

**DATA EVALUATION REPORT
ECOLOGICAL EFFECTS BRANCH**

1. **Chemical:** SAN582H
2. **Test Material:** SAN 582H TECHNICAL, 97% purity, Lot #9024
3. **Study Type:** Early Life Stage Toxicity Test - 90 day Exposure with rainbow trout, *Onchorhynchus mykiss*
4. **Study Identification:**
Study Laboratory: Graves, William, PhD.
Study Director: Wildlife International Ltd, Easton, Md.
Study Dates: November 27 - February 25, 1991
Study Identification: Project 131A-130A
Sponsor: Sandoz Crop Protection Corp. DesPlaines, Ill.
EPA Identification: MRID 423366-05
5. **Reviewed by:** Brian Montague, Fisheries Biologist
Ecological Effects Branch
Environmental Fate & Effects Division *Brian Montague* 10/15/92
6. **Approved by:** Les Touart, Supervisory Biologist
Ecological Effects Branch
Environmental Fate & Effects Division *LT* 10/22/92
7. **Conclusions:** The conclusions reached by the study author appear to be supported adequately by the study results and independent statistical analysis by the Agency. The MATC of SAN 582H is $> 0.12 < 0.24$ mg ai/L based on reduced larvae growth. The NOEL is 0.12 mg ai/L and the LOEL is 0.24 mg ai/L. Hatch success, time to swim up, survival, and growth were affected at 0.95 mg ai/L. The study is acceptable for registration purposes.
8. **Recommendations:** N/A.

9. **Submission Purpose:** Submitted to satisfy 72-4, Fish Early Life Stage Testing Requirements for SAN 582H, the new active ingredient of Frontier herbicide.
10. **Study Design and Protocol:** FIFRA subdivision E and ASTM E1241-88 "Standard Guide for Conducting Early Life-Stage Toxicity Tests with Fish" were used as guidance in design of protocol used by Wildlife International.

Test Organisms: Unfertilized eggs and sperm were obtained from Mt. Lassen Trout Farms in Red Bluff, Ca. These had been obtained from 3 female and 4 male trout. The eggs and sperm were fertilized at WLI on November 27, 1991 and the test was initiated 3 hours later.

Test Solutions and Dilution Water: Dilution water was well water obtained from a 45 M deep well located on the WLI site and passed through a 25 micron mesh sand filter to remove particulates. The water was then pumped into a 37,800 L storage tank aerated by spray nozzles. Water was UV filtered prior to use in the test system. Stock test solutions were prepared biweekly for each test concentration. Dimethyl formamide was used as a solvent at maximum concentration of 19.09 mg/ml in stock solutions. The master stock was used to prepare 4 concentration stocks at 9.55, 4.77, 2/.39 and 1.19 mg SAN582H/ml. Maximum DMF contained in test solutions was <0.054 ml/L.

Test Materials and Designs: A continuous flow diluter system was used to deliver the control, solvent control, and 5 test concentrations to test vessels. The flow rate from mixing chambers was rotameter controlled. Flow was then split to the replicate 9 L glass test aquaria maintained at a 7.0 L volume. Each test chamber received 12 volume additions per 24 hr. period. Calibration was checked 8 days prior to test initiation. Daily visual observations of diluter function was performed during the study period. Embryo cups were suspended via rocker arms in test solutions. Cups were glass cylinders 50 mm in diameter and covered on the bottom by 425 micron mesh nylon screen. Rocker arm reciprocation was approximately 2 RPM. Test chambers were housed in a 12±1°C environmental chamber and lit by ambient room light at a surface intensity of 24 foot candles. A16D/8N photoperiod was employed with a 30 minute transition period. A constant temperature monitor was utilized in one control vessel. Weekly temperature, pH and dissolved O₂ measurements were taken during the test period, except for the 1st seven days in which DO was measured daily in one replicate (alternating) of each test group.

Measurement of test material concentrations was made in one replicate of each test group on days 0, 4, 7, 14, 21, 27, 35,

42, 49, 56, 63, 70, 77, 84 and 90. Egg viability was determined on day 12 from embryos maintained in dilution water. Other embryos were removed and placed in acetic acid and then examined for presence of neural keels to determine percent of viability. After hatch larval fish were fed starter mash until swimup stage was reached. Larvae were fed 2 times/day 7 days after hatch and then 3-2 times/day until 48 hours prior to study termination. Rations were adjusted on a per fish remaining basis. Based on wet weight of fish in one control replicate on day 90 loading was estimated to have been 0.22 gms of fish/Liter/24 hours. Instantaneous loading was 2.6 gm fish/liter. Analysis of hatch success, time to swimup, % survival, wet weight, dry weight, and length of juvenile fish was performed. Hatch success was based on viable egg hatch up to day 31. The % survival was based on Day 60 posthatch survivors. Length was measured day 31 and day 90.

11. Reported Test Results: Mean measured concentrations were 0.06, 0.12, 0.24, 0.48, 0.95 mg ai/L. This was generally within 95% of nominal estimates. Conductivity, hardness and alkalinity remained stable during the study period. The pH ranged from 8.1-8.3, D.O from 10.0 to 8.4 mg/L, and temperature from 12.4 to 11.6°C during the 90 day study period. Mean percent hatch success was 70%, 69%, 78%, 87%, 94%, 97% and 50% for controls, solvent control, 0.06, 0.12, 0.24, 0.48, 0.95 mg/L concentrations, respectively. The % of successful swimup recorded by day 15 was 49% for the 0.95 mg/L test level. All other concentrations demonstrated above 97% successful swimup by day 15. Six day posthatch survival was 94%, 95%, 92%, 98%, 100%, 97% and 78% for control, solvent control, 0.06, 0.12, 0.24, 0.48, and 0.95 mg/L concentrations, respectively. At 60 days posthatch survival was >97% in all concentrations except 0.95 mg/L which had 62% survival. Length was slightly affected at 0.94 mg/L concentrations on day 31 and 60 posthatch. Mean wet weight and dry wet showed statistically significant reduction at 0.95 mg/L and slight reductions at 0.48 mg/L. The 0.95 mg/L measurements were based on 50% fewer larvae than other concentrations.

