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(ii) If Procedure 3 was employed in making rate measurements, use the mean initial concentration (C_o) and the mean concentration of chemical (C) in Equation 4 under paragraph (a)(2)(v)(B) of this section to calculate k_h for each pH used in the experiments. Calculate the hydrolysis half-life using k_h in Equation 3 under paragraph (a)(2)(v)(B) of this section.

(iii) For each set of three concentration replicates, calculate the mean value of C and the standard deviation.

(iv) For test chemicals that are not ionized or protonated between pH 3 and 11, calculate k_A, k_B, and k_N using Equation 5.

(2) *Specific analytical and recovery procedures.* (i) Provide a detailed description or reference for the analytical procedure used, including the calibration data and precision.

(ii) If extraction methods were used to separate the solute from the aqueous solution, provide a description of the extraction method as well as the recovery data.

(3) *Test data report.* (i) For Procedures 1 and 2, report k_h, the hydrolysis half-life ($t_{1/2}$), and the coefficient of determination (R^2) for each pH employed in the rate measurements. In addition, report the individual values, the mean value, and the standard deviation for each set of replicate concentration measurements. Finally, report k_A, k_B, and k_N.

(ii) For Procedure 3, report k_h and the half-life for each pH employed in the rate measurements. In addition, report the individual values, the mean value, and the standard deviation for each set of replicate concentration measurements. Finally, report k_A, k_B, and k_N.

(iii) If, after 672 hours, the concentration (C) is the same as the initial concentration (C_o) within experimental error, then k_h cannot be calculated and the chemical can be reported as being persistent with respect to hydrolysis.

[50 FR 39252, Sept. 27, 1985, as amended at 53 FR 10391, Mar. 31, 1988; 53 FR 12526, Apr. 15, 1988; 53 FR 22323, June 15, 1988; 60 FR 34467, July 3, 1995; 69 FR 18803, Apr. 9, 2004]

PART 797—ENVIRONMENTAL EFFECTS TESTING GUIDELINES

Subpart A [Reserved]

Subpart B—Aquatic Guidelines

Sec.
797.1050 Algal acute toxicity test.
797.1300 Daphnid acute toxicity test.
797.1330 Daphnid chronic toxicity test.
797.1400 Fish acute toxicity test.
797.1600 Fish early life stage toxicity test.
797.1930 Mysid shrimp acute toxicity test.
797.1950 Mysid shrimp chronic toxicity test.

AUTHORITY: 15 U.S.C. 2603.

SOURCE: 50 FR 39321, Sept. 27, 1985, unless otherwise noted.

Subpart A [Reserved]

Subpart B—Aquatic Guidelines

§ 797.1050 Algal acute toxicity test.

(a) *Purpose.* The guideline in this section is intended for use in developing data on the acute toxicity of chemical substances and mixtures (''chemicals'') subject to environmental effects test regulations under the Toxic Substances Control Act (TSCA) (Pub. L. 94–469, 90 Stat. 2003, 15 U.S.C. 2601 et seq.). This guideline prescribes test procedures and conditions using freshwater and marine algae to develop data on the phytotoxicity of chemicals. The United States Environmental Protection Agency (U.S. EPA) will use data from these tests in assessing the hazard of a chemical to the environment.

(b) *Definitions.* The definitions in section 3 of the Toxic Substances Control Act (TSCA) and the definitions in part 792—Good Laboratory Practice Standards of this chapter apply to this test guideline. The following definitions also apply to this guideline:

(1) *Algicidal* means having the property of killing algae.

(2) *Algistatic* means having the property of inhibiting algal growth.

(3) *ECx* means the experimentally derived chemical concentration that is calculated to effect X percent of the test criterion.

(4) *Growth* means a relative measure of the viability of an algal population based on the number and/or weight of

algal cells per volume of nutrient medium or test solution in a specified period of time.

(5) *Static system* means a test container in which the test solution is not renewed during the period of the test.

(c) *Test procedures*—(1) *Summary of the test.* (i) In preparation for the test, fill test containers with appropriate volumes of nutrient medium and/or test solution. Start the test by introducing algae into the test and control containers in the growth chambers. Environmental conditions within the growth chambers are established at predetermined limits.

(ii) At the end of 96 hours enumerate the algal cells in all containers to determine inhibition or stimulation of growth in test containers compared to controls. Use data to define the concentration-response curve, and calculate the EC_{10}, EC_{50}, and EC_{90} values.

(2) [Reserved]

(3) *Range-finding test.* (i) A range-finding test should be conducted to determine:

(A) If definitive testing is necessary.

(B) Test chemical concentrations for the definitive test.

(ii) Algae are exposed to a widely spaced (e.g., log interval) chemical concentration series. The lowest value in the series, exclusive of controls, should be at the chemical's detection limit. The upper value, for water soluble compounds, should be the saturation concentration. No replicates are required; and nominal concentrations of the chemical are acceptable unless definitive testing is not required.

(iii) The test is performed once for each of the recommended algal species or selected alternates. Test chambers should contain equal volumes of test solution and approximately 1×10^4 *Selenastrum* cells/ml or 7.7×10^4 *Skeletonema* cells/ml of test solution. The algae should be exposed to each concentration of test chemical for up to 96 hours. The exposure period may be shortened if data suitable for the purposes of the range-finding test can be obtained in less time.

(iv) Definitive testing is not necessary if the highest chemical concentration tested (water saturation concentration or 1000 mg/l) results in less than a 50 percent reduction in growth or if the lowest concentration tested (analytical detection limit) results in greater than a 50 percent reduction in growth.

(4) *Definitive test.* (i) The purpose of the definitive test is to determine the concentration response curves, the EC_{10}'s, EC_{50}'s, and EC_{90}'s for algal growth for each species tested, with a minimum amount of testing beyond the range-finding test.

(ii) Algae should be exposed to five or more concentrations of the test chemical in a geometric series in which the ratio is between 1.5 and 2.0 (e.g., 2, 4, 8, 16, 32, and 64 mg/l). Algae shall be placed in a minimum of three replicate test containers for each concentration of test chemical and control. More than three replicates may be required to provide sufficient quantities of test solution for determination of test substance concentration at the end of the test. Each test chamber should contain equal volumes of test solution and approximately 1×10^4 *Selenastrum* cells/ml or 7.7×10^4 *Skeletonema* cells/ml of test solution. The chemical concentrations should result in greater than 90 percent of algal growth being inhibited or stimulated at the highest concentrations of test substance compared to controls.

(iii) Every test shall include a control consisting of the same nutrient medium, conditions, procedures, and algae from the same culture, except that none of the test substance is added. If a carrier is present in any of the test chambers, a separate carrier control is required.

(iv) The test begins when algae from 5- to 10-day-old stock cultures are placed in the test chambers containing test solutions having the appropriate concentrations of the test substance. Algal growth in controls should reach the logarithmic growth phase by 96 hours. If logarithmic growth cannot be demonstrated, the test shall be repeated. At the end of 24, 48, 72, and 96 hours the algal growth response (number or weight of algal cells/ml) in all test containers and controls shall be determined by an indirect (spectrophotometry, electronic cell counters, dry weight, etc.) or a direct (actual microscopic cell count) method. Indirect methods shall be calibrated by a direct microscopic count.

The percentage inhibition or stimulation of growth for each concentration, EC_{10}, EC_{50}, EC_{90} and the concentration-response curves are determined from these counts.

(v) At the end of the definitive test, the following additional analyses of algal growth response shall be performed:

(A) Determine whether the altered growth response between controls and test algae was due to a change in relative cell numbers, cell sizes or both. Also note any unusual cell shapes, color differences, flocculations, adherence of algae to test containers, or aggregation of algal cells.

(B) In test concentrations where growth is maximally inhibited, algistatic effects may be differentiated from algicidal effects by the following two methods for *Skeletonema* and by the second method for *Selenastrum*.

(*1*) Add 0.5 ml of a 0.1 percent solution (weight/volume) of Evans blue stain to a 1 milliliter aliquot of algae from a control container and to a 1 milliliter aliquot of algae from the test container having the lowest concentration of test chemical which completely inhibited algal growth (if algal growth was not completely inhibited, select an aliquot of algae for staining from the test container having the highest concentration of test chemical which inhibited algal growth). Wait 10 to 30 minutes, examine microscopically, and determine the percent of the cells which stain blue (indicating cell mortality). A staining control shall be performed concurrently using heat-killed or formaldehyde-preserved algal cells; 100 percent of these cells shall stain blue.

(*2*) Remove 0.5 ml aliquots of test solution containing growth-inhibited algae from each replicate test container having the concentration of test substance evaluated in paragraph (c)(4)(v)(B)(*1*) of this section. Combine these aliquots into a new test container and add a sufficient volume of fresh nutrient medium to dilute the test chemical to a concentration which does not affect growth. Incubate this subculture under the environmental conditions used in the definitive test for a period of up to 9 days, and observe for algal growth to determine if the algistatic effect noted after the 96-hour test is reversible. This subculture test may be discontinued as soon as growth occurs.

(5) [Reserved]

(6) *Analytical measurements*—(i) *Chemical*. (A) Glass distilled or deionized water shall be used in the preparation of the nutrient medium. The pH of the test solution shall be measured in the control and test containers at the beginning and at the end of the definitive test. The concentration of test chemical in the test containers shall be determined at the beginning and end of the definitive test by standard analytical methods which have been validated prior to the test. An analytical method is unacceptable if likely degradation products of the chemical, such as hydrolysis and oxidation products, give positive or negative interference.

(B) At the end of the test and after aliquots have been removed for algal growth-response determinations, microscopic examination, mortal staining, or subculturing, the replicate test containers for each chemical concentration may be pooled into one sample. An aliquot of the pooled sample may then be taken and the concentration of test chemical determined. In addition, the concentration of test chemical associated with the algae alone should be determined. Separate and concentrate the algal cells from the test solution by centrifuging or filtering the remaining pooled sample and measure the test substance concentration in the algal-cell concentrate.

(ii) *Numerical*. Algal growth response (as percent of inhibition or stimulation in the test solutions compared to the controls) is calculated at the end of the test. Mean and standard deviation should be calculated and plotted for each treatment and control. Appropriate statistical analyses should provide a goodness-of-fit determination for the concentration response curves. The concentration response curves are plotted using the mean measured test solution concentrations obtained at the end of the test.

(d) *Test conditions*—(1) *Test species*. Species of algae recommended as test organisms for this test are the freshwater green alga, *Selenastrum*

capricornutum, and the marine diatom, *Skeletonema costatum*. Algae to be used in acute toxicity tests may be initially obtained from commercial sources and subsequently cultured using sterile technique. Toxicity testing shall not be performed until algal cultures are shown to be actively growing (i.e., capable of logarithmic growth within the test period) in at least 2 subcultures lasting 7 days each prior to the start of the definitive test. All algae used for a particular test shall be from the same source and the same stock culture. Test algae shall not have been used in a previous test, either in a treatment or a control.

(2) *Facilities*—(i) *General*. (A) Facilities needed to perform this test include: a growth chamber or a controlled environment room that can hold the test containers and will maintain the air temperature, lighting intensity and photoperiod specified in this test guideline; apparatus for culturing and enumerating algae; a source of distilled and/or deionized water; and apparatus for carrying out analyses of the test chemical.

(B) Disposal facilities should be adequate to accommodate spent glassware, algae and test solutions at the end of the test and any bench covering, lab clothing, or other contaminated materials.

(ii) *Test containers*. Erlenmeyer flasks should be used for test containers. The flasks may be of any volume between 125 and 500 ml as long as the same size is used throughout a test and the test solution volume does not exceed 50 percent of the flask volume.

(iii) *Cleaning and sterilization*. New test containers may contain substances which inhibit growth of algae. They shall therefore be cleaned thoroughly and used several times to culture algae before being used in toxicity testing. All glassware used in algal culturing or testing shall be cleaned and sterilized prior to use according to standard good laboratory practices.

(iv) *Conditioning*. Test containers should be conditioned by a rinse with the appropriate test solutions prior to the start of the test. Decant and add fresh test solutions after an appropriate conditioning period for the test chemical.

(v) *Nutrient medium*. (A) Formulation and sterilization of nutrient medium used for algal culture and preparation of test solutions should conform to those currently recommended by the U.S. EPA for freshwater and marine algal bioassays. No chelating agents are to be included in the nutrient medium used for test solution preparation. Nutrient medium should be freshly prepared for algal testing and may be dispensed in appropriate volumes in test containers and sterilized by autoclaving or filtration. The pH of the nutrient medium shall be 7.5 (±0.1) for *Selenastrum* and 8.1 (±0.1) for *Skeletonema* at the start of the test and may be adjusted prior to test chemical addition with 0.1N NaOH or HC1.

(B) Dilution water used for preparation of nutrient medium and test solutions should be filtered, deionized or glass distilled. Saltwater for marine algal nutrient medium and test solutions should be prepared by adding a commercial, synthetic, sea salt formulation or a modified synthetic seawater formulation to distilled/deionized water to a concentration of 30 parts per thousand.

(vi) *Carriers*. Nutrient medium shall be used in making stock solutions of the test chemical. If a carrier other than nutrient medium is absolutely necessary to dissolve the chemical, the volume used shall not exceed the minimum volume necessary to dissolve or suspend the chemical in the test solution.

(3) *Test parameters*. (i) The test temperature shall be 24 °C for *Selenastrum* and 20 °C for *Skeletonema*. Excursions from the test temperature shall be no greater than ±2 °C. Temperature should be recorded hourly during the test.

(ii) Test chambers containing *Selenastrum* shall be illuminated continuously and those containing *Skeletonema* shall be provided a 14-hour light and 10-hour dark photoperiod with a 30 minute transition period under fluorescent lamps providing 300 ±25 uEin/m^2 sec (approximately 400 ft-c) measured adjacent to the test chambers at the level of test solution.

(iii) Stock algal cultures should be shaken twice daily by hand. Test containers shall be placed on a rotary

shaking apparatus and oscillated at approximately 100 cycles/minute for *Selenastrum* and at approximately 60 cycles/minute for *Skeletonema* during the test. The rate of oscillation should be determined at least once daily during testing.

(iv) The pH of nutrient medium in which algae are subcultured shall be 7.5 (±0.1) for *Selenastrum* and 8.1 (±0.1) for *Skeletonema*, and is not adjusted after the addition of the algae. The pH of all test solutions shall be measured at the beginning and end of the test.

(v) Light intensity shall be monitored at least daily during the test at the level of the test solution.

(e) *Reporting*. The sponsor shall submit to the EPA all data developed by the test that are suggestive or predictive of acute phytotoxicity. In addition to the general reporting requirements prescribed in part 792—*Good Laboratory Practice Standards of this Chapter*, the following shall be reported:

(1) Detailed information about the test organisms, including the scientific name, method of verification, and source.

(2) A description of the test chambers and containers, the volumes of solution in the containers, the way the test was begun (e.g., conditioning, test substance additions, etc.), the number of replicates, the temperature, the lighting, and method of incubation, oscillation rates, and type of apparatus.

(3) The concentration of the test chemical in the control and in each treatment at the end of the test and the pH of the solutions.

(4) The number of algal cells per milliliter in each treatment and control and the method used to derive these values at the beginning, 24, 48, and 72 hours, and end of the test; the percentage of inhibition or stimulation of growth relative to controls; and other adverse effect in the control and in each treatment.

(5) The 96-hour EC_{10}, EC_{50}, and EC_{90} values, and when sufficient data have been generated, the 24, 48, and 72 hour LC_{50}'s and 95 percent confidence limits, the methods used to derive these values, the data used to define the shape of the concentration-response curve and the goodness-of-fit determination.

(6) Methods and data records of all chemical analyses of water quality and test substance concentrations, including method validations and reagent blanks.

(7) The results of any optional analyses such as: Microscopic appearance of algae, size or color changes, percent mortality of cells and the fate of subcultured cells, the concentration of test substance associated with algae and test solution supernate or filtrate.

(8) If the range-finding test showed that the highest concentration of the chemical tested (not less than 1000 mg/l or saturation concentration) had no effect on the algae, report the results and concentration and a statement that the chemical is of minimum phytotoxic concern.

(9) If the range-finding test showed greater than a 50 percent inhibition of algal growth at a test concentration below the analytical detection limit, report the results, concentration, and a statement that the chemical is phytotoxic below the analytical detection limit.

[50 FR 39321, Sept. 27, 1985, as amended at 52 FR 19058, May 20, 1987]

§ 797.1300 Daphnid acute toxicity test.

(a) *Purpose*. This guideline is intended for use in developing data on the acute toxicity of chemical substances and mixtures (''chemicals'') subject to environmental effects test regulations under the Toxic Substances Control Act (TSCA) (Pub. L. 94–469, 90 Stat. 2003, 15 U.S.C. 2601 *et seq.*). This guideline prescribes an acute toxicity test in which daphnids (*Daphnia magna* or *D. pulex*) are exposed to a chemical in static and flow-through systems. The United States Environmental Protection Agency will use data from this test in assessing the hazard a chemical may present in the aquatic environment.

