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ANALYTICAL AND EXPERIMENTAL STUDY TO IMPROVE COMPUTER
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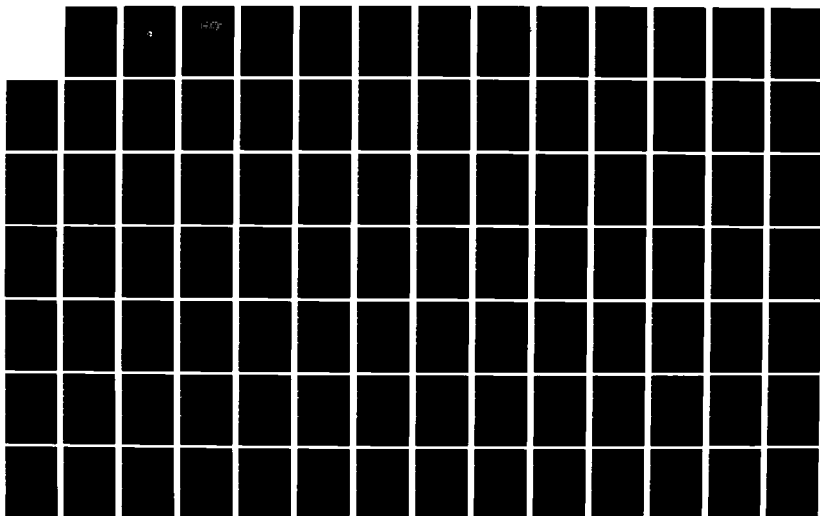
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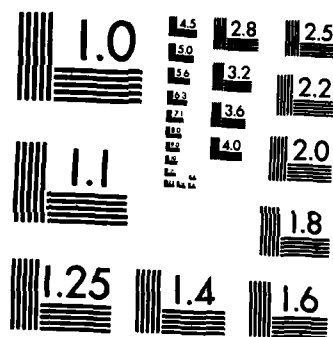
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ANALYTICAL AND EXPERIMENTAL STUDY TO IMPROVE
COMPUTER MODELS FOR MIXING AND DILUTION OF
SOLUBLE HAZARDOUS CHEMICALS: TEST DATA VOLUME

FRANKLIN T. DODGE
J. CHRISTOPHER BUCKINGHAM
THOMAS B. MORROW



FINAL REPORT

AUGUST 1982

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UNITED STATES COAST GUARD
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Washington, D.C. 20593

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ANALYTICAL AND EXPERIMENTAL STUDY TO IMPROVE COMPUTER MODELS FOR MIXING AND DILUTION OF SOLUBLE HAZARDOUS CHEMICALS: TEST DATA VOLUME

by

Franklin T. Dodge
J. Christopher Buckingham
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Approved:

Robert L. Bass, Director
Department of Mechanical Sciences

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APPENDIX A

CONCENTRATION PROFILES FOR RUN II.1-1

$$\rho_c/\rho = 0.79 \text{ (Ethyl Alcohol)}$$

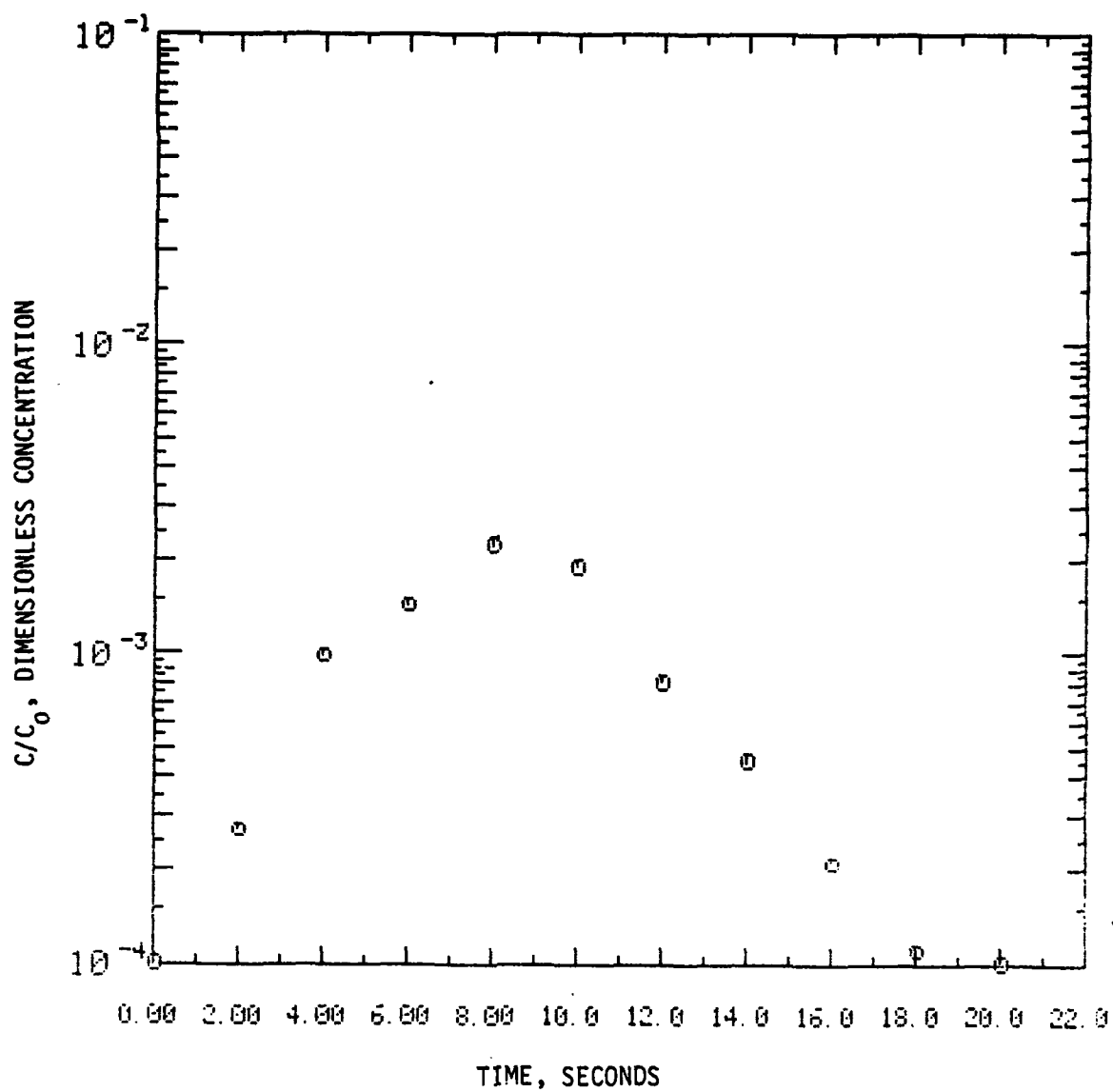
$$r_i/d = 0.125$$

$$u_\tau/U = 0.05$$

$$U(\text{cm/sec}) = 14.1$$

Time elapsed from spill to $t=0$ (Reference) for:

time history graph	28 sec.
cross stream profiles	28 sec.
vertical profiles	30 sec.



X = 168 IN., Y = 0, Z = 0.25 IN.