- 12. Study Author's Conclusions:** "There were no apparent treatment related signs of toxicity at the 0.06, 0.12, 0.24, and 0.48 mg ai/L test concentrations. Any mortalities or observations noted at those test concentrations were intermittent, not dose responsive and were considered incidental to treatment. Fish exposed at the 0.95 mg ai/L test concentration were smaller darker, and more lethargic than the controls. Fish in this treatment group were also observed to develop more slowly than fish in the control group and appeared to exhibit a high incidence of mortality. The observations noted at the 0.95 mg ai/L test concentration were considered to be treatment

related.

There were no apparent treatment related effects upon swim up at test concentrations of 0.06, 0.12, 0.24, 0.48 mg ai/L from the time swimup commenced on day 10 post hatch until it was competed on day 15...However, at the 0.95 mg ai/L test concentration, there was a lower percentage of larvae swimming up from, the bottom of the test chamber when compared to the pooled controls.

Rainbow trout exposed to test concentrations of 0.06 and 0.12 mg/L showed no apparent treatment related effects upon early life stage development during the 90 day study. However, at 0.24 and 0.48 mg ai/L test concentrations, there was a reduction in growth during the first 31 days of the study...evaluation of early life stage development in the 0.95 mg ai/L group showed reductions in hatching success, time to swim up, survival, and growth. Based on the reduction in growth, the no observed effect concentration was 0.12 mg ai/L, while the lowest observed effect concentration (LOEC) was 0.24 mg ai/L. The maximum acceptable toxicant concentration (MATC) was greater than 0.12 mg ai/L and less than 0.24 mg ai/L, with the geometric mean of the MATC calculated to be 0.17 mg ai/L."

13. Reviewer's Discussion:

The study has been conducted soundly and fulfills data requirements for early life stage testing. Minor variations from Agency suggested guidelines included use of 12°C temperature instead of 10°C, use of high pH water of 8.1 (7.2-7.6 is recommended), and use of dilution water with hardness of 140-148 mg/L as CaCO₃. These deviations from suggested protocol were not felt to have adversely affected results.

Independent statistical analysis by the Agency has confirmed the conclusions reached by the study author. In future studies provision of mean values for individual replicates would be appreciated for ease of data input into statistical programs.

SAN 582H has been shown to demonstrate an MATC of >0.12 <0.24 mg ai/L based on effects to growth of larvae after 31 days of exposure. The NOEL for the study is 0.12 mg ai/L.

Adequacy of Study:

Category: Core

Rationale: The study results appear to support the study author's conclusions and the study was conducted according to acceptable procedures as outlined by the

Agency.

Repairability: N/A

Calculated H Value = 22.415 Critical H Value Table = 11.070
 Since Calc H > Crit H REJECT Ho: All groups are equal.

30 Day Trout Embryo Mortality SAN 582H
 File: sanembmrt Transform: NO TRANSFORMATION

DUNNS MULTIPLE COMPARISON - KRUSKAL-WALLIS - TABLE 2 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP					
				0	0	0	0	0	0
				5	4	3	2	1	6
5	0.48	1.000	1.000	\					
4	0.24	1.750	1.750	.	\				
3	0.12 ppm	4.000	4.000	.	.	\			
2	0.06 ppm	6.500	6.500	.	.	.	\		
1	GRPS 1&2 POOLED	7.750	7.750	.	.	.	.	\	
6	0.95	15.000	15.000	*	*	.	.	.	\

* = significant difference (p=0.05)
 Table q value (0.05,6) = 2.936

. = no significant difference
 Unequal reps - multiple SE values

Percent Hatch Success Trout - San582H

File: Hatchsan582

Transform: NO TRANSFORM

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Solvent control	4	66.700	76.700	69.200
2	Control	4	76.700	83.300	79.175
3	0.06 ppm	4	66.700	90.000	78.350
4	0.12	4	80.000	96.700	86.675
5	0.24	4	90.000	100.000	94.150
6	0.48	4	93.300	100.000	96.650
7	0.95	4	46.700	56.700	50.025

Percent Hatch Success Trout - San582H

File: Hatchsan582

Transform: NO TRANSFORM

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM
1	Solvent control	25.000	5.000	2.500
2	Control	9.983	3.160	1.580
3	0.06 ppm	92.297	9.607	4.804
4	0.12	52.149	7.221	3.611
5	0.24	17.630	4.199	2.099
6	0.48	14.963	3.868	1.934
7	0.95	22.223	4.714	2.357

Percent Hatch Success Trout - San582H

File: Hatchsan582

Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	6	6143.120	1023.853	30.597
Within (Error)	21	702.733	33.463	
Total	27	6845.853		

Critical F value = 2.57 (0.05,6,21)

Since F > Critical F REJECT Ho:All groups equal

Percent Hatch Success Trout - San582H

File: Hatchsan582

Transform: NO TRANSFORM

DUNNETTS TEST - TABLE 1 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	Solvent control	69.200	69.200		
2	Control	79.175	79.175	-2.439	
3	0.06 ppm	78.350	78.350	-2.237	
4	0.12	86.675	86.675	-4.272	
5	0.24	94.150	94.150	-6.100	
6	0.48	96.650	96.650	-6.711	
7	0.95	50.025	50.025	4.688	*

Dunnett table value = 2.46 (1 Tailed Value, P=0.05, df=20,6)

Percent Hatch Success Trout - San582H

File: Hatchsan582

Transform: NO TRANSFORM

DUNNETTS TEST - TABLE 2 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	Solvent control	4			
2	Control	4	10.062	14.5	-9.975
3	0.06 ppm	4	10.062	14.5	-9.150
4	0.12	4	10.062	14.5	-17.475
5	0.24	4	10.062	14.5	-24.950
6	0.48	4	10.062	14.5	-27.450
7	0.95	4	10.062	14.5	19.175