(b) *Definitions*. The definitions in section 3 of the Toxic Substances Control Act (TSCA) and part 792—*Good Laboratory Practice Standards* of this chapter apply to this test guideline. In addition, the following definitions apply to this guideline:

(1) *Brood stock* means the animals which are cultured to produce test organisms through reproduction.

(2) EC_{50} means that experimentally derived concentration of test substance in dilution water that is calculated to affect 50 percent of a test population during continuous exposure over a specified period of time. In this guideline, the effect measured is immobilization.

(3) *Ephippium* means a resting egg which develops under the carapace in response to stress conditions in daphnids.

(4) *Flow-through* means a continuous or an intermittent passage of test solution or dilution water through a test chamber or culture tank with no recycling.

(5) *Immobilization* means the lack of movement by the test organisms except for minor activity of the appendages.

(6) *Loading* means the ratio of daphnid biomass (grams, wet weight) to the volume (liters) of test solution in a test chamber at a point in time, or passing through the test chamber during a specific interval.

(7) *Static system* means a test system in which the test solution and test organisms are placed in the test chamber and kept there for the duration of the test without renewal of the test solution.

(c) *Test procedures*—(1) *Summary of the test.* (i) Test chambers are filled with appropriate volumes of dilution water. In the flow-through test, the flow of dilution water through each chamber is adjusted to the rate desired. The test chemical is introduced into each treatment chamber. The addition of test chemical in the flow-through system is conducted at a rate which is sufficient to establish and maintain the desired concentration in the test chamber. The test is started within 30 minutes after the test chemical has been added and uniformly distributed in static test chambers or after the concentration of test chemical in each flow-through test chamber reaches the prescribed level and remains stable. At the initiation of the test, daphnids which have been cultured and acclimated in accordance with the test design are randomly placed into the test chambers. Daphnids in the test chambers are observed periodically during the test, the immobile daphnids removed, and the findings recorded.

(ii) Dissolved oxygen concentration, pH, temperature, the concentration of test chemical and other water quality parameters are measured at specified intervals in selected test chambers. Data are collected during the test to develop concentration-response curves and determine EC_{50} values for the test chemical.

(2) [Reserved]

(3) *Range-finding test.* (i) A range-finding test should be conducted to establish test solution concentrations for the definitive test.

(ii) The daphnids should be exposed to a series of widely spaced concentrations of the test chemical (e.g., 1, 10, 100 mg/1, etc.), usually under static conditions.

(iii) A minimum of five daphnids should be exposed to each concentration of test chemical for a period of 48 hours. The exposure period may be shortened if data suitable for the purpose of the range-finding test can be obtained in less time. No replicates are required and nominal concentrations of the chemical are acceptable.

(4) *Definitive test.* (i) The purpose of the definitive test is to determine the concentration-response curves and the 24- and 48-hour EC_{50} values with the minimum amount of testing beyond the range-finding test.

(ii) A minimum of 20 daphnids per concentration shall be exposed to five or more concentrations of the chemical chosen in a geometric series in which the ratio is between 1.5 and 2.0 (e.g., 2, 4, 8, 16, 32, and 64 mg/l). An equal number of daphnids shall be placed in two or more replicates. If solvents, solubilizing agents or emulsifiers have to be used, they shall be commonly used carriers and shall not possess a synergistic or antagonistic effect on the toxicity of the test chemical. The concentration of solvent should not exceed 0.1 mg/l. The concentration ranges shall be selected to determine the concentration-response curves and EC_{50} values at 24 and 48 hours. Concentration of test chemical in test solutions should be analyzed prior to use.

(iii) Every test shall include controls consisting of the same dilution water, conditions, procedures and daphnids

from the same population (culture container), except that none of the chemical is added.

(iv) The dissolved oxygen concentration, temperature and pH shall be measured at the beginning and end of the test in each chamber.

(v) The test duration is 48 hours. The test is unacceptable if more than 10 percent of the control organisms are immobilized during the 48-hour test period. Each test chamber shall be checked for immobilized daphnids at 24 and 48 hours after the beginning of the test. Concentration-response curves and 24-hour and 48-hour EC_{50} values for immobilization shall be determined along with their 95 percent confidence limits.

(vi) In addition to immobility, any abnormal behavior or appearance shall also be reported.

(vii) Test organisms shall be impartially distributed among test chambers in such a manner that test results show no significant bias from the distributions. In addition, test chambers within the testing area shall be positioned in a random manner or in a way in which appropriate statistical analyses can be used to determine the variation due to placement.

(viii) The concentration of the test chemical in the chambers should be measured as often as is feasible during the test. In the static test the concentration of test chemical shall be measured, at a minimum, at the beginning of the test and at the end of the test in each test chamber. In the flow-through test the concentration of test chemical shall be measured at a minimum:

(A) In each chamber at the beginning of the test and at 48 hours after the start of the test;

(B) In at least one appropriate chamber whenever a malfunction is detected in any part of the test substance delivery system.

Among replicate test chambers of a treatment concentration, the measured concentration of the test chemical shall not vary more than ±20 percent.

(5) [Reserved]

(6) *Analytical measurements.* (i) *Test chemical.* Deionized water should be used in making stock solutions of the test chemical. Standard analytical methods should be used whenever available in performing the analyses. The analytical method used to measure the amount of test chemical in a sample shall be validated before beginning the test by appropriate laboratory practices. Any analytical method is not acceptable if likely degradation products of the test chemical, such as hydrolysis and oxidation products, give positive or negative interferences which cannot be systematically identified and corrected mathematically.

(ii) *Numerical.* The number of immobilized daphnids shall be counted during each definitive test. Appropriate statistical analyses should provide a goodness-of-fit determination for the concentration-response curves. A 24- and 48-hour EC_{50} and corresponding 95 percent interval shall be calculated.

(d) *Test conditions*—(1) *Test species*—(i) *Selection.* (A) The cladocerans, *Daphnia magna* or *D. pulex*, are the test species to be used in this test. Either species may be used for testing of a particular chemical. The species identity of the test organisms should be verified using appropriate systematic keys. First instar daphnids, ≤24 hours old, are to be used to start the test.

(B) Daphnids to be used in acute toxicity tests should be cultured at the test facility. Records should be kept regarding the source of the initial stock and culturing techniques. All organisms used for a particular test shall have originated from the same culture population.

(C) Daphnids shall not be used for a test (*1*) if cultures contain ephippia; (*2*) if adults in the cultures do not produce young before day 12; (*3*) if more than 20 percent of the culture stock die during the 2 days preceding the test; (*4*) if adults in the culture do not produce an average of at least 3 young per adult per day over the 7-day period prior to the test and (*5*) if daphnids have been used in any portion of a previous test, either in a treatment or in a control.

(ii) *Acclimation.* (A) Brood daphnids shall be maintained in 100-percent dilution water at the test temperature for at least 48 hours prior to the start of the test. This is easily accomplished by culturing them in the dilution water at

the test temperature. During production of neonates, daphnids should not be fed.

(B) During culturing and acclimation to the dilution water, daphnids should be maintained in facilities with background colors and light intensities similar to those of the testing area.

(iii) *Care and handling*. (A) Daphnids should be cultured in dilution water under similar environmental conditions to those used in the test. Organisms should be handled as little as possible. When handling is necessary it should be done as gently, carefully, and quickly as possible. During culturing and acclimation, daphnids should be observed carefully for ephippia and other signs of stress, physical damage and mortality. Dead and abnormal individuals shall be discarded. Organisms that touch dry surfaces or are dropped or injured in handling shall be discarded.

(B) Smooth glass tubes (I.D. greater than 5 mm) equipped with rubber bulb should be used for transferring daphnids with minimal culture media carry-over. Care should be exercised to introduce the daphnids below the surface of any solution to avoid trapping air under the carapace.

(iv) *Feeding*. A variety of foods (e.g., unicellular green algae) have been demonstrated to be adequate for daphnid culture. Daphnids shall not be fed during testing.

(2) *Facilities*—(i) *Apparatus*. (A) Facilities needed to perform this test include: (*1*) Containers for culturing and acclimating daphnids; (*2*) a mechanism for controlling and maintaining the water temperature during the culturing, acclimation, and test periods; (*3*) apparatus for straining particulate matter, removing gas bubbles, or aerating the water as necessary; and (*4*) an apparatus for providing a 16-hour light and 8-hour dark photoperiod with a 15 to 30 minute transition period. In addition, the flow-through system shall contain appropriate test chambers in which to expose daphnids to the test chemical and an appropriate test substance delivery system.

(B) Facilities should be well ventilated and free of fumes and disturbances that may affect the test organisms.

(C) Test chambers shall be loosely covered to reduce the loss of test solution or dilution water due to evaporation and to minimize the entry of dust or other particulates into the solutions.

(ii) *Construction materials*. (A) Materials and equipment that contact test solutions should be chosen to minimize sorption of test chemicals from the dilution water and should not contain substances that can be leached into aqueous solution in quantities that can affect the test results.

(B) For static tests, daphnids can be conveniently exposed to the test chemical in 250 ml beakers or other suitable containers.

(C) For flow-through tests, daphnids can be exposed in glass or stainless steel containers with stainless steel or nylon screen bottoms. The containers should be suspended in the test chamber in such a manner to insure that the test solution flows regularly into and out of the container and that the daphnids are always submerged in at least 5 centimeters of test solution. Test chambers can be constructed using 250 ml beakers or other suitable containers equipped with screened overflow holes, standpipes or V-shaped notches.

(iii) *Dilution water*. (A) Surface or ground water, reconstituted water or dechlorinated tap water are acceptable as dilution water if daphnids will survive in it for the duration of the culturing, acclimation and testing periods without showing signs of stress. The quality of the dilution water should be constant and should meet the following specifications:

Substance	Maximum concentration
Particulate matter	20 mg/liter.
Total organic carbon or	2 mg/liter.
Chemical oxygen demand	5 mg/liter.
Un-ionized ammonia	1 µg/liter.
Residual chlorine	<3 µg/liter.
Total organophosphorus pesticides	50 ng/liter.
Total organochlorine pesticides plus polychlorinated biphenyls (PCBs) or.	50 ng/liter.
Organic chlorine	25 ng/liter.

(B) The above water quality parameters under paragraph (d)(2)(iii)(A) of this section shall be measured at least twice a year or whenever it is suspected that these characteristics may

have changed significantly. If dechlorinated tap water is used, daily chlorine analysis shall be performed.

(C) If the diluent water is from a ground or surface water source, conductivity and total organic carbon (TOC) or chemical oxygen demand (COD) shall be measured. Reconstituted water can be made by adding specific amounts of reagent-grade chemicals to deionized or distilled water. Glass distilled or carbon-filtered deionized water with a conductivity less than 1 μohm/cm is acceptable as the diluent for making reconstituted water.

(iv) *Cleaning*. All test equipment and test chambers shall be cleaned before each use using standard laboratory procedures.

(v) *Test substance delivery system*. In flow-through tests, proportional diluters, metering pump systems, or other suitable devices should be used to deliver test chemical to the test chambers. The system shall be calibrated before each test. Calibration includes determining the flow rate through each chamber and the concentration of the test chemical in each chamber. The general operation of the test substance delivery system should be checked twice during a test. The 24-hour flow through a test chamber shall be equal to at least 5 times the volume of the test chamber. During a test, the flow rates should not vary more than 10 percent from any one test chamber to another.

(3) *Test parameters*. Environmental parameters of the water contained in test chambers shall be maintained as specified below:

(i) The test temperature shall be 20 °C. Excursions from the test temperature shall be no greater than ±2 °C.

(ii) Dissolved oxygen concentration between 60 and 105 percent saturation. Aeration, if needed to achieve this level, shall be done before the addition of the test chemical. All treatment and control chambers shall be given the same aeration treatment.

(iii) The number of daphnids placed in a test chamber shall not affect test results. Loading shall not exceed 40 daphnids per liter test solution in the static system. In the flow-through test, loading limits will vary depending on the flow rate of dilution water. Loading shall not cause the dissolved oxygen concentration to fall below the recommended levels.

(iv) Photoperiod of 16 hours light and 8 hours darkness.

(e) *Reporting*. The sponsor shall submit to the U.S. EPA all data developed by the test that are suggestive or predictive of acute toxicity and all concomitant gross toxicological manifestations. In addition to the reporting requirements prescribed in part 792—*Good Laboratory Practice Standards* of this chapter, the reporting of test data shall include the following:

(1) The name of the test, sponsor, testing laboratory, study director, principal investigator, and dates of testing.

(2) A detailed description of the test chemical including its source, lot number, composition (identity and concentration or major ingredients and major impurities), known physical and chemical properties and any carriers or other additives used and their concentrations.

(3) The source of the dilution water, its chemical characteristics (e.g., conductivity, hardness, pH, etc.) and a description of any pretreatment.

(4) Detailed information about the daphnids used as brood stock, including the scientific name and method of verification, age, source, treatments, feeding history, acclimation procedures, and culture method. The age of the daphnids used in the test shall be reported.

(5) A description of the test chambers, the volume of solution in the chambers, the way the test was begun (e.g., conditioning, test chemical additions), the number of test organisms per test chamber, the number of replicates per treatment, the lighting, the method of test chemical introduction or the test substance delivery system and the flow rate (in flow-through test) expressed as volume additions per 24 hours.

(6) The concentration of the test chemical in each test chamber at times designated for static and flow-through tests.

(7) The number and percentage of organisms that were immobilized or

showed any adverse effects in each test chamber at each observation period.

(8) Utilizing the average measured test chemical concentration, concentration-response curves should be fitted to immobilization data at 24 and 48 hours. A statistical test of goodness-of-fit should be performed and the results reported.

(9) The 24- and 48-hour EC_{50} values and their respective 95 percent confidence limits using the mean measured test chemical concentration and the methods used to calculate both the EC_{50} values and their confidence limits.

(10) All chemical analyses of water quality and test chemical concentrations, including methods, method validations and reagent blanks.

(11) The data records of the culture, acclimation and test temperatures.

(12) Any deviation from this test guideline and anything unusual about the test, e.g., diluter failure, temperature fluctuations, etc.

[50 FR 39321, Sept. 27, 1985, as amended at 52 FR 19059, May 20, 1987]

§ 797.1330 Daphnid chronic toxicity test.

(a) *Purpose*. This guideline is intended for use in developing data on the chronic toxicity of chemical substances and mixtures (''chemicals'') subject to environmental effects test regulations under the Toxic Substances Control Act (TSCA) (Pub. L. 94–469, 90 Stat. 2003, 15 U.S.C. 2601 *et seq.*). This guideline prescribes a chronic toxicity test in which daphnids are exposed to a chemical in a renewal or a flow-through system. The United States Environmental Protection Agency will use data from this test in assessing the hazard a chemical may present to the aquatic environment.

(b) *Definitions*. The definitions in section 3 of the Toxic Substances Control Act (TSCA), and the definitions in part 792 *Good Laboratory Practice Standards* of this chapter apply to this test guideline. In addition, the following definitions apply to this guideline:

(1) *Brood stock* means the animals which are cultured to produce test organisms through reproduction.

(2) *Chronic toxicity test* means a method used to determine the concentration of a substance in water that produces an adverse effect on a test organism over an extended period of time. In this test guideline, mortality and reproduction (and optionally, growth) are the criteria of toxicity.

(3) EC_{50} means that experimentally derived concentration of test substance in dilution water that is calculated to affect 50 percent of a test population during continuous exposure over a specified period of time. In this guideline, the effect measured is immobilization.

(4) *Ephippium* means a resting egg which develops under the carapace in response to stress conditions in daphnids.

(5) *Flow-through* means a continuous or intermittent passage of test solution or dilution water through a test chamber or culture tank with no recycling.

(6) *Immobilization* means the lack of movement by daphnids except for minor activity of the appendages.

(7) *Loading* means the ratio of daphnid biomass (grams, wet weight) to the volume (liters) of test solution in a test chamber at a point in time or passing through the test chamber during a specific interval.

(8) *MATC (Maximum Acceptable Toxicant Concentration)* means the maximum concentration at which a chemical can be present and not be toxic to the test organism.

(9) *Renewal system* means the technique in which test organisms are periodically transferred to fresh test solution of the same composition.

(c) *Test procedures*—(1) *Summary of the test*. (i) Test chambers are filled with appropriate volumes of dilution water. In the flow-through test the flow of dilution water through each chamber is then adjusted to the rate desired. The test substance is introduced into each test chamber. The addition of test substance in the flow-through system is done at a rate which is sufficient to establish and maintain the desired concentration of test substance in the test chamber.

(ii) The test is started within 30 minutes after the test substance has been added and uniformly distributed in the test chambers in the renewal test or after the concentration of test substance in each test chamber of the flow-through test system reaches the

prescribed level and remains stable. At the initiation of the test, daphnids which have been cultured or acclimated in accordance with the test design, are randomly placed into the test chambers. Daphnids in the test chambers are observed periodically during the test, immobile adults and offspring produced are counted and removed, and the findings are recorded. Dissolved oxygen concentration, pH, temperature, the concentration of test substance, and other water quality parameters are measured at specified intervals in selected test chambers. Data are collected during the test to determine any significant differences ($p \leq 0.05$) in immobilization and reproduction as compared to the control.

