing, A.H. 1973. AAAS Herbicide Assessment Commission. Science 179: 1278-1279.

Westing, A.H. 1976. Ecological Consequences of the Second Indochina War. Stockholm International Peach Research Institute. Almqvist and Wiksell, Stockholm, Sweden.

Westing, A.H. 1978. Ecological considerations regarding massive environmental contamination with 2,3,7,8-tetrachlorodibenzo-p-dioxin. Ecol. Bull (Stockholm) 27: 285-294.

Whiteside, T. 1977. A reporter at large. The pendulum and the toxic cloud. New Yorker 25 July: 30-55.

Whiteside, T. 1978. Contaminated. New Yorker 4 Sept.: 34-81.

Wiese, A.F., and R.C. Davis. 1964. Herbicide movement in soil with various amounts of water. Weeds 12(2): 101-103.

Wong, A.S., and D.G. Crosby. 1978. Decontamination of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) by photochemical action. In: F. Cattebeni, A. Cavallaro, and G. Galli (eds.), Dioxin: Toxicological and Chemical Aspects, S.P. Medical and Scientific Books, New York.

MR. MICHAEL DELLARCO
Office of Pesticide Programs
Environmental Protection Agency
Washington, D.C.

Mr. Dellarco, the current Project Manager for the Rebuttal Presumption Against Registration (RPAR) reviews of 2,4,5-T and silvex, will testify regarding the RPAR review of 2,4,5-T. His testimony will include summaries of rebuttal submissions in which RPAR respondents attributed injury to humans, domestic animals, livestock, crops and other vegetation to the use of 2,4,5-T.

Exhibits

EPA. 1978. Rebuttable Presumption Against Registration and Continued Registration of Pesticide Products Containing 2,4,5-T (43 FR 17116, 21 April 1978).

RPAR rebuttal submissions in which people report injury to human health, animals, and/or vegetation.

* * *

MR. JAMES BOLAND
Office of Pesticide Programs
Environmental Protection Agency
Washington, D.C.

Mr. Boland, the Coordinator for the Pesticide Incident Monitoring System (PIMS), will testify regarding the general operation of the System and will present summaries of PIMS reports describing injury to humans, domestic animals, livestock, crops, and other vegetation which the complainant associated with the use of 2,4,5-T and/or silvex.

Exhibits

PIMS Abstracts of Pesticide Incidents Involving 2,4,5-T (1966 to the present)

PIMS Abstracts of Pesticide Incidents Involving Silvex (1966 to the present)

PIMS Reporting Form and Instructions.

PIMS Operations Document (in preparation).

MR. DONALD MARLOW
Office of Pesticide Programs
Environmental Protection Agency
Washingon, D.C.

Mr. Marlow will testify regarding EPA's review of PIMS reports, RPAR rebuttals, and other materials to select reports for investigation as case studies on the relationship between the uses of 2,4,5-T or silvex and human exposure to these chemicals under ordinary use conditions. His testimony will describe EPA investigations to determine that the uses in question were registered and represented ordinary usage, and to verify that reports of plant damange and/or the presence of chemical residues were officially documented.

Exhibits

Mr. Marlow will have no exhibits.

* * *

MR. EMIL REGELMAN
Office of Pesticide Programs
Environmental Protection Agency
Washington, D.C.

Mr. Regelman, a chemist, will testify regarding EPA's investigation of the chemical laboratory reports in the exhibits listed for the case studies on the relationship between use and exposure. His testimony will include an assessment of the reliability of the data relating to the presence of 2,4,5-T and silvex residues in water, soil and vegetation samples analyzed in connection with these reports.

Exhibits

Mr. Regleman's exhibits will include the laboratory reports listed as exhibits for the case studies.

* * *

MR. ALAN PUMPHREY
Houston, Arkansas

Mr. Pumphrey, a teacher and farmer, will testify regarding drift exposure to his farmland property in June 1978 which resulted from the aerial application of 2,4,5-T to forest lands adjoining his property in Houston, Arkansas. Mr. Pumphrey will describe his observations of the herbicide application, its effects on his crops, ornamental trees, and garden. (Case Study)

Exhibits

Certified copy of Warranty Deed containing legal description of Mr. Pumphrey's farm.

Certified copy of Warranty Deed describing adjoining land belonging to the owners of the forest which was sprayed with 2,4,5-T.

U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service Aerial Photographs of the lands described in No. 1 and 2 above.

Thompson-Hayward Chemical Company registered label for "DED-WEED," EPA Reg. No. 148-431.

"Report of Inspection on 2,4-D, Etc. Complaint" filed by Mr. Alan Pumphrey with the Arkansas State Plant Board on July 5, 1978.

Letter of July 19, 1978, to Mr. Pumphrey from E.F. Wilson, Director, Bureau of Environmental Health Services, Arkansas Department of Health, containing the results of the analysis for 2,4,5-T in the samples collected from Mr. Pumphrey's farm on July 5, 1978.

Letter of July 21, 1978, to Mr. Pumphrey from James T. Green, Jr., Ph. D., Agronomist, Cooperative Extension Service, University of Arkansas Division of Agriculture, containing Dr. Green's visual observations of phenoxy damage to Mr. Pumphrey's alfalfa crop.

Letter of July 31, 1978, to Mr. Pumphrey from James T. Green, Jr., Ph. D., Agronomist, Cooperative Extension Service, University of Arkansas Division of Agriculture, containing a "Soil Diagnosis and Plant Analysis Report", "Diagnostic Soil Sample Information Sheet", and "Plant Analysis Information Sheet".

Letter of August 7, 1978, to Mr. Pumphrey from E.E. Wilson, Director, Bureau of Environmental Health Services, Arkansas Department of Health, containing the results of the analysis for 2,4,5-T in samples collected from Mr. Pumphrey's farm on July 21, 1978.

Certified copies of Interrogatories and Responses to Interrogatories in Civil Case No. CIV-78-47 filed June 26, 1979 in the Circuit Court of Perry County, Arkansas.

Polaroid photographs taken by Mr. Pumphrey of the damaged alfalfa crop and trees.

* * *

MR. RICHARD PETRIE
Office of Pesticide Programs
Environmental Protection Agency
Washington, D.C.

Mr. Petrie will testify regarding EPA's investigation of the circumstances of 2,4,5-T use on forest land which resulted in residues and phenoxy damage on Mr. Pumphrey's farm.

Exhibits

Record of Custom-Application with 2,4-D, 2,4-5-T, or Other Hormone-Type Herbicide.

Aircraft Inspection for Certificate to Apply 2,4-D, 2,4,5-T or Other Hormone-Type Herbicide.

Letter of July 25, 1978 from Mr. Pay notifying Omniflight Helicopters, Inc. that symptoms of hormone-type herbicide 2,4,5-T were found on Mr. Pumphrey's farm.

Letter of July 21, 1978 from Dr. Green to Mr. Pumphrey containing Dr. Green's observations of phenoxy damage to Mr. Pumphrey's alfalfa crop.

Letter of July 31, 1978, to Mr. Pumphrey from Dr. Green containing a "Soil Diagnosis and Plant Analysis Report", "Diagnostic Soil Sample Information Sheet", and "Plant Analysis Information Sheet".

35mm slides taken of damaged alfalfa crop at the time of Dr. Green's visit to the Pumphrey farm.

* * *

MR. WILBUR D. WISE
Arkansas Department of Health
Little Rock, Arkansas

Mr. Wise, a chemist and inspector for the Arkansas State Department of Health, will testify regarding his inspection and sampling of damaged vegetation on Mr. Phumprey's farm. Mr. Wise will describe the phenoxy damage to crops, shrubs, and trees which he witnessed and explain how he sampled damaged crops and other vegetation on Mr. Pumphrey's farm which were exposed to 2,4,5-T through drift.

Exhibits

Arkansas State Department of Health Pesticide Collection and Analysis Report[s] Nos. 3499, 3500, 3501, 3502, 3503, 3504, 3505, 3506, and 3507.

* * *

MR. JAMES T. CRIDER
Arkansas State Department of Health
Little Rock, Arkansas

Mr. Crider, a chemist, will testify regarding the methods he used in analyzing samples taken from Mr. Pumphrey's farm by Mr. Wise. Mr. Crider will describe the results of his analyses and explain the evidence of phenoxy residues which he found.

Exhibits

Arkansas State Department of Health Pesticide Collection and Analysis Report[s] Nos. 3499, 3500, 3501, 3502, 3503, 3504, 3505, 3506, 3507.

Arkansas State Department of Health Pesticide Collection and Analysis Report[s] Nos. 3499, 3500, 3501, 3502, 3503, 3504, 3505, 3506, and 3507 - Chromatographic Scans.

* * *

MR. MICHAEL COOPER
Tennessee Department of Agriculture
Nashville, Tennessee

MR. CHARLES LEWIS
Office of Pesticide Programs
Environmental Protection Agency
Washington, D.C.

Mr. Cooper will testify about the state investigation of plant damage claims arising out of a July, 1978 use of 2,4,5-T (and 2,4-D) on land undergoing conversion to pasture in Houston and Dickson Counties, Tennessee; Mr. Lewis will testify about EPA's participation in this investigation. Mr. Cooper and Mr. Lewis' testimonies will be based in part on chemical residue data indicating that 2,4,5-T was present on garden vegetables, tobacco plants, and trees on non-target property adjacent to the pesticide application site. (Case Study)

Exhibits

U.S. Environmental Protection Agency Affidavits:
- Sworn July 20/26, 1978 by E.N. Stanfill
- Sworn July 26, 1978 by Dortoty Parchman
- Sworn July 20, 1978, by W.D. Parchman
- Sworn July 21, 1978 by Pat Whitaker
- Sworn July 21, 1978 by Earlene Whitaker
- Sworn July 20, 1978 by Willie Roy Pate
- Sworn July 20, 1978 by John Spice
- Sworn July 20/27, 1978 by Douglas Adams
- Sworn July 26, 1978 by Charles Adkins
- Sworn July 21, 1978 by Bob Dillard

Pesticide container labels for DED-WEED (2,4,5-T), EPA Reg. No. 148-212, used in this application.

U.S. Environmental Protection Agency Reports of Analysis:
- dated 11-14-78, Sample TN 130114, Whitaker Tobacco
- dated 11-14-78, Sample TN 130105, Whitaker Tobacco
- dated 11-14-78, Sample TN 130103, Vann Tobacco
- dated 11-14-78, Sample TN 130115, Vann Tobacco
- dated 11-14-78, Sample TN 130116, Guthrie Tobacco
- dated 11-14-78, Sample TN 130113, Parchmont Tobacco
- dated 11-14-78, Sample TN 130104, Baker Tap Water
- dated 8-16-78, Sample TN 130122, DED-WEED 2,4,5-T
- dated 8-16-78, Sample TN 130120, use dilution

Letter from Joseph H. Rossman, Tennessee Water Quality Control Division, to Mr. E.H. Trenckmann, owner of the spraysite, reporting the complaints of area residents. July 25, 1978.

* * *

DR. WILLIAM LOY
Department of Geography
University of Oregon
Eugene, Oregon

Dr. Loy, a geographer whose publications include the Atlas of Oregon, will testify regarding his survey of herbicide use in relation to the topography, population distribution, hydrology, and climate of the towns of Alsea and Rose Lodge, areas which are representative of the forested areas of the Oregon Coastal range. His testimony will include information showing that homes and water supplies in the area are close to pesticide application sites.

Exhibits

Loy, William G. 1976. Atlas of Oregon.

Aerial photographs of the towns of Alsea and Rose Lodge, Oregon.

Maps of Alsea, Oregon, showing vegetation, population settlement, hydrology, land ownership and herbicide application sites.

Maps of Rose Lodge, Oregon showing vegetation, population settlement, hydrology, land ownership and herbicide application sites.

Contour models of the Alsea and Rose Lodge areas.

* * *

MR. WILLIAM KOSESAN
Oregon Department of Agriculture
Salem, Oregon

MR. THOMAS HARRISON
Oregon Department of Agriculture
Salem, Oregon

Mr. Kosesan and Mr. Harrison, officials charged with pesticide regulation for the State of Oregon, will testify regarding pesticide use in Oregon. Their testimony will include information relating to the Department of Agriculture's investigation of claims of herbicide related damage of non-target vegetation.

Exhibits

Letter from Kent A. Smith, Oregon State Department of Agriculture, to Bob Greaves, Oregon State Department of Forestry, dated July 26, 1978. Forest Pesticides Investigation by OSDA.

MR. ODOS LOWERY
Bureau of Land Management
Coos Bay, ORegon

Mr. Lowery, based on his experience as a silviculturist in the Oregon Costal Range, will testify in regard to the influence of coastal weather and topography on the aerial application of herbicides for forest use. Mr. Lowery's testimonies will include information on the conduct of spray operations in forest areas.

Exhibits

Bureau of Land Management map of forest ownership in the state of Oregon.

Topographic models of forest areas (in preparation).

Photographic slides of terrain.

MRS. GISELA GREEN
Alsea, Oregon

DR. THOMAS ELLWANGER
Office of Pesticide Programs
Environmental Protection Agency
Washington, D.C.

Mrs. Green, a farmer, will testify regarding her observations of herbicide drift during and following the use of silvex (and 2,4-D) in 1977 for forest management in Alsea, Oregon. She will testify that herbicide-caused damage occurred to food crops such as peas and grapes as well as to other vegetation on her property.

Dr. Ellwanger will testify regarding his investigation of the origin and nature of the damage to vegetation on the Green's farm. His testimony will include general information on pesticide drift, and attribute the vegetation damage to herbicide (silvex and 2,4-D) drift from the application site.

(Case Study)

Exhibits

Warren, L.E. 1976. Controlling Drift of Herbicides, World of Agricultural Aviation, Vol. 3, numbers 3,4,5 and 6.

Zauck, J.E. 1974. Application of Paraquat and Diquat by Air, Chevron Chemical Company, Ortho Division, San Francisco, California 94120.

Von Rumker, R. and G.L. Kelso 1975. A Study of the Efficiency of the Use of Pesticides in Agriculture, EPA-540/9-75-025, Washington, D.C. 20460.

Performance summary of Herbicide Project 1976: From Matthew Kowalewski (Alsea area silviculturist) to File YA 514-CT6-132.

Statement of Gisela Green

Statement of Merrill Maloney

Statement of Gary Green

Deposition of Charles H. McKeen

Observation of Mell Killman, April 3, 1976.

Record of Phone conversation between Thomas C. Ellwanger (EPA) and William Kemp, contract officer for Evergreen Helicopter in McMinnville, Oregon April 19, 1979.

Interview Sheet by Joe Patton, conversation with Gene Russell (Oregon State Department of Forestry), dated April 5, 1976.

Investigation Report of David Humphrey (Oregon Department of Agriculture), dated April 16 and June 8, 1976.

Laboratory Reports (Oregon Department of Agriculture) numbered 9056 and 9057, 2,4-D and 2,4,5-TP analysis, dated April 30, 1976.

Pesticide residue analysis, reports and letter from James M. Witt (Oregon State Extension Chemist), dated April 21, 1976.

Letter from Gisela Green to Bruce Z. Engel, dated May 30, 1976.

BLM Project Map for S-A-HT-76-1d, showing portions of townships 13s and 14s.

Pilot's log book of Charles H. McKeen, notations from April 1-6, 1976.

Aerial photograph of Green's property.

Statement of Daniel Elam.

BLM Memorandum, from Joe Patton to District Manager and Files, dated April 9, 1976.

BLM Report Number 1 (Form 9100-1a) by Matthew Kowalewski, dated April 3, 1976.

Letter from Robert Thompson (Evergreen Helicopter) to Thomas C. Ellwanger (EPA), dated May 29, 1979.

Letter from Niel Skill (State of Oregon Forestry Department) to Thomas C. Ellwanger (EPA), dated May 25, 1979.

Maps of the Alsea area of Oregon, showing vegetation, population settlement, hydrology, land ownership and herbicide application sites.

Photographic slides and prints of plant damage on the Green property.

* * *

DR. BERNARD SMALE
Office of Pesticide Programs
Environmental Protection Agency
Washington, D.C.

Dr. Smale will testify regarding his investigation of the circumstances surrounding movement or drift of herbicide from its site of application for forest management to adjacent non-target property in Rose Lodge, Oregon. Dr. Smale's testimony will include discussion of the nature of phenoxy herbicide damage to plants, and documentation by state officials and photography of the presence of phenoxy herbicide effects on garden vegetables and other vegetation in the area.

Exhibits

Klingman, G.C., F. Ashton. 1975. Weed Science Principles and Practices. John Wiley and Sons.

State of Oregon Department of Agriculture memorandum by T. Harrison summarizing the Rose Lodge incident, 1977.

State of Oregon, Department of Agriculture memorandum by T. Harrison summarizing Rose Lodge incident, 1978.

Aerial photograph of Rose Lodge Settlement and McMillan residence.

North Half Lincoln County and Rose Lodge area (map).

Rose Lodge Settlement (map)

Publishers Paper Company land in Rose Lodge area (map)

Hydrology of Rose Lodge (map)

Cartographer's sketches of streams and residences relative to clear cut of Rose Lodge area.

Notification of Operations (Oregon Forest Practices Act) filed by Publishers Paper Company of intent to apply herbicides. April 20, 1978.

Weedone 170 product label.

Record of phone call to Lee Ash, Oregon State Forester, relative to probable and commonly used rates of Weedone 170.

Vegetation management with herbicides Volume I, pp. ---.

Oregon Forest Practices Act Chemical Rules and Guidelines, 1978. State of Oregon, Department of Forestry.

Field guide to Oregon Forest Practice Rules, 5th revision effective June 7, 1978. State of Oregon Department of Forestry.

Color prints and slides of damaged ornamental and garden plants on McMillan property.

Vegetation of Rose Lodge area (map)

U.S. Forest Service applications of 2,4,5-T relative to McMillan Rose Lodge area (map)

Herbicide application in Rose Lodge area 1976, 1977 and 1978. (map diagram)

Publishers Paper Company's 1978 and 1979 Pesticide Spray Program for Rose Lodge area (diagram)

Three-dimensional model of Rose Lodge area.

Notification of Operations (Oregon Forest Practices Act) filed by Publishers Paper Company of content to apply herbicides. February 4, 1977.

* * *

MRS. CHRISTINA HUTCHINSON
North Bend, Oregon

Mrs. Hutchinson will testify regarding her observations of a 1977 incident in which the forest use of 2,4,5-T led to the presence of 2,4,5-T in the spring from which the Hutchinson family obtained water for household and irrigation purposes. (Case Study)

Exhibits

Oregon Department of Agriculture Laboratory Report, dated March 16, 1977.

Oregon Department of Agriculture Laboratory Report, dated March 31, 1977.

Letter from Logan Norris, U.S. Forest Service, to Susan Page, Oregon Forestry Department, dated April 26, 1977.

Letter from J.E. Schroeder, Oregon Forestry Department to Mr. Hutchinson, dated May 2, 1977.

Letter from Susan Page, Oregon Forestry Department to Logan Norris, U.S. Forest Service, dated April 7, 1977.

Oregon Forestry Department map showing spray site and water sampling point.

* * *

MR. JOHN ANDERSON
Bureau of Land Management
Coos Bay, Oregon

Mr. Anderson, District Fisheries Biologist for the Bureau of Land Management in Coos Bay, will testify regarding a 1977 BLM project for monitoring forest streams during the 72-hour period following aerial application of silvex. Mr. Anderson's testimony will include data showing that silvex residues were found in 9 of the 11 streams from which samples were taken.

Exhibits

Cameron, J. and John W. Anderson. Results of the Stream Monitoring Program - Conducted during FY 1977 Herbicide Spray Project.

Photographic slides showing aerial application of the pesticide, maps, vegetation, waterways and other aspects of the monitoring area.

* * *

MR. PAUL PARSONS
Millstone, West Virginia

MR. JOHN PERDUE
West Virginia Department
of Agriculture
Charleston, West Virginia

Mr. Parsons, a farmer, will testify concerning a June 1978 application of 2,4,5-T (and other herbicides) along a power line right-of-way adjacent to his property. He will testify that he observed plant damage under the power line and near a spring from which his cattle take water.

Mr. Perdue, the state investigator, will testify that 2,4,5-T was present in plant tissues taken from the property and that herbicide related plant damage was present near the spring.

(Case Study)

Exhibits

Investigator's report by John Perdue, West Virginia Department of Agriculture, Plant Pest Control Division, August 1978.

Photographs taken by Mr. Perdue during his investigation.

Letter of reprimand to Asplundh Tree Expert Company from Robert Frame, West Virginia Department of Agriculture, Plant Pest Control Division, 22 August 1978.

Maps of location (in preparation).

Letter from John D. Perdue to Paul A. Parsons, dated October 10, 1978.

West Virginia Department of Agriculture Laboratory Service Sample Reports, dated September 13, 1978.

* * *

MR. DEWARD OFFUTT
Grantsville, West Virginia

MR. JOHN PERDUE
West Virginia Department
of Agriculture

Charleston, West Virginia

Mr. Offutt will testify concerning a July, 1978 application of 2,4,5-T (and other herbicides) along a right-of-way adjacent to his father-in-law's property. He will testify that he observed plant damage on both sides of a creek which passes under the power line and is used to water livestock.

Mr. Perdue, the investigator for the state will testify that dead foliage in the trees over the stream indicated that the watercourse had been sprayed. (Case Study)

Exhibits

Investigator's report by John Perdue of West Virginia Department of Agriculture, Plant Pest Control Division, August 1978.

Letter of reprimand to Asplundh Tree Expert Company from Robert Frame, West Virginia Department of Agriculture, Plant Pest Control Division, 22 August 1978.

Photographs taken by Perdue during his investigation.

Maps of the sites (in preparation).

Maps showing relation of power distribution lines to dwellings, highways and watercourses, Calhoun County, West Virginia (in preparation).

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing Respondent's Direct Evidence Submission on Risk were delivered by hand or mailed first class postage prepaid on July 17, 1979 to the persons on the attached list.

Dorothy E. Patton

Dorothy E. Patton

July 17, 1979

Graham Purcell, Esq.
Michael P. Andrews, Esq.
Doub, Purcell, Muntzing & Hansen
Counsel for Riverdale Chemical Co.
Platte Chemical Co.
PBI Gordon Corp.
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P.O. Box 3666
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JUL 17 1979

THE UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY

| | | |
|---|---|---|
| In re: | ) | |
| Notice of Intent To Cancel Certain Registrations For 2,4,5-T And Silvex | ) | FIFRA Docket Nos. 415, et al. |

TENTATIVE WITNESS LIST PROPOSED ON BEHALF
OF THE SECRETARY OF AGRICULTURE FOR THE UNITED STATES

The Secretary of Agriculture for the United States of America seeks to insure a fully developed record in the above-captioned case that will contain all relevant and credible scientific information pertaining to the issues raised by the various parties. To assist in the development of a complete record, counsel for the Secretary will present a number of witnesses who will predominantly address the benefits portion of the case. However, several of the witnesses presently scheduled to appear on behalf of the Department of Agriculture will also address topics which include chemical structure of 2,4,5-T, the dioxin TCDD, or silvex, degradation of various products, contaminants, avenues of exposure, environmental fate, and related subjects such as rates of use. These topics could arguably be included in the "risk assessment" portion of these proceedings, and for that reason, a list of these potential witnesses is submitted at this time.

The witnesses to be offered on behalf of the Secretary are listed alphabetically below. A brief summary of the subjects which each witness will discuss is included following each name and some exhibits are listed.

As preparations are completed and other parties provide lists of proposed witnesses and abstracts of their testimony so that issues may be clarified and gaps in the presentation noted, additional witnesses and exhibits which further develop and expand on the testimony will be provided by counsel for the Secretary.

Although the nature of these proceedings requires the Secretary to be posited as an adversary, the Secretary's position is not strictly aligned with any single major active party to these proceedings. We therefore propose to offer any risk assessment witnesses presented on behalf of the Secretary following the presentation of witnesses by the various registrants, of EPA, and of EDF.

TENTATIVE LIST OF WITNESSES

Name: Rodney W. Bovey, Ph.D.

Address: USDA, SEA-AR; Department of Range Science, Texas A&M University, College Station, Texas 77843

Background: Research Agronomist

Subject Area of Testimony:

Testimony will address 2,4,5-T use and its fate in the environment, with emphasis on pastures and rangeland.

Exhibits: USDA-States-EPA 2,4,5-T Assessment Report

Name: Jere J. Christner

Address: Willamette National Forest, P.O. Box 10607, Eugene, Oregon 97440

Background: Hydrologist, presently Watershed Staff, Willamette National Forest.

Subject Area of Testimony:

Testimony will cover the design of a water monitoring program associated with project aerial application of 2,4,5-T to selected Forest plantations. Water monitoring was conducted to closely check for any presence of 2,4,5-T following spraying on sampling sites located in close proximity to the sprayed areas.

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Name: David A. Graham

Address: USDA - Forest Service, P.O. Box 2417, Room 1205-B, RPE, Washington, D.C. 20013

Background: USDA - Forest Service, Pesticide Specialist

Subject Area of Testimony:

Mr. Graham will discuss Forest Service policy and coordination of information services concerning 2,4,5-T and Silvex. The witness is prepared to testify on Forest Service use of 2,4,5-T from 1972 to the present and on both past and current use policy. He will present estimates of future Forest Service 2,4,5-T needs and Forest Service efforts to fill identified 2,4,5-T information gaps. Forest Service participation in the USDA-States-EPA 2,4,5-T Assessment Report will also be described by Mr. Graham.

Exhibits: USDA-States-EPA 2,4,5-T Assessment Report.

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Name: Philip C. Kearney, Ph.D

Address: Pesticide Degradation Laboratory, Agricultural Environmental Quality Institute, Agricultural Research Service, USDA, Agricultural Research Center-West, Beltsville, Maryland 20705.

Background: Biochemist

Subject Area of Testimony:

Dr Kearney is Chief, Pesticide Degradation Laboratory, the pesticide group in the Department of Agriculture that has primary responsibility for dioxin research in soils. He has summarized existing literature and published on the persistence of 2,4,5-T and the dioxin TCDD under a variety of soil and climatic conditions. He has advised the Italian Government on decontamination in the Seveso, Italy area.

---

Name: Logan A. Norris, Ph.D.

Address: Pacific Northwest Forest and Range Experiment Station, 3200 Jefferson Way, Corvallis, Oregon 97331

Background: Assistant in Agricultural and Biochemistry, Oregon State University, Corvallis, 1961-1968. Research Chemist 1968-1971. Supervisory Research Chemist and Project Leader, Behavior and Impact of Introduced Chemicals on the Forest Environment 1971-1973. Presently Project Leader for a combined research work unit dealing with Managed Forest Watersheds, including responsibility for behavior and impact or chemicals in the forest environmental.

Subject Area of Testimony:

Testimony will cover 2,4,5-T persistence in forest floor, soil and vegetation, adsorption on forest floor, residues in forest streams, toxicity of TCDD to aquatic organisms, and effects on fish and wildlife. Most of the work relates to Pacific Northwest but some persistence data is from southern California.

Exhibits: USDA-States-EPA 2,4,5-T Assessment Report.

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Name: Ralph Ross, Ph.D.

Address: USDA, SEA-AR, Washington, D.C. 20250

Background: Assistant to the Deputy Director, Agricultural Research Science and Education Administration

Subject Area of Testimony:

Dr. Ross will discuss his participation in the EPA dioxin implementation program and work involving analytical methodology in detecting residues of 2,4,5-T and TCDD in various monitoring programs. He will also address developments involving TCDD on the national and international levels.

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Name: Lavell O. Stanger

Address: USDA, Forest Service, Timber Management, P.O. Box 3623, Portland, Oregon 97208

Background: Forester, Silviculturist

Subject Area of Testimony:

He will discuss preparation of a portion of the joint USDA-States EPA Assessment Report on applicator exposure.

Exhibits: USDA-States-EPA 2,4,5-T Assessment Report.

Respectfully submitted,

MARGARET M. BREINHOLT
JUDITH A. WENKER
TERRENCE G. JACKSON

By: Margaret M. Breinholt
Attorneys
Office of the General Counsel
United States Department of Agriculture
Washington, D.C. 20250
(202) 447-4733

Dated: July 17, 1979

BEFORE THE
ENVIRONMENTAL PROTECTION AGENCY
OF THE UNITED STATES OF AMERICA

| | |
|---|---|
| In re: | |
| The Dow Chemical Company, et al. | FIFRA Docket Nos. 415, et al. |

# THE DOW CHEMICAL COMPANY'S INITIAL LIST OF RISK WITNESSES AND EXHIBITS


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Of Counsel:

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2030 Dow Center
Midland, Michigan 48640

Rudolf H. Schroeter
LaFOLLETTE, JOHNSON, SCHROETER, & DeHAAS
320 North Vermont Avenue
Los Angeles, California 90004

Counsel for The Dow Chemical Company


July 17, 1979

BEFORE THE
ENVIRONMENTAL PROTECTION AGENCY
OF THE UNITED STATES OF AMERICA

| | |
|---|---|
| In re: | |
| The Dow Chemical Company, et al. | FIFRA Docket Nos. 415, et al. |

THE DOW CHEMICAL COMPANY'S
INITIAL LIST OF RISK WITNESSES
AND EXHIBITS

Pursuant to the order entered in these proceedings on June 7, 1979, The Dow Chemical Company (Dow) submits its initial list of risk witnesses (attached as Appendix A) and its initial list of proposed risk exhibits (attached as Appendix B).

Dow's list of risk witnesses is arranged alphabetically. The listing includes for each witness an address and a description of testimony, setting forth the specific areas and issues to be covered by the witness.

Dow's list of proposed exhibits is organized by various risk issues: carcinogenicity and mutagenicity; gestational period effects; application, drift, and exposure potential; environmental fate; residue analysis and analytical chemistry; the Alsea I and Alsea II studies; foreign governmental reports, Seveso, and Vietnam; and relative risk and safety.

A sponsoring witness is listed for each exhibit, although a few exhibits may be discussed by more than one witness.

In selecting its witnesses for these hearings, Dow has chosen the most knowledgeable individuals available in all areas. As shown in Appendix A, the individuals selected are recognized authorities and leaders in their respective disciplines. Dow is committed to a thorough scientific review of all issues in these proceedings, which will demonstrate the safety of 2,4,5-T and silvex for all registered uses.

Respectfully submitted,

Edward W. Warren

Edward W. Warren
L. Mark Wine
Richard L. McConnell

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2030 Dow Center
Midland, Michigan 48640

July 17, 1979

## APPENDIX A

## The Dow Chemical Company's Initial List of Risk Witnesses

1. Norman Akesson, Ph.D.
   Professor of Agricultural Engineering
   University of California, Davis
   Davis, CA 95616

Dr. Akesson, one of the country's leading experts on pesticide application methods and drift control, will testify concerning available methods to minimize airborne drift potential at the time of 2,4,5-T and silvex application. Dr. Akesson's testimony will cover the basic factors affecting pesticide drift, including especially the elimination of small spray particles, prevailing weather conditions, and geographical characteristics. He will also explain that available equipment and formulations permit highly accurate application.

2. Etcyl H. Blair, Ph.D.
   Vice President, Health and
   Environmental Sciences
   The Dow Chemical Co.
   2020 Dow Center
   Midland, MI 48640

Dr. Blair, Dow's Vice President for Health and Environmental Sciences, will present an overview of Dow's extensive research efforts, including an historical account of Dow's development of agricultural chemicals. He will explain Dow's philosophy of product stewardship, including Dow's participation in the regulatory process, the relative risk concept,

and the importance of sound scientific analysis in regulatory decision-making. Dr. Blair also will present an overview of the registration status and use of 2,4,5-T and silvex throughout the world.

3. Wayne Binns, D.V.M.
555 North 3rd East
Logan, UT 84321

Dr. Binns, a veterinarian and former Director of the U.S. Department of Agriculture's Poisonous Plant Research Laboratory, will testify concerning the harmful effects of poisonous plants on livestock, including particularly his extensive studies demonstrating adverse reproductive effects produced in lambs by native plant species. Dr. Binns will also present his own studies which show no teratogenic effects in lambs from 2,4,5-T.

Dr. Binns will also testify concerning his work as a member of the USDA Interdepartmental Panel which investigated allegations of damage following a spraying incident at Globe, Arizona. After an extensive investigation, the USDA team found that the alleged effects from the spraying either were not present or were caused by other factors.

4. Werner H. Braun
Toxicology Research Laboratory
Dow Chemical U.S.A.
1803 Building
Midland, MI 48640

Mr. Braun, a senior research chemist, will testify on exposure, pharmacokinetics, and risk, and will address the conclusions reached in EPA's Alsea II study. He will discuss

the three potential routes of human exposure: skin contact (absorption), inhalation, and ingestion. Mr. Braun's testimony will include estimates of the general population's negligible potential exposure to 2,4,5-T, silvex and TCDD, and will present the results of his recently-completed study of herbicide exposure and pharmacokinetics in spray applicators working with 2,4,5-T.

Mr. Braun will testify that the toxicity of a chemical to an organism is dependent on the dose to which the organism is exposed. His testimony will show that the potential doses of 2,4,5-T, silvex, and TCDD to which the public might be exposed are so small that the potential risk is negligible.

5. Robert R. Bumb, Ph.D.
Director, Research and Development
Michigan Division
Dow Chemical U.S.A.
566 Building
Midland, MI 48640

Dr. Bumb will testify on recent research by Dow and others showing that TCDD is produced in normal combustion processes. He will discuss the introduction of TCDD into the environment from municipal incinerators and other sources, creating residues not derived from herbicides or pesticides. Dr. Bumb will explain that the presence of chlorinated dioxins in the environment is due in large part to the existence of a natural phenomenon -- chemical reactions which occur at very low concentrations during normal combustion processes in refuse

incinerators and fossil-fueled powerhouses, gasoline and diesel powered vehicles, fireplaces, charcoal grills and even cigarettes.

6. Ralph R. Cook, M.D.
Director of Epidemiology
Dow Chemical U.S.A.
1603 Building
Midland, MI 48640

Dr. Cook will testify on epidemiologic studies conducted in Sweden, Vietnam, and Michigan, as well as EPA's Alsea II study. He will testify that these studies show no evidence that 2,4,5-T or silvex contaminated with low levels of TCDD causes toxic effects in humans under current manufacturing and use practices.

Dr. Cook's testimony will explain the irrelevance of the collected Alsea spray data to the incidence of miscarriages in the area and will testify that the statistical analyses employed in the Alsea II report, while superficially sophisticated, are inappropriate and misleading.

7. Dr. Frederick Coulston
Director, Institute of
Comparative and Human
Toxicology
Albany Medical College
Albany, NY 12208

Dr. Coulston, a former president of the Society of Toxicology, will testify concerning a conference of leading epidemiologists and other scientists which he convened in New York on July 10 and 11, 1979 to analyze the Alsea studies.

The final report of the conference has not yet issued but should be available prior to the cancellation hearing.

In addition, Dr. Coulston will present his own research concerning the effects of 2,4,5-T on pregnant rhesus monkeys, showing that large doses produce no adverse effects.

8. Donald Crosby, Ph.D.
Department of Environmental Toxicology
University of California, Davis
Davis, CA 95616

Anthony Wong, Ph.D.
California Analytical Laboratories, Inc.
401 North 16th Street
Sacramento, CA 95814

Dr. Crosby and/or Dr. Wong will testify concerning their research showing that TCDD degrades rapidly on leaves or soil in natural sunlight in the presence of hydrogen donors. This testimony will include an explanation of experimental studies showing that herbicide formulations containing known amounts of TCDD and exposed to natural sunlight lose most or all of the TCDD during a single day, due principally to photochemical dechlorination. They will further testify that TCDD is not stable as a contaminant in thin herbicide films exposed to sunlight.

9. Kenneth Crow, M.D.
Princess Margaret Hospital
Swinden, Wilts
England

Dr. Crow, a dermatologist, is a leading world authority on chloracne, a skin condition caused by contact with chlorinated organic chemicals. Chloracne is the most sensitive symptomatic indicator of exposure to such chemicals. Dr. Crow

will describe the chloracne he observed in residents of Seveso, Italy after the explosion of a trichlorophenol plant, and will explain the results of other medical examinations of Seveso residents. Dr. Crow will also testify concerning his examinations of other chloracne patients.

10. Warren B. Crummett, Ph.D.
Technical Manager
Analytical Laboratories
Dow Chemical U.S.A.
574 Building
Midland, MI 48640

Dr. Crummett will testify on the environmental chemistry of herbicides. In particular, his testimony will include a description of EPA's Dioxin Implementation Plan, in which Dow participated, and an explanation of analytical techniques for low-level detection of TCDD residues in environmental samples.

Dr. Crummett and his colleagues at Dow have been among the leaders in developing more precise analytic techniques for the detection of TCDD in environmental samples. His testimony will explain currently available analytical techniques, including measurement difficulties encountered near the level of detection due to problems with sample selection, sample contamination, sample degradation, background noise, interferences, signal detection, signal measurement, identification and confirmation.

11. Philip D. Darney, M.D.
Director of Reproductive Health
Associate Professor of Obstetrics and Gynecology
University of Oregon School of Medicine
3181 Sam Jackson Road
Portland, OR

Dr. Darney will testify on the medical aspects of Alsea II. Dr. Darney's testimony will address deficiencies in data collection for Alsea II, including EPA's failure to investigate alternative causes of miscarriage or to analyze the medical histories of the subject pregnancies. He will testify that the data actually collected in the Alsea II investigation demonstrate no link between herbicide use and the incidence of miscarriage.

12. Fred Decker, Ph.D.
Oregon State University
827 N.W. 31st Street
Corvallis, OR 97330

Dr. Decker, a meteorologist, will testify concerning weather patterns and geography in the Pacific Northwest and in the Alsea Basin. More specifically, Dr. Decker will describe the differing aspects of the study, control and urban areas employed in Alsea II. In addition, Dr. Decker's testimony will address specific data essential in evaluating the limited potential for human exposure in the Alsea study area.

13. Thomas Downs, Ph.D.
Professor of Biometry
Health Science Center at Houston,
School of Public Health
The University of Texas
P.O. Box 20186
Houston, TX 77025

Dr. Downs will testify on the statistical aspects of Alsea II, and will present a critical analysis of the study design, data collection techniques, and statistical methodology employed in the Alsea II study. His testimony will address, inter alia, the use of "hospitalized" miscarriage data in lieu of actual rates of miscarriage, the selection of control areas for the study, the insufficiency of the collected spray data, medical practice differences in the control and study areas, and the analysis of variance and cross-correlation analyses that were conducted in Alsea II.

14. F. Clarke Fraser, M.D., Ph.D.
Molson Professor of Human Genetics
Department of Biology
McGill University
Montreal, Quebec, Canada

Dr. Fraser will testify on teratology and developmental genetics. Dr. Fraser, a past President of the Teratology Society, is an emminent teratologist who has published widely in his field, and co-edited the four volume Handbook of Teratology. Dr. Fraser will discuss interactions between teratogens and environmental variables; interactions between teratogens and genotypes, including species and strain differences; and the testing of drugs and other environmental agents for teratogenic properties.

Dr. Fraser, who served on the National Academy of Sciences Committee on the Effects of Herbicides in Vietnam, will also present the NAS report on Vietnam, explaining the Academy's conclusion that the heavy use of phenoxy herbicides during the Vietnam War could not be associated with any increase in adverse reproductive effects among the population.

15. Perry J. Gehring, D.V.M., Ph.D.
Director, Health and Environmental Sciences
Dow Chemical U.S.A.
1803 Building
Midland, MI 48640

Dr. Gehring is one of the country's foremost toxicologists and the President-Elect of the Society of Toxicology. He will testify, inter alia, on EPA's Alsea II study; experimental animal data regarding carcinogenicity, teratogenicity and fetotoxicity; metabolism and pharmacokinetics in humans and animals; Seveso; and relevant reports on 2,4,5-T and silvex issued by foreign governments. Dr. Gehring will present data from numerous toxicological studies in animals demonstrating the very low risk posed by current potential exposure to 2,4,5-T, silvex, and TCDD.

16. Milton E. Getzendaner, Ph.D.
Associate Scientist
Health and Environmental Sciences
Dow Chemical U.S.A.
9008 Building
Midland, MI 48640

Dr. Getzendaner will testify about the environmental fate and presence of 2,4,5-T, silvex and TCDD. He has con-

ducted studies of residues in environmental samples and will explain the results of those studies. In addition, he will present experimental results which show that 2,4,5-T and silvex are rapidly decomposed in the environment, and will explain the very slight potential for human exposure.

17. Ray Harbison, Ph.D.
Department of Pharmacology
Vanderbilt University Medical Center
Nashville, TN 37232

Dr. Harbison will testify concerning the appropriate animal testing models for the determination of reproductive effects in animals and the interpretation of such studies in evaluating the safety of chemical exposures to man. In addition, Dr. Harbison will review the animal data on 2,4,5-T, silvex and TCDD and present his views as to the established no-effect levels for these chemicals.

18. Otto Hutzinger, Ph.D.
Laboratory of Environmental Chemistry
University of Amsterdam
Nielerve Achtergracht 166
The Netherlands

Dr. Hutzinger will testify regarding his research which has demonstrated the generation of TCDD and other dioxins (and related compounds) in municipal incineration.

19. David J. Jensen, Ph.D
Research Specialist
Agricultural Products
Department
Dow Chemical U.S.A.
9001 Building
Midland, MI 4864015.

Dr. Jensen will testify about the environmental fate of 2,4,5-T, silvex, and TCDD. Dr. Jensen has studied pesticide residues in beef fat, milk, sheep and rice, and will explain the results of these studies.

20. Hyland R. Johns
Senior Vice President
Asplundh Tree Expert Co.
Blair Mill Road
Willow Grove, PA 19090

Mr. Johns will testify on application methods for 2,4,5-T in rights-of-way vegetation management. His testimony will include a discussion of various herbicide application techniques, types of equipment used in application of 2,4,5-T, training and supervision of personnel, and accident prevention. He will explain such rights-of-way maintenance criteria as: safety, effectiveness, economy, environmental safety, asthetic acceptability, ecological soundness, and public acceptability.

Mr. Johns will further testify that his company has used 2,4,5-T and other herbicides nationwide safely and effectively for 33 years with no evidence of adverse human or environmental effects, and that alternatives are more costly, less efficacious, and present greater risk to the environment and humans.

21. Richard Jones, Ph.D.
Dept. of Biometrics
University of Colorado
Medical Center
Box 119
4200 E. 9th Avenue
Denver, CO 80262

Dr. Jones will testify about the statistical aspects of the Alsea II study. He will explain that the statistical analyses employed by EPA were inappropriate for the data collected, or were otherwise improperly performed. Dr. Jones' testimony will show that the conclusions reached by EPA's Alsea II team on the basis of these statistical analyses were in error.

22. Eugene E. Kenaga
Dow Chemical U.S.A.
9008 Building
Midland, MI 48640

Dr. Kenaga will testify on the environmental impact of 2,4,5-T, silvex and TCDD on fish, wildlife and birds. Dr. Kenaga will analyze the distribution of 2,4,5-T in the environment, and the fate of 2,4,5-T and TCDD in soil and water. He will discuss the complex interacting factors which determine the environmental behavior of a pesticide.

23. Robert Kilpatrick, M.D.
Dean, School of Medicine
University of Leicester
Medical Sciences Building
University Road
Leicester, LEI 7RH, England

Dr. Kilpatrick, Chairman of the Advisory Committee on Pesticides formed to advise the British Government, will pre-

sent the Committee's March, 1979 report on the safety of 2,4,5-T. Dr. Kilpatrick will explain the Committee's conclusion that 2,4,5-T as currently manufactured can be safely used, even when contaminated with small amounts of TCDD.

24. Richard J. Kociba, D.V.M., Ph.D.
Dow Chemical U.S.A.
1803 Building
Midland, MI 48640

Dr. Kociba will testify concerning the claimed carcinogenicity of 2,4,5-T, silvex and TCDD. His testimony will include evidence concerning appropriate laboratory protocols as well as actual test results. Dr. Kociba, a pathologist and veterinarian, has studied the chronic and acute toxic effects of 2,4,5-T and TCDD in rats. He will testify that numerous oncogenic studies conducted in laboratory animals do not show a reproducible oncogenic effect from 2,4,5-T or silvex in either animals or man.

25. Steven H. Lamm, M.D.
Tabershaw Occupational
Medicine Associates
6110 Executive Boulevard
Suite 740
Rockville, MD 20852

Dr. Lamm, an epidemiologist who has studied EPA's Alsea reports and data, will testify concerning the general principles of epidemiology, and will present a detailed critical analysis of the Alsea II Study. Dr. Lamm's testimony

will explain the deficiencies in data collection, study design, and statistical methodology employed in Alsea II. He will also present his own analyses of the data collected by EPA, which show no indication that the spraying of 2,4,5-T led to increased incidences of miscarriage as claimed by EPA.

26. Frank Lyman, M.D.
North Beach, NJ 08008

Dr. Lyman, a medical toxicologist with extensive experience in evaluating the human effects of man-made chemicals, will testify concerning the human health effects of 2,4,5-T, silvex and TCDD exposure.

27. E.G. McQueen, Ph.D.
Professor of Clinical Pharmacology
University of Otago Medical School
New Zealand

Dr. McQueen, a consultant to the New Zealand Department of Health, will testify concerning several New Zealand government reports on 2,4,5-T. One report, which Dr. McQueen helped write in 1977, studied allegations of 2,4,5-T-induced human birth defects. This study concluded that there is no evidence to to suggest that 2,4,5-T causes human birth defects. Dr. McQueen will also present a critique of EPA's Alsea II study by the New Zealand Department of Health, which concluded that Alsea II was "grossly inadequate" and that "no weight whatsoever" could be accorded its conclusions.

28. Donald S. Morehouse, Jr.
Manager, Agricultural
Chemicals Production
Dow Chemical U.S.A.
834 Building
Midland, MI 48640

Mr. Morehouse will testify concerning the production of 2,4,5-T and silvex, with emphasis on the control of TCDD contamination, and will present data concerning the amount of TCDD in Dow products. He will testify on the chemistry of dioxin formation, and on Dow's quality control and process safety procedures.

29. Michael Newton, Ph.D.
Dept. of Forest Science,
School of Forestry
Oregon State University
Corvallis, OR 97331

Dr. Newton, the leader of the USDA/States/EPA Assessment Team for 2,4,5-T, will testify regarding human exposure, forest ecology, environmental fate, and EPA's Alsea II Report. He will present the results of his studies on dermal absorption of 2,4,5-T and his field studies investigating residues of 2,4,5-T in mountain beaver and deer which show minimal residues. He will further testify that forest residents are not exposed to significant amounts of the herbicides. Dr. Newton will also explain environmental damage caused by alternative control techniques such as burning and mechanical clearance. He may also testify concerning weather conditions, geography, and other characteristics of the Alsea Basin in the course of presenting his critique of the Alsea II study.