Percent Hatch Success Trout - San582H

File: Hatchsan582

Transform: NO TRANSFORM

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	6	6143.120	1023.853	30.597
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Critical F value = 2.57 (0.05,6,21)

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Percent Hatch Success Trout - San582H

File: Hatchsan582

Transform: NO TRANSFORM

BONFERRONI T-TEST - TABLE 1 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	Solvent control	69.200	69.200		
2	Control	79.175	79.175	-2.439	
3	0.06 ppm	78.350	78.350	-2.237	
4	0.12	86.675	86.675	-4.272	
5	0.24	94.150	94.150	-6.100	
6	0.48	96.650	96.650	-6.711	
7	0.95	50.025	50.025	4.688	*

Bonferroni T table value = 2.60 (1 Tailed Value, P=0.05, df=21,6)

Percent Hatch Success Trout - San582H

File: Hatchsan582

Transform: NO TRANSFORM

BONFERRONI T-TEST - TABLE 2 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	Solvent control	4			
2	Control	4	10.643	15.4	-9.975
3	0.06 ppm	4	10.643	15.4	-9.150
4	0.12	4	10.643	15.4	-17.475
5	0.24	4	10.643	15.4	-24.950
6	0.48	4	10.643	15.4	-27.450
7	0.95	4	10.643	15.4	19.175

Percent Hatch Success Trout - San582H

File: Hatchsan582

Transform: NO TRANSFORM

WILLIAMS TEST (Isotonic regression model)

TABLE 1 OF 2

GROUP	IDENTIFICATION	N	ORIGINAL MEAN	TRANSFORMED MEAN	ISOTONIZED MEAN
1	Solvent control	4	69.200	69.200	84.033
2	Control	4	79.175	79.175	84.033
3	0.06 ppm	4	78.350	78.350	84.033
4	0.12	4	86.675	86.675	84.033
5	0.24	4	94.150	94.150	84.033
6	0.48	4	96.650	96.650	84.033
7	0.95	4	50.025	50.025	50.025

Percent Hatch Success Trout - San582H

File: Hatchsan582

Transform: NO TRANSFORM

WILLIAMS TEST (Isotonic regression model)

TABLE 2 OF 2

IDENTIFICATION	ISOTONIZED MEAN	CALC. WILLIAMS	SIG P=.05	TABLE WILLIAMS	DEGREES OF FREEDOM
Solvent control	84.033				
Control	84.033	3.626	*	1.72	k= 1, v=21
0.06 ppm	84.033	3.626	*	1.80	k= 2, v=21
0.12	84.033	3.626	*	1.83	k= 3, v=21
0.24	84.033	3.626	*	1.84	k= 4, v=21
0.48	84.033	3.626	*	1.85	k= 5, v=21
0.95	50.025	4.688	*	1.85	k= 6, v=21

s = 5.785

Note: df used for table values are approximate when v > 20.

Percent Hatch Success Trout - San582H

File: Hatchsan582 Transform: NO TRANSFORM

STEELS MANY-ONE RANK TEST			- Ho:Control<Treatment			
GROUP	IDENTIFICATION	TRANSFORMED MEAN	RANK SUM	CRIT. VALUE	df	SIG
1	Solvent control	69.200				
2	Control	79.175	25.00	10.00	4.00	
3	0.06 ppm	78.350	23.00	10.00	4.00	
4	0.12	86.675	26.00	10.00	4.00	
5	0.24	94.150	26.00	10.00	4.00	
6	0.48	96.650	26.00	10.00	4.00	
7	0.95	50.025	10.00	10.00	4.00	*

Critical values use k = 6, are 1 tailed, and alpha = 0.05

Percent Hatch Success Trout - San582H

File: Hatchsan582 Transform: NO TRANSFORMATION

Chi-square test for normality: actual and expected frequencies

INTERVAL	<-1.5	-1.5 to <-0.5	-0.5 to 0.5	>0.5 to 1.5	>1.5
EXPECTED	1.876	6.776	10.696	6.776	1.876
OBSERVED	0	9	11	8	0

Calculated Chi-Square goodness of fit test statistic = 4.7117

Table Chi-Square value (alpha = 0.01) = 13.277

Data PASS normality test. Continue analysis.

Percent Hatch Success Trout - San582H

File: Hatchsan582

Transform: NO TRANSFORMATION

Hartley test for homogeneity of variance

Calculated H statistic (max Var/min Var) = 9.25

Closest, conservative, Table H statistic = 216.0 (alpha = 0.01)

Used for Table H ==> R (# groups) = 7, df (# reps-1) = 3

Actual values ==> R (# groups) = 7, df (# avg reps-1) = 3.00

Data PASS homogeneity test. Continue analysis.

NOTE: This test requires equal replicate sizes. If they are unequal but do not differ greatly, the Hartley test may still be used as an approximate test (average df are used).

Percent Hatch Success Trout - San582H

File: Hatchsan582

Transform: NO TRANSFORMATION

Bartlett's test for homogeneity of variance

Calculated B statistic = 5.05

Table Chi-square value = 16.81 (alpha = 0.01)

Table Chi-square value = 12.59 (alpha = 0.05)

Average df used in calculation ==> df (avg n - 1) = 3.00

Used for Chi-square table value ==> df (#groups-1) = 6

Data PASS homogeneity test at 0.01 level. Continue analysis.

NOTE: If groups have unequal replicate sizes the average replicate size is used to calculate the B statistic (see above).