(2) [Reserved]

(3) *Range-finding test.* (i) A range-finding test should be conducted to establish test solution concentrations for the definitive test.

(ii) The daphnids should be exposed to a series of widely spaced concentrations of the test substance (e.g., 1, 10, 100 mg/l), usually under static conditions.

(iii) A minimum of five daphnids should be exposed to each concentration of test substance for a period of time which allows estimation of appropriate chronic test concentrations. No replicates are required and nominal concentrations of the chemical are acceptable.

(4) *Definitive test.* (i) The purpose of the definitive test is to determine concentration-response curves, EC_{50} values and effects of a chemical on immobilization and reproduction during chronic exposure.

(ii) A minimum of 20 daphnids per concentration shall be exposed to five or more concentrations of the chemical chosen in a geometric series in which the ratio is between 1.5 and 2.0 (e.g., 2, 4, 8, 16, 32, 64 mg/l). An equal number of daphnids shall be placed in two or more replicates. The concentration ranges shall be selected to determine the concentration-response curves, EC_{50} values and MATC. Solutions shall be analyzed for chemical concentration at designated times during the test.

(iii) Every test shall include controls consisting of the same dilution water, conditions, procedures and daphnids from the same population (culture container), except that none of the chemical is added.

(iv) The test duration is 21 days. The test is unacceptable if:

(A) More than 20 percent of the control organisms appear to be immobilized, stressed or diseased during the test.

(B) Each control daphnid living the full 21 days produces an average of less than 60 young.

(C) Any ephippia are produced by control animals.

(v) The number of immobilized daphnids in each chamber shall be recorded on day 21 of the test. After offspring are produced, they shall be counted and removed from the test chambers every 2 or 3 days. Concentration-response curves, EC_{50} values and associated 95 percent confidence limits for adult immobilization shall be determined for day 21. An MATC shall be determined for the most sensitive test criteria measured (number of adult animals immobilized, number of young per adult, and number of immobilized young per adult).

(vi) In addition to immobility, any abnormal behavior or appearance shall also be reported.

(vii) Test organisms shall be impartially distributed among test chambers in such a manner that test results show no significant bias from the distributions. In addition, test chambers within the testing area shall be positioned in a random manner as in a way in which appropriate statistical analyses can be used to determine the variation due to placement.

(5) [Reserved]

(6) *Analytical measurements.* (i) *Test chemical.* Deionized water should be used in making stock solutions of the test substance. Standard analytical methods should be used whenever available in performing the analyses. The analytical method used to measure the amount of test substance in a sample shall be validated before beginning the test by appropriate laboratory practices. An analytical method is not acceptable if likely degradation products of the test substance, such as hydrolysis and oxidation products, give positive or negative interferences

which cannot be systematically identified and corrected mathematically.

(ii) *Numerical*. The number of immobilized adults, total offspring per adult, and immobilized offspring per adult shall be counted during each test. Appropriate statistical analyses should provide a goodness-of-fit determination for the adult immobilization concentration-response curves calculated on day 21. A 21-day EC_{50} based on adult immobilization and corresponding 95 percent confidence intervals shall also be calculated. Appropriate statistical tests (e.g., analysis of variance, mean separation test) should be used to test for significant chemical effects on chronic test criteria (cumulative number of immobilized adults, cumulative number of offspring per adult and cumulative number of immobilized offspring per adult) on day 21. An MATC shall be calculated using these chronic test criteria.

(d) *Test conditions*—(1) *Test species*—(i) *Selection*. (A) The cladocerans, *Daphnia magna* or *D. pulex*, are the species to be used in this test. Either species can be utilized for testing of a particular chemical. The species identity of the test organisms should be verified using appropriate systematic keys.

(B) First instar daphnids, ≤24 hours old, are to be used to start the test.

(ii) *Acquisition*. (A) Daphnids to be used in chronic toxicity tests should be cultured at the test facility. Records should be kept regarding the source of the initial stock and culturing techniques. All organisms used for a particular test shall have originated from the same culture population.

(B) Daphnids shall not be used for a test if:

(*1*) Cultures contain ephippia.

(*2*) Adults in the cultures do not produce young before day 12.

(*3*) More than 20 percent of the culture stock die in the 2 days preceding the test.

(*4*) Adults in the culture do not produce an average of at least 3 young per adult per day over the 7-day period prior to the test.

(*5*) Daphnids have been used in any portion of a previous test either in a treatment or in a control.

(iii) *Feeding*. (A) During the test the daphnids shall be fed the same diet and with the same frequency as that used for culturing and acclimation. All treatments and control(s) shall receive, as near as reasonably possible, the same ration of food on a per-animal basis.

(B) The food concentration depends on the type used. Food concentrations should be sufficient to support normal growth and development and to allow for asexual (parthenogenic) reproduction. For automatic feeding devices, a suggested rate is 5 to 7 mg food (either solids or algal cells, dry weight) per liter dilution water or test solution. For manual once-a-day feeding, a suggested rate is 15 mg food (dry weight) per liter dilution water or test solution.

(iv) *Loading*. The number of test organisms placed in a test chamber shall not affect test results. Loading shall not exceed 40 daphnids per liter in the renewal system. In the flow-through test, loading limits will vary depending on the flow rate of the dilution water. Loading shall not cause the dissolved oxygen concentration to fall below the recommended level.

(v) *Care and handling of test organisms*. (A) Daphnids should be cultured in dilution water under similar environmental conditions to those used in the test. A variety of foods have been demonstrated to be adequate for daphnid culture. They include algae, yeasts and a variety of mixtures.

(B) Organisms should be handled as little as possible. When handling is necessary it should be done as gently, carefully, and quickly as possible. During culturing and acclimation, daphnids should be observed carefully for ephippia and other signs of stress, physical damage, and mortality. Dead and abnormal individuals shall be discarded. Organisms that touch dry surfaces or are dropped or injured during handling shall be discarded.

(C) Smooth glass tubes (I.D. greater than 5mm) equipped with a rubber bulb can be used for transferring daphnids with minimal culture media carryover.

(D) Care should be exercised to introduce the daphnids below the surface of any solution so as not to trap air under the carapace.

(vi) *Acclimation.* (A) Brood daphnids shall be maintained in 100 percent dilution water at the test temperature for at least 48 hours prior to the start of the test. This is easily accomplished by culturing them in dilution water at the test temperature. During acclimation, daphnids shall be fed the same food as will be used for the definitive test.

(B) During culturing and acclimation to the dilution water, daphnids should be maintained in facilities with background colors and light intensities similar to those of the testing area.

(2) *Facilities*—(i) *General.* (A) Facilities needed to perform this test include:

(*1*) Containers for culturing and acclimating daphnids.

(*2*) A mechanism for controlling and maintaining the water temperature during the culturing, acclimation and test periods.

(*3*) Apparatus for straining particulate matter, removing gas bubbles, or aerating the water when water supplies contain particulate matter, gas bubbles, or insufficient dissolved oxygen, respectively.

(*4*) An apparatus for providing a 16-hour light and 8-hour dark photoperiod.

(*5*) An apparatus to introduce food if continuous or intermittent feeding is used.

(*6*) In addition, the flow-through test shall contain appropriate test chambers in which to expose daphnids to the test substance and an appropriate test substance delivery system.

(B) Facilities should be well ventilated and free of fumes and other disturbances that may affect the test organisms.

(ii) *Test chambers.* (A) Materials and equipment that contact test solutions should be chosen to minimize sorption of test chemicals from the dilution water and should not contain substances that can be leached into aqueous solution in quantities that can affect test results.

(B) For renewal tests, daphnids can be conveniently exposed to the test solution in 250 ml beakers or other suitable containers.

(C) For flow-through tests daphnids can be exposed in glass or stainless steel containers with stainless steel or nylon screen bottoms. Such containers shall be suspended in the test chamber in such a manner to ensure that the test solution flows regularly into and out of the container and that the daphnids are always submerged in at least 5 centimeters of test solution. Test chambers can be constructed using 250 ml beakers or other suitable containers equipped with screened overflow holes, standpipes or V-shaped notches.

(D) Test chambers shall be loosely covered to reduce the loss of test solution or dilution water due to evaporation and to minimize the entry of dust or other particulates into the solutions.

(iii) *Test substance delivery system.* (A) In the flow-through test, proportional diluters, metering pump systems or other suitable systems should be used to deliver the test substance to the test chambers.

(B) The test substance delivery system shall be calibrated before each test. Calibration includes determining the flow rate through each chamber and the concentration of the test substance in each chamber. The general operation of the test substance delivery system should be checked twice daily during a test. The 24-hour flow rate through a test chamber shall be equal to at least five times the volume of the test chamber. During a test, the flow rates shall not vary more than 10 percent from any one test chamber to another. For the renewal test, test substance dilution water shall be completely replaced at least once every 3 days.

(iv) *Dilution water.* (A) Surface or ground water, reconstituted water, or dechlorinated tap water are acceptable as dilution water if daphnids will survive in it for the duration of the culturing, acclimation, and testing periods without showing signs of stress. The quality of the dilution water should be constant and should meet the following specificiations:

Substance	Maximum concentration
Particulate matter	20 mg/l.
Total organic carbon or	2 mg/l.
Chemical oxygen demand	5 mg/l.
Un-ionized ammonia	20 µg/l.
Residual chlorine	<3 µg/l.

Substance	Maximum concentration
Total organophosphorus pesticides	50 ng/l.
Total organochlorine pesticides plus polychlorinated biphenyls (PCBs).	50 ng/l.
or organic chlorine	25 ng/l.

(B) The water quality characteristics listed above shall be measured at least twice a year or when it is suspected that these characteristics may have changed significantly. If dechlorinated tap water is used, daily chlorine analysis shall be performed.

(C) If the diluent water is from a ground or surface water source, conductivity and total organic carbon (TOC) or chemical oxygen demand (COD) shall be measured. Reconstituted water can be made by adding specific amounts of reagent-grade chemicals to deionized or distilled water. Glass distilled or carbon filtered deionized water with a conductivity of less than 1 microohm/cm is acceptable as the diluent for making reconstituted water.

(D) If the test substance is not soluble in water an appropriate carrier should be used.

(v) *Cleaning of test system.* All test equipment and test chambers shall be cleaned before each use following standard laboratory procedures. Cleaning of test chambers may be necessary during the testing period.

(3) *Test parameters.* (i) Environmental conditions of the water contained in test chambers should be maintained as specified in this paragraph:

(A) The test temperature shall be 20 °C. Excursions from the test temperature shall be no greater than ±2 °C.

(B) Dissolved oxygen concentration between 60 and 105 percent saturation. Aeration, if needed to achieve this level, shall be done before the addition of the test substance. All treatment and control chambers shall be given the same aeration treatment.

(C) Photoperiod of 16-hours light and 8-hours darkness.

(ii) Additional measurements include:

(A) The concentration of the test substance in the chambers shall be measured during the test.

(B) At a minimum, the concentration of test substance should be measured as follows:

(*1*) In each chamber before the test.

(*2*) In each chamber on days 7, 14, and 21 of the test.

(*3*) In at least one appropriate chamber whenever a malfunction is detected in any part of the test substance delivery system. Equal aliquots of test solution may be removed from each replicate chamber and pooled for analysis. Among replicate test chambers of a treatment concentration, the measured concentration of the test substance should not vary more than 20 percent.

(*4*) An apparatus for providing a 16-hour light and 8-hour dark photoperiod.

(C) The dissolved oxygen concentration, temperature and pH shall be measured at the beginning of the test and on days 7, 14, and 21 in at least two chambers of the high, middle, low, and control test concentrations.

(e) *Reporting.* The sponsor shall submit to the U.S. Environmental Protection Agency all data developed by the test that are suggestive or predictive of chronic toxicity and all associated toxicologic manifestations. In addition to the reporting requirements prescribed in the part 792—*Good Laboratory Practice Standards* of this chapter the reporting of test data shall include the following:

(1) The name of the test, sponsor, testing laboratory, study director, principal investigator, and dates of testing.

(2) A detailed description of the test substance including its source, lot number, composition (identity and concentration of major ingredients and major impurities), known physical and chemical properties, and any carriers or other additives used and their concentrations.

(3) The source of the dilution water, its chemical characteristics (e.g., conductivity, hardness, pH), and a description of any pretreatment.

(4) Detailed information about the daphnids used as brood stock, including the scientific name and method of verification, age, source, treatments, feeding history, acclimation procedures, and culture methods. The age of

the daphnids used in the test shall be reported.

(5) A description of the test chambers, the volume of solution in the chambers, the way the test was begun (e.g., conditioning, test substance additions), the number of test organisms per test chamber, the number of replicates per treatment, the lighting, the renewal process and schedule for the renewal chronic test, the test substance delivery system and flow rate expressed as volume additions per 24 hours for the flow-through chronic test, and the method of feeding (manual or continuous) and type of food.

(6) The concentration of the test substance in test chambers at times designated for renewal and flow-through tests.

(7) The number and percentage of organisms that show any adverse effect in each test chamber at each observation period.

(8) The cumulative adult and offspring immobilization values and the progeny produced at designated observation times, the time (days) to first brood and the number of offspring per adult in the control replicates and in each treatment replicate.

(9) All chemical analyses of water quality and test substance concentrations, including methods, method validations and reagent blanks.

(10) The data records of the culture, acclimation, and test temperatures.

(11) Any deviation from this test guideline, and anything unusual about the test, (e.g., dilution failure, temperature fluctuations).

(12) The MATC to be reported is calculated as the geometric mean between the lowest measured test substance concentration that had a significant ($p \leq 0.05$) effect and the highest measured test substance concentration that had no significant ($p \leq 0.05$) effect on day 21 of the test. The most sensitive of the test criteria (number of adult animals immobilized, the number of young per female and the number of immobilized young per female) is used to calculate the MATC. The criterion selected for MATC computation is the one which exhibits an effect (a statistically significant difference between treatment and control groups; $p \leq 0.05$) at the lowest test substance concentration for the shortest period of exposure. Appropriate statistical tests (analysis of variance, mean separation test) shall be used to test for significant test substance effects. The statistical tests employed and the results of these tests shall be reported.

(13) Concentration-response curves utilizing the average measured test substance concentration shall be fitted to cumulative adult immobilization data at 21 days. A statistical test of goodness-of-fit shall be performed and the results reported.

(14) An EC_{50} value based on adult immobilization with corresponding 95 percent confidence limits when sufficient data are present for day 21. These calculations shall be made using the average measured concentration of the test substance.

[50 FR 39321, Sept. 27, 1985, as amended at 52 FR 19060, May 20, 1987]

§ 797.1400 Fish acute toxicity test.

(a) *Purpose*. This guideline may be used to develop data on the acute toxicity of chemical substances and mixtures (''chemicals'') subject to environmental effects test regulations under the Toxic Substances Control Act (TSCA) (Pub. L. 94–469, 90 Stat. 2003, 15 U.S.C. 2601 *et seq.*). This guideline prescribes tests to be used to develop data on the acute toxicity of chemicals to fish. The United States Environmental Protection Agency (EPA) will use data from these tests in assessing the hazard of a chemical to the environment.

(b) *Definitions*. The definitions in section 3 of the Toxic Substances Control Act (TSCA), and the definitions in part 792—*Good Laboratory Practice Standards* of this chapter apply to this test guideline. The following definitions also apply to this guideline:

(1) *Acclimation* means the physiological compensation by test organisms to new environmental conditions (e.g., temperature, hardness, pH).

(2) *Acute toxicity test* means a method used to determine the concentration of a substance that produces a toxic effect on a specified percentage of test organisms in a short period of time (e.g., 96 hours). In this guideline, death is used as the measure of toxicity.

(3) *Carrier* means a solvent used to dissolve a test substance prior to delivery to the test chamber.

(4) *Conditioning* means the exposure of construction materials, test chambers, and testing apparatus to dilution water or to test solutions prior to the start of a test in order to minimize the sorption of the test substance onto the test facilities or the leaching of substances from the test facilities into the dilution water or test solution.

(5) *Death* means the lack of opercular movement by a test fish.

(6) *Flow-through* means a continuous or an intermittent passage of test solution or dilution water through a test chamber, or a holding or acclimation tank with no recycling.

(7) *Incipient* LC_{50} means that test substance concentration, calculated from experimentally-derived mortality data, that is lethal to 50 percent of a test population when exposure to the test substance is continued until the mean increase in mortality does not exceed 10 percent in any concentration over a 24-hour period.

(8) LC_{50} means that test substance concentration, calculated from experimentally-derived mortality data, that is lethal to 50 percent of a test population during continuous exposure over a specified period of time.