30. Kenneth R. Niswander, M.D.
Department of Obstetrics and Gynecology,
School of Medicine
University of California, Davis
Professional Building
4301 X Street
Sacramento, CA 95817

Dr. Niswander will testify on the medical aspects of the Alsea II study. He will testify that he was originally asked by EPA to comment on the agency's Alsea I study, and concluded that no relationship was shown between herbicide spraying and the reported abortions. Dr. Niswander will testify that the Alsea II study similarly demonstrates no relationship between the reported spraying and miscarriage. Finally, he will testify that Alsea II was poorly designed and badly executed and that the conclusions drawn by EPA are unwarranted.

31. Colin N. Park, Ph.D.
Research Supervisor
Mathematical Applications
Group,
Dow Chemical U.S.A.
1707 Building
Midland, MI 48640

Dr. Park will testify concerning biostatistical aspects of Alsea II and quantitative risk estimation. He will discuss the selection of a data base for risk analysis, the choice of a mathematical model to describe dose/response, the estimation of human dose, and the extrapolation of animal data to humans. Dr. Park's application of conventional procedures for risk extrapolation demonstrates that there is no

significant risk to humans exposed to the concentrations of TCDD which result from current patterns of use.

32. John C. Ramsey, Ph.D.
Research Specialist
Toxicology Research
Laboratory
Dow Chemical U.S.A.
1803 Building
Midland, MI 48640

Dr. Ramsey will testify concerning human exposure and the pharmacokinetics of 2,4,5-T and silvex. He will present his study of exposure and pharmacokinetics in spray applicators working with 2,4,5-T. Dr. Ramsey will testify that even workers actually engaged in application operations are exposed only to minute quantities of 2,4,5-T and silvex which present no hazard to humans.

33. G. Reggiani, M.D.
Medical Research Board
F. Hoffman-La Roche & Co., Ltd.
Grenzacherstrasse 124
Basel, Switzerland

Dr. Reggiani has closely and continuously monitored the health of the population surrounding Seveso, Italy, since the 1976 chemical plant explosion which released TCDD into the environment. His testimony will include a detailed presentation of health statistics observed in the area and an explanation of the extensive health surveillance system established by Italian health officials with the cooperation of Dr. Reggiani and Hoffman-La Roche. Dr. Reggiani's testimony will show that despite exposure to TCDD, the Seveso population has not

suffered serious adverse health effects from TCDD exposure although chloracne has been observed in some residents.

34. Francis J. C. Roe, M.D.
19 Marryat Rd.
Wimbledon, Common SW195BB
England

Dr. Roe, a leading international toxicologist, will testify concerning the mechanisms of cancer causation and the many factors affecting the design and interpretation of animal tests for carcinogenicity. He will further testify concerning the interpretation of tests for the mutagenicity of substances and the evaluation of the safety of chemicals in general. Finally, he will review the specific carcinogenicity studies conducted for 2,4,5-T and silvex, showing these substances are not carcinogenic in test animals.

35. W.B. Roe, Sr.
Campbell Air Service, Inc.
P.O. Box 872
Vivian, LA 71082

Dwayne S. Bailey
Penn Line Service
Box 462
Scottdale, PA 15683

Mr. Roe and Mr. Bailey have extensive experience as aerial applicators of herbicides. They will testify concerning application techniques and equipment designed to reduce spray drift, and will explain safe spraying practices. In addition, Mr. Roe and Mr. Bailey will testify that they have observed no adverse health affects that could be attributed to herbicide applications in themselves, their families, or their colleagues in the aerial application industry, during many years of dealing with 2,4,5-T and other herbicides.

36. Bernard A. Schwetz, D.V.M., Ph.D.
Director, Toxicology Research
Laboratory
Dow Chemical U.S.A.
1803 Building
Midland, MI 48640

Dr. Schwetz will present the results of his studies on the reproductive effects of 2,4,5-T and TCDD in rats. Based on these studies and other data, Dr. Schwetz will testify that the minute traces of TCDD present in 2,4,5-T and silvex pose no reproductive risk to humans under current patterns of use.

37. Louis Shadoff, Ph.D.
Analytical Specialist
Analytical Laboratories
Dow Chemical U.S.A.
574 Building
Midland, MI 48640

Dr. Shadoff, an analytical chemist, will explain various techniques for detecting low levels of TCDD in environmental samples, including thin layer chromatography, gas chromatography and mass spectrometry. He will also testify on the results of various environmental sampling studies generated in EPA's Dioxin Implementation Plan. Dr. Shadoff will explain the difficulties surrounding low-level detection and analysis of TCDD, and will explain that lowering the limit of detection reduces the sensitivity of the test.

38. Donald L. Slaughter, M.D.
3724 Kimberly Way
Carmichael, CA 95608

Dr. Slaughter was formerly associated with the California State Department of Food and Agriculture and is currently engaged in the private practice of medicine. He will testify concerning the 1978 Report on the Aerial Use of Phenoxy Herbicides compiled by California's Phenoxy Herbicide Investigation Team, of which he was a member. In 1977-78, the Team held a series of ten meetings and conducted extensive field investigations to determine whether phenoxy herbicides pose a hazard to man and animals in the environment. The Team concluded that no adverse human health effects could be attributed to or associated with the spraying of phenoxy herbicides.

39. Eugene Smith
Route 2
Box 445
Rolla, MO 65401

Mr. Smith is a rancher who has extensive experience in applying herbicides with fixed-wing aircraft. He will testify concerning application techniques and equipment, as well as safe spraying practices. Mr. Smith will also testify that he has observed no adverse health affects attributable to herbicide applications in himself, his family, or his fellow ranchers and aerial applicators, during several years of using 2,4,5-T and other herbicides. Since he will also testify concerning the benefits of 2,4,5-T on range and pasture, Mr. Smith may appear during Dow's benefits case, rather than during Dow's risk presentation.

40. James M. Taylor, M.D.
Director, Department of
Industrial Dermatology
Cleveland Clinic Foundation
Cleveland, OH

Dr. Taylor is a dermatologist who has examined a number of patients exposed to TCDD as a result of industrial accidents. His testimony will focus on the dermal effects of TCDD in humans and his specific observations of chloracne.

41. H. Tuchmann-Duplessis, M.D.
Faculty of Medicine Paris
University Rene Descartes
Laboratory of Embryologie
45 Rue Des Saints-Peres
75270 Paris, France

Dr. Tuchmann-Duplessis is an acknowledged international authority on the effects of drugs on the developing embryo and fetus. He will testify on teratology and on his investigations of the residents of Seveso, Italy and the surrounding area. Dr. Tuchmann-Duplessis will explain that exposure to TCDD from the Seveso accident did not produce reproductive effects in humans, and that there was no change in the frequency of miscarriages.

42. Sheldon Wagner, M.D.
Research Professor
Environmental Health
Sciences Center
Oregon State University
Corvallis, OR 97330

Dr. Wagner will testify on the medical aspects of Alsea II. Dr. Wagner, along with other scientists at Oregon State, is preparing a comprehensive analysis of EPA's Alsea reports. Dr. Wagner will present the conclusions of the group.

43. Philip G. Watanabe, Ph.D.
Group Leader, Molecular
Toxicology Section
Toxicology Research
Laboratory
Dow Chemical U.S.A.
1803 Building
Midland, MI 48640

Dr. Watanabe, a toxicologist, will testify on general principles of carcinogenicity and mutagenicity. His testimony will explain that the carcinogenic process is a complex, multi-step process dependent, inter alia, on the accesibility of a critical cellular target to a carcinogenic agent, and on the operation of repair or reversal mechanisms. Dr. Watanabe will discuss both genetic and non-genetic mechanisms of carcinogenesis. He will testify that no valid reproducible study has suggested that 2,4,5-T or silvex is carcinogenic in animals, and that the available experimental data suggests that the risk of carcinogenesis from low-level exposure to TCDD is negligible.

44. James G. Wilson, Ph.D.
Department of Pediatrics and Anatomy
University of Cincinnati
College of Medicine
Elland and Bethesda Avenue
Cincinnati, OH 45229

Dr. Wilson is an emminent teratologist and co-editor of the four volume Handbook of Teratology. He will explain general principles of teratology, including the impact of factors such as the genetic characteristics of the conceptus, the developmental stage of the fetus at the time of exposure,

and the dose to which the developing organism is exposed. He will further testify concerning his research with 2,4,5-T in rhesus monkeys.

45. Richard Wilson, Ph.D.
15 Bracebridge Rd.
Newton Center, MA 02159

Dr. Wilson will testify on relative risk comparisons, focusing on the many hazards to which one is susceptible in everyday life. His testimony will demonstrate that the risks, if any, presented by the use of 2,4,5-T and silvex are much less than the risks encountered through eating peanut butter, flying on high-altitude commercial jets, and engaging in other common human endeavors.

46. James M. Witt, Ph.D.
Professor, Department of
Agricultural Chemistry
Oregon State University
Corvallis, OR 97330

Dr. Witt, a member of the Assessment Team, will testify concerning the exposure analysis presented in the USDA/States/EPA Assessment Team Report, and will explain the margins of safety applicable to current use patterns. Dr. Witt will also present a critique of the exposure analyses contained in the Administrator's suspension decision and the Alsea II study.

47. Alvin Young, Ph.D.*/
5226 Prince Valiant Drive
San Antonio, TX 78218

Dr. Young, a United States Air Force scientist who has studied 2,4,5-T extensively, will testify on toxicology and the environmental fate of 2,4,5-T and TCDD. Dr. Young will present the results of his biodegradation work at Eglin AFB, Florida, and his field studies with beach mice which have provided extensive data on actual environmental exposure from massive amounts of herbicides applied in field tests. Dr. Young will also present important aspects of "The Toxicology, Environmental Fate, and Human Risk of Herbicide Orange and Its Associated Dioxin," a comprehensive report prepared for the Surgeon General of the United States Air Force by Dr. Young and his colleagues.

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*/ Dr. Young's appearance is dependent upon approval by his Air Force superiors.

## APPENDIX B

The Dow Chemical Company's Initial List of Proposed Risk Exhibits by Issue with Sponsoring Witnesses

| | Sponsoring Witness |
|---|---|
| **1. Carcinogenicity and Mutagenicity** | |
| Axelson, O. and L. Sundell, "Herbicide Exposure, Mortality and Tumor Incidence: An Epidemiological Investigation on Swedish Railroad Workers," Arch. Environm. Health 11 at 21-28 (1974). | Cook |
| Berenblum, I., "Irritation and Carcinogenesis," Arch. Pathol. 38 at 233-244 (1944). | Watanabe |
| Berry, D.L., J. DiGiovanni, M.R. Juchau, W.M. Bracken, G.L. Gleason, and T.J. Slaga, "Lack of Tumor Promoting Ability of Certain Environmental Chemicals in a Two-Stage Mouse Skin Tumorigenisis Assay," Res. Com. in Chem. Pathol. and Pharmacol. 20(1) at 101-08 (1978) (Dow RPAR 19).*/ | Kociba |
| DiGiovanni, J., A. Viaje, D.L. Berry, T.J. Slaga, and M.R. Juchau, "Tumor-Initiating Ability of TCDD and Arochlor 1254 in the Two-Stage System of Mouse Skin Carcinogenesis," Environm. Contam. Toxicol. 18(5) at 552-57 (1977) (Dow RPAR 21). | Kociba |
| EPA, "TDAP Review at University of Wisconsin, TCDD in Rats," Report of GLP Audit from H.W. Spencer to H. Warnick (February 8, 1979) (ARI R-32). | Kociba |
| FDA, "Assessment of Estimated Risk Resulting from Aflatoxins in Consumer Peanut Products and other Food Commodities," (January 19, 1978). | Kociba |

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*/ "ARI R-__" or "B-__" refer to documents in the Administrator's Record Index for the Suspension of 2,4,5-T and Silvex, February 28, 1979. "EPA RPAR ___" refers to documents cited by EPA in the April 21, 1978 Rebuttable Presumption Against Registration for 2,4,5-T, 43 Fed. Reg. 17116. "Dow RPAR ___" refers to documents cited in the "Response of Dow Chemical, U.S.A. to Notice of RPAR and Continued Registration of Pesticide Products Containing 2,4,5-T," filed with EPA on August 4, 1978.

Fears, T.R., R.E. Tasone, and K.C. Chee, "Error Rates for Carcinogenicity Screens," Advisory Center Toxicology, National Cancer Institute, Bethesda, Md. (October 5, 1976) (Dow RPAR 15). Kociba

Gart, J.J., Letter to the Editor, Br. J. Cancer 31 at 696-97 (1975). Kociba

Gehring, P.J. and J.E. Betso, "Phenoxy Acids: Effects and Fate in Mammals," in Chlorinated Phenoxy Acids and Their Dioxins, Ecological bulletin No. 27 at 122 C.E. Ramel (ed.) Stockholm (1978). Kociba

Hardell, L., "Malignant Mesenchymal Tumors and Exposure to Phenoxy Acids -- A Clinical Observations," (abstract, translated from Swedish) Lakartidningen 74 at 2753-54 (1977) (EPA RPAR 108). Cook

Hardell, L., and A. Sandstrom, "Case-Control Study-Malignant Mesenchymal Soft Tissue Tumor and Exposure to Phenoxy Acids or Chlorophenols," (Translated from Swedish) Lakartidningen 75 at 40 (1978). Cook

Kociba, R.J. et al., "Results of a Two-year Chronic Toxicity and Oncogenic Study of Rats Ingesting Diets Containing 2,4,5-Trichlorophenoxyacetic Acid (2,4,5-T)," in press Fd. Cosmetic. Toxicol. (1979). Kociba

Kociba, R.J., D.G. Keyes, J.E. Beyer, R.M. Carreon, C.E. Wade, D.A. Dittenber, R.P. Kalnins, L.E. Frauson, C.N. Park, S.D. Barnard, R.A. Hummel and C.G. Humiston, "Results of a Two Year Chronic Toxicity and Oncogenicity Study of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin in Rats," Toxicol. Appl. Pharm., 46 at 279-303 (1978) (ARI R-30). Kociba

Kociba, R.J., D.J., Keyes, G.C. Jersey, J.J. Ballard, D.A. Dittenber, J.F. Quast, C.E. Wade, C.G. Humiston, and B.A. Schwetz," Results of a Two-Year Study with Hexachlorobutadiene in Rats," Am. Ind. Hyg. Assoc. J. 38 at 589 (1977). Kociba

Laroye, G.J., "How Efficient is Immunologic Surveillance Against Cancer and Why Does it Fail", Lancet at 1097-1100 (June 1, 1974). Watanabe

Leuschner, F., et al., Chronic Oral Toxicity of 2,4,5-T in a Reproduction Study Covering Three Generations of Sprague-Dawley Rats," Unpublished data of Celamerck GmbH Co., KG D-6507 Ingelheimam Rhein (May 2, 1978) (Confidential) (Dow RPAR 45) (AIR R-26). Kociba

Moore, J.A., Chairman, et al., "Long-Term Hazards of Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans," Joint NIEHS/IARC Working Group Report, IARC Internal Technical Report No. 78/001 (June 1978) (ARI R-19). Kociba

National Academy of Sciences, "The Effects of Herbicides in South Vietnam," Committee on the Effects of Herbicides in Vietnam, Washington, D.C. (1974) (Dow RPAR 31). Cook

Ott, M.G., B.B. Holder, and R.D. Olson, "A Longevity Survey of Employees Exposed to 2,4,5-T," The Dow Chemical Co. (Confidential) (Dow RPAR 28). Cook

Pegg, A.E., et al., "Importance of DNA Repair in the Organ Specificity of Tumor Induction by N-Nitroso Carcinogens," Proc. Evironm. Soc. Toxicol. 17 at 39-54 (1976). Watanabe

Peto, R., "Guidelines on the Analysis of Tumor Rates and Death Rates in Experimental Animals," Br. J. Cancer 29 at 101 (1974). Kociba

Prejean, J.D., J.C. Peckman, A.E. Cosey, D.P. Griswold, E.K. Weisburger and J.H. Weisburger, "Spontaneous Tumors in Sprague-Dawley Rats and Swiss Mice," Cancer Res. 32 at 2768 (1973). Kociba

Riihimaki, V., S. Asp. A.M. Seppalainen and S. Hernberg, "Symptomatology, Morbidity and Mortality Experience of Chlorinated Phenoxyacid Herbicide (2,4-D; 2,4,5-T) Spayers in Finland: A Clinical and Epidemiological Study." Working paper from IARC Longterm Hazards of Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans (1978) (ARI R-19). Cook

Roe, F.J.C., "Chemical Carcinogenesis: Animals and Man," in Scientific Foundations of Oncology (T. Symington and R.L. Carter, eds.) London (1976). Roe

Roe, F.J.C., "General Toxicological Considerations of Extrapolation from Animals to Man," in Science for Better Environment, HESC Organizing Committee-Science Council of Japan at 489-93 (1976). Roe

Roe, F.J.C., "The Evaluation of Cosmetics and Toiletries for Carcinogenicity," in Symposium on Cosmetics and Toiletries -- Safety Assurance (1977). Roe

Roe, F.J.C., "The Principles of Cancer Prevention," Gazzetta Sanitaria, Vol.XIX (2) (1970). Roe

Roe, F.J.C. and M.J. Tucker, "Recent Developments in the Design of Carcinogenicity Tests on Laboratory Animals," Proceedings of the European Society for the Study of Drug Toxicity, Vol. XV, Zurich (June 1973). Roe

Sher, S.P. "Mammary Tumors in Control Rats: Literature Tabulation," Toxicol. Appl. Pharmacol. 22 at 562-588. (1972) (Dow RPAR 18). Kociba

Slaga, T.J., et al., "Inhibition of Tumor Production by Anti-Inflammatory Agents: An Approach to the Biochemical Mechanism of Promotion," in Carcinogenesis: Mechanisms of Tumor Promotion and Carcinogenesis, vol. 2, edited by T.J. Slaga, A. Sivak and R.K. Boutwell at 173-195 (1978). Watanabe

Sontag, J.M., M.P. Page, and U. Saffiotti, "Guidelines for Carcinogen Bioassay in Small Rodents," NCI-CG-TR-1 (1976). Kociba

Wogan, G.N., S. Paglialunga, and P.M. Newberne, "Carcinogenic Effects of Low Dietary Levels of Aflatoxin B in Rats," Fd. Cosmet. Toxicol., 12 at 681 (1974). Kociba

World Health Organization, "Environmental Health Criteria for TCDD," IARC, Lyon, France at 42 (1978). Kociba

2. Gestational Period Effects

Bage, G., E. Akonova and K.S. Larson, "Teratogenic and Embryotoxic Effects of the Herbicides Di- and Trichlorophenoxyacetic Acid (2,4-D and 2,4,5-T)," Acta Pharmacol. Toxicol. 32(6) at 408-416 (1973)(ARI R-103). Gehring

Beck, F. and J.B. Lloyd, "An Investigation of the Relationship Between Fetal Death and Fetal Malformations," J. Anat. 97 at 555-564 (1963). Schwetz

Binns, W., "Poisonous Weeds and Livestock Losses," Prac. Nutr., 6(4) at 19 (1972). Binns

Binns, W. (Project Leader), Report on "Summary of Results -- Two Experimental Feeding Trials to Determine Teratogenic EFfects of 2,4,5-Trichlorophenoxyacetic Acid and 2,4,5-Trichlorophenoxyacetic Acid Propylene Glycol Butyl Ester on Lambs." Binns

Binns, W., L.F. James, R.F. Keeler, and L.D. Balls, "Effects of Teratogenic Agents in Range Plants," Cancer Research, 28 at 2323-2326 (1968). Binns

Binns, W., L.F. James and J.L. Shupe, "Congenital Malformations in Lambs Reproduced by Feeding a Poisonous Range Plant," Southwestern Veterinarian, 17(3) (1964). Binns

Binns, W., R.F. Keeler, and L.D. Balls, "Congenital Deformities in Lambs, Calves, and Goats Resulting from Maternal Ingestion of Veratrum californicum: Hare Lip, Cleft Palate, Ataxia and Hypoplasia of Metacarpal and Metarsal Bones," USDA Report (1972). Binns

Binns, W., et al., "A Congenital Cyclopian-Type Malformation in Lambs Induced by Maternal Ingestion of a Range Plant, Veratrum californicum," Amer. J. Vet. Res., 24(103) at 1164-1175 (1963). Binns

Dougherty, W.H., F. Coulston and L. Golberg, "The Evaluation of the Teratogenic Effects of 2,4,5-Trichlorophenoxyacetic Acid in the Rhesus Monkey," Environm. Qual. and Safety 5 at 89-96 (1976) (Dow RPAR 35). Coulston

Emerson, J.L., D.J. Thompson, R.J. Strebing, C.G. Gerbig and V.B. Robinson, "Teratogenic Studies on 2,4,5-Trichlorophenoxyacetic Acid in the Rat and Rabbit," Fd. Cosmet. Toxicol. 9 at 395-404 (1971)(ARI R-104). Gehring

Frohbert, H., "Investigations on the Embroyotoxic Effect of 2,4,5-T in NMRI Mice," Naunyn Schmiedeberg's Arch. Pharmacol. 282 at R.22 (abstract)(1974) (Dow RPAR 38). Gehring

Gebhardt, D.O.E., "The Embryolethal and Teratogenic Effects of Cyclophosphamide on Mouse Embryos," Teratology 3 at 273-278 (1970). Schwetz

Hall, S.M., "Effects on Pregnant Rats and Their Progeny of Adequate or Low Protein Diets Containing 2,4,5-T or p, p'-DDT," Fed. Proc. 31(2) (1972) (Dow RPAR 40). Gehring

Hart, E.R. and M.G. Valerio, "Teratogenic Effects of 2,4,5-T in Mice," Toxicol. Appl. Pharmacol. 22 at 317 (Abstract) (1972) (Dow RPAR 41). Gehring

Hobson, W.C., G.B. Fuller, and F. Coulston, "The Reproductive Endocrine System of Nonhuman Primates -- A Model for Prediction of Toxicity," Ecotoxicology and Environmental Safety, 2 (1978). Coulston

Murray, F.J., F.A. Smith, K.D. Nitschke, C.G. Humiston, R.J. Kociba and B.A. Schwetz, "Three-Generation Reproduction Study in Rats Ingesting 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) in the Diet" (in press) (1979). Schwetz

Nelson, C.J., J.F. Holson, H.G. Green, and D.W. Gaylor, "Retrospective Study of the Relationship Between Agricultural Use of 2,4,5-T and Cleft Palate Occurrence in Arkansas," Teratology, 19 at 377-384 (1979). Gehring

Schwetz, B.A., et al., "Toxicology of Chlorinated Dibenzo-p-dioxins," Environm. Health Perspectives at 87-99 (September 1973). Schwetz

Smith, F.A., B.A. Schwetz and K.D. Nitschke, "Teratogenicity of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin in CF-1 Mice," Toxicol. Appl. Pharmacol. 38 at 517-523 (1976) (ARI R-7). Schwetz

Sparschu, G.L., F.L. Dunn and V.K. Rowe, "Study of the Teratogenicity of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin in the Rat," Fd. Cosmet. Toxicol. 9 at 405-412 (1971) (ARI R-4). Schwetz

Thompson, D.J., J.L. Emerson, R.J. Streibig, and C.G. Gerbig, "Teratology and Postnatal Studies in Rats Treated Orally with SILVEX-PGBE," unpublished. The Dow Chemical Company (1972) (Confidential). Schwetz

Thompson, D.J., R.J. Streibig, C.G. Gerbig and J.L. Emerson, "Teratology and Postnatal Studies in Rats Treated with Silvex," A Dow Chemical Company Report (1972) (Confidential) (ARI R-117). Schwetz

Tschirley, F.H. (Chairman), et al., "Investigation of Spray Project Near Globe, Arizona," Report of Interdepartmental Panel, USDA (February 1970). Binns

Tuchmann-Duplessis, H., "Design and Interpretation of Teratogenic Tests," in Embryopathic Activities of Drugs at 56-93 (1965). Tuchmann-Duplessis

Wilson, J.G., "Abnormalities of Intrauterine Development in Non-Human Primates," Symposium on the Use of Non-Human Primates for Research on Problems of Human Reproduction, Sukhumi, U.S.S.R. (December 13-17, 1971) (Dow RPAR 34). J. Wilson

Wilson, J.G., "Current Status of Teratology," in Handbook of Teratology, Vol. 1, edited by Wilson, J.G. and C.F. Fraser, Academic Press, New York, N.Y., at 47-74 (1977). J. Wilson

Wilson, J.G., Chairman, "Report of the Advisory Committee on 2,4,5-T to the Administrator of the Environmental Protection Agency" (submitted May 7, 1971) (EPA RPAR 48). J. Wilson

Wilson, J.G., "Teratological Potential of 2,4,5-T," Proceedings of the 25th Annual Meeting of Southern Weed Science Society (January 18-20, 1972). J. Wilson

Wilson, J.G., "Use of Rhesus Monkeys in Teratological Studies," Fed. Proc., 30(1) at 104-109 (January-February 1971). J. Wilson

Wilson, J.G., R. Fradkin, and A. Hardman, "Breeding and Pregnancy in Rhesus Monkeys Used for Teratological Testing," Teratology, 3 at 59-72 (1970). J. Wilson

3. Application Methods, Drift and Exposure Potential

Akesson, N., "Drift Problems in the Application of 2,4-D by Aircraft," Down to Earth (1955). Akesson

Akesson, N. and W.E. Yates, "Report on Pesticides in the Air Environment" (unpublished). Akesson

| | |
|---|---|
| Asplundh Tree Expert Company, "Asplundh Chemical Foreman's Manual" (Revised 1979). | Johns |
| Asplundh Tree Expert Company, "Chemical Vegetation Management of Rights-of-Way." | Johns |
| Bramble, W.C. and W.R. Byrnes, "A Long-term Ecological Study of Game Food and Cover on a Sprayed Utility Right-of-Way," Research Bulletin, No. 885 (February 1972). | Johns |
| Bramble, W.C. and W.R. Byrnes, "Impact of Herbicides Upon Game Food and Cover on a Utility Right-of-Way," Research Bulletin, No. 918 (December 1974). | Johns |
| California Dept. of Food and Agriculture, "Report on the Aerial Use of Phenoxy Herbicides" (April 6, 1978). | Slaughter |
| Crow, K., "Chloracne: The Chemical Disease," New Scientist at 78-80 (13 April 1978). | Crow |
| Dow Chemical Co., "Realistic Evaluation of Human Exposure from Application of 2,4,5-T Sprays," Appendix V to Dow Chemical 2,4,5-T RPAR Response (August 4, 1978). | Ramsey |
| Gehring, P.J., C.G. Kramer, B.A. Schwetz, J.Q. Rose and V.K. Rowe, "The Fate of 2,4,5-Trichlorophenoxyacetic Acid (2,4,5-T) Following Oral Administration to Man," Toxicol. Appl. Pharmacol. 26 at 352-361 (1973) (EPA RPAR 74). | Ramsey |
| Lavy, T.L., "Measurement of 2,4,5-T Exposure to Forest Workers," Project Completion Report to National Forest Products Association (August 30 to October 3, 1978) (ARI R-61). | Ramsey |
| Newton, M., "Dermal Exposure of Humans to 2,4,5-T," Submitted to U.S. Environmental Protection Agency in Response to the Rebuttable Presumption Against Registration of 2,4,5-T, Oregon State University, Corvallis (1978). | Newton |
| Newton, M., Letter to Dr. Bernard Smale of EPA's Office of Pesticide Programs Re Hazards of TCDD (September 29, 1975). | Newton |
| Newton, M., Letter to Senator Mark Hatfield Re Health Effects of 2,4,5-T in Forests (February 27, 1979). | Newton |

Newton, M. and S.P. Snyder, "Exposure of Forest Herbivores to TCDD in Areas Sprayed With 2,4,5-T," (unpublished, 1978) (RPAR Rebuttal Comment #2625[30000/26]). Newton

Piper, W.N., J.A. Rose, M.L. Leng and P.J. Gehring, "The Fate of 2,4,5-Trichlorophenoxyacetic Acid (2,4,5-T) Following Oral Administration to Rats and Dogs," Toxicol. Appl. Pharmacol. 26 at 339-351 (1973). Ramsey

Poland, A.P., D. Smith, G. Metler, and P. Possick, "A Health Survey of Workers in a 2,4-D and 2,4,5-T Plant," Arch. Environm. Health, 22 at 316-327 (1971) (EPA RPAR 93). Cook

Ramsey, J.C., T.L. Lavy and W.H. Braun, "Exposure of Forest Workers to 2,4,5-T: Calculated Dose Levels," submitted to U.S. Environmental Protection Agency in Response to the Rebuttable Presumption Against Registration of 2,4,5-T, The Dow Chemical Company, Midland, Michigan (1979) (ARI R-61). Braun

Rose, J.Q., J.C. Ramsey, T.H. Wentzler, R.A. Hummel, and P.J. Gehring, "The Fate of 2,3,7,8-Tetrachlorodibenzo-p-dioxin Following Single and Repeated Oral Doses to the Rat," Toxicol. Appl. Pharmacol., 36 at 209-226 (1976). Ramsey

Sauerhoff, M.W., W.H. Braun, G.E. Blau and P.J. Gehring, "The Dose-Dependent Pharmacokinetic Profile of 2,4,5-T following Intravenous Administration in Rats," Toxicol. Appl. Pharmacol. 36 at 491-501 (1976). Ramsey

Sauerhoff, M.W., M.B. Chenoweth, R.J. Karbowski, W.H. Braun, J.C. Ramsey, P.J. Gehring and G.E. Blau, "Fate of Silvex Following Oral Administration to Humans," J. Toxicol. Environm. Health 3 at 941-952 (1976). Ramsey

Witt, J.M., "Exposure and Hazard Analysis of 2,4,5-T Uses," Extracted from Biologic and Economic Assessment of 2,4,5-T, a Report of the USDA/States/EPA 2,4,5-T RPAR Assessment Team (February 15, 1979). Witt

Young, J.D., J.C. Ramsey and W.H. Braun, "Pharmacokinetics of 2,4,5-T PGBE Ester Applied Dermally to Rats," The Dow Chemical Company, Midland, Michigan, Manuscript in preparation (1979). Ramsey

4. Environmental Fate


Altom, J.D. and J.F. Stritzke, "Degradation of Dicamba, Picloram and Four Phenoxy Herbicides in Soil," Weed Sci. 21 at 556-60 (1973). — Getzendaner

Arnold, E.L., A.L. Young, and A.M. Wachinski, "Three Years of Field Studies on the Soil Persistence and Movement of 2,4-D, 2,4,5-T and TCDD," Presentation to the Weed Science Society of America, Denver, Colorado (February 3, 1976). — Young

Bailey, G.W., A.D. Thruston, Jr., J.D. Pope, Jr. and D.R. Cochrane, "The Degradation Kinetics of an Ester of Silvex and the Persistence of Silvex in Water and Sediment," Weed Sci. 18(3) at 413-418 (1970) (EPA RPAR 49). — Getzendaner

Bounds, H.C. and A.R. Colmer, "Detoxification of Some Herbicides by Streptomyces." Weeds 13 at 249-52 (1965). — Getzendaner

Brown, E. and X.A. Neshioka, "Pesticides in Selected Western Streams," Pest. Monit. J. 1 at 38-41 (1967) (EPA RPAR 59). — Getzendaner

Buser, H.R., H.P. Bosshardt, and C. Rappe, "Identification of Polychlorinated Dibenzo-p-dioxin Isomers Found in Fly Ash," Chemosphere, No. 2 at 165-172 (1978). — Hutzinger

Crosby, D.G., "Conquering the Monster - the Photochemical Destruction of Chlorodioxins," presented at 174th Nat'l ACS Meeting, Chicago (unpublished 1977) (ARI R-80). — Crosby/Wong

Crosby, D.G., "The Environmental Chemistry of Herbicides," Chapter 6 in Pesticide Chemistry in the 20th Century, edited by J.R. Plimmer, ACS Symposium Series 37, Washington, D.C. at 93-108 (1977) (Dow RPAR 94). — Crosby/Wong

Crosby, D.G., "The Photodecomposition of Pesticides in Water," Adv. Chem. Ser. 111 at 173-88 (1972). — Crosby/Wong

Crosby, D.G., and Ming-Yu Li, "Herbicide Photodecomposition," in Degradation of Herbicides, edited by P.C. Kearney and D.D. Kaufman, Dekker, NY at 321-63 (1969). — Crosby/Wong

| | |
|---|---|
| Crosby, D.G., K.W. Moilanen and A.S. Wong, "Environmental Generation and Degradation of Dibenzodioxins and Dibenzofurans," in Environmental Health Perspectives, Experimental Issue No. 5, at 259, U.S. Dept. of Health, Education and Welfare, Public Health Service, National Institutes of Health, Publication No. (NIH) 74-218 (Sept. 1973). | Crosby/ Wong |
| Crosby, D.G., and A.S. Wong, "Environmental Degradation of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD)," Science 195 at 1337-38 (1977). | Crosby/ Wong |
| Crosby, D.G., and A.S. Wong, "Photochemical Generation of Chlorinated Dioxins," Chemosphere, 5 (1976). | Crosby/ Wong |
| Crosby, D.G., and A.S. Wong, "Photodecomposition of 2,4,5-Trichlorophenoxyacetic Acid (2,4,5-T) in Water," J. Agr. Food Chem. 21(6) at 1052-54 (1973). | Crosby/ Wong |
| Day, B., Chairman, et al., "The Phenoxy Herbicides," Council for Agricultural Science and Technology Report No. 77 (August 1978). | Getzendaner |
| Dow Chemical Co., "Review of Residue, Surveillance and Environmental Fate Studies of TCDD," Appendix II to Dow Chemical 2,4,5-T RPAR Response (August 4, 1978). | Getzendaner |
| Dow Chemical Co., "The Trace Chemistries of Fire -- A Source of and Routes for the Entry of Chlorinated Dioxins into the Environment," by the Chlorinated Dioxin Task Force (1978). | Bumb |
| Dupuy, A.J. and J.A. Schulze, "Selected Water Quality Records for Texas Surface Waters," Tex. Water Dev. Board Report No. 149 (1972). HAPO 6(5) at 241 (1973). | Getzendaner |
| Hunter, J.H. and A.L. Young, "Vegetation Succession Studies on a Defoliant-Equipment Test Area, Eglin AFB Reservation, Florida," Technical Report AFATL-TR-72-31 (February 1972). | Young |
| Jensen, D.J., R.A. Hummel, H.S. Higgins, L. Lamparski, E.T. Madrid, "Secretion of TCDD in Milk and Cream Following the Feeding of TCDD to Lactating Dairy Cows," Unpublished. The Dow Chemical Company. (1978) (Confidential) (Dow RPAR 9). | Jensen |

Jensen, D.J. and P.W. Miller, "Dissipation of Silvex from Soil in Fields Treated with Kuron Herbicide," unpublished. The Dow Chemical Company (1975) (Confidential). — Jensen

Jensen, D.J. and P.W. Miller, "Residue Study: Dissipation of Silvex and 2,4,5-Trichlorophenol in Tissues of Cattle Fed Silvex," unpublished. The Dow Chemical Company (1974) (Confidential). — Jensen

Leng, M.L., "Residues in Milk and Meat and Safety to Livestock from the Use of Phenoxy Herbicides in Pasture and Rangeland," Down To Earth 28(1) at 12-20 (1972) (EPA RPAR 37). — Getzendaner

Manigold, D.B. and J.A. Schulze, "Pesticides in Selected Western Streams in a Progress Report," Pestic. Monit. J. 3 at 124-35 (1969) (EPA RPAR 60). — Getzendaner

Nash, R.G. and M.L. Beall, Jr., "A Microagroecosystem to Monitor the Environmental Fate of Pesticides," ARS, USDA, Beltsville, MD (1977). — Getzendaner

Newton, M., "Environmental Impact of 'Agent Orange' Used in Reforestation Tests in Western Oregon," Abstract 144, Meeting of Weed Sci. Soc. Am., Washington, D.C. (1975) (Dow RPAR 99). — Newton

Newton, M., Project Director, "Silvicultural Chemicals and Protection of Water Quality," Oregon State Univ. School of Forestry, EPA 910/9-77-036 (June 1977). — Newton

Newton, M. and L.A. Norris, "Evaluating Short- and Long-Term Effects of Herbicides on Nontarget Forest and Range Biota," Down to Earth 32(3) at 18-26 (1976). — Newton

Newton, M. and L.A. Norris, "Herbicide Residues in Blacktail Deer from Forests Treated with 2,4,5-T and Atrazine," Proc. Western Weed Control Conference, Boise at 32-34 (1968). — Newton

Norris, L.A., "Physiological and Biochemical Bases of Herbicide Selectivity," Herbicides and Vegetation Management Symposium Proceedings, University of Oregon at 52-59 (1967). — Getzendaner

| | |
|---|---|
| Ou, L.T. and H.C. Sikka, "Extensive Degradation of Silvex by Synergistic Action of Aquatic Organisms," Syracuse Univ. Research Corp. Submitted to Science (1975). | Getzendaner |
| Plimmer, J.R., U. Klingebeil, D.G. Crosby, and A.S. Wong, "Photochemistry of Dibenzo-p-Dioxins," in Chlorodioxins - Origin and Fate, edited by Etcyl H. Blair, Advances in Chemistry Series No. 120, American Chemical Society, Washington, D.C. (1973). | Crosby/ Wong |
| Schulze, J.A., D.B. Manigold and F.L. Andrews, Pestic. Monit. J. 7 at 73-84 (1973). Pest. Abstr. 7(2) at 66-7 (1974). | Getzendaner |
| Teasley, I.I. and P.W. Williams, "The Degradation of 5 Esters of Chlorophenoxyalkyl Acids Used in Aquatic Weed Control," Private communication with E.E. Kenaga from U.S.D.I., Athens, GA (1969). | Getzendaner |
| U.S.F.S., "Vegetation Management With Herbicides," Volume I of Final Environmental Impact Statement for Pacific Northwest Region (1978). | Newton |
| Whitney, E.W., and E.O. Gangstad, "Silvex Residues in Aquatic Fauna. Aquatic Plant Control Program Technical Report 5 Aquatic-use Pattern for Silvex," U.S. Army Engineer Waterways Expt. Sta., Vicksburg, MS (Oct. 1973). | Getzendaner |
| Wiese, A.F. and R.G. Davis, "Herbicide Movement in Soil with Various Amounts of Water," Weeds 12(2) at 101-2 (1964). | Getzendaner |
| Wong, A.S., and D.G. Crosby, "Decontamination of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) by Photochemical Action," Proceedings of TCDD Workshop at Milan, Italy. Published by Spectum Publications, Inc., Jamaica, N.Y. (October, 1976). | Crosby/ Wong |
| Woolson, E.A., P.D.J. Ensor, W.L. Reichel, and A.L. Young, "Dioxin Residues in Lakeland Sand and Bald Eagle Samples," Chlorodioxins-Origin and Fate, Ch. 12 at 112-118 (1972). | Young |
| Young, A.L. "Chlorinated Dibenzo-p-Dioxins," Chapter 5 in Science of 2,4,5-T and Related Phenoxy Herbicides, edited by R.W. Bovey and A.L. Young, Wiley Inter Science, in press (1979). | Young |

Young, A.L., "Ecological Studies on a Herbicide Equipment Test Area (TA C-52A) Eglin AFB Reservation, Florida," Tech. Rep. AFATL-TR-74-12, Air Force Armament Laboratory, Eglin Air Force Base, Florida (1974). Young

Young, A.L., et al., "The Toxicology, Environmental Fate and Human Risk of Herbicide Orange and Its Associated Dioxin," USAF Rpt OEHL TR-78-92 (1978) (ARI B-68). Young

Young, A.L., E.L. Arnold and A.M. Wachinski, "Field Studies on the Soil Persistence and Movement of 2,4-D, 2,4,5-T, and TCDD," Presentation to the Weed Science Society of America, Abst. No. 226 (February 13, 1974). Young

Young, A.L., P.J. Lehn and M.F. Mettee, "Absence of TCDD Toxicity in an Aquatic Ecosystem," Weed Sci. Soc. Am. Mut. Abstr. 107 at 46 (1976). Young

Young, A.L., C.E. Thalken, E.L. Arnold, J.M. Cupello and L.G. Cockerham, "Fate of TCDD in the Environment: Summary and Decontamination Recommendations," USAFA-TR-76-18, Department of Chemistry and Biological Sciences, USAF Academy, Colorado (1976). Young

Young, A.L., C.E. Thalken, W.E. Ward, and W.J. Cairney, "The Ecological Consequences of Massive Quantities of 2,4-D and 2,4,5-T Herbicides - Summary of a Five Year Field Study," Presentation to the Weed Sciences Society of America, Abst. No. 164 (February 14, 1974). Young

Young, A.L., C.E. Thalken and W.E. Ward, "Studies of the Ecological Impact of Repetitive Aerial Applications of Herbicides on the Ecosystem of Test Area C-52A, Eglin AFB, Florida," Tech. Rpt. AFATL-TR-74-12, Air Force Armament Laboratory, Eglin AFB, Fla., and Department of Chemistry and Biological Sciences, USAF Academy, Colorado (1975). Young

5. Residue Analysis, Analytical Chemistry

Blaser, W.W., R.A. Bredeweg, L.A. Shadoff, and R.H. Stehl, "Determination of Chlorinated Dibenzo-p-dioxins in Pentachlorophenol by Gas Chromatography-Mass Spectrometry," Anal. Chem., 48 at 984-986 (1976). Shadoff

Crummett, W.B. and R.H. Stehl, "Determination of Chlorinated Dibenzo-p-Dioxins and Dibenzofurans in Various Materials," Environm. Health Perspectives, 5 at 15 (1973). — Crummett

Dow Chemical Co., "Review of Residue, Surveillance and Environmental Fate Studies of TCDD," Appendix II to Dow Chemical 2,4,5-T RPAR Response (August 4, 1978). — Shadoff

EPA, "Dioxin Position Document," Draft Report of the Dioxin Working Groups (April 26, 1977). — Crummett

Frank, P.A., "Herbicidal Residues in Aquatic Environments (2,4-D), 2,4,5-T, Silvex," Adv. Chem. Serv. 111 at 13548 (1972). — Getzendaner

Heath, R.G., "Interlaboratory Method Validation Study for Dioxin," Interim Report of EPA's Human Effects Monitoring Branch (January 5, 1979). — Crummett

Hummel, R.A., "Clean-Up Techniques for the Determination of Parts per Trillion Residue Levels of TCDD," J. Agric. Food Chem. 25 at 1049-53 (1977). — Shadoff

Jensen, D.J., R.A. Hummel, H.S. Higgins, L. Lamparski, E. Madrid, "A Residue Study on Sheep Consuming 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)," Unpublished. The Dow Chemical Company (1978) (Confidential) (Dow RPAR 8). — Jensen

Jensen, D.J., R.A. Hummel, H.S. Higgins, E. Madrid, L. Shadoff, J. Turley, "Analysis for TCDD Residues in Rice Grain from Retail Stores and from Fields Treated with 2,4,5-T," Unpublished. The Dow Chemical Company. (1978) (Confidential) (Dow RPAR 10). — Jensen

Jensen, D.J., R.A. Hummel, N.H. Mahle, C.W. Kocher, "A Residue Study on Beef Cattle Consuming 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)," Unpublished. The Dow Chemical Company (1978) (Confidential) (Dow RPAR 7). — Jensen

Jensen, D.J., P.W. Miller and L.R. Berhenke, "Analysis of Cattle and Sheep Tissues for Bound Residues of Silvex and 2,4,5-Trichlorophenol," unpublished. The Dow Chemical Company (1972) (Confidential). — Jensen

Kocher, C.W., et al., "A Search for the Presence of TCDD in Beef Fat," Bull. Environm. Contam. Toxicol. 19 at 229-36 (1978). Shadoff

Lahaniatis, E.S., H. Parlar and F. Karte, "On the Occurrence of Chlorinated Hydrocarbons in Fly Ash from Waste Combustion Facilities," Chemospere, No. 1 at 11 (1977) (in German). Hutzinger

McKinney, J.D., "TCDD in Human Milk Study," NIEHS Memorandum (February 13, 1979). Crummett

Muelder, W.W. and L.A. Shadoff, "The Preparation of Uniformly Labeled $^{14}$C-2,7-Dichlorodibenzo-p-dioxin and $^{14}$C-2,3,7,8-Tetrachloro-p-dioxin," Reprinted from Advances in Chemistry Series Number 120, Chlorodioxins-Origin and Fate (E.H. Blair, ed.) (1973). Crummett

Olie, K., P.L. Vermeulen, and O. Hutzinger, "Chlorodibenzo-p-Dioxins and Chlorodibenzofurans are Trace Compounds of Fly Ash and Flue Gas of Some Municipal Incinerators in the Netherlands," Chemosphere, No. 8 at 455 (1977). Hutzinger

Shadoff, L.A. and R.A. Hummel, "The Determination of 2,3,7,8-Tetrachlorodibenzo-p-dioxin in Biological Extracts by Gas Chromatography Mass Spectrometry," Biomedical Mass Spectrometry, 5(1) at 7-13 (1978). Shadoff

Shadoff, L.A. and R.A. Hummel, "The Determination of 2,3,7,8-Tetrachlorodibenzo-p-dioxin at the Part-per-Trillion Level in Biological Samples," Presented at the Symposium on the New Face of Analytical Chemistry, American Chemical Society (August 28, 1975). Shadoff

Shadoff, L.A., et al., "A Search for TCDD in an Environment Exposed Annually to 2,4,5-T Ester Herbicides," Bull. of Environm. Contam. & Toxicol. 18(4) at 478-85 (1977). Shadoff

Shadoff, L.A., et al., "Chlorinated Benzyl Phenyl Ethers: A Possible Interference in the Determination of Chlorinated Dibenzo-p-Dioxins in 2,4,5-Trichlorophenol and its Derivatives," Anal. Chem., 50 at 1586-1588 (September 1978). Shadoff

6. EPA's Alsea I And Alsea II Studies


Australia, National Health and Medical Research Council, "Re-examination of 2,4,5-T" (March 26, 1979). — Gehring

Colorado Epidemiologic Pesticide Studies Center, "Forest Spray - Miscarriage Investigation, Alsea, Oregon: Questionnaire and Study Plan," Keefe Deposition Exhibit 5, Draft (November 7, 1978). — Lamm

Colorado Epidemiologic Pesticide Studies Center, "Protocol for Second Phase of Spontaneous Abortion Study" (October 1978). — Lamm

Colorado State, "Investigation of Six-Year Spontaneous Abortion Rates in Three Oregon Areas in Relation to 2,4,5-T Spray Areas," Draft (December 15, 1978). — Lamm