FIGURE A-1. RUN II.1-1 CONCENTRATION TIME HISTORY

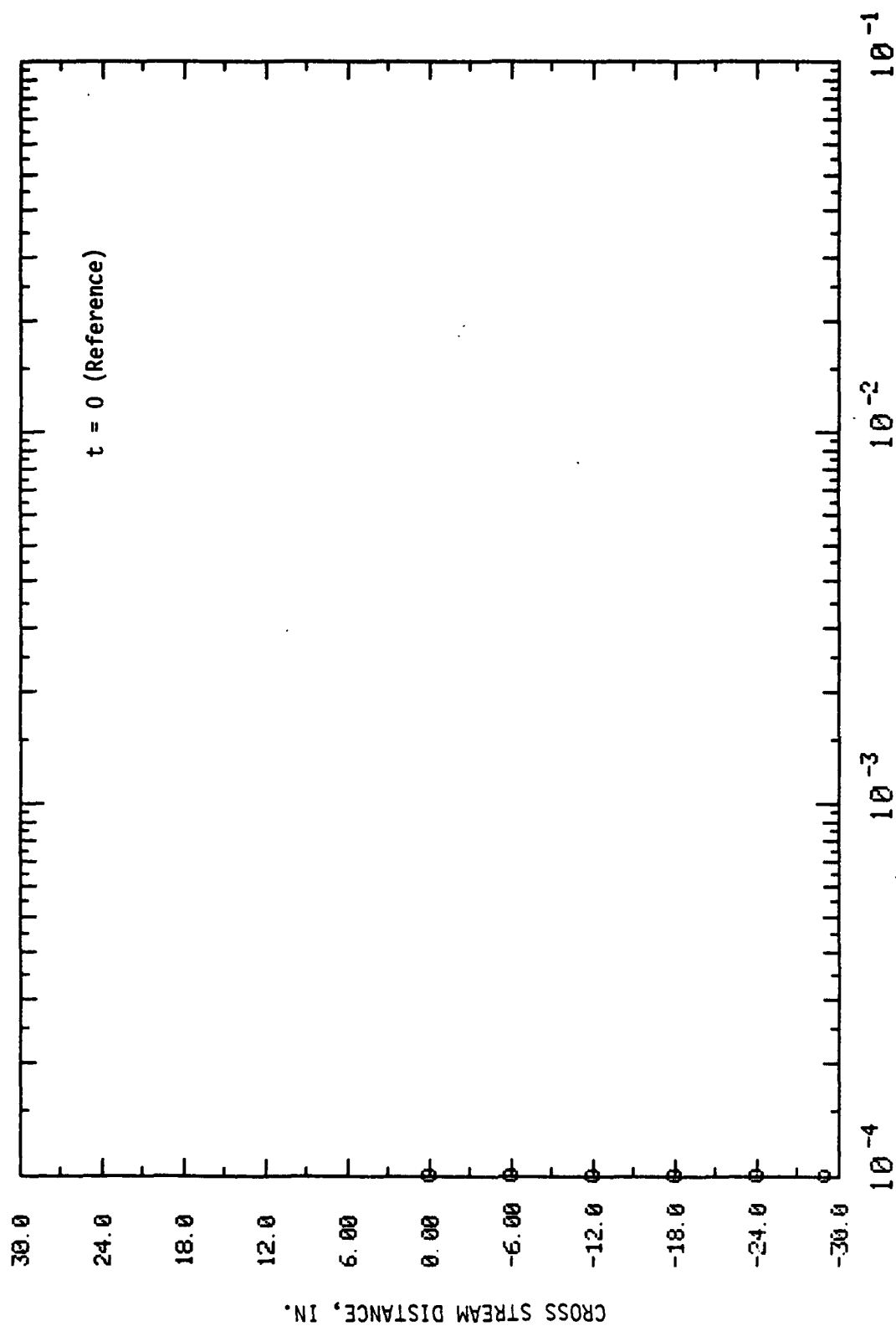


FIGURE A-2. RUN II.1.1-1 CROSS STREAM CONCENTRATION PROFILE

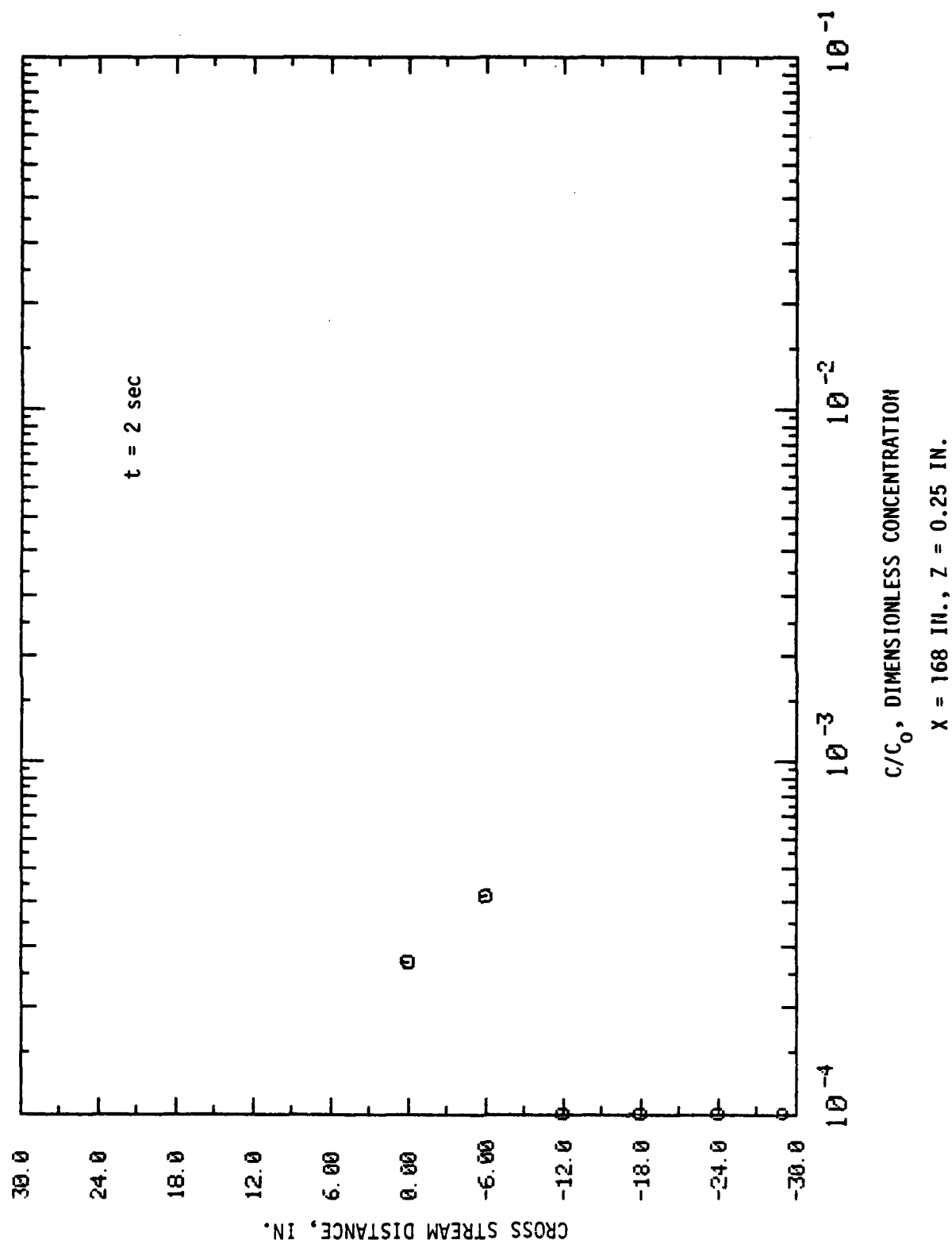