(9) *Loading* means the ratio of fish biomass (grams, wet weight) to the volume (liters) of test solution in a test chamber or passing through it in a 24-hour period.

(10) *Static* means the test solution is not renewed during the period of the test.

(11) *Test solution* means the test substance and the dilution water in which the test substance is dissolved or suspended.

(c) *Test procedures*—(1) *Summary of the test*. (i) Test chambers are filled with appropriate volumes of dilution water. If a flow-through test is performed, the flow of dilution water through each chamber is adjusted to the rate desired.

(ii) The test substance is introduced into each test chamber. In a flow-through test, the amount of test substance which is added to the dilution water is adjusted to establish and maintain the desired concentration of test substance in each test chamber.

(iii) Test fish which have been acclimated in accordance with the test design are introduced into the test and control chambers by stratified random assignment.

(iv) Fish in the test and control chambers are observed periodically during the test; dead fish are removed at least twice each day and the findings are recorded.

(v) The dissolved oxygen concentration, pH, temperature and the concentration of test substance are measured at intervals in selected test chambers.

(vi) Concentration-response curves and LC_{50} values for the test substance are developed from the mortality data collected during the test.

(2) [Reserved]

(3) *Range finding test*. If the toxicity of the test substance is not already known, a range finding test should be performed to determine the range of concentrations to be used in the definitive test. The highest concentration of test substance for use in the range finding test should not exceed its solubility in water or the permissible amount of the carrier used.

(4) *Definitive test*. (i) A minimum of 20 fish should be exposed to each of five or more test substance concentrations. The range of concentrations to which the fish are exposed should be such that in 96 hours there are at least two partial mortality exposures bracketing 50 percent survival.

(ii) For exposure to each concentration of a test substance, an equal number of test fish shall be placed in two or more replicate test chambers. Test fish shall be impartially distributed among test chambers in such a manner that test results show no significant bias from the distributions.

(iii) Every test shall include a control consisting of the same dilution water, conditions, procedures, and fish from the same group used in the test, except that none of the test substance is added.

(iv) Mortality data collected during the test are used to calculate a 96-hour LC_{50}. The 24-, 48-, and 72-hour values should be calculated whenever there is sufficient mortality data to determine such values. If the 96-hour LC_{50} is less than 50 percent of the estimated 48-

hour LC_{50} in a flow-through test, the test shall be continued until the mean increase in mortality at any test concentration does not exceed 10 percent over a 24-hour period or until 14 days.

(v) Test fish shall not be fed while they are being exposed to the test substance under static conditions or during the first 96 hours of flow-through testing. If the test continues past 96 hours, the fish should be fed a suitable food at a maintenance level every other day beginning on test day 5. Any excess food and the fecal material should be removed when observed.

(5) *Test results.* (i) Death is the primary criterion used in this test guideline to evaluate the toxicity of the test substance.

(ii) In addition to death, any abnormal behavior such as, but not limited to, erratic swimming, loss of reflex, increased excitability, lethargy, or any changes in appearance or physiology such as discoloration, excessive mucous production, hyperventilation, opaque eyes, curved spine, or hemorrhaging shall be recorded.

(iii) Observations on compound solubility shall be recorded. The investigator shall report the appearance of surface slicks, precipitates, or material adhering to the sides of the test chamber.

(iv) Each test and control chamber shall be checked for dead fish and observations recorded at 24, 48, 72, and 96 hours after the beginning of the test or within one hour of the designated times. If the test is continued past 96 hours, additional observations shall be made every 24 hours until termination.

(v) The mortality data is used to calculate LC_{50}'s and their 95 percent confidence limits, and to plot concentration-response curves for each time interval whenever sufficient data exists. The methods recommended for use in calculating LC_{50}'s include probit, logit, binomial, and moving average angle.

(vi) A test is unacceptable if more than 10 percent of the control fish die or exhibit abnormal behavior during a 96-hour test. If a flow-through test is continued past 96 hours, the maximum allowable additional mortality is 10 percent.

(6) *Analytical measurements*—(i) *Water quality analysis.* (A) The hardness, acidity, alkalinity, pH, conductivity, TOC or COD, and particulate matter of the dilution water should be measured at the beginning of each static test and at the beginning and end of each flow-through test. The month to month variation of the above values should be less than 10 percent and the pH should vary less than 0.4 units.

(B) During static tests, the dissolved oxygen concentration, temperature, and pH shall be measured in each test chamber at the beginning and end of the test. The test solution volume shall not be reduced by more than 10 percent as a result of these measurements.

(C) During flow-through tests, dissolved oxygen, temperature and pH measurements shall be made in each chamber at the beginning and end of the test.

(ii) *Collection of samples for measurement of test substance.* Test solution samples to be analyzed for the test substance should be taken midway between the top, bottom, and sides of the test chamber. These samples should not include any surface scum or material dislodged from the bottom or sides. Samples should be analyzed immediately or handled and stored in a manner which minimizes loss of test substance through microbial degradation, photodegradation, chemical reaction, volatilization, or sorption.

(iii) *Measurement of test substance.* (A) For static tests, the concentration of the test substance shall be measured at a minimum in each test chamber at each test concentration at the beginning (0-hour, before fish are added) and at the end of the test. During flow-through tests, the concentration of test substance shall be measured as follows:

(*1*) In at least the chamber of each test concentration at 0-hour.

(*2*) In at least the chamber of each test concentration at 96-hours and every 4 days thereafter, as long as the test is continued.

(*3*) In at least one appropriate chamber whenever a malfunction is detected in any part of the test substance delivery system.

(*4*) Equal aliquots of test solution may be removed from each replicate chamber and pooled for analysis.

(B) Filters and their holders used for determining the dissolved test substance concentrations should be prewashed with several volumes of distilled water and undergo a final rinse with test solution. Glass or stainless steel filter holders are best for organic test substances, while plastic holders are best for metals. The sample should be filtered within 30 minutes after it is taken from the test chamber.

(C) The analytical methods used to measure the amount of test substance in a sample shall be validated before beginning the test. The accuracy of a method should be verified by a method such as using known additions. This involves adding a known amount of the test substance to three water samples taken from a chamber containing dilution water and the same number and species of fish as are used in the test. The nominal concentration of the test substance in those samples should span the concentration range to be used in the test.

(D) An analytical method is not acceptable if likely degradation products of the test substance give positive or negative interferences, unless it is shown that such degradation products are not present in the test chambers during the test.

(E) In addition to analyzing samples of test solution, at least one reagent blank, containing all reagents used, should also be analyzed.

(F) If the measured concentrations of dissolved test substance are considerably lower (e.g., <50 percent) than the nominal concentrations, the total test substance concentration should be measured in the highest test concentration.

(G) Among replicate test chambers, the measured concentrations shall not vary more than 20 percent. The measured concentration of the test substance in any chamber during the test should not vary more than 30 percent from the measured concentration at time 0.

(H) The mean measured concentration of test substance shall be used to calculate all LC_{60}'s and to plot all concentration-response curves.

(d) *Test conditions*—(1) *Test species*—(i) *Selection*. The test species for this test are the rainbow trout (*Salmo gairdneri*), bluegill (*Lepomis macrochirus*) and fathead minnow (*Pimephales promelas*). The particular species of fish to be used will be prescribed in the test rule.

(ii) *Age and condition of fish*. (A) Juvenile fish shall be used. Fish used in a particular test shall be the same age and be of normal size and appearance for their age. The longest fish shall not be more than twice the length of the shortest.

(B) All newly acquired fish should be quarantined and observed for at least 14 days prior to use in a test.

(C) Fish shall not be used for a test if they appear stressed or if more than five percent die during the 48 hours immediately prior to the test.

(iii) *Acclimation of test fish*. (A) If the holding water is not from the same source as the test dilution water, acclimation to the dilution water should be done gradually over a 48-hour period. The fish should then be held an additional 14 days in the dilution water prior to testing. Any changes in water temperature should not exceed 3 °C per day. Fish should be held for a minimum of 7 days at the test temperature prior to testing.

(B) During the final 48-hours of acclimation, fish should be maintained in facilities with background colors and light intensities similar to those of the testing area and should not be fed.

(2) *Facilities*—(i) *General*. Facilities needed to perform this test include:

(A) Flow-through tanks for holding and acclimating fish.

(B) A mechanism for controlling and maintaining the water temperature during the holding, acclimation and test periods.

(C) Apparatus for straining particulate matter, removing gas bubbles, or insufficient dissolved oxygen, respectively.

(D) Apparatus for providing a 16-hour light and 8-hour dark photoperiod with a 15- to 30-minute transition period.

(E) Chambers for exposing test fish to the test substance.

(F) A test substance delivery system for flow-through tests.

(ii) *Construction materials*. Construction materials and commercially purchased equipment that may contact

the stock solution, test solution, or dilution water should not contain substances that can be leached or dissolved into aqueous solutions in quantities that can alter the test results. Materials and equipment that contact stock or test solutions should be chosen to minimize sorption of test chemicals. Glass, stainless steel, and perfluorocarbon plastic should be used whenever possible. Concrete, fiberglass, or plastic (e.g., PVC) may be used for holding tanks, acclimation tanks, and water supply systems, but they should be used to remove rust particles. Rubber, copper, brass, galvanized metal, epoxy glues, and lead should not come in contact with the dilution water, stock solution, or test solution.

(iii) *Test substance delivery system.* In flow-through tests, diluters, metering pump systems, or other suitable devices should be used to deliver the test substance to the test chambers. The system used should be calibrated before each test. Calibration includes determining the flow rate through each chamber and the concentration of the test substance delivered to each chamber. The general operation of the test substance delivery system should be checked twice daily during a test. The 24-hour flow rate through a test chamber should be a minimum of 6 tank volumes. During a test, the flow rates should not vary more than 10 percent from one test chamber to another.

(iv) *Test chambers.* Test chambers made of stainless steel should be welded, not soldered. Test chambers made of glass should be fused or bonded using clear silicone adhesive. As little adhesive as possible should be left exposed in the interior of the chamber.

(v) *Cleaning of test system.* Test substance delivery systems and test chambers should be cleaned before each test. They should be washed with detergent and then rinsed in sequence with clean water, pesticide-free acetone, clean water, and 5 percent nitric acid, followed by two or more changes of dilution water.

(vi) *Dilution water.* (A) Clean surface or ground water reconstituted water, or dechlorinated tap water is acceptable as dilution water if the test fish will survive in it for the duration of the holding, acclimating, and testing periods without showing signs of stress, such as discoloration, hemorrhaging, disorientation or other unusual behavior. The quality of the dilution water should be constant and should meet the following specifications measured at least twice a year:

Substance	Maximum
Particulate matter	20 mg/liter.
Total organic carbon or	2 mg/liter.
chemical oxygen demand	5 mg/liter.
Un-ionized ammonia	1 μg/liter.
Residual chlorine	1 μg/liter.
Total organochloring pesticides	50 μg/liter.
Total organocholorine pesticides plus polychlorinated biphenyls (PCBs).	50 μg/liter.
or organic chlorine	25 μg/liter.

(B) The concentration of dissolved oxygen in the dilution water should be between 90 and 100 percent saturation; 9.8 to 10.9 mg/l for tests with trout, and 8.0 to 8.9 mg/l for tests with bluegill or fathead minnow at sea level. If necessary, the dilution water can be aerated before the addition of the test substance. All reconstituted water should be aerated before use. Buffered soft water should be aerated before but not after the addition of buffers.

(C) If disease organisms are present in the dilution water in sufficient numbers to cause infection, they should be killed or removed by suitable equipment.

(D) Glass distilled or carbon filtered deionized water with a conductivity less than 1 micromho/cm is acceptable for use in making reconstituted water. If the reconstituted water is prepared from a ground or surface water source, conductivity, and total organic carbon (TOC) or chemical oxygen demand (COD) should be measured on each batch.

(vii) *Carriers.* (A) Distilled water should be used in making stock solutions of the test substance. If the stock volume however is more than 10 percent of the test solution volume, dilution water should be used. If a carrier is absolutely necessary to dissolve the test substance, the volume used should not exceed the minimum volume necessary to dissolve or suspend the test substance in the test solution. If the test substance is a mixture, formulation, or commercial product, none of the ingredients is considered a carrier

unless an extra amount is used to prepare the stock solution.

(B) Triethylene glycol and dimethyl formamide are the prefered carriers, but acetone may also be used. The concentration of triethylene glycol in the test solution should not exceed 80 mg/1. The concentration of dimethyl formamide or acetone in the test solution should not exceed 5.0 mg/1.

(3) *Test parameters*—(i) *Loading*. The number of fish placed in a test chamber should not be so great as to affect the results of the test. The loading should not be so great that the test substance concentrations are decreased by more than 20 percent due to uptake by the fish. In static tests, loading should not exceed 0.5 grams of fish per liter of solution in the test chamber at any one time. In flow-through tests loading should not exceed 0.5 grams of fish per liter of test solution passing through the chamber in 24 hours. These loading rates should be sufficient to maintain the dissolved oxygen concentration above the recommended levels and the ammonia concentration below 20 μg/l.

(ii) *Dissolved oxygen concentration*. (A) During static tests with rainbow trout the dissolved oxygen in each test chamber shall be greater than 5.5 mg/1. In tests with bluegill and fathead minnows, the DO shall be maintained above 4.5 mg/1.

(B) During flow-through tests the dissolved oxygen concentration shall be maintained above 8.2 mg/1 in tests with trout and above 6.6 mg/l in tests with bluegills or fathead minnows.

(iii) *Temperature*. The test temperature shall be 22 °C for bluegill and fathead minnow and 12 °C for rainbow trout. Excursions from the test temperature shall be no greater than ±2 °C. The temperature shall be measured at least hourly in one test chamber.

(iv) *Light*. A 16-hour light and 8-hour dark photoperiod should be maintained.

(e) *Reporting*. The sponsor shall submit to the EPA all data developed by the test that are suggestive or predictive of toxicity. In addition to the reporting requirements prescribed in part 792—*Good Laboratory Practice Standards* of this chapter, the reported test data shall include the following:

(1) The source of the dilution water, a description of any pretreatment, and the measured hardness, acidity, alkalinity, pH, conductivity, TOC or COD and particulate matter.

(2) A description of the test chambers, the depth and volume of solution in the chamber, the specific way the test was begun (e.g., conditioning, test substance additions), and for flow-through tests, a description of the test substance delivery system.

(3) Detailed information about the test fish, including the scientific name and method of verification, average weight (grams, wet weight), standard length, age, source, history, observed diseases, treatments, and mortalities, acclimation procedures, and food used.

(4) The number of replicates used, the number of organisms per replicate, the loading rate, and the flow rate for flow-through tests.

(5) The measured DO, pH and temperature and the lighting regime.

(6) The solvent used, the test substance concentration in the stock solution, the highest solvent concentration in the test solution and a description of the solubility determinations in water and solvents if used.

(7) The concentrations of the test substance at each test concentration just before the start of the test and at all subsequent sampling periods.

(8) The number of dead and live tests organisms, the percentage of organisms that died, and the number that showed any abnormal effects in the control and in each test chamber at each observation period.

(9) The 96-hour LC_{50}, and when sufficient data have been generated, the 24–, 48–, 72–, and incipient LC_{50} values, their 95 percent confidence limits, and the methods used to calculate the LC_{50} values and their confidence limits.

(10) When observed, the observed no effect concentration (the highest concentration tested at which there were no mortalities or abnormal behavioral or physiological effects).

(11) The concentration-response curve at each observation period for which a LC_{50} was calculated.

(12) Methods and data records of all chemical analyses of water quality parameters and test substance concentrations, including method validations and reagent blanks.

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§ 797.1600 Fish early life stage toxicity test.

(a) *Purpose*. This guideline is intended to be used for assessing the propensity of chemical substances to produce adverse effects to fish during the early stages of their growth and development. This guideline describes the conditions and procedures for the continuous exposure of several representative species to a chemical substance during egg, fry and early juvenile life stages. The Environmental Protection Agency (EPA) will use data from this test in assessing the potential hazard of the test substance to the aquatic environment.

(b) *Definitions*. The definitions in section 3 of the Toxic Substances Control Act (TSCA) and the definitions in part 792—*Good Laboratory Practice Standards,* apply to this section. In addition, the following definitions are applicable to this specific test guideline:

(1) ''Acclimation'' physiological or behavioral adaptation of organisms to one or more environmental conditions associated with the test method (e.g., temperature, hardness, pH).

(2) ''Carrier'' solvent or other agent used to dissolve or improve the solubility of the test substance in dilution water.

(3) ''Conditioning'' exposure of construction materials, test chambers, and testing apparatus to dilution water or to the test solution prior to the start of the test in order to minimize the sorption of test substance onto the test facilities or the leachig of substances from test facilities into the dilution water or the test solution.

(4) ''Control'' an exposure of test organisms to dilution water only or dilution water containing the test solvent or carrier (no toxic agent is intentionally or inadvertently added).

(5) ''Dilution water'' the water used to produce the flow-through conditions of the test to which the test substance is added and to which the test species is exposed.

