Drinking Water
Early Warning Detection and Monitoring Technology Evaluation and Demonstration

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Presentation Outline

- Early Warning Detection and Monitoring Technology Evaluation
- What are Biomonitors?
- Biomonitors Advantages
- Biomonitors Tested
- Results of Preliminary Testing
- Future Plans

U.S. EPA Test & Evaluation Facility

What are Biomonitors?

- Instruments that measure changes in the function of organisms in response to pollutants
- Made possible by advances in digital video processing, signal analysis, and fast computers

Biomonitor Advantages

- Real-time Drinking Water Source Testing.
- Sensitive to toxic compounds. Unlike analytical instruments, will respond to several toxic compounds without pre-calibration.
- Alarms can be set to not only monitor high toxicity but also rate of change of toxicity.
- Remote Connectivity Possible

Available Biomonitors

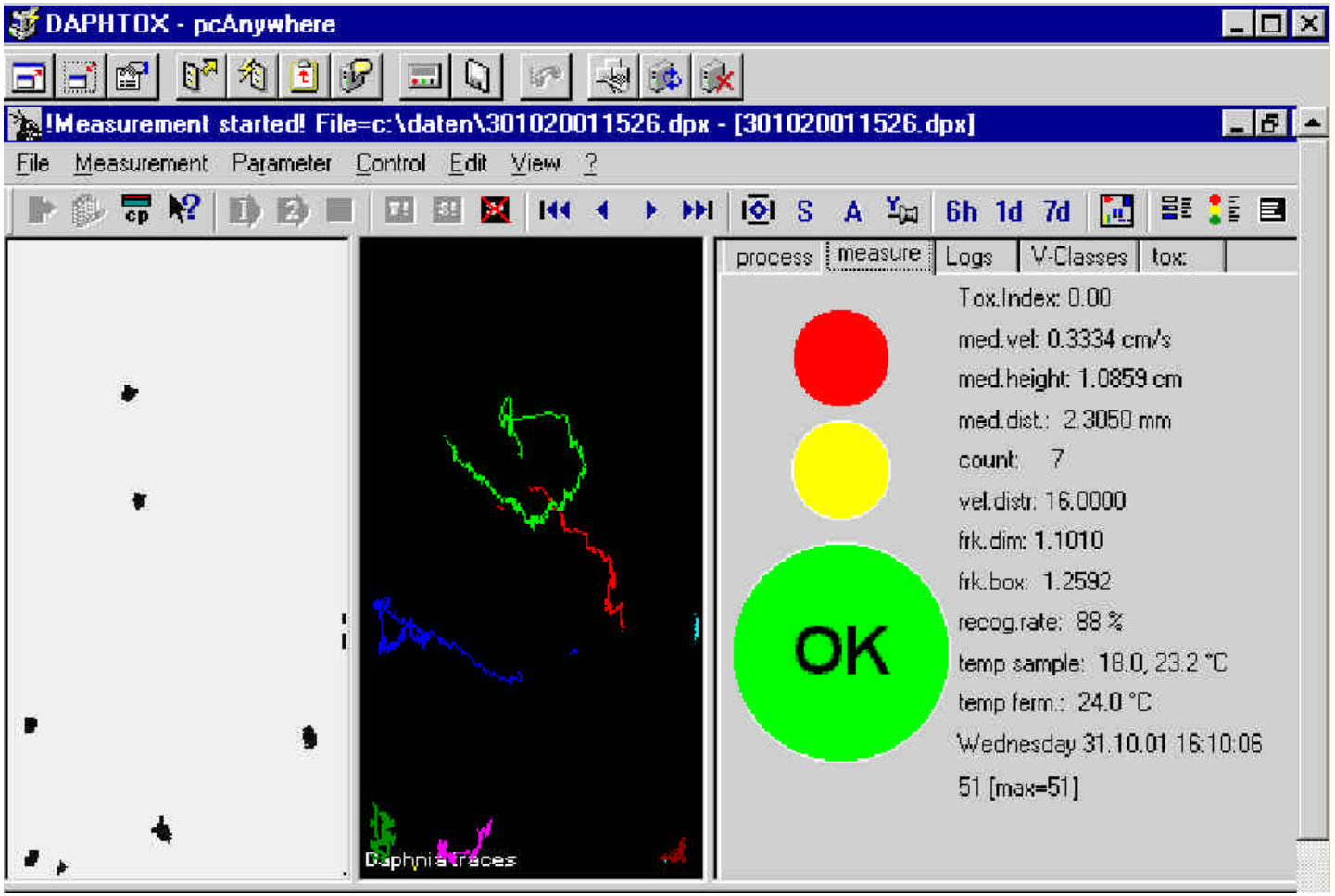
- Daphnia Biomonitor - Preliminary testing performed at T&E Facility
- Algae Biomonitor - Testing initiated at T&E Facility
- Clam Biomonitor - Unit to be installed at T&E in FY2003
- Fish Biomonitor - Proposed unit for FY2003