Downs, T., "A Description and Critical Review of a Report With the Title: Report of Assessment of a Field Investigation of Six-Year Spontaneous Abortion Rates In Three Oregon Areas In Relation to Forest 2,4,5-T Spray Practices," unpublished (March 12, 1979). — Cook

Duncan Deposition Exhibit 4, Handwritten Table of Spontaneous Abortions, 1972-1977, transmitted to Dr. Duncan (February 1979). — Lamm

Duncan, R.C., "Exploratory Analysis of Data in and Collected for the Draft Report "Investigation of Six-Year Spontaneous Abortion Rates in Three Oregon Areas in Relation to 2,4,5-T Spray Areas'" (February 1, 1979). — Lamm

Duncan, R.C., "Further Analysis of Oregon/2,4,5-T Data" (February 8, 1979). — Lamm

EPA, "Forest Spray-Miscarriage Investigation, Alsea, Oregon: Questionnaire Evaluation and Study Plan" (1978) (ARI R-42) (Alsea I, revised). — Lamm

EPA, "Report of Assessment of a Field Investigation of Six Year Spontaneous Abortion Rates in Three Oregon Areas in Relation to Forest 2,4,5-T Spray Practices" (February 28, 1979) (ARI R-49) (Alsea II). — Lamm

| | |
|---|---|
| Griffith Deposition Exhibit G-2(g); Duncan Deposition Exhibit 11. Comments of Dr. George S. Woodson on R.C. Duncan, "Draft Report: 'Preliminary Assessment of Field Investigation of Six-Year Spontaneous Abortion Rate in Three Oregon Areas in Relation to 2,4,5-T Spray Areas.'" | Lamm |
| Heath Exhibit 7. "Shopping List" of Barton (EPA) (February 6, 1979). | Lamm |
| Hewitt, J.J., Letter to Weber (President, Canadian Agricultural Chemicals Association) re ban on 2,4,5-T and 2,4,5-TP (June 6, 1979). | Gehring |
| Keefe-Savage Deposition Exhibit 4, note to Savage re Alsea Study (October 31, 1978). | Lamm |
| Keefe-Savage Deposition Exhibit 39, "Request from EPA: Post-Questionnaire: Alsea, Oregon Miscarriage Investigation" (undated). | Lamm |
| McQueen, E.G., et al., (Reviewers), "An Evaluation of the 'Preliminary Report of Assessment of a Field Investigation of Six-Year Spontaneous Abortion Rates in Three Oregon Areas in Relation to Forest 2,4,5-T Spray Practices,'" New Zealand Division of Public Health, Department of Health (May 1979). | McQueen |
| Newton, H., "Response to EPA's Rebuttal of Critique of Alsea, Oregon Studies on 2,4,5-T-Induced Miscarriages" (May 29, 1979). | Newton |
| Reggiani, G., Letter to Douglas M. Costle (EPA) re Emergency Suspensions of 2,4,5-T and Silvex (March 30, 1979). | Reggiani |
| U.S. Forest Service, Additional Spray Maps of the Alsea, Oregon Area, prepared for the National Forest Products Association. (April 11, 1979). | Witt |
| Watson, M., Letter to John and Debbie Marano (August 15, 1977). | Lamm |

7. Foreign Reports, Seveso, Vietnam

| | |
|---|---|
| Australia, Victoria Ministry of Health, "Report of the Consultative Council on Congenital Abnormalities in the Yarram District" (September 26, 1978) (ARI R-37). | McQueen |

Bisanti, L., et al., "Experience of the Accident of Seveso," from the Proceedings of the 6th European Teratology Society Conference, pub. by Akademiai Kiado, Budapest (1979). Tuchmann-Duplessis

De Carli, L., M. Fraccaro, F. Nuzzo, B. Nicoletti, F. Cefis, P. Mocarelli, G. Zei and G. Morganti, "Report on Cytogenetic Investigations in Individuals Exposed to the Toxic Action of TCDD: Performed in the Context of the Agreement Between the Lombardy Region and the Institutes of General Biology of the Faculties of Medicine and Surgery of the Universities of Milan and Pavia" (unpublished). Reggiani

Homberger, E., G. Reggiani, J. Sambeth and H. Wipf, "The Seveso Accident: Its Nature, Extent and Consequences," Givaudan Research Co., Ltd. (unpublished) (1979). Reggiani

Kilpatrick, R. (Chairman), "Review of the Safety for Use in the U.K. of the Herbicide 2,4,5-T," Advisory Committee on Pesticides, submitted to Ministry of Agriculture, Fisheries and Food (March 1979). Kilpatrick

McQueen, E.G., et al., "2,4,5-T and Human Birth Defects," New Zealand Department of Health (June 1977). McQueen

Morganti, G., Coordinator, et al., "Cytogenic Investigations in Individuals Exposed to the Toxic Action of TCDD: Performed in the Context of the Agreement Between the Lombardy Region and the Institutes of General Biology of the Faculties of Medicine and Surgery of the Universities of Milan and Pavia" (unpublished 1979). Reggiani

Pocchiari, F., "Accidental TCDD Contamination in Seveso (Italy): Epidemiological Aspects," Working Paper from Joint NIEHS/IARC Working Group Report on "Long-Term Hazards of Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans" (June 1978) (ARI R-19). Reggiani

Reggiani, G., "Medical Problems Raised by the TCDD Contamination in Seveso, Italy," Arch. Toxical. 40 at 161-188 (1978) (unpublished paper is ARI R-86). Reggiani

Reggiani, G., "The Estimation of the TCDD Toxic Potential in the Light of the Seveso Accident," Paper presented at the 20th Congress of the European Society of Toxicology, Berlin (West) (June 25-28, 1978). — Reggiani

Reggiani, G., "Toxic Efects of TCDD in Man," Report from NATO Workshop on Ecotoxicology (July-August 1977). — Reggiani

Rehder, H., L. Sanchioni, F. Cefis and A. Gropp, "Pathological-Embryological Investigations in Cases of Abortion Related to the Seveso Accident," Schweizerische Medizinische Wochenschrift 108 at 1617-1625 (1978). — Tuchmann-Duplessis

Simoni, G., G. Della Valle, L. Larizza, N. Sacchi, and F. Rosella, "Chromosome Lesions in Amniotic Fluid Cell Cultures," Reprinted from Symposium at European Society of Human Genetics (May 14 and 15, 1977). — Reggiani

Tenchini, M.L., et al., "Approaches to Examination of Genetic Damage After a Major Hazard in Chemical Industry: Preliminary Cytogenic Findings on TCDD-Exposed Subjects After Seveso Accident," from Expert Conference on Genetic Damage Caused by Environmental Factors, Oslo (11-13 May 1977). — Reggiani

Tuchmann-Duplessis, H., "Embryo Problems Posed by the Seveso Accident," (Translated from French) Le Concours Medical, 44 (1977) (ARI R-84). — Tuchmann-Duplessis

Tuchmann-Duplessis, H., "Pollution of the Environment and Offspring Apropos of the Accident of Seveso" (translated from French), Medicine et Hygiene 36 at 1758-66 (1978). — Tuchmann-Duplessis

Turner, D.J., "The Safety of the Herbicides 2,4-D and 2,4,5-T," Agricultural Research Council Weed Research Organization, London (1977). — Gehring

U.K., Ministry of Agriculture, Press Release on Advisory Committee Reports on the Herbicide 2,4,5-T (July 19, 1978). — Kilpatrick

Wipf, H.K., E. Homberger, N. Neuner, U.B. Ranalder, W. Vetter and J.P. Vuilleumier, "TCDD Analysis in Vegetation Samples from the Seveso Area," Paper Presented at the 23rd Collaborative International Pesticide Advisory Council (CIPAC) Symposium at Baltimore, Maryland (June 6, 1979). — Reggiani

8. Relative Risk


Albert, R.E., et al., "Rationale Developed by the EPA for the Assessment of Carcinogenic Risks," J. Natl. Cancer Inst. 58(5) at 1537-1541 (1977). — Park

Butler, W. and J. Barnes, "Carcinogenic Action of Ground Nutmeal Containing Aflatoxin in Rats," Fd. Cosmet. Toxicol., 6 at 135 (1968). — R. Wilson

Butler, W., M. Greenblatt and W. Lijinsky, "Carcinogenesis in Rats by Aflatoxins $B_1$, $G_1$, and $B_2$," Cancer Res., 29 at 2206 (1969). — R. Wilson

Comar, Cyrie L. (Chairman), et al., "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," Report of the Advisory Committee on Biological Effects of Ionizing Radiation (BEIR), National Academy of Sciences (November 1972). — R. Wilson

Cornfield, J., "Carcinogenic Risk Estimation," Science, 198 at 693-699 (1977). — Park

Doll, R., "Age Distribution of Cancer: Implications for Models of Carcinogenesis," Journ. of Royal Stat. Soc., 134A at 133 (1971). — R. Wilson

FDA, "Saccharin and Its Salts: Proposed Rule and Hearing," 42 Fed. Reg. 19996 (1977). — R. Wilson

Jones, H.B. and A. Grendon, "Analysis of Mathematical Models Used in Data Extrapolation," Clinical Toxicology, 9 at 791 (1976). — R. Wilson

Doll, R. and A.B. Hill, "Mortality in Relation to Smoking: Ten Years Observations of British Doctors," Br. Med. J., 1 at 1460 (1964). — R. Wilson

Lowrance, W.W., Of Acceptable Risk, Kaufman (1976). — R. Wilson

Mantel, N. and W.R. Bryan, "Safety Testing of Carcinogenic Agents," J. Nat. Cancer. Inst., 27 at 455-470 (1961). — Park

NAS, "Perspectives on Benefit-Risk Decision Making," National Academy of Engineering (1972). — R. Wilson

NAS "Principles of Evaluating Chemicals in the Environment," Chapter III, Benefits. Report of the Committee for the Working Conference on Principles of Protocols for Evaluating Chemicals in the Environment. National Academy of Sciences (1975). R. Wilson

Peers, F. and C. Tinsell, "Dietary Aflatoxins and Liver Cancer: A Population Based Study in Kenya," Br. J. Cancer, 27 at 473 (1973). R. Wilson

Rall, D.P., "Difficulties in Extrapolating the Results of Toxicity Studies in Laboratory Animals to Man," Environm. Res., 2 at 360-367 (1969). Park

Ramsey, J.C., C.N. Park, M.G. Ott and P.J. Gehring, "Carcinogenic Risk Assessment: Ethylene Dibromide," Toxicol. Appl. Pharmacol., (In Press). Park

Rothman, K.G., "Alcohol," Chapter 9 in Persons at High Risk of Cancer: An Approach to Cancer Etiology and Control (J.F. Fraumeni, Jr., ed.), Academic Press (1977). R. Wilson

Selikoff, Irving J. and E. Cuyler Hammond, "Multiple Risk Factors in Environmental Cancer," Ch. 28 in Persons at High Risk of Cancer: An Approach to Cancer Etiology and Control, (J.F. Fraumeni, ed.) New York: Academic Press (1975). R. Wilson

Shank, R., J. Gordon, E. Wogan, A. Nondasuta, and B. Subhamani, "Dietary Aflatoxins and Human Liver Cancer II: Field Survey of Rural Thai Families for Ingested Aflatoxins," Fd. Cosmet. Toxicol., 10 at 71 (1972). R. Wilson

Shubik, P., et al., "General Criteria for Assessing the Evidence for Carcinogenicity of Chemical Substances: Report of the Subcommittee on Environmental Carcinogenesis," National Cancer Advisory Board, Journal of the National Cancer Inst. 58 at 461 (1977). R. Wilson

Starr, Chauncy, Science, 165 at 1232 (1969). R. Wilson

Van Horn, A.J. and Richard Wilson, "Factors Influence the Public Perception of Risks to Health and Safety -- A Brief Summary Report," Energy and Environmental Policy Center for Brookhaven National Laboratory (1977). R. Wilson

Wilson, Richard, "Examples in Risk Benefit Analysis," Chemtech (October 1975). R. Wilson

Wilson, Richard, "The Risks of Low Levels of Pullution," Yale Journal of Biology and Medicine (Jan/Feb, 1978). R. Wilson

## CERTIFICATE OF SERVICE

I HEREBY CERTIFY that copies of The Dow Chemical Company's Initial List of Risk Witnesses and Exhibits were delivered by hand or mailed first class postage prepaid, on July 17, 1979, to the persons on the attached list.

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# SILVEX: POSITION DOCUMENT 1/2/3

U.S. ENVIRONMENTAL PROTECTION AGENCY
PROJECT MANAGER: MICHAEL DELLARCO

JUL 9 1979

Silvex: Position Document

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Silvex : Position Document

## I. INTRODUCTION

During the past two years, the Environmental Protection Agency (EPA) has been gathering information about the closely related phenoxy herbicides, 2-(2,4,5-trichlorophenoxy) propionic acid (silvex) and 2,4,5-trichlorophenoxy acetic acid (2,4,5-T), as part of its Rebuttable Presumption Against Registration (RPAR) process in order to determine whether the registrations of these pesticides should be continued. This review was prompted in part by studies showing that silvex, 2,4,5-T, and/or TCDD (2,3,7,8-tetrachlor-dibenzo-p-dioxin), the dioxin contaminant of both 2,4,5-T and silvex caused reproductive and oncogenic effects in test animals.

On April 11, 1978, the Agency issued a notice of rebuttable presumption against all registrations of the herbicide 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) [43 FR 17116, 21 April 1978]. Subsequently, on February 28, 1979, responding in part to information developed through the 2,4,5-T RPAR, the Administrator ordered the emergency suspension of silvex for forestry, rights-of-way, pasture, aquatic weed control/ditchbanks, home and garden, and commercial/ornamental turf uses ("suspended uses") (44 FR 15897, 15 March 1979). At the same time, the Administrator also issued notices of

intent to cancel these uses. These actions initiated public hearings on issues relating to the risks and benefits of these silvex uses.*/

Because the data reviewed and analyzed for the suspension action indicated that the suspended uses of silvex created an imminent hazard for human health, the Agency accelerated its review of the use of silvex on rangeland, rice, sugarcane, orchards and non-crop**/ areas (non-suspended uses). These uses were assessed in terms of the RPAR risk criteria (40 CFR 162.11(a)), using data presented in the Emergency Decision and Order suspending certain uses of silvex (44 FR 15897, 15 March 1979), data and information on TCDD submitted in rebuttal to the 2,4,5-T RPAR, and other relevant information. From this review, the Agency has concluded that when used in accordance with widespread and commonly recognized practice, the non-suspended uses of silvex appear to cause unreasonable adverse effects on the environment. As a result, the Agency is issuing a notice of intent to hold a hearing to determine whether the non-suspended uses of silvex should be cancelled.

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*/ Suspension proceedings commenced on April 19, 1979, but were discontinued on May 15, 1979 after all registrants withdrew from the hearings. The first pre-hearing conference for the cancellation proceedings was held on June 5, 1979; the formal hearing will probably begin in the fall.

**/ The non-crop uses of silvex include use on fencerows, hedgerows, fences (not otherwise included in suspended uses, e.g., rights-of-way, pasture); industrial sites or buildings (not otherwise included in suspended uses, e.g., rights-of-way, commercial/ornamental turf); storage areas, waste areas, vacant lots, parking areas, and the other sites for which silvex use is registered.

This Position Document reviews the Agency's assessment of the risks and benefits of the non-suspended uses of silvex, particularly use on rice, rangeland, sugarcane, and orchards, and explains the bases for the Agency's decision to convene a hearing to determine whether to cancel these uses.

This Position Document contains four parts. Part I, this introduction, summarizes the legal provisions relating to the registration and cancellation of pesticides, and background information on the chemistry and uses of silvex. Part II is an evaluation of the data and information relating to the risks associated with the non-suspended uses of silvex. This part includes the Agency's analysis of laboratory data on silvex and TCDD, information on TCDD developed through the 2,4,5-T RPAR review, information on exposure potential of the uses of silvex, and other risk considerations. Part III reviews the benefits associated with the non-suspended uses of silvex on a use-by-use basis. Part IV discusses and explains the bases for the determination to hold a hearing on the risks and benefits of the orchard, sugarcane, rice, rangeland and the noncrop area uses of silvex.

## A. Legal Authority

### (1) Statutory Provisions

The Federal Insecticide, Fungicide, and Rodenticide Act, as amended ("FIFRA") [7 U.S.C. 136 et seq.] requires the Environmental Protection Agency (EPA) to regulate all pesticide products through review of the risks and

benefits of the uses of these chemicals. A key provision is Section 12(a)(1)(A) of FIFRA which specifies that all pesticide products must be registered by the Administrator before they may be sold or distributed. Before a pesticide may be registered, however, the Administrator must determine that its use will not result in "unreasonable adverse effects on the environment," defined in Section 2(bb) of FIFRA as "any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide." In other words, any decision on pesticide registration must take into account both risks and benefits from the pesticide's use.

Under Section 6(b) of FIFRA the Administrator may cancel the registration of a pesticide or change its terms and conditions of registration if it appears that the pesticide "when used in accordance with widespread and commonly recognized practice, generally causes unreasonable adverse effects on the environment." For example, the Administrator may cancel the registration of a pesticide, or change its terms and conditions of registration, if its labeling does not comply with the misbranding provisions of FIFRA which require the labeling to contain the language "adequate to protect health and the environment" [FIFRA 2(q)]. The Administrator may also change the classification of any use of a pesticide if he determines that such a change "is necessary to prevent unreasonable adverse effects on the environment" [FIFRA 3(d)(2)].

Two types of proceedings are available under section 6(b) of FIFRA to cancel a pesticide registration, or modify the terms and conditions of a pesticide registration: FIFRA Section 6(b)(1) proceedings and FIFRA Section 6(b)(2) proceedings. In general, FIFRA section 6(b)(1) proceedings begin with a notice specifying the regulatory action which the Administrator is proposing. This action takes effect automatically, without hearings, at the expiration of a notice period prescribed by statute, unless the registrant or a person adversely affected by the notice requests a hearing within that period. If a hearing is requested, the regulatory action proposed by the Administrator does not take effect; however, at the conclusion of the hearing, the Administrator may implement the proposed action, if he determines that it is appropriate to do so based on the record developed in the hearing.

Section 6(b)(2) proceedings, on the other hand, begin with a general notice specifying the issues which the Administrator desires to have explored at a hearing. Unlike section 6(b)(1) proceedings, Section 6(b)(2) proceedings do not include an initial proposed regulatory solution which would take effect automatically if a hearing is not requested. Interested persons may participate in the hearing; at the conclusion of the hearing, the Administrator may take whatever action he deems appropriate, based upon the record developed in the hearing, including cancellation of a pesticide registration or modification of the terms and conditions of registration.

(2) The RPAR Process

The Rebuttable Presumption Against Registration (RPAR) process provides a mechanism through which the Agency gathers risk and benefit information about pesticides which appear to pose risks of adverse effects to human health or the environment which may be unreasonable. Through this process, the Agency invites pesticide registrants, environmentalists, and other interested persons to participate in the Agency's review of suspect pesticides and in reaching an open and balanced decision on the continued use of the pesticides.

The RPAR regulations at 40 CFR 162.11 (a)(5) prescribe regulatory criteria for the Agency's preliminary assessment of a pesticide's health and environmental effects and provide that an RPAR shall arise if the Agency determines that any of the risk criteria have been met. The Agency generally announces that an RPAR has arisen by publishing a Notice in the Federal Register. Once a rebuttable presumption has arisen, registrants, applicants, and interested persons may submit evidence in rebuttal or in support of the presumption. Information on the economic, social, and environmental benefits of any use of the pesticide may also be submitted.

If the presumptions of risk are not rebutted, the benefits evidence submitted and that gathered by the Agency must be evaluated and considered in light of the risk information. If the Agency determines that the risks

appear to outweigh the benefits, the Agency can initiate action under FIFRA section 6(b)(1) to cancel the registration for a use or to modify the terms and conditions of registration for the use. FIFRA Section 6(b)(2) proceedings are appropriate (among other situations) where a pesticide use appears to pose unreasonable adverse effects, and additional information on risks or benefits would assist the Agency in making a decision on the ultimate fate of the pesticide use.

## B. Background Information Relating to Silvex

### (1) Chemical/Physical Characteristics

The herbicide commonly known as silvex, 2-(2,4,5-Trichlorophenoxy) Propionic Acid*/, has an empirical formula of $C_9H_7CL_3O_3$ and a molecular weight of 269.53, with a melting point of 181.6°C. At 25°C, it is essentially insoluble in water (0.014%) but is relatively soluble in organic solvents such as acetone (15.2%), methanol (10.5%), ether (7.13%), and benzene (0.16%) (Raw, 1970). The esters of silvex are formulated to be emulsifiable in water and soluble in most oils, while its amine salts are soluble in water but insoluble in petroleum oils (Packer, 1975). A water soluble salt with triethanolamine, called silveramine, is also produced.

*/ Also called 2-(2,4,5-trichlorophenoxy) propanoic acid, sylvex, 2,4,5-TP or fenoprop.

(2) Manufacturing Process and Contaminants

Silvex is produced commercially by hydrolysis of 1,2,4,5-tetrachlorobenzene using methanol and sodium hydroxide to yield the sodium salt of 2,4,5-trichlorophenol (2,4,5-TCP).*/ This product is reacted with 2-chloropropionic acid in hot aqueous sodium hydroxide to form the sodium salt of silvex, which is converted to silvex by the addition of acid. The acid form of silvex can be reacted readily with a variety of alcohols to produce a large selection of esters, and with amines to produce amine salts (Packer, 1975).

During the first step in the manufacturing process of silvex, if temperature and pressure are not carefully controlled, condensation reactions can occur to produce large quantities of highly toxic polychlorinated dibenzo-p-dioxin contaminants. The term dioxin does not apply to any one compound but to a group of related substances, which are distinguished by the number and orientation of chlorine atoms they contain. The particular dioxin formed is dependent on the chlorophenols present (Poland and Kende, 1976). Dioxin toxicity varies with the position and numbers of chlorines attached to the phenol rings.

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*/ 2,4,5-TCP is the subject of a separate Rebuttable Presumption Against Registration (RPAR) Position Document. It is discussed in this document because both it and its contaminant 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) may be present in some commercial silvex and in silvex samples used in animal experiments.

In the silvex manufacturing process an especially toxic dioxin, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), is formed when the reaction temperature is excessive (Fike and Seaton, 1962), most commonly at temperatures above 160°C. Halogens at the 2, 3, and 7 positions are known to produce the most toxic dioxins (Burger, 1973). In the case of TCDD, the chlorine atoms are attached at the 2, 3, 7, and 8 positions which are considered the most toxic positions possible (Schwetz et al., 1973). The dioxin contaminant in silvex is of particular concern because of its extremely high toxicity, and because of the apparent inability of manufacturers to produce silvex without the contaminant, TCDD.*/

TCDD occurs as a white crystalline solid. It is 99.5% decomposed at 800°C. TCDD has the following solubility in various solvents at 25°C (Harvey, 1973):

| Solvent | Solubility (wt. per cent) |
|---|---|
| Acetone | 0.011 |
| Benzene | 0.057 |
| Dimethylsulfoxide | <0.01 |
| Methanol | 0.001 |
| Water | 0.00000002 (0.2 ppb) |

*/ Current methods for manufacturing silvex produce TCDD as a by-product of the manufacturing process. Although silvex manufacturers attempt to remove this contaminant, TCDD cannot be completely removed. An EPA contract laboratory has measured the TCDD content in 8 recently produced commercial samples of technical grade silvex from two different manufacturers. The contractor reported that the TCDD content in these samples ranged from 0.012 to 0.024 ppm (limit of detection 0.01 ppm) Therefore, because TCDD is present as a low-level contaminant in commercial samples of silvex, references in this document to "silvex" or the "pesticide product" mean silvex that is contaminated with TCDD.

Since 1950, most of the chemical industry has known that large quantities of TCDD may be formed as a byproduct of the 2,4,5-TCP manufacturing process if the procedures are not carefully controlled. After concern arose in 1969 about the extremely toxic effects of TCDD, manufacturing methods were changed and carefully controlled by manufacturers. By 1971 industry had reduced TCDD content in commercial phenoxy herbicides to less than 1 ppm (Milnes, 1971; Grieg et al.,1973; Hussain et al., 1972). Current U.S. manufacturing specifications require silvex presently being sold to contain less than 0.1 ppm TCDD.*/ (Dow Chemical Co., FIFRA Docket No. 295).

(3) Registered Uses and Production

Silvex is a selective herbicide for control of woody plants, broadleaf herbaceous weeds, and aquatic weeds. Registered uses include selective weed control in rice, sugarcane, pastures, rangeland, rights-of-way, forest site preparation, conifer release, industrial areas, fence rows, highways, commercial turf, home lawns, uncultivated agricultural land, waste land, aquatic sites (still water, lakes, and ponds) and ditch banks. At sub-herbicidal concentrations, silvex is used as a plant regulator to retard preharvest fruit drop on plums (prunes), pears, and apples.

Silvex is effective against a number of weed species resistant to 2,4-dichlorophenoxy acetic acid (2,4-D) and 2,4,5-T. Among the silvex target species are wild lettuce,

*/ See footnote, page 9.

chicory, nightshade tievine, alligatorweed, post oak, blackjack oak, sand shinnery oak, yucca, salt cedar, chickweeds, spurges, black medic, and poison ivy.

Silvex is commonly applied postemergence in water, oil, oil-water, and granular carriers using conventional aerial and ground equipment. The most commonly used formulations are the low volatile esters for brush, rice , sugarcane and mixtures with 2,4-D, or 3,6-dichloro-o-anisic acid (dicamba), for lawn and turf weed control (Thompson, 1975). Silvex also occurs in formulations mixed with triethanolamine (silveramine) or 2,4,5-T. Application rates vary from 0.75 to 4 pounds acid equivalent (a.e.)/acre, 6 to 16 pounds a.e./AHG and 6 to 8 pounds a.e./acre ft. depending upon target species and use site.

Silvex has been produced as a registered pesticide in the United States since 1953. According to EPA records, approximately 100 companies hold Federal registrations and formulate 247 registered products; 14 companies have former state registrations and formulate 25 products (Memo, 1979a).

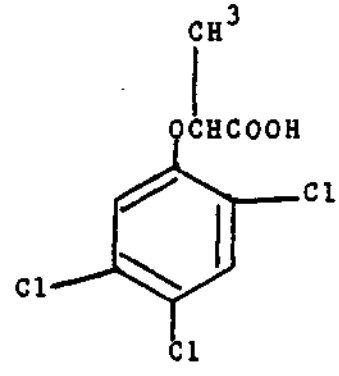
(4) Environmental Fate

(a) Degredation

There is little data available regarding the persistence of silvex; however, several studies of the degredation of phenylalkanoic acids, a group that includes silvex, indicate that certain of these chemicals can be degraded photochemically or biologically (Crosby and Tutass,

1966; Gaunt and Evans, 1961). Alexander and MacRae (1964, 1965) have found degradation is limited when a halogen atom occurs at the meta position of an alkylated aromatic ring compound, or when the aromatic ring is linked to the alkyl ether side chain at the alpha position, independent of the halogen orientation. Both of these conditions exist in the silvex molecule. A likely degredation product of silvex would be 2,4,5-trichlorophenol. However, efforts to produce 2,4,5-trichlorophenol by treating saturated solutions of silvex with different concentrations of hydrochloric acid or sodium hydroxide at room temperature have not been successful (Bailey, et.al., 1970). Also, silvex was stable to irradiation in the dry state, and could be photolyzed to 2,4,5-TCP only when irradiated as the sodium salt in water (Crosby, 1969).

Fig. 1. Silvex molecule illustrating the alpha carbon atom on the alkyl chain and the meta position of the chlorine atom at position 5 of the aromatic ring:




(b) Persistence: Soils

Silvex has a relatively short half-life and appears to have an affinity for soil particles. Wiese and Davis (1964) estimated silvex movement through soil to range from 3 to 6

inches, using Pullman silty clay loam. Altom (1973) determined that the half-life of silvex in grassland soil was 14 days. Similar results were reported by Leng after application of silvex to grasses.

When considering the persistence of silvex, the persistence of its contaminant, TCDD, must also be considered. Helling et al. (1973) found that TCDD was not photodecomposed on soil. TCDD was found to be immobile in Norfolk and Lakeland sandy loams, Hagerstown silty clay loam, Barnes clay loam, and Celeryville muck, and was not leached further into soil by rainfall or irrigation. The investigators observed that TCDD's persistence was predictable since it is insoluble in water. During surface erosion of soil, however, lateral transport of TCDD could occur. The persistence of TCDD in Lakeland loamy sand and Hagerstown silty clay loam was also studied by Kearney et al. (1972). After one year these researchers recovered 56 and 63% of the originally applied TCDD in Hagerstown and Lakeland soils, respectively.

(c) Persistence: Water

Phenoxy chemicals entering water may be lost by volatilization, degradation, adsorption on sediment, adsorption by biota, and dilution as additional stream water passes through the site. Almost all authorities agree that there is adsorption on bottom sediment (Bailey et al.,1970; Frank and Comes, 1967).

In October 1965, the U.S. Geological Survey initiated a limited program of pesticide monitoring of 11 waterways in the western United States (Brown and Nishioka, 1967) where the probability of observing pesticide residues would be greatest. Pesticides chosen for analysis included the insecticides aldrin, DDD, DDE, DDT, dieldrin, endrin, heptachlor, heptachlor epoxide, and lindane, and the herbicides 2,4-D, 2,4,5-T, and silvex. The authors reported that no herbicide was found at any time at any station during the first year of the sampling program (limit of detection: 5ppt). Manigold and Schulze (1969), reporting on the results for October 1966 to September 1968, observed that beginning in August 1967, 2,4-D, silvex, and 2,4,5-T had been detected frequently. Silvex was found in 10 of the 235 samples at concentrations ranging from 0.01 to 0.21 ppb.

The National Interium Primary Drinking Water Regulations (EPA, 1977) allow up to 10 ppb of silvex in drinking water. However, these regulations are meant to apply in the event silvex is found in water. Deliberate addition of silvex to drinking water sources is not sanctioned by these standards.

Kearney et al. (1972) concluded that contamination of underground water supplies with TCDD seemed very unlikely, since vertical movement of TCDD did not occur in a wide range of soil types. The fact that no leaching occurred, however, would not preclude runoff contamination when soil erosion is significant (Helling et al., 1973).

(d) Transport

There are few published studies regarding the translocation of silvex and its TCDD contaminant in plants. Isensee and Jones (1971) measured uptake of TCDD from soil by two crop species. Oats (Avena sativa) and soybeans (Glycine max) were grown in Lakeland sandy loam soil treated with 0.06 ppm TCDD. The tops of these plants were harvested at intervals to maturity. Mature oats and soybean tops contained less than 1 part per billion (ppb) TCDD. TCDD was detected (detection limit: 1 ppb) in mature oat grain, while no TCDD was found in the bean of soybeans. The authors concluded that soil uptake of TCDD by plants was highly unlikely, since little or no TCDD was taken up by oats or soybeans under the conditions of this experiment.

(e) Fish and Wildlife

Generally, silvex esters are considered to be more toxic to fish and aquatic invertebrates than the silvex salts. The concentration of silvex that kills 50% of the number of fish exposed ($LC_{50}$) in 48 hour or 96 hour laboratory studies ranges from 0.14 to 70 ppm for silvex esters in contrast to 14 to 540 ppm for silvex salts (Swabey and Schenele, 1963; Hiltibran, 1967; Butler, 1965). Furthermore, the data indicate that the butoxyethanol ester (BEE) is the most toxic silvex formulation to fish (Reinert, 1975). Similarly, 48-hour and 96-hour $LC_{50}$ estimates for aquatic invertebrates range from 0.2 to greater than 100 ppm

depending on the silvex formulation used and the species tested (Burtler, 1965; Crosby and Tucker,1966; Sanders, 1970).

In contrast, benthic fauna were observed to increase in direct proportion to the amount of silvex applied to a Missouri pond (Harp and Campbell, 1964). The pond that was partitioned and treated with 0, 2.8, and 4.6 ppm of silvex potassium salt. The most abundant invertebrates sampled throughout the course of the 13-month study were oligochaete worms, odonates, leeches and snails. Only the Chrysops (grove flies) populations were reduced by the silvex treatment.

Comparative data regarding the toxic effects of silvex formulations in wild mammals or avians is limited To date, there have not been any field studies conducted on the toxic effects of silvex on wildlife; published reports have been limted to studies of laboratory and domestic animals. Available evidence from avian studies indicate that silvex esters are more toxic to young birds than silvex acid (Stickel, 1964; Tucker and Crabtree, 1970 and Heath et al., 1972).

Studies by Moffett and co-workers suggest that silvex is relatively non-toxic to honey bees. In separate experiments, silvex propylene glycol butyl ether ester (PGBEE) was tested for its effect on brood production, and mortality in both new born worker bees and adult bees. The authors concluded that silvex is not toxic to bees and that

adverse effects to hives could be attributed to the use of silvex with diesel oil as the carrier(Moffett et al., 1972; Morton and Moffett, 1972; and Morton et al., 1972).

(f) Bioaccumulation

Suggestive evidence exists which indicates that silvex residues may persist in wildlife. In a study of water fowl collected where silvex had been applied at 20 lbs ai/acre seven months earlier, 36% (5 of 14) of birds sampled contained silvex residues ranging from 0.06 to 0.20 ppm. Similarly, in field trials of silvex as an aquatic herbicide by the U.S. Army Engineers, silvex residues of 0.053 ppm were found in fish 35 days after silvex treatment at 8 lbs. ai./acre.

Woolson et al. (1973) conducted a study to determine if TCDD residues could be detected in tissue extracts of the bald eagle (Haliaectas leucocephalus) as a representative of the top of a food chain. Nineteen bald eagle carcasses from fifteen states were examined between 1966 and 1971. No dioxin residues were detected at a level of 0.05 ppm TCDD, the lower limit of detection. The authors stated that the non-detection of dioxin residues could imply that there was no dioxin build-up in the food chain; that the build-up was less than the detectable level of their analytical equipment; that the eagles examined were not contaminated although other samples might be; or that other species could feed on a different food chain to accumulate dioxins.

Isensee and Jones (1975) exposed several organisms in a model aquatic ecosystem to $^{14}C$-labeled TCDD for up to 31 days to determine the distribution and bioaccumulation potential in an aquatic environment. Soil with 0.0001 to 7.45 ppm adsorbed $^{14}C$-TCDD was placed in aquaria containing snails (Physa sp.), a few strands of algae (Oedogonium cardiacum), and old aquarium water containing various diatoms, protozoa, and rotifers. Duckweed (Lemna minor) plants were also added to one aquarium. Samples of daphnids were taken for analysis at 30 days, and mosquito fish (Gambusia affinis) were added to each tank. Three days later all of the organisms were removed for analysis, and two fingerling channel catfish (Ictalurus punctatus) were added to each tank and exposed for six days.

The authors stated that all organisms in both treatment and control tanks prospered during this exposure period, indicating that TCDD was not toxic at the concentrations used. TCDD accumulated in all organisms. At the highest TCDD concentration (7.45 ppm) algae accumulated 6,690 $\pm$ 960 ppb TCDD; snails, 1,820 $\pm$ 170 ppb; daphnids, 10,400 $\pm$ 480 ppb; and Gambusia, 1,380 $\pm$ 220 ppb. Catfish were not analyzed for TCDD residues. At the second highest TCDD concentration (3.17 ppm), however, catfish accumulated 720 $\pm$ 130 ppb TCDD. The authors stated that accumulation in all of the test organisms from soil containing 0.1 ppb TCDD is important since this concentration approaches the concentration which would occur under normal field use of 2,4,5-T.

The authors concluded that the data suggested that under certain circumstances (e.g., discharge of storm runoff from recently treated rangeland into a small pond), water-eroded surface soil or debris may contain enough TCDD for measurable residues to accumulate in fish or other aquatic organisms. However, the authors speculated that TCDD, orginating from 2,4,5-T applications, discharged into large lakes, streams, or estuaries would probably become sufficiently diluted so that no measurable accumulation would occur.

In contrast to the results reported by Isensee and Jones, Norris and Miller (1974) reported that adverse effects were irreversible in guppies exposed to 0.1, 1.0, or 10.0 ppb of TCDD for 120 hours. All of the fish died by the 37th day after the exposure period.

(5) Residues in Man and Animals

Sauerhoff et al. (1976) studied the fate of silvex following oral administration to man. Volunteers ingested a single 1.0 mg/kg dose of analytical grade silvex with a purity greater than 99% and less than the detectable level (0.01 ppm) of TCDD. Blood, urine, and feces were collected at intervals for up to 186 hours after ingestion. Approximately 65% of the silvex ingested by these subjects was excreted in the urine within 24 hours. The plasma silvex concentration increased rapidly following ingestion and after 2 to 4 hours reached a peak of approximately 6.0 ug/g plasma. The plasma clearance was found to be biphasic with a half-life

of 4.0±1.9 hr in the first phase and 16.5±7.3 hr in the second phase. Total recovery of silvex and its conjugates in urine and feces ranged from 66.6% to 95.1% of the administered dose with a mean value of 80.3%. No trichlorophenol conjugates were found in the urine. Only small amounts of silvex and silvex conjugates were found in feces. The authors concluded that this may represent unabsorbed compound excreted in bile and eliminated from the body in feces.

The National Human Monitoring Program for Pesticides, through its cooperative arrangement with the Health and Nutritional Examination Survey II (Hanes II project), is currently analyzing human urine samples for silvex, 2,4,5-T, and 2,4,5-TCP (Memo,1977). The survey is scheduled for completion in 1979; however, preliminary results on 864 samples show measurable amounts of silvex in 3 samples, at levels as high as 33 ppm, and trace amounts in 10 samples.

Phenoxy acetic acids are relatively strong acids, and animals rapidly excrete them unchanged in their urine In their study of the fate of atrazine, kuron, silvex, and 2,4,5-T in the dairy cow, St. John et al. (1976) found that dairy cows given 2,4,5-T and silvex in their feed at 5 ppm for four days, completely eliminated both 2,4,5-T and silvex as soluble salts in the urine two days after dosing stopped. Sauerhoff et al. (1976) fed rats a single oral dose of 5 mg/kg $^{14}C$ silvex and recovered 77.54±5.05% of the radioactivity in urine and 16.5±7.74% of the radioactivity in

feces However, confirmatory analysis that the radioactive material was silvex or silvex metabolite(s) was not conducted in the study.

Experimental results suggest that liver and kidney are the main sites for silvex clearence activity. Sauerhoff et al. (1977) treated rats with a single intravenous injection of 5 mg/kg or 50 mg/kg of silvex in an aqueous solution. They sacrificed the animals at 8 hours and 216 hours after injection and analyzed several tissues for silvex. The highest $^{14}C$ levels were recorded in the liver and the kidney at both doses. These findings were confirmed by separate experiments measuring the half-life of silvex clearance from plasma and bile which indicated that silvex is rapidly removed from the circulatory system to the liver and then rapidly excreted from the body in urine. Similar results were obtained in a preliminary report from a two-year chronic toxicity feeding study with TCDD by Dow Chemical USA (1977) (reported). Female rats ingesting 220 ppt TCDD/day or 2,200 ppt TCDD/day were noted to have high TCDD residues in liver and in fat at both treatment levels. The preliminary report gives no residue data for treated males, or for controls of either sex.

Zitko (1972) assayed chlorinated dibenzodioxin residues in aquatic animals, but was unable to detect these compounds (detection limit: 0.04 ppm for TCDD) in any of several aquatic animals from Canadian locations. The author had selected species from high trophic levels of the aquatic

food web to measure cumulative pesticide contamination. More recently, using improved analytical methods for detection of dioxin at ppt levels, Baughman and Meselson (1973) found mean TCDD levels ranging from 18 ppt to 810 ppt in fish and crustaceans taken from Vietnamese rivers in August and September, 1970. TCDD levels tended to be higher in fish from interior rivers than in those from seacoast locations. In comparison, Baughman and Meselson (1973) found less than 3 ppt TCDD in fish obtained in a market in Cape Cod, Massachusetts. In another study, Matsumura and Benezet (1973) placed TCDD-coated sand directly in an aquarium containing brine shrimp, mosquito larvae, and fish (silverside). TCDD pickup was low in fish (2 ppb) and brine shrimp (157 ppb) under the experimental conditions. But mosquito larvae, which are bottom feeders, showed a surprisingly high rate of accumulation (4,150 ppb). The authors concluded that TCDD was not likely to accumulate in as many biological systems as DDT because of TCDD's low solubility in water and lipids, as well as its low partition coefficient in lipids.

(6) Residues in Food Products

Available data indicate that silvex residues may occur in foods. When sprayed on oranges, a silvex ester was hydrolyzed to the free acid, conjugated in the peel and persisted for several months (Hendrickson, 1969). Leidy et al. (1975) did not detect silvex in harvested apples 29 to 91 days after the application of silvex to the ground

cover under apple trees. However, Cochrane et al. (1976) reported that direct application of a 20 ppm solution of silvex to apple trees (to prevent fruit drop) resulted in residues in unwashed fruit of 0.097 ppm initially, 0.046 ppm at harvest (day 10) and 0.036 ppm after 4 months in storage. Also after storage, washed fruit contained 0.015 ppm; washed and waxed fruit contained 0.014 ppm.

Studies where cattle and sheep were fed rations containing silvex for several weeks and then immediately slaughtered, indicate that silvex residues ranging from 0.6 to 18.0 ppm can be found in muscle, fat, liver, and kidney. However, when animals were allowed to withdraw from the treated feed, residue levels decreased markedly, often below 0.05ppm the limit of detection in these studies (Leng, 1972; Clark, 1975). Although Duggan et al. (1967) reported that silvex residues of 0.018 and 0.029 ppm were found in two composite samples of dairy product in 1965-1966, silvex residues have not been detected in total diet studies since that time (Martin and Duggan, 1968; Corneliussen, 1970, 1972; Manslee and Corneliussen, 1974).

C. Regulatory History

(1) Tolerances

A tolerance of 0.05 ppm has been established for silvex in or on pears (the raw agricultural commodity) resulting from post harvest application of the triethanolamine salt of silvex to pear trees. (40 CFR, 180.340). There are also interim tolerances of 0.1 ppm for silvex on sugarcane and pre-harvest application to apples and plums for prunes (40 CFR 180.319). No tolerances have been set specifically for TCDD in or on food crops. However, 40 CFR 180.302 establishes a tolerance of 0.05 ppm for hexachlorophene on cotton seed, with a stated limitation that the technical grade fungicide shall not contain more than 0.1 ppm TCDD. The limitation does not constitute a tolerance.

(2) Other

Regulatory Action

Silvex was developed and registered as a herbicide on brush shortly after World War II. Since then, it, along with 2,4,5-T, has been the subject of several Federal regulatory actions.

Initially, silvex was classified as a non residue, zero tolerance chemical. However, on April 13, 1966, the United States Department of Agriculture (USDA) and the Food and Drug Administration (FDA) published an announcement in the Federal Register abolishing the "No Residue and Zero Tolerance" concepts. Future registrations would be granted

on the basis of either "Negligible Residue" or "Permissible Residue." Industry was given until December 31, 1967, to comply by obtaining tolerances for residues of silvex in all treated food, feed products, and byproducts. In addition none of the old registrations would be continued beyond December 31, 1970.

Following this action, a series of Pesticide Registration (PR) Notices were issued over several years, extending certain "no residue" and "zero tolerance" registrations beyond the December 31, 1967, deadline for obtaining residue tolerances. Among uses of silvex extended beyond the deadline were uses on pasture grasses and rangeland; on apples, pears, plums, rice, and sugarcane; and in lakes and ponds.

PR Notice 70-22, published by the USDA on September 28, 1970, addressed the presence of chlorodioxin contaminants in commerical poisons. This notice stated that the USDA had determined that certain toxic chlorodioxins (such as TCDD) may be present as contaminants in the basic materials used in formulating 2,4,5-T and silvex. The notice also stated that the presence of such chlorodioxins constituted a possible hazard to man since they had been found to be extremely toxic to laboratory animals, and that appropriate regulatory action would be taken under provisions of FIFRA since products containing chlorodioxins are considered to be in violation of FIFRA.

On July 20, 1973, a notice of intent to hold public hearings on all uses of 2,4,5-T was filed with the EPA Hearing Clerk under Section 6(b)(2) of FIFRA, as amended 1972. All federally approved uses of 2,4,5-T were to be explored in a public hearing scheduled for April 1974, following completion of an intensive monitoring program for detecting dioxin in the ppt range (38 FR 19869, July 29, 1973). On May 10, 1974, the FIFRA Section 6(b)(2) hearing was expanded to include all insecticides and herbicides having 2,4,5-TCP in their manufacturing process. These included silvex, erbon, and ronnel, as well as 2,4,5-T and 2,4,5-TCP, all of which may contain TCDD.

On June 24, 1974, EPA halted the FIFRA Section 6(b)(1) and 6(b)(2) proceedings initiated against 2,4,5-T and related compounds because of its inability to monitor food for TCDD residues with the necessary analytical precision. Although the hearing was terminated, the Agency stated that it "will continue its TCDD residue monitoring program and will take such further action as it deems appropriate once the results of the monitoring project are available" (39 FR 24050 June 28, 1974).

In 1976, 2,4,5-T, silvex and related chemicals*/ were placed on the original list of chemicals scheduled for

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*/ The related chemicals were ronnel, erbon, and 2,4,5-trichlorophenol.

pre-RPAR review, because of adverse effects that were observed in test animals exposed to 2,4,5-T. Much of the concern centered around TCDD, the extremely toxic contaminant found in these chemicals.

On April 11, 1978, EPA issued an RPAR with respect to pesticide products containing 2,4,5-T. The RPAR review for some uses of 2,4,5-T was terminated on February 28, 1979, when the Administrator suspended the use of 2,4,5-T on forests, rights-of-way, and pastures because he found that these uses presented an imminent hazard to human health.

At the same time, the Administrator also suspended the forestry, rights-of-way, pasture, aquatic weed control/ ditch bank, home and garden, and commercial/ornamental turf uses of silvex because he found that these uses presented an imminent hazard to human health. The Administrator's action regarding silvex was based on data and information about TCDD presented in the 2,4,5-T RPAR Position Document 1, new information developed through the RPAR process, and studies reporting adverse effects in test animals exposed to silvex. An expedited hearing on the suspension orders was convened on April 19, 1979; on May 15, 1979, the hearing was discontinued.

In addition, shortly after the suspension orders were issued, Dow and other affected parties filed suit on March 6, 1979 in the United States District Court, Eastern District of Michigan, Northern Division for judicial review of this decision, requesting an immediate stay of the emergency suspension orders. The court denied plaintiffs' request for an immediate stay of the suspension order, and a hearing for a preliminary injunction was held on April 5, 6, 7, and 9, 1979. On April 12, 1979, the Court denied plaintiffs request for an injunction against the Agency's suspension orders.