(6) ''Early life stage toxicity test'' a test to determine the minimum concentration of a substance which produces a statistically significant observable effect on hatching, survival, development and/or growth of a fish species continuously exposed during the period of their early development.

(7) ''Embryo cup'' a small glass jar or similar container with a screened bottom in which the embryos of some species (i.e., minnow) are placed during the incubation period and which is normally oscillated to ensure a flow of water through the cup.

(8) ''Flow through'' refers to the continuous or very frequent passage of fresh test solution through a test chamber with no recycling.

(9) ''Hardness'' the total concentration of the calcium and magnesium ions in water expressed as calcium carbonate (mg $CaCO_3$/liter).

(10) ''Loading'' the ratio of biomass (grams of fish, wet weight) to the volume (liters) of test solution passing through the test chamber during a specific interval (normally a 24-hr. period).

(11) ''No observed effect concentration (NOEC)'' the highest tested concentration in an acceptable early life stage test: (i) which did not cause the occurrence of any specified adverse effect (statistically different from the control at the 95 percent level); and (ii) below which no tested concentration caused such an occurrence.

(12) ''Observed effect concentration (OEC)'' the lowest tested concentration in an acceptable early life stage test: (i) Which caused the occurrence of any specified adverse effect (statistically different from the control at the 95 percent level); and (ii) above which all tested concentrations caused such an occurrence.

(13) ''Replicate'' two or more duplicate tests, samples, organisms, concentrations, or exposure chambers.

(14) ''Stock solution'' the source of the test solution prepared by dissolving the test substance in dilution water or a carrier which is then added to dilution water at a specified, selected concentration by means of the test substance delivery system.

(15) ''Test chamber'' the individual containers in which test organisms are maintained during exposure to test solution.

(16) ''Test solution'' dilution water with a test substance dissolved or suspended in it.

(17) ''Test substance'' the specific form of a chemical substance or mixture that is used to develop data.

(c) *Test Procedures*—(1) *Summary of test.* (i) The early life stage toxicity test with fish involves exposure of newly fertilized embryos to various concentrations of a test substance. Exposure continues for 28 days post hatch for the minnows and 60 days post hatch for the trout species. During this time various observations and measurements are made in a specific manner and schedule in order to determine the lowest effect and highest no-effect concentrations of the test substance.

(ii) A minimum of five exposure (treatment) concentrations of a test substance and one control are required to conduct an early life stage toxicity test. The concentration of the test substance in each treatment is usually 50 percent of that in the next higher treatment level.

(iii) For each exposure concentration of the test substance and for each control (i.e., regular control and carrier control is required) there shall be:

(A) At least two replicate test chambers, each containing one or more embryo incubation trays or cups; and there shall be no water connections between the replicate test chambers;

(B) At least 60 embryos divided equally in such a manner that test results show no significant bias from the distributions, between the embryo incubation trays or cups for each test concentration and control (i.e., 30 per embryo cup with 2 replicates);

(C) All surviving larvae divided equally between the test chambers for each test concentration and control (e.g., 30 larvae per test chamber with 2 replicates).

(iv) *Duration.* (A) For fathead minnow and sheepshead minnow a test begins when the newly fertilized minnow embryos (less than 48-hours old) are placed in the embryo cups and are exposed to the test solution concentrations. The test terminates following 28 days of post-hatch exposure, i.e., 28 days after the newly hatched fry are transferred from the embryo cups into the test chambers.

(B) For brook trout and rainbow trout a test begins when newly fertilized trout embryos (less than 96-hours old) are placed in the embryo trays or cups and are exposed to the test solution concentrations. The test terminates following 60 days of post-hatch exposure (for an approximate total exposure period of 90 days).

(C) For silverside a test begins with newly fertilized embryos (less than or equal to 48 hours old) and is terminated 28 days after hatching. The chorionic fibrils should be cut before randomly placing the embryos in the egg incubation cups.

(2) [Reserved]

(3) *Range-finding test.* (i) A range finding test is normally performed with the test substance to determine the test concentrations to be used in the early life stage toxicity test, especially when the toxicity is unknown. It is recommended that the test substance concentrations be selected based on information gained from a 4- to 10-day flow-through toxicity test with juveniles of the selected test species.

(ii) The highest concentration selected for the early life stage toxicity test should approximate the lowest concentration indicated in any previous testing to cause a significant reduction in survival. The range of concentrations selected is expected to include both observed effect and no-observed effect levels. The dilution factor between concentrations is normally 0.50, however, other dilution factors may be used as necessary.

(4) *Definitive test*—(i) *General.* (A) A test shall not be initiated until after the test conditions have been met and the test substance delivery system has been observed functioning properly for 48-hours. This includes temperature stability, flow requirements of dilution water, lighting requirements, and the function of strainers and air traps included in the water-supply system, and other conditions as specified previously.

(B) New holding and test facilities should be tested with sensitive organisms (i.e., juvenile test species or

daphnids) before use to assure that the facilities or substances possibly leaching from the equipment will not adversely affect the test organisms during an actual test.

(C) Embryos should be acclimated for as long as practical to the test temperature and dilution water prior to the initiation of the test.

(D) When embryos are received from an outside culture source (i.e., rainbow and brook trout) at a temperature at variance with the recommended test temperature they shall be acclimated to the test temperature. When eggs are received, they should be immediately unpacked and the temperature of the surrounding water determined. Sudden temperature changes should be avoided. Acclimation to the appropriate test temperature should be accomplished within a period of 6 hours, and should incorporate the use of dilution water.

(E) Embryos should be visually inspected prior to placement in the embryo cups or screen trays. All dead embryos shall be discarded. Dead embryos can be discerned by a change in coloration from that of living embryos (e.g., trout embryos turn white when dead). During visual inspection, empty shells, opaque embryos, and embryos with fungus or partial shells attached shall be removed and discarded. If less than 50 percent of the eggs to be used appear to be healthy, all embryos in such a lot shall be discarded.

(ii) *Embryo incubation procedures.* (A) Embryos can be distributed to the embryo cups or screen trays using a pipette with a large bore or a similar apparatus. Newly-hatched silverside fry are very sensitive to handling; the egg incubation cups should not be handled at all the first 5 days after hatching begins. Just before hatching is expected to begin, the embryos should be transferred to clean incubation cups. Trout embryos can be distributed by using a small container which has been precalibrated to determine the approximate number of embryos it can hold; embryos are measured volumetrically in this manner, and are then poured onto the screen tray (or embryo cup). Trout embryos should be separated on the screen tray so that they are not in contact with each other. A final count will ensure the actual number on the screen tray. After random assignment, the screen trays or embryo cups are placed in the test chambers.

(B) Each day until hatch the embryos are visually examined. Minnow embryos may be examined with the aid of a magnifying viewer. Trout embryos should not be touched. Trout embryos should be maintained in low intensity light or in darkness until 1-week post hatch, and are usually examined with the aid of a flashlight or under low intensity light. Dead embryos should be removed and discarded. Any embryos which are heavily infected with fungus shall be discarded and shall be subtracted from the initial number of embryos used as a basis for the calculations of percentage hatch.

(C) When embryos begin to hatch they should not be handled.

(iii) *Initiation of fry exposure.* (A) Forty-eight hours after the first hatch in each treatment level, or when hatching is completed, the live young fish shall be counted and transferred from each embryo cup into the appropriate test chamber. For silverside, all surviving fry are not counted until six days after hatching and are not transferred to embryo cups. All of the normal and abnormal fry shall be gently released into the test chamber by allowing the fry to swim out of each embryo cup; nets shall not be used. The trout embryos incubated on screen trays will hatch out in the test chambers, therefore handling of fish is not necessary.

(B) If necessary, fry can be transferred from one replicate embryo cup to the other replicate within a test concentration to achieve equal numbers in each replicate chamber.

(C) The number of live fry, live normal fry, live embryos, dead embryos and unaccounted for embryos for each cup shall be recorded when hatching is deemed complete. Those fry which are visibly (without the use of a dissecting scope or magnifying viewer) lethargic or grossly abnormal (either in swimming behavior or physical appearance) shall be counted. Late hatching embryos shall be left in the embryo cups to determine if they will eventually hatch or not. The range of time-to-hatch (to the nearest day) for each cup shall be recorded.

(iv) *Time to first feeding.* (A) The first feeding for the fathead and sheepshead minnow fry shall begin shortly after transfer of the fry from the embryo cups to the test chambers. Silversides are fed the first day after hatch. Trout species initiate feeding at swim-up. The trout fry shall be fed trout starter mash three times a day *ad libitum,* with excess food siphoned off daily. The minnow fry shall be fed live newly-hatched brine shrimp nauplii (*Artemia salina*) at least three times a day.

(B) For the first seven days, feeding shall be done at minimum intervals of four hours (i.e., 8 am, 12 noon, and 4 pm); thereafter the fry shall be fed as indicated below.

(v) *Feeding.* (A) The fathead and sheepshead minnow fry shall be fed newly hatched brine shrimp nauplii for the duration of the test at approximately 4-hour intervals three times a day during the week and twice on the weekend after the first week. Trout fry shall be fed at similar intervals and may receive live brine shrimp nauplii in addition to the trout starter food after the first week. Between days 1 and 8 after first hatching, silverside fry are fed the rotifer, *Brachionus plicatilis,* three times daily at a concentration of 5,000 to 10,000 organisms per egg cup (based on 15 fish/cup). From days 9 to 11, the fry shall be fed approximately 2,500 newly hatched brine shrimp (*Artemia*) nauplii and 5,000 to 10,000 rotifers twice daily. For the remainder of the test, the fish will be fed brine shrimp exclusively. The number of organisms used should be gradually increased to approximately 5,000 nauplii by test day 28.

(B) An identical amount of food should be provided to each chamber. Fish should be fed *ad libitum* for 30 minutes with excess food siphoned off the bottom once daily if necessary.

(C) Fish should not be fed for the last 24 hours prior to termination of the test.

(vi) *Carriers.* Water should be used in making up the test stock solutions. If carriers other than water are absolutely necessary, the amount used should be the minimum necessary to achieve solution of the test substance. Triethylene glycol and dimethyl formamide are preferred, but ethanol and acetone can be used if necessary. Carrier concentrations selected should be kept constant at all treatment levels.

(vii) *Controls.* Every test requires a control that consists of the same dilution water, conditions, procedures, and test organisms from the same group used in the other test chambers, except that none of the test substance is added. If a carrier (solvent) is used, a separate carrier control is required in addition to the regular control. The carrier control shall be identical to the regular control except that the highest amount of carrier present in any treatment is added to this control. If the test substance is a mixture, formulation, or commercial product, none of the ingredients is considered a carrier unless an extra amount is used to prepare the stock solution.

(viii) *Randomization.* The location of all test chambers within the test system shall be randomized. A representative sample of the test embryos should be impartially distributed by adding to each cup or screen tray no more than 20 percent of the number of embryos to be placed in each cup or screen tray and repeating the process until each cup or screen tray contains the specified number of embryos. Alternatively, the embryos can be assigned by random assignment of a small group (e.g., 1 to 5) of embryos to each embryo cup or screen tray, followed by random assignment of a second group of equal number to each cup or tray, which is continued until the appropriate number of embryos are contained in each embryo cup or screen tray. The method of randomization used shall be reported.

(ix) *Observations.* During the embryo exposure period observations shall be made to check for mortality. During the exposure period of the fry, observations shall be made to check for mortality and to note the physical appearance and behavior of the young fish. The biological responses are used in combination with physical and chemical data in evaluating the overall lethal and sublethal effects of the test substance. Additional information on the specific methodology for the data obtained during the test procedure are discussed in the following sections.

(x) *Biological data.* (A) Death of embryos shall be recorded daily.

(B) When hatching commences, daily records of the number of embryos remaining in each embryo cup are required. This information is necessary to quantify the hatching success. A record of all deformed larvae shall be kept throughout the entire post-hatch exposure. Time to swim-up shall be recorded for the trout. Upon transfer of fry from the embryo cups to the test chambers, daily counts of the number of live fish should be made. At a minimum, live fish shall be counted on days 4, 11, 18, 25 and (weekly thereafter for the trout species) finally on termination of the test.

(C) The criteria for death of young fish is usually immobility, especially absence of respiratory movement, and lack of reaction to gentle prodding. Deaths should be recorded daily and dead fish removed when discovered.

(D) Daily and at termination of the test, the number of fish that appear (without the use of a magnifying viewer) to be abnormal in behavior (e.g., swimming erratic or uncoordinated, obviously lethargic, hyperventilating, or over excited, etc.) or in physical appearance (e.g., hemorrhaging, producing excessive mucous, or are discolored, deformed, etc.) shall be recorded and reported in detail.

(E) All physical abnormalities (e.g., stunted bodies, scoliosis, etc.) shall be photographed and the deformed fish which die, or are sacrificed at the termination of the test, shall be preserved for possible future pathological examination.

(F) At termination, all surviving fish shall be measured for growth. Standard length measurements should be made directly with a caliper, but may be measured photographically. Measurements shall be made to the nearest millimeter (0.1 mm is desirable). Weight measurements shall also be made for each fish alive at termination (wet, blotted dry, and to the nearest 0.01 g for the minnows and 0.1 g for the trout). If the fish exposed to the toxicant appear to be edematous compared to control fish, determination of dry, rather than wet, weight is recommended.

(G) Special physiological, biochemical and histological investigations on embryos, fry, and juveniles may be deemed appropriate and shall be performed on a case by case basis.

(5) *Test results.* (i) Data from toxicity tests are usually either continuous (e.g. length or weight measurements) or dichotomous (e.g. number hatching or surviving) in nature. Several methods are available and acceptable for statistical analysis of data derived from early life stage toxicity tests; however, the actual statistical methodology to analyze and interpret the test results shall be reported in detail.

(ii) The significance level for all statistical testing shall be a minimum of P=0.05 (95 percent confidence level).

(A) *Example of statistical analysis.* (*1*) Mortality data for the embryonic stage, fry stage and for both stages in replicate exposure chambers should first be analyzed using a two-way analysis of variance (ANOVA) with interaction model. This analysis will determine if replicates are significantly different from each other. If a significant difference between replicates or a significant interaction exists, cause for the difference should be determined. Modification should then be made in the test apparatus or in handling procedures for future toxicity tests. Further calculations should incorporate the separation of replicates. If no significant difference is observed, replicates may be pooled in further analyses.

(*2*) After consideration of replicate responses, mortality data should then be subjected to one-way ANOVA. The purpose of this analysis is to determine if a significant difference exists in the percentage mortality between control fish and those exposed to the test material.

(*3*) If the one-way ANOVA results in a F ratio that is significant, it would be acceptable to perform t-tests on the control versus each concentration. A second technique is to identify treatment means that are significantly different; this method should involve the additional assumption that the true mean response decreases generally

with increasing concentration. The researcher may also be interested in determining significant differences between concentrations.

(*4*) Growth data should also be analyzed by one-way ANOVA with the inclusion of a covariate to account for possible differences in growth of surviving fry in embryo cup(s) that contain fewer individuals. This condition can occur in cases when the same amount of food is given to each test chamber regardless of the number of survivors.

(B) *Test data to be analyzed*. Data to be statistically analyzed are:

(*1*) Percentage of healthy, fertile embryos at 40–48 hours after initiation of the test. Percentage is based upon initial number used.

(*2*) Percentage of embryos that produce live fry for release into test chambers. Percentage is based on number of embryos remaining after thinning.

(*3*) Percentage of embryos that produce live, normal fry for release into test chambers. Percentage is based upon number of embryos remaining after thinning.

(*4*) Percentage of fry survival at swim-up for trout. Percentage is based upon number of embryos remaining after thinning.

(*5*) Percentage of embryos that produce live fish at end of test. Percentage is based upon number of embryos remaining after thinning.

(*6*) Percentage of embryos that produce live, normal fish at end of test. Percentage is based upon number of embryos remaining after thinning.

(*7*) Weights and lengths of individual fish alive at the end of the test.

(C) It is important that fish length and weight measurements be associated with individual test chambers since the density of the fish and available food should be considered in the growth of the organism.

(iii) *Acceptability criteria*. (A) An early life stage toxicity test is not acceptable unless at least one of the following criteria is significantly different (p=0.05) from control organisms when compared with treated organisms, and the responses are concentration-dependent: mortality of embryos, hatching success, mortality of fry (at swim-up for trout), total mortality throughout the test, and growth (i.e. weight). If no significant effects occur, but the concentrations tested were the highest possible due to solubility or other physio-chemical limitations, the data will be considered for acceptance.

(B) In addition to obtaining significant effects on the exposed test species, a measure of acceptability in the response of control fish is also required.

(C) A test is not acceptable if the average survival of the control fish at the end of the test is less than 80 percent or if survival in any one control chamber is less than 70 percent. For silversides, a test is not acceptable if the average overall survival of the control embryos and fish at the end of the test is less than 60 percent.