FIGURE A-3. RUN II.1.1-1 CROSS STREAM CONCENTRATION PROFILE

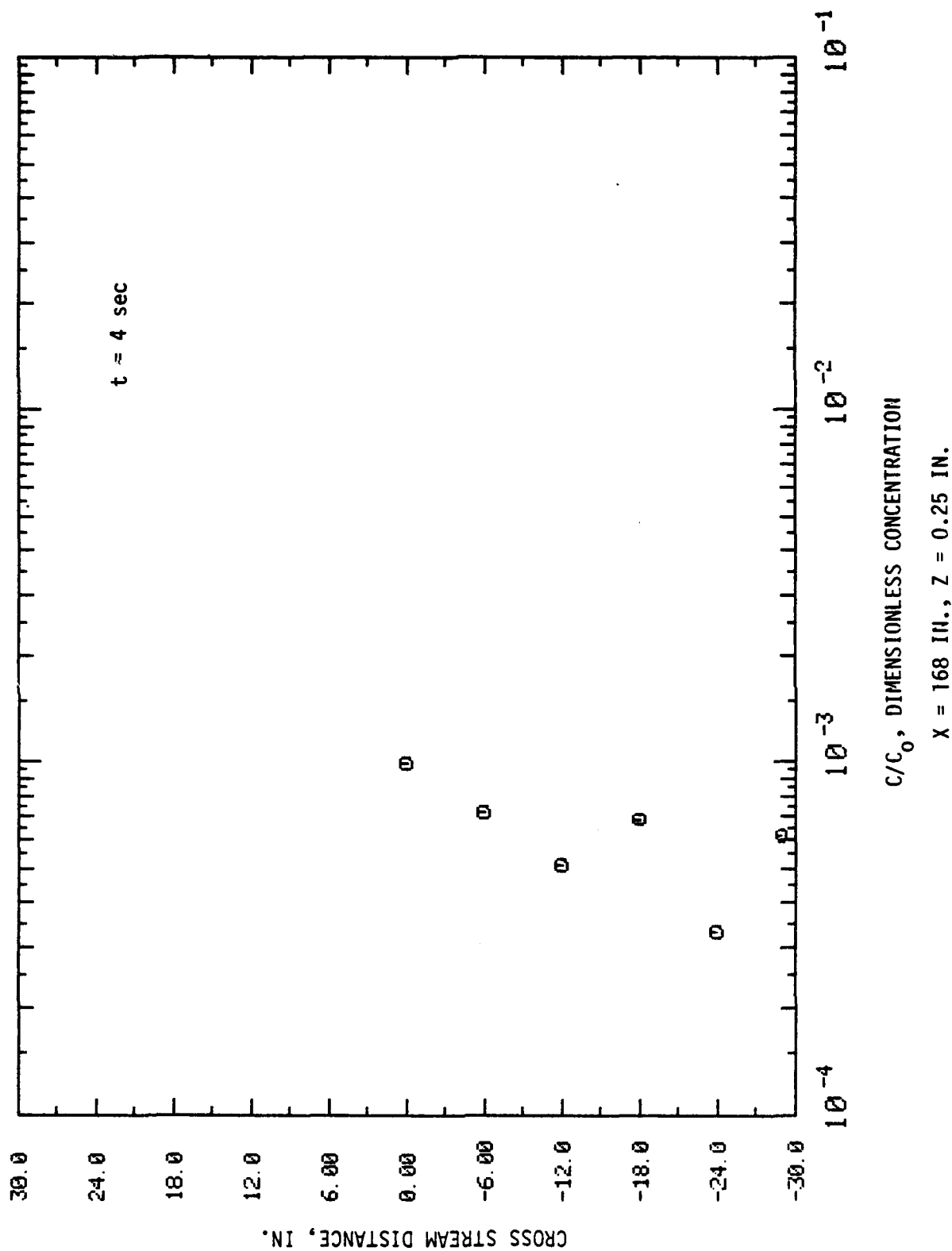


FIGURE A-4. RUN II.1-1 CROSS STREAM CONCENTRATION PROFILE

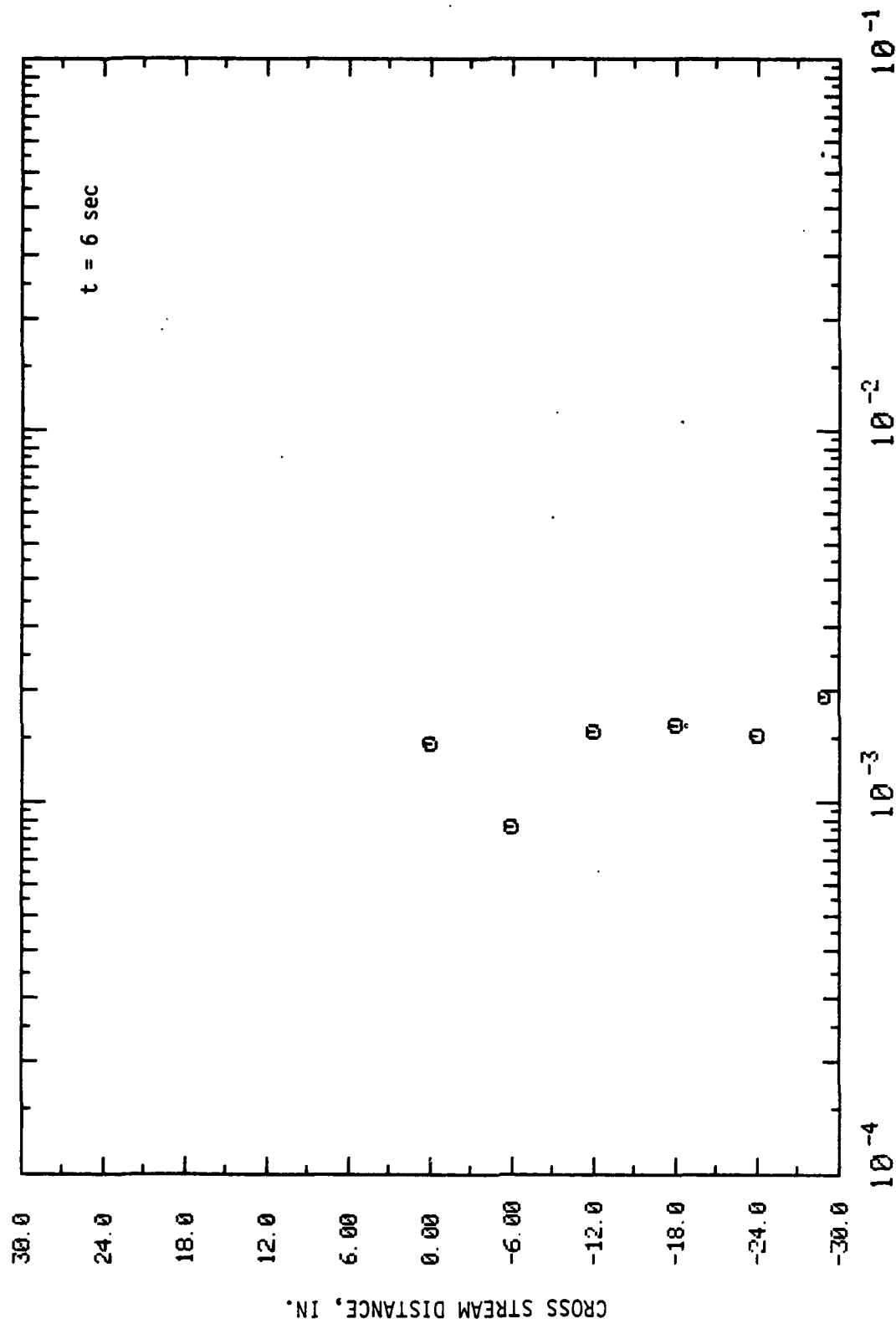
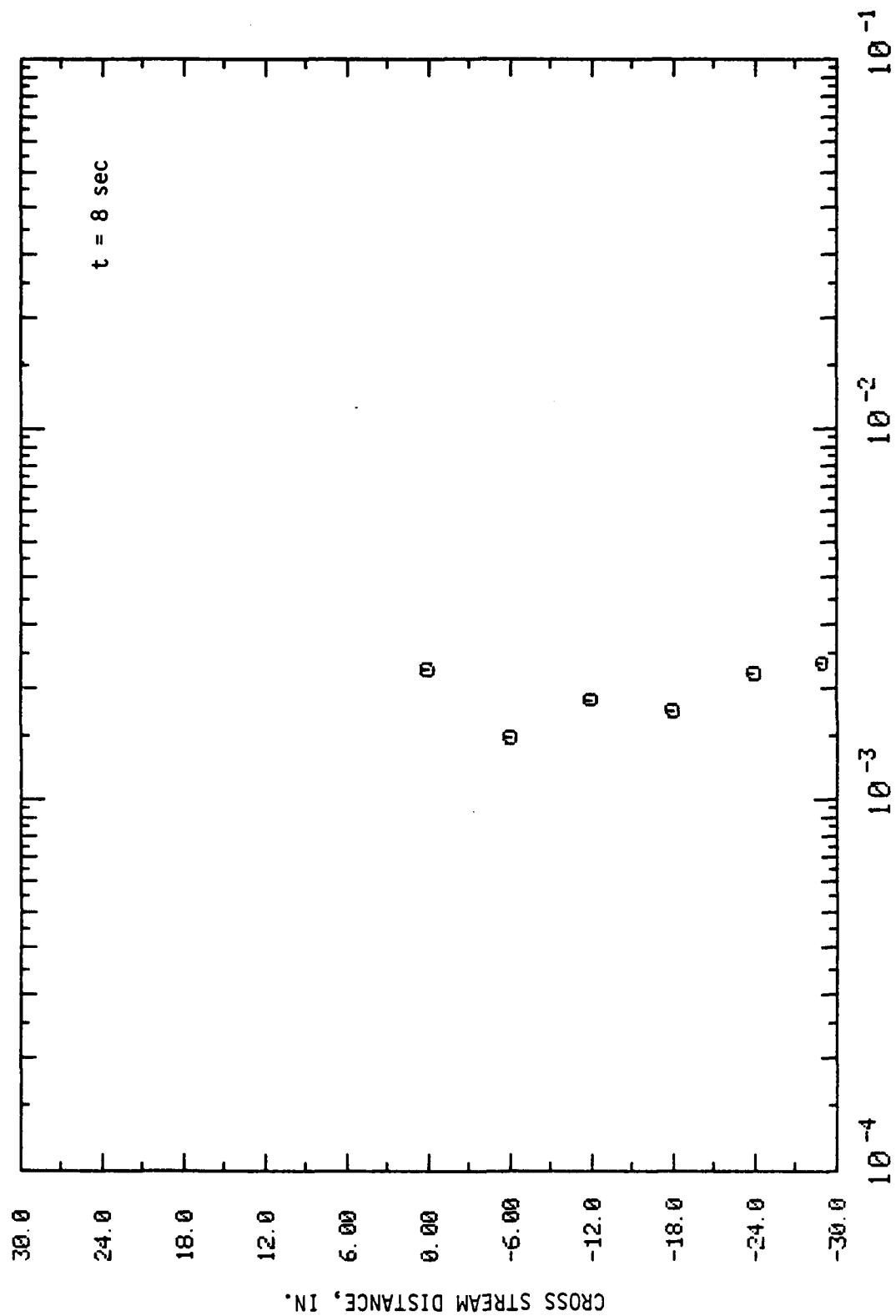