% Survival 60 Days Posthatch

File: survsan.582

Transform: NO TRANSFORMATION

Chi-square test for normality: actual and expected frequencies

INTERVAL	<-1.5	-1.5 to <-0.5	-0.5 to 0.5	>0.5 to 1.5	>1.5
EXPECTED	1.876	6.776	10.696	6.776	1.876
OBSERVED	0	9	10	9	0

Calculated Chi-Square goodness of fit test statistic = 5.2572

Table Chi-Square value (alpha = 0.01) = 13.277

Data PASS normality test. Continue analysis.

% Survival 60 Days Posthatch

File: survsan.582

Transform: NO TRANSFORMATION

Shapiro Wilks test for normality

D = 430.750

W = 0.971

Critical W (P = 0.05) (n = 28) = 0.924

Critical W (P = 0.01) (n = 28) = 0.896

Data PASS normality test at P=0.01 level. Continue analysis.

% Survival 60 Days Posthatch

File: survsan.582

Transform: NO TRANSFORMATION

Hartley test for homogeneity of variance

Bartlett's test for homogeneity of variance

These two tests can not be performed because at least one group has zero variance.

Data FAIL to meet homogeneity of variance assumption.

Additional transformations are useless.

% Survival 60 Days Posthatch

File: survsan.582

Transform: NO TRANSFORMATION

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Solvent control	4	91.000	100.000	94.500
2	controls	4	90.000	100.000	95.000
3	0.06	4	85.000	100.000	92.000
4	0.12	4	96.000	100.000	98.000
5	0.24	4	100.000	100.000	100.000
6	0.48	4	93.000	100.000	97.500
7	0.95	4	71.000	86.000	78.250

% Survival 60 Days Posthatch

File: survsan.582

Transform: NO TRANSFORMATION

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM
1	Solvent control	19.000	4.359	2.179
2	controls	16.667	4.082	2.041
3	0.06	51.333	7.165	3.582
4	0.12	5.333	2.309	1.155
5	0.24	0.000	0.000	0.000
6	0.48	11.000	3.317	1.658
7	0.95	40.250	6.344	3.172

% Survival 60 Days Posthatch

File: survsan.582

Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	6	1265.929	210.988	10.286
Within (Error)	21	430.750	20.512	
Total	27	1696.679		

Critical F value = 2.57 (0.05,6,21)

Since $F > \text{Critical } F$ REJECT H_0 : All groups equal

% Survival 60 Days Posthatch

File: survsan.582

Transform: NO TRANSFORMATION

DUNNETTS TEST - TABLE 1 OF 2

 H_0 : Control < Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	Solvent control	94.500	94.500		
2	controls	95.000	95.000	-0.156	
3	0.06	92.000	92.000	0.781	
4	0.12	98.000	98.000	-1.093	
5	0.24	100.000	100.000	-1.717	
6	0.48	97.500	97.500	-0.937	
7	0.95	78.250	78.250	5.074	*

Dunnett table value = 2.46 (1 Tailed Value, $P=0.05$, $df=20,6$)

% Survival 60 Days Posthatch

File: survsan.582

Transform: NO TRANSFORMATION

DUNNETTS TEST - TABLE 2 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	Solvent control	4			
2	controls	4	7.878	8.3	-0.500
3	0.06	4	7.878	8.3	2.500
4	0.12	4	7.878	8.3	-3.500
5	0.24	4	7.878	8.3	-5.500
6	0.48	4	7.878	8.3	-3.000
7	0.95	4	7.878	8.3	16.250

% Survival 60 Days Posthatch

File: survsan.582

Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	6	1265.929	210.988	10.286
Within (Error)	21	430.750	20.512	
Total	27	1696.679		

Critical F value = 2.57 (0.05,6,21)

Since F > Critical F REJECT Ho:All groups equal

% Survival 60 Days Posthatch

File: survsan.582

Transform: NO TRANSFORMATION

BONFERRONI T-TEST - TABLE 1 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	Solvent control	94.500	94.500		
2	controls	95.000	95.000	-0.156	
3	0.06	92.000	92.000	0.781	
4	0.12	98.000	98.000	-1.093	
5	0.24	100.000	100.000	-1.717	
6	0.48	97.500	97.500	-0.937	
7	0.95	78.250	78.250	5.074	*

Bonferroni T table value = 2.60 (1 Tailed Value, P=0.05, df=21,6)

% Survival 60 Days Posthatch

File: survsan.582

Transform: NO TRANSFORMATION

BONFERRONI T-TEST

- TABLE 2 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	Solvent control	4			
2	controls	4	8.333	8.8	-0.500
3	0.06	4	8.333	8.8	2.500
4	0.12	4	8.333	8.8	-3.500
5	0.24	4	8.333	8.8	-5.500
6	0.48	4	8.333	8.8	-3.000
7	0.95	4	8.333	8.8	16.250

% Survival 60 Days Posthatch

File: survsan.582

Transform: NO TRANSFORMATION

WILLIAMS TEST (Isotonic regression model)

TABLE 1 OF 2

GROUP	IDENTIFICATION	N	ORIGINAL MEAN	TRANSFORMED MEAN	ISOTONIZED MEAN
1	Solvent control	4	94.500	94.500	96.167
2	controls	4	95.000	95.000	96.167
3	0.06	4	92.000	92.000	96.167
4	0.12	4	98.000	98.000	96.167
5	0.24	4	100.000	100.000	96.167
6	0.48	4	97.500	97.500	96.167
7	0.95	4	78.250	78.250	78.250

% Survival 60 Days Posthatch

File: survsan.582

Transform: NO TRANSFORMATION

WILLIAMS TEST (Isotonic regression model)

TABLE 2 OF 2

IDENTIFICATION	ISOTONIZED MEAN	CALC. WILLIAMS	SIG P=.05	TABLE WILLIAMS	DEGREES OF FREEDOM
Solvent control	96.167				
controls	96.167	0.520		1.72	k= 1, v=21
0.06	96.167	0.520		1.80	k= 2, v=21
0.12	96.167	0.520		1.83	k= 3, v=21
0.24	96.167	0.520		1.84	k= 4, v=21
0.48	96.167	0.520		1.85	k= 5, v=21
0.95	78.250	5.074	*	1.85	k= 6, v=21

s = 4.529

Note: df used for table values are approximate when v > 20.