(D) If a carrier is used, the criteria for effect (mortality of embryos and fry, growth, etc.) used in the comparison of control and exposed test organisms shall also be applied to the control and control with carrier chambers. For the test to be considered acceptable, no significant difference shall exist between these criteria.

(E) A test is not acceptable if the relative standard deviation (RSD=100 times the standard deviation divided by the mean) of the weights of the fish that were alive at the end of the test in any control test chamber is greater than 40 percent.

(6) *Analytical measurements*—(i) *Analysis of water quality*. Measurement of certain dilution water quality parameters shall be performed every 6 months, to determine the consistency of the dilution water quality. In addition, if data in 30-day increments are not available to show that freshwater dilution water is constant, measurements of hardness, alkalinity, pH, acidity, conductivity, TOC or COD and particulate matter should be conducted once a week in the highest test substance concentration. Measurement of calcium, magnesium, sodium, potassium, chloride, and sulfate is desirable.

(ii) *Dissolved oxygen measurement*. The dissolved oxygen concentration shall be measured in each test chamber at the beginning of the test and at least once weekly thereafter (as long as live

organisms are present) in two replicates of the control and the high, medium, and low test substance concentrations.

(iii) *Temperature measurement.* Temperatures shall be recorded in all test chambers at the beginning of the test, once weekly thereafter and at least hourly in one test chamber. When possible, the hourly measurement shall be alternated between test chambers and between replicates.

(iv) *Test substance measurement.* (A) Prior to the addition of the test substance to the dilution water, it is recommended that the test substance stock solution be analyzed to verify the concentration. After addition of the test substance, the concentration of test substance should be measured at the beginning of the test in each test concentration and control(s), and at least once a week thereafter. Equal aliquots of test solution may be removed from each replicate chamber and pooled for analysis. If a malfunction in the delivery system is discovered, water samples shall be taken from the affected test chambers immediately and analyzed.

(B) The measured concentration of test substance in any chamber should be no more than 30 percent higher or lower than the concentration calculated from the composition of the stock solution and the calibration of the test substance delivery system. If the difference is more than 30 percent, the concentration of test substance in the solution flowing into the exposure chamber (influent) should be analyzed. These results will indicate whether the problem is in the stock solution, the test substance delivery system or in the test chamber. Measurement of degradation products of the test substance is recommended if a reduction of the test substance concentration occurs in the test chamber.

(v) *Sampling and analysis methodology.* (A) Generally, total test substance measurements are sufficient; however, the chemical characteristics of the test substance may require both dissolved and suspended test substance measurements.

(B) For measurement of the test substance, water samples shall be taken midway between the top, bottom, and sides of the test chamber and should not include any surface scum or material stirred up from the bottom or sides. Samples of test solutions shall be handled and stored appropriately to minimize loss of test substance by microbial degradation, photodegradation, chemical reaction, volatilization, or sorption.

(C) Chemical and physical analyses shall be performed using standardized methods whenever possible. The analytical method used to measure the concentration of the test substance in the test solution shall be validated before the beginning of the test. At a minimum, a measure of the accuracy of the method should be obtained on each of two separate days by using the method of known additions, and using dilution water from a tank containing test organisms. Three samples should be analyzed at the next-to-lowest test substance concentration. It is also desirable to study the accuracy and precision of the analytical method for test guideline determination by use of reference (split) samples, or interlaboratory studies, and by comparison with alternative, reference, or corroborative methods of analysis.

(D) An analytical method is not acceptable if likely degradation products of the test substance, such as hydrolysis and oxidation products, give positive or negative interferences, unless it is shown that such degradation products are not present in the test chambers during the test. In general, atomic absorption spectrophotometric methods for metals and gas chromatographic methods for organic compounds are preferable to colorimetric methods.

(E) In addition to analyzing samples of test solution, at least one reagent blank also should be analyzed when a reagent is used in the analysis. Also, at least one sample for the method of known additions should be prepared by adding test substance at the concentration used in the toxicity test.

(d) *Test conditions*—(1) *Test species.* (i) One or more of the recommended test species will be specified in rules under part 799 of this chapter requiring testing of specific chemicals. The recommended test species are:

(A) Fathead minnow (*Pimephales promelas* Rafinesque).

(B) Sheepshead minnow (*Cyprinodon variegatus*).

(C) Brook trout (*Salvelinus fontinalis*).

(D) Rainbow trout (*Salmo gairdneri*).

(E) Atlantic silverside (*Menidia menidia*).

(F) Tidewater silverside (*Menidia peninsulae*).

(ii) Embryos used to initiate the early life stage test shall be less than 48 hours old for the fathead and sheepshead minnows, silversides, and less than 96 hours old for the brook trout and rainbow trout. In addition, the following requirements shall be met:

(A) All embryos used in the test shall be from the same source. Embryos shall be obtained from a stock cultured in-house when possible, and maintained under the same parameters as specified for the test conditions. When it is necessary to obtain embryos from an external source, caution should be exercised to ensure embryo viability and to minimize the possibility of fungal growth. A description of the brood stock history or embryo source shall be made available to EPA upon request.

(B) Test species shall be cared for and handled properly in order to avoid unnecessary stress. To maintain test species in good condition and to maximize growth, crowding shall be prevented, and the dissolved oxygen level shall be maintained near saturation.

(C) Embryos and fish shall be handled as little as possible. Embryos shall be counted and periodically inspected until hatching begins. When larvae begin to hatch, they shall not be handled. Transfer of minnow larvae from embryo cups to test chambers shall not involve the use of nets. No handling is necessary following introduction into the test chambers until termination of the test.

(D) If fathead minnow embryos are obtained from in-house culture units, the embryos should be gently removed from the spawning substrate. The method for separating the fertilized eggs from the substrate is important and can affect the viability of the embryos; therefore the finger-rolling procedure is recommended.

(E) Disease treatment. Chemical treatments to cure or prevent diseases should not be used before, and should not be used during a test. All prior treatments of brood stock should be reported in detail. Severely diseased organisms should be destroyed.

(2) *Test facilities*—(i) *Construction materials*. Construction materials and equipment that contact stock solutions, test solutions, or dilution water into which test embryos or fish are placed should not contain any substances that can be leached or dissolved into aqueous solutions in quantities that can affect test results. Materials and equipment that contact stock or test solutions should be chosen to minimize sorption of test chemicals from dilution water. Glass, #316 stainless steel, nylon screen and perfluorocarbon plastic (e.g., Teflon#) are acceptable materials. Concrete or rigid (unplasticized) plastic may be used for holding and acclimation tanks, and for water supply systems, but they should be thoroughly conditioned before use. If cast iron pipe is used in freshwater supply systems, colloidal iron may leach into the dilution water and strainers should be used to remove rust particles. Natural rubber, copper, brass, galvanized metal, epoxy glues, and flexible tubing should not come in contact with dilution water, stock solutions, or test solutions.

(ii) *Test chambers* (exposure chambers). (A) Stainless steel test chambers should be welded or glued with silicone adhesive, and not soldered. Glass should be fused or bonded using clear silicone adhesive. Epoxy glues are not recommended, but if used ample curing time should be allowed prior to use. As little adhesive as possible should be in contact with the water.

(B) Many different sizes of test chambers have been used successfully. The size, shape and depth of the test chamber is acceptable if the specified flow rate and loading requirements can be achieved.

(C) The actual arrangement of the test chambers can be important to the statistical analysis of the test data. Test chambers can be arranged totally on one level (tier) side by side, or on two levels with each level having one of the replicate test substance concentrations or controls. Regardless of the arrangement, it shall be reported

in detail and considered in the data analysis.

(iii) *Embryo incubation apparatus.* (A) Recommended embryo incubation apparatus include embryo cups for the minnow species and screen trays for the trout species, although embryo cups can be used for the trout species. Embryo cups are normally constructed from approximately 4–5 cm inside diameter, 7–8 cm high, glass jars with the end cut off or similar sized sections of polyethylene tubing. One end of the jar or tubing is covered with stainless steel or nylon screen (approximately 40 meshes per inch is recommended). Embryo cups for silversides are normally constructed by using silicone adhesive to glue a 10-cm high, 363-um nylon mesh tube inside a 9-cm I.D. glass Petri dish bottom. The embryo cups shall be appropriately labeled and then suspended in the test chamber in such a manner as to ensure that the test solution regularly flows through the cup and that the embryos are always submerged but are not agitated too vigorously. Cups may be oscillated by a rocker arm apparatus with a low rpm motor (e.g., 2 rpm) to maintain the required flow of test water. The vertical-travel distance of the rocker arm apparatus during oscillation is normally 2.5–4.0 cm. The water level in the test chambers may also be varied by means of a self-starting siphon in order to ensure exchange of water in the embryo cups.

(B) The trout embryo incubation trays can be made from stainless steel screen (or other acceptable material such as plastic) of about 3–4 mm mesh. The screen tray should be supported above the bottom of the test chamber by two folds of screen or other devices which function as legs or supports. The edges of the screen tray should be turned up to prevent bump spills and to prevent the embryos from rolling off in the event of excessive turbulence. Suspending or supporting the screen tray off the bottom ensures adequate water circulation around the embryos and avoids contact of embryos with possible bottom debris.

(iv) *Test substance delivery system.* (A) The choice of a specific delivery system depends upon the specific properties and requirements of the test substance. The apparatus used should accurately and precisely deliver the appropriate amount of stock solution and dilution water to the test chambers. The system selected shall be calibrated before each test. Calibration includes determining the flow rate through each chamber, and the proportion of stock solution to dilution water delivered to each chamber. The general operation of the test substance delivery system shall be checked at least twice daily for normal operation throughout the test. A minimum of five test substance concentrations and one control shall be used for each test.

(B) The proportional diluter and modified proportional diluter systems and metering pump systems have proven suitable and have received extensive use.

(C) Mixing chambers shall be used between the diluter and the test chamber(s). This may be a small container or flow-splitting chamber to promote mixing of test substance stock solution and dilution water, and is positioned between the diluter and the test chambers for each concentration. If a proportional diluter is used, separate delivery tubes shall run from the flow-splitting chamber to each replicate test chamber. Daily checks on this latter system shall be made.

(D) Silverside fry are injured easily and are susceptible to impingement on the mesh of the incubation cups. Consequently, water flow into and out of the cups when counting fry must be at a slow rate. This can be accomplished by using small diameter (e.g., 2 mm I.D.) capillary tubes to drain the test solution from spitter boxes into the replicate test chambers. The use of a self-starting siphon to gradually lower (i.e., less than or equal to 1 min.) the water level approximately 2 cm in the test chamber is recommended. A minimum water depth of 5 cm should be maintained in the cups. Although it may be satisfactory, a rocker-arm type apparatus has not yet been used with silversides.

(v) *Other equipment required.* (A) An apparatus for removing undesirable organisms, particulate matter and air bubbles.

(B) An apparatus for aerating water.

(C) A suitable magnifying viewer for examination of minnow embryos.

(D) A suitable apparatus for the precise measurement of growth of the fish, including both length (e.g., with metric or ruler caliper or photographic equipment) and weight.

(E) Facilities for providing a continuous supply of live brine shrimp nauplii (*Artemia salina*).

(F) For silversides, facilities for providing a supply of rotifers (*Brachionus plicatilis*) for approximately 11 days.

(G) Facilities (or access to facilities) for performing the required water chemistry analyses.

(vi) *Cleaning of equipment.* (A) Test substance delivery systems and test chambers should be cleaned before use. Test chambers should be cleaned during the test as needed to maintain the dissolved oxygen concentration, and to prevent clogging of the embryo cup screens and narrow flow passages.

(B) Debris can be removed with a rubber bulb and large pipette or by siphoning with a glass tube attached to a flexible hose. Debris should be run into a bucket light enough to observe that no live fish are accidentally discarded.

(vii) *Dilution water*—(A) *General.* (*1*) A constant supply of acceptable dilution water should be available for use throughout the test. Dilution water shall be of a minimum quality such that the test species selected will survive in it for the duration of testing without showing signs of stress (e.g., loss of pigmentation, disorientation, poor response to external stimuli, excessive mucous secretion, lethargy, lack of feeding, or other unusual behavior). A better criterion for an acceptable dilution water for tests on early life stages should be such that the species selected for testing will survive, grow, and reproduce satisfactorily in it.

(*2*) The concentration of dissolved oxygen in the dilution water (fresh or salt) shall be between 90 percent and 100 percent saturation. When necessary, dilution water should be aerated by means of airstones, surface aerators, or screen tubes before the introduction of the test substance.

(*3*) Water that is contaminated with undesirable microoganisms (e.g., fish pathogens) shall not be used. If such contamination is suspected, the water should be passed through a properly maintained ultraviolet sterilizer equipped with an intensity meter before use. Efficacy of the sterilizer can be determined by using standard plate count methods.

(B) *Freshwater.* (*1*) Natural water (clean surface or ground water) is preferred, however, dechlorinated tap water may be used as a last resort. Reconstituted freshwater is not recommended as a practical dilution water for the early life stage toxicity test because of the large volume of water required.

(*2*) Particulate and dissolved substance concentrations should be measured at least twice a year and should meet the following specifications:

Substance	Concentration maximum
Particulate matter	<20 mg/liter.
Total organic carbon (TOC)	<2 mg/liter.
Chemical oxygen demand (COD)	<5 mg/liter.
Un-ionized ammonia	<1 μg/liter.
Residual chlorine	<1 μg/liter.
Total organoposphorus pesticides	<50 ng/liter.
Total organochlorine pesticides plus polychlorinated biphenyls (PCBs).	<50 ng/liter.
Total organic chlorine	<25 ng/liter.

(*3*) During any one month, freshwater dilution water should not vary more than 10 percent from the respective monthly averages of hardness, alkalinity and specific conductance; the monthly pH range should be less than 0.4 pH units.

(C) *Saltwater.* (*1*) Marine dilution water is considered to be of constant quality if the minimum salinity is greater than 15‰ and the weekly range of the salinity is less than 15‰. The monthly range of pH shall be less than 0.8 pH units. Saltwater shall be filtered to remove larval predators. A pore size of ≤20 micrometers (μm) is recommended. For silversides, the recommended salinity is 20 ppt and shall be maintained between 15 and 25 ppt throughout testing.

(*2*) Artificial sea salts may be added to natural seawater during periods of low salinity to maintain salinity above 15‰.

(3) *Test parameters*—(i) *Dissolved oxygen concentration.* It is recommended that the dissolved oxygen concentration be maintained between 90 and 100

percent saturation; but it shall be no less than 75 percent saturation at all times for both minnow species and between 90 and 100 percent saturation for the trout species in all test chambers. Dilution water in the head box may be aerated, but the test solution itself shall not be aerated.

(ii) *Loading and flow rate.* (A) The loading in test chambers should not exceed 0.1 grams of fish per liter of test solution passing through the test chamber in 24 hours. The flow rate to each chamber should be a minimum of 6 tank volumes per 24 hours. During a test, the flow rates should not vary more than 10 percent from any one test chamber to any other.

(B) A lower loading or higher flow rate or both shall be used if necessary to meet the following three criteria at all times during the test in each chamber containing live test organisms:

(*1*) The concentration of dissolved oxygen shall not fall below 75 percent saturation for the fathead and sheepshead minnows and 90 percent for the rainbow and brook trout;

(*2*) The concentration of un-ionized ammonia should not exceed 1 μg/1; and

(*3*) The concentration of toxicant should not be lowered (i.e., caused by uptake by the test organisms and/or materials on the sides and bottoms of the chambers) more than 20 percent of the mean measured concentration.

(iii) *Temperature.* (A) The recommended test temperatures are:

(*1*) Fathead minnow—25 °C for all life stages.

(*2*) Sheepshead minnow—30 °C for all life stages.

(*3*) Rainbow and brook trout—10 °C for embryos. 12 °C for fry and alevins.

(*4*) Atlantic and tidewater silversides—25 °C for all life stages.

(B) Excursions from the test temperature shall be no greater than ±2.0 °C. It is recommended that the test system be equipped with an automatic alarm system to alert staff of instantaneous temperature changes in excess of 2 °C. If the water is heated (i.e., for minnow species), precautions should be taken to ensure that supersaturation of dissolved gases is avoided. Temperatures shall be recorded in all test chambers at the beginning of the test and weekly thereafter. The temperature shall be recorded at least hourly in one test chamber throughout the test.

(iv) *Light.* (A) Brook and rainbow trout embryos shall be maintained in darkness or very low light intensity through one week post-hatch, at which time a 14-hour light and 10-hour dark photoperiod shall be provided.

(B) For fathead and sheepshead minnows, a 16-hour light and 8-hour dark (or 12:12) photoperiod shall be used throughout the test period.

(C) For silversides, a 14-hour light and 10-hour dark photoperiod shall be used throughout the test period.

(D) A 15-minute to 30-minute transition period between light and dark is optional.

(E) Light intensities ranging from 30 to 100 lumens at the water surface shall be provided; the intensity selected should be duplicated as closely as possible for all test chambers.