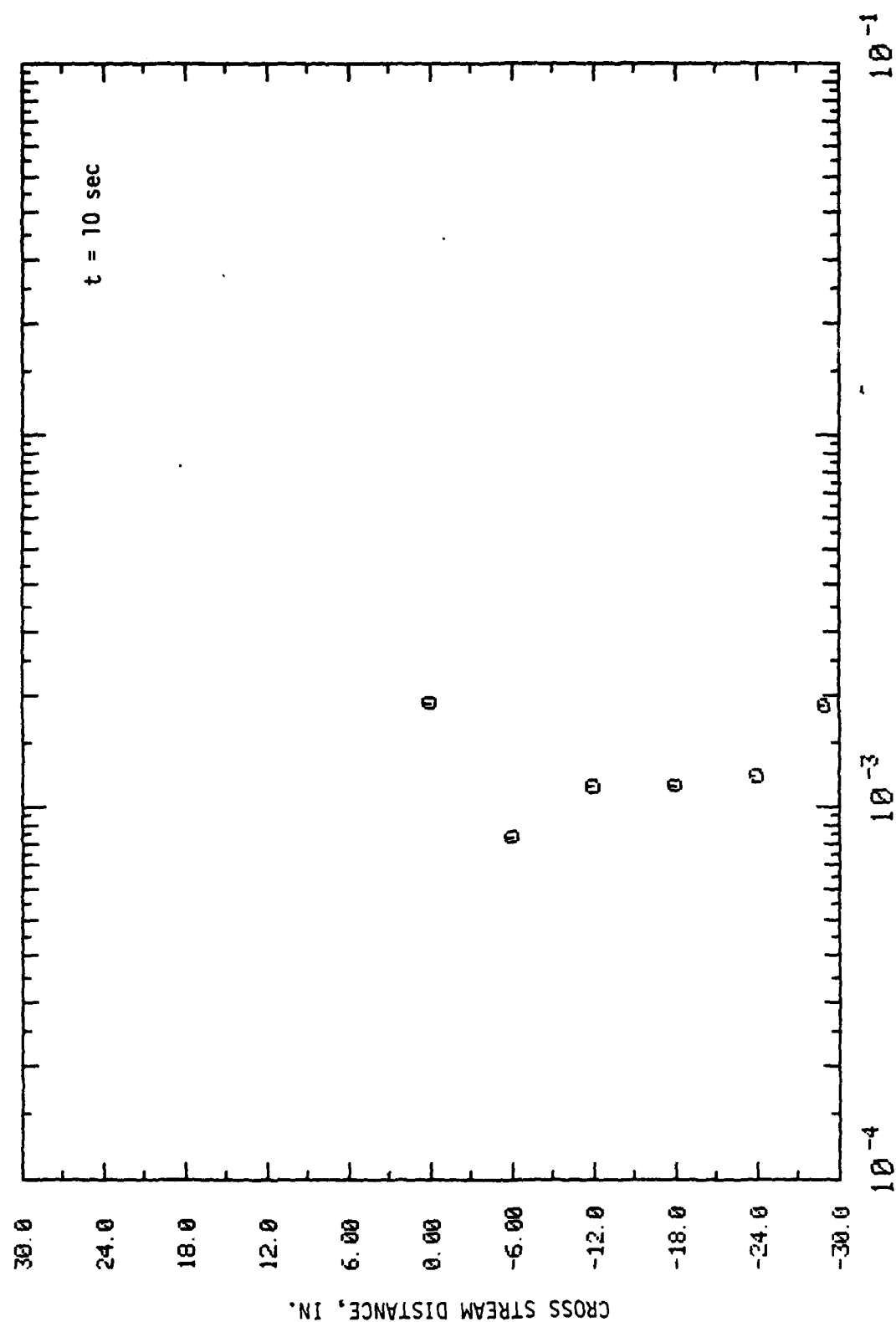
FIGURE A-5. RUN II.1.1-1 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