% Survival 60 Days Posthatch

File: survsan.582

Transform: NO TRANSFORMATION

Controls Pooled

30 Day Trout Embryo Mortality SAN 582H

File: sanembmrt

Transform: NO TRANSFORMATION

t-test of Solvent and Blank Controls

Ho:GRP1 MEAN = GRP2 MEAN

GRP1 (SOLVENT CRTL) MEAN	=	9.2500	CALCULATED t VALUE	=	3.3717
GRP2 (BLANK CRTL) MEAN	=	6.2500	DEGREES OF FREEDOM	=	6
DIFFERENCE IN MEANS	=	3.0000			

TABLE t VALUE (0.05 (2), 6) = 2.447** SIGNIFICANT DIFFERENCE at alpha=0.05
TABLE t VALUE (0.01 (2), 6) = 3.707 NO significant difference at alpha=0.01

30 Day Trout Embryo Mortality SAN 582H

File: sanembmrt

Transform: NO TRANSFORMATION

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	GRPS 1&2 POOLED	8	5.000	10.000	7.750
2	0.06 ppm	4	3.000	10.000	6.500
3	0.12 ppm	4	1.000	6.000	4.000
4	0.24	4	0.000	3.000	1.750
5	0.48	4	0.000	2.000	1.000
6	0.95	4	13.000	16.000	15.000

30 Day Trout Embryo Mortality SAN 582H

File: sanembmrt

Transform: NO TRANSFORMATION

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM
1	GRPS 1&2 POOLED	3.929	1.982	0.701
2	0.06 ppm	8.333	2.887	1.443
3	0.12 ppm	4.667	2.160	1.080
4	0.24	1.583	1.258	0.629
5	0.48	1.333	1.155	0.577
6	0.95	2.000	1.414	0.707

30 Day Trout Embryo Mortality SAN 582H

File: sanembmrt

Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	5	536.000	107.200	29.028
Within (Error)	22	81.250	3.693	
Total	27	617.250		

Critical F value = 2.66 (0.05,5,22)
 Since $F > \text{Critical } F$ REJECT H_0 : All groups equal

30 Day Trout Embryo Mortality SAN 582H
 File: sanembmrt Transform: NO TRANSFORMATION

DUNNETTS TEST

***** WARNING *****

This data set has unequal replicates. The Bonferroni T-test should be used instead of the Dunnetts test.

30 Day Trout Embryo Mortality SAN 582H
 File: sanembmrt Transform: NO TRANSFORMATION

DUNNETTS TEST - TABLE 1 OF 2 Ho: Control < Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	GRPS 1&2 POOLED	7.750	7.750		
2	0.06 ppm	6.500	6.500	1.062	
3	0.12 ppm	4.000	4.000	3.187	*
4	0.24	1.750	1.750	5.099	*
5	0.48	1.000	1.000	5.736	*
6	0.95	15.000	15.000	-6.161	

Dunnett table value = 2.39 (1 Tailed Value, $P=0.05$, $df=20,5$)

30 Day Trout Embryo Mortality SAN 582H
 File: sanembmrt Transform: NO TRANSFORMATION

DUNNETTS TEST - TABLE 2 OF 2 Ho: Control < Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	GRPS 1&2 POOLED	8			

2	0.06 ppm	4	2.813	36.3	1.250
3	0.12 ppm	4	2.813	36.3	3.750
4	0.24	4	2.813	36.3	6.000
5	0.48	4	2.813	36.3	6.750
6	0.95	4	2.813	36.3	-7.250

30 Day Trout Embryo Mortality SAN 582H
File: sanembmrt Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	5	536.000	107.200	29.028
Within (Error)	22	81.250	3.693	
Total	27	617.250		

Critical F value = 2.66 (0.05,5,22)
Since F > Critical F REJECT Ho:All groups equal

30 Day Trout Embryo Mortality SAN 582H
File: sanembmrt Transform: NO TRANSFORMATION

BONFERRONI T-TEST - TABLE 1 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	GRPS 1&2 POOLED	7.750	7.750		
2	0.06 ppm	6.500	6.500	1.062	
3	0.12 ppm	4.000	4.000	3.187	*
4	0.24	1.750	1.750	5.099	*
5	0.48	1.000	1.000	5.736	*
6	0.95	15.000	15.000	-6.161	

Bonferroni T table value = 2.51 (1 Tailed Value, P=0.05, df=22,5)

30 Day Trout Embryo Mortality SAN 582H
File: sanembmrt Transform: NO TRANSFORMATION

BONFERRONI T-TEST - TABLE 2 OF 2 Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	GRPS 1&2 POOLED	8			
2	0.06 ppm	4	2.953	38.1	1.250
3	0.12 ppm	4	2.953	38.1	3.750
4	0.24	4	2.953	38.1	6.000

5	0.48	4	2.953	38.1	6.750
6	0.95	4	2.953	38.1	-7.250

30 Day Trout Embryo Mortality SAN 582H
File: sanembmrt Transform: NO TRANSFORMATION

WILLIAMS TEST (Isotonic regression model) TABLE 1 OF 2

GROUP	IDENTIFICATION	N	ORIGINAL MEAN	TRANSFORMED MEAN	ISOTONIZED MEAN
1	GRPS 1&2 POOLED	8	7.750	7.750	4.792
2	0.06 ppm	4	6.500	6.500	4.792
3	0.12 ppm	4	4.000	4.000	4.792
4	0.24	4	1.750	1.750	4.792
5	0.48	4	1.000	1.000	4.792
6	0.95	4	15.000	15.000	15.000

30 Day Trout Embryo Mortality SAN 582H
File: sanembmrt Transform: NO TRANSFORMATION

WILLIAMS TEST (Isotonic regression model) TABLE 2 OF 2

IDENTIFICATION	ISOTONIZED MEAN	CALC. WILLIAMS	SIG P=.05	TABLE WILLIAMS	DEGREES OF FREEDOM
GRPS 1&2 POOLED	4.792				
0.06 ppm	4.792	2.514	*	1.72	k= 1, v=22
0.12 ppm	4.792	2.514	*	1.80	k= 2, v=22
0.24	4.792	2.514	*	1.83	k= 3, v=22
0.48	4.792	2.514	*	1.84	k= 4, v=22
0.95	15.000	6.161	*	1.85	k= 5, v=22

s = 1.922

Note: df used for table values are approximate when v > 20.