Daphnia Biomonitor

Daphnia Biomonitor - Operating Principle

- Uses a camera to monitor activity of several *Daphnia Magna* in a test cell.
- Computer analyzes the image continuously to detect changes in several parameters such as speed, swimming height, curviness of swim pattern, etc.
- Computer uses measurements of these parameters to compute a “toxicity index”. Alarms based on limits set on this computed toxicity index.

Daphnia Biomonitor - Screen Shot



Tests Completed on Daphnia Biomonitor

- Approximately 55 total test runs, including baseline and controls.
- Exposure to Cadmium at 2.5 ppm, 0.5 ppm, and 0.1 ppm.
- Exposure to Gasoline at 5 ppm.
- Effect of water source - Tested reconstituted hard water, laboratory control water and surface water (from East Fork Lake).
- Test results correlated to water quality Parameters: pH, DO, Alkalinity, Hardness

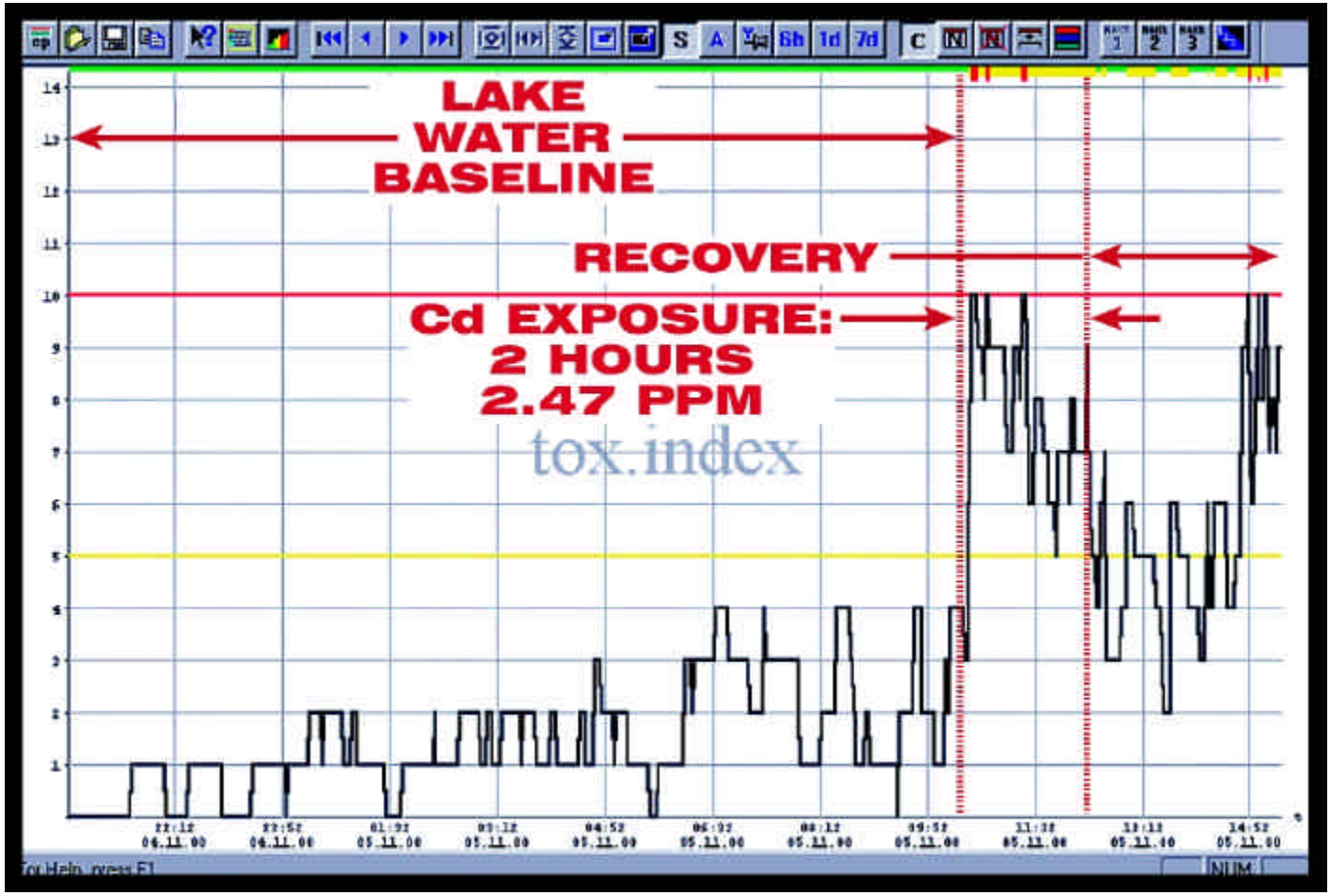
Cadmium Tests on Daphnia

- Baseline Time: 12 to 24 hours
- Cadmium Concentrations: 0.1, 0.5, 2.5 ppm
- Exposure Times: 2 hours and 4 hours
- Recovery Period: 6 to 24 hours.