FIGURE A-6. RUN II.1.1-1 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

FIGURE A-7. RUN II.1.1-1 CROSS STREAM CONCENTRATION PROFILE

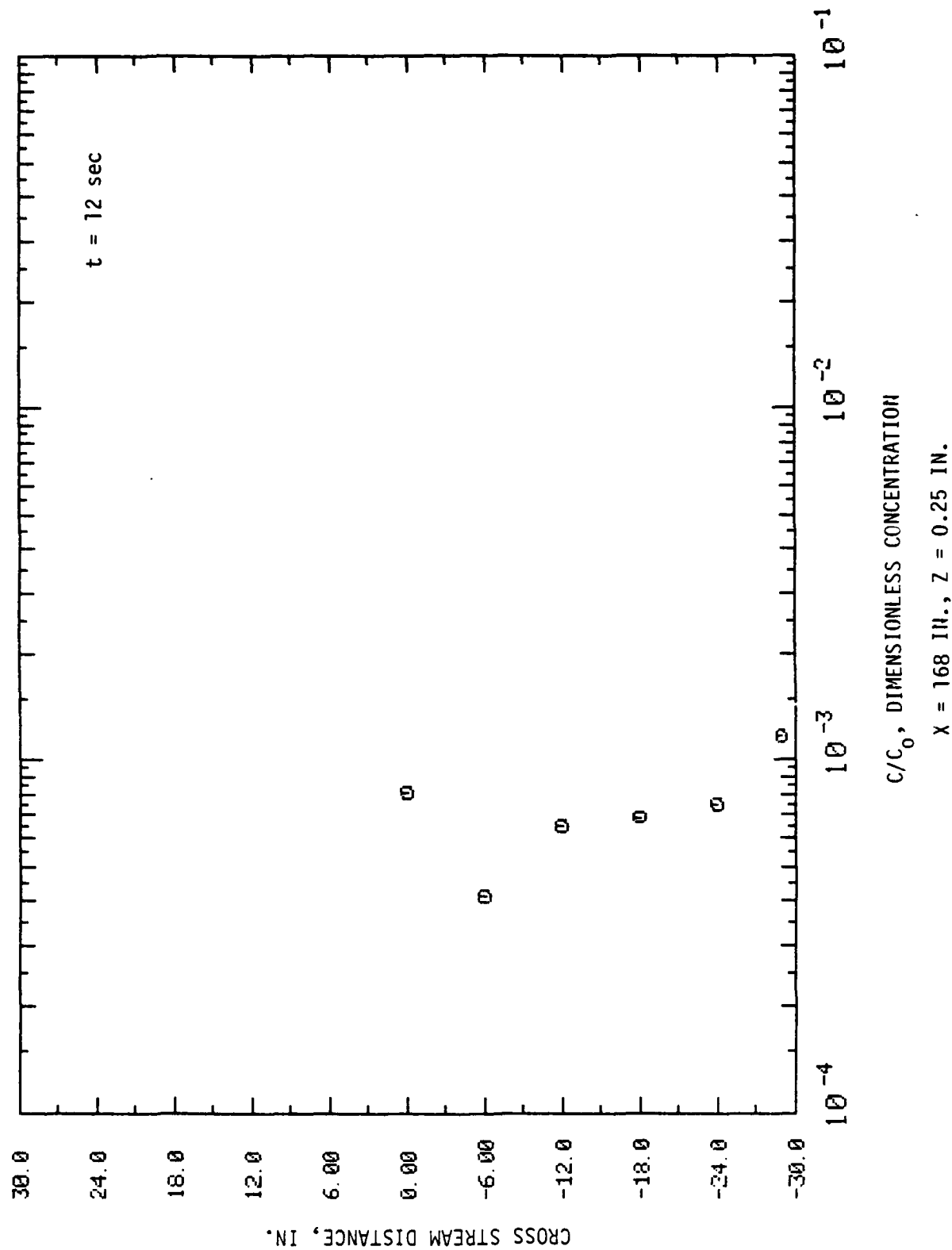
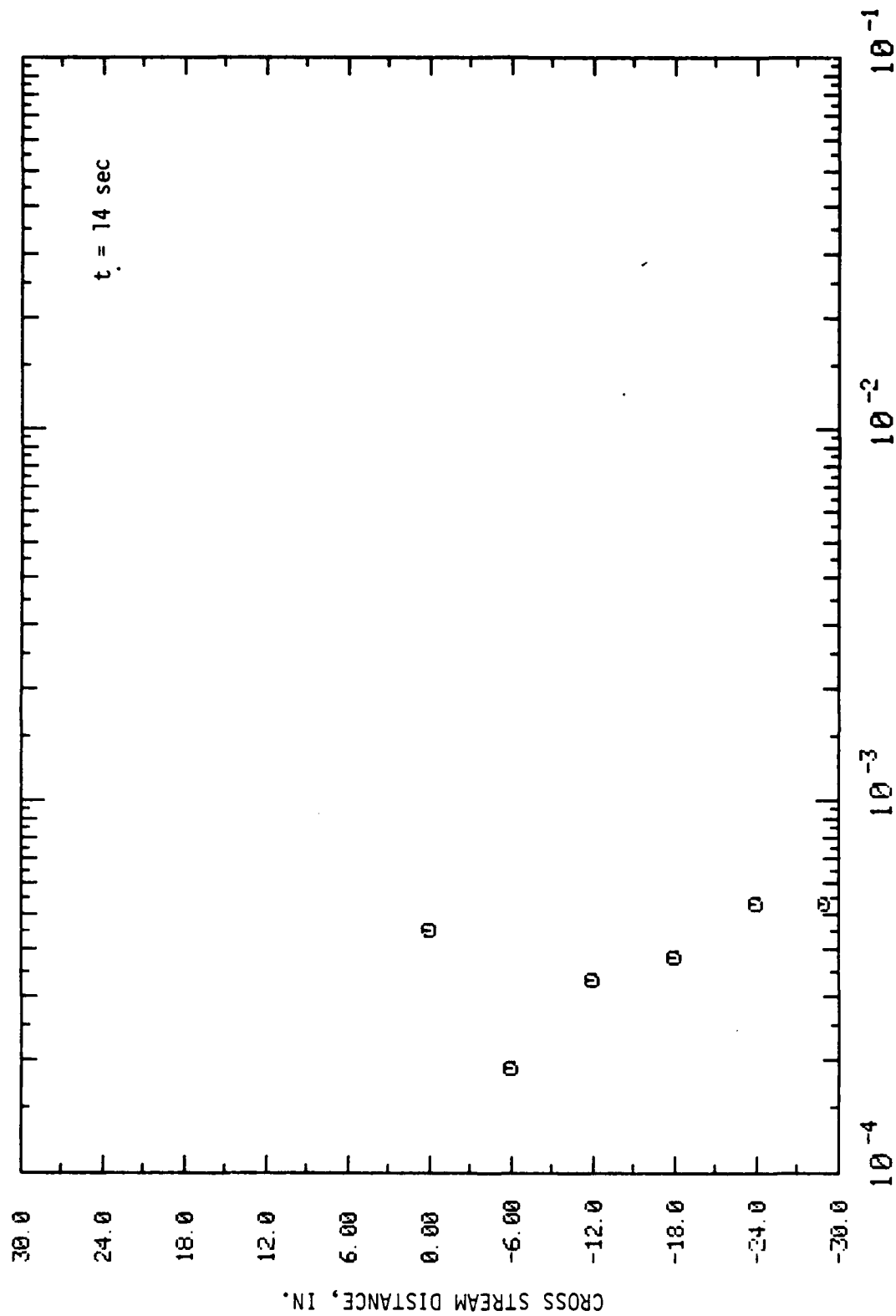