(e) *Reporting.* A report of the results of an early life stage toxicity test shall include the following:

(1) Name of test, sponsor, investigator, laboratory, and dates of test duration.

(2) Detailed description of the test substance including its source, lot number, composition (identity and concentration of major ingredients and major impurities), known physical and chemical properties, and any carriers (solvents) or other additives used.

(3) The source of the dilution water, its chemical characteristics, and a description of any pretreatment.

(4) Detailed information about the test organisms including scientific name and how verified and source history, observed diseases, treatments, acclimation procedure, and concentration of any contaminants and the method of measurement.

(5) A description of the experimental design and the test chambers, the depth and volume of the solution in the chambers, the way the test was begun, the number of organisms per treatment, the number of replicates, the loading, the lighting, a description of the test substance delivery system, and the flow rate as volume additions per 24 hours.

(6) Detailed information on feeding of fish during the toxicity test, including

type of food used, its source, feeding frequency and results of analysis (i.e., concentrations) for contaminants.

(7) Number of embryos hatched, number of healthy embryos, time to hatch, mortality of embryos and fry, measurements of growth (weight and length), incidence of pathological or histological effects and observations of other effects or clinical signs, number of healthy fish at end of test.

(8) Number of organisms that died or showed an effect in the control and the results of analysis for concentration(s) of any contaminant in the control(s) should mortality occur.

(9) Methods used for, and the results of (with standard deviation), all chemical analyses of water quality and test substance concentration, including validation studies and reagent blanks; the average and range of the test temperature(s).

(10) Anything unusual about the test, any deviation from these procedures, and any other relevant information.

(11) A description of any abnormal effects and the number of fish which were affected during each period between observations in each chamber, and the average concentration of test substance in each test chamber.

(12) Reference to the raw data location.

[50 FR 39321, Sept. 27, 1985, as amended at 52 FR 19064, May 20, 1987]

§ 797.1930 Mysid shrimp acute toxicity test.

(a) *Purpose*. This guideline is intended for use in developing data on the acute toxicity of chemical substances and mixtures (''chemicals'') subject to environmental effects test regulations under the Toxic Substances Control Act (TSCA) (Pub. L. 94–469, 90 Stat. 2003, 15 U.S.C. 2601 *et seq.*). This guideline prescribes a test using mysid shrimp as test organisms to develop data on the acute toxicity of chemicals. The United States Environmental Protection Agency (EPA) will use data from these tests in assessing the hazard of a chemical to the aquatic environment.

(b) *Definitions*. The definitions in section 3 of the Toxic Substances Control Act (TSCA) and in part 792—*Good Laboratory Practice Standards* of this chapter, apply to this test guideline. The following definitions also apply to this guideline.

(1) ''Death'' means the lack of reaction of a test organism to gentle prodding.

(2) ''Flow-through'' means a continuous or an intermittent passage of test solution or dilution water through a test chamber or a holding or acclimation tank, with no recycling.

(3) ''LC_{50}'' means that experimentally derived concentration of test substance that is calculated to kill 50 percent of a test population during continuous exposure over a specified period of time.

(4) ''Loading'' means the ratio of test organisms biomass (grams, wet weight) to the volume (liters) of test solution in a test chamber.

(5) ''Retention chamber'' means a structure within a flow-through test chamber which confines the test organisms, facilitating observation of test organisms and eliminating loss of organisms in outflow water.

(6) ''Static system'' means a test chamber in which the test solution is not renewed during the period of the test.

(c) *Test procedures*—(1) *Summary of the test*. In preparation for the test, test chambers are filled with appropriate volumes of dilution water. If a flow-through test is performed, the flow of dilution water through each chamber is adjusted to the rate desired. The test substance is introduced into each test chamber. In a flow-through test, the rate at which the test substance is added is adjusted to establish and maintain the desired concentration of test substance in each test chamber. The test is started by randomly introducing mysids acclimated in accordance with the test design into the test chambers. Mysids in the test chambers are observed periodically during the test, the dead mysids removed and the findings recorded. Dissolved oxygen concentration, pH, temperature, salinity, the concentration of test substance, and other water quality characteristics are measured at specified intervals in test chambers. Data collected during the test are used to develop concentration-response curves and LC_{50} values for the test substance.

(2) [Reserved]

(3) *Range-finding test.* (i) A range-finding test should be conducted to determine:

(A) Which life stage (juvenile or young adult) is to be utilized in the definitive test.

(B) The test solution concentrations for the definitive test.

(ii) The mysids should be exposed to a series of widely spaced concentrations of test substance (e.g., 1, 10, 100 mg/l, etc.), usually under static conditions.

(iii) This test should be conducted with both newly hatched juvenile (< 24 hours old) and young adult (5 to 6 days old) mysids. For each age class (juvenile or young adult), a minimum of 10 mysids should be exposed to each concentration of test substance for up to 96 hours. The exposure period may be shortened if data suitable for the purpose of the range-finding test can be obtained in less time. The age class which is most sensitive to the test substance in the range-finding test shall be utilized in the definitive test. When no apparent difference in sensitivity of the two life stages is found, juveniles shall be utilized in the definitive test. No replicates are required, and nominal concentrations of the chemical are acceptable.

(4) *Definitive test.* (i) The purpose of the definitive test is to determine the concentration-response curves and the 48- and 96-hour LC_{50} values with the minimum amount of testing beyond the range-finding test.

(ii) The definitive test shall be conducted on the mysid life stage (juveniles or young adults) which is most sensitive to the test substance being evaluated.

(iii) A minimum of 20 mysids per concentration shall be exposed to five or more concentrations of the chemical chosen in a geometric series in which the ratio is between 1.5 and 2.0 (e.g., 2, 4, 8, 16, 32, and 64 mg/l). An equal number of mysids shall be placed in two or more replicates. If solvents, solubilizing agents or emulsifiers have to be used, they shall be commonly used carriers and shall not possess a synergistic or antagonistic effect on the toxicity of the test substance. The concentration of solvent shall not exceed 0.1 ml/1. The concentration ranges shall be selected to determine the concentration-response curves and LC_{50} values at 48 and 96 hours.

(iv) Every test shall include controls consisting of the same dilution water, conditions, procedures, and mysids from the same population or culture container, except that none of the chemical is added.

(v) The dissolved oxygen concentration temperature, salinity, and pH shall be measured at the beginning and end of the test in each chamber.

(vi) The test duration is 96 hours. The test is unacceptable if more than 10 percent of the control organisms die or exhibit abnormal behavior during the 96 hour test period. Each test chamber should be checked for dead mysids at 24, 48, 72, and 96 hours after the beginning of the test. Concentration-response curves and 24-, 48-, 72- and 96-hour LC_{50} values should be determined along with their 95 percent confidence limits.

(vii) In addition to death, any abnormal behavior or appearance shall also be reported.

(viii) Test organisms shall be impartially distributed among test chambers in such a manner that test results show no significant bias from the distributions. In addition, test chambers within the testing area shall be positioned in a random manner or in a way in which appropriated statistical analyses can be used to determine the variation due to placement.

(ix) The concentration of the test substance in the chambers should be measured as often as is feasible during the test. At a minimum, during static tests the concentration of test substance shall be measured at each concentration at the beginning and at the end of the test. During the flow-through test, the concentration of test substance should be measured at the beginning and end of the test and in at least one appropriate chamber whenever a malfunction is detected in any part of the test substance delivery system. Equal aliquots of test solution may be removed from each replicate chamber and pooled for analysis. Among replicate test chambers of a treatment concentration, the measured concentration of the test substance should not vary more than 20 percent.

(5) [Reserved]

(6) *Analytical measurements*—(i) *Test chemical*. Deionized water should be used in making stock solutions of the test substance. Standard analytical methods should be used whenever available in performing the analyses. The analytical method used to measure the amount of test substance in a sample shall be validated before beginning the test by appropriate laboratory practices. An analytical method is not acceptable if likely degradation products of the test substance, such as hydrolysis and oxidation products, give positive or negative interferences which cannot be systematically identified and corrected mathematically.

(ii) *Numerical*. The number of dead mysids shall be counted during each definitive test. Appropriate statistical analyses should provide a goodness-of-fit determination for the concentration-response curves. A 48- and 96-hour LC_{50} and corresponding 95 percent interval shall be calculated.

(d) *Test conditions*—(1) *Test species*—(i) *Selection*. (A) The mysid shrimp, *Mysidopsis bahia*, is the organism specified for these tests. Either juvenile (<24 hours old) or young adult (5 to 6 days old) mysids are to be used to start the test.

(B) Mysids to be used in chronic toxicity tests should originate from laboratory cultures in order to ensure the individuals are of similar age and experimental history. Mysids used for establishing laboratory cultures may be purchased commercially or collected from appropriate natural areas. Because of similarities with other mysids species, taxonomic verification should be obtained from the commercial supplier by experienced laboratory personnel or by an outside expert.

(C) Mysids used in a particular test shall be of similar age and be of normal size and appearance for their age. Mysids shall not be used for a test if they exhibit abnormal behavior or if they have been used in a previous test, either in a treatment or in a control group.

(ii) *Acclimation*. (A) Any change in the temperature and chemistry of the dilution water used for holding or culturing the test organisms to those of the test shall be gradual. Within a 24-hour period, changes in water temperature shall not exceed 1 °C, while salinity changes shall not exceed 5 percent.

(B) During acclimation mysids should be maintained in facilities with background colors and light intensities similar to those of the testing areas.

(iii) *Care and handling*. Methods for the care and handling of mysids such as those described in paragraph (f)(1) of this section can be used during holding, culturing and testing periods.

(iv) *Feeding*. Mysids should be fed during testing. Any food utilized should support survival, growth and reproduction of the mysids. A recommended food is live *Artemia* spp. (48-hour-old nauplii).

(2) *Facilities*—(i) *Apparatus*. (A) Facilities which may be needed to perform this test include: (*1*) flow-through or recirculating tanks for holding and acclimating mysids; (*2*) a mechanism for controlling and maintaining the water temperature during the holding, acclimation and test periods; (*3*) apparatus for straining particulate matter, removing gas bubbles, or aerating the water, as necessary; and (*4*) an apparatus for providing a 14-hour light and 10-hour dark photoperiod with a 15 to 30 minute transition period. In addition, for flow-through tests, flow-through chambers and a test substance delivery system are required. Furthermore, it is recommended that mysids be held in retention chambers within test chambers to facilitate observations and eliminate loss of test organisms through outflow water. For static tests, suitable chambers for exposing test mysids to the test substance are required. Facilities should be well ventilated and free of fumes and disturbances that may affect the test organisms.

(B) Test chambers shall be loosely covered to reduce the loss of test solution or dilution water due to evaporation and to minimize the entry of dust or other particulates into the solutions.

(ii) *Cleaning*. Test substance delivery systems and test chambers shall be cleaned before each test following standard laboratory practices.

(iii) *Construction materials*. (A) Materials and equipment that contact test solutions should be chosen to minimize

sorption of test chemicals from dilution water and should not contain substances that can be leached into aqueous solution in quantities that can affect test results.

(B) For use in the flow-through test, retention chambers utilized for confinement of test organisms can be constructed with netting material of appropriate mesh size.

(iv) *Dilution water.* (A) Natural or artificial seawater is acceptable as dilution water if mysids will survive and successfully reproduce in it for the duration of the holding, acclimating and testing periods without showing signs of stress, such as reduced growth and fecundity. Mysids shall be cultured and tested in dilution water from the same origin.

(B) Natural seawater shall be filtered through a filter with a pore size of <20 microns prior to use in a test.

(C) Artificial seawater can be prepared by adding commercially available formulations or by adding specific amounts of reagent-grade chemicals to deionized water. Deionized water with a conductivity less than 1 μohm/cm at 12 °C is acceptable for making artificial seawater. When deionized water is prepared from a ground or surface water source, conductivity and total organic carbon (or chemical oxygen demand) shall be measured on each batch.

(v) *Test substance delivery system.* In flow-through tests, proportional diluters, metering pumps, or other suitable systems should be used to deliver test substance to the test chambers. The system used shall be calibrated before each test. Calibration includes determining the flow rate through each chamber and the concentration of the test substance in each chamber. The general operation of the test substance delivery system should be checked twice daily during a test. The 24-hour flow through a test chamber shall be equal to at least 5 times the volume of the test chamber. During a test, the flow rates should not vary more than 10 percent among test chambers or across time.

(3) *Test parameters.* Environmental parameters of the water contained in test chambers shall be maintained as specified below:

(i) The test temperature shall be 25 °C. Excursions from the test temperature shall be not greater than ±2 °C.

(ii) Dissolved oxygen concentration between 60 and 105 percent saturation. Aeration, if needed to achieve this level, shall be done before the addition of the test substance. All treatment and control chambers shall be given the same aeration treatment.

(iii) The number of mysids placed in a test solution shall not be so great as to affect results of the test. Loading shall not exceed 30 mysids per liter for a static test. Loading requirements for the flow-through test will vary depending on the flow rate of dilution water. The loading shall not cause the dissolved oxygen concentration to fall below the recommended levels.

(iv) Photoperiod of 14 hours light and 10 hours darkness, with a 15 to 30 minute transition period.

(v) Salinity of 20 parts per thousand ±3 percent.

(e) *Reporting.* The sponsor shall submit to the EPA all data developed during the test that are suggestive or predictive of acute toxicity and all concomitant toxicologic manifestations. In addition to the general reporting requirements prescribed in part 792—*Good Laboratory Practice Standards* of this chapter, the reporting of test data shall include the following:

(1) The source of the dilution water, its chemical characteristics (e.g., salinity, pH, etc.) and a description of any pretreatment.

(2) Detailed information about the test organisms, including the scientific name and method of verification, age, source, history, abnormal behavior, acclimation procedures and food used.

(3) A description of the test chambers, the depth and volume of solution in the chamber, the way the test was begun (e.g., conditioning, test substance additions, etc.), the number of organisms per treatment, the number of replicates, the loading, the lighting, the test substance delivery system and the flow rate expressed as volume additions per 24 hours.

(4) The measured concentration of test substance in test chambers at the times designated.

(5) The number and percentage of organisms that died or showed any other

adverse effects in the control and in each treatment at each observation period.

(6) Concentration-response curves shall be fitted to mortality data collected at 24, 48, 72, and 96 hours. A statistical test of goodness-of-fit shall be performed and the results reported.

(7) The 96-hour LC_{50} and when sufficient data have been generated, the 24-, 48-, and 72-hour LC_{50}'s and the corresponding 95-percent confidence limits and the methods used to calculate the values. These calculations shall be made using the average measured concentration of the test substance.

(8) Methods and data records of all chemical analyses of water quality and test substance concentrations, including method validations and reagent blanks.

(9) The data records of the holding, acclimation and test temperature and salinity.

(f) *References*. For additional background information on this test guideline the following references should be consulted:

(1) U.S. Environmental Protection Agency, ''Bioassay Procedures for the Ocean Disposal Permit Program,'' EPA Report No. 600–9–78–010 (Gulf Breeze, Florida, 1978).

(2) [Reserved]

[50 FR 39321, Sept. 27, 1985, as amended at 52 FR 19068, May 20, 1987; 52 FR 26150, July 13, 1987]

§ 797.1950 Mysid shrimp chronic toxicity test.

(a) *Purpose*. This guideline is intended for use in developing data on the chronic toxicity of chemical substances and mixtures (''chemicals'') subject to environmental effects test regulations under the Toxic Substances Control Act (TSCA) (Pub. L. 94–469, 90 Stat. 2003, 15 U.S.C. 2601 *et seq.*). This guideline prescribes tests using mysids as test organisms to develop data on the chronic toxicity of chemicals. The United States Environmental Protection Agency (EPA) will use data from these tests in assessing the hazard of a chemical to the aquatic environment.

(b) *Definitions*. The definitions in section 3 of the Toxic Substances Control Act (TSCA) and in part 792—*Good Laboratory Practice Standards* of this chapter apply to this test guideline. The following definitions also apply to this guideline:

(1) ''Chronic toxicity test'' means a method used to determine the concentration of a substance that produces an adverse effect from prolonged exposure of an organism to that substance. In this test, mortality, number of young per female and growth are used as measures of chronic toxicity.

(2) ''Death'' means the lack of reaction of a test organism to gentle prodding.

(3) ''Flow-through'' means a continuous or an intermittent passage of test solution or dilution water through a test chamber or a holding or acclimation tank, with no recycling.

(4) ''G1 (Generation 1)'' means those mysids which are used to begin the test, also referred to as adults; G2 (Generation 2) are the young produced by G1.

(5) ''LC_{50}'' means that experimentally derived concentration of test substance that is calculated to kill 50 percent of a test population during continuous exposure over a specified period of time.

(6) ''Loading'' means the ratio of test organism biomass (gram, wet weight) to the volume (liters) of test solution in a test chamber.

(7) ''MATC'' (Maximum Acceptable Toxicant Concentration) means the maximum concentration at which a chemical can be present and not be toxic to the test organism.

(8) ''Retention chamber'' means a structure within a flow-through test chamber which confines the test organisms, facilitating observation of test organisms and eliminating washout from test chambers.

