

the single low oral dose of the test substance (Groups B and C) shall be compared to the corresponding results obtained in rats receiving repeated oral doses of the test substance (Group F).

(B) *Mini-Pig studies—Extent of absorption.* The total quantities of radioactivity shall be determined for excreta daily for 7 days or until at least 90 percent of the test substance has been excreted.

(ii) *Metabolism.* Four animals from each group shall be used for these purposes.

(A) *Rat studies—(1) Biotransformation.* Appropriate qualitative and quantitative methods shall be used to assay urine, feces, and expired air collected from rats. Efforts shall be made to identify any metabolite which comprises 5 percent or more of the administered dose and the major radioactive components of blood.

(2) *Changes in biotransformation.* Appropriate qualitative and quantitative assay methodology shall be used to compare the composition of radioactive compounds in excreta from rats receiving a single oral dose (Groups B and C) with those in the excreta from rats receiving repeated oral doses (Group H).

(d) *Data and reporting.* The final test report shall include the following:

(1) *Presentation of results.* Numerical data shall be summarized in tabular form. Pharmacokinetic data shall also be presented in graphical form. Qualitative observations shall also be reported.

(2) *Evaluation of results.* All quantitative results shall be evaluated by an appropriate statistical method.

(3) *Reporting results.* In addition to the reporting requirements as specified in 40 CFR part 792, the following specific information shall be reported:

(i) Species and strains of laboratory animals.

(ii) Chemical characterization of the test substance, including:

(A) For the radioactive test substances, information on the site(s) and degree of radiolabeling, including type of label, specific activity, chemical purity, and radiochemical purity.

(B) For the nonradioactive compound, information on chemical purity.

(C) Results of chromatography.

(iii) A full description of the sensitivity, precision, and accuracy of all procedures used to generate the data.

(iv) Percent of absorption of test substance after oral and dermal exposures to rats and dermal exposure to mini-pigs.

(v) Quantity and percent recovery of radioactivity in feces, urine, expired air, and blood. In dermal studies on rats and mini-pigs, include recovery data for skin, skin washings, and residual radioactivity in the covering as well as results of the washing efficacy study.

(vi) Tissue distribution reported as quantity of radioactivity in blood and in various tissues, including bone, brain, fat, gastrointestinal tract, gonads, heart, kidney, liver, lung, muscle, skin and in residual carcass of rats.

(vii) Materials balance developed from each study involving the assay of body tissues and excreta.

(viii) Biotransformation pathways and quantities of test substance and metabolites in excreta collected after administering single high and low doses to rats.

(ix) Biotransformation pathways and quantities of the test substance and metabolites in excreta collected after administering repeated low doses to rats.

(x) Pharmacokinetics model(s) developed from the experimental data.

[54 FR 33411, Aug. 14, 1989; 54 FR 49844, Dec. 1, 1989; 55 FR 25392, June 21, 1990]

§ 795.231 Pharmacokinetics of isopropanal.

(a) *Purpose.* The purposes of these studies are to:

(1) Ascertain whether the pharmacokinetics and metabolism of the “test substance” are similar after oral and inhalation administration.

(2) Determine bioavailability of the test substance after oral and inhalation administration.

(3) Examine the effects of repeated dosing on the pharmacokinetics and metabolism of the test substance.

(b) *Definitions.* (1) “*Bioavailability*” refers to the rate and relative amount of administered test substance which reaches the systemic circulation.

(2) “*Metabolism*” means the study of the sum of the processes by which a

particular substance is handled in the body, and includes absorption, tissue distribution, biotransformation, and excretion.

(3) "*Pharmacokinetics*" means the study of the rates of absorption, tissue distribution, biotransformation, and excretion.

(c) *Test procedures*—(1) *Animal selection*—(i) *Species*. The rat shall be used because it has been used extensively for metabolic and toxicological studies.

(ii) *Test animals*. For pharmacokinetics testing, adult male and female rats (Fischer 344 or strain used for major toxicity testing), 7 to 9 weeks of age, shall be used. The animals should be purchased from a reputable dealer and shall be identified upon arrival at the testing laboratory. The animals shall be selected at random for the testing groups and any animal showing signs of ill health shall not be used. In all studies, unless otherwise specified, each test group shall contain at least four animals of each sex for a total of at least eight animals.

(iii) *Animal care*. (A) Animal care and housing should be in accordance with DHEW Publication No. (NIH)-85-23, 1985, entitled "Guidelines for the Care and Use of Laboratory Animals."

(B) The animals should be housed in environmentally controlled rooms with at least 10 air changes per hour. The rooms shall be maintained at a temperature of 22 ± 2 °C and humidity of 50 ± 20 percent with a 12-hour light/dark cycle per day. The animals shall be kept in a quarantine facility for at least 7 days prior to use and shall be acclimated to the experimental environment for a minimum of 48 hours prior to treatment.