FIGURE A-8. RUN 11.1-1 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

FIGURE A-9. RUN II.1.1-1 CROSS STREAM CONCENTRATION PROFILE

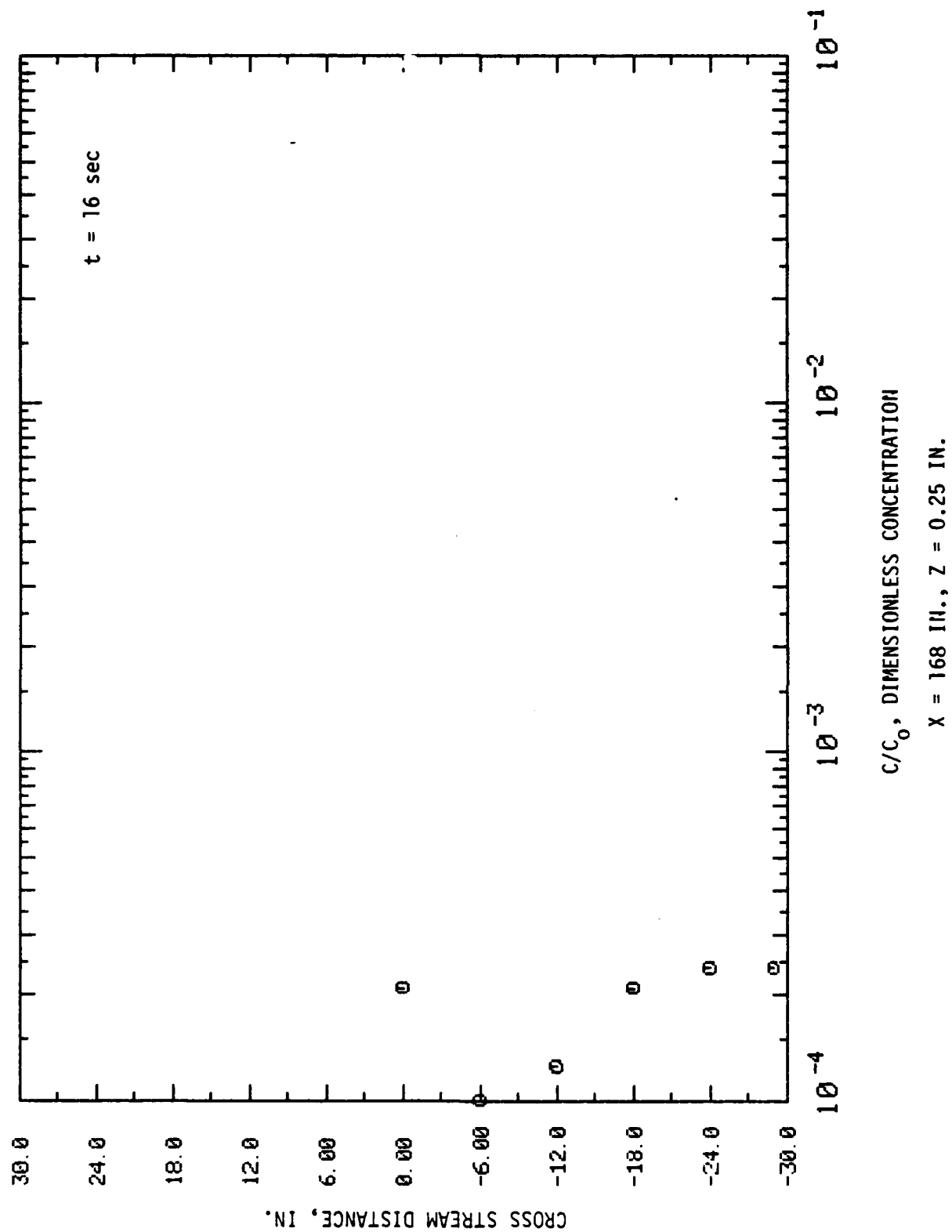


FIGURE A-10 . RUN II.1.1-1 CROSS STREAM CONCENTRATION PROFILE

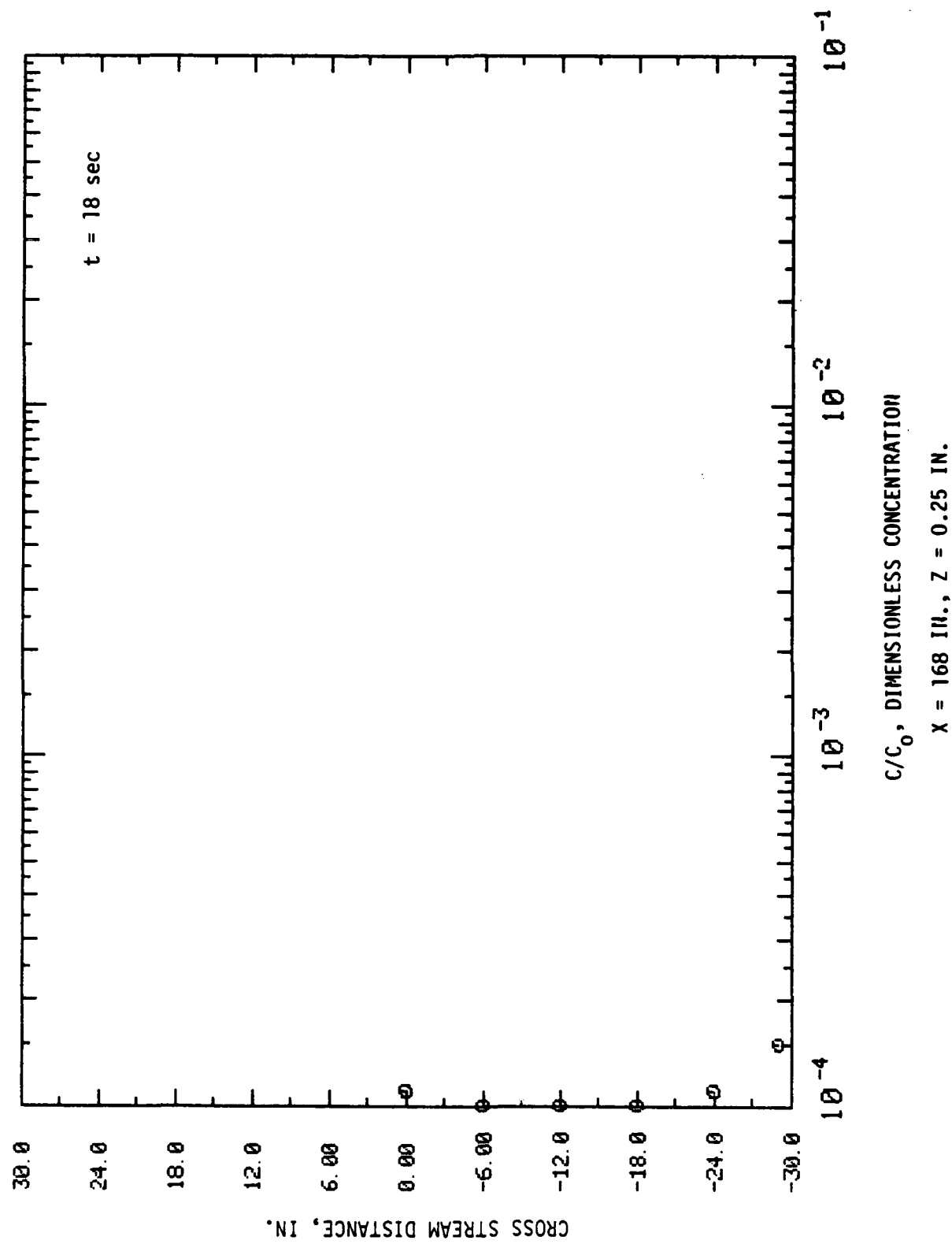
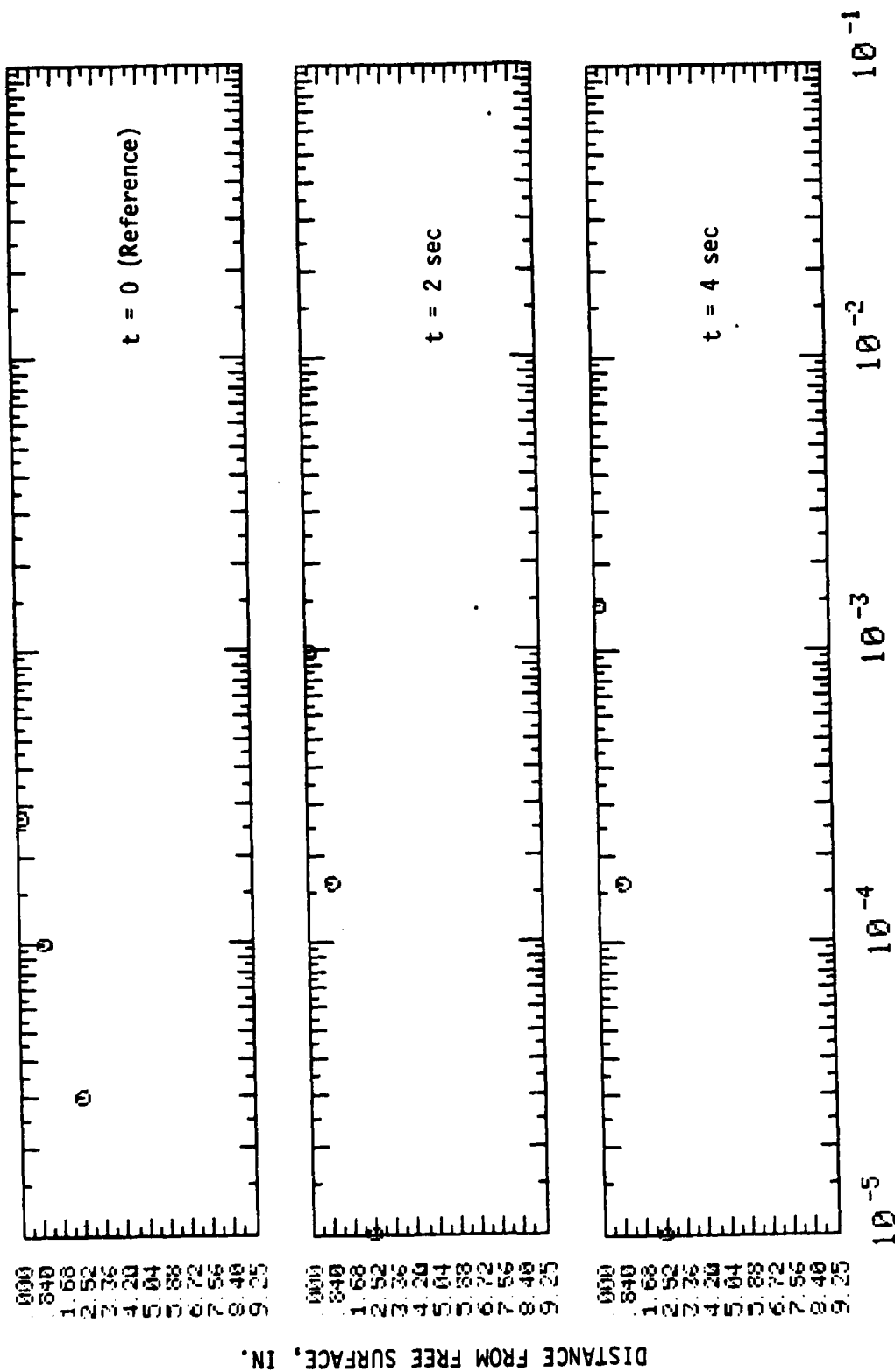