## II. RISK ANALYSIS

There are two key components to the assessment of any chemical-related risk: (1) assessment of the toxicological properties of the chemical, and 2) assessment of exposure to the chemical. The risk assessment itself is a summation of the conclusions in each of these areas. For example, a highly toxic chemical may pose low risks if exposure is low; conversely a compound of low to moderate toxicity may pose high risks if exposure is high. In the present instance, TCDD, is an extremely toxic chemical, whereas silvex is significantly less toxic to test animals. However, because commercial samples of silvex contain TCDD, pesticide products containing silvex may have adverse effects on human health.

The RPAR process requires the Agency to assess the risk potential of a pesticide in terms of the risk criteria set out at 40 CFR 162.11(a). Specifically, 40 CFR 162.11(a)(3)(ii)(A) provides that a rebuttable presumption shall arise "if a pesticide's ingredient(s)...(i)nduces oncogenic effects in experimental mammalian species or in man as a result of oral, inhalation or dermal exposure..." Section 162.3(bb) defines the term oncogenic as "the property of a substance or a mixture of substances to produce or induce benign or malignant tumor formation in living animals."

40 CFR 162.11(a)(3)(ii)(B) provides that "a rebuttable presumption shall arise if a pesticide's ingredient(s)...(p)roduces any other chronic or delayed toxic effect in test animals at any dosage up to a level, as determined by the Administrator, which is substantially higher than that to which humans can reasonably be anticipated to be exposed, taking into account ample margins of safety." This section reflects concern that chronic exposure to chemicals may result,among other things, in injury to the reproductive system and/or the fetus and provides that a rebuttable presumption shall arise if chronic chemical exposure in test animals produces such results.

The following data and information on toxic effects and exposure indicate that silvex and/or TCDD exceed the oncogenic effects and other chronic or delayed toxic effects risk criteria for issuance of a rebuttable presumption against registration. This data also indicates that these chemicals may pose risks of adverse effects on human health.

A. Toxicity in Test Animals

Studies have demonstrated that TCDD and/or silvex contaminated with TCDD can produce fetotoxic, teratogenic, and carcinogenic effects in experimental animals which have been exposed to these chemicals.*/ The occurrence of these effects in test animals indicates that humans who are exposed to TCDD and/or silvex may experience comparable effects. The Agency has extracted key data from the numerous studies for presentation in this document.

(1) Adverse Reproductive Effects

TCDD and silvex with TCDD produce fetotoxic and teratogenic effects such as death and reduced fetal size; skeletal deformities such as cleft palate; injury to internal organs such as intestinal bleeding, intestinal lesions, and abnormal kidneys; and post-partum effects such as reduced survival. These effects appear in several different mammalian strains and species, occur in all of the litters in some dose groups, and occur in rats at doses as low as 0.001 ug/kg of TCDD and 50 mg/kg of silvex.

*/ Other studies have attributed additional adverse effects to silvex and/or TCDD exposure. The Agency is currently analyzing these studies to assess the serious implications suggested by their results.

### (a) Exposure of Test Animals to TCDD */

#### (i) Fetotoxic and Embryolethal Effects

Fetotoxic and embryolethal effects have been reported for at least three different mouse strains, two different rat strains, and one strain of subhuman primates exposed to daily dosages of TCDD during the period of major organogenesis in gestation. For example, in studies using generally low-dose regimens of TCDD, Neubert and Dillmann (1972) reported that resorption sites (resorbed or dead embryos) occurred in 54% (7/13) of the litters at 0.3 ug/kg and in 100% (3/3) of the litters at 9.0 ug/kg for NMRI mice, compared to 24-32% (23/95 and 21/65) of litters exhibiting resorptions in control animals which had not been exposed to TCDD (Table 1). Sparschu et al. (1971) reported resorption of 100% (110/110) of the fetuses in Sprague-Dawley rats exposed to 8 ug/kg of TCDD, compared to 20% resorption (63/309) of the fetuses from the control animals. Khera and Ruddick (1973) reported 100% (77/77) resorption of fetuses at 4 ug/kg and 36% (56/153) at exposures of 1 ug/kg in Wistar rats, compared to 7% (3/152) in the control animals.

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*/ Except as otherwise specified, all reproductive data were derived from studies in which pregnant rodents were orally exposed to TCDD and/or silvex with TCDD during the second one-third of gestation by daily gavage or in which primates were chronically exposed before mating and during gestation. The pregnant rodents were sacrificed shortly before the scheduled birth of the offspring, and the fetuses were examined for abnormalities. Pregnant primates delivered offspring at term.

Table 1. Embryotoxic and Teratogenic Effects of TCDD on NMRI Mice[a/]

| Dose (ug/kg)[b/] | Litters Affected/Viable Litters | | | |
|---|---|---|---|---|
| | Resorptions | | Cleft Palate | |
| | # | % | # | % |
| 0 | 23/95 | 24 | 6/95 | 6 |
| oil | 21/65 | 32 | 4/65 | 6 |
| 0.3 | 7/13 | 54 | 0/13 | 0 |
| 3.0 | 16/24 | 67 | 7/24 | 29 |
| 4.5 | 5/12 | 42 | 6/12 | 50 |
| 9.0 | 3/3 | 100 | 3/3 | 100 |
| 9.0 | 3/6 | 50 | 5/6 | 83 |

a/ Data from Neubert and Dillmann.
b/ All doses administered on days 6 to 15, except second 9.0 ug/kg dose which was administered on days 9 to 13.

Similar effects have been reported at higher dosages of TCDD. Neubert and Dillmann (1972) reported that a single dose of 45 ug/kg to NMRI mice on day 6 produced resorptions in 100% (3/3) of the viable litters, compared to resorptions in 24% (23/95) of the control litters. Courtney (1977) reported an average of 87% mortality in 6 litters of CD-1 mice orally exposed to 200 ug/kg, compared to an average mortality of 6% in 15 vehicle control litters (Table 2). This investigator also reported an average of 76% mortality in 6 litters of CD-1 mice exposed subcutaneously to 200 ug/kg of TCDD, compared to 14% in the six litters of control animals. Some of these studies also describe statistically significant weight depression in the surviving embryos (e.g., Sparschu et al. 1971).

These and other studies also reported that TCDD had no measurable adverse effects at some dose levels in some strains. For example, Khera and Ruddick (1973) reported no fetotoxic effects at 0.125 ug/kg in Wistar rats, and Neubert and Dillmann (1972) reported no teratogenic effects at 0.3 ug/kg in NMRI mice. Courtney and Moore (1971) reported that TCDD had no effect on fetal weight or embryonic mortality at 0.5 ug/kg in CD rats, and Sparschu et al. (1971) reported no effect at 0.03 ug/kg in Sprague-Dawley rats. However, subsequent experiments in the same species have demonstrated adverse fetal effects at even lower dose levels.

Table 2. Fetotoxic and Teratogenic Effects of TCDD in CD-1 Mice[a/]

| Dose (ug/kg per day) | Route of Administration | % Average Fetal Mortality/Litter | Average # Abnormal Fetuses per Litter | Anomalies/Total Fetuses | | |
|---|---|---|---|---|---|---|
| | | | | Cleft Palate % | Kidney Anomalies % | Club Foot % |
| 25 | Oral | 6 | 4.6 | 3 | 34 | 3 |
| 50 | Oral | 13 | 8.1 | 19 | 72 | 7 |
| 100 | Oral | 14 | 8.3 | 66 | 71 | 13 |
| 200 | Oral | 87 | 1.5 | 100 | 100 | 14 |
| 400 | Oral | 97 | 0.4 | 100 | 50 | 50 |
| 25 | Subcutaneous | 36 | 6.7 | 82 | 53 | 11 |
| 50 | Subcutaneous | 56 | 5.0 | 79 | 58 | 17 |
| 100 | Subcutaenous | 72 | 3.5 | 85 | 95 | 0 |
| 200 | Subcutaenous | 76 | 3.1 | 100 | 38 | 18 |
| 5% anisole corn oil (0.1 ml) | Oral | 6 | 0.8 | 0 | 1 | 4 |
| DMSO[b/] | Subcutaneous | 14 | 0.2 | 0 | 0 | 1 |

a/ Data from Courtney.
b/ DMSO = dimethylsulfoxide.

Dow Chemical Company has recently completed a study of the effects of TCDD on reproduction in Sprague-Dawley rats exposed to low dose levels of this chemical for three generations. Dow concluded that "impairment of reproduction was clearly evident among rats ingesting 0.01 or 0.1 ug/kg/day of TCDD. Significant decreases were observed in fertility, litter size, gestation survival, post-natal survival and postnatal body weight." In addition, exposure to 0.001 ug /kg/day of TCDD, the lowest level tested in this study, resulted in statistically significant increases in the percentage of pups dead at birth and/or dying before the end of three weeks of life and in the incidence of dilated renal pelvis in some generations.*/

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*/ Dow Chemical Company has claimed that the raw data and/or results of certain of its studies are "trade secret" or "confidential." An injunction issued on April 4, 1978, in the case of Dow Chemical Co. v. Costle, Civil Action No. 76-10087, U.S. District Court for the Eastern District of Michigan (Northern Division), arguably precludes EPA from disclosing this information at the present time. Although the relevant provisions of FIFRA have since been amended to allow disclosure of data such as this [see, e.g., FIFRA Sections 10(d) and 10(g)], the injunction has not yet been modified. EPA has requested the Court to modify the injunction, but until this has been done the Agency will not publicly disclose the data from the study. The summary presented in the text of this Position Document does not, in EPA's opinion, constitute disclosure of the allegedly "trade secret" data submitted by Dow and would not cause any harm to Dow's legitimate competitive interests. The data from the study may be made available to any party in a cancellation proceeding under an appropriate protective arrangement.

Recent reproductive studies in rhesus monkeys indicate that maternal exposure to TCDD results in an increased incidence of early spontaneous abortions and reproductive difficulties. The significance of these results in nonhuman primates should not be underestimated because of the close similarities between the reproductive systems of humans and monkeys. Long-term exposure to even minute quantities of TCDD resulted in a marked increase in spontaneous abortions in the first third of the gestational period, even where there was no evidence of maternal toxicity by clinical observation or biomedical testing. Monkeys exposed to 50 ppt TCDD (2.5 ng/kg per day) before and during pregnancy had a total fetal loss of 67% (50% by abortion and 17% as stillbirth) and fertility rate of 75%, compared with 0% and 100%, respectively, in the controls. Attempts to re-breed one of the aborters resulted in an additional early abortion (Schantz 1979; Spencer, 1979). When animals were treated with a higher dose, the fertility rate dropped to 25%, with one of the two gravid animals aborting in the first third of gestation. Irregularities in menstrual cycles, anovulation, and reduction in the reproductive hormones, progesterone and estrogen, were among the toxic effects seen at the higher dose. The investigators concluded that the reproductive abnormalities were most probably the result of hormone imbalance, and were apparently the result of the TCDD treatment, rather than general toxicity, because the hormonal alterations were observed before the animals became obviously ill (Allen et al., 1977; Barsotti 1979).

Early abortions have also been observed in monkeys where exposure has only been for a short period of the pregnancy. An accumulated dose of 1 ug/kg (1,000 ppt) of TCDD over a three-week period resulted in a 75% abortion rate, compared with 0% in the controls. All abortions in the treated animals were during the first third of the gestational period, and the only evidence of maternal toxicity was slight acnegenic response in one animal, observed months later. The viable offspring produced at this dose had abnormal palate development, and three of the four at a lower dose had debatable abnormal development in the same orofacial region (McNulty, 1979).

Although the experimental protocols and animal strains differ for the several studies cited, in each case TCDD significantly increased the incidence of resorbed embryos or stillborn animals relative to the rate observed in control animals not exposed to TCDD. The regular occurrence of embryonic death in studies by different investigators in primates and in different rodent strains indicates that exposure to TCDD during mammalian gestation may result in the death of the embryos and related maternal reproductive failure.

(ii) Skeletal Anomalies

Skeletal defects appear in six studies involving four different mouse strains. Courtney and Moore (1971) report the following incidences of cleft palate in the indicated strains exposed to 3 ug/kg TCDD: 71% (5/7) of litters of C57BL/6 mice, compared to none (0/23) in the controls; 22% (2/9) in litters of DBA/2 mice compared to none (0/23) in the controls; and 30% (3/10) for CD-1 mice, compared to none (0/9) in the controls (Table 3). Neubert and Dillmann (1972), also using 3 ug/kg of TCDD, reported 29% (7/24) of the viable litters had fetuses with cleft palate for NMRI mice compared to 6% (10/160) of the control litters (Table 1). Smith et al. (1976) reported cleft palate in 71% (10/14) of CF-1 mouse litters at 3 ug/kg, compared to none (0/34) in the controls (Table 4).

In exposures of shorter duration, Moore et al. (1973) reported cleft palate in 86% (12/14) of C57BL/6 mouse litters exposed on days 10-13 to 3 ug/kg, compared to none (0/27) in the control litters. Neubert and Dillmann (1972) reported cleft palate in 71% (10/14) of litters of NMRI mice exposed to a single 45 ug/kg dose on day 11, compared to 6% (6/95) of litters in the controls.

Courtney and Moore (1971) reported no cleft palate in any of the litters in CD rats exposed to 0.5 ug/kg. Similarly, Khera and Ruddick (1973), using Wistar rats, reported that the occurrence of the skeletal anomalies in the fetuses exposed to 2.0 ug/kg was comparable to the rate for the untreated animals.

(iii) Injury to Internal Organs

Exposure to TCDD produced injury to the kidneys and intestinal tracts of at least five different mouse and rat strains. Smith et. al. (1976) reported 28% (4/14) of litters with kidney anomalies at 3 ug/kg in CF-1 mice, compared to none (0/34) in the controls (Table 4). Moore et al. (1973) reported 100% (14/14) of litters with kidney anomalies in C57BL/6 mice exposed to 3 ug/kg on days 10-13, compared to none (0/27) in the control litters. Courtney and Moore (1971) reported kidney anomalies in 100% (10/10) of the litters of CD-1 mice at 3 ug/kg, compared to 33% (3/9) in the controls, and 67% (4/6) litters with abnormal kidneys in the CD rat at 0.5 ug/kg as compared to none (0/9) in the control litters (Table 3). Sparschu et al. (1971) reported hemorrhages or lesions in the intestine of 36% (36/99) of the examined fetuses of Sprague-Dawley rats exposed to 0.5 ug/kg, compared to none (0/246) in the control fetuses.

Table 3. Teratogenic Effects of TCDD in Mice and Rats [a/]

| Strain | Dose (ug/kg) | Litters Affected/Live Litters: Cleft Palate # | Cleft Palate % | Kidney Anomalies # | Kidney Anomalies % |
|---|---|---|---|---|---|
| Mouse | | | | | |
| CD-1 | 0 (DMSO) | 0/9 | 0 | 3/9 | 33 |
| | 1 | 1/9 | 11 | 5/9 | 56 |
| | 3 | 3/10 | 30 | 10/10 | 100 |
| DBA/2 | 0 (DMSO) | 0/23 | 0 | 3/23 | 13 |
| | 3 | 2/9 | 22 | 8/9 | 89 |
| C57BL/6 | 0 (DMSO) | 0/23 | 0 | 2/23 | 9 |
| | 3 | 5/7 | 71 | 7/7 | 100 |
| Rat | | | | | |
| CD | 0 (DMSO) | 0/9 | 0 | 0/9 | 0 |
| | 0.5 | 0/6 | 0 | 4/6 | 67 |

a/ Data from Courtney and Moore.

Table 4. Fetotoxic and Teratogenic Effects of TCDD in CF-1 Mice [a/]

| Dose (ug/kg) | Incidence of Cleft Palate in Litters per Live Litters # | % | Litters With Resorbed Fetuses per Live Litters # | % | Litters With Dilated Renal Pelvis per Live Litters # | % |
|---|---|---|---|---|---|---|
| 0 | 0/34 | 0 | 25/34 | 74 | 0/34 | 0 |
| 0.001 | 2/41 | 5 | 30/41 | 73 | 0/41 | 0 |
| 0.01 | 0/19 | 0 | 17/19 | 89 | 0/19 | 0 |
| 0.1 | 1/17 | 6 | 16/17 | 94 | 0/17 | 0 |
| | | b/ | | | | |
| 1.0 | 4/19 | 21 | 18/19 | 95 | 1/19 | 5 |
| | | b/ | | | | b/ |
| 3.0 | 10/14 | 71 | 11/14 | 78 | 4/14 | 28 |

a/ Data from Smith et al.

b/ Statistically different from controls by the Fishers exact probability test ($p < 0.05$).

(b) Exposure of Test Animals to Silvex

Silvex has been shown to produce fetotoxic effects such as fetal mortality, reduced body weight, skeletal anomalies, and injury to internal organs. The effects have been observed in test rodent species at maternal doses as low as 50 mg/kg (TCDD < 0.05 ppm). These results clearly indicate that silvex is fetotoxic and teratogenic in mammals.

Courtney (1977) reported significant incidences of increased fetal mortality and reduced fetal weight in CD-1 mice which had received prenatal exposure to silvex. Maternal subcutaneous exposure to 405 mg/kg silvex (TCDD < 0.1 ppm) resulted in 25% (33/132) fetal mortality and an average fetal weight of 0.87 g, compared with control values of 12% (19/171) and 1.03 g, respectively. Oral exposure to the same dose resulted in an average fetal weight of 0.83 g, compared with 1.01 g in the controls. An increased incidence of cleft palate was also observed among the treated fetuses. Oral exposure resulted in an incidence of 7% (7/95); subcutaneous exposure resulted in 3% (3/99). No cleft palates (0/260) were observed among the control animals.

Dow Chemical Company*/ studied the reproductive effects of silvex and the propylene glycol butyl ether ester of silvex (silvex-PGBE), each containing less than 0.05 ppm TCDD. Sprague-Dawley rats were exposed to 25 to 100 mg/kg of silvex on days 6 through 15 of gestation. Significant effects on fetal mortality and birth weight were observed in the litters of treated dams. Skeletal anomalies, such as cleft palate, retarded ossification, and extra cervical ribs were observed among the exposed fetuses. Micropthalmia (abnormal smallness of the eyeball) and cardiovascular abnormalities were also seen. Similar effects were observed when animals were dosed with silvex-PGBE, or when dosed for three-day intervals during the period of early organogenesis.

In each of the studies cited above, some maternal toxic effects were observed. Courtney found some increased maternal weight gains and increases in liver to body weight ratios among the treated groups; Dow noted baldness (alopecia), lack of appetite and vaginal bleeding. However, the existence of maternal toxic effects does not negate the impact of the observed injury to and death of the fetus.

In summary, TCDD produces fetotoxic effects in test animals at the lowest doses tested. For example, maternal doses as low as 0.001 ug/kg in rats and 50 ppt in monkeys have increased lethality to fetuses. To date, a no-observed effect level has not been established for TCDD-related

*/ Dow Chemical Co. has also requested confidentiality for the results of this study. The discussion in the footnote in Section II.A.(1)(a)(i) of this document applies to these data.

effects on reproduction in any species tested. Exposure to silvex containing less than 0.05 ppm TCDD resulted in increased fetotoxicity at 400 mg/kg in mice and at 50 mg/kg in rats. No significant effects were observed below these levels.

(c) Risk of Adverse Reproductive Effects

Generally, a no-effect level is viewed as a toxicological endpoint, marking a level of exposure in animals which is "safe" because there are no observable adverse effects. Toxicologists generally assume that the animal no-effect level can serve as a base for estimating exposure levels which would be "safe" for humans. The "safe" level for humans is set at some level lower than the animal no-effect level to provide a "margin of safety" that takes into account differences in sensitivities between animals and humans, and differences in sensitivities among humans. This "margin of safety" does not represent an infallible indicator of potential hazard to humans. Error could be introduced because humans are more sensitive than the test species by a greater factor than normally allowed, or by the incorrect choice of a no-effect level.

The lowest level at which TCDD has no observable effects in test animals is crucial to the Agency's determination of the risk potential of silvex. TCDD is present in this pesticide as a low-level contaminant and thus will be present in the environment at low levels whenever and wherever silvex is used. If there truly were a no-effect level in animals, it would be reasonable to at least begin to estimate a possible "safe" level for humans and to assess the possible risk to humans by relating this assumed "safe" level to the level of the pesticide that may be in the environment, if that level were known. However, if there were no no-effect level, any use of silvex would result in potentially significant exposure to TCDD, because there would be no minimum level upon which to estimate a margin of safety. It is the Agency's position that no no-effect level has been found for fetotoxic effects resulting from TCDD exposure. Therefore, any exposure to TCDD or silvex containing TCDD must be considered potentially dangerous to the human fetus.

(2) Oncogenic Effects in Test Animals

Chronic exposure studies have shown that TCDD induces oncogenic responses in mice and rats at exceedingly low dose levels. These effects, together with data showing that TCDD is mutagenic, constitute substantial evidence that TCDD is likely to be a human carcinogen.

(a) Effects of TCDD

The Agency's Carcinogen Assessment Group (CAG) has concluded there is a sufficient evidence from animal studies to indicate that TCDD is likely to be a human carcinogen (Memo, 1979). Carcinogenic responses have been observed at doses as low as 210 ppt in rats.

Dow Chemical Company, a silvex registrant, studied the effects of TCDD on male and female Sprague-Dawley rats exposed to 22, 210 or 2200 ppt TCDD and reported that there were statistically significant increases in the incidence of hepatocellular carcinoma in female rats exposed to 2200 ppt TCDD (Dow Chemical U.S.A., 1977). After analyzing the raw data from this study, the CAG has concluded that the combined increase

in the incidence of hepatocellular hyperplastic nodules and hepatocellular carcinoma in rats exposed to both the 2,200 ppt and 210 ppt levels is significant.*/ In another study using Sprague-Dawley rats, Van Miller et al. (1977) reported that 1000 ppt and 5000 ppt TCDD produced a carcinogenic response in male Sprague-Dawley rats. These observations tend to confirm the registrant's observations that TCDD produces an oncogenic response in the livers of male Sprague-Dawley rats.**/

Further, a preliminary report of a not-yet-completed National Cancer Institute study tends to confirm these observations of a carcinogenic response in rats. A contractor for the National Cancer Institute has reported that TCDD is carcinogenic in the rats and mice used in that study.

CAG also emphasized that, at low levels, TCDD is a potent inducer of arylhydrocarbon hydroxylase, an enzyme system that contains an enzyme that is known to mediate the formation of epoxides, compounds which are

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*/ Dow Chemical Company has also requested confidentiality for raw data supporting this finding. The discussion in the footnote in Section IIA (1) (a) of this document applies to these data.

**/ The CAG and an EPA audit found that this study had major shortcomings in design and conduct that limited the reliability of the data developed at dose levels lower than 1000 ppt.

potentially active carcinogenic metabolites. In addition, CAG reported that TCDD is mutagenic in the Ames test without the metabolic activation system. Its mutagenic activity is exhibited by frameshift mutations caused by intercalation between base-pairs of DNA (EPA, 1979).

Finally, CAG and others have compared the carcinogenic potency of TCDD with other known carcinogens (EPA, 1979) Based on these calculations, TCDD appears to be the most potent chemical carcinogen known (several times more potent than aflatoxin).

(b) Effects of Silvex

There is little definitive information regarding the oncogenic potential of silvex. Innes et al. (1969) reported no significant differences in the incidence of tumors between control animals and mice fed a diet containing 121 ppm silvex for 18 months. Similar results were obtained by Mullison (1966) who fed Kurosol, S.L., containing 53.3% silvex acid to rats at 10, 30, 100, and 300 ppm for two years. However, when beagle dogs were fed 190 ppm silvex potassium salt for two years and 560 ppm for one year, necrosis and fibroplastic proliferation in the liver were reported (Mullison, 1966).

(c) Risk of Oncogenic Effects

The Agency has examined the data showing that TCDD is carcinogenic at very low exposure levels in light of other information indicating that the use and distribution of silvex to the environment creates opportunities for human exposure to these chemicals. In view of the non-threshold concept upon which Agency Cancer Policy is based (Albert et al., 1977), any exposure to TCDD poses a significant risk of oncogenic effects occuring in the exposed population.

(3) Conclusion

In summary, available information supports the conclusion that there is a very real potential for human risks due to exposure to silvex and/or TCDD. These risks primarily relate to the oncogenic and fetotoxic effects of TCDD. Because TCDD is invariably present as a contaminant of commercial silvex, any exposure to silvex represents a significant potential risk to the exposed human population.

## B. Exposure Resulting from the Use of Silvex

The use of silvex results in the distribution of the pesticide to air, water, non-target vegetation, soil, and other environmental components in areas where people live and work. As a result, people and their food and water supplies may be exposed directly or indirectly to silvex and its dioxin contaminant, TCDD. This section of the Position Document details information on the exposure potential resulting from the non-suspended uses of silvex, particularly use on orchards, sugarcane, rice, and rangeland. In some cases, information on exposure potential from these uses is derived from data on use practices, and in other cases this information is based on chemical residue data.

### (1) Exposure due to Silvex Use on Rice

About 2,000 acres (1%) of the annual rice crop are treated with silvex to control broadleaf and aquatic weeds. The major use areas are in Mississippi, Arkansas, Louisiana, and Missouri.

Greater than 99% of all application of silvex for rice production is by fixed-wing aircraft which fly at speeds of 85 to 120 mph, 3 to 10 feet above the rice crop, when winds do not exceed 5 mph.

(a) Direct Exposure from Aerial Drift

The total rural population of the Delta region rice-growing counties is about 653,000 with an estimated 222,000 people residing within 1/2 mile of rice fields.

The average rural population density is 40 people/square mile. When the use of the pesticide results in drift to these areas of human work and habitation, people who live and work in the path of the drift may be directly exposed to the pesticide by inhalation and/or by dermal exposure to pesticide droplets in the airborn drift.

Cotton farmers who live in the Delta rice-growing region have reported drift onto their cropland and related crop damage (30,000/26:#302, #1888). These reports indicate that the pesticide has drifted beyond the spray area of the rice fields and into non-target areas. Such reports are consistent with studies showing that aerial application of other pesticides may result in drift for several miles away from the site of the spray operation (Akesson and Yates, undated; Maybank et al., 1978).

(b) Contamination of Surface Waters

Application of silvex to rice fields may result in contamination of rivers and streams. Rice fields are flooded with well water 2 to 4 inches deep and maintained at this level until harvest, except when producers drain their fields for an application of fertilizer in the middle of the growing season. About two weeks before harvest, the water is diverted from the fields to ditches which eventually enter streams and rivers. Silvex contamination of these waters is demonstrated by data retrieved from the STORET system which indicate that silvex residues are present in surface waters throughout the Delta region. It is noted, however, that the monitoring programs do not distinquish between silvex residues originating from rice, pasture and rights-of-way uses in these areas.

In the Delta Region, surface waters are a source of commercial and sport fishing. Although well water is recommended for catfish confinement operations, surface water is sometimes impounded. As a result, some of the fish harvested annually in this region may be cultivated in water contaminated with silvex. This practice creates an opportunity for exposure to the local population which consumes much of the catfish harvested each year. Estimates indicate that the average person in the Delta Region consumes 2.8 kilograms of freshwater catfish, mostly from local sources, each year.

Because surface waters in this area are used for local fish cultivation, the Agency has considered these waters as a possible source of human exposure to silvex. However, in rice-growing areas of Mississippi and Arkansas, the majority of the population obtain drinking water from deep wells and the exposure of these populations would be greater if the ground water also is contaminated. However, because silvex has a half-life in water of about 2 weeks, and TCDD residues, though stable, are relatively immobile in soil, the Agency assumes that contamination of ground water from the rice use is generally unlikely.

(2) Exposure due to Silvex Use on Rangeland

(a) Use Practices and Populations Exposed

Silvex is used on rangeland throughout the country but major usage occurs in Arizona, Arkansas, Kansas, Missouri, New Mexico, Oklahoma, and Texas where about 1.6 million acres of rangeland are treated annually with 2,4,5-T and/or silvex. Estimates indicate that 47,000 people reside within 1/4 mile of the treated areas. Rural population density is generally 3 to 4 people/sq mi with one exception of 16 people/sq mi. in central Missouri.

Generally, silvex is applied by fixed-wing aircraft which fly at speeds of 85 to 105 mph, 10 ft above vegetation in winds that do not exceed 10 mph. The average spray droplet size is 300 microns, and drift control agents are used to reduce spray drift in 50% of the applications. Ground rigs and backpack spray units are used to treat small areas or especially troublesome areas. Applicators set their equipment to deliver droplet sizes ranging from 200 to 300 microns. Estimates indicate that up to 6% of the spray would be 100 microns or less, the particle size most likely to drift significant distances from the target area when these methods are used to apply silvex (Akesson and Yates, Undated).

The amount and formulation of silvex used depends on the kind of vegetation being treated and the density of the growth in the area (see Table 5). Both amine and low volatile ester formulations of 2,4,5-T and silvex are used, frequently in emulsions of water and oil during the spring and summer.

Rates of 0.5 to 2.0 pounds a.i./acre, in 1 to 4 gal/acre volumes are used, but 2 gal/acre volumes are used by 50% of the applicators. Average droplet size is 300 microns, and half of the applications are made with drift control agents. Treatment schedules vary from 1 to 3 consecutive years, depending on the severity of the problem, followed by retreatment 5 or more years later depending on the need.

(b) Water and Soil Residues

The STORET system contains data which show silvex residues in water and sediment in the major rangeland use areas, and residues of silvex have been reported in several Western streams during monthly monitoring for chemical residues at USGS stations. However, because silvex may also have been used on rights-of-way, ditch banks, pastures or aquatic sites in the localities where the residues were detected, it has not been determined if rangeland use of silvex is the source of these residues. The National Surface Water Monitoring Program for Pesticides has not detected levels of silvex in surface water in rangeland use areas.

Studies by Leng (1972) indicate that silvex residues in rangeland decline during the first few months after application. For example, residues of silvex on soil or grasses immediately after application of 0.5 to 1.0 a.i./acre range from 27 ppm to 199 ppm but decline to 0 after 16 weeks. The hydrolytic half-life for silvex has been estimated to be about 14 days (Altom, 1973). The half-life of TCDD residues is estimated to be one year in soil, but TCDD residues were not found deeper than 6 inches below the soil surface (Isensee and Jones, 1971).

Table 5. 2,4,5-T/Silvex Application Rates on Rangeland by Different Treatment Methods

| Application Site | Application Method | Region Applied | Application Rate | Number of Applications |
|---|---|---|---|---|
| Mesquite | Aerial | South Texas Plains | 0.67 pounds acid equivalent per acre | 3 consecutive seasons; retreatment in 16 years |
| | | Rolling Plains of Texas and Oklahoma | 0.5 pounds a.e./acre | one application; retreatment in 8 years |
| | | Rolling Plains of Texas and New Mexico | 0.5 pounds a.e./acre | one application; retreatment in 10 years |
| | | Gulf Coast and Coastal Prairie | 1 pound a.e./acre | one application; retreatment in 5 years |
| | | South Texas Plains | 1 pound a.e./acre | one application; retreatment in 5 years |
| | | | 2 pounds a.e./acre of 2,4,5-T + picloram (50:50) | one application; retreatment in 5 years |
| | | Southwest | 0.5 pounds a.e./acre | one application; retreatment in 10 years |
| Post and Blackjack Oak Savannah | Aerial | | 2 pounds a.e./acre | one application; retreatment in 5 years |
| | | | 2 pounds a.e/acre 1st year & 1.5 to 2 pounds a.e. per acre 2nd year | one application; retreatment in 10 years |

Table 5. Continued Methods

| Application Site | Application Method | Region Applied | Application Rate | Number of Applications |
|---|---|---|---|---|
| Hardwoods within Post and Blackjack Oak Savannahs | Aerial | | 2 pounds a.e./acre | for 2 seasons; retreatment in 10 years |
| Sand Shinnery Oak | | | 0.5 pounds a.e./acre | for 2 seasons; retreatment in 10 years. |
| | | | 0.5 pounds a.e./acre | one application; retreatment in 5 years |
| Cactus | | | 2 pounds a.e./acre | retreatment in 20 years |
| Yucca | | | 0.67 pounds a.e./acre | retreatment in 10 to 15 years |
| Mesquite and Oak | Broadcast Ground Application | | 2 pounds a.e./acre | one application; retreatment frequency varies from 5 to 10 years |
| Yucca | | | 0.67 pounds a.e./acre | one application; retreatment in 10 to 15 years |
| Mesquite, Oaks, and other species | Spot Treatment | | 8 to 16 pounds aehg oil for bark treatment, or 6 to 8 pounds aehg water-oil emulsions for basal-stem treatments | |

(3) Exposure due to Silvex Use on Apples

Approximately 52,000 acres (10%) of apples are treated annually with silvex to control preharvest fruit drop and to enhance fruit color(Melster, 1977). An estimated 2,500 pounds of silvex active ingredient (ai) is used mainly to treat Red Delicious apples. This accounts for 35% of the 520,000 acres of apple production in the United States. The major areas producing this variety of apple are Washington (55%), North Carolinia (6%), New York (4%), Virginia (4%), Oregon (3%), and Michigan (3%) All other states producing this variety of apple account for 21% of the annual crop.

Silveramine, the triethanolamine salt of silvex is the formulation used on apples. The application rate generally used is 3/4 pint/acre in 300 gallons of water (0.8 ai./acre) applied aerially and by ground rigs.

The impact of spray drift on the population that resides in the vicinity of apple orchards has not been determined but the impact of the extent of possible spray drift can be estimated from other studies. Spray drift during aerial application has been shown to be dependent on the spray equipment used, hydrolic pressure, air turbulence, and the prevailing wind speed. Spray droplets can drift many miles away from the site of application (Akesson and Yates, undated). Drift estimates for ground rig appication of 2,4-D have been calculated experimentally. Estimates indicate

that there is a potential for up to 8.0% of the spray to drift at least as far as 5 meters away from the target site depending on the spray equipment used, hydrolic pressure, and the prevailing wind speed (Maybank et al., 1978).

The number of people who reside or work in the vicinity of orchards who may be subjected to spray drift has not been assessed. Moreover, apples are harvested by hand which may result in exposure to farm workers during the harvest season. There is little information regarding the persistence of silvex and TCDD residues on this food source, and the related question of exposure to persons who harvest and handle the crop. However, the need for pertinent data regarding potential exposure to silvex and TCDD is underscored by the finding of an average 0.036 ppm silvex residues in unwashed apples several months after harvest (Cochrane et al., 1976).

(4) Exposure due to Silvex Use on Pears

Silvex is registered for use on Anjou pear trees immediately after harvest to improve fruit set for the following year. It is used on an estimated 600 to 700 acres annually, primarily in Oregon and Washington.

The triethanolamine silvex formulation is applied at a rate of one ounce silvex [11.4 grams (a.i.)] in 70 gallons of water/acre by ground rigs.

The extent of exposure to farm workers and the population in the vicinity of these orchards has not been assessed, but a study conducted with a ground rig application of 2,4-D indicates that as much as 8.0% of the spray may drift at least as far as 5 meters away from the site of application (Maybank et al., 1978). Measurements to determine drift beyond 5 meters were not made. The impact of this potential spray drift has not been determined.

(5) Exposure from Silvex Use on Plums

Approximately 8,300 acres (9%) of the 93,638 acres of plums (for use as prunes) are cultivated annually are treated with silvex. Most of the usage, estimated at 400 pounds active ingredients (a.i), occurs in Oregon (7,407 acres), Washington (1,940 acres), and Idaho (978 acres) where the Italian and Early Italian varieties comprise the greatest percentage of plum acreage in the United States.and account for approximately 11% of the annual prune harvest

Ground rigs are used to apply silvex to virtually all of the plums that are cultivated in these three states. The triethanolamine salt is the only formulation used to prevent fruit drop in plums. The Agency estimates that silvex is applied at the rate of 0.8 ounces (a.i.)/acre

of silvex trietanolamine salt. While information regarding the impact of silvex drift away from this use site is lacking, drift estimates for ground rig application of 2,4-D have been calculated experimentally. Estimates indicate that there is a potential as much as 8.0 of the spray to drift 5 meters away from the target site depending on the spray equipment used, hydrolic pressure, and the prevailing wind speed (Maybank et al., 1978).

There is a substantial need for data regarding the extent of silvex and TCDD exposure due to the use of silvex on plums. The population in the vicinity of the major use areas that may be subjected to spray drift from ground rigs has not been estimated. Moreover, neither the extent of exposure to applicators or farm workers during spraying or harvesting nor the persistence of silvex and TCDD residues on plums has been investigated.

(6) Exposure due to Silvex Use on Sugarcane

Silvex is used annually on approximately 115,000 to 230,000 acres of sugarcane primarily for contol of weeds that are resistant to 2,4-D on an estimated 30,000 acres (10%) in Florida and on approximately 85,000 to 200,000 (30 to 65%) acres (63%) of the sugarcane grown in Louisiana. Silvex is applied mainly by aerial application when the cane

is less than 3 1/2 feet tall in Louisiana. In contrast, silvex is usually applied by ground rigs in Florida for pre-emergent weed control when seeds are expected to germinate or immediately after the crop bed has been shaped.

The most common silvex formulations used are the low volatile esters which are applied at the rate of 0.75 to 1.0 pounds active ingredients (a.i.)/acre in 10 to 15 gallons of water/acre for both pre-emergent and post-emergent weed control.

The impact of spray drift on the population that resides in the vicinity of sugarcane fields has not been determined but the impact of the extent of possible spray drift can be estimated from other studies. Spray drift during aerial application has been shown to be dependent on the spray equipment used, hydrolic pressure, air turbulence, and the prevailing wind speed. Spray droplets can drift many miles away from the site of application (Akesson and Yates, undated). Drift estimates for ground rig appication of 2,4-D have been calculated experimentally. Estimates indicate that there is a potential for up to 8.0% of the spray to drift at least 5 meters away from the target site depending on the spray equipment used, hydrolic pressure, and the prevailing wind speed (Maybank et al., 1978). Therefore, when the use of the pesticide results in drift in these areas of human work and habitation, people who live and work in the path of the

drift may be directly exposed to the pesticide by inhalation and/or by dermal exposure to pesticide droplets in the airborn drift. Moreover, there is little information regarding the persistence of silvex and TCDD residues on this food source, and the related question of exposure to persons who harvest and handle the crop.

Data retrieved from the STORET System for both of these sugarcane growing areas indicates the presence of silvex residues in both surface water and sediment. However, because silvex was used on other sites in the sugarcane growing areas, it has not been determined whether these residues orginated from silvex sugarcane use.

(7) Exposure due to Silvex Use on Non-crop Sites

Silvex is used to treat many broadleaf, herbaceous, and that may be present in a variety of urban and rural non-crop areas such as hedgerows, storage areas, and vacant lots. Recent data regarding the extent of silvex used for these purposes is unavailable. However, data is available from a 1974 report which indicated that approximately 60,000 pounds active ingredient (a.i.) of silvex was used annually for general maintenance of grounds at industrial, commercial and institutional sites. Presently, the Agency has no better estimate of how much silvex is used for non-crop areas (EPA, 1978).

Silvex is used throughout the country for this kind of weed control. The most common formulations are the low volatile silvex esters which are frequently formulated with 2,4-D or Dicamba for a broad spectrum of weed control action. Ground rigs are used to treat large areas but hand held application devices are frequently used for spot treatments in small areas. The Agency has no estimate of the number of people that use silvex or the number of people in the immediate vicinity of these spray sites because of their heterogeneous nature.

Exposure for this kind of usage appears to be confined to the applicator and those people residing or working in the immediate vicinity of the spray area. Information from studies of forest workers who apply phenoxy-herbicides with backpack sprayers indicates that it may be possible for the applicator to contact 0.8 ppb of the chemical spray due to dermal exposre and 0.3 ppb due to inhalation exposure (Lavy, 1978). Therefore, the Agency is concerned about the exposure that may result due to direct contact as well as drift.

C. Epidemiologic Data

The risk assessment for silvex is based in part on data showing that exposure to silvex and/or TCDD results in tumors, and dead and deformed offspring in test animals, and that the uses of the pesticide create opportunities for exposure to humans. Together these facts suggest that

if the use of the pesticide results in human exposure, humans who live and work in areas of use may experience the kinds of adverse health effects observed in test animals.

This reasoning is borne out by the results of a recent epidemiological study which reported that women living in the vicinity of Alsea, Oregon have a statistically significant higher incidence of spontaneous abortions (miscarriages) than women living in a control area. Alsea is an area in which two dioxin-containing pesticides, 2,4,5-T and silvex are used extensively for forest management and on rights of way. Additional analyses of the data indicate that there is a significant correlation between the use of 2,4,5-T in the study area and the subsequent increase in the rate of spontaneous abortions in the study area.*/

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*/ The Alsea study was analyzed using only 2,4,5-T data. However, the serious implications of this study are as applicable to silvex as to 2,4,5-T, because TCDD, the contaminant contained in both herbicides, is a potent mammalian fetotoxin and teratogen at very low doses. Conversely, silvex and 2,4,5-T are fetotoxic and teratogenic at comparatively higher doses. It is reasonable to assume that the adverse human reproductive effects observed in Alsea, which have been attributed to low-level exposure to 2,4,5-T, are due primarily, or at least in part, to the TCDD in the 2,4,5-T. Therefore, since silvex also contains TCDD, it is prudent to conclude that the Alsea data are applicable to silvex use when evaluating potential reproductive risk to humans. See 44 FR 15904.

This relationship between exposure to TCDD-containing phenoxy herbicides and an increased incidence of miscarriages in humans is not surprising. This is the same relationship that has been demonstrated to exist in test animals through numerous animal studies. While there are uncertainties concerning the amount of phenoxy herbicide and/or TCDD to which the Alsea area women may have been exposed and concerning the precise route (or routes) of human exposure, the statistically significant incidence of miscarriages described above, coupled with the uncontestable data from the animal studies, makes it reasonable to conclude that women in the Alsea study area may be exposed to, and adversely affected by 2,4,5-T, silvex and/or TCDD. Moreover, it is also reasonable to assume that the same type of effects may occur wherever and whenever 2,4,5-T or silvex containing TCDD is used.

Further, the Alsea experience may not be an isolated incident. Reports of people adversely affected by exposure to phenoxy herbicides and/or TCDD have frequently appeared in medical and scientific journals. Recent summaries appear in IARC, NRCC, and U.S. Air Force documents on phenoxy herbicides and dioxins. In addition, as a result of the 2,4,5-T RPAR, the Agency has received numerous accounts of adverse human health effects which the reporters attributed to phenoxy herbicides and/or TCDD. The cumulative effect of these reported incidents suggests that people who live and/or work in areas of silvex use may experience adverse health effects.

## III. Preliminary Benefits Analysis of Silvex use on Range, Rice, Orchards, Sugarcane and Non-crop Areas.

### A. Introduction

This preliminary analysis is an assessment of the economic impact of the cancellation of silvex for use on range, rice, orchards, sugarcane, and non-crop areas. The analysis assumes that 2,4,5-T also will be cancelled for these uses. In view of the virtually identical toxicological characteristics of the two compounds and the similarity of the benefits of both, it is unlikely that only one of them would be cancelled.

The information, relating to the benefits of silvex, used in this report was derived principally from a single source - The Biologic and Economic Assessment of 2,4,5-T ("USDA Assessment Report").*/ Also under this memorandum, a joint USDA-States-EPA Silvex Assessment Team was formed to provide benefits information on silvex. The economic analyses for the sugarcane and orchard uses of silvex are based on preliminary information partially provided by members of the Silvex Assessment Team.

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*/ This report was prepared jointly by the USDA-States-EPA 2,4,5-T Assessment Team, established pursuant to a memorandum of understanding between USDA and EPA.

There are disadvantages to the heavy reliance of this analysis upon the 2,4,5-T Assessment Report for the range and rice information. As is commonly the case in assessing benefits of pesticides, the available information reported in the USDA Assessment Report was a mixture of empirical data and expert opinion and did not lend itself to precise statistical analysis. Thus, the estimates reported in this analysis represent rough predictions of the impact of cancellation. The lack of confidence intervals or error terms does not imply exact precision. The estimates are merely approximations of the projected impacts within the limitations of the data and analyses.**/

The general approach of this analysis is to evaluate the economic impacts arising from users' shifting to alternatives to silvex (other than 2,4,5-T) where alternatives are available and, where no alternatives are available, economic impacts on users and at the commodity and consumer levels are projected based on crop yield reduction and possible user shifts to other crops then projecting these impacts at the commodity and consumer levels where appropriate. Impacts on users are considered on a per-unit, per-establishment basis and at the state, regional, and national levels.

**/ The Agency is continuing to collect and review data relating to the benefits of silvex use for range, rice, orchards, sugarcane and non-crop areas.

(B) Summary of Findings

(1) Rangeland***/

There are an estimated one billion acres of range and pasture land suitable for grazing in the contiguous 48 states, plus 351 million acres in Alaska and 3 million acres in Hawaii. About 90 percent of this total acreage is rangeland. Of this total, approximately one percent is treated with herbicides, primarily 2,4-D. Only about 150,000 acres, or less than 0.1% of range acres, are treated with silvex.

Silvex is used to control various woody and herbaceous plants found in rangeland. Most silvex use is directed at control of various oak species which compete with desirable forage plants for water, nutrients, sunlight and space. Treatment is generally directed at acreage with severe infestation which, if left uncontrolled, would reduce forage available for livestock grazing.

A number of chemical and non-chemical alternatives to silvex are available to control the various weeds now

***/ "Rangeland" is defined as land producing forage for animal consumption, harvested by grazing, which is not cultivated, seeded, fertilized, irrigated or treated with pesticides or other such similar practices on an annual basis. Fencerows enclosing range areas are included as part of the range.

treated with silvex. However, none of these alternatives is effective against oaks when applied aerially. Thus, effective substitute treatments for silvex must be applied by ground techniques which are more expensive and less convenient. The availability of alternatives and the very small quantity of acreage involved indicate that no significant economic impacts will be felt at either the consumer or market levels if silvex is cancelled for this use. At the user level, some increased control costs and decreased production may be experienced by a small number of users. In some locations, the impact on users may be significant.

(2) Rice

Although about 98% of all U.S. rice areas are treated with one or more herbicides, silvex is used on only 2,000 acres annually, or less than 0.1% of all U.S. rice acres. In those areas where silvex is used, it is employed to control various broadleaf, aquatic and sedge weeds. These weeds, if not controlled, reduce yield and lower the quality of the rice by contaminating the harvested grain with weed seeds.

There are several chemical alternatives which are likely to be employed as substitutes for silvex use on rice. These compounds may be somewhat less effective and/or more expensive than silvex for use on some weeds. Therefore, some degree of increased control costs and reduced production

may be experienced on some acres as a result of the substitution of these materials for silvex. However, because silvex is used on so little rice-growing acreage, the economic impact at the user, consumer and market levels will be quite small if silvex were cancelled for this use.