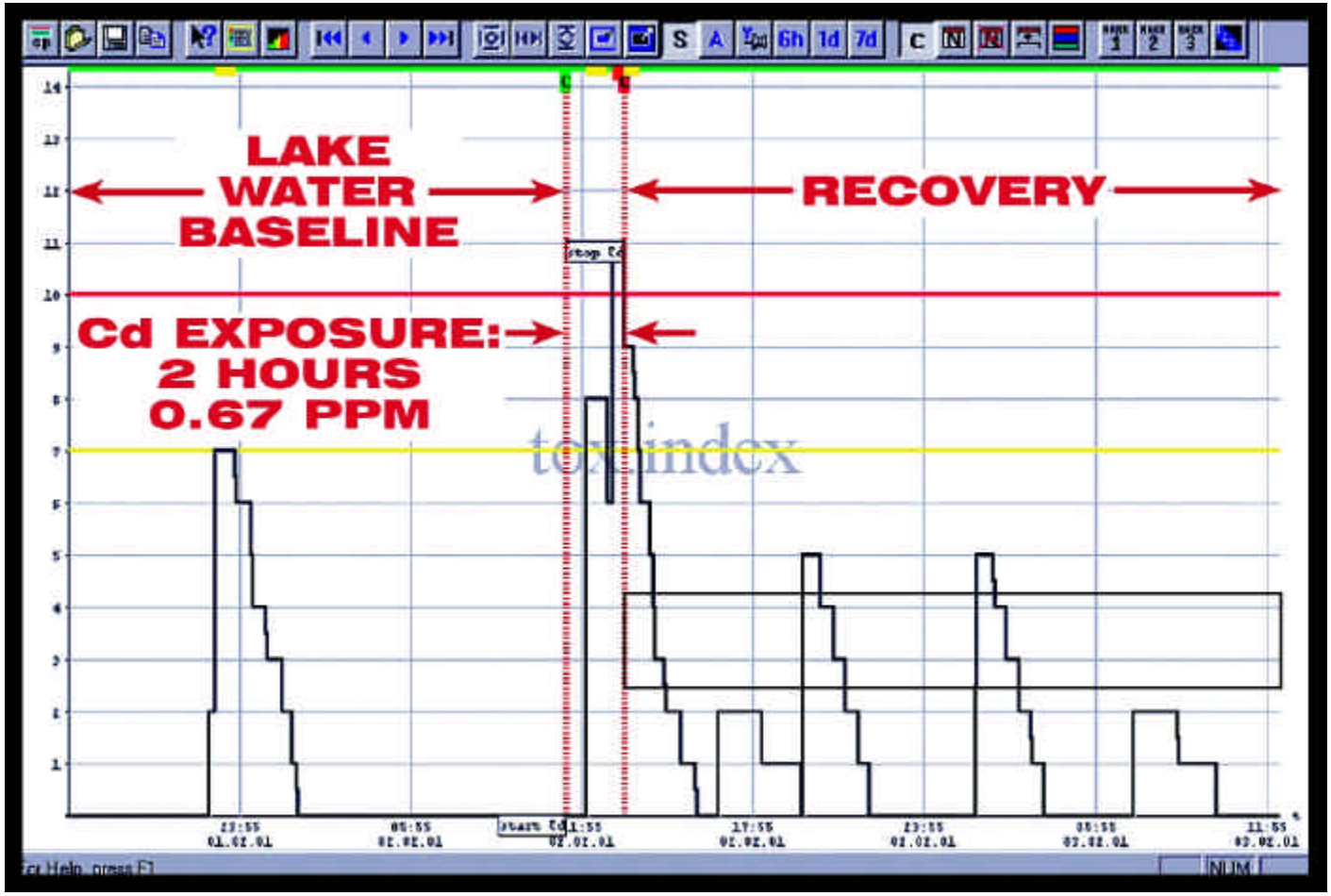
Results of Cadmium Testing

- Cadmium is not acutely toxic at low concentrations; this is borne out by the following results:
  - Alarms consistently achieved at 2.5 ppm cadmium.
  - Alarms seen 50% of the time at 0.5 ppm.
  - No alarms at 0.1 ppm cadmium.