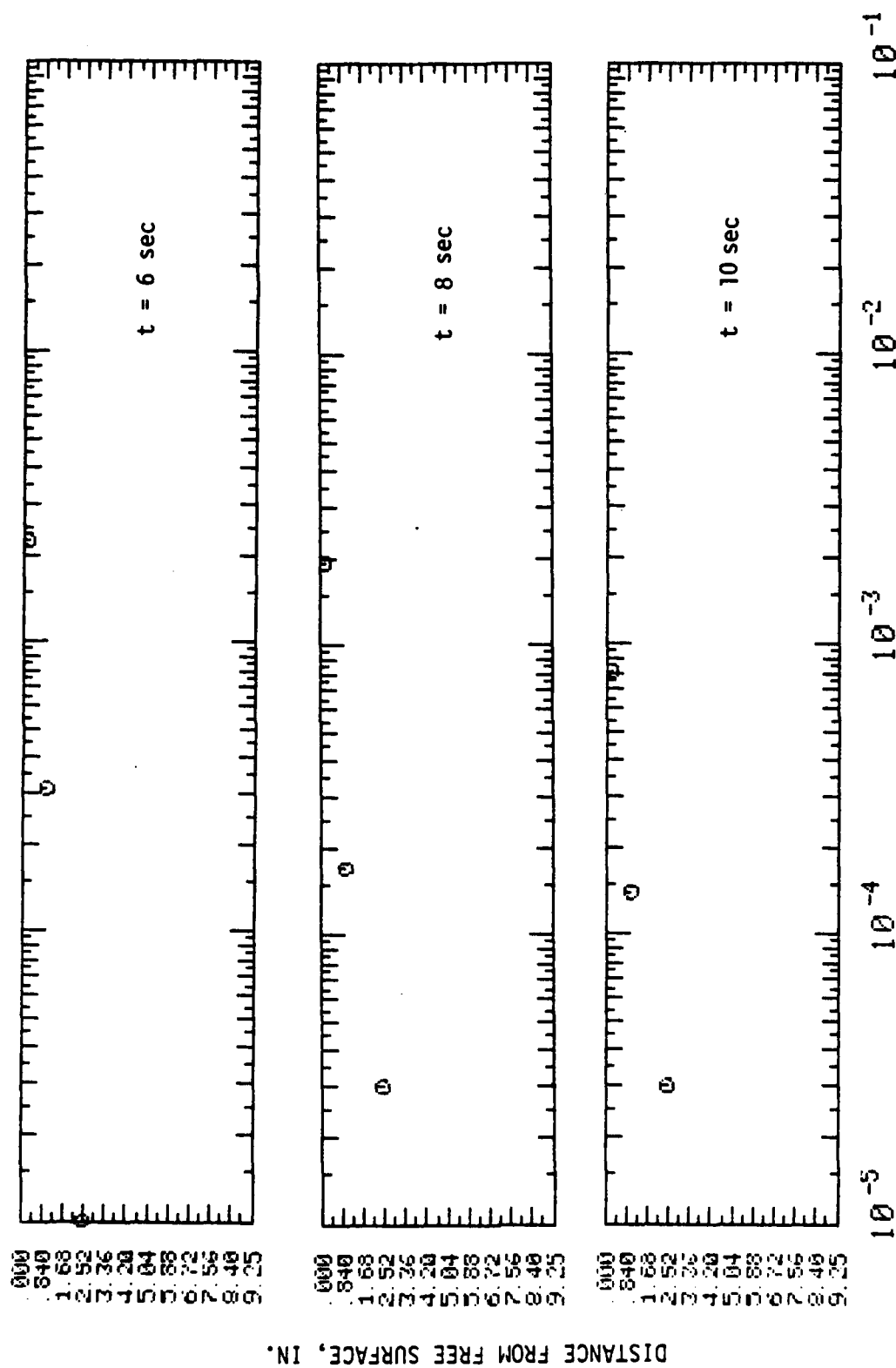
FIGURE A-11. RUN II.1.1-1 CROSS STREAM CONCENTRATION PROFILE



C/C₀, DIMENSIONLESS CONCENTRATION

X = 168 IN., Y = 0 IN.