(3) Orchard

Silvex is used on apples and prunes to control preharvest fruit drop and on pears to increase fruit set. Premature drops cause a complete economic loss of prunes and a substantial loss of apple crops. Approximately 50,000 acres of apples (10% of U.S. crop) are treated annually with about 2,500 pounds of silvex. Most of the treated apples are Red Delicious, grown in Washington and several other states, which are sold for fresh consumption. About 8,300 acres of Italian prunes (9% of U.S. acres) grown in Oregon, Washington, and Idaho are treated with about 400 pounds of silvex annually. Treated prunes are believed to be sold primarily for fresh consumption. The extent of silvex usage on pears is unknown.

NAA (1-napthaleneacetic acid) and Alar (succinic acid 2,2-dimethyl hydrazine) probably would be used by apple growers as chemical alternatives to silvex. Some acres would require two annual treatments with these materials for effective control, whereas use of silvex requires only one

treatment. The economic impact is likely to consist of higher costs to apple growers, totaling approximately $1 million per year or $20 per average affected acre, resulting from the use of these alternatives. The higher drop control costs will increase production costs by 2-3% per year. Apple production and quality should not be significantly affected.

Prune growers currently using silvex would suffer significant income reductions if silvex is unavailable. Italian and early Italian prunes in the Northwest states drop an average of 35% of the fruit if silvex is not applied in mid-June to control summer drop. Since there are no registered alternatives to silvex for this use, production and revenues would decline sharply on the affected acres. Revenue reductions totaling $1.8 million annually, or about $222 per affected acre, are projected to occur, assuming no alternatives to silvex are developed to prevent preharvest drop. Continued losses of this magnitude would eventually cause growers to grow alternative crops on the estimated 8,300 acres of prunes for which preharvest drop problems are significant.

The retail price of apples and pears would probably be unaffected by cancellation of silvex for orchard use. The retail price of prunes would increase by an undetermined amount.

(4) Sugarcane

Silvex is used on sugarcane fields to control weeds not controlled by 2,4-D. Failure to control these weeds can result in reduced yields. About 15% (115,000 acres) of all U.S. sugarcane acres (752,000 acres) were treated with silvex in 1978. This reflects a significant decrease in silvex use over previous years, probably resulting from increased use of an alternative dicamba /2,4-D mixture. The dicamba / 2,4-D combination alternative is likely to be the most commonly used substitute if silvex is canceled for use on sugarcane. Economic impacts arising from a cancellation of silvex would result from reduced yield, which would occur because the alternative is less efffective than silvex . A worst-case estimate indicates a 2% loss of overall U.S. sugarcane production could be experienced. Since U.S. - produced cane sugar comprises only 18% of the total U.S. sugar supply, no measurable sugar price changes are likely to occur at either the market or consumer levels.

(5) Non-Crop Uses*/

Silvex is registered for control of many broadleaved and herbaceous weeds in a variety of urban and rural non-crop areas such as fencerows, storage areas and parking lots. Only a very small percentage of non-crop areas is treated with silvex each year.

*/"Non-crop areas" includes: fencerows, hedgerows, fences (not otherwise included among previously suspended uses, e.g. rights-of-way, pasture); industrial sites or buildings (not other wise included among previously suspended uses, e.g. rights-of-way, commercial/ornamental turf); storage areas, waste areas, vacant and parking lots.

Both chemical and non-chemical controls are available as alternatives to silvex for use on non-crop areas. The chemical alternatives include 2,4-D, picloram, dicamba, AMS, amitrole. Non-chemical controls include mechanical methods such as mowing, shearing, and manual methods. The relative efficacy of the alternatives in comparsion to silvex is unknown. However, it is believed that one or a combination of the chemical alternatives will be widely substituted for silvex and will provide equivalent control.

The economic impact of cancelling silvex for non-crop uses is not likely to be significant at user, consumer or market levels because little acreage is treated with silvex and effective alternatives are readily available.

(C) General Production and Use Pattern

Silvex is produced domestically by The Dow Chemical Company, Thompson-Hayward Chemical Company, Transvaal Inc., and Vertac Inc. Domestic use of silvex is estimated to be about 3.0 million pounds acid equivalent (a.e.) annually. The use of silvex on range and rice comprises almost 7.0% (202,000 pounds a.e.) of the estimated 3.0 million pounds a.e. used annually. Rangeland usage accounts for 6.7% (200,000 pounds a.e.) of this amount, and use on rice accounts for 0.1% (2,000 pounds a.e.). Reliable use information for

orchard uses is not available. Silvex is used on approximately 100,000 acres of rangeland and 2,000 acres of rice annually. This acreage amounts to about 0.01 percent of the total U.S. range acreage and 0.08% of total U.S. rice acreage.

(D) Preliminary Benefits Analysis of Silvex Use on Rangeland*/

(1) Current Use

A wide variety of herbaceous and woody plants grow on rangelands. Several weed species controlled with silvex such as yucca, salt cedar and various oak species, compete with the desired forage species for nutrients, water, space and light. Serious infestations of range weeds can significantly reduce forage available for grazing and thus reduce livestock production on the infested acres.

Silvex is not a major range weed herbicide. Its use has been limited because 2,4,5-T is slightly less expensive and controls a broader spectrum of weeds. Of the 900 million acres of range in the U.S., only about 150,000 acres are treated with silvex annually. Silvex is used primarily to control several oak species, almost exclusively in Texas, New Mexico, Arkansas, Oklahoma, Kansas, and Missouri.

*/ "Rangeland" is defined as land producing forage for animal consumption, harvested by grazing, which is not cultivated, seeded, fertilized, irrigated or treated with pesticides or other such similar practices on an annual basis. Fencerows enclosing range areas are included as part of the range.

This analysis evaluates only aerial application for the control of oak species; such applications are believed to account for the majority of silvex range treatments.

(2) Evaluation of Silvex and Alternatives

Silvex provides good control of several oak species for periods of 5-10 years per application. Several registered chemical alternatives as well as non-chemical controls not analyzed here are effective against one or more of the various range weeds controlled by silvex. However, these chemicals are either not registered for aerial application or are not as effective as silvex for aerial application. For example, 2,4-D and dicamba can be applied aerially, to rangeland, as foliar sprays, but they are relatively ineffective as foliar sprays. The USDA Assessment Team concluded that there is no effective alternative for aerial spray control of oaks. For situations where ground applications, especially spot treatment, are practical, the chemical alternatives may provide effective control, depending on the nature and complexity of the weed problem.

Assuming there are no alternatives to aerially applied silvex for oak control, the yield effects could be severe on acreage currently treated with silvex. Cancellation would leave users with no aerially applied alternative control for oak on these acres. In the post-blackjack oak area, beef

yields could fall from about 28 pounds of beef (live weight) per acre with silvex control to 11 pounds of beef (live weight) per acre for calf production and from about 84 to 45 pounds per acre for steer production. In the sand-shinnery oak area beef yield could decline from about 27 to 14 pounds per acre following a shift from silvex to no-control.

### (3) Economic Impact

Current silvex use appears to be limited primarily to control of various oak species by aerial application. If silvex is cancelled for this use most users will probably choose not to treat large areas formerly treated with silvex because of the absence of a practical and efficacious aerially applied control agent. These users will save from $4.60 to $13.00 per acre in control costs. However, this savings will be offset by lower revenues from lower beef production. Those silvex users who need only spot treatments will be able to obtain at least some control with one or more of the various alternatives now available.*/ The aggregate impact on users will be small because of the small acreage involved.

*/ In addition to the chemical alternatives now registered for range use, several promising herbicides are under review; this analysis does not attempt to estimate the impact of these or other possible new alternatives.

The cancellation of silvex for range weed control will not have significant economic impacts at either the consumer or market levels, since few rangeland acres are currently treated.

## E. Preliminary Benefits Analysis of Silvex Use on Rice

### (1) Current Use

Conditions favorable for growing rice also favor the growth and reproduction of many terrestrial, aquatic, and semi-aquatic weeds. Weeds in rice-growing areas produce an abundance of seed. Once these infest the land, they are difficult to remove and may remain viable in the soil for many years. Rice weeds reduce yields by direct competition and reduce quality through contamination of the harvested rice with weed seeds.

The total estimated direct losses and expenditures for weed control in U.S. rice acreage were $295 million annually for the 1975-1977 period. Weeds reduce the yield and quality of rice in the U.S. by an estimated 15 percent each year on approximately 2.5 million acres. The average loss was valued at about $165 million annually during the 1975-1977 period. The cost of using all herbicides on rice acreage was about $60 million each year during the same period. The

cost of cultural practices (including rotation, land preparation, irrigation, and fertilization) during this period was estimated at $70 million.

Silvex is useful for controlling certain weed pests, but it is injurious to soybeans, an important crop grown in rotation with rice. Silvex is used annually on only 2,000 rice-growing acres, primarily in the lower Mississippi Valley area. The average annual cost of silvex for use on these 2,000 acres for 1975-1977 was approximately $20,000.

Propanil and molinate are the herbicides used most heavily on rice acreage. Combined, these chemicals account for 73% of herbicide acre-applications to rice. Each of these compounds controls some of the weeds controlled by silvex and is likely to be used to replace silvex on some acres now treated with silvex. In addition, 2,4-D, MCPA, bifenox, bentazon and oxadiazon are all currently used on rice and will control various combinations of weeds currently controlled by silvex.

Cultural and mechanical weed control methods used in rice production include summer fallowing, seedbed preparation, crop rotation, special seeding methods, management of irrigation water, cultivation and hand weeding (in sparse weed infestations or in small isolated areas). Although some of these

methods are effective alone on some rice weeds, they are usually combined with chemical herbicide treatments.

(2) Evaluation of Silvex and Alternatives

Silvex controls most broadleaf, aquatic and sedge weeds more effectively than the registered chemical alternatives. However, silvex is very injurious to soybeans, a crop commonly grown in rotation with rice. In addition, silvex is also damaging to cotton, a crop often grown near rice fields.

Propanil is currently applied to about 95% of the rice acres in the lower Mississippi Valley area for early season control of grasses. Propanil selectively kills barnyard grass and many other grass, aquatic, broadleaf and sedge weeds. At maximum label rates (8 lbs/acre/season) propanil alone is said to often fail to provide adequate control of the total weed population. Propanil controls hemp sesbania as effectively as silvex. However, northern jointvetch, ducksalad, and redstem are only partially controlled by propanil. 2,4-D is thought to be comparable to silvex in controlling most broadleaf, aquatic and sedge weeds. It is not as effective as silvex for control of northern jointvetch, and grass weeds. Its use is restricted somewhat by most rice growing states because it is highly injurious to cotton.

Several other herbicides used for control of rice weeds include molinate, MCPA, bifenox, bentazon and oxadiazon.

Molinate does not effectively control hemp sesbania,northern jointvetch, ducksalad, morningglory or redstem. MCPA is not used in the silvex use area since it is relatively ineffective on hemp sesbania, northern jointvetch, and Indian jointvetch. Bifenox, bentazon, and oxadiazon are three new herbicides which are currently used to a limited extent. They are not as effective as silvex on most broadleaf and aquatic weeds.

If silvex were canceled for use on rice, current silvex users probably would turn to alternative chemical controls. 2,4-D and propanil would be the most likely alternatives. Use of these alternatives would cost $7.40 per acre-treatment for 2,4-D and $12.90 per acre-treatment for propanil compared with $9.50 per acre-treatment for silvex. Use of propanil may require a second treatment, thus raising the annual cost of control to $21.80 per acre.

(3) Economic Impact

Silvex is used on only 2,000 rice-growing acres in the U.S. There are several alternative controls available which will function adequately as substitutes for silvex. For these reasons, economic impacts are not expected to be significant at user, consumer or market levels.

## F. Preliminary Benefits Analysis of Silvex Use in Orchards

### (1) Current Use

Silvex is registered for use in preventing preharvest fruit drop of apples and prunes and to increase the yield of pears.

Prunes that drop from trees prematurely cannot be put to any commercial use; apples that drop prematurely can, in some cases, be sold for low-return uses, such as cider.

On apples, silvex applications are generally made using ground equipment a few days before preharvest drop would normally occur. Ordinarily, the application takes place one to two weeks prior to the expected peak of harvest for a given apple variety, and one application controls drop for several weeks (through harvest). Both the timing and application rate of the silvex spray vary according to the cultivar involved.

In addition to minimizing preharvest apple drop and thus increasing aggregate production, silvex also acts to increase the quality of treated fruit. The extra one to two weeks of on-tree ripening of fruit facilitated by the use of silvex tends to improve the color, sugar content and

flavor of the sprayed fruit. These chacteristics are particularly important for fresh-market growers*/.

Silvex use on certain prune varieties in the Northwest is of major importance. Silvex is used in the production of Italian and Early Italian prunes in Oregon, Washington and Idaho. It is believed that silvex applications prevent an average 30% drop rate which would otherwise occur. Silvex is also used on about 700 acres of Anjou pears in Oregon and Washington to increase fruit set in the year following application. The use of silvex for this purpose is not recommended by either state.

Very little quantitative data are available indicating the specific location and/or extent of silvex use on apples or prunes. Information for this analysis was developed through discussions with horticultural specialists. Based on these discussions, it is estimated that approximately 50,000

*/ The majority of the silvex used on apples is probably applied to Red Delicious, the leading apple variety which accounted for 35% of U.S. apple production in 1977. The major Red Delicious producing states, ranked in order of 1977 production, are as follows: Washington (55% of U.S. Red Delicious crop), North Carolina (5%), California (5%), New York (4%), Virginia (4%), Oregon (3%), Michigan (3%), all other states (21%). Small quantities of silvex are also applied to other apple cultivars susceptible to pre-harvest drop, including Jonathan, Rome Beauty, and Stayman.

acres of U.S. apples (10% of U.S. apple acreage) are treated annually with silvex */

Silvex use on prunes is probably restricted to Italian and Early Italian varieties in the Northwest states (Oregon, Washington, Idaho).**/ Recent estimates indicate that about 80% and 100%, respectively, of Washington and Idaho prunes are treated annually with silvex. The extent of silvex use on pears is not known.

(2) Evaluation of Silvex and Alternatives

Currently, two alternatives to silvex are available for use on apples to control preharvest drop. NAA (1-naphthaleneacetic acid) is registered for apples both as an early season thinning agent and as a late season drop control agent. NAA may be applied at the rate of 35 grams of active

*/ The quantity of silvex required to treat 50,000 acres of apples per year was derived based on the following assumptions:

| | |
|---|---|
| material used: | triethanolamine salt of silvex 9.6% equivalent to 6.2% silvex by weight or 8.5 ounces a.i. per gallon. |
| application rate: | 1/4 pint/100 gallons water, 300 gallons water/acre; 3/4 pint/acre x 1.063 ounces a.i./pint = .8 ounces a.i./acre. |
| quantity a.i. used: | 50,000 acres treated x .8 ounces a.i./acre = 2,500 pounds silvex a.i. |

**/ Prune acreage in the affected states is as follows:

| | |
|---|---|
| Oregon | 7,407 acres |
| Washington | 1,940 acres |
| Idaho | 978 acres |
| | 10,325 acres |

ingredient per acre via air or ground to control premature drop; application is made 7 to 14 days before harvest. Alar (succinic acid 2,2-dimethyl hydrazide) is registered for premature drop control at the rate of 6.8 pounds of active ingredient per acre.

Silvex is believed to be effective in preventing apples from dropping prematurely. However, quantitative data indicating the amount of drop actually prevented are not available. It is believed that silvex is a preferable drop control agent in many areas because of its relatively long period of effectiveness (3 to 4 weeks in the East, up to 5 to 6 weeks in the West).

NAA and Alar would have increased usage on apples if silvex were unavailable, but they are thought to be somewhat less effective than silvex. NAA is less effective in the southern apple states and is best suited for varieties other than Red Delicious. NAA's period of effectiveness is shorter than silvex's; a second application may be needed in some cases. Alar is a major alternative to silvex on apples since it is suitable for use on Red Delicious. However, Alar is believed to be less effective than silvex for preharvest drop control and may reduce fruit size. Alar may also cause undesirable changes in fruit shape the following year if applied within 60 days of harvest. Alar may be applied from 10 to 70 days after full bloom but is usually applied from 50 to 70 days following bloom to minimize the adverse fruit size

effects. Thus, use of Alar as a silvex alternative would necessitate a carefully timed spray schedule and would result in somewhat lower preharvest drop effectiveness.

Silvex treatment of prunes is believed to result in retention of approximately 95% of the fruit until harvest. Silvex use on prunes is particularly useful during years when cool but not frosty conditions occur in the spring, resulting in a particularly light fruit set. Without silvex, as much as 50% of the Early Italian prunes and about 22.5% of the standard Italian prunes in the northwest states would be lost due to premature fruit drop.

There are currently no registered alternatives to silvex for premature drop control on prunes. However, 2,4-DP (currently registered for some non-crop applications) reportedly has provided good prune drop control in field tests. There are no registered alternatives for silvex use on pears.

There is no indication that non-chemical controls are effective in preventing preharvest drop of apples or prunes.

### (3) Economic Impact

#### (a) General Considerations

Since apples and prunes are permanent, capital-intensive crops, the loss of silvex would not cause a shift to other

crops but would instead lead to adoption of alternative materials (in the case of apples). Prune growers would be left without a registered preharvest drop control agent and would likely incur some adverse economic impacts. These effects could cause a long-term shift from prunes to other crops.

For apples, it is assumed that all of the estimated acreage currently treated with silvex will be treated with alternatives (Alar and NAA). Due to NAA's shorter effectiveness period relative to silvex's and the disruption in harvesting some NAA-treated orchards which may be expected to occur because of poor weather, labor shortages, and other factors, it is assumed that as much as 25% of the NAA-treated acreage may require an additional application. In addition, since Alar may not provide a level of preharvest drop control equal to that provided by NAA or silvex, an assumption was made that an additional preharvest application of NAA may be required on as much as 25% of the Alar-treated acreage to provide a level of preharvest drop control equal to that provide by silvex.

Although Alar is significantly more expensive to use than NAA, its beneficial effects other than drop control would tend to encourage usage.*/ In the absence of a precise method to

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*/ Alar promotes intensification of color in red cultivars, reduces incidence of water core and vegetative growth, and promotes flower bed formation.

determine the relative substitution ratio of Alar and NAA for silvex, this analysis assumes an equal distribution of the two alternatives.

For prunes, the analysis assumes that, as a worst case, the unavailability of silvex will result in an incremental loss in annual production of 30% of the Italian prune crop in Oregon, Washington, and Idaho. This assumption is based on a "normal" (with silvex) preharvest drop of 5% and an "abnormal" (without silvex) loss rate of 35% due to unchecked mid-June drop.

(b) User Impacts

The unavailability of silvex will increase grower preharvest drop control costs for apple growers by about $5.00 (using NAA) or $35.00 (using Alar) per acre-treatment. Although the use of Alar significantly increases preharvest drop control costs, it also provides additional benefits: Alar, like silvex, enhances the quality of the fruit and promotes early-season marketability. Thus, it is reasonable to conclude that Alar would be used by growers as a silvex alternative.

The use of Alar and NAA as silvex alternatives may increase apple grower production costs by as much as about $1 million per year or an average of $20 per affected acre. Since apple production (growing + harvesting) costs range from about $700 - $950 per acre, the projected increase in drop control costs would increase total production costs by from 2-3% per year on the affected acres. Assuming that 50,000 acres of apples are currently treated with silvex per year, the cost impact would occur on about 10% of U.S. apple producers.

Growers of Italian-variety prunes would incur major adverse income impacts if silvex is unavailable. Prune grower impacts were derived as follows:*/

with silvex:

| | |
|---|---|
| average production per acre: | 5 tons |
| market: | fresh |
| grower price per ton: | $155 |
| average gross revenue per acre: | $775 |
| average production costs per acre: | $504 |
| net revenue per acre: | $271 |

*/This analysis is based on a 3-year (1975-1977) average price for fresh prunes grown in Oregon. Production averages and costs are based on a 1974 budget for Italian prunes grown in the Willamette Valley of Oregon. Costs were adjusted upward by 3% per year to account for inflation during the 1974-1979 period. Costs without silvex were reduced by $10 per acre to account for the lack of treatment expense if silvex is unavailable (treatment costs using silvex on prunes assumed to be the same as those for apples).

without silvex:

| | |
|---|---|
| average production per acre: | 3.5 tons |
| market: | fresh |
| grower price per ton: | $155 |
| average gross revenue per acre: | $543 |
| average production costs per acre: | $494 |
| net revenue per acre: | $49 |

Reduction in per acre net revenues (from $271 to $49) of this magnitude (82%) due to the lack of preharvest drop control amounts to an aggregate revenue loss of about $1.8 million per year. Revenue losses of this magnitude (assuming the continuing lack of an alternative for silvex) would probably lead growers gradually to replace the Italian prune cultivars with other crops; completion of this process would take several years following cancellation of silvex. Assuming growers would replant the affected acres with other tree fruits, they would incur establishment costs ranging from about $3,000 to $5,000 per acre in current dollars.

Sufficient information to evaluate producer the impact of a cancellation of silvex for use on pears is not available.

(c) Consumer Impacts

The cost increases projected for affected apple growers ($1 million/year) may be absorbed at the grower level since only about 10% of U.S. growers would be directly affected by a restriction on silvex. If the costs were passed on to consumers, the retail price effects would be negligible.

Retail prices for prunes would be expected to increase as supplies dropped, but the extent of such an increase cannot be reliably determined with available data. The estimated 30% reduction in production of Italian prune cultivars in the Northwest would result in production losses of 12,390 tons (8,260 affected acres X 1.5 ton loss per acre), as much as 40% of U.S. fresh prune production (30,700 tons in 1977) and 6% of total U.S. prune production (fresh, processed, and dried prunes; 215,000 tons).

Sufficient information to evaluate the consumer impact of cancellation of silvex for use on pears is not available.

(d) Limitations of Analysis

The foregoing analysis has the following limitations in addition to the limitations common to the economic analysis of the range, rice, non-crop and sugarcane uses of silvex:

(1) Extremely little data are available concerning the extent of silvex use on apples, prunes or pears; and

(2) Information provided by horticultural specialists was used in lieu of quantitative data concerning extent of silvex use and crop yields without silvex.

## G. Preliminary Benefits Analysis of Silvex Use on Sugarcane

### (1) Current Use of Silvex and Alternatives

Silvex is used in Louisiana and Florida sugarcane fields to control various weeds which have developed resistance to 2,4-D. In Louisiana, these weeds include goldenrod, aster, alligator weed, and various winter annual broadleaves. In Florida, the primary target weed pests are dogfennel, ground cherry, nightshade, and ragweed.

In Louisiana, the principal alternative to silvex is a combination product, consisting of dicamba (1 pound per gallon) and 2,4-D (3 pounds per gallon). Florida does not now have a registration for this combination product. Therefore, 2,4-D is the only currently available alternative to silvex in Florida.

Silvex use has decreased markedly in Louisiana in recent years (Table 1). The decreased levels of silvex in Louisiana have been attributed to shortages of silvex and the lower application costs of the 2,4-D-dicamba combination product. Some of the Louisiana cane growers are likely to shift back from the 2,4-D-dicamba combination product to silvex because of yield losses reportedly experienced with the

combination product. In addition, some sugarcane acreage is shifting to soybean production in Louisiana. The 2,4-D-dicamba combination product cannot be used on sugarcane adjacent to soybean fields because it is phytotoxic to soybeans. This is expected to further increase silvex use.

Table 1. Silvex Use on Sugarcane Grown for Sugar and Seed, 1978

| Location | 1976 | | 1977 | | 1978 | |
|---|---|---|---|---|---|---|
| | Harvested | Treated | Harvested | Treated | Harvested | Treated |
| | 1,000 acres | | | | | |
| Florida | 298.0 | 30.0 | 300.0 | 30.0 | 310.0 | 30.0 |
| Hawaii | 106.7 | 0 | 103.5 | 0 | 108.3 | 0 |
| Louisiana | 315.0 | 200.0 | 322.0 | 170.0 | 300.0 | 85.0 |
| Texas | 27.3 | 0 | 33.9 | 0 | 34.1 | 0 |
| U.S.* | 747.0 | 230.0 | 759.4 | 200.0 | 752.4 | 115.0 |

*/ Puerto Rico is not included, but silvex use in that location is negligible.

Expert opinion suggests that sugarcane yield loss of less than 10% would occur in Louisiana if the 2,4-D-dicamba combination product were substituted for silvex. In Florida, yield losses of up to a maximum of 30% could occur if 2,4-D were substituted for silvex.

### (2) Economic Impact

#### (a) User Impacts

The economic impacts of the cancellation of silvex to sugarcane producers include changes in weed control costs and potential yield losses in Louisiana and Florida. Herbicide costs would decline in both Louisiana and Florida.

In Louisiana, the substitution of the 2,4-D-dicamba combination product for silvex would reduce chemical costs from $5.00 to $3.50 per acre. In Florida, the substitution of 2,4-D for silvex would reduce chemical costs from about $5.00 to $4.00 per acre. The aggregate decrease in weed control costs is estimated at approximately $260,000 annually (assumes the 1976-1978 average of silvex treated acres).

This saving in herbicide costs will be offset by yield losses and therefore gross revenue losses to sugarcane producers. Yield losses of 25% are expected to result in a loss in value of production of approximately $4.0 million in Florida. Yield losses ranging from 0 to 10 percent could result in losses in value of production as high as $6.3 million in Louisiana.

Aggregate economic impacts to the users of silvex are estimated at approximately $3.8-10.1 million annually. Aggregate losses of $4.0 million ($130 per silvex treated acre) are expected in Florida. In Louisiana, estimated economic impacts range from gains of $0.2 million to losses of $6.1 million (economic impacts ranging from a gain of approximately $1.50 per acre to losses of $40 per silvex treated acre), depending on the level of yield loss (0-10%).

(b) Market and Consumer Impacts

The 1976-1978 average annual sugarcane production exceeded 26 million tons. Production losses of 596,580

tons following a silvex cancellation (assuming a 25% yield loss and a 10% yield loss on silvex treated acreage in Florida and Louisiana, respectively) is approximately 2% of the total U.S. cane production. 1978 U.S. - produced cane sugar represented less than 18% of the U.S. sugar supply. Therefore, the cancellation of silvex is not anticipated to result in measurable sugar price changes at the market or consumer level. Since cane can be sold for either sugar or seed at approximately the same price, measurable price changes are not anticipated in the seed cane market.

## H. Preliminary Benefits Analysis of Silvex use on Non-crop Areas*/

### (1) Current Use

Silvex is registered for control of many broadleaved and herbaceous weeds**/ in a variety of urban and rural non-crop areas such as fencerows, storage areas and parking lots. Silvex is used because of its relatively low cost, the broad spectrum of weeds it controls and its selectivity for control of undesirable plant species. Generally, the weed control achieved on these sites does not involve major economic benefits.

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*/"Non-crop areas" includes: fencerows, hedgerows, fences (not otherwise included among previously suspended uses, e.g. rights-of-way, pasture); industrial sites or buildings (not other wise included among previously suspended uses, e.g. rights-of-way, commercial/ornamental turf); storage areas, waste areas, vacant and parking lots.

**/ Pest weeds include the following broadleaved plants--pigweed, ragweed, lambsquarters horsenettle, cocklebur, morningglory--and woody plants--oaks, poplar, cottonwood, wild cherry, blackberry, honeysuckle, poison ivy, and wild grape.

Recent data on the usage of silvex for noncrop areas is not available. However, a 1974 publication reported that 60,000 lbs. a.e. of silvex were used for general maintenance on 30,000 acres of grounds at industrial, commercial and institutional sites. This area is a small proportion (1.7%) of the 1.8 million acres treated with herbicides for grounds maintenance.

Both chemical and non-chemical controls are available as alternatives to silvex. Chemical alternatives include herbicides, such as 2,4-D, picloram, dicamba, AMS, or amitrole. Probably the most comparable alternatives are combination products, such as 2,4-D + picloram or 2,4-D + dicamba. Soil sterilants, such as sodium borate or sodium chlorate, control weeds that silvex controls but are effective primarily as preventive controls. Subsequent infestations sometimes may require follow-up treatments with conventional herbicides.

Mechanical methods of control, such as mowing or shearing, or manual methods could also serve as alternatives to silvex.

(2) Evaluation of Silvex and Alternatives

The efficacy of the alternatives compared with that of silvex is not known. The spectrum of weeds controlled will differ from that of silvex for the individual active ingredients.

However, silvex's weed spectrum may be approximated fairly closely by using a combination product or by using multiple applications of different herbicides.

Generally, no more than one treatment with silvex is needed annually to achieve control of the problem weeds. In some circumstances, one treatment will give control for up to four years. Combination products with 2,4-D and picloram will give control for a length of time comparable to that provided by silvex, but other herbicides, such as 2,4-D alone or amitrole, may require more than one treatment annually. The length of control with mechanical or manual means is unknown.

(3) Economic Impact

In general, effective alternatives to silvex exist for non-crop sites. Effective alternative combination products which provide equally long term control are registered. Impacts on users of silvex will be felt in the form of increased control costs for the combination alternatives.

Cancellation for the non-crop use of silvex is likely to cause little, if any, economic impact at the market and consumer levels. Effective alternatives are available, and the economic value of weed control on non-crop sites is very small.

## IV. REGULATORY DETERMINATION

Section 6(b) of FIFRA provides that the Agency may move to cancel the registration of a pesticide "[i]f it appears to the Administrator that a pesticide... when used in accordance with widespread and commonly recognized practice, generally causes unreasonable adverse effects on the environment." In effect, this "unreasonable adverse effects" standard requires a finding that the risks of each use of the pesticide exceed the benefits of use, when the pesticide is used in accordance with the terms and conditions of registration or in accordance with widespread and commonly recognized practice.

Upon concluding the RPAR review of a pesticide, if the Administrator determines that the risks of use outweigh the benefits of use, he may issue a notice of intent to cancel or deny registration, pursuant to section 6(b)(1) or Section 3(c)(6). If on the other hand, the Administrator determines that the use of the pesticide appears to cause unreasonable adverse effects on the environment, that there are uncertainties in the data relating to the risks and benefits of these uses, and that additional data on the risks and benefits will assist the Agency in determining whether or not to cancel the pesticide, he may issue a notice of intent

to hold a hearing pursuant to section 6(b)(2) of FIFRA to determine whether the registration should be cancelled or applications for registration denied. In the present instance, relative to the orchard, sugarcane, rice, rangeland, and other non-suspended uses of silvex, a determination to issue a notice of intent to hold a hearing pursuant to section 6 (b) (2) is the prudent course of action.

The foregoing review indicates that exposure to silvex and/or TCDD may result in significant adverse effects on exposed populations. Agency analysis shows that the rice, sugarcane, orchard, rangeland and non-crop uses of silvex create opportunities for direct and indirect exposure to humans through aerial drift and/or related contamination of water, food, and environmental media. Even without quantitative data*/ on levels and routes of exposure, it is clear that any exposure, particularly in the case of TCDD, whether from a single source or cumulative sources, appears to pose risks of oncogenic, fetotoxic and/or teratogenic effects in the exposed populations. Additional data on routes of exposure, relative contribution from the several uses of the pesticide in areas of multiple use, and mechanisms for reducing exposure would assist the Agency in assessing with greater precision the degree of hazard associated with the non-suspended uses of silvex.

*/ Because of the many varied and widespread uses of silvex silvex, it is often difficult, or impossible, to ascribe residue to any one particular use.

The Agency estimates that cancelling the use of silvex on range would have only a slight impact on farm income and beef prices. A number of chemical and non-chemical alternatives to silvex are available to control the various weeds not treated with silvex. The availability of alternatives and the very small quantity of acreage involved indicate that no unreasonable economic impacts will be felt at either the consumer or market levels if silvex is cancelled for this use. At the user level, some increased control costs and decreased production may be experienced by a small number of users. In some locations, the impact on users may be significant.

There are several chemical alternatives which are likely to be employed as substitutes for silvex use on rice. These compounds may be somewhat less effective and/or more expensive than silvex for use on some weeds. Therefore, some degree of increased control costs and reduced production may be experienced on some acres as a result of the substitution of these materials for silvex. At the user level the increased costs and reduced production will not be large. However, because silvex is used on little rice-growing acreage, the economic impact at the user, the consumer and market levels will be quite small if silvex were cancelled for this use.

NAA (1-Napthnleneactic acid) and Alar (Succinic acid 2,2-dimethyl hydrazine) probably would be used by apple growers as chemical alternatives to silvex. Some acres would require two annual treatments with these materials for effective control, whereas use of silvex requires only one treatment. The economic impact is likely to consist of higher costs to apple growers resulting from the use of these alternatives equivalent to a total of approximately $1 million per year or $20 per average affected acre. The higher drop control costs will increase production costs by 2-3% per year. Apple production and quality should not be significantly affected. Prune growers currently using silvex would suffer significant income reductions if silvex is unavailable. Italian and early Italian prunes in the Northwest states drop an average of 35% of the fruit if silvex is not applied in mid-June to control summer drop. Since there are no registered alternatives to silvex, production and revenues would decline sharply on the affected acres. Revenue reductions totaling $1.8 million annually, or $222 per affected acre, are projected to occur, assuming no alternatives to silvex are developed to prevent preharvest drop. Continued losses of this magnitude would eventually cause growers to push out the estimated 8,300 acres of prunes for which preharvest drop problems are significant.

The retail price of apples and pears would be unaffected by cancellation of silvex for orchard use. The retail price of prunes would increase by an undetermined amount.

The dicamba - 2,4-D combination alternative is likely to be the most commonly used substitute if silvex is cancelled for use on sugarcane. Economic impacts arising from a cancellation of silvex would result from reduced yield, which would occur because the alternative is less effective than silvex. A worst-case estimate indicates a 2% loss of overall U.S. sugarcane production could be experienced. Since U.S. produced cane sugar comprises only 18% of the total U.S. sugar supply, no measurable sugar price changes are likely to occur at either the market or consumer levels.

Both chemical and non-chemical controls are available as alternatives to silvex for use on non-crop areas. The chemical alternatives include 2,4-D, picloram, dicamba, AMS, amitrole. Non-chemical controls include mechanical methods such as mowing, shearing, and manual methods. The relative efficacy of the alternatives in comparsion to silvex is unknown. However, it is believed that one or a combination of the chemical alternatives will be widely substituted for silvex and will provide equivalent control.

The economic impact of cancelling silvex for non-crop uses is not likely to be significant at user, consumer or market levels; little acreage is treated with silvex, and effective alternatives are readily available. In addition, weed control on these acres does not confer significant economic benefits.

While the benefits of silvex use on rangeland, rice, sugarcane, orchards and non-crop areas are in some respects not insubstantial, these benefits do not, in the Agency's judgement, appear to offset the risks which these uses pose to man and the environment. Accordingly, the rangeland, rice, sugarcane, orchard and non-crop uses of silvex appear generally to cause unreasonable adverse effects on the environment.

Because of uncertainties and incomplete data relating to some of the factors which enter into the risk-benefit analysis, the Agency is seeking additional data on these silvex uses before making a final regulatory determination. FIFRA provides for the resolution of such questions through public hearings held pursuant to section 6 (b)(2). Through the hearing process, the uncertain areas become subject to public debate, new information is collected, and the Agency is able to arrive at an informed decision.

Moreover, in this case, a section 6(b)(2) hearing is particularly appropriate because section 6(b)(1) hearings on the suspended uses of silvex are currently in progress. Because many of the issues to be reviewed and resolved are generic to both the suspended and the non-suspended silvex uses, information and approaches developed for one category may shed additional light on the other category. Thus, a section 6(b)(2) hearing merged with the ongoing 6(b)(1) hearing would allow consolidated debate and disposition regarding all silvex uses.

References for the Silvex Position Document

Akesson, N.B., and W.E. Yates. Undated. Pesticides in the air environment. (Unpublished.) [Cited in Position Document 1 as Ref. #168.]

Albert, R.E., R.E.Train, and E. Anderson. 1977. Rationale Developed by the Environmental Protection Agency for the Assessment of Carcinogenic Risks. J. Natl. Cancer Inst. 58(2):1537-1541.

Allen, J.R., D.A. Barsotti, J.P. Van Miller, L.J. Abrahamson and J.J. Lalich (1977). Monphological changes in Monkeys Consuming a Diet Containing Low-levels of 2,3,7,8-Tetrachloro-Libenro-p-Dioxin Food Cosmet. Toxicol. 15:401-410.

Altom, J.D. and J.F. Stritzke, 1973. Degradation of dicamba, picloram, and four phenoxy herbicides in soils. Weed Sci. 21, (6), 556-560.

Bailey, G.W., A.D. Thruston, Jr. J.D. Pope, Jr., and D.R. Cochrane. 1970. The degradation kinetics of an ester of silvex and the persistence of silvex in water and sediment. Weed Sci. 18(3):413:418.

Barsotti, D.A., J.J. Abrahamson, and J.R. Allen. 1979 Hormononal Alteration in female rhesus monkeys fed on a diet of 2,3,7,8 tetrachloro-dibenzo-p-dioxin. Bal. Environ. Contam. Toxicol. 21:463-469.

Bauer, H., K.H. Schultz, and U. Spiegelberg. 1961. Occupational intoxication in the production of chlorinated phenol compounds. (transl. from German.) Arch. Indust. path. Indust. Hyg. 18:538-555.

Baughman, R., and M. Meselson. 1973. An analytical method for detecting TCDD (dioxin): levels of TCDD in samples from Vietnam. Environ. Health perspec. 5:27-34.

Brown, E., and Y.A. Nishloka. 1967. Pesticides in selected western streams-a contribution to the National Program. Pest. Mon. J. 1(2):38-46.

Burger, E.J., Jr. 1973. summary: conference on dibenzodioxins and dibenzofurans, National Institute of Environmental Health Services, April 2-3, 1973. Environ. Health Prespec. 5-279-282.

Buser, H. 1975. Polychlorinated dibenzo-p-dioxins: separation and identification of isomers by gas chromatography mass spectrometry. J. Chromatog. 114:95-108.

Butler, P.A., 1965. Commercial fishery investigations, p. 65-77. In Effects of Pesticides on Fish & Wildlife, 1964 Research Findings of the Fish and Wildlife Service. U.S. Fish & Wildlife Service, Circ. 226.

Clark, D.E., J.S. Palmer, R.D. Radeleff, H.R. Crookshank, and F.M. Farr. 1975. Residues of Chlorophenoxy Acid Herbicides and their Phenolic Metabolites in Tissues of Sheep and Cattle. J. Agr. Food Chem. 23(3):571-578.

Cochrane, W.P., Greenhalgh, R., Looney, N.E. Residues in Apples Sprayed with Fenoprop Canadian Journal of Plant Science 56:207-210 (Jan. 76).

Corneliussen, P.E. 1970. Pesticide Residues in Total Diet Samples (V). Pest. Mon. J. 4(3):89-105.

Corneliussen, P.E. 1972. Pesticide Residues in Total Diet Samples (VI). Pest Mon. J. 5(4):313-341.

Courtney, K.D., and J.A. Moore. 1971. Teratology studies with 2,4,5-trichlorophenoxyacetic acid and 2,3,7,8-tetrachlorodibenzo-p-dioxin. Toxicol. Appl. Pharmacol. 20:396-403. [Cited in Position Document 1 as Ref. #128.]

Courtney, K.D. 1976. Mouse teratology studies with chlorodibenzo-p-dioxins. Bull. Environ. Contam. Toxicol. 16:(6)674-681.

Crosby, P.G. and H.O. Tutass. 1966. Photodecomposition of 2,4-dichlorophenoxacetic acid. J. Agr. Food Chem. 14:596-599.

Dow Chemical USA. 1977. Preliminary assessment of chronic toxicity study and three-generation reproduction study of 2,3,7,8-tetrachlorodibenzo-p-dioxin. The Dow Chemical company, Midland, Michigan (unpublished - CONFIDENTIAL). [Cited in Position Document 1 as Ref. #110.].

Duggan, R.E., H.C. Barry, and L.Y. Johnson, 1967. Pesticide Residues in Total Diet Samples (III) Pest. Mon. J. 1(2):2-12.

EPA. U.S. Environmental Protection Agency. 1978. Rebuttable Presumption Against Registration and Continued Registration of Pesticide Products Containing 2,4,5-T. Fed. Reg. 43(78):17116-17157.

EPA. U.S. Environmental Protection Agency. 1979. Decision and emergency suspension order suspending registrations for the forest, rights-of-way, and pasture uses of 2,4,5-T. Fed. Reg. 44(52):15874-15897.

Firestone, D.J. Ress, N.L. Brown, R. P. Barron, and J.N. Damico. 1972. Industrial chemicals: determination of polychlorodibenzo-p-dioxins and related compounds in commercial chlorophenols. J. Ass. offic. Anal. Chem. 55(1):85-92.

Fishbein, L. 1973. Mutagens and potential mutagens in the biosphere: I. DDT and its metabolities, polychlorinated byphenyis, chlorodioxins, polycyclic aromatic hydrocarbons, haloethers. Sci. Tox. Environ., 4:305-340.

Frank, P.A., and R.D. Comes. 1967. Herbicidal residues in pond water and hydrosoil. Weeds 15(3):210-213.

Grieg, J.B. G. Jones, W.H. Butler, and J.M. Barnes. 1973. Toxic effects of 2,3,7,8-tetrachlorodibenzo-p-dioxin. Fd. Cosmet. Toxicol. 11:585-595.

Hansen, J.R., and K.P. Buchholtz. 1952. Inactivation of 2,4-D by Riboflavin in Light. Weeds 1:237-242.

Harp, G.L. and R.S. Campbell. 1964. Effects of the Herbicide Silvex on Benthos of a Farm Pond. J. Wildl. Management. 28(2):308-317.

Harvey, R.G. 1973. Dioxins, a contaminant in 2,4,5-T. Presented at Wisconsin Pest Control Conference with Industry: January 17, 1973 (unpublished).

Heath, R.G., J.W. Spann, E.F. Hill, and J.F. Kreitzer. 1972. Comparative Dietary Toxicities of Pesticides to Birds. Burr. Sport Fish. Wildl., Spec. Sci. Rep. - Wildl. 152, 57p.

Helling, C.S., A.R. Isensee, E.A. Woolson, P.D.,J. Ensor, G.E. Jones, J.R. Plimmer, and P.C. Kearney. 1973. Chlorodioxins in pesticides, soils, and plants. J. Environ. Quality 2(2):171-178.

Higginbotham, G.R., A. Huang, D. Firestone, J. Verrett, J. Ress, and A.D. Campbell. 1968. Chemical and toxicological evaluations of isolated and synthetic chloro derivatives of dibenzo-p-dioxin. Nature 220:702-703.

Hussain, S.L., Ehrenberg, G. Lofroth, and T. Gejvall. 1972. Mugatenic effects of TCDD on bacterial systems. Ambio 1(1):32-33. (Dow chemical Co. FIFRA Docket No. 295).

Innes, J.R.M., B.M. Ulland, M.G. Valerio, L. Petrucelli, L. Fishbein, E.R. Hart, A.J. Pallotta, R.R. Bates, H.L. Falk, J.J. Gart, M. Klein, I. Mitchell, and J. Peters. 1969. Bioassay of pesticides and industrial chemicals for tumorigenicity in mice: a preliminary note. J. Natl. Cancer Inst. 42:1101-1114. [Cited in Position Document 1 as Ref. #107.]

Isensee, A.R., and G.E. Jones. 1971. Absorption and translocation of root and foliage applied 2,4-dichlorophenol. 2,7-dichlorodibenzo-p-dioxin and 2,3,7,8-tetrachlorodibenzo-p-dioxin. J. Agr. Food Chem. 19(6):1210-1214.

Isensee, A.R., and G.E. Jones. 1975. Distribution of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in aquatic model ecosystem. Environ. Sci. Technol. 9(7):668-672.

Jones, E.L., and H. Krizek. 1962. A technical for testing acnegenic potency in rabbits, applied to the potent acnegen, 2,3,7,8-tetrachlorodibenzo-p-dioxin. J. Invest. Dermatol, 39:511-517.

Kearney, P.C., E.A. Woolson, and C.P. Ellington, Jr. 1972. Persistence and metbolism of chlordioxins in soils. Environ. Sci. Technol. 6(12):1017-1029.

Kearney, P.C., E.A., Woolson, A.R. Isensee, and C.S. Helling. 1973. Tetrachlorodibenzodioxin in the environment: sources, fate, and decontamination. Environ. Health Perspec. 5:273-277.

Khera, K.S., and J.A. Ruddick. 1973. Polychlorodibenzo-p-dioxins: perinatal effects and the dominant lethal test in Wistar rats. Pages 70-84 in E.A. Blair, ed., Chlorodioxins--origin and fate. Advances in Chemistry Series, No. 120. Am. Chem. Soc., Washington, D.C. [Cited in Position Document 1 as Ref. #6.]

Kimbrough. G.D. 1972. Toxicity of chlorinated hydrocarbons and related compounds: a review including chlorinated dibenzodioxins and chlorinated dibenzofurans. Arch. Environ. health 25(1):125-131.

Kimmig. J., and K.H. schultz. 1957. Occupational acne (chlorache) caused by chlorinated aromatic cyclic ether. (Tansl. from German.) Dermatologica, 115:540-546.

Lavy, T.L. 1979. Measurement of 2,4,5-T Exposure of Forest Workers, August 30 to October 3, 1978. University of Arkansas (unpublished). Dow Rebuttal Document 30000/26-1023H.

Leidy, R.B., M.D. Jackson, W.A. Skroch, and T.J. Sheets. 1975. Residue Studies with Silvex in Apples. Bull. Environ. Contam. Tox. 13(3), 338-341.

Leng, M.L. 1972. Residues in milk and meat and safety to livestock from the use of phenoxy herbicides in pasture and rangeland. Down to Earth. (28):12-20.

Letter. 1979. [Untitled], dated January 29, 1979. From W.P. McNulty, Oregon Regional Primate Research Center, to Mr. Mike Dellarco, Office of Pesticide Programs.

MacRae, I.C. and M. Alexander. 1964. Use of Gas Chromatography for the Demonstration of a Pathway of Phenoxy Herbicide Degradation. Agr. J. 56:72-91.

MacRae, I.C. and M. Alexander. 1965. Microbial Degradation of Selection Herbicides in Soil. J. Agr. Food Chem. 13:72-76.

Manigold, D.B., and J.A. Schuize. 1969. Pesticides in selected western steams-a progress report. pest. Mon. J. 3(2):124-135.

Manske, D.D. and P.E. Corneliussen. 1974. Pesticide Residue in Total Diet Samples. (VII). Pest. Mon. J. 8(2):110-124.