(C) During the acclimatization period, the animals should be housed in suitable cages. All animals shall be provided with certified feed and tap water *ad libitum*.

(2) *Administration of test substance*—(i) *Test substance*. The use of radioactive test substance is required for all materials balance and metabolite identification requirements of the study. Ideally, the purity of both radioactive and non-radioactive test substance should be greater than 99 percent. The radioactive and nonradioactive substances shall be chromatographed separately

and together to establish purity and identity. If the purity is less than 99 percent or if the chromatograms differ significantly, EPA should be consulted.

(ii) *Dosage and treatment*—(A) *Intravenous*. The low dose of test substance, in an appropriate vehicle, shall be administered intravenously to four rats of each sex.

(B) *Oral*. Two doses of test substance shall be used in the oral portion of the study, a low dose and a high dose. The high dose should ideally induce some overt toxicity, such as weight loss. The low dose level should correspond to a no-observed effect level. The oral dosing shall be accomplished by gavage or by administering an encapsulated test substance. If feasible, the same high and low doses should be used for oral and dermal studies.

(C) *Inhalation*. Two concentrations of the test substance shall be used in this portion of the study, a low concentration and a high concentration. The high concentration should ideally induce some overt toxicity, while the low concentration should correspond to a no observed level. Inhalation treatment should be conducted using a "nose-cone" or "head only" apparatus to prevent ingestion of the test substance through "grooming".

(iii) *Dosing and sampling schedule*. After administration of the test substance, each rat shall be placed in a separate metabolic unit to facilitate collection of excreta. For the inhalation studies, excreta from the rats shall also be collected during the exposure periods. At the end of each collection period, the metabolic units shall be cleaned to recover any excreta that might adhere to the cages. All studies, except the repeated dose study, shall be terminated at 7 days, or after at least 90 percent of the radioactivity has been recovered in the excreta, whichever occurs first.

(A) *Intravenous study*. Group A shall be dosed once intravenously at the low dose of test substance.

(B) *Oral studies*. (1) Group B shall be dosed once *per os* with the low dose of the test substance.

(2) Group C shall be dosed once *per os* with the high dose of the test substance.

(C) *Inhalation studies.* A single 6-hour exposure period shall be used for each group.

(1) Group D shall be exposed to a mixture of the test substance in air at the low concentration.

(2) Group E shall be exposed to a mixture of test substance in air at the high concentration.

(D) *Repeated dosing study.* Group F shall receive a series of single daily oral low doses of nonradioactive test substance over a period of at least 7 consecutive days. Twenty four hours after the last nonradioactive dose, a single oral low dose of radioactive test substance shall be administered. Following dosing with radioactive substance, the rats shall be placed in individual metabolic units as described in paragraph (c)(2)(iii) of this section. The study shall be terminated 7 days after the last dose, or after at least 90 percent of the radioactivity has been recovered in the excreta, whichever occurs first.

(3) *Types of studies—(i) Pharmacokinetics studies.* Groups A through F shall be used to determine the kinetics of absorption of the test substance. In groups administered the substance by intravenous or oral routes, (i.e., Groups A, B, C, F), the concentration of radioactivity in blood and excreta including expired air shall be measured following administration. In groups administered the substance by the inhalation route (i.e., Groups D and E), the concentration of radioactivity in blood shall be measured at selected time intervals during and following the exposure period. In the groups administered the substance by inhalation (i.e., Groups D and E), the concentration of radioactivity in excreta (including expired air) shall be measured at selected time intervals following the exposure period. In addition, in the groups administered the substance by inhalation, the concentration of test substance in inspired air shall be measured at selected time intervals during the exposure period.

(ii) *Metabolism studies.* Groups A through F shall be used to determine the metabolism of the test substance. Excreta (urine, feces, and expired air) shall be collected for identification and quantification of test substance and metabolites.

(4) *Measurements—(i) Pharmacokinetics.* Four animals from each group shall be used for these purposes.

(A) *Bioavailability.* The levels of radioactivity shall be determined in whole blood, blood plasma or blood serum at 15 minutes, 30 minutes, 1, 2, 3, 6, 9, and 18 hours after dosing; and at 30 minutes, 3, 6, 6.5, 7, 8, 9, 12, and 18 hours after initiation of inhalation exposure.

(B) *Extent of absorption.* The total quantities of radioactivity shall be determined for excreta collected daily for 7 days, or after at least 90 percent of the radioactivity has been recovered in the excreta, whichever occurs first.