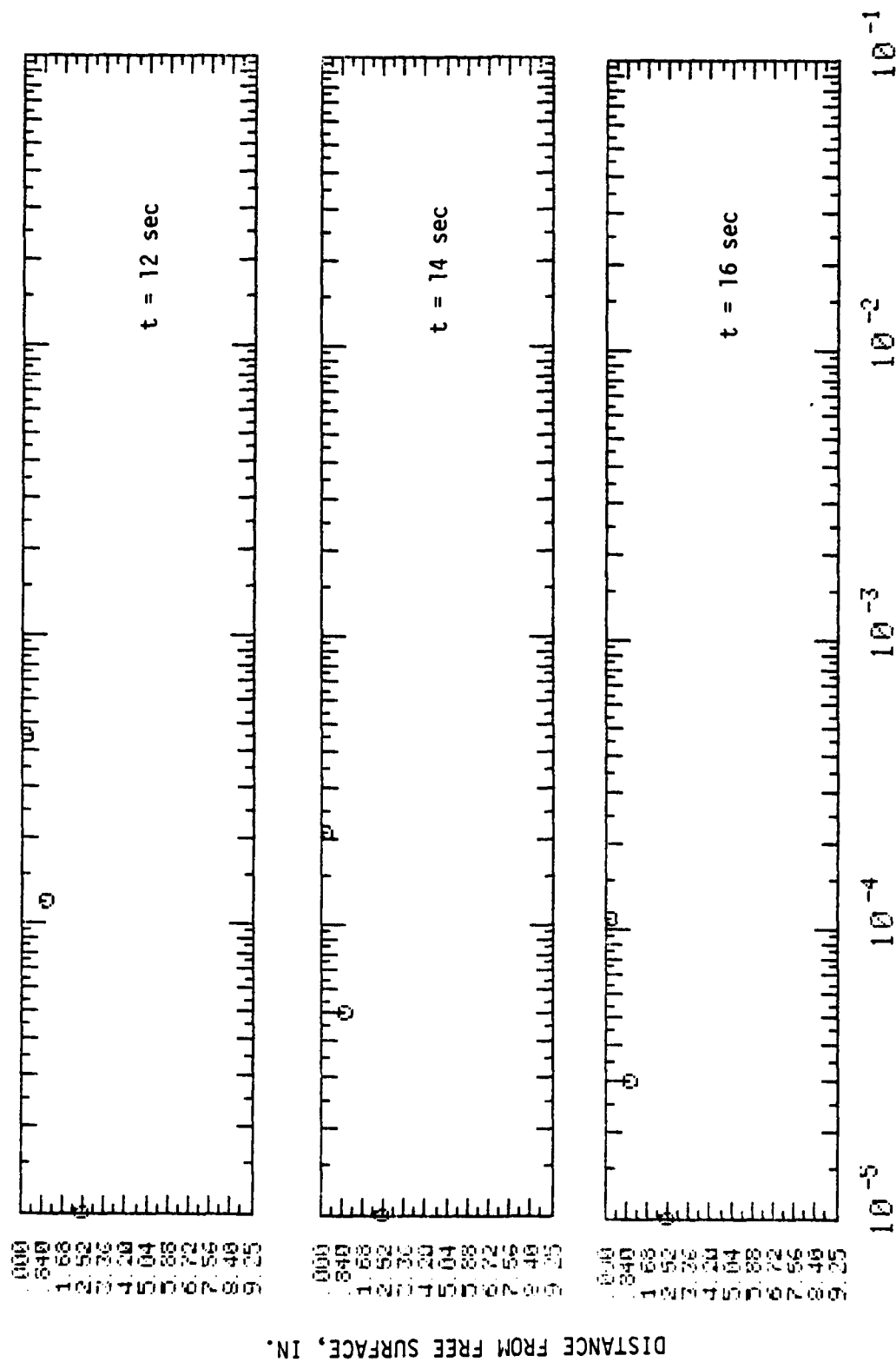
FIGURE A-12. RUN II.1-1 VERTICAL CONCENTRATION PROFILES



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Y = 0 \text{ IN.}$

FIGURE A-13. RUN 11.1-1 VERTICAL CONCENTRATION PROFILES



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$ IN.

FIGURE A-14. RUN II.1.1-1 VERTICAL CONCENTRATION PROFILES

APPENDIX B

CONCENTRATION PROFILES FOR RUN II.1-2

$$\rho_c/\rho = 0.79 \text{ (Ethyl Alcohol)}$$

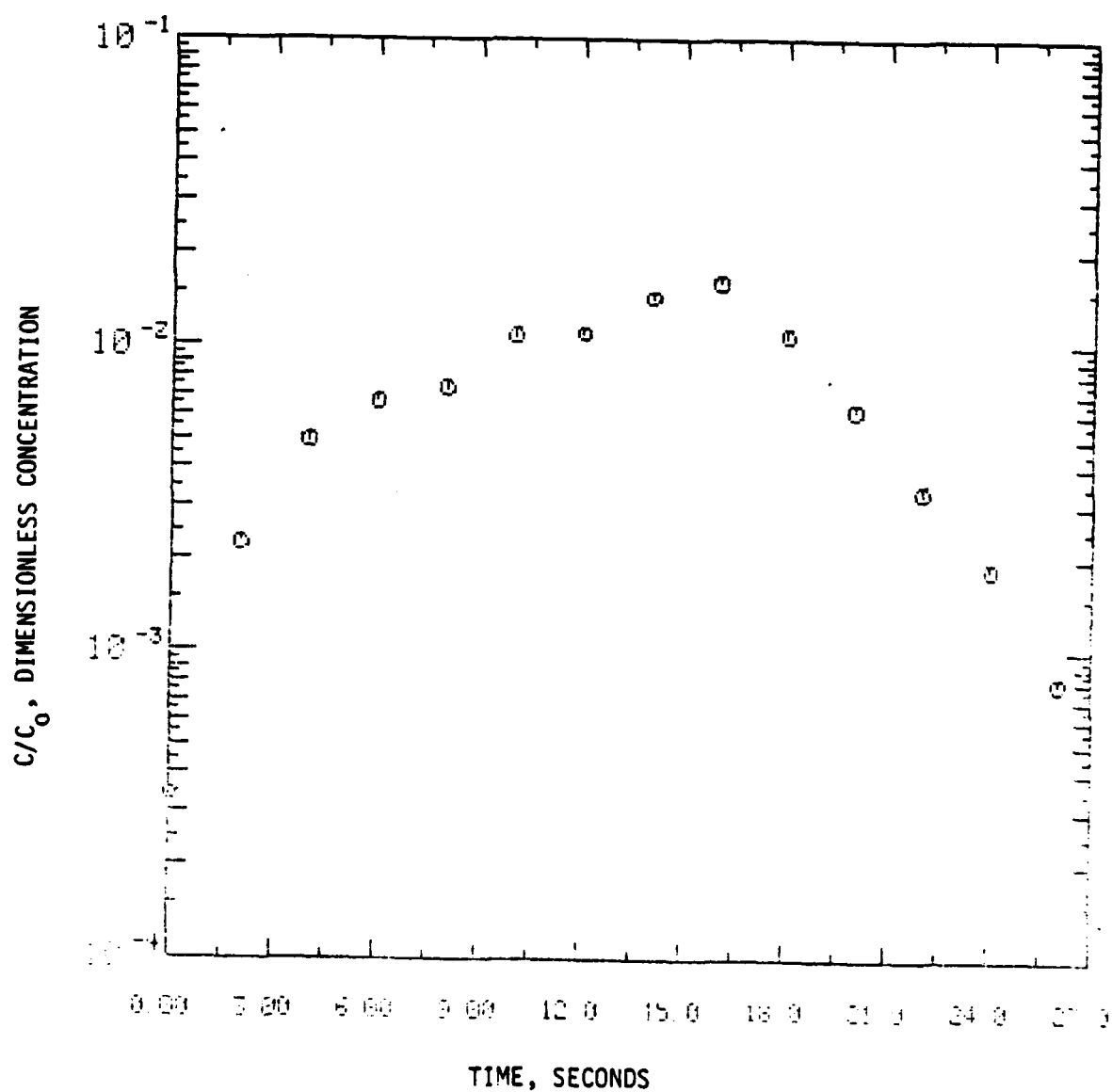
$$r_i/d = 0.23$$

$$u_r/U = 0.05$$

$$U(\text{cm/sec}) = 14.1$$

Time elapsed from spill to $t=0$ (Reference) for:

time history graph	27 sec.
cross stream profiles	27 sec.
vertical profiles	29 sec.



X = 168 IN., Y = 0, Z = 0.25 IN.

FIGURE B-1 . RUN II.1-2 CONCENTRATION TIME HISTORY