Martin, R.J. and R.E. Duggan. 1968. Pesticide Residues in Total Diet Samples (III). Pest. Mon. J. 8(2):110-124).

Matsumura, F., and H.J. Benzet. 1973. Studies on the bioaccumulation and microbial degradation of 2,3,7,8-tetrachlorodibenzo-p-dioxin. Environ. Health Perspec. 5:253-258.

Maybank, J., K. Yoshida, R. Grover. 1978. Spray drift from agricultural pesticide applications. Journal of Air Pollution Control Association. 28:1009-1014.

McNulty. 1979. Personal Communication.

Melster, R.T., ed. 1977. Farm chemicals handbook. Melster Publishing Co., Willoughby, Ohio.

Memo: 1977a Environmental monitoring data on 2,4,5-T, 2,4,5-TP (silvex), erbon, and ronnel, dated July 6, 1977. From Federick W. Kutz, Acting Chief, Ecological Monitoring Branch to Harvey L. Warnick, Project Manager, Office of Special Pesticide Reviews.

Memo: 1977b Rationale for 0.1 ppm limit for tetrachloro-dibenzo-p-dioxin in hexachlorophene, dated April 19, 1977. From Orville E. Paynter, Chief, Toxicology Branch, to Mary Reece, OSPR.

Memo: 1979a Silvex Production, dated June 25, 1979. From Michael J. Dellarco, Project Manager, Office of Special Pesticide Reviews, to Edwin L. Johnson, Deputy Assistant Administrator, Office of Pesticide Programs. (Confidential)

Memo. 1979b. TADP review at University of Wisconsin, TCDD in rats, dated February 8, 1979. From H.W. Spencer and W. Woodrow to D. Reisa and H. Warnick.

Memo: 1979c TCDD toxicity in various animal models, dated March 30, 1979. From H.W. Spencer, Toxicology Branch to Patricia Roberts, Office of General Counsel.

Memo. 1979d. Response to rebuttal comments on risk assessment on 2,4,5-trichloropenoxy [sic] acetic acid (2,4,5-T) and 2,3,7,8-tetrachloro-dibenzo-p-dioxin (TCDD), dated April 4, 1979. From Roy E. Albert, Chairman, Carcinogen Assessment Group, to Harvey L. Warnick, Project Manager, Special Pesticide Review Division.

Memo. 1979e. Carcinogen Assessment Group's risk assessment on 2,4,5-trichlorophenoxy acetic acid (2,4,5-T), and 2,3,7,8-tetrachloro-dibenzo-p-dioxin (TCDD), dated February 23, 1979. From Elizabeth L. Anderson, Executive Director, Carcinogen Assessment Group, to Harvey L. Warnick, Project Manager, Special Pesticide Review Division.

Milnes, M.H. 1971. formation of 2,4,7,8-tetrachloro-dibenzodioxin by thermal deccmposition of sodium 2,4,5-trichorophenate. Nature 232:395-398.
Moore, J.A., B.N. Gupta, J.G. Zinkle, and J.G. Vos. 1973. Postnatal effects of maternal exposure to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Environ. Health Perspec. 5:81-85. [Cited in Position Document 1 as Ref. #174.]

Morton, H.L., J.O. Moffett, and R.H. MacDonald. 1972. Toxicity of Herbicides to Newly Emerged Honey Bees. Environ. Entomol. 1(1):102-104.

Muelder, W.W., and L.A. Shadoff. 1973. The preparation of uniformly labeled $^{14}C$-2,7-dichlorodibenzo-p-dioxin and $^{14}C$-2,3,7,8-tetrachlorodibenzo-p-dioxin. Pages 1-6 in E.A. Blair, ed., Chlorodioxins-origin and fate. Advances in Chemistry Series, No. 120. Am. Chem. Soc., Washington, D.C.

National Interim Primary Drinking Water Regulation. 1977. U.S. Govt. Printing Office 0-255-006.

Neubert, D., and I. Dillmann. 1972. Embryotoxic effects in mice treated with 2,4,5-trichlorophenoxyacetic acid and 2,3,7,8-tetrachlorodibenzo-p-dioxin. Naunyn-schmiedeberg's Arch. Parmacol. 272:243.

Norris, L.A. and R.A. Miller. 1974. The Toxicity of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in Guppies (Poecilia reticulatus Peters). Bull. Environ. Contam. Tox. 12(1):76-80.
Packer, K. 1975. Nanogen Index. A Dictionary of Pesticides and Chemical Pollutants. Nonogens International (Freedom, Calif.).

Poland, A., and A. Kende, 19776. 2,3,7,8-tetrachloro-dibenzo-p-dioxin: environmental contaminant and molecular probe. Fed. Proc. 35:2404-2411.

Raw, G.R., ed. 1970. CIPAC handbook, Vol. I, analysis of technical and formulated pesticides. Collab., Intntl. Pest. anal. Counsil Ltd. Herfordshire, England.

Report to the Advisory Committee on 2,4,5-T to the Administrator of the Environmental Protection Agency. May 7, 1971.

Report on 2,4,5-T: a report of the Panel on Herbicides of the President's Science Advisory Committee. 1971. Executive Office of the President, Office of Science and Technology, Washington, D.C.

Sanders, H.O. 1979. Toxicities of Some Herbicides to Six Species of Freshwater Cuestaceans. J. Wat. Poll. Contr. Fed. 42(8):1544-1550.

Schantz, S.L., D.A. Barsotti and J.R. Allen. 1979. *Toxicological Effects Produced in Non-humans Primates Chromologically Exposed to Fifty Parts Per Trillion TCDD. Abstract of a Paper Presented at the 18th Annual Meeting of the Society of Toxicology, New Orleans (March 11-15).

Schultz, K.H. 2968. On the clinical aspects and etiology of chloracne. (Transl. from German) Arbeltsmedizin Sozlalmedizin Arbeltshygiene 3(2):25-29.

Schwetz, B.A., J.M. Norris, G.L. Sparschu, V.K. Rowe, P.J. Gehring, J.L. Emerson, and C.G. Gerbig. 1973. Toxicology of clorinated dibenzo-p-dioxins. Environ. health Perspec. 5:87-99.

Smith, F.A., B.Z. Schwets, and K.D. Nitschke. 1976. tetratogenicity of 2,3,7,8-tetrachlorodibenzy-p-dioxin in CF-1 mice. Toxicol. Appl. Pharmacol. 38:517:523.

Sparschu, G.L., F.L. Dunn, and V.K. Rowe. 1971. Study of the teratogenicity of 2,3,7,8-tertrachlorodibenzo-p-dioxin in the rat. Fd. Cosmet. Toxicol. 9:405-412. [Cited in Position Document 1 as Reb. #129.]

Spencer, H.W. and W. Woddraw. 1979. TADP review at University of Wisconsin, TCDD in Rats. EPA Memorandum to D. Reisa and H. Warnick (February 8).

Stickel, L. 1964. Wildlife Studies. Patuxent Wildlife Research Center, p. 77-115. In: Pesticide-wildlife Studies, 1963. A Review of Fish and Wildlife Service Investigations During the Calendar Year. Fish. Wildl. Serv., Circ. 199.

Thomas, W.T. 1975. Agricultural chemicals: book II herbicides. Thomson Publications, Indianapolis, Indiana.

Tucker, R.K. and D.G. Crabtree. 1970. Handbook of Toxicity of Pesticides to Wildlife. Fish Wildl. Serv., Bur. Sport Fish. Wildl., Res. Publ. 84. 131 p.

U.S. Department of Agriculture 1968.. PR Notice 68-1. Looseleaf pub. 5 pp.

U.S. Department of Agriculture.1968. PR Notice 68-2. Looseleaf pub. 5 pp.

U.S. Department of Agriculture.1968. PR Notice 68-9. Looseleaf pub. 5 pp.

U.S. Department of Agriculture.1969. PR Notice 69-1. Looseleaf pub. 6 pp.

U.S. Department of Agriculture.1969. PR Notice 69-2. Looseleaf pub. 4 pp.

U.S. Department of Agriculture 1969. PR Notice 69-3. Looseleaf pub. 3 pp.

U.S. Department of Agriculture 1970. PR Notice 70-8. Looseleaf pub. 1 pp.

U.S. Department of Agriculture 1970. PR Notice 70-10. Looseleaf pub. 2 pp.

U.S. Department of Agriculture 1970. PR Notice 70-11. Looseleaf pub. 2 pp.

U.S. Department of Agriculture 1970. PR Notice 70-13. Looseleaf pub. 2 pp.

U.S. Department of Agriculture 1970. PR Notice 70-22. Looseleaf pub. 1 pp.

U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service. 1976. The Pesticide Review 1975. U.S. Department of Agriculture, Washington, D.C.

USDA-States-EPA. 1979. The biological and economic assessment of 2,4,5-T: a report of the USDA-States-EPA 2,4,5-T RPAR assessment team. Washington, D.C. (Unpublished.)

Van Miller, J.P., J.J. Lalich, and J.R. Allen. 1977. Increased incidence of neoplasms in rats exposed to low levels of 2,3,7,8-tetrachlordibenzo-p-dioxin. Chemosphere 6(10):625-632. [Unpublished version cited in Position Document 1 as Ref. #109.]

Wiese, A.F., and R.G. Davis. 1964. Herbicide movement in soil with various amounts of water. Weeds 12(2):101-103.

Woolson, E.A., P.D., J. Ensor, W.L. Relchel, and A.L. Young. 1973. Dioxin residues in lakeland sand and bald eagle samples. pages 112-118 in E.A. Blair, ed., Chlorodioxins-origin and fate. Advances in Chemistry Series, No. 120. Am. Chem. Soc., Washington, D.C.

World Health Organization, International Agency for Research on Cancer. 1977. LARC mongraphs on the evaluation of the carcinogenic risk of chemicals to man: some fumigants, the herbicides 2,4-D and 2,4,5-T, chloriniated dibenzodioxins and miscellaneous industrial chemicals. Vol. 15. international Agency for Research on Cancer. Lyon. (France).

Zitko, V. 1972. Absence of chlorinated dibenzodioxins and dibenzourans from aquatic animals. Bull. Environ. Contam. Toxicol. 7:105-110.

# 2,4,5-T: Position Document 2/3

U.S. Environmental Protection Agency
Project Manager: Michael Dellarco

JUL 9 1979

2,4,5-T: Position Document 2/3

CONTENTS

2,4,5-T: Position Document 2/3

## I. INTRODUCTION

On April 11, 1978, the Environmental Protection Agency (EPA) issued a notice of rebuttable presumption against all registrations of the herbicide 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) [43 FR 17116, 21 April 1978]. Issuance of the RPAR began the Agency's public review of the risks and benefits of all uses of this chemical. On February 28, 1979, responding in part to information developed through the RPAR, the Administrator ordered the emergency suspension of the use of 2,4,5-T on forests, rights-of-way, and pastures ("suspended uses") [44 FR 15874, 15 March 1979]. At the same time, the Administrator also issued notices of intent to cancel these uses. These actions terminated the RPAR review of the suspended uses of 2,4,5-T and initiated public hearings on issues relating to the risks and benefits of these uses.*/

The Agency continued to review the use of 2,4,5-T on rangeland, rice, and non-crop areas**/ ("non-suspended

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*/ Suspension proceedings began on April 19, 1979, but were discontinued on May 15, 1979 after all registrants withdrew from the hearings. The first pre-hearing conference for the cancellation proceedings was held on June 5, 1979; the formal hearing will probably begin in the fall.

**/ The non-crop uses of 2,4,5-T include use at the following sites: airports; fences, hedgerows (not otherwise included in suspended uses, e.g., rights-of-way, pasture); lumber yards; refineries; non-food crop areas; storgage areas; wastelands (not otherwise included in suspended uses, e.g., forestry); vacant lots; tank farms; industrial sites and areas (not otherwise included in suspended uses, e.g. rights-of-way).

uses") and has concluded that, when used in accordance with widespread and commonly recognized practice, the non-suspended uses of 2,4,5-T appear to cause unreasonable adverse effects on the environment. As a result, the Agency is issuing a notice of intent to hold a hearing to determine whether the non-suspended uses of 2,4,5-T should be cancelled.

This Position Document reviews the Agency's assessment of the risks and benefits of the non-suspended uses of 2,4,5-T, particularly use on rice and rangeland, and explains the bases for the Agency's decision to terminate the RPAR for these uses by convening a hearing to determine whether or not to cancel these uses.

This Position Document contains five parts. Part I, this introduction, summarizes the legal provisions relating to the RPAR review and cancellation of pesticides, and background information on the chemistry and uses of 2,4,5-T. Part II is the Agency's analysis of rebuttal comments submitted in response to the risks cited in Position Document 1. Part III is an evaluation of the data and information relating to the risks associated with the non-suspended uses of 2,4,5-T. This part includes the Agency's analysis of laboratory data, other new data and information developed through the RPAR review, information on exposure potential,

and other risk considerations. Part IV reviews the benefits associated with the non-suspended uses of 2,4,5-T on a use-by-use basis and discusses the data on risks in light of the data on benefits. Part V contains the Agency's regulatory determination and explains the bases for the determination that a hearing on the risks and benefits of these uses is the most appropriate way to terminate the RPAR.

## A. Legal Authority

### (1) Statutory Provisions

The Federal Insecticide, Fungicide, and Rodenticide Act, as amended ("FIFRA") [7 U.S.C. 136 et seq.] requires the Environmental Protection Agency (EPA) to regulate all pesticide products through review of the risks and benefits of the uses of these chemicals. A key provision is Section 12(a)(1)(A) of FIFRA which specifies that all pesticide products must be registered by the Administrator before they may be sold or distributed. Before a pesticide may be registered, however, the Administrator must determine that its use will not result in "unreasonable adverse effects on the environment," defined in Section 2(bb) of FIFRA as "any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide." In other

words, any decision on pesticide registration must take into account both risks and benefits from the pesticide's use.

Under Section 6(b) of FIFRA, the Administrator may cancel the registration of a pesticide or change its terms and conditions of registration if it appears that the pesticide, "when used in accordance with widespread and commonly recognized practice, generally causes unreasonable adverse effects on the environment." For example, the Administrator may cancel the registration of a pesticide or change its terms and conditions of registration, if its labeling does not comply with the misbranding provisions of FIFRA which require the labeling to contain language "adequate to protect health and the environment" [FIFRA 2(q)].

Two types of proceedings are available under Section 6(b) of FIFRA to cancel a pesticide registration, or to modify the terms and conditions of its registration: FIFRA Section 6(b)(1) proceedings and FIFRA Section 6(b)(2) proceedings. In general, FIFRA Section 6(b)(1) proceedings begin with a notice specifying the regulatory action which the Administrator is proposing. This action takes effect automatically, without hearings, at the expiration of a notice period prescribed by statute, unless the registrants or a person adversely affected by the notice requests a hearing within that period. If a hearing is requested, the

regulatory action proposed by the Administrator does not take effect; however, at the conclusion of the hearing, the Administrator may implement the proposed action, if he determines that it is appropriate to do so based on the record developed in the hearing.

Section 6(b)(2) proceedings, on the other hand, begin with a general notice specifying the issues which the Administrator desires to have explored at a hearing. Unlike Section 6(b)(1) proceedings, the Section 6(b)(2) proceeding does not include an initial proposed regulatory solution which would take effect automatically if a hearing is not requested. Interested persons may participate in the hearing; at the conclusion of the hearing, the Administrator may take whatever action he deems appropriate, based upon the record developed in the hearing, including cancellation of a pesticide registration or modification of the terms and conditions of its registration.

(2) The "RPAR" Process

The Rebuttable Presumption Against Registration (RPAR) process provides a mechanism through which the Agency gathers risk and benefit information about pesticides which appear to pose risks of adverse effects to human health or the environment which may be unreasonable. Through this process, the Agency invites pesticide registrants, environmen-

talists, and other interested persons to participate in the Agency's review of suspect pesticides in order to reach an open and balanced decision on the continued use of the pesticides.

The RPAR regulations at 40 CFR 162.11 (a)(3) prescribe regulatory criteria for the Agency's preliminary assessment of a pesticide's health and environmental effects and provide that an RPAR shall arise if the Agency determines that any of the risk criteria have been met. The Agency generally announces that an RPAR has arisen by publishing a notice in the Federal Register. Once a rebuttable presumption has arisen, registrants, applicants, and interested persons may submit evidence in rebuttal or in support of the presumption. Information on the economic, social, and environmental benefits of any use of the pesticide may also be submitted.

If the presumptions of risk are not rebutted, the benefits evidence submitted and that gathered by the Agency must be evaluated and considered in light of the risk information. If the Agency determines that the risks appear to outweigh the benefits, the Agency can initiate action under FIFRA Section 6(b)(1) to cancel the registration for a use, or to modify the terms and conditions of registration for the use. FIFRA Section 6(b)(2) proceedings are appropriate (among other situations) when a pesticide use appears to pose a risk of unreasonable adverse effect,

and additional information on risks or benefits would assist the Agency in making a decision on the ultimate fate of the pesticide use.

B. Background Information Relating to 2,4,5-T

(1) Chemical and Physical Characteristics

The chemical name of the herbicide 2,4,5-T is 2,4,5-trichlorophenoxyacetic acid. Its chemical formula is $C_8H_5Cl_3O_3$. The pure acid form occurs as white crystals and has a molecular weight of 255.49; its melting point is 156.6°C with a solubility in water of 278 parts per million (ppm) at 25°C. 2,4,5-T is also soluble in acetone, ethanol, ether, and alkaline solutions. The esters of 2,4,5-T are formulated to be emulsifiable in water and soluble in most oils, while its amine salts are soluble in water, but insoluble in petroleum oils (EPA 1978).

During the manufacturing process, at temperatures above 160°C, 2,4,5-T becomes contaminated with an especially toxic polychlorinated dibenzo-p-dioxin, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). TCDD occurs as a white, crystalline solid, is 99.5% decomposed at 800°C, and is soluble in acetone, benzene, dimethylsulfoxide, and methanol. It is slightly soluble in water [0.2 parts per billion (ppb)] at 25°C (EPA 1978). Current U.S. manufacturing specifications require 2,4,5-T presently being sold to

contain less than 0.1 ppm TCDD.*/

(2) Registered Uses and Production

2,4,5-T is a selective, broadleaf herbicide. It is used mainly to clear brush and hardwood on pastures, rangeland, utility rights-of-way, and in forestry.

Agency records show that 122 companies hold federal registrations and formulate 424 products; 11 companies have applied for federal registration of 21 state-registered products (EPA 1978).

In 1969, 11,626,000 pounds of 2,4,5-T acid, esters, and salts were produced in the U.S.; 12,335,000 pounds were produced in 1970. For the period 1971 through 1974, 738,907 pounds of 2,4,5-T were imported into the U.S., for a yearly average of 148,000 pounds (EPA 1978).

(3) Tolerances

There are no tolerances established for 2,4,5-T or TCDD in or on food crops. However, 40 CFR 180.302

*/ Although 2,4,5-T manufacturers attempt to remove this contaminant, TCDD cannot be completely removed. An EPA contract laboratory has measured the TCDD content in 16 recently produced commercial samples of technical grade 2,4,5-T from five different manufacturers. The contractor reported that the TCDD content in these samples ranged from not detectable to 0.025 ppm (limit of detection 0.01 ppm) [excluding higher values that the contractor reported as doubtful] (EPA 1979a). Therefore, because TCDD is present as a low-level contaminant in commercial samples of 2,4,5-T, references in this document to "2,4,5-T" or the "pesticide product" mean 2,4,5-T that is contaminated with TCDD.

does establish a tolerance of 0.05 ppm for hexachlorophene on cotton seed with a stated limitation that the technical grade fungicide shall not contain more than 0.1 ppm TCDD. The limitation does not constitute a tolerance (EPA 1978).

(4) Regulatory History

Pesticides containing 2,4,5-T have been federally registered since 1948. A summary of regulatory actions on 2,4,5-T prior to the issuance of the RPAR is given in "2,4,5-T: Position Document 1" (EPA 1978). Subsequent regulatory actions are summarized in Part I of this document.

## II. REBUTTAL ANALYSIS

The 2,4,5-T RPAR notice cited two risk criteria which both 2,4,5-T and TCDD had met or exceeded. [All such risk criteria are listed in the Code of Federal Regulations, 40 CFR 162.11(a)(3).] These two risk criteria were oncogenic effects in test animals [40 CFR 162.11(a)(3)(ii)(A)] and chronic and/or delayed toxicity causing teratogenic or fetotoxic effects in test animals [40 CFR 162.11(a)(3)(ii)(B)].

A. Rebuttals Relating to the Presumption of Oncogenicity

The Agency received responses from two respondents to our request for rebuttal comments and additional information on this risk criterion. The Agency has reviewed the rebuttals submitted by the respondents and has concluded that these rebuttals do not rebut the oncogenic effects risk presumption upon which the RPAR was partially based. The four laboratory studies, cited in the RPAR notice, in which oncogenic effects were reported for test animals exposed to TCDD and/or 2,4,5-T are summarized below.

Muranyi-Kovacs et al. (1969) administered 2,4,5-T (containing <0.05 ppm TCDD) to inbred C3Hf and XVII/G mice by giving 100 mg/liter in the drinking water for two months beginning at six weeks of age, and 80 ppm in the diet during the succeeding 15 to 20 months. In C3Hf mice, 48 percent of the treated females (12/25) and 55 percent of the treated males (12/22) developed tumors, compared with control values of 21 percent (9/44) and 49 percent (21/43), respectively. In XVII/G mice, 84 percent of the treated females (16/19) and 75 percent of the treated males (15/20) developed tumors, compared with control values of 53 percent (21/40) and 78 percent (25/32), respectively.

Innes et al. (1969), under contract with the National Cancer Institute, studied the tumorigenicity of 2,4,5-T, containing possibly as much as 30 ppm TCDD, in two hybrid strains of mice, designated as "X" and "Y", after oral or subcutaneous administration of the maximum tolerated dose. Results of the studies were calculated comparing treated groups with matched and pooled controls. In the subcutaneous study, mice were given a single injection of 21.5 mg/kg of 2,4,5-T at about 18 months of age. Seventeen percent (3/18) of the treated "Y" males developed pulmonary adenomas. This incidence of pulmonary adenomas was significant relative to both control groups. In the oral study, 21.5 mg/kg of 2,4,5-T was administered daily, beginning at 7 days of age. After weaning, 60 ppm of 2,4,5-T in the diet was provided until the end of the study at about 18 months. Gross and histological examinations were made of all major organs and visible lesions; thyroid glands were not examined. There were no significant differences between treated and control groups of mice with respect to tumors at specific sites or total number of tumor-bearing animals (Memo 1979a; 1979b).

Van Miller et al. (1977) reported the results of a two-year feeding study with male Sprague-Dawley rats fed ground chow containing 0.1, 5, 50, or 500 ppt and 1, 5, 50, 500, or 1,000 ppb TCDD. Tumorigenic and toxic effects were observed in rats in the six lowest dose groups.

Dow Chemical Company (1977) reported preliminary results of a study of TCDD's chronic toxic effects in Sprague-Dawley rats fed TCDD at 0.1, 0.01, or 0.001 ug/kg body weight daily (about 2,200, 210, and 22 ppt in the diet) for two years. Dow reported "discernible increases" in the incidence of hepatocellular carcinomas of the liver and of squamous cell carcinomas of the lung, hard palate/nasal turbinates, and tongue in rats at 0.1 ug/kg. Hepatocellular nodules and alveolar hyperplasia were observed in the 0.01 ug/kg group.

(1) Carcinogenic Potency of TCDD

(a) As a Complete Carcinogen

Dow Chemical (30000/26:#16)*/ commented that laboratory researchers for the National Cancer Institute have concluded that "TCDD is a weak carcinogen in animals." Conversely, Harris (30000/26:#2392) commented that, on the basis of work done at the University of California, TCDD is about 10 times more potent than the potent human carcinogen, aflatoxin.

Recent communication to the Agency's Carcinogen Assessment Group (CAG) from the National Cancer Institute (NCI) on its as yet incomplete study on TCDD in rats and mice indicate that TCDD

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*/ Rebuttal citations refer to accession numbers in OPP's Federal Register Section. Rebuttals are available for public inspection.

appears to be as potent as observed in the Sprague-Dawley rat study performed by the Dow Chemical Company (Memo 1979b). In citing the published abstract of the NCI study, Dow stated only part of the total thought. The entire sentence reads, "This study suggests that TCDD and HCDD are weak carcinogens given orally and are complete carcinogens when applied to the skin."**/

In addition, CAG has independently calculated the relative potency of TCDD as a carcingoen and has concluded that TCDD is a more potent carcinogen than aflatoxin. This analysis is consistent with the information given in the Harris rebuttal (Memo 1979a).

(b) As a Promoter

Dow Chemical Company (30000/26:#16) further argued that Van Miller et al. stated that their study did not prove conclusively that TCDD is a carcinogen. They suggested that TCDD was acting as a "potent promoter" of neoplastic changes, and that this led to the wide variety of tumors reported to be associated with ingestion of low dose levels in the diet.

**/ The results reported in this abstract were increased hepatic tumors among male mice and markedly increased epithelial tumors in female mice due to oral TCDD exposure. Dermal exposure resulted in skin tumors, increased in both numbers and aggression.

This rebuttal raises two issues relating to the carcinogenicity of TCDD: 1) does TCDD induce cancer development in experimental animals; and 2), if so, does TCDD produce the carcinogenic effects by acting as a co-carcinogen or promoter at low levels as Van Miller et al. implied. With regard to the first issue, the Dow Chemical Company study, as well as the Van Miller et al. study, showed that TCDD is a carcinogen in the same strain of rats (Sprague-Dawley), exposed through the same route of administration (feeding in diet), and exposed to comparable dose levels ranging from 2,200 ppt in the Dow study to 1,000 ppt in the Van Miller study.*/ In regard to the second issue of whether TCDD acts as a promoter or as a carcinogen, the Agency regards any compound which induces a carcinogenic response as a carcinogenic hazard regardless of its mechanism of action (Memo 1979a; 1979b).

(2) Lowest Effect Level of TCDD

In reporting its rat feeding study, Dow did not consider the effects seen at 210 ppt TCDD as indicative of a positive carcinogenic effect. Harris (30000/26:#2392) commented that in the Dow study, 220 ppt [sic] in the diet also appeared to induce liver tumors in female rats.

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*/ The Agency evaluation of this study indicates that it has experimental deficiencies which limit the reliability of the results at dose levels below 1,000 ppt. However, these deficiencies do not affect the positive findings observed at higher doses.

CAG has re-evaluated this study and now concludes that the combined incidence of hepatocellular hyperplastic nodules and hepatocellular carcinomas is statistically significant at both the 2,200 and 210 ppt level.

(3) Enzymatic Effects

Dow Chemical (30000/26:#16) commented upon EPA's statement that TCDD has possible carcinogenic potential because it is an inducer of arylhydrocarbon hydroxylase (AHH). Dow maintained that the induction of AHH by TCDD has no bearing on the carcinogenic potential of this chemical.

The Agency notes that, although the biochemical mechanism of tumor induction by TCDD is not known in detail, TCDD is known to be a potent inducer of the arylhydrocarbon hydroxylase system. Epoxidase, one component of the AHH system, is known to be involved in the metabolic activation and carcinogenicity of polycyclic aromatic hydrocarbons. Therefore the carcinogenic action of TCDD could be mediated by this enzyme system.

(4) Carcinogenicity of 2,4,5-T

Dow Chemical (30000/26:#16) claimed that the Agency's characterization of 2,4,5-T as a carcinogen was in error. According to Dow, out of a total of 10 animal studies based on chronic exposure to 2,4,5-T,

only one was reported to have been associated with a statistical increase in tumors. Dow further claimed that even this observation was non-reproducible when the same investigators gave 2,4,5-T to the same strain of mice by a different route of exposure. Moreover, as the number of studies increases, the probability of false positive results increase.

The Agency acknowledges that the Muranyi-Kovacs study is deficient in the following respects: 1) only one dose was used; 2) the animal husbandry was inadequate, as acknowledged by the authors (Memo 1979a); 3) the histology data on all animals were not available; 4) some mice were arbitrarily excluded from the calculations of tumor incidence; and 5) the authors themselves were reluctant to defend the results. For these reasons, this study cannot alone be regarded as establishing the carcinogenicity of 2,4,5-T.

However, although the Muranyi-Kovacs study did not produce tumors in single target tissues as a result of exposure to 2,4,5-T, this study did show a statistically significant excess of combined tumors in important organs in animals treated with 2,4,5-T (liver, leukemia, and other rare tumors not found in control animals). In addition, the editor and referees of the British Journal of Cancer, publisher of the study, believe that the statistical method

used in the evaluation of the tumor data is valid for the data generated (Memo 1979a). For these reasons, the Agency does not accept all points in Dow's rebuttal.

Dow Chemical Company (30000/26:#16) further claimed that the (subcutaneous injection) study cited by the Agency as a basis for the presumption against 2,4,5-T was incorrectly interpreted and that no increased tumor incidence was reported by the original investigators (Innes et al. 1969).

Although animal bioassays in which 2,4,5-T, was administered to test animals yield somewhat inconclusive results, the presence of small quantities of TCDD, a potent oncogen, in commercial 2,4,5-T means that pesticide products containing 2,4,5-T also contain an oncogenic agent. The oncogenic effects reported in bioassays using 2,4,5-T as the test material may not have been as pronounced as those reported for TCDD because the test animals exposed to 2,4,5-T were exposed to lower dose levels of TCDD than the levels which produced significant carcinogenic effects in animals exposed to pure TCDD.

### B. Rebuttals Relating to the Presumption of Reproductive and Fetotoxic Effects

The Agency received numerous responses to its request for rebuttal comments and additional information on this risk criterion. Most of these comments addressed the question of human exposure potential*/, rather

*/ See Section II.C.

than the substantive validity of the toxicological studies. The Agency has reviewed the rebuttals and additional information submitted by the registrants on the reproductive toxicity of 2,4,5-T and TCDD and has concluded that this risk criterion has not been rebutted. The studies cited in Position Document 1 are summarized below.

Fetototoxic and embryolethal effects have been reported in studies*/ using generally low-dose regimens of TCDD. For example, Neubert and Dillmann (1972) reported that resorption sites (resorbed or dead embryos) occurred in 54% (7/13) of the litters at 0.3 ug/kg per day and in 100% (3/3) of the litters at 9.0 ug/kg per day for NMRI mice, compared to 24 to 32% (23/95 and 21/65) of litters exhibiting resorptions in control animals which had not been exposed to TCDD. Sparschu et al. (1971) reported resorptions of 100% (110/110) of the fetuses in Sprague-Dawley rats exposed to 8 ug TCDD/kg per day, compared to 20% resorption (63/309) of the fetuses from the control animals. Khera and Ruddick (1973) reported 100% (77/77) resorption of fetuses at 4 ug/kg per day and 36% (56/153) at exposures of 1 ug/kg per day in Wistar rats, compared to 2 to 7% (3/152 and 10/127) in the control animals.

*/ Except as otherwise noted, the studies on the fetotoxic and embryotoxic effects of TCDD and 2,4,5-T with TCDD involved the daily oral administration of the chemical to pregnant test animals for the period of major organogenesis during gestation (e.g., on gestation days 6 to 15).

In a preliminary report of a study of the effects of TCDD on reproduction in Sprague-Dawley rats exposed to low levels for three generations, Dow Chemical Company (1977) concluded that "impairment of reproduction was clearly evident among rats ingesting 0.01 or 0.1 ug TCDD/kg per day. Significant decreases were observed in fertility, litter size, gestation survival, post-natal survival, and postnatal body weight."*/

Exposure to TCDD has also produced skeletal anomalies and injury to internal organs in the offspring of animals treated during pregnancy. Courtney and Moore reported the following incidences of cleft palate in the indicated strains exposed by subcutaneous injection to 3 ug/kg per day TCDD: 71% (5/7) in litters of C57BL/6 mice, compared to none (0/23) in the controls; 22% (2/9) in litters of DBA/2

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*/ Dow Chemical Company has claimed that the raw data and/or results of certain of its studies are "trade secret" or "confidential." An injunction issued on April 4, 1978, in the case of Dow Chemical Co. v. Costle, Civil Action No. 76-10087, U.S. District Court for the Eastern District of Michigan (Northern Division), arguably precludes EPA from disclosing this information at the present time. Although the relevant provisions of FIFRA have since been amended to allow disclosure of data such as this [see e.g., FIFRA Sections 10(d) and 10(g)], the injunction has not yet been modified. EPA has requested the Court to modify the injunction, but until this has been done, the Agency will not publicly disclose the data from the study. The summary presented in the text of this Position Document does not, in EPA's opinion, constitute disclosure of the allegedly "trade secret" data submitted by Dow and would not cause any harm to Dow's legitimate competitive interests. The data from the study may be made available to any party in a cancellation proceeding under an appropriate protective arrangement.

mice, compared to none (0/23) in the controls; and 30% (3/10) of CD-1 mice, compared to none (0/9) in the controls. Neubert and Dillmann, also using 3 ug/kg per day TCDD, reported 29% (7/24) of the viable litters had fetuses with cleft palate for NMRI mice, compared to 6% (10/160) of the control litters. Smith et al. (1976) reported cleft palate in 71% (10/14) of CF-1 mouse litters at 3 ug/kg per day, compared to none (0/34) in the controls.

In exposures of shorter duration, Moore et al. (1973) reported cleft palate in 86% (12/14) of C57BL/6 mouse litters exposed on days 10-13 of gestation to 3 ug/kg per day, compared to none (0/27) in the control litters. Neubert and Dillmann (1972) reported cleft palate in 71% (10/14) of litters of NMRI mice exposed to a single 45 ug/kg dose on gestation day 11, compared to 6% (6/95) of litters in the controls.

Smith et al. (1976) reported 28% (4/14) of litters with kidney anomalies at 3 ug/kg per day TCDD in CF-1 mice, compared to none (0/34) in the controls. Moore et al. (1973) reported 100% (14/14) of litters with kidney anomalies in C57BL/6 mice exposed to 3 ug/kg per day on gestation days 10-13, compared to none (0/27) in the control litters. Courtney and Moore (1971) administered TCDD subcutaneously to CD-1 mice on gestation days 6-15 and reported kidney anomalies in 100% (10/10) of the litters at 3 ug/kg per day,

compared to 33% (3/9) in the controls, and 67% (4/6) litters with abnormal kidneys in the CD rat at 0.5 ug/kg per day, compared to none (0/9) in the control litters. Sparschu et al. (1971) reported hemorrhages or lesions of the intestine of 36% (36/99) of the examined fetuses of Sprague-Dawley rats exposed to 0.5 ug/kg, compared to none (0/246) in the control fetuses.

Cleft palate, high incidences of fetal mortality, reduced fetal weight, and other indicators of injury to the developing fetus have been reported in several studies in which test animals were exposed to 2,4,5-T contaminated with varying levels of dioxin. Some of these effects have been reported in test rodents at maternal doses as low as 20 mg/kg 2,4,5-T containing 0.5 ppm TCDD. For example, Neubert and Dillmann (1972) studied the effects of 2,4,5-T contaminated with dioxin in NMRI mice. Using 2,4,5-T with 0.05 ppm TCDD, these investigators reported resorptions in 57% of the litters and cleft palate in 71% of the litters at 60 mg 2,4,5-T/kg, compared to 24 to 32% resorptions and 6% cleft palate in the controls.

Similarly, Courtney and Moore (1971) reported that oral exposure of CD rats to 80 mg/kg per day 2,4,5-T containing 0.5 ppm TCDD led to 52% fetal mortality per litter, compared to 3.4% in the controls. At this dose, kidney anomalies were observed in 50% of the litters, compared to

none in the controls, but none of the fetuses had cleft palate at any dose. However, subcutaneous injection of 100 mg/kg 2,4,5-T containing 0.05 ppm TCDD led to cleft palate in 40% of the litters of CD-1 mice, compared to none in the controls.

Collins and Williams (1971) studied the effects of 2,4,5-T containing various amounts of dioxin on the reproduction in the Syrian hamster. At 20 mg/kg 2,4,5-T (containing 0.5 ppm TCDD), there were significant decreases in fetal weight and viability. The same type of effects were seen with 2,4,5-T containing less than 0.1 ppm TCDD at 80 mg/kg. Exposure to higher doses of this 2,4,5-T resulted in an increased incidence of fetal anomalies, such as exencephaly, eye abnormalities, delayed head ossification, and hind limb deformities.

(1) Nature of Fetotoxic Effects

Several commenters attempted to rebut the fetotoxic risk criterion by arguing that 2,4,5-T and/or TCDD are not teratogenic because the abnormal effects are observed only in sensitive species of test animals and are generally types other than gross anatomical defects. Examples of specific arguments are: (1) the observed kidney anomalies are really retardation of normal development and not "true" terata [Dow (30000/26/:#16)]; and (2) TCDD is more of a toxicant than a teratogen, usually causing death of the fetus rather than abnormalities [CAST (30000/26:#2297)].

Rebuttal arguments of this type are not persuasive when considered in terms of either scientific or legal criteria. Although there may be many differences between, for example, animals born with anatomical defects and stillborn or size-retarded animals, the essential fact is that both groups of animals have been injured and/or are abnormal. Thus, in terms of human health consequences, the distinction that Dow makes is a distinction without a difference. Moreover, because FIFRA charges the Agency with protecting the environment from any unreasonable adverse effects, the Agency's ability to regulate is not limited only to certain types of adverse effects, particularly when, as here, differences between certain effects relate to mechanism of origin, not to health consequences.

The same reasoning applies to the distinction between growth retardation and "true" teratogenesis. For regulatory purposes, it is not relevant whether the observed anomalies are retardation or "true" teratogenic effects. An infant born with retarded mental or physical development is clearly disadvantaged, and possibly subject to increased risk during any "catch-up" period, even though the handicap may ultimately be overcome.

(2) Maternal Toxicity

Several commenters argued that the effects observed on the fetus are the secondary result of maternal toxicity, rather than a direct effect on the fetus. "When gestating animals are poisoned by massive doses of any substance, there are usually adverse effects on the developing offspring" [CAST (30000/26:#2297)].

This again is primarily a mechanism of action argument. In addition, arguments based on maternal toxicity find little support in the experimental data. Fetal effects have routinely been observed in mammalian species at doses where the mothers appear perfectly normal. [See, for example, the Schantz et al. (1979) monkey study at 50 ppt in Section III.A.(1)]. As for the use of "massive doses," adverse fetal effects have repeatedly been reported at low dose levels where no adverse maternal effects have been observed. A simple comparison of reproductive effect levels with $LD_{50}$ values demonstrates the weakness of this argument (even though reproductive studies involve low-level, repeated daily doses and acute toxicity studies are usually carried out with higher dose levels administered once). For example, reproductive effects have been observed in the rat at doses as low as 1/40,000 of the $LD_{50}$ for adult animals.

(3) No-Effect Levels

Dow Chemical Company (30000/26:#16) argued that there are ample margins of safety for women of child-bearing age between potential exposure and no-effect levels. As the bases for calculating these margins of safety, Dow used values from the 2,4,5-T RPAR.

The Agency cannot accept the margins of safety suggested by Dow because studies by Dow and others which became available to the Agency after issuance of the RPAR clearly show that effects are observed in test animals at levels lower than those reported in the RPAR. For example, in a new Dow reproduction study using rats (Dow Chemical Co. 1978) fetotoxic and teratogenic effects were reported at 0.001 ug/kg per day, the lowest dose tested in any species to date. Because effects are observed at the lowest dose levels to which the test animals were exposed,

it is possible that adverse effects occur at lower, as yet untested, dose levels. Finally, because the lowest levels at which effects may occur are unknown, and because effects nevertheless are observed at low levels of exposure which approach levels to which humans may be exposed, there may be no adequate margin of safety. Therefore, because of the known opportunities for human exposure, and the absence of an established level at which there are no adverse effects, neither Dow nor the Agency can reliably determine whether or not there is an adequate margin of safety.

(4) Species Specific Teratogenic Effects

Dow (30000/26:#16) states that the subject chemicals are teratogenic only "in certain strains of mice which are genetically predisposed to the development of cleft palate" and that "[t]he effects seen in other species and other strains of mice are either embryotoxic or fetotoxic, not teratogenic effects."

The Agency does not agree with Dow's contention that the teratogenicity of 2,4,5-T and/or TCDD has been observed only as cleft palate in certain susceptible strains of mice. Other anomalies such as dilated renal pelvis and delayed ossification have been seen in rats, and palate abnormalities have been seen in monkeys [see Section III.A.(1)]. Other types of teratogenic effects have been observed in studies using 2,4,5-T and/or TCDD, most notably kidney anomalies.

Use of a susceptible strain has the advantage of making the experimental system more sensitive. In addition, any baseline effects due to the particular sensitivities of the test strain should be nullified through the customary use of adequate controls. Finally, in making regulatory decisions, the Agency has traditionally used results obtained in the most sensitive species as the basis for evaluating the potential risk to humans from exposure to a given substance. This is because of the very real possibility that humans too may be "genetically predisposed" to a given teratogenic effect.

(5) Teratogenic Potency of TCDD

A report, "The Phenoxy Herbicides," submitted by the Council for Agricultural Science and Technology (CAST) [30000/26:#2297] concluded that TCDD should be classed as a weak teratogen because of the narrow range of dosage between the no-effect level on the fetus and the lethal effect on the mother.

The Agency disagrees with both premises in this rebuttal. First, in marked contrast to CAST's position, many scientists interpret the data showing that TCDD produces many different birth defects in several different species at very low dose levels as indicating that TCDD is one of the most potent teratogens known. Moreover, because of the many and varied uses of TCDD-containing herbicides, significant

segments of the population may be exposed to TCDD. This combination of high toxicity and significant exposure clearly results in signficant risk potential for persons who are exposed to TCDD-containing herbicides. Further, even though TCDD has lower teratogenic activity in some animal tests, the risk potential for humans appears to be significant because the uses of the pesticide result in substantial exposure to some population groups.

Second, CAST's reliance on a no-effect level as the basis for its position is misplaced because significant adverse effects have been observed in the offspring of animals from the lowest-dose groups tested. More specifically, the fetal effect level for TCDD in rats is 0.001 ug/kg per day, which is over 40,000 times lower than the $LD_{50}$ (0.045 mg/kg) for adult female rats. The difference between 0.001 ug/kg per day and 45 ug/kg clearly is not a narrow range.

(6) Fetotoxicity in Nonhuman Primates

Dow (30000/26:#16) cited two negative studies in rhesus monkeys (Wilson 1971; Dougherty et al. 1976) to demonstrate that 2,4,5-T lacked teratogenic potential in subhuman primates. McNulty (30000/26:#915) submitted data indicating that low maternal exposure to TCDD during pregnancy resulted in an increased incidence of spontaneous abortions. Leng (30000/26:#16E), of Dow Chemical Company, questioned

McNulty's results on the basis of whether maternal exposure was really as low as it appeared.

The studies cited by Dow were designed to focus primarily on teratogenic effects. In Dougherty, pregnant monkeys were administered 2,4,5-T, containing 0.05 ppm TCDD, "at dose levels approximating human exposure." No evidence of teratogenesis was observed. The authors concluded that 2,4,5-T was not teratogenic at the levels tested. However, the negative results on teratogenicity were for a relatively narrow dose range and did not cover early embryogenesis. Moreover, a close analysis of the study indicates that there may be other evidence of fetotoxicity in the form of increased abortions. In light of the TCDD studies cited above, the apparent doubling of the abortion rate observed in this study cannot be ruled out as a possible effect. Sufficient experimental details regarding the second "study" (Wilson 1971) are not available in the cited reference to allow for an adequate assessment of the study.*/ However, evidence of abortion, lowered birth weight, and incomplete ossification were indicated. In analyzing effects on nonhuman primates, Dow chose to ignore available information which demonstrates fetotoxic effects in monkeys at doses of TCDD where no maternal toxicity was observed prior to the abortion [see Section III.A.(1)].

*/ For example, information regarding dioxin contamination of the 2,4,5-T, method of dosing, and methods of analysis were not included.

Leng challenged the results observed by McNulty by arguing that the equivalent dietary dose reported by McNulty was lower than the actual dose used. McNulty administered a total of 1 ug/kg in 10 ml acetone-corn oil in nine doses, three times a week, over a three-week period. This is about 0.1 ug/kg per dose, or 0.05 ug/kg per day, if the dosing had been daily. Using the standard dietary consumption figure for the rhesus monkey, this represents a dose of 1,000 ppt in the diet for the 20 days. Leng argued that the correct figure should be 75,000 ppt, and that any extrapolation to human dietary consumption should be based on this figure. To arrive at this figure, Leng divided the total weight of the dose by the weight of the oil (based on density). In short, 75,000 ppt represents the relationship of the TCDD to the oil. This is not the common meaning given to "ppt" when it is used to express a dose, and certainly does not represent a dietary equivalent.

(7) Combined Effects of 2,4,5-T and TCDD

Dow Chemical Company (30000/26:#16) argued that the level of TCDD in 2,4,5-T must exceed current specifications, and be greater than 1 ppm, before the "toxicity" of TCDD becomes detectable. According to Dow, animal studies have indicated that this amount of TCDD does not enhance or potentiate the toxic effect of 2,4,5-T.

In making this assertion, Dow has again apparently made a distinction between fetotoxicity and teratogenicity

which, for purposes of regulation, the Agency does not recognize. The lack of teratogenic effects will not negate other fetotoxic effects observed under the same experimental conditions. For example, in one of the studies cited and conducted by Dow, there was no increase in teratogenic effects; however, there was a significant increase in fetal loss at the lowest dose of TCDD (0.01 ug/kg per day) combined with 2,4,5-T, when compared to the effect of 2,4,5-T alone.*/ Like teratogenic effects, this increased fetal loss is an indicator of injury to the fetus.

(8) Agency Analysis

Another Dow rebuttal argument (30000/26:#16) was that the Working Group appeared to give all studies cited in the RPAR notice equal weight and validity without regard to study quality. As an example, Dow cited the Agency's use of a study in which dose levels were given in millimoles per unit body weight, rather than in weight per unit body weight. This use of an uncommon dose unit caused Dow to argue that the study's results could not be readily compared with other studies.

The Agency cannot accept this argument. A thorough reading of the RPAR notice will show that whenever possible, confounding factors, such as maternal toxicity, were observed in a study, the Working Group noted them in its reporting of that study. Any omissions were by inadvertence, rather

*/ Dow has also claimed that the raw data and/or results of this study are confidential. See previous footnote on this subject.

than design. Even if Dow's argument were sound, and several of the studies could be invalidated or given lesser weight, one still could not ignore the overwhelming consensus of the many studies in this area: TCDD and/or 2,4,5-T contaminated with TCDD are clearly fetotoxic and teratogenic agents.