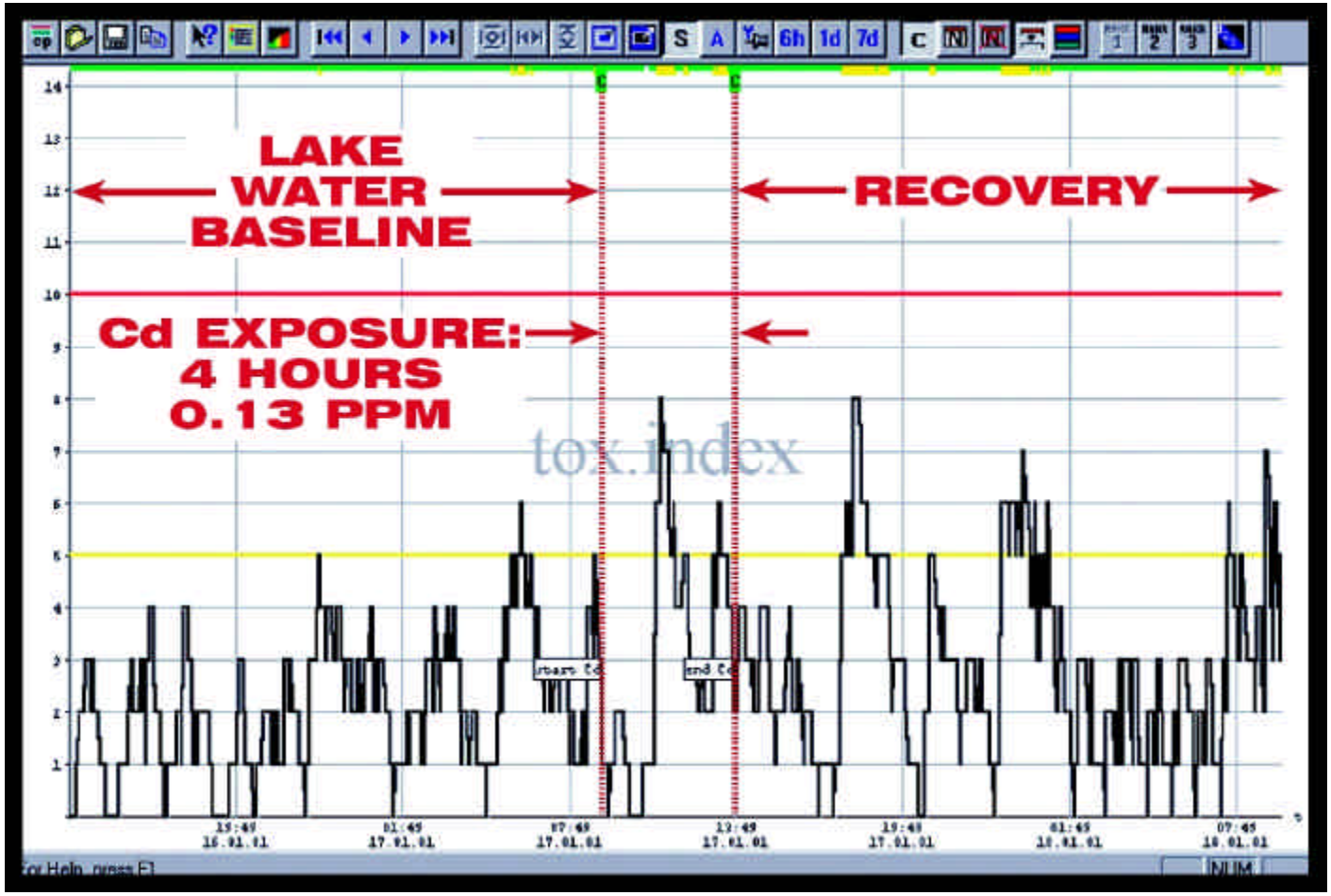
Cadmium Exposure Test - 2.47 ppm



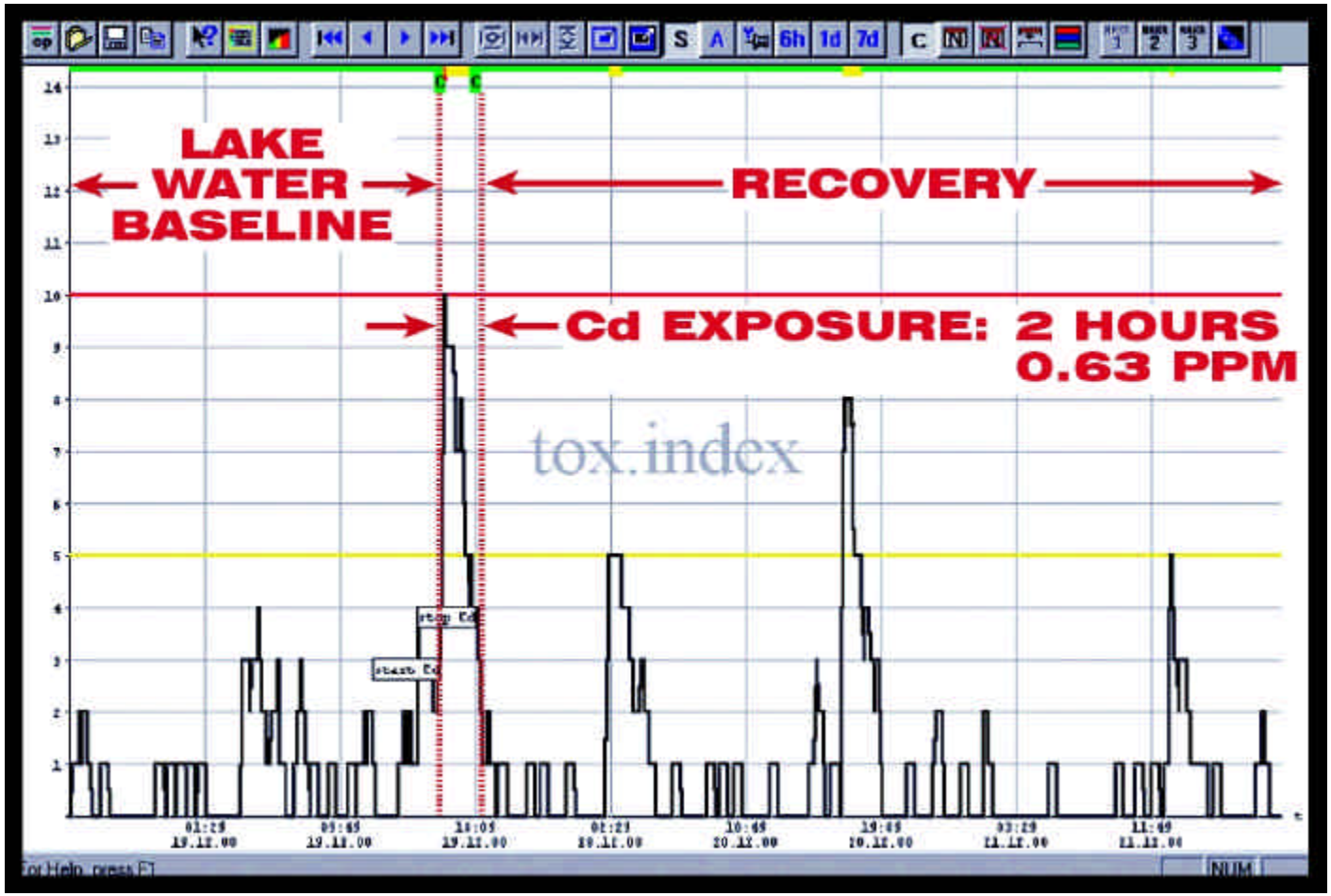
Cadmium Exposure Test - 0.67 ppm



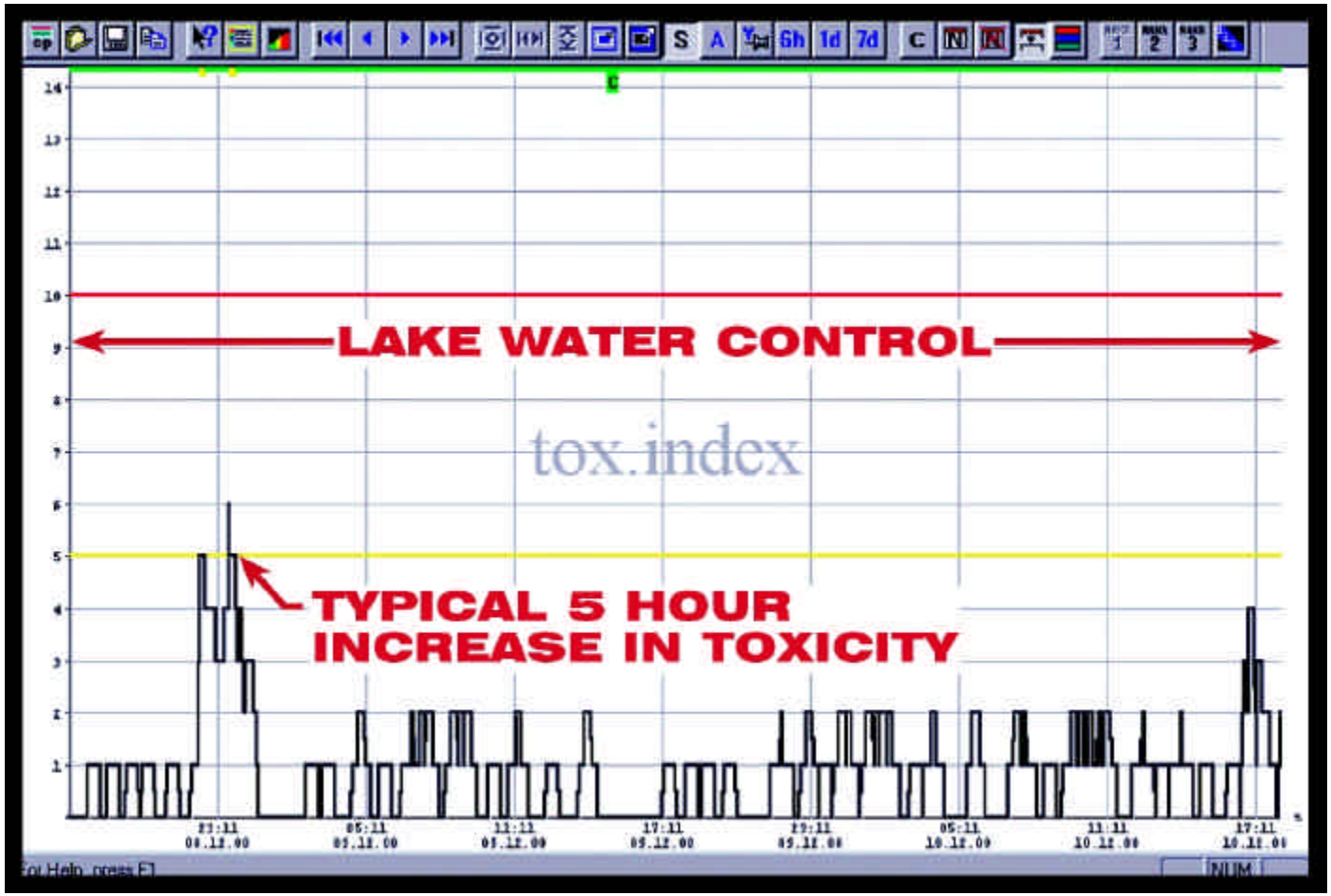
Cadmium Exposure Test - 0.13 ppm



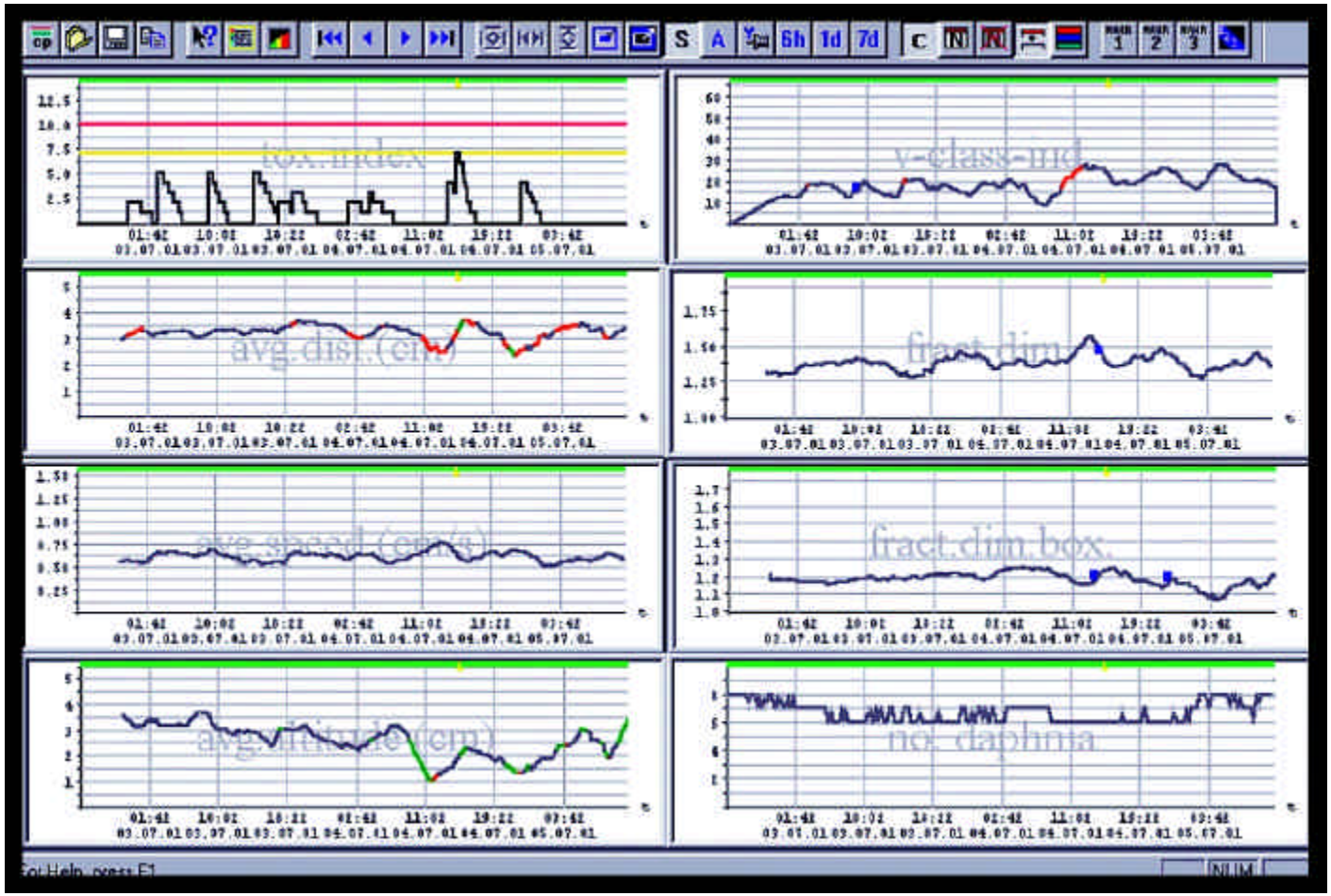
Cadmium Exposure Test - 0.63 ppm



Cadmium Exposure Test - Lake Water Control



Baseline Control Tests



Gasoline Tests on Daphnia Biomonitor

- Gasoline tested at 5 ppm.
- Biomonitor responds to presence of gasoline at 5 ppm.

Algae Biomonitor

Algae Biomonitor - Operating Principle

- Measures the fluorescence of an algae population.
- Compares measured fluorescence in the presence of toxic compounds to that measured under baseline conditions.
- Alarms based on limits set for the difference in fluorescence.

Tests Conducted on Algae Biomonitor

- Exposure to Gasoline at 5 ppm.
- Preliminary tests conducted on Atrazine. Additional tests planned in the future.

Future Activities Planned

- Expand the Biological Early Warning System Evaluation Laboratory to house additional instruments.
- Procure and install a Clam Biomonitor.
- Procure and install a Fish Biomonitor.
- Test the instruments for compounds on the Contaminant Candidate List (CCL) and others. Possible compounds:
  - Atrazine (herbicide)
  - Malathion (pesticide)
  - Diuron (herbicide)
  - Dieldrin (pesticide)
  - Aldrin (pesticide)