(C) *Excretion.* The quantities of radioactivity eliminated in the urine, feces, and expired air shall be determined separately at appropriate time intervals. The collection of the intact test substance or its metabolites, including carbon dioxide, may be discontinued when less than 1 percent of the administered dose is found to be exhaled as radioactive carbon dioxide in 24 hours.

(D) *Tissue distribution.* At the termination of each study, the quantities of radioactivity in blood and in various tissues, including bone, brain, fat, gastrointestinal tract, gonads, heart, kidney, liver, lungs, muscle, skin, spleen, and residual carcass of each animal shall be determined.

(E) *Changes in pharmacokinetics.* Results of pharmacokinetics measurements (i.e., biotransformation, extent of absorption, tissue distribution, and excretion) obtained in rats receiving the single low oral dose of test substance (Group B) shall be compared to the corresponding results obtained in rats receiving repeated oral doses of test substance (Group F).

(F) *Biotransformation.* Appropriate qualitative and quantitative methods shall be used to assay urine, feces, and expired air collected from rats. Efforts shall be made to identify any metabolite which comprises 5 percent or more of the dose eliminated.

(G) *Changes in biotransformation.* Appropriate qualitative and quantitative assay methodology shall be used to compare the composition of radioactive substances in excreta from the rats receiving a single oral dose

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(Groups B and C) with those in the excreta from rats receiving repeated oral doses (Group F).

(ii) [Reserved]

(d) *Data and reporting.* The final test report shall include the following:

(1) *Presentation of results.* Numerical data shall be summarized in tabular form. Pharmacokinetics data shall also be presented in graphical form. Qualitative observations shall also be reported.

(2) *Evaluation of results.* All quantitative results shall be evaluated by an appropriate statistical method.

(3) *Reporting results.* In addition to the reporting requirements as specified in the EPA Good Laboratory Practice Standards (40 CFR 792.185), the following specific information shall be reported:

(i) Species and strains of laboratory animals.

(ii) Chemical characterization of the test substance, including:

(A) For the radioactive test substance, information on the site(s) and degree of radiolabeling, including type of label, specific activity, chemical purity, and radiochemical purity.

(B) For the nonradioactive substance, information on chemical purity.

(C) Results of chromatography.

(iii) A full description of the sensitivity, precision, and accuracy of all procedures used to generate the data.

(iv) Extent of absorption of the test substance as indicated by: percent absorption of the administered oral dose; and total body burden after inhalation exposure.

(v) Quantity and percent recovery of radioactivity in feces, urine, expired air, and blood.

(vi) Tissue distribution reported as quantity of radioactivity in blood and in various tissues, including bone, brain, fat, gastrointestinal tract, gonads, heart, kidney, liver, lung, muscle, skin, spleen and in residual carcass of each rat.

(vii) Biotransformation pathways and quantities of the test substance and metabolites in excreta collected after administering single high and low doses to rats.

(viii) Biotransformation pathways and quantities of the test substance and metabolites in excreta collected

after administering repeated low doses to rats.

(ix) Pharmacokinetics model(s) developed from the experimental data.

[54 FR 43261, Oct. 23, 1989]

§ 795.232 Inhalation and dermal pharmacokinetics of commercial hexane.

(a) *Purposes.* The purposes of these studies are to:

(1) Determine the bioavailability of the test substances after dermal and inhalation administration.

(2) Compare the pharmacokinetics and metabolism of the test substances after intravenous, dermal, and inhalation administration.

(3) Examine the effects of repeated doses on the pharmacokinetics and metabolism of the test substances.

(b) *Definitions.* (1) *Bioavailability* refers to the relative amount of administered test substance which reaches the systemic circulation and the rate at which this process occurs.

(2) *Metabolism* means the sum of the enzymatic and nonenzymatic processes by which a particular substance is handled in the body.

(3) *Pharmacokinetics* means the study of the rates of absorption, tissue distribution, biotransformation, and excretion.

(4) *Low dose* should correspond to 1/10 of the high dose.

(5) *High dose* shall not exceed the lower explosive limit (LEL) and ideally should induce minimal toxicity.

(6) *Test substance* refers to the unlabeled and both radiolabeled mixtures (¹⁴C-*n*-hexane and ¹⁴C-methylcyclopentane) of commercial hexane used in the testing.

(c) *Test procedures*—(1) *Animal selection*—(i) *Species.* The rat shall be used for pharmacokinetics testing because it has been used extensively for metabolic and toxicological studies.

(ii) *Test animals.* Adult male and female rats shall be used for testing. The rats shall be 7 to 9 weeks old and their weight range should be comparable from group to group. The animals shall be purchased from a reputable dealer and shall be permanently identified upon arrival. The animals shall be selected at random for the testing groups, and any animal showing signs of ill health shall not be used.