As to Dow's example, the Agency agrees that millimoles per unit body weight is an uncommon expression of dose. However, the simple multiplication of the millimoles by the molecular weight of the compound will yield the more familiar dose expression of weight per unit of body weight.

C. Rebuttals Relating to Exposure

Most of the substantive rebuttals to the 2,4,5-T RPAR addressed the question of potential human exposure to 2,4,5-T and/or TCDD. The bulk of these comments challenged the exposure estimates included in Position Document 1; others, however, offered constructive suggestions for improving the Agency's exposure analysis without addressing any specific point in the RPAR.

The Agency's exposure estimates are designed to approximate actual exposure. The estimates are based on relevant data and, when such data are not available, on assumptions relating to probable exposure. The accuracy of these estimates depends in part on the bases of the assumptions. The more empirical data supporting the assumption, the more reliable the exposure estimate.

When Position Document 1 was written, very little empirical data were available on 2,4,5-T human exposure levels. Since then, partially in response to the RPAR, additional information has become available. The Agency has re-examined its exposure analysis in light of this new data and has concluded that for some use situations, the estimates in the Position Document may have been higher or lower than actual exposure would be.

Because toxicological data which Dow Chemical Company presented to the Agency after issuance of the RPAR indicate that there are no no-effect exposure levels for the fetotoxic and teratogenic effects associated with TCDD, and consequently for 2,4,5-T containing TCDD, the quantitative exposure estimates for 2,4,5-T and TCDD upon which the RPAR was based have little value beyond suggesting the potential for exposure. The discussion below summarizes the Agency's original estimates and the rebuttals to these estimates.

In Position Document 1, the 2,4,5-T Working Group set forth several estimates for the oral, dermal, inhalation, and cumulative exposures to 2,4,5-T and TCDD for a woman weighing 60 kg, in a variety of situations. Upon reviewing these estimates, the Working Group recommended that the Agency issue an RPAR for all pesticide products containing 2,4,5-T.

Oral Exposure: After determining the average daily consumption of beef and milk contaminated with 2,4,5-T, the Working Group calculated that the cumulative oral exposure to 2,4,5-T could be 0.0007 mg/kg per day. Because information on TCDD residues in beef was sparse, the Agency did not calculate the oral exposure to TCDD through the ingestion of contaminated beef or milk.

Dermal Exposure: Extrapolating from both dermal exposure data for fenthion and information on the concentration and dilution rates for 2,4,5-T, the Working Group estimated that an applicator using a backpack sprayer would be exposed to 6.8 mg/kg of 2,4,5-T and 0.0007 ug/kg of TCDD per day. The Agency also calculated that the dermal exposure to 2,4,5-T and TCDD for a spray applicator, using tractor-mounted, low-boom spray equipment, would be 1.8 mg/kg and 0.00018 ug/kg per day, respectively. These estimates were based, in part, on exposure studies using similar equipment, but a different herbicide, together with the concentration and dilution rates for 2,4,5-T. For the exposed population directly beneath the spray plane, the Working Group determined that the daily dermal exposure estimates would be 0.051 mg/kg for 2,4,5-T and $5 \times 10^{-6}$ ug/kg for TCDD.

Inhalation Exposure: EPA also estimated that unprotected persons directly beneath a spray plane would

inhale 0.026 mg/kg of 2,4,5-T and 2 X $10^{-6}$ ug/kg of TCDD for each day of application. Due to the fact that no studies on 2,4,5-T inhalation exposure were available, the Agency based these estimates, in part, on several studies which provided similar exposure data for malathion.

Cumulative Exposure: In addition to providing oral, dermal, and inhalation exposure estimates, the Agency also calculated cumulative levels of exposure to 2,4,5-T and TCDD for three different situations. The Working Group supplied these estimates because of the possibility of a single individual being exposed through two or more of the above routes. The Agency estimated that cumulative exposure for a spray applicator using a backpack sprayer would be 7 mg/kg for 2,4,5-T and 0.0007 ug/kg for TCDD, based on an average concentration of 0.1 ppm of TCDD (EPA 1978). For those applicators using tractor-mounted, low-boom spray equipment, cumulative exposure would consist of 1.85 mg/kg of 2,4,5-T and 0.00018 ug/kg of TCDD (EPA 1978). Finally, the Working Group determined that those directly beneath the path of a spray plane would be subject to a cumulative exposure of 0.0777 mg/kg of 2,4,5-T and 7 X $10^{-6}$ ug/kg of TCDD (EPA 1978).

(1) Basic Assumptions

(a) Level of TCDD Contamination

Laverty Sprayers, Inc. (30000/26:#75) commented that although significant amounts of dioxin have contaminated

2,4,5-T in the past, manufacturers have shown that they can now drastically reduce the dioxin levels. Laverty asserts that 0.1 ppm therefore does not represent the level of TCDD contamination on the present product, and urges that the Agency consider the "new" 2,4,5-T to a greater degree than the obsolete product.

The Agency acknowledges that manufacturers can make 2,4,5-T with less than 0.1 ppm dioxin contaminant.*/ However, since the current manufacturing specifications permit up to 0.1 ppm TCDD in 2,4,5-T, it was appropriate for the Working Group to use this level of contamination in their calculations.

(b) Worst Case Assumptions

William M. Upholt (30000/26:#50) and the National Cattlemen's Association (30000/26:#77C) questioned the Agency's exclusive use of "worst case" assumptions, rather than "average case" assumptions.

Ideally, exposure estimates provide information regarding the exposure encountered by all segments of the population. Unfortunately, data is not always available to make these estimates. Hence, "worst case" estimates are

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*/ Recent Agency analysis of 16 commercial samples of 2,4,5-T found that the TCDD content in these samples ranged from not detectable to 0.025 ppm (limit of detection: 0.01 ppm) [excluding higher values that the contractor reported as doubtful].

used as a means to assess the risk to the population segment receiving the greatest exposure and therefore, the greatest risk. Considerations for other elements of the population can be made from these determinations.

The Agency's use of "worst case" assumptions is consistent with a conservative approach to assessing the potential risks of human exposure to toxic substances. This approach takes into consideration the risks involved for persons who have above average exposure, as well as those with "average" exposure. Because every average is the mean of some higher and some lower values, "average case" assumptions would address only the average and below, and would preclude the Agency from identifying other populations which may be at greater than average risk.

(c) Female as a Model

Detroit Edison Company (30000/26:#210) and The National Cattlemen's Association (30000/26:#77C) objected to the Agency's use of a female model for the calculations. These commenters asserted that this approach, "a priori," would result in excessive exposure estimates (in mg/kg) for the same absolute amount of exposure, because of a woman's smaller weight. The Pacific Legal Foundation (30000/26:1015) argued that women applicators are more appropriately the concern of the Occupational Safety and Health Administration (OSHA), and that EPA should, at most, require labels which warn of the possible harm to pregnant applicators.

In developing the Position Document, the Agency found that major risks of exposure to 2,4,5-T and/or TCDD were fetotoxic and teratogenic effects. Since these reproductive effects apply only to the developing fetus, the exposure of possibly pregnant women was of necessity considered. This led naturally to the use of a woman's weight in the calculations. However, even if the weight of a man (70 kg) had been used instead, the exposure estimate would have changed only by about 17%.

The argument made by the Pacific Legal Foundation is based on an incorrect view of the law. EPA has an obligation under FIFRA to protect applicators of pesticides from unreasonable adverse effects.

(d) Protective Clothing and Devices

Several respondents argued that the Agency did not take into consideration the use of protective clothing and devices when calculating potential exposure, and that use of such protective items would reduce the total amount of exposure, particularly by dermal routes, by an estimated 10 to 20%.

The Agency based its initial exposure estimates and related risk estimates on the potential for exposure under conditions of ordinary, unregulated use. This approach is sound because existing regulations requiring protective clothing and devices are not universally applicable to all 2,4,5-T users and uses. For example, such regulations might

apply to persons in some occupations in some states, but not to the same workers in other states nor to bystanders not subject to the regulations. Further, even when such regulations are in effect, some users and applicators may ignore the regulations and label warnings. Thus, in order to assess the exposure potential under ordinary use conditions, the Agency considers probable and worst-case exposure situations, rather than well-regulated conditions. This approach requires the Agency to make conventional allowances for clothing.

(2) Specific Calculations

(a) Oral Exposure

(i) Urinary Excretion of 2,4,5-T

The National Cattlemen's Association (30000/26: #77C) argued that, in calculating oral exposure, the Agency had ignored the fact that 95% of ingested 2,4,5-T is eliminated in the urine within 96 hours.

The respondent is apparently basing the comment on the work of Sauerhoff et al. (1976), but this is unclear from the rebuttal. The Agency agrees that 2,4,5-T is relatively rapidly excreted in the urine. However, even 96 hours (4 days) represents a significant period of exposure for adverse effects during a susceptible period for the developing fetus, or for the initiation of a carcinogenic response. In addition, this clearance period of 96 hours is for 2,4,5-T. It has no relevance to the retention of TCDD in the body.

(ii) FDA Market Basket Survey

The University of California Cooperative Extension (30000/26:#1299A) commented that the FDA "Market Basket Survey" has failed to show 2,4,5-T present in any food composite at or above 0.02 ppm, and that a specific search for TCDD in milk with the best existing method was also negative.

The Agency considers the "Market Basket Survey" a reasonable indicator of the dietary intake of the population as a whole. However, the survey results are not to be taken as absolutes. The occasional sample or batch of food with a high 2,4,5-T or TCDD content could be missed in the random sampling. Foodstuffs which do not pass through the market before being consumed are not considered. Also, and this is particularly relevant to TCDD exposure, the analytical methodology used in the survey may not be sophisticated enough to detect very small quantities - quantities, however, which may be sufficient to cause adverse effects. Because these adverse effects (e.g., teratogenic effects) could conceivably result from a single exposure, the Agency cannot ignore the possibility that there are residues in food which escape detection in the "Market Basket Survey." Moreover, even non-detectable 2,4,5-T and/or TCDD residues in food could contribute to the total body burden of the exposed population, and could contribute to unacceptable levels of risk from cumulative exposure.

(iii) Beef Residues

The University of California Cooperative Extension (30000/26:#1299A) argued that the estimate for 2,4,5-T provided in Position Document 1 was based on a single highly artificial animal feeding experiment, and was therefore meaningless. In addition, Dow Chemical Company (30000/26:#16B) and the National Cattlemen's Association (NCA) [30000/26:#77C] argued that if label restrictions were followed, the withdrawal periods for meat and dairy cattle would reduce the possibility of significant residues.

Reliable data from a feeding study using high dose levels may be scaled down to reasonable levels of exposure which might approximate the maximum oral intake likely for some individuals from dietary sources. As explained above, the Agency's exposure estimates are often "worst case" assumptions designed to assure that the Agency considers the exposure potential for highly exposed populations.

Moreover, Position Document 1 did not include an estimate for possible dietary intake of TCDD as a result of consumption of beef grazed on 2,4,5-T treated pastures or rangelands. However, after reviewing studies on persistence of TCDD in cattle, an EPA contractor has concluded:

"There is substantial evidence that TCDD is taken up by cattle feeding on treated pasture or rangeland and is stored

in their fat at levels in the low parts per trillion range."*/

This conclusion was based on residue studies by Dow and others, and monitoring studies performed as part of the Dioxin Implementation Plan which showed measurable amounts of TCDD in samples of beef, beef fat, milk, and cream. The levels of residues present also generally indicated bioaccumulation.**/ The serious implications of these results cannot be ignored. They represent a very real potential hazard for people with "normal" dietary habits, and a serious threat to those with specialized eating habits, such as heavy meat consumers, and young children whose diet contains a high proportion of milk.

(iv) Milk Residues

The Commonwealth of Virginia, Division of Forestry (30000/26:#1239) commented that it is unreasonable to assume that milk from deliberately contaminated cattle would be available for human consumption without a withdrawal period. According to Virginia, if cattle were exposed just before marketing, the normal period of shipping and marketing would exceed the withdrawal period cited.

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*/ The summary concludes, "There is less conclusive, but at least suggestive, evidence that TCDD is also present in rice and in fish from treated rice fields at low parts per trillion levels. The potential for human exposure via wild game from treated areas cannot be assessed with the evidence available" (Clement Assoc. Inc. 1979).

**/ Although similar studies have not been performed on humans for ethical reasons, bioaccumulation in other mammalian species should be taken as an indicator that bioaccumulation is also possible in humans.

The Agency acknowledges that milk from "deliberately contaminated cattle" probably would not be used; however, use of milk from accidentally and/or unknowingly contaminated cattle is a possibility, and there could be residues in the milk in such cases.

(b) Dermal Exposure

(i) Nature of Exposure

The National Cattlemen's Association (30000/26: #77C) and the University of California Cooperative Extension (30000/26:#1299A) argued that there would be no exposed population under a spray plane, except in an unforeseeable accident.

In order to get direct exposure from an application by a spray plane, one need not be directly under the plane. The Agency's calculations for this type of exposure were developed using data from Caplan et al. (1956). Samples were taken from subjects working in unprotected areas which had been sprayed with malathion in oil. These subjects were not necessarily directly under the spray plane. The exposure was due to spray particles settling on the subjects. The spray residue was collected on pads placed on various parts of the body. The exposure was calculated from results of the analysis of these pads and the known surface areas of exposed skin areas. For these calculations, it was assumed

that the subjects were dressed in long trousers, short-sleeved shirts with open collars, and without hats. If subjects were dressed in more scanty attire, considerably more exposure would have resulted.

In addition, information developed since the issuance of the RPAR clearly indicates that direct exposure to spray from aerial application, due to drift beyond the designated treatment area, occurs in many use areas. This situation necessitated a more broad definition of "exposed population," one which includes non-worker groups. These groups are of particular concern because their exposure is totally involuntary and unprepared-for (i.e., no safety precautions taken, as with some workers, to prevent or minimize exposure).

(ii) Rate of Dermal Absorption

The University of California Cooperative Extension (30000/26:#1299A) and Indiana State Chemist and Seed Commissioner, Dept. of Biochemistry, Purdue Univ. (30000/26: #265) challenged the Agency's use of 10% of dose as the rate of dermal absorption. California commented that although skin absorption for 2,4,5-T has not been determined, 2,4-D absorption is 5.8%. Malathion is 6.8%, and ethion is 3.3.%.

The Agency acknowledges that it may be more appropriate to use the absorption rate of 5.8% for 2,4-D determined by

Maibach and Feldman (1974) since one would expect the absorption rate to be much like 2,4,5-T. It should be remembered, however, that that absorption rate was based on a five-day urinary excretion of radioactivity. Consequently, the 5.8% is a minimal value for 2,4-D. In addition to the values for malathion and ethion, Maibach and Feldman also gave absorption values for other compounds. One, carbaryl, was as high as 73.9%. Diquat at 0.3% and ethion at 3.3% are the only pesticides with absorptions below 2,4-D. Thus, although the 10% value may be too high, it may also be too low.

(iii) Duration of Dermal Exposure

Several respondents challenged the Agency's estimate of duration of dermal exposure as too long because the Agency assumed that exposure would be for a full working day. Respondents argued that exposure time is more appropriately equated with spraying time.

Evidence to support the respondents' view was not provided in their submissions. The Agency feels that as a starting point in estimating dermal exposure, the time the skin is exposed to spray could be roughly equated to spraying time, including additional increments of direct spray exposure time assuming that some applicators make multiple applications each day. In addition, even after

actual direct spraying, deposited spray may remain on the applicators' skin and continue to be absorbed throughout the entire working day, or part of it until the worker washes deposited spray from the skin. Further, dermal exposure from and through clothing is possible during the spray operation and afterward until the applicator removes contaminated clothing.

(c) Inhalation Exposure

Dow Chemical Company (30000/26:#16), the American Paper Institute and National Forest Products Association (30000/26:#1023) challenged the Agency's estimate of inhalation exposure on the basis of the type of spray used in 2,4,5-T application. They argued that inhalation exposure would be negligible because a very coarse spray or microfoil is used.

The Agency agrees that coarse sprays will present less of an inhalation hazard than a fine spray, and that under usual conditions of usage, 2,4,5-T is applied as a coarse spray. Therefore, inhalation exposure may be negligible when 2,4,5-T is applied as a coarse spray, particularly when compared to dermal exposure under the same conditions.

(d) Application Procedures

Numerous respondents challenged the Agency's exposure estimates because of differences in application procedures. They argued that normal application practices would significantly reduce the levels of exposure cited in Position Document 1. Among the conditions suggested by the respondents were (1) lower application rates; (2) differences in application techniques (e.g., backpack basal application, where the spray is directed toward the lower stem and root collar); (3) reduced flying and application times; and (4) differences in application techniques (e.g., use of large-nozzle, low-pressure sprayers, which results in less fine spray or aerosols).

The Agency acknowledges that each of these application procedures can reduce the amount of exposure. However, none of them would eliminate exposure completely, and the respondents do not argue that no exposure potential would exist under the changed conditions. Therefore, because the Agency has concluded that any exposure to TCDD and/or 2,4,5-T contaminated with TCDD poses a significant risk to humans, these arguments are not sufficient to rebut the risk criteria.

(e) API/NFPA/Dow Study

The American Paper Institute (API), National Forest Products Association (NFPA), and Dow Chemical Company have prepared and submitted calculations of exposure and dose levels which were designed to reflect the formulations and procedures actually used in forest applications of 2,4,5-T. These calculations were based on (1) measurements taken during routine applications of 2,4,5-T, (2) extrapolations from urinary excretion levels to dose levels, and (3) interviews with professional foresters with field experience in application of 2,4,5-T. The values calculated by Dow from the API/NFPA study ranged from 0.002 mg/kg (not detectable to 0.01) for flagmen to 0.07 (0.01 to 0.16) for mixers. Backpack sprayers averaged 0.06 mg/kg (0.02 to 0.13).

The Agency applauds the initiative taken by these respondents in the development of much needed exposure information. Based in part on this study, the Agency has reassessed its own exposure estimates published in Position Document 1, and concluded that lower estimates probably more accurately reflect normal working conditions. Because of the similarities in application rates and procedures among the many uses of 2,4,5-T, the information developed in this study is applicable to uses other than

forestry uses. However, it should be emphasized that this is one study, dealing with one set of conditions. Therefore, it may not accurately reflect potential exposure under all possible circumstances.

(3) Alternative Methods of Estimating Exposure

The Agency received a number of comments which made constructive suggestions concerning the improvement of the Agency's exposure estimate analysis. These comments, however, did not specifically challenge the exposure estimates set forth in Position Document 1. EPA appreciates the submission of these comments, some of which have assisted the Agency in the development of its more recent exposure analyses.

The Indiana State Chemist and Seed Commissioner, Dept. of Biochemistry, Purdue Univ. (30000/26:#265) stated that the Agency should have used data on the blood level of 2,4,5-T after exposure, in order to calculate levels of exposure. The Agency recognizes that information on blood levels of 2,4,5-T after exposure would be useful in determining actual exposure levels. However, there is currently an insufficient amount of valid data concerning 2,4,5-T blood levels.

William M. Upholt (30000/26:#40) suggested that the Agency should have estimated the levels of lifetime

exposure to 2,4,5-T and/or TCDD for those human subjects with appreciable exposure to those chemicals. The Agency believes that this suggestion could be useful, particularly in the case of TCDD, which may have a slow metabolic turn-over rate and consequently may accumulate in human tissue.

The Environmental Defense Fund (EDF) [30000/26:#1021] stated that the continued use of 2,4,5-T is unacceptable because of the possible cumulative effects of exposure to low levels of TCDD from multiple sources. EDF suggested that because exposure to TCDD could be caused by a variety of sources, the Agency should have taken these sources into account when estimating the level of exposure to TCDD. The Agency recognizes that the environment contains multiple sources for possible human exposure to TCDD. However, for the purpose of regulating 2,4,5-T, it is important to establish potential exposure to TCDD resulting from the use of 2,4,5-T. The omission of other possible sources of TCDD exposure in the 2,4,5-T Position Document does not mean that the Agency is not aware of, and concerned about, these other sources.

EDF also suggested that the Agency record be kept open to include the results of both the EPA human milk monitoring study and similar studies which have not yet

been completed. The Agency will make public the results of any monitoring study and include them in the 2,4,5-T record, whenever such studies are completed.

## III. RISK ANALYSIS

There are two key components to the assessment of any chemical-related risk: (1) assessment of the toxicological properties of the chemical, and (2) assessment of exposure to the chemical. The risk assessment itself is a summation of the conclusions in each of these areas. Each component has a key bearing on the conclusion. For example, a highly toxic chemical may pose low risks if exposure is low; conversely a compound of low to moderate toxicity may pose high risks if exposure is high. In the present instance, TCDD is an extremely toxic chemical, whereas purified 2,4,5-T appears to be less toxic. However, because TCDD invariably contaminates commercial samples of 2,4,5-T, the use of, and exposure to, products containing these chemicals appear to present risks to human health. This section of the Position Document presents the data and information on toxic effects, and the relation between pesticide use and exposure which indicate that the uses of 2,4,5-T appear to pose risks to human health.

### A. Toxicity in Test Animals

The studies upon which the RPAR was based are summarized with relevant rebuttal comments in Section

II of this document. The data in these studies are largely unrebutted. In addition, new data relating to the risk potential of 2,4,5-T and TCDD has come to the Agency's attention after issuance of the RPAR. These new data are summarized below.

(1) Adverse Reproductive Effects

Dow Chemical Company has recently completed the study of the effects of TCDD on reproduction in Sprague-Dawley rats exposed to low dose-levels of this chemical for three generations.*/ Dow concluded that "impairment of repoduction was clearly evident among rats ingesting 0.01 or 0.1 ug TCDD/kg per day. Significant decreases were observed in fertility, litter size, gestation survival, post-natal survival, and postnatal body weight." In addition, exposure to 0.001 ug TCDD/kg per day (the lowest level tested in this study) resulted in statistically significant increases in the percentage of pups dead at birth and/or dying before the end of three weeks of life, and in the incidence of dilated renal pelvises in some generations.

Recent reproductive studies in rhesus monkeys indicate that maternal exposure to TCDD results in an

*/ Dow has also claimed that the results of this study are confidential.

increased incidence of early spontaneous abortions and reproductive difficulties. The significance of these results in nonhuman primates should not be underestimated because of the close similarities between the reproductive systems of humans and monkeys. Long-term exposure to even minute quantities of TCDD resulted in a marked increase in spontaenous abortions in the first third of the gestational period, even where there was no evidence of maternal toxicity by clinical observation or biomedical testing. Monkeys exposed to 50 ppt TCDD (2.5 ng/kg per day) before and during pregnancy had a total fetal loss of 67% (50% by abortion and 17% as stillbirth) and fertility rate of 75%, compared with 0% and 100% in the controls. Attempts to re-breed one of the aborters resulted in an additional early abortion (Schantz et al. 1979; Memo 1979c; 1979d). When animals were treated with a higher dose, the fertility rate dropped to 25%, with one of the two gravid animals aborting in the first third of gestation. Irregularities in menstrual cycles, anovulation, and reduction in the reproductive hormones, progesterone and estrogen, were among the toxic effects seen at the higher dose. The investigators concluded that the reproductive abnormalities were most probably the result of hormone imbalance, and were apparently the result of the TCDD treatment, rather than general toxicity, because the hormonal alterations were observed before the animals became obviously ill (Allen et al. 1977; Barsotti et al. 1979).

Early abortions have also been observed in monkeys where exposure has only been for a short period of the pregnancy. An accumulated dose of 1 ug/kg (1,000 ppt) of TCDD over a three-week period resulted in a 75% abortion rate, compared with 0% in the controls. All abortions in the treated animals were during the first third of the gestational period, and the only evidence of maternal toxicity was slight chloracne in one animal, observed months later. The viable offspring produced at this dose had abnormal palate development, and three of the four at a lower dose had debatable abnormal development in the same orofacial region (Letter 1979).

The National Center for Toxicological Research (NCTR) has recently published the results of a teratological study on 2,4,5-T, using over 10,000 pregnant mice and multiple dose replications (Nelson and Holson 1978). Four inbred strains (C3H/He, C57Bl/6, Balb/C, and A/J) and one random-bred strain (CD-1) were treated daily by gavage with 15 to 120 mg/kg of technical 2,4,5-T on days 6-14 of pregnancy. Teratogenic effects were observed at 15 mg/kg in A/J mice and at 30 mg/kg in the other strains. For each strain, this was the lowest dose tested. There were significant differences in sensitivities between strains, and great variation between replications in the same strain with regard to induction of cleft palate, embyronic death,

and fetal weight reduction. According to the authors, this variability may explain why studies on 2,4,5-T using small numbers of animals fail to demonstrate teratogenicity at low doses, although the same low dose levels of 2,4,5-T were shown to be teratogenic in this study.

In another recently completed study, Dow Chemical Company reported on the effects of 3, 10 or 30 mg/kg of purified 2,4,5-T (containing less than 0.5 ppb TCDD) on reproduction in Sprague-Dawley rats.*/ Exposure for three generations to 10 and/or 30 mg 2,4,5-T/kg per day resulted in statistically significant increases in the frequency of stillborn rat pups, and/or decreased survival of the pups that were born alive. No significant effects were observed at 3 mg/kg.

In summary, TCDD produces fetotoxic effects in test animals at the lowest doses tested. For example, maternal doses as low as 0.001 ug/kg in rats and 50 ppt in monkeys have increased lethality to fetuses. To date a no-observed effect level has not been found for TCDD-related effects on reproduction in any species tested. Exposure to purified 2,4,5-T with no detectable TCDD contamination (detection

*/ Dow has also claimed that the results of this study are confidential. See previous footnote on this subject.

limit = 0.5 ppb) resulted in increased fetotoxicity at 10 mg/kg, with no significant effects in the same study at 3 mg/kg.*/

Generally, a no-effect level is viewed as a toxicological endpoint, marking a level of exposure in animals which is "safe" because there are no observable adverse effects. Toxicologists generally assume that the animal no-effect level can serve as a base for estimating exposure levels which would be "safe" for humans. The "safe" level for humans is set at some level lower than the animal no-effect level to provide a "margin of safety" that takes into account differences in sensitivities between animals and humans, and differences in sensitivities among humans. This "margin of safety" does not represent an infallible indicator of potential hazard to humans. Error could be introduced because humans are more sensitive than the test species by a greater factor than normally allowed, or by the incorrect choice of a no-effect level.

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*/ The no-effect levels determined with purportedly "pure" 2,4,5-T have little value for assessing potential human risk from exposure to 2,4,5-T, since commercial 2,4,5-T contains TCDD. Therefore, it is prudent to assume that there is no no-effect level both for TCDD and 2,4,5-T containing TCDD.

The lowest level at which TCDD has no observable effects in test animals is crucial to the Agency's determination of the risk potential of 2,4,5-T. TCDD is present in this pesticide as a low-level contaminant and thus will be present in the environment at low levels whenever and wherever 2,4,5-T is used. If there truly were a no-effect level in animals, it would be reasonable to at least begin to estimate a possible "safe" level for humans and to assess the possible risk to humans by relating this assumed "safe" level to the level of the pesticide that may be in the environment, if that level is known. However, if there were no no-effect level, any use of 2,4,5-T would result in potentially significant exposure to TCDD, because there would be no minimum level upon which to estimate a margin of safety. Thus, because adverse reproductive effects have been reported at the lowest doses tested and because these doses approach the levels at which some humans may be exposed, any exposure to TCDD or 2,4,5-T containing TCDD must be considered potentially dangerous to the human fetus.

(2) Oncogenic Effects

As summarized in Section II, at the time of the 2,4,5-T RPAR, the Agency's Carcinogen Assessment Group (CAG) had available for assessment preliminary reports of two studies and one complete study. Dow Chemical Company studied the effects of TCDD on male and female

Sprague-Drawley rats exposed to 0.022, 0.21 or 2.2 ppb TCDD, and preliminarily reported that there were statistically significant increases in the incidence of hepatocellular carcinoma in female rats exposed to 2.2 ppb TCDD. In another study using Sprague-Dawley rats, Van Miller reported that 1 ppb and 5 ppb TCDD produced a carcinogenic response in the livers of male rats.*/

Since the 2,4,5-T RPAR was issued, CAG has had an opportunity to review the complete Dow study (Kociba et al. 1978) and has concluded that the combined incidence of hepatocellular hyperplastic nodules and hepatocellular carcinoma in rats is statistically significant at both the 2,200 and 210 ppt levels.**/ Also a more recent communication to CAG from the National Cancer Institute indicated that, in their as yet incomplete study, TCDD appears to be as carcinogenic and potent as was observed in the Dow study. In addition, CAG and others have compared the carcinogenic potency of TCDD with other known carcinogens. Based on these calculations, TCDD appears to be the most potent chemical carcinogen known (several times more potent than aflatoxin).

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*/ CAG (Memo 1979b) and an EPA audit found that this study had major shortcomings in design and conduct that limited the reliability of the data developed at dose levels lower than 1 ppb.

**/ Dow has also claimed that the raw data and/or results of this study are confidential. See previous footnote on this subject.

The Agency has examined the data showing that TCDD is carcinogenic at very low exposure levels in light of other information indicating that the use and distribution of 2,4,5-T to the environment creates opportunities for human exposure to these chemicals. In view of the non-threshold concept upon which the Agency cancer policy is based (Albert et al. 1977), any exposure to TCDD poses a significant risk of oncogenic effects occurring in the exposed population.

(3) Conclusion

In summary, available information supports the conclusion that there is a real potential for human risks due to exposure to 2,4,5-T and/or TCDD. These risks primarily relate to the oncogenic and fetotoxic effects of TCDD. Because TCDD is invariably present as a contaminant of commercial 2,4,5-T, any exposure to 2,4,5-T represents a significant potential risk to the exposed human population.

B. Exposure Resulting from the Use of 2,4,5-T

The use of 2,4,5-T results in the distribution of the pesticide to air, water, non-target vegetation, soil, and other environmental components in areas where people live and work. As a result, people and their food and water supplies may be exposed directly or indirectly to 2,4,5-T and its dioxin contaminant, TCDD. This section of the Position Document details information on the exposure

potential resulting from the non-suspended uses of 2,4,5-T, particularly use on rice and rangeland. In some cases, information on exposure potential from these uses is derived from data on use practices, and in other cases this information is based on chemical residue data.

(1) Exposure due to 2,4,5-T Use on Rice

About 300,000 acres (12%) of the annual rice crop are treated with 2,4,5-T to control broadleaf and aquatic weeds. The major use areas are in Mississippi and Arkansas (93%), but some use occurs in Louisiana (6%), Missouri (1%), and California (<1%).

Greater than 99% of all application of 2,4,5-T for rice production is by fixed-wing aircraft which fly at speeds of 85 to 120 mph, 3 to 10 feet above the rice crop, when winds do not exceed 5 mph.

(a) Direct Exposure from Aerial Drift

The total rural population of the Delta region rice-growing counties is about 653,000 people with an estimated 222,000 people residing within 1/2 mile of rice fields, and an average rural population density of 40 people/square mile. When the use of the pesticide results in drift to areas of human work and habitation, people in these areas may be directly exposed to the pesticide by the inhalation and/or dermal routes.

Cotton farmers who live in the Delta rice-growing region have reported drift onto their cropland and related crop damage (30000/26:#302; #1888). These reports indicate that the pesticide has drifted beyond the spray area of the rice fields and into non-target areas. Such reports are consistent with studies showing that aerial application of other pesticides may result in drift for distances as great as 55 miles from the site of the spray operation (Akesson and Yates Undated).

(b) Contamination of Surface Waters

Application of 2,4,5-T to rice fields may result in contamination of rivers and streams. Rice fields are flooded with well water 2 to 4 inches deep and maintained at this level until about two weeks before harvest, except when producers drain their fields for an application of fertilizer in the middle of the growing season. About two weeks before harvest, the water is diverted from the fields to ditches from which the water eventually enters streams and rivers. 2,4,5-T contamination of these waters is demonstrated by data retrieved from the STORET system which indicate that 2,4,5-T residues are present in surface waters throughout the Delta region. Also, residues of 2,4,5-T have been detected in Louisiana by the National Surface Water Monitoring Program for Pesticides in the Tensas River at Tendal (12.9 ppb), the Red River at Alexandria (0.03 ppb), and the Calcasieu River near Lake Charles (0.03 ppb) during

August 1978. It is noted, however, that the monitoring programs do not distinguish between 2,4,5-T residues originating from rice, pasture, and rights-of-way uses in these areas.

In the Delta Region, especially in Louisiana, surface waters are a source of commercial and sport fishing. Although well water is recommended for crayfish confinement operations, surface water is sometimes impounded to flood the rice fields for the crayfish crop after the rice has been harvested. As a result, some the the 7.6 million pounds of fish and 24 million pounds of crayfish harvested annually in Louisiana may be cultivated in water contaminated with 2,4,5-T. This practice creates an opportunity for exposure to the local population which consumes more than 80% of the crayfish harvested each year in Louisiana. Estimates indicate that the average person in the Delta Region consumes 2.8 kilograms of freshwater catfish, mostly from local sources, each year.

Because surface waters in this area are used for drinking water and local fish cultivation, the Agency has considered these waters as a possible source of human exposure to 2,4,5-T. For example, in Louisiana rice-growing areas where 2,4,5-T is used, 6,000 people (<1%) derive their drinking water from surface sources. However, in rice-growing areas of Mississippi and Arkansas, the majority of the population obtains drinking water from deep wells.

The exposure of these populations would be greater if the ground water also is contaminated. However, because 2,4,5-T has a half-life ranging from 2 to 7 weeks, and TCDD residues though stable, are relatively immobile in soil, the Agency assumes that contamination of ground water from the rice use is generally unlikely.

(2) Exposure due to 2,4,5-T Use on Rangeland

(a) Use Practices and Populations Exposed

2,4,5-T is used on rangeland throughout the country, but major usage occurs in Arizona, Arkansas, Kansas, Missouri, New Mexico, Oklahoma, and Texas where about 1.4 million acres of rangeland are treated annually with 2,4,5-T. Estimates indicate that 47,000 people reside within 1/4 mile of the treated areas. Rural population density is generally 3 to 4 people/sq mi with one exception of 16 people/sq mi in central Missouri.

Ninety percent of the 2,4,5-T is applied by fixed-wing aircraft which fly at speeds of 85 to 105 mph, 10 ft above vegetation in winds that do not exceed 10 mph. The average spray droplet size is 300 microns, and drift control agents are used to reduce spray drift in 50% of the applications. Ground rigs and backpack spray units are used to treat small areas or especially troublesome areas. Droplet size ranges from 200 to 300 microns when applied with these units. Estimates indicate that about 0.1 to 6% of the spray would be 100 microns or less and could drift away from the target area when these methods are used to apply 2,4,5-T.

The amount and formulation of 2,4,5-T used depends on the kind of vegetation being treated and the density of the growth in the area (see Table 1). Both amine and low volatile ester formulations of 2,4,5-T and silvex are used, frequently in emulsions of water or oil during the spring and summer.

Rates of 0.5 to 2.0 pounds a.i./acre, in 1 to 4 gal/acre volumes are used, but 2 gal/acre volumes are used by 50% of the applicators. Average droplet size is 300 microns, and half of the applications are made with drift control agents. Treatment schedules vary from 1 to 3 consecutive years, depending on the severity of the problem, followed by retreatment 5 or more years later depending on the need.

(b) Water and Soil Residues

The STORET system contains data which show 2,4,5-T residues in water and sediment in the major rangeland use areas, and residues of 2,4,5-T have been reported in several Western streams during monthly monitoring for chemical residues at U.S. Geological Survey stations. However, because 2,4,5-T may have been used on rights-of-ways or pastures in the localities where the residues were detected, it has not been determined whether rangeland use of 2,4,5-T is the source of these residues. The National Surface Water Monitoring Program for Pesticides has not detected 2,4,5-T in surface water in these areas.

Studies indicate that 2,4,5-T residues on rangeland decline after application. For example, residues of 2,4,5-T on grasses immediately after application of 4 pounds/gallon, 3 gallons/acre at four sites in California, Michigan, North Carolina, and Texas ranged initially from 684 ppm to 1,668 ppm but declined to an average of 3 ppm after 16 weeks (Leng 1972). Residues of 2,4,5-T applied at 2 and 4 pounds a.i./acre in run-off water from cleared watersheds averaged 2.1 ppm three weeks after application but were below the limit of detection after two months (Lawson 1976). The hydrolytic half-life for 2,4,5-T has been estimated to be less than 14 days and about 2 to 7 weeks in soil. The half-life of TCDD residues is estimated to be one year in soil, but TCDD residues are not found deeper than 6 inches below the soil surface (Kearney et al. 1972; Helling et al. 1973).

(3) Exposure due to 2,4,5-T Use on Non-crop Sites

2,4,5-T is used to treat many broadleaf, herbaceous, and that may be present in a variety of urban and rural non-crop areas such as hedgerows, storage areas, and vacant lots. Recent data regarding the extent of 2,4,5-T used for these purposes is unavailable.

2,4,5-T is used throughout the country for this kind of weed control. The most common formulations are the low volatile esters. Ground rigs are used to treat large areas but hand held application devices are frequently used for spot treatments in small areas. The Agency has no estimate of the number of people that use 2,4,5-T or the number of people in the immediate vicinity of these spray sites because of their heterogeneous nature.

Exposure for this kind of usage appears to be confined to the applicator and those people residing or working in the immediate vicinity of the spray area. Information from studies of forest workers who apply phenoxy-herbicides with backpack sprayers indicates that it may be possible for the applicator to contact 0.8 ppb of the chemical spray due to dermal exposre and 0.3 ppb due to inhalation exposure (Lavy 1978). Therefore, the Agency is concerned about the exposure that may result due to direct contact as well as drift.

Table 1. 2,4,5-T Application Rates on Rangeland by Different Treatment Methods

| Application Site | Application Method | Region Applied | Application Rate | Number of Applications |
|---|---|---|---|---|
| Mesquite | Aerial | South Texas Plains | 0.67 pounds acid equivalent per acre | 3 consecutive seasons; retreatment in 16 years |
| | | Rolling Plains of Texas and Oklahoma | 0.5 pounds a.e./acre | one application; retreatment in 8 years |
| | | Rolling Plains of Texas and New Mexico | 0.5 pounds a.e./acre | one application; retreatment in 10 years |
| | | Gulf Coast and Coastal Prairie | 1 pound a.e./acre | one application; retreatment in 5 years |
| | | South Texas Plains | 1 pound a.e./acre | one application; retreatment in 5 years |
| | | | 1 pound a.e./acre of 2,4,5-T + picloram (50:50) | one application; retreatment in 5 years |
| | | Southwest | 0.5 pounds a.e./acre | one application; retreatment in 10 years |
| Post and Blackjack Oak Savannah | Aerial | | 2 pounds a.e./acre | one application; retreatment in 5 years |
| | | | 2 pounds a.e/acre 1st year & 1.5 to 2 pounds a.e. per acre 2nd year | one application; retreatment in 10 years |

Table 1. Continued

| Application Site | Application Method | Region Applied | Application Rate | Number of Applications |
|---|---|---|---|---|
| Hardwoods within Post and Blackjack Oak Savannahs | Aerial | | 2 pounds a.e./acre | for 2 seasons; retreatment in 10 years |
| Sand Shinnery Oak | | | 0.5 pounds a.e./acre | for 2 seasons; retreatment in 10 years |
| | | | 0.5 pounds a.e./acre | one application; retreatment in 5 years |
| Cactus | | | 2 pounds a.e./acre | retreatment in 20 years |
| Yucca | | | 0.67 pounds a.e./acre | retreatment in 10 to 15 years |
| Mesquite and Oak | Broadcast Ground Application | | 2 pounds a.e./acre | one application; retreatment frequency varies from 5 to 10 years |
| Yucca | | | 0.67 pounds a.e./acre | one application; retreatment in 10 to 15 years |
| Mesquite, Oaks, and other species | Spot Treatment | | 8 to 16 pounds aehg oil for bark treatment, or 6 to 8 pounds aehg water-oil emulsions for basal-stem treatments | |

C. Epidemiologic Data

The risk assessment for 2,4,5-T is based in part on data showing that exposure to 2,4,5-T and/or TCDD results in tumors, and dead and deformed offspring in test animals, and that the uses of the pesticide create opportunities for exposure to humans. Together these facts suggest that if the use of the pesticide results in human exposure, humans who live and work in areas of use may experience the kinds of adverse health effects observed in test animals.

This reasoning is borne out by the results of a recent epidemiological study which reported that women living in the vicinity of Alsea, Oregon, have a statistically significant higher incidence of spontaneous abortions (miscarriages) than women living in a control area. Alsea is an area in which two dioxin-containing pesticides, 2,4,5-T and silvex are used extensively for forest management and on rights-of-way. Additional analyses of the data indicate that there is a significant correlation between the use of 2,4,5-T in the study area and the subsequent increase in the rate of spontaneous abortions in the study area.*/

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*/ The Alsea study was analyzed using 2,4,5-T data. However, the serious implications of this study are as applicable to silvex as to 2,4,5-T, because TCDD, the contaminant contained in both herbicides, is a potent mammalian fetotoxin and teratogen at very low doses. Conversely, silvex and 2,4,5-T are fetotoxic and teratogenic at comparatively higher doses. It is reasonable to assume that the adverse human reproductive effects observed in Alsea, which have been attributed to low-level exposure to 2,4,5-T, are due primarily, or at least in part, to the TCDD in the 2,4,5-T. Therefore, since silvex also contains TCDD, it is prudent to conclude that the Alsea data are applicable to silvex use when evaluating potential reproductive risk to humans. [See 44 FR 15904].

This relationship between exposure to 2,4,5-T spraying and an increased incidence of miscarriages in humans is not surprising. This is the same relationship that has been demonstrated to exist in test animals through numerous animal studies. While there are uncertainties concerning the amount of 2,4,5-T and/or TCDD to which the Alsea area women may have been exposed and concerning the precise route (or routes) of human exposure, the statistically significant incidence of miscarriages described above, coupled with the uncontestable data from the animal studies, makes it reasonable to conclude that women in the Alsea study area may be exposed to, and adversely affected by, 2,4,5-T, silvex and/or TCDD. Moreover, it is also reasonable to assume that the same type of effects may occur wherever and whenever 2,4,5-T or silvex containing TCDD is used.

Further, the Alsea experience may not be an isolated incident. Reports of people adversely affected by exposure to phenoxy herbicides and/or TCDD have frequently appeared in medical and scientific journals. Recent summaries appear in IARC, NRCC, and U.S. Air Force documents on phenoxy herbicides and dioxins. In addition, as a result of the 2,4,5-T RPAR, the Agency has received numerous accounts of adverse human health effects which the reporters attributed to phenoxy herbicides and/or TCDD. The cumulative effect of these reported incidents suggests that people who live and/or work in areas of 2,4,5-T use may experience adverse health effects.

## IV. Preliminary Benefits Analysis of 2,4,5-T Use on Rangeland, Rice, and Non-crop Areas

### A. Introduction

This preliminary analysis is an economic assessment of the impact of the cancellation of 2,4,5-T for use on rangeland, rice, and non-crop uses. The analysis assumes that silvex also will be cancelled for these uses. In view of the virtually identical toxicological characteristics of the two compounds and the similar nature of the benefits for both, it is unlikely that one would be cancelled and not the other.

The information relating to the benefits of 2,4,5-T used in this report was derived principally from a single source: The Biologic and Economic Assessment of 2,4,5-T ("USDA Assessment Report") [USDA 1979].*/

In addition, benefits information submitted by registrants, users, and other parties in response to the RPAR notice on 2,4,5-T was used in the analysis where appropriate.

There are some disadvantages to the heavy reliance of this analysis upon the USDA Assessment Report for the rangeland and rice information. As is commonly the case in

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*/ This report was prepared jointly by the USDA-States-EPA 2,4,5-T Assessment Team, established pursuant to a memorandum of understanding between USDA and EPA.

assessing benefits of pesticides, the available information reported and analyzed in the USDA Assessment Report was a mixture of empirical data and expert opinion and did not lend itself to precise statistical analysis. Thus, the estimates reported in this analysis and based on the USDA Assessment Report represent rough predictions of the impact of cancellation. The lack of confidence intervals or error terms does not imply exact precision. The estimates are merely approximations of the projected impacts, within the limitations of the data and analyses.*/

The general approach of this analysis is to evaluate the impacts of shifting to alternatives at the user level and projecting these impacts to the market and consumer levels where appropriate. Impacts on users are considered on a per-unit, per-establishment basis, and at state, regional, and national levels.

B. Summary of Findings

(1) Rangeland

There are an estimated one billion acres of rangeland

*/ The Agency is continuing to collect and review data relating to the benefits of 2,4,5-T for rice, range and non-crop uses.

and pasture*/ suitable for grazing in the contiguous 48 states, plus 351 million acres in Alaska and 3 million acres in Hawaii. About 90 percent of this total acreage is rangeland. Of this total, about one percent is treated with herbicides, primarily 2,4-D.

2,4,5-T is used to control various woody and herbaceous plants on about 1,500,000 acres of rangeland. The most important weed species treated are mesquite and several species of oak. Cactus, yucca, poisonous plants, and desert shrubs are also treated with 2,4,5-T to a lesser extent.

The estimated impact on farm income and beef prices of cancelling 2,4,5-T on range would be slight. When compared with the U.S. total farm value of beef production (about $15 billion annually), these impacts, averaging less than $16.5 million annually, are relatively small (0.1 percent). In those local areas where target weed species are a problem, local farm income may be affected significantly. Adequate information to evaluate such local impacts is not available. At the retail level, cancellation of 2,4,5-T for use on rangeland could cause the consumer price index for food and beverages to increase by a maximum of 0.05 percent, an insignificant increment.

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*/ "Rangeland" is land producing forage for animal consumption harvested by grazing, which is not cultivated, seeded, fertilized, irrigated, or treared with pesticides or other such similar practices on an annual basis. Fencerows enclosing range areas are included as part of the range. This precludes land listed in the definition of pasture. "Pasture" is land producing forage for animal consumption, harvested by grazing, which has annual or more frequent cultivation, seeding, fertilization, irrigation, pesticide application and other similar practices applied to it. Fencerows enclosing the pastures are included as part of the pasture.

(2) Rice

Over 99 percent of the 2.5 million acres of U.S. rice-growing acres are located in Arkansas, Louisiana, Texas, Mississippi and California. 2,4,5-T is currently used to control broadleaf and aquatic weeds on an estimated 300,000 acres in the lower Mississippi Valley area comprising about 12 percent of U.S. rice acres.

Propanil and 2,4-D are the most likely substitutes for 2,4,5-T for control of rice weeds. These chemicals are thought to be generally less effective than 2,4,5-T for control of the major rice weeds; thus yield and quality reductions may occur where propanil and 2,4-D are used to replace 2,4,5-T. The substitution of these chemicals for 2,4,5-T could result in production reductions of less than 0.1% of national production.