(c) *Test procedures*—(1) *Summary of the test*. (i) In preparation for the test, the flow of test solution through each chamber is adjusted to the rate desired. The test substance is introduced into each test chamber. The rate at which the test substance is added is adjusted to establish and maintain the desired concentration of test substance in each test chamber. The test is started by randomly introducing mysids acclimated in accordance with the test design into retention chambers within the test and the control chambers.

Mysids in the test and control chambers are observed periodically during the test, the dead mysids removed and the findings reported.

(ii) Dissolved oxygen concentration, pH, temperature, salinity, the concentration of test substance and other water quality characteristics are measured at specified intervals in selected test chambers.

(iii) Data collected during the test are used to develop a MATC (Maximum Acceptable Toxicant Concentration) and quantify effects on specific chronic parameters.

(2) [Reserved]

(3) *Range-finding test.* (i) A range-finding test should be conducted to establish test solution concentrations for the definitive test.

(ii) The mysids should be exposed to a series of widely spaced concentrations of the test substance (e.g., 1, 10, 100 mg/l), usually under static conditions.

(iii) A minimum of 10 mysids should be exposed to each concentration of test substance for a period of time which allows estimation of appropriate chronic test concentrations. No replicates are required and nominal concentrations of the chemical are acceptable.

(4) *Definitive test.* (i) The purpose of the definitive test is to determine concentration-response curves, LC_{50} values, and effects of a chemical on growth and reproduction during chronic exposure.

(ii) A minimum of 40 mysids per concentration shall be exposed to four or more concentrations of the chemical chosen in a geometric series in which the ratio is between 1.5 and 2.0 (e.g., 2, 4, 8, 16, 32, and 64 mg/1). An equal number of mysids shall be placed in two or more replicates. If solvents, solubilizing agents or emulsifiers have to be used, they shall be commonly used carriers and shall not possess a synergistic or antagonistic effect on the toxicity of the test substance. The concentration of solvent should not exceed 0.1 ml/1. The concentration ranges should be selected to determine the concentration response curves, LC_{50} values and MATC. Concentration of test substance in test solutions should be analyzed prior to use.

(iii) Every test should include controls consisting of the same dilution water, conditions, procedures and mysids from the same population or culture container, except that none of the chemical is added.

(iv) The dissolved oxygen concentration, temperature, salinity, and pH shall be measured weekly in each chamber.

(v) The test duration is 28 days. The test is unacceptable if more than 20 percent of the control organisms die, appear stressed or are diseased during the test. The number of dead mysids in each chamber shall be recorded on days 7, 14, 21, and 28 of the test. At the time when sexual characteristics are discernible in the mysids (approximately 10 to 12 days in controls; possible delays may occur in mysids exposed to test substances), the number of males and females (identified by ventral brood pouch) in each chamber shall be recorded. Body length (as measured by total midline body length, from the anterior tip of the carapace to the posterior margin of the uropod) shall be recorded for males and females at the time when sex can be determined simultaneously for all mysids in control and treatment groups. This time cannot be specified because of possible delays in sexual maturation of mysids exposed to test substances. A second observation of male and female body lengths shall be conducted on day 28 of the test. To reduce stress on the mysids, body lengths can be recorded by photography through a stereomicroscope with appropriate scaling information. As offspring are produced by the G1 mysids (approximately 13 to 16 days in controls), the young shall be counted and separated into retention chambers at the same test substance concentration as the chambers where they originated. If available prior to termination of the test, observations on the mortality, number of males and females and male and female body length shall be recorded for the G2 mysids. Concentration-response curves, LC_{50} values and associated 95 percent confidence limits for the number of dead mysids (G1) shall be determined for days 7, 14, 21, and 28. An MATC shall be determined for the most sensitive test criteria

measured (cumulative mortality of adult mysids, number of young per female, and body lengths of adult males and females).

(vi) In addition to death, any abnormal behavior or appearance shall also be reported.

(vii) Test organisms shall be impartially distributed among test chambers in such a manner that test results show no significant bias from the distributions. In addition, test chambers within the testing area shall be positioned in a random manner or in a way in which appropriate statistical analyses can be used to determined the variation due to placement.

(viii) The concentration of the test substance in the chambers should be measured as often as is feasible during the test. The concentration of test substance shall be measured:

(A) At each test concentration at the beginning of the test and on days 7, 14, 21, and 28; and

(B) In at least one appropriate chamber whenever a malfunction is detected in any part of the test substance delivery system.

Equal aliquots of test solutions may be removed from each test chamber and pooled for analysis. Among replicate test chambers of a treatment concentration, the measured concentration of the test substance should not vary more than 20 percent.

(5) [Reserved]

(6) *Analytical measurements*—(i) *Test chemical.* Deionized water should be used in making stock solutions of the test substance. Standard analytical methods should be employed whenever available in performing the analyses. The analytical method used to measure the amount of test substance in a sample shall be validated before beginning the test by appropriate laboratory practices. An analytical method is not acceptable if likely degradation products of the test substance, such as hydrolysis and oxidation products, give positive or negative interferences which cannot be systematically identified and corrected mathematically.

(ii) *Numerical.* (A) The number of dead mysids, cumulative young per female, and body lengths of male and female mysids shall be recorded during each definitive test. Appropriate statistical analyses shall provide a goodness-of-fit determination for the day 7, 14, 21 and 28 adult (Gl) death concentration-response curves.

(B) A 7-, 14-, 21- and 28-day LC_{50}, based on adult (Gl) death, and corresponding 95 percent confidence intervals shall be calculated. Appropriate statistical tests (e.g., analysis of variance, mean separation test) should be used to test for significant chemical effects on chronic test criteria (cumulative mortality of adults, cumulative number of young per female and body lengths of adult male and females) on designated days. An MATC shall be calculated using these chronic tests criteria.

(d) *Test conditions*—(1) *Test species*—(i) *Selection.* (A) The mysid shrimp, *Mysidopsis bahia*, is the organism specified for these tests. Juvenile mysids, ≤24 hours old, are to be used to start the test.

(B) Mysids to be used in chronic toxicity tests should originate from laboratory cultures in order to ensure the individuals are of similar age and experimental history. Mysids used for establishing laboratory cultures may be purchased commercially or collected from appropriate natural areas. Because of similarities with other mysid species, taxonomic verification should be obtained from the commercial supplier, by experienced laboratory personnel, or by an outside expert.

(C) Mysids used in a particular test shall be of similar age and be of normal size and appearance for their age.

(D) Mysids shall not be used for a test if they exhibit abnormal behavior, or if they have been used in a previous test, either in a treatment or in a control group.

(ii) *Acclimation.* (A) Any change in the temperature and chemistry of the water used for holding or culturing the test organisms to those of the test should be gradual. Within a 24-hour period, changes in water temperature should not exceed 1 °C, while salinity changes should not exceed 5 percent.

(B) During acclimation mysids should be maintained in facilities with background colors and light intensities similar to those of the testing areas.

(iii) *Care and handling.* Methods for the care and handling of mysids such

as those described in paragraph (f)(1) of this section can be used during holding, culturing and testing periods.

(iv) *Feeding*. Mysids should be fed during testing. Any food utilized should support survival, growth and reproduction of the mysids. A recommended food is live *Artemia* spp. nauplii (approximately 48 hours old).

(2) *Facilities*—(i) *Apparatus*. (A) Facilities which may be needed to perform this test include: (*1*) flow-through or recirculating tanks for holding and acclimating mysids; (*2*) a mechanism for controlling and maintaining the water temperature during the holding, acclimation and test periods; (*3*) apparatus for straining particulate matter, removing gas bubbles, or aerating the water, as necessary; and (*4*) an apparatus for providing a 14-hour light and 10-hour dark photoperiod with a 15- to 30-minute transition period. In addition, flow-through chambers and a test substance delivery system are required. It is recommended that mysids be held in retention chambers within test chambers to facilitate observations and eliminate loss through outflow water.

(B) Facilities should be well ventilated and free of fumes and disturbances that may affect test organisms.

(C) Test chambers shall be loosely covered to reduce the loss of test solution or dilution water due to evaporation and to minimize the entry of dust or other particulates into the solutions.

(ii) *Cleaning*. Test substance delivery systems and test chambers shall be cleaned before each use following standard laboratory practices.

(iii) *Construction materials*. (A) Materials and equipment that contact test solutions should be chosen to minimize sorption of test chemicals from the dilution water and should not contain substances that can be leached into aqueous solution in quantities that can affect the test results.

(B) Retention chambers utilized for confinement of test organisms can be constructed with netting material of appropriate mesh size.

(iv) *Dilution water*. (A) Natural or artificial seawater is acceptable as dilution water if mysids will survive and successfully reproduce in it for the duration of the holding, acclimating and testing periods without showing signs of stress, such as reduced growth and fecundity. Mysids shall be cultured and tested in dilution water from the same origin.

(B) Natural seawater shall be filtered through a filter with a pore size of >20 microns prior to use in a test.

(C) Artificial seawater can be prepared by adding commercially available formulations or by adding specific amounts of reagent-grade chemicals to deionized or glass-distilled water. Deionized water with a conductivity less than 1 μohm/cm at 12 °C is acceptable as the diluent for making artificial seawater. When deionized water is prepared from a ground or surface water source, conductivity and total organic carbon (or chemical oxygen demand) shall be measured on each batch.

(v) *Test substance delivery system*. Proportional diluters, metering pumps, or other suitable systems should be used to deliver test substance to the test chambers. The system used shall be calibrated before each test. Calibration includes determining the flow rate and the concentration of the test substance in each chamber. The general operation of the test substance delivery system should be checked twice daily during a test. The 24-hour flow rate through a chamber shall be equal to at least 5 times the volume of the chamber. The flow rates should not vary more than 10 percent among chambers or across time.

(3) *Test parameters*. Environmental parameters of the water contained in test chambers shall be maintained as specified below:

(i) The test temperature shall be 25 °C. Excursions from the test temperature shall be no greater than ±2 °C.

(ii) Dissolved oxygen concentration between 60 and 105 percent saturation. Aeration, if needed to achieve this level, shall be done before the addition of the test substance. All treatment and control chambers shall be given the same aeration treatment.

(iii) The number of mysids placed in a test solution shall not be so great as to affect results of the test. Loading requirements for the test will vary depending on the flow rate of dilution water. The loading shall not cause the

dissolved oxygen concentration to fall below the recommended levels.

(iv) Photoperiod of 14 hours light and 10 hours darkness, with a 15–30 minute transition period.

(v) Salinity of 20 parts per thousand ±3 percent.

(e) *Reporting*. The sponsor shall submit to the EPA all data developed by the test that are suggestive or predictive of chronic toxicity and all concomitant toxicologic manifestations. In addition to the general reporting requirements prescribed in part 792—*Good Laboratory Practice Standards* of this chapter, the reporting of test data shall include the following:

(1) The source of the dilution water, its chemical characteristics (e.g., salinity, pH, etc.) and a description of any pretreatment.

(2) Detailed information about the test organisms, including the scientific name and method of verification, average length, age, source, history, observed diseases, treatments, acclimation procedures and food used.

(3) A description of the test chambers, the depth and volume of solution in the chamber, the way the test was begun (e.g., conditioning, test substance additions, etc.), the number of organisms per treatment, the number of replicates, the loading, the lighting, the test substance delivery system, and the flow rate expressed as volume additions per 24 hours.

(4) The measured concentration of test substance in test chambers at the times designated.

(5) The first time (day) that sexual characteristics can be observed in controls and in each test substance concentration.

(6) The length of time for the appearance of the first brood for each concentration.

(7) The means (average of replicates) and respective 95 percent confidence intervals for:

(i) Body length of males and females at the first observation day (depending on time of sexual maturation) and on day 28.

(ii) Cumulative number of young produced per female on day 28.

(iii) Cumulative number of dead adults on day 7, 14, 21 and 28.

(iv) If available prior to test termination (day 28), effects on G2 mysids (number of males and females, body length of males and females and cumulative mortality).

(8) The MATC is calculated as the geometric mean between the lowest measured test substance concentration that had a significant ($P<0.05$) effect and the highest measured test substance concentration that had no significant ($P<0.05$) effect in the chronic test. The most sensitive of the test criteria for adult (G1) mysids (cumulative number of dead mysids, body lengths of males and females or the number of young per female) is used to calculate the MATC. The criterion selected for MATC computation is the one which exhibits an effect (a statistically significant difference between treatment and control groups; $P<0.05$) at the lowest test substance concentration for the shortest period of exposure. Appropriate statistical tests (analysis of variance, mean separation test) should be used to test for significant chemical effects. The statistical tests employed and the results of these tests shall be reported.

(9) Concentration-response curves shall be fitted to the cumulative number of adult dead for days 7, 14, 21, and 28. A statistical test of goodness-of-fit shall be performed and the results reported.

(10) An LC_{50} value based on the number of dead adults with corresponding 95 percent confidence intervals for days 7, 14, 21 and 28. These calculations shall be made using the average measured concentration of the test substance.

(11) Methods and data records of all chemical analyses of water quality and test substance concentrations, including method validations and reagent blanks.

(12) The data records of the holding, acclimation and test temperature and salinity.

(f) *References*. For additional background information on this test guideline the following references should be consulted:

(1) U.S. Environmental Protection Agency, ''Bioassay Procedures for the Ocean Disposal Permit Program,'' EPA Report No. 600/9–78–010 (Gulf Breeze, Florida, 1978).

(2) [Reserved]

[50 FR 39321, Sept. 27, 1985, as amended at 52 FR 19069, May 20, 1987]

PART 798—HEALTH EFFECTS TESTING GUIDELINES

Subparts A–B [Reserved]

Subpart C—Subchronic Exposure

Sec.
798.2250 Dermal toxicity.
798.2450 Inhalation toxicity.
798.2650 Oral toxicity.

Subpart D—Chronic Exposure

798.3260 Chronic toxicity.
798.3300 Oncogenicity.
798.3320 Combined chronic toxicity/oncogenicity.

Subpart E—Specific Organ/Tissue Toxicity

798.4100 Dermal sensitization.
798.4350 Inhalation developmental toxicity study.
798.4700 Reproduction and fertility effects.
798.4900 Developmental toxicity study.

Subpart F—Genetic Toxicity

798.5195 Mouse biochemical specific locus test.
798.5200 Mouse visible specific locus test.
798.5265 The salmonella typhimurium reverse mutation assay.
798.5275 Sex-linked recessive lethal test in drosophila melanogaster.
798.5300 Detection of gene mutations in somatic cells in culture.
798.5375 In vitro mammalian cytogenetics.
798.5385 In vivo mammalian bone marrow cytogenetics tests: Chromosomal analysis.
798.5395 In vivo mammalian bone marrow cytogenetics tests: Micronucleus assay.
798.5450 Rodent dominant lethal assay.
798.5460 Rodent heritable translocation assays.
798.5500 Differential growth inhibition of repair proficient and repair deficient bacteria: ''Bacterial DNA damage or repair tests.''
798.5955 Heritable translocation test in drosophila melanogaster.

Subpart G—Neurotoxicity

798.6050 Functional observational battery.
798.6200 Motor activity.
798.6400 Neuropathology.
798.6500 Schedule-controlled operant behavior.
798.6560 Subchronic delayed neurotoxicity of organophosphorus substances.

AUTHORITY: 15 U.S.C. 2603.

SOURCE: 50 FR 39397, Sept. 27, 1985, unless otherwise noted.

Subparts A–B [Reserved]

Subpart C—Subchronic Exposure

§ 798.2250 Dermal toxicity.

(a) *Purpose.* In the assessment and evaluation of the toxic characteristics of a chemical, the determination of subchronic dermal toxicity may be carried out after initial information on toxicity has been obtained by acute testing. The subchronic dermal study has been designed to permit the determination of the no-observed-effect level and toxic effects associated with continuous or repeated exposure to a test substance for a period of 90 days. The test is not capable of determining those effects that have a long latency period for development (e.g., carcinogenicity and life shortening). It provides information on health hazards likely to arise from repeated exposure by the dermal route over a limited period of time. It will provide information on target organs, the possibilities of accumulation, and can be of use in selecting dose levels for chronic studies and for establishing safety criteria for human exposure.

(b) *Definitions.* (1) Subchronic dermal toxicity is the adverse effects occurring as a result of the repeated daily exposure of experimental animals to a chemical by dermal application for part (approximately 10 percent) of a life span.

(2) Dose in a dermal test is the amount of test substance applied to the skin (applied daily in subchronic tests). Dose is expressed as weight of the substance (g, mg) per unit weight of test animal (e.g., mg/kg).

(3) No-effect level/No-toxic-effect level/No-adverse-effect level/No-observed-effect level is the maximum dose used in a test which produces no observed adverse effects. A no-observed-effect level is expressed in terms of the weight of a test substance given daily per unit weight of test animal (mg/kg).

(4) Cumulative toxicity is the adverse effects of repeated doses occurring as a