30 Day Trout Embryo Mortality SAN 582H
File: sanembmrt Transform: NO TRANSFORMATION

KRUSKAL-WALLIS ANOVA BY RANKS - TABLE 1 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	RANK SUM
1	GRPS 1&2 POOLED	7.750	7.750	150.500
2	0.06 ppm	6.500	6.500	65.500
3	0.12 ppm	4.000	4.000	42.500
4	0.24	1.750	1.750	24.500
5	0.48	1.000	1.000	17.000
6	0.95	15.000	15.000	106.000

31 Day Larval Length Trout SAN582H

File: C:LARLEN31.SAN

Transform: NO TRANSFORMATION

Chi-square test for normality: actual and expected frequencies

INTERVAL	<-1.5	-1.5 to <-0.5	-0.5 to 0.5	>0.5 to 1.5	>1.5
EXPECTED	1.072	3.872	6.112	3.872	1.072
OBSERVED	0	5	4	7	0

Calculated Chi-Square goodness of fit test statistic = 5.7294

Table Chi-Square value (alpha = 0.01) = 13.277

Data PASS normality test. Continue analysis.

31 Day Larval Length Trout SAN582H

File: C:LARLEN31.SAN

Transform: NO TRANSFORMATION

Hartley test for homogeneity of variance

Calculated H statistic (max Var/min Var) = 24.84

Closest, conservative, Table H statistic = 120.0 (alpha = 0.01)

Used for Table H ==> R (# groups) = 4, df (# reps-1) = 3
Actual values ==> R (# groups) = 4, df (# avg reps-1) = 3.00

Data PASS homogeneity test. Continue analysis.

NOTE: This test requires equal replicate sizes. If they are unequal but do not differ greatly, the Hartley test may still be used as an approximate test (average df are used).

31 Day Larval Length Trout SAN582H

File: C:LARLEN31.SAN

Transform: NO TRANSFORMATION

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Controls	4	34.400	35.400	34.925
2	0.24	4	33.000	34.200	33.425
3	0.48	4	32.000	33.400	32.875
4	0.95	4	26.500	31.300	29.838

31 Day Larval Length Trout SAN582H

File: C:LARLEN31.SAN

Transform: NO TRANSFORMATION

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM
1	Controls	0.209	0.457	0.229
2	0.24	0.296	0.544	0.272
3	0.48	0.449	0.670	0.335
4	0.95	5.196	2.279	1.140

31 Day Larval Length Trout SAN582H

File: C:LARLEN31.SAN

Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	3	54.734	18.245	11.871
Within (Error)	12	18.449	1.537	
Total	15	73.184		

Critical F value = 3.49 (0.05,3,12)

Since $F > \text{Critical } F$ REJECT H_0 : All groups equal

31 Day Larval Length Trout SAN582H

File: C:LARLEN31.SAN

Transform: NO TRANSFORMATION

DUNNETTS TEST - TABLE 1 OF 2

H_0 : Control < Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	Controls	34.925	34.925		
2	0.24	33.425	33.425	1.711	
3	0.48	32.875	32.875	2.338	*
4	0.95	29.838	29.838	5.803	*

Dunnett table value = 2.29 (1 Tailed Value, $P=0.05$, $df=12,3$)

31 Day Larval Length Trout SAN582H

File: C:LARLEN31.SAN

Transform: NO TRANSFORMATION

DUNNETTS TEST - TABLE 2 OF 2

H_0 : Control < Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
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1	Controls	4			
2	0.24	4	2.008	5.7	1.500
3	0.48	4	2.008	5.7	2.050
4	0.95	4	2.008	5.7	5.088

31 Day Larval Length Trout SAN582H

File: C:LARLEN31.SAN

Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	3	54.734	18.245	11.871
Within (Error)	12	18.449	1.537	
Total	15	73.184		

Critical F value = 3.49 (0.05,3,12)

Since $F > \text{Critical } F$ REJECT H_0 :All groups equal

31 Day Larval Length Trout SAN582H

File: C:LARLEN31.SAN

Transform: NO TRANSFORMATION

BONFERRONI T-TEST - TABLE 1 OF 2

H_0 :Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	Controls	34.925	34.925		
2	0.24	33.425	33.425	1.711	
3	0.48	32.875	32.875	2.338	
4	0.95	29.838	29.838	5.803	*

Bonferroni T table value = 2.40 (1 Tailed Value, $P=0.05$, $df=12,3$)

31 Day Larval Length Trout SAN582H

File: C:LARLEN31.SAN

Transform: NO TRANSFORMATION

BONFERRONI T-TEST - TABLE 2 OF 2

H_0 :Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	Controls	4			
2	0.24	4	2.107	6.0	1.500
3	0.48	4	2.107	6.0	2.050
4	0.95	4	2.107	6.0	5.088

31 Day Larval Length Trout SAN582H

File: C:LARLEN31.SAN

Transform: NO TRANSFORMATION

WILLIAMS TEST (Isotonic regression model)

TABLE 1 OF 2

GROUP	IDENTIFICATION	N	ORIGINAL MEAN	TRANSFORMED MEAN	ISOTONIZED MEAN
1	Controls	4	34.925	34.925	34.925
2	0.24	4	33.425	33.425	33.425
3	0.48	4	32.875	32.875	32.875
4	0.95	4	29.838	29.838	29.838

31 Day Larval Length Trout SAN582H

File: C:LARLEN31.SAN

Transform: NO TRANSFORMATION

WILLIAMS TEST (Isotonic regression model)

TABLE 2 OF 2

IDENTIFICATION	ISOTONIZED MEAN	CALC. WILLIAMS	SIG P=.05	TABLE WILLIAMS	DEGREES OF FREEDOM
Controls	34.925				
0.24	33.425	1.711		1.78	k= 1, v=12
0.48	32.875	2.338	*	1.87	k= 2, v=12
0.95	29.838	5.803	*	1.90	k= 3, v=12

s = 1.240

Note: df used for table values are approximate when v > 20.

31 Day Larval Length Trout SAN582H

File: C:LARLEN31.SAN

Transform: NO TRANSFORMATION

KRUSKAL-WALLIS ANOVA BY RANKS - TABLE 1 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	RANK SUM
1	Controls	34.925	34.925	58.000
2	0.24	33.425	33.425	37.000
3	0.48	32.875	32.875	31.000
4	0.95	29.838	29.838	10.000

Calculated H Value = 13.000

Critical H Value Table = 7.235

Since Calc H > Crit H REJECT Ho: All groups are equal.

31 Day Larval Length Trout SAN582H

File: C:LARLEN31.SAN

Transform: NO TRANSFORMATION

DUNNS MULTIPLE COMPARISON - KRUSKAL-WALLIS - TABLE 2 OF 2

Montague SAN582H Static Acute-Sheepshead Minnow

CONC.	NUMBER EXPOSED	NUMBER DEAD	PERCENT DEAD	BINOMIAL PROB. (PERCENT)
20.2	10	10	100	9.765625E-02
11.6	10	10	100	9.765625E-02
7.77	10	6	60.00001	37.69531
4.27	10	0	0	9.765625E-02
2.84	10	0	0	9.765625E-02

THE BINOMIAL TEST SHOWS THAT 4.27 AND 11.6 CAN BE USED AS STATISTICALLY SOUND CONSERVATIVE 95 PERCENT CONFIDENCE LIMITS, BECAUSE THE ACTUAL CONFIDENCE LEVEL ASSOCIATED WITH THESE LIMITS IS GREATER THAN 95 PERCENT.

AN APPROXIMATE LC50 FOR THIS SET OF DATA IS 7.201996

WHEN THERE ARE LESS THAN TWO CONCENTRATIONS AT WHICH THE PERCENT DEAD IS BETWEEN 0 AND 100, NEITHER THE MOVING AVERAGE NOR THE PROBIT METHOD CAN GIVE ANY STATISTICALLY SOUND RESULTS.

Montague SAN582H Shell Reduction Eastern Oyster

CONC.	NUMBER EXPOSED	NUMBER DEAD	PERCENT DEAD	BINOMIAL PROB. (PERCENT)
9.850001		20	17	85
.1288414				
5.26	20	10	50	58.80985
3.35	20	7	35	13.1588
2.18	20	2	10	2.012253E-02
1.13	20	0	0	9.536742E-05

THE BINOMIAL TEST SHOWS THAT 2.18 AND 9.850001 CAN BE USED AS STATISTICALLY SOUND CONSERVATIVE 95 PERCENT CONFIDENCE LIMITS, BECAUSE THE ACTUAL CONFIDENCE LEVEL ASSOCIATED WITH THESE LIMITS IS GREATER THAN 95 PERCENT.

AN APPROXIMATE LC50 FOR THIS SET OF DATA IS 5.26

RESULTS CALCULATED USING THE MOVING AVERAGE METHOD

SPAN	G	LC50	95 PERCENT CONFIDENCE LIMITS	
3	.1564043	4.833762	3.88713	6.349311

RESULTS CALCULATED USING THE PROBIT METHOD

ITERATIONS	G	H
4	.1243839	1
.823725		

SLOPE = 3.520581
95 PERCENT CONFIDENCE LIMITS = 2.278939 AND 4.762223

Controls Separate

30 Day Trout Embryo Mortality SAN 582H

File: sanembmrt

Transform: NO TRANSFORMATION

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 1 of 2

GRP	IDENTIFICATION	N	MIN	MAX	MEAN
1	Solvent control	4	7.000	10.000	9.250
2	Control	4	5.000	7.000	6.250
3	0.06 ppm	4	3.000	10.000	6.500
4	0.12 ppm	4	1.000	6.000	4.000
5	0.24	4	0.000	3.000	1.750
6	0.48	4	0.000	2.000	1.000
7	0.95	4	13.000	16.000	15.000

30 Day Trout Embryo Mortality SAN 582H

File: sanembmrt

Transform: NO TRANSFORMATION

SUMMARY STATISTICS ON TRANSFORMED DATA TABLE 2 of 2

GRP	IDENTIFICATION	VARIANCE	SD	SEM
1	Solvent control	2.250	1.500	0.750
2	Control	0.917	0.957	0.479
3	0.06 ppm	8.333	2.887	1.443
4	0.12 ppm	4.667	2.160	1.080
5	0.24	1.583	1.258	0.629
6	0.48	1.333	1.155	0.577
7	0.95	2.000	1.414	0.707

30 Day Trout Embryo Mortality SAN 582H

File: sanembmrt

Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	6	554.000	92.333	30.655
Within (Error)	21	63.250	3.012	
Total	27	617.250		

Critical F value = 2.57 (0.05,6,21)

Since $F > \text{Critical } F$ REJECT H_0 : All groups equal

30 Day Trout Embryo Mortality SAN 582H

File: sanembmrt

Transform: NO TRANSFORMATION

DUNNETTS TEST - TABLE 1 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	Solvent control	9.250	9.250		
2	Control	6.250	6.250	2.445	
3	0.06 ppm	6.500	6.500	2.241	
4	0.12 ppm	4.000	4.000	4.278	*
5	0.24	1.750	1.750	6.112	*
6	0.48	1.000	1.000	6.723	*
7	0.95	15.000	15.000	-4.685	

Dunnett table value = 2.46 (1 Tailed Value, P=0.05, df=20,6)

30 Day Trout Embryo Mortality SAN 582H

File: sanembmrt

Transform: NO TRANSFORMATION

DUNNETTS TEST - TABLE 2 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	Solvent control	4			
2	Control	4	3.019	32.6	3.000
3	0.06 ppm	4	3.019	32.6	2.750
4	0.12 ppm	4	3.019	32.6	5.250
5	0.24	4	3.019	32.6	7.500
6	0.48	4	3.019	32.6	8.250
7	0.95	4	3.019	32.6	-5.750

30 Day Trout Embryo Mortality SAN 582H

File: sanembmrt

Transform: NO TRANSFORMATION

ANOVA TABLE

SOURCE	DF	SS	MS	F
Between	6	554.000	92.333	30.655
Within (Error)	21	63.250	3.012	
Total	27	617.250		

Critical F value = 2.57 (0.05,6,21)

Since F > Critical F REJECT Ho:All groups equal

30 Day Trout Embryo Mortality SAN 582H

File: sanembmrt

Transform: NO TRANSFORMATION

BONFERRONI T-TEST

- TABLE 1 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	T STAT	SIG
1	Solvent control	9.250	9.250		
2	Control	6.250	6.250	2.445	
3	0.06 ppm	6.500	6.500	2.241	
4	0.12 ppm	4.000	4.000	4.278	*
5	0.24	1.750	1.750	6.112	*
6	0.48	1.000	1.000	6.723	*
7	0.95	15.000	15.000	-4.685	

Bonferroni T table value = 2.60 (1 Tailed Value, P=0.05, df=21,6)

30 Day Trout Embryo Mortality SAN 582H

File: sanembmrt

Transform: NO TRANSFORMATION

BONFERRONI T-TEST

- TABLE 2 OF 2

Ho:Control<Treatment

GROUP	IDENTIFICATION	NUM OF REPS	Minimum Sig Diff (IN ORIG. UNITS)	% of CONTROL	DIFFERENCE FROM CONTROL
1	Solvent control	4			
2	Control	4	3.193	34.5	3.000
3	0.06 ppm	4	3.193	34.5	2.750
4	0.12 ppm	4	3.193	34.5	5.250
5	0.24	4	3.193	34.5	7.500
6	0.48	4	3.193	34.5	8.250
7	0.95	4	3.193	34.5	-5.750

30 Day Trout Embryo Mortality SAN 582H

File: sanembmrt

Transform: NO TRANSFORMATION

WILLIAMS TEST (Isotonic regression model)

TABLE 1 OF 2

GROUP	IDENTIFICATION	N	ORIGINAL MEAN	TRANSFORMED MEAN	ISOTONIZED MEAN
1	Solvent control	4	9.250	9.250	4.792
2	Control	4	6.250	6.250	4.792
3	0.06 ppm	4	6.500	6.500	4.792
4	0.12 ppm	4	4.000	4.000	4.792
5	0.24	4	1.750	1.750	4.792
6	0.48	4	1.000	1.000	4.792
7	0.95	4	15.000	15.000	15.000

30 Day Trout Embryo Mortality SAN 582H

File: sanembmrt

Transform: NO TRANSFORMATION

WILLIAMS TEST (Isotonic regression model)

TABLE 2 OF 2

IDENTIFICATION	ISOTONIZED MEAN	CALC. WILLIAMS	SIG P=.05	TABLE WILLIAMS	DEGREES OF FREEDOM
Solvent control	4.792				
Control	4.792	3.633	*	1.72	k= 1, v=21
0.06 ppm	4.792	3.633	*	1.80	k= 2, v=21
0.12 ppm	4.792	3.633	*	1.83	k= 3, v=21
0.24	4.792	3.633	*	1.84	k= 4, v=21
0.48	4.792	3.633	*	1.85	k= 5, v=21
0.95	15.000	4.686	*	1.85	k= 6, v=21

s = 1.735

Note: df used for table values are approximate when v > 20.

30 Day Trout Embryo Mortality SAN 582H

File: sanembmrt

Transform: NO TRANSFORMATION

KRUSKAL-WALLIS ANOVA BY RANKS - TABLE 1 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	MEAN CALCULATED IN ORIGINAL UNITS	RANK SUM
1	Solvent control	9.250	9.250	86.000
2	Control	6.250	6.250	64.500
3	0.06 ppm	6.500	6.500	65.500
4	0.12 ppm	4.000	4.000	42.500
5	0.24	1.750	1.750	24.500
6	0.48	1.000	1.000	17.000
7	0.95	15.000	15.000	106.000

Calculated H Value = 23.278

Critical H Value Table = 12.590

Since Calc H > Crit H REJECT Ho: All groups are equal.

30 Day Trout Embryo Mortality SAN 582H

File: sanembmrt

Transform: NO TRANSFORMATION

DUNNS MULTIPLE COMPARISON - KRUSKAL-WALLIS - TABLE 2 OF 2

GROUP	IDENTIFICATION	TRANSFORMED MEAN	ORIGINAL MEAN	GROUP 0 0 0 0 0 0 0 6 5 4 2 3 1 7
6	0.48	1.000	1.000	\
5	0.24	1.750	1.750	. \
4	0.12 ppm	4.000	4.000	. . \
2	Control	6.250	6.250	. . . \
3	0.06 ppm	6.500	6.500	 \
1	Solvent control	9.250	9.250	 \
7	0.95	15.000	15.000	* * \

* = significant difference (p=0.05)

Table q value (0.05,7) = 3.038

. = no significant difference

SE = 5.784