If 2,4,5-T is cancelled for use on rice, annual producer weed control cost increases and production losses are estimated at about $6 million per year.
Prices received by farmers, and ultimately paid by consumers, could increase by about five percent within three years. Since rice comprises only a small portion of the U.S. consumer's diet (consumption of milled rice is less than eight pounds per capita annually), price increases of this magnitude will have only minor impacts on consumers.

(3) Non-crop Uses*/

. 2,4,5-T is registered for control of many broadleaf and herbaceous weeds in a variety of urban and rural non-crop areas such as hedgerows, storage areas, and vacant lots. It is believed that only about 11% (190,000 acres) of all non-crop areas treated with herbicides are treated with 2,4,5-T annually.

Both chemical and non-chemical controls are available as alternatives to 2,4,5-T for chemical control in non-crop areas. The chemical alternatives include 2,4-D, picloram, dicamba, AMS, and amitrole. Non-chemical controls include mechanical methods, such as mowing or shearing, and manual methods. The relative efficacy of the alternatives in comparison to 2,4,5-T is unknown. However, it is believed that chemical alternatives, either in multiple applications or in combination, will be widely substituted for 2,4,5-T and will provide equivalent control.

*/ "Non-crop uses" include: airports; fences, hedgerows not otherwise included among the previously suspended uses, e.g., rights-of-way, pasture); lumber yards; refineries; non-food crop areas; storage areas; wastelands (not otherwise included among the previously suspended uses, e.g., forestry); vacant lots; tank farms; industrial sites and areas (not otherwise included among the previously suspended uses, e.g., rights-of-way).

## C. General Production and Use Patterns

### (1) Production, Imports, and Exports

2,4,5-T is produced domestically by The Dow Chemical Company, Rhodia, Inc., Thompson-Hayward Chemical Co., and Transvaal Inc. Since 1970, 2,4,5-T production has declined. Current production is in the range of 7.0 to 9.0 million pounds annually. Imports of 2,4,5-T in 1977 were estimated at 670,000 pounds, well above the 341,000 pound average for the previous five years. Total domestic use of 2,4,5-T is estimated to have been about 9.0 million pounds of active ingredient for 1977.

### (2) Quantitative Usage Analysis

The use of 2,4,5-T on rangeland and rice comprises about 23 percent (2.1 million pounds) of the estimated 9.0 million pounds of 2,4,5-T active ingredient used annually and 38 percent (1.8 million acres) of the 4.7 million acres treated annually with 2,4,5-T (Table IV-1). Rangeland use of 2,4,5-T accounts for 20 percent of the active ingredient and 31.9 percent of the acres treated; however, only 0.2 percent of grazing acreage in the U.S. is treated annually with 2,4,5-T. Rice usage of 2,4,5-T (300,000 pounds on 300,000 acres), while minor compared with the extent of usage on rangeland, represents nearly 12 percent of the U.S.

rice acreage and about 28 percent of rice acres in the lower Mississippi Valley area. Recent data on the use of 2,4,5-T for non-crop areas is not available. However, a 1974 report indicates that 2,4,5-T and 2,4,5-T + 2,4-D products combined were used on a total of 190,000 acres, or only 11% of the total 1.8 million acres treated with one or more of 15 chemicals for grounds maintenance on these sites.

Table IV-1. Quantitative Usage Analysis of 2,4,5-T

| Site | Estimated U.S. Acreage | Extent of Use* Active Ingredient | | Units Treated | | Acres Treated As a Percent of Total U.S. Acres |
|---|---|---|---|---|---|---|
| | (millions acres) | (million) (pounds) | (Pct) | (million) (acres) | (Pct) | |
| Range | 900.0 | 1.8** | 20.0 | 1.5 | 31.9 | 0.2 |
| Rice | 2.5 | 0.3 | 3.3 | 0.3 | 6.4 | 12.0 |
| All Sites*** | — | 9.0 | 100.0 | 4.7 | 100.0 | — |

* USDA-1979.
** Includes both aerially and ground applied. Approximately 1.6 million pounds are aerially applied.
*** Includes estimated usage on Rights-of-way, Pasture, and Forestry.

## D. Preliminary Benefit Analysis of 2,4,5-T Use on Rangeland

### (1) Current Use

A wide variety of herbaceous and woody plants grow on rangelands. The major weed species controlled with 2,4,5-T, such as mesquite, post oak, blackjack oak, and sand-shinnery oak, compete with the desired forage species

for nutrients, water, space and light. Other important species controlled with 2,4,5-T are cactus, miscellaneous hardwoods and plants poisonous to livestock. The most serious problems, and the majority of 2,4,5-T use, occur on rangeland in the southwestern U.S.

Estimates of acres treated are available only for the major weed pests treated with 2,4,5-T; thus, the analysis is limited to the use of 2,4,5-T to control mesquite and various oak species. Of about 93 million acres of mesquite-infested rangeland in the Southwest, an estimated 570,000 acres are treated with 2,4,5-T annually. This figure includes about 183,000 acres treated with mixtures of 2,4,5-T and picloram. Over the life of the control cycle for mesquite, about 5.4 million acres are treated with 2,4,5-T.

The post-blackjack oak savannah infests about 35 million acres in Texas, Arkansas, Oklahoma, Kansas, and Missouri. An estimated 460,000 acres of this savannah area are treated with 2,4,5-T (920,000 pounds) annually for control of post and blackjack oaks. Over the life of the control cycle, an estimated 2.3 million acres are treated.

Sand-shinnery oak infests about 14 million acres in Texas, Oklahoma, and New Mexico. Each year, about 382,000 acres are treated with 2,4,5-T (382,000 pounds). Over the life of the control cycle, 3.8 million acres are treated.

2,4,5-T is applied both aerially and by ground methods on range. This analysis evaluated only aerial application for the control of mesquite and the specified oak species on rangeland in the southwestern U.S. Aerial applications are believed to account for the vast majority of 2,4,5-T treated acres. For mesquite control by aerial application, dicamba is likely to be the most viable alternative to 2,4,5-T. There is no registered and effective substitute for aerial treatment of the oak species.

Other registered chemical alternatives as well as non-chemical controls not analyzed here are effective against one or more of the various range weeds controlled by 2,4,5-T. However, these chemicals are either not registered for aerial use or are not effective when applied aerially. Thus, these alternatives are not likely to replace the majority of 2,4,5-T use. Where ground application, especially spot treatment, is adequate, one or more of these alternatives will generally provide effective control depending on the nature and complexity of the weed problem. Thus, the alternatives, other than dicamba, may provide some weed control in the absence of 2,4,5-T for rangeland.

The following analysis is based on an assumption that dicamba will be the primary alternative to 2,4,5-T. The use of this assumption reflects the utility of dicamba for aerial treatments, the prevalent method of application of 2,4,5-T. Economic impacts of the cancellation of 2,4,5-T on rangeland using ground application methods has not been quantitatively evaluated. However, since very few acres are treated by this method and because alternatives are available, the impact of cancellation would be quite small.

To control mesquite, 2,4,5-T aerial application rates vary from 0.5 to 1.0 pounds acid equivalent (a.e.) per acre applied alone and 0.25 to 0.5 pounds a.e./acre applied in

combination with picloram. To control oak, aerial application rates vary from 0.5 to 2.0 pounds a.e. per acre for 2,4,5-T. An estimated 1.6 million pounds a.e. of 2,4,5-T are applied to control these weeds annually--340,300 pounds to control mesquite and 1.3 million pounds to control oaks.

The quantity of dicamba used currently on rangeland is not known. However, the USDA Assessment Team predicted that if 2,4,5-T were cancelled, an estimated 217,000 pounds a.e. of dicamba would be used annually to control mesquite.

(2) Evaluation of 2,4,5-T and Alternatives

Information, including research, from experts on the USDA Assessment team suggests that dicamba is as effective as 2,4,5-T against mesquite in some areas. In other areas, the experts believed dicamba would not be effective. No other registered chemical is believed to be effective against oaks when applied aerially. Substitute treatment of oak infested acres would be limited to more expensive ground application treatments. It is likely that on many acres treatments will be foregone.

In those areas where dicamba would be as effective as 2,4,5-T against mesquite, no yield effects would occur. Beef production would be reduced on those acres where dicamba was not effective against mesquite and on oak infested acres not treated. Thus, it was estimated that

total U.S. production losses would be about 21.5 million pounds of beef in the first year and would increase progressively during each of the following years until other alternatives become available.

Equally concentrated solutions (4 pounds a.e./gal.) of 2,4,5-T and dicamba cost $15 and $36 per gallon, respectively. This difference in herbicide material cost is reflected in increases in the total application cost for mesquite control. For example, at an application rate of 0.5 pounds a.e. per acre, the aerial application cost, including herbicide material, diesel oil, flaggers, and application is $4.35 per acre for 2,4,5-T and $6.85 per acre for dicamba.

Table IV-2. Costs of Aerially Spraying 2,4,5-T and Dicamba

| Herbicide | Farm Price | Application Rate | Application Cost | |
|---|---|---|---|---|
| | | | Herbicidal Material | Total[a/] |
| | $/gal. | lbs./acre | -$/acre- | |
| 2,4,5-T | 15 | 0.50 | 1.88 | 4.35 |
| | | 0.67 | 2.51 | 4.75 |
| | | 1.00 | 3.75 | 6.75 |
| | | 2.00 | 7.50 | 11.00 |
| Dicamba | 36 | 0.50 | 4.50 | 6.85 |

a/ Includes herbicide, diesel oil, flaggers and applications.
Source: USDA-1979.

(3) Economic Impact

(a) User Impacts

The economic impacts at the user (ranch) level were estimated for six delineated mesquite areas and two oak areas. The areas were delineated on the basis of differences in woody plant species, beef production, stocking rates, life span of treatment, and various other factors. The effects of cancelling 2,4,5-T were estimated over a 16-year period and discounted to 1978.

The 16-year period was chosen as a convenient long-term period because in some areas 2,4,5-T treatment provides control for 16 years. One disadvantage of projecting impacts over a long period in which all factors are assumed to remain constant is the possibility, if not the likelihood, that new control techniques and/or tools (chemical or non-chemical) will come into use during that period. In addition to the chemical alternatives now registered for range use, several promising herbicides are currently under review for registration. Economic impacts could be substantially reduced by the advent of cheaper or more efficacious controls than the alternatives initially evaluated. It is not now possible to assess the impact of potential alternatives upon future range weed control practices.

The cancellation of 2,4,5-T for control of mesquite and oaks could result in increased control costs, decreased beef production or both. The estimated first-year impacts of 2,4,5-T cancellation is $5.6 million. The cumulative 16-year estimated impact, discounted at a 7 percent rate and expressed in 1978 dollars is $262.5 million. (Note items 2, 3, and 4 under "Limitations and Assumptions," below). If no control is practiced, the 16-year impact is estimated to be $347.5 million.

On a per-acre basis, the reduction in average annual returns from beef production in different areas are estimated to range from 3.6% to 42% if dicamba replaces 2,4,5-T. If no control is used, the change in value of beef production varies from a gain of $0.10 per acre in one area to a reduction of $6.53 per acre in another area.

(b) Market/Consumer Impacts

The market and consumer impacts of the cancellation of 2,4,5-T were evaluated using a standard, computerized beef marketing model to simulate the markets. The model used the liveweight livestock production impacts from the USDA Assessment Report and estimated market and consumer impacts after allowing normal adjustments in the marketplace. Based on historical data, market prices and consumption were

predicted for 12 years into the future, assuming all factors remain constant. Impacts were then measured as changes caused by cancellation of 2,4,5-T and silvex.

During the early years following cancellation, beef slaughter (and domestic consumption) was estimated to rise as affected ranchers reduced their herd size. The temporary increase in supply was reflected in depressed beef prices. Then, after the fifth year, as the market continued to adjust, beef slaughter declined and prices rose.

Over the 12-year period, the change in prices for utility cows and choice steers at Omaha varied from a low of -0.03 percent to a high of 0.36 percent. The change in prices averaged $0.06/cwt ($0.0006/pound). The Wholesale Price Index for Farm Products was higher by an average of 0.084 percent annually.

Domestic disappearance of nonfed beef averaged 25 million pounds higher than the control condition for the first five years and 21 million pounds lower than the control condition during the next seven years. Over the 12-year period, there was an average annual reduction of 1.7 million pounds of nonfed beef. This reduction amounted to 0.025 percent of domestic disappearance of nonfed

beef (6.8 billion pounds annually) and 0.007 percent of total domestic disappearance of beef (fed and nonfed; 25.2 billion pounds annually).

At the consumer level, the Consumer Index for Food and Beverages increased by no more than 0.046 percent in any year and had an average increase of 0.03 percent annually.

Based on the fractional changes in prices and consumption attributed to cancellation of rangeland uses of 2,4,5-T, the market and consumer level impacts would be insignificant.

(c) Limitations and Assumptions

In addition to the limiting factors discussed in the general introduction to this economic analysis, the following specific limitations and assumptions are applicable to the foregoing market/consumer impact analysis.

1. The economic assessment is taken from the USDA Assessment Report. Since the completion of this evaluation, there has been some reinterpretation of the base acreages treated with 2,4,5-T. Some of the mesquite acreage reportedly treated with 2,4,5-T (single active ingredient) was actually treated with a combination of picloram and 2,4,5-T. Similarly, for the oaks, some acreage reportedly treated with 2,4,5-T

was treated with silvex. This assessment includes the most recent estimates of acreage treated with 2,4,5-T, picloram + 2,4,5-T, and silvex. The total acreage evaluated, either for individual areas or in the aggregate, has not changed.

However, the picloram + 2,4,5-T combination is more expensive than 2,4,5-T alone. Therefore, the effect of this change is to increase the base cost-of-control (current situation) and reduce the estimated economic impact. The exact amount of this reduction has not been calculated, but the acreage involved and the cost difference per acre do not appear large enough to affect the basic conclusions of this report. If 2,4,5-T is cancelled, dicamba will be the major alternative in those areas and on those weed species where it is effective.

2. The analysis was limited to weed species evaluated (mesquite and selected oaks), the method of application (aerial), and the geographic area (southwestern U.S.). However, it is believed that this analysis accounted for the majority of 2,4,5-T used on U.S. rangeland.

3. Benefits were estimated solely on the basis of beef production, although control of weeds with 2,4,5-T may also produce other benefits in terms of increased watershed yield and possible adverse effects on wildlife production. It was not possible to quantify these factors based on available information.

4. In discounting future net returns it was assumed that no new alternative controls would become available, no adjustments in management practices would substitute for 2,4,5-T, and no technological changes in beef production would occur during the 16-year period of analysis. In the short-term this assumption may be realistic but in the long-term, e.g., greater than 5 years, it is not. Other chemicals are currently being tested, and it is likely that one or more of these would be registered within a few years.

5. This analysis did not quantify localized impacts which are likely to result from a cancellation of 2,4,5-T.

6. Costs of production, other than weed control costs, were assumed to remain fixed regardless of changes in herd size. In reality, some of these costs, e.g., supplemental feed or pond maintenance, are variable, increasing or decreasing with changes in herd size.

## E. Preliminary Benefit Analysis of 2,4,5-T Use on Rice

### (1) Current Use

#### (a) Pest Infestation and Damage

Weeds reduce the yield and quality of rice in the U.S. by an estimated 15 percent each year on about 2.5 million acres; the average yearly loss was valued at about

$165 million during the 1975-1977 period. The cost of using herbicides to prevent greater losses was about $60 million each year during the same period. The cost of cultural practices (including crop rotation, land preparation, irrigation, and fertilization) during this period, was estimated at $70 million. Thus, the total estimated direct losses and expenditures for weed control were $295 million annually for the 1975-1977 period.

Conditions favorable for growing rice also favor the growth and reproduction of many terrestrial, aquatic, and semi-aquatic weeds. Weeds in rice produce an abundance of seed. Once these infest the land, they are difficult to remove and may remain viable in the soil for many years. Rice weeds reduce yields by direct competition and reduce quality through contamination of the harvested grain with weed seeds.

The principal weed pests for which 2,4,5-T use is most important include hemp sesbania, northern jointvetch, morningglory, ducksalad, and redstem. Without weed control it is estimated that 13% yield and 4% quality reductions on rice in the 2,4,5-T use area would occur.

(b) 2,4,5-T and Alternatives

Herbicides registered for use in rice may be classed into three groups: (1) those that control grass weeds

(propanil and molinate); (2) those that control broadleaf and aquatic weeds (2,4,5-T, 2,4-D, MCPA, silvex, and bentazon); and (3) those that control a combination of grass, broadleaf, aquatic, and sedge weeds (bifenox and oxadiazon). The pesticides in the last group of herbicides were registered for use on rice only recently, and they are usually combined with propanil to achieve satisfactory control. Copper compounds (copper sulfate and copper complexes) are used for control of green and blue-green filamentous algae in rice, but the efficacy of these compounds is erratic. Endothall is registered and used only in California for the control of submerged aquatic weeds in rice; it is not effective on the immersed aquatic weed complex in the lower Mississippi Valley area.

Cultural practices and other non-chemical means may be practical for control of weeds in some circumstances and could mitigate some of the economic impacts that might result from the cancellation of 2,4,5-T. However, these alternatives have not yet been evaluated in depth. Thus, the following analysis is based on the assumption that only chemical alternatives would be used to replace 2,4,5-T.

(c) Use of 2,4,5-T and Chemical Alternatives

Based on information collected by experts on the USDA Assessment Team, it was estimated that about 98% of the 2.5

million U.S. rice acres receive one or more annual applications of herbicides for control of rice weeds. Currently, 2,4,5-T is applied to an estimated 300,000 acres annually. This amounts to only 12% of all rice acres treated with herbicides. At the most common application rate of one pound of 2,4,5-T a.e. per acre, 300,000 pounds of 2,4,5-T are used annually.

Virtually all 2,4,5-T use on rice occurs in four lower Mississippi Valley states (Arkansas, northern Louisiana, Mississippi, and Missouri). The majority of rice acre-treatments of 2,4,5-T were applied in Arkansas (177,000 acres) and Mississippi (101,000 acres) with a lesser number of acre-treatments in northern Louisiana (18,000 acres) and Missouri (4,000 acres). The rice acreage treated with 2,4,5-T in each state ranges from three percent in Louisiana to 71 percent in Mississippi, with 21 and 25 percent in Arkansas and Missouri, respectively. Major rice producing areas of Texas and California, where 37 percent of U.S. rice is produced, use little or no 2,4,5-T.

Expenditures for 2,4,5-T use on rice (1975-77 period) averaged approximately $3 million annually or about five percent of total U.S. rice herbicide expenditures. Expenditures for rice herbicides, including application costs, generally averaged $60.8 million annually during the 1975-77 period.

(2) Evaluation of 2,4,5-T and Alternatives

(a) Comparative Efficacy and Yield Effects

2,4,5-T is thought to provide somewhat better control of broadleaf, aquatic, and sedge weeds than other herbicides. It is also believed to be less injurious to non-target crops (cotton and soybeans) than the other phenoxy herbicides, 2,4-D, MCPA, and silvex.

2,4-D is thought to be comparable to 2,4,5-T in controlling most broadleaf, aquatic, and sedge weeds and would be used more frequently if it were not highly injurious to cotton. Most rice-growing states regulate the aerial application of 2,4-D to reduce the damage to nearby cotton fields caused by spray drift. Therefore, 2,4-D could be used on only about half of the rice acreage now treated with 2,4,5-T. 2,4-D does not control northern jointvetch as effectively as 2,4,5-T and is ineffective on grass weeds.

Yield and quality losses could average two and one percent above current losses respectively, if 2,4-D were substituted for 2,4,5-T for use on rice-growing acres during the first three-year cropping cycle. During the second three-year period, yield losses could average four percent annually, and quality losses could average two percent annually.

Several other herbicides used for control of rice weeds include molinate, MCPA, bifenox, bentazon, and oxadiazon. Molinate is not thought to effectively control hemp sesbania, northern jointvetch, ducksalad, morning glory or redstem. MCPA is not used in the Lower Mississippi Valley area since it is believed to be relatively ineffective on hemp sesbania, northern jointvetch, and Indian jointvetch. Bifenox, bentazon, and oxadiazon are three new herbicides which are currently used to a limited extent; they are not believed to be as effective as 2,4,5-T on most broadleaf and aquatic weeds.

Cultural/mechanical weed control practices include summer fallowing, seedbed preparation, crop rotation, special seeding methods, management of irrigation water, cultivation, and handweeding (in sparse weed infestations or in small isolated areas). Effective weed control systems in rice should combine preventive, cultural, mechanical, and biological methods with chemical control methods. Weed management systems which omit any one of these components are often inadequate and may fail to control weeds effectively.

While some cultural/mechanical practices are effective on some rice weeds without the use of chemicals, most are not dependable or predictable tools as sole alternatives to the use of chemical herbicides.

(b) Comparative Costs

Estimated costs for using 2,4,5-T and alternative herbicides in the lower Mississippi Valley areas during 1975-77 are summarized in Table IV-3. 2,4,5-T costs are estimated at $9.50 per acre compared with $7.40 per acre for 2,4-D and $12.90 to $21.80 per acre for propanil. Bentazon, molinate, and oxadiazon material and application costs range from $13.50 to $13.90 per acre, while bifenox costs are estimated at $21 per acre.

Table IV-3. Estimated Cost of Using 2,4,5-T and Alternate Herbicides in Rice Areas, Southern Rice Producing area, 1975-1977

| Item | Unit | Herbicide | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2,4,5-T | Propanil* | | Molinate | 2,4-D | Silvex | Bifenox | Bentazon | Oxadiazon |
| | | | 1 appl. | 2 appl. | | | | | | |
| Quantity | pounds | 1.0 | 3.0 | 6.0 | 3.0 | 1.0 | 1.0 | 3.0 | 0.75 | 0.75 |
| Cost per pound | dollars | 5.50 | 3.30 | 3.30 | 3.70 | 3.40 | 5.50 | 6.00 | 14.00 | 14.50 |
| Herbicide cost per acre | dollars | 5.50 | 9.90 | 19.80 | 11.10 | 3.40 | 5.50 | 18.00 | 10.50 | 10.90 |
| Application cost per acre | dollars | 4.00 | 3.00 | 3.00 | 2.75 | 4.00 | 4.00 | 3.00 | 3.00 | 3.00 |
| Total Herbicide cost | dollars | 9.50 | 12.90 | 21.80 | 13.85 | 7.40 | 9.50 | 21.00 | 13.50 | 13.90 |

* One application of 3 pounds/acre controls many broadleaf weeds; two applications at 3 pounds/acre each control weed grasses.

SOURCE: Data adapted from Table 22, Page 4-79, USDA 1979.

(3) Economic Impact

(a) User Impacts

The following assumptions and limitations, in addition to those noted in the general introduction, are specifically applicable to the following rice user impact analysis.

(1) The analysis was limited to aerial application of 2,4,5-T, which accounts for 97.3 percent (292,000 acres) of current use. Ground application, accounting for 2.7 percent or 8,000 acres of 2,4,5-T use, were not evaluated due to data limitations.

(2) To reduce the year-to-year variability of climatic and market effects, statistics for acres harvested, per-acre production, farm level prices, and herbicide material and application costs were based on 1975-77 averages. These averages were assumed to be representative of impacted acres.

(3) To demonstrate short and mid-term effects of weeds in rice if 2,4,5-T is cancelled, two cycles of rice-soybean rotations (one year rice and two years soybeans) were considered.

Yield and quality impacts were estimated by the USDA Assessment Team for the first and second three-year crop rotation periods (1978-83). Estimated revenue impacts were discounted to present value using a seven percent discount rate.

(4) Crop production budgets, based on the opinions of research and Agricultural Extension Service personnel in rice producing areas, were used to estimate cost differences between 2,4,5-T and alternative weed-control programs.

(5) This analysis assumes no new herbicides will be registered to control rice weeds during the six-year impact period.

If 2,4,5-T is cancelled for use on rice, producers would most likely shift to weed control programs utilizing 2,4-D and propanil. Yield and quality reductions might result on those acres treated with 2,4-D and propanil because these herbicides are thought to be less effective than 2,4,5-T.

Weed-control cost increases and production losses without 2,4,5-T are estimated at $5.0., $4.7, $4.4, $6.8, $6.3 and $5.9 million, respectively, during the first six

years following cancellation. The total value of rice in the lower Mississippi Valley averaged more than $0.5 billion per year between 1975-77. Thus, in this four-state area economic impacts would range from 0.8 to 1.2 percent of the value of production. The estimated impact on U.S. rice production if 2,4,5-T is cancelled is minor, ranging from 0.04 to 0.08 percent.

During the first three-year period, estimated annual increased costs and production losses range from $12 to $21 per acre in the lower Mississippi Valley area for a weighted average of $14 per acre. During the second three-year period, estimated annual per-acre impacts range from $20 to $31 for a weighted average of $23 per acre.

Based on information from the USDA Assessment Team Report, an average of 46 acres of rice per farm in the lower Mississippi Valley area are treated with 2,4,5-T. During the first three-year period, annual losses on these 46 acres could total about $644 or 15.2 percent of net revenue per rice acre. During the second three-year period, the average annual loss on these 46 acres of rice could total $920 or 21.7 percent of net revenues per acre.

(b) Consumer and Market Impacts

The Data Resources Inc. (DRI) Model of U.S. agriculture was used to estimate regional and national producer impacts,

in terms of changed cash prices and domestic disappearance of rice if 2,4,5-T and silvex are cancelled for use on rice.

The DRI model dynamically solves for national acreage, yield, production, domestic use, export use, ending stocks, cash prices and farm prices of rice. The model is not region-specific in rice production variables. However, it is possible to solve the national model by making adjustments in the appropriate yield and acreage factors in the model and solving the model under these new conditions.

For purposes of this analysis, the following methodology and assumptions were used to make factor adjustments in the DRI model.

(1) Rice production and control cost changes as estimated by the USDA Assessment Report were used to adjust initial values in the DRI model.

(2) Based on net revenue data from the USDA Assessment Report, users of 2,4,5-T in rice-producing areas of Louisiana, Mississippi, and Missouri could shift from rice to soybean production as competition from 2,4,5-T controlled weeds increased. For the Consumer and Market analysis, rice producers in this area were assumed, at the

outset, to shift from rice to soybean production. Rice producers in Arkansas were assumed to continue rice production since rice, treated with alternatives to 2,4,5-T, is more profitable than soybeans.

(3) The DRI model was solved dynamically from the fourth quarter of 1978 through the fourth quarter of 1990 assuming 2,4,5-T and silvex are cancelled and all other alternatives are available.

Louisiana, Mississippi, and Missouri rice producers who shift from rice to soybean production could have revenue reductions ranging from $18 to $29 per acre on 120,000 acres. The addition of 120,000 acres to U.S. soybean production is small relative to total national soybean acreage (60 to 70 million acres); thus measurable impacts on soybean production or prices are unlikely.

Arkansas rice producers using 2,4,5-T will continue to produce rice rather than soybeans since rice is more profitable under any alternative weed control strategy. If 2,4,5-T is cancelled, the value of production net of treatment costs will decline by about 4.2 percent in 1980 ($2.3 million) and 2.2 percent in 1981 ($1.3 million). By 1982, the estimated value of rice production, net of treatment costs, approaches the pre-cancellation levels. Projected

prices received by both 2,4,5-T users and non-users, responding to lower rice production, increase 1.4., 3.2 and 4.7 percent, respectively, during 1980, 1981, and 1982.

Rice producers who are unaffected by cancellation of 2,4,5-T would receive net benefits from cancellation of 2,4,5-T since their production and costs would be unaffected while prices received and acres planted, responding to lower U.S. rice production, would increase above projected 1979-1990 levels. The value of production on unaffected acreage (if 2,4,5-T were cancelled) was estimated to increase 1.4, 3.4, and 5.5 percent respectively, during 1980, 1981, and 1982. Thus, much of the negative impact of the cancellation of 2,4,5-T would be offset. At both the consumer and market level, the economic impact of the cancellation would not be significant.

F. 2,4,5-T Use on Non-crop Areas*/

(1) Current Use

2,4,5-T is registered for control of many broadleaved

*/ "Non-crop areas" includes: airports; fences, hedgerows (not otherwise included among previously suspended uses, e.g., rights-of-way, pasture); lumber yards; refineries; non-food crop areas; storage areas; wastelands (not otherwise included among previously suspended uses, e.g., forestry); vacant lots; tank farms; industrial sites and areas (not otherwise included among previously suspended uses, e.g., rights-of-way).

and herbaceous weeds*/ in a variety of urban and rural non-crop areas such as hedgerows, storage areas, and vacant lots. 2,4,5-T is used because of its relatively low cost, the broad spectrum of weeds it controls and its selectivity for control of undesirable plant species.

Recent data on the usage of 2,4,5-T for non-crop areas is not available. However, a 1974 publication reported that 200,000 pounds a.e. of 2,4,5-T were used annually for general maintenance on 100,000 acres of grounds at industrial, commercial, and institutional sites. An additional 180,000 pounds a.e. of 2,4-D and 2,4,5-T combination products were also used annually on 90,000 acres on these sites. Even combined, this area (190,000 acres) is only 11% of the total 1.8 million acres treated with one or more of 15 chemicals for grounds maintenance on these sites.

(2) Evaluation of 2,4,5-T and Alternatives

Both chemical and non-chemical controls are available as alternatives to 2,4,5-T. Chemical alternatives include herbicides, such as 2,4-D, picloram, dicamba, AMS, and amitrole. The most comparable chemical alternatives are

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*/ The weeds are numerous and include the following broadleaf and woody plants: pigweed, ragweed, lambsquarters, horsenettle, cocklebur, and morning glory; oaks, poplar, cottonwood, wild cherry, maple, blackberry, honeysuckle, poison ivy, and wild grape.

combination products, such as 2,4-D + picloram, or 2,4-D + dicamba. Soil sterilants, such as sodium borate or sodium chlorate, could serve as alternatives to 2,4,5-T, although their use would involve a different weed control strategy. Rather than treating the foliage or stems of weeds after they emerge, soil sterilants are applied to the soil prior to weed emergence in anticipation of a weed problem.

Mechanical methods of control, such as mowing or shearing, or manual methods could also serve as alternatives to 2,4,5-T.

The comparative efficacy of the alternatives to 2,4,5-T is not known. The spectrum of weeds controlled by any one of the alternatives is thought to be smaller than 2,4,5-T. However, 2,4,5-T's weed spectrum may be approximated fairly closely by using a combination product or by using multiple applications of different active ingredients.

Generally, no more than one treatment with 2,4,5-T is needed annually to achieve control of the problem weeds. In some circumstances, one treatment will give control for up to four years. Combination products with 2,4-D and picloram will give comparable length of control to

2,4,5-T, but other herbicides, such as 2,4-D alone or amitrole, may require more than one treatment annually. The length of control with mechanical or manual means is unknown.

To compare the cost of using 2,4,5-T with the cost of using the alternatives, several of the most likely substitutes were identified. For ground broadcast and selective foliar sprays, 2,4,5-T is commonly used alone or in various combinations with other chemicals such as 2,4-D, picloram, or dicamba. Herbicide costs for 2,4,5-T, when used alone, are about $8.00 per acre and range from about $30.00 to $44.50 per acre when used in combination with other chemicals. In comparison, material costs for combinations of 2,4-D and picloram, or 2,4-D and dicamba, the most likely alternatives, range from about $24.00 to $42.50 per acre. Material costs for other chemical alternatives range from $2.45 per acre (2,4-D) to about $67.00 per acre (glyphosphate). However, use of these latter alternatives may require successive multiple applications with the same or several other herbicides in order to achieve control comparable to that provided by using 2,4,5-T.

(3) Economic Impact Analysis

In general, effective alternatives to 2,4,5-T exist for non-crop sites. For users of 2,4,5-T combination products, economic impacts will be slight. Effective alternative combination products which provide equally long-term

control at a comparable price are registered and available. Impacts on users of 2,4,5-T applied as a single active ingredient will be felt in the form of increased control costs for the combination alternatives. Most of the effective combination alternatives are more expensive than 2,4,5-T alone.

Little, if any, impact is expected on the market and consumer levels because effective alternatives are available and because the economic value of weed control on non-crop sites is very small.

## V. REGULATORY DETERMINATION

Section 6(b) of FIFRA provides that the Agency may move to cancel the registration of a pesticide "[i]f it appears to the Administrator that a pesticide... when used in accordance with widespread and commonly recognized practice, generally causes unreasonable adverse effects on the environment." In effect, this "unreasonable adverse effects" standard requires a finding that the risks of each use of the pesticide exceed the benefits of use, when the pesticide is used in accordance with the terms and conditions of registration or in accordance with widespread and commonly recognized practice.

Upon concluding the RPAR review of a pesticide, if the Administrator determines that the risks of use outweigh

the benefits of use, he may issue a notice of intent to cancel or deny registration, pursuant to section 6(b)(1) or Section 3(c)(6). If, on the other hand, the Administrator determines that the use of the pesticide appears to cause unreasonable adverse effects on the environment, that there are uncertainties in the data relating to the risks and benefits of this use, and that additional data on the risks and benefits will assist the Agency in determining whether or not to cancel the pesticide, he may issue a notice of intent to hold a hearing pursuant to section 6(b)(2) of FIFRA to determine whether the registration should be cancelled or applications for registration denied. In the present instance a determination to issue a notice of intent to hold a hearing on the non-suspended uses of 2,4,5-T pursuant to section 6(b)(2) is the prudent course of action.

The foregoing review indicates that exposure to 2,4,5-T and/or TCDD may result in significant adverse effects in exposed populations. Agency analysis shows that the rice, rangeland, and non-crop uses of 2,4,5-T create opportunities for direct and indirect exposure to humans through aerial drift and/or related contamination of water, food, and environmental media. Even without quantitative*/ data on levels and routes of exposure, it is clear

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*/ Because of the many varied and widespread uses of silvex and 2,4,5-T, it is difficult to ascribe residue to any one particular use.

that any exposure, particularly in the case of TCDD, whether from a single source or cumulative sources, appears to pose risks of oncogenic, fetotoxic and/or teratogenic effects in the exposed populations. Additional data on routes of exposure, relative contribution from the several uses of the pesticide in areas of multiple use, and mechanisms for reducing exposure would assist the Agency in assessing with greater precision the degree of hazard associated with the non-suspended uses of 2,4,5-T.

The estimated impact on farm income and beef prices of cancelling 2,4,5-T on range would be slight. When compared with the U.S. total farm value of beef production (about $15 billion annually), these impacts are relatively small (0.1 percent), averaging less than $16.5 million annually. In those localized areas where target weed species are a problem, local farm income may be affected significantly. Adequate information to evaluate such local impacts is not available. At the retail level the consumer price index for food and beverages could increase by a maximum of 0.05 percent, an insignificant increment.

If 2,4,5-T is cancelled for use on rice, annual producer weed control cost increases and production losses without 2,4,5-T are estimated at about $6 million per year. Prices received by farmers, and ultimately paid by consumers, could increase by about five percent within three years.

Since rice comprises only a small portion of the U.S. consumers' diet (consumption of milled rice is less than eight pound per capita annually), price increases of this magnitude will have only minor impacts on consumers.

Both chemical and non-chemical controls are available as alternatives to 2,4,5-T for weed control in non-crop areas. The chemical alternatives include 2,4-D, picloram, dicamba, AMS, and amitrole. Non-chemical controls include mechanical methods, such as mowing or shearing, and manual methods. The relative efficacy of the alternatives in comparison to 2,4,5-T is unknown. However, it is believed that chemical alternatives, either in multiple applications or in combination, will be widely substituted for 2,4,5-T and will provide equivalent control. Potential risks associated with the increased usage of these alternative chemicals, singly or in combination, has not been addressed by the Agency.

While the benefits of 2,4,5-T use on rangeland, rice, and non-crop areas are in some respects not insubstantial, these benefits do not, in the Agency's judgment, appear to offset the risks which these uses pose to humans and the environment. Accordingly, the rangeland, rice, and non-crop uses of 2,4,5-T appear generally to cause unreasonable adverse effects on the environment.

Because of uncertainties and incomplete data relating to some of the factors which enter into the risk-benefit analysis, the Agency is seeking additional data on these 2,4,5-T uses before making a final regulatory determination.

FIFRA provides for the resolution of such questions through public hearings held pursuant to section 6(b)(2). Through the hearing process, the uncertain areas become subject to public debate, new information is collected, and the Agency is able to arrive at an informed decision.

Moreover, in this case, a section 6(b)(2) hearing is particularly appropriate because section 6(b)(1) hearings on the suspended uses of 2,4,5-T are currently in progress. Because many of the issues to be reviewed and resolved are generic to both the suspended and the non-suspended 2,4,5-T uses, information and approaches developed for one category may shed additional light on the other category. Thus, a section 6(b)(2) hearing merged with the ongoing 6(b)(1) hearing would allow consolidated debate and disposition regarding all 2,4,5-T uses.

## References*/

Akesson, N.B., and W.E. Yates. Undated. Pesticides in the air environment. (Unpublished.) [Cited in Position Document 1 as Ref. #168.]

Albert, R.E., R.E. Train, and E. Anderson. 1977. Rationale developed by the Environmental Protection Agency for the assessment of carcinogenic risks. J. Natl. Cancer Inst. 58(2):1537-1541.

Allen, J.R., D.A. Barsotti, J.P. Van Miller, L.J. Abrahamson, and J.J. Lalich. 1977. Morphological changes in monkeys consuming a diet containing low-levels of 2,3,7,8-tetrachlorodibenzo-p-dioxin. Fd. Cosmet. Toxicol. 15:401-410.

Barsotti, D.A., L.J. Abrahamson, and J.R. Allen. 1979. Hormonal alteration in female rhesus monkeys fed on a diet of 2,3,7,8-tetrachlorodibenzo-p-dioxin. Bull. Environ. Contam. Toxicol. 21:463-469.

Caplan, P.E., D. Culver, and W.C. Thielen. 1956. Human exposures in populated areas during airplane application of malathion. AMA Arch. Indust. Health 14:326-332. [Cited in Position Document 1 as Ref. #167.]

Clement Associates, Inc. 1979. Exposure, toxicity, and risk assessment of 2,4,5-T/TCDD. U.S. Environmental Protection Agency, Washington, D.C. (Unpublished - CONFIDENTIAL).

Collins, T.F.X., and C.H. Williams. 1971. Teratogenic studies with 2,4,5-T and 2,4-D in the hamster. Bull. Environ. Contam. Toxicol. 6(6):865-866. [Cited in Position Document 1 as Ref. #124.]

Courtney, K.D., and J.A. Moore. 1971. Teratology studies with 2,4,5-trichlorophenoxyacetic acid and 2,3,7,8-tetrachlorodibenzo-p-dioxin. Toxicol. Appl. Pharmacol. 20:396-403. [Cited in Position Document 1 as Ref. #128.]

*/ References not listed as CONFIDENTIAL are available for examination in the office of the Special Pesticide Review Division (SPRD). References listed as "cited in Position Document 1" are available for inspection in the SPRD file for that document.

Dougherty, W.H., F. Carlston, and L. Goldberg. 1976. The evaluation of the teratogenic effects of 2,4,5-trichlorphenoxyacetic acid in the rhesus monkey. Environ. Qual. Safety 5:89-96.

Dow Chemical USA. 1977. Preliminary assessment of chronic toxicity study and three-generation reproduction study of 2,3,7,8-tetrachlorodibenzo-p-dioxin. The Dow Chemical company, Midland, Michigan (unpublished - CONFIDENTIAL). [Cited in Position Document 1 as Ref. #110.].

Dow Chemical Company. 1978. Three generation reproduction study of rats ingesting 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). The Dow Chemical Company, Midland, Michigan (unpublished - CONFIDENTIAL).

EPA. U.S. Environmental Protection Agency. 1978. Rebuttable presumption against registration and continued registration of pesticide products containing 2,4,5-T. Fed. Reg. 43(78):17116-17157.

EPA. U.S. Environmental Protection Agency. 1979. Decision and emergency suspension order suspending registrations for the forest, rights-of-way, and pasture uses of 2,4,5-T. Fed. Reg. 44(52):15874-15897.

Helling, C.S., A.R. Isensee, E.A. Woolson, P.D.J. Ensor, G.E. Jones, J.R. Plimmer, nd P.C. Kearney. 1973. Chlorodioxins in pesticides, soils, and plants. J. Environ. Quality 2(2):171-178. [Cited in Position Document 1 as Ref. #39.]

Innes, J.R.M., B.M. Ulland, M.G. Valerio, L. Petrucelli, L. Fishbein, E.R. Hart, A.J. Pallotta, R.R. Bates, H.L. Falk, J.J. Gart, M. Klein, I. Mitchell, and J. Peters. 1969. Bioassay of pesticides and industrial chemicals for tumorigenicity in mice: a preliminary note. J. Natl. Cancer Inst. 42:1101-1114. [Cited in Position Document 1 as Ref. #107.]

Kearney, P.C., E.A. Woolson, and C.P. Ellington, Jr. 1972. Persistence and metabolism of chlorodioxins in soils. Environ. Sci. Technol. 6(12):1017-1019. [Cited in Position Document 1 as Ref. #46.]

Khera, K.S., and J.A. Ruddick. 1973. Polychlorodibenzo-p-dioxins: perinatal effects and the dominant lethal test in Wistar rats. Pages 70-84 in E.A. Blair, ed., Chlorodioxins--origin and fate. Advances in Chemistry Series, No. 120. Am. Chem. Soc., Washington, D.C. [Cited in Position Document 1 as Ref. #6.]

Kociba, R.J., D.G. Keyes, J.E. Beyer, R.M. Carreon, C.E. Wade, D.A. Dittenber, R.P. Kalnins, L.E. Frauson, C.N. Park, S.D. Barnard, R.A. Hummel, and C.G. Humiston. 1978. Results of a two-year chronic toxicity and oncogenicity study of 2,3,7,8-tetrachlordibenzo-p-dioxin in rats. Toxicol. Appl. Pharmacol. 46:279-303.

Lavy, T.L. 1978. Realistic evaluation of human exposure from application of 2,4,5-T sprays. The Dow Chemical Company, Midland, Michigan [submitted to EPA in response to the 2,4,5-T RPAR].

Lawson, E.R. 1976. 2,4,5-T residues in storm runoff from small watersheds. J. Soil Water Conserv. 31(5):217-219. [Cited in Position Document 1 as Ref. #61.]

Leng, M.L. 1972. Residues in milk and meat and safety to livestock from the use of phenoxy herbicides in pasture and rangeland. Down to Earth 28(1):12-20. [Cited in Position Document 1 as Ref. #37.]

Letter. 1979. [Untitled], dated January 29, 1979. From W.P. McNulty, Oregon Regional Primate Research Center, to Mr. Mike Dellarco, Office of Pesticide Programs.

Maibach, H.I., and R. Feldman. 1974. Systematic absorption of pesticides through the skin of man. Pages 120-127 in Federal Working Group on Pest Management, Occupational exposure to pesticides. Washington, D.C.

Memo. 1979a. Response to rebuttal comments on risk assessment on 2,4,5-trichloropenoxy [sic] acetic acid (2,4,5-T) and 2,3,7,8-tetrachloro-dibenzo-p-dioxin (TCDD), dated April 4, 1979. From Roy E. Albert, Chairman, Carcinogen Assessment Group, to Harvey L. Warnick, Project Manager, Special Pesticide Review Division.

Memo. 1979b. Carcinogen Assessment Group's risk assessment on 2,4,5-trichlorophenoxy acetic acid (2,4,5-T), and 2,3,7,8-tetrachloro-dibenzo-p-dioxin (TCDD), dated February 23, 1979. From Elizabeth L. Anderson, Executive Director, Carcinogen Assessment Group, to Harvey L. Warnick, Project Manager, Special Pesticide Review Division.

Memo. 1979c. TADP review at University of Wisconsin, TCDD in rats, dated February 8, 1979. From H.W. Spencer and W. Woodrow to D. Reisa and H. Warnick.

Memo. 1979d. TCDD toxicity in various animal models, dated March 30, 1979. From H. W. Spencer, Toxicology Branch, to Patricia Roberts, Office of General Counsel.

Moore, J.A., B.N. Gupta, J.G. Zinkle, and J.G. Vos. 1973. Postnatal effects of maternal exposure to 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Environ. Health Perspec. 5:81-85. [Cited in Position Document 1 as Ref. #174.]

Muranyi-Kovacs, I., G. Rudali, and J. Imbert. 1976. Bioassay of 2,4,5-trichlorophenoxyacetic acid for carcinogenicity in mice. Br. J. Cancer 33:626-633. [Cited in Position Document 1 as Ref. #105.]

Nelson, C.J., and J.F. Holson. 1978. Statistical analysis of teratologic data: problems and advancements. J. Environ. Path. Toxicol. 2:187-199.

Neubert, D., and I. Dillmann. 1972. Embryotoxic effects in mice treated with 2,4,5-trichlorophenoxyacetic acid and 2,3,7,8-tetrachlorodibenzo-p-dioxin. Naunyn-Schiedeberg's Arch. Pharmacol. 272:243-264. [Cited in Position Document 1 as Ref. #127.]

Sauerhoff, M.W., W.H. Braun, G.E. Blau, and P.J. Gehring. 1976. The dose-dependent pharmacokinetic profile of 2,4,5-T following intravenous administration in rats. Tox. Appl. Pharmacol. 36:491-501.

Schantz, S.L., D.A. Barsotti, and J.R. Allen. 1979. Toxicological effects produced in nonhuman primates chronically exposed to fifty parts per trillion 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). ABSTRACT: 18th Annual Soc. of Toxicology, New Orleans, La., 3/11 - 3/15/79.

Smith, F.A., B.Z. Schwets, and K.D. Nitschke. 1976. Teratogenicity of 2,3,7,8-tetrachlorodibenzo-p-dioxin in CF-1 mice. Toxicol. Appl. Pharmacol. 38:517-523. [Cited in Position Document 1 as Ref. #135.]

Sparschu, G.L., F.L. Dunn, and V.K. Rowe. 1971. Study of the teratogenicity of 2,3,7,8-tetrachlorodibenzo-p-dioxin in the rat. Fd. Cosmet. Toxicol. 9:405-412. [Cited in Position Document 1 as Reb. #129.]

USDA. 1979. The biological and economic assessment of 2,4,5-T: a report of the USDA-States-EPA 2,4,5-T RPAR assessment team. Washington, D.C. (Unpublished.)

Van Miller, J.P., J.J. Lalich, and J.R. Allen. 1977. Increased incidence of neoplasms in rats exposed to low levels of 2,3,7,8-tetrachlordibenzo-p-dioxin. Chemosphere 6(10):625-632. [Unpublished version cited in Position Document 1 as Ref. #109.]

Wilson, J.G. 1971. Abnormalities of intrauterine development in non-human primates for research on problems of human reproduction. Sukumi, U.S.S.R. 13-17 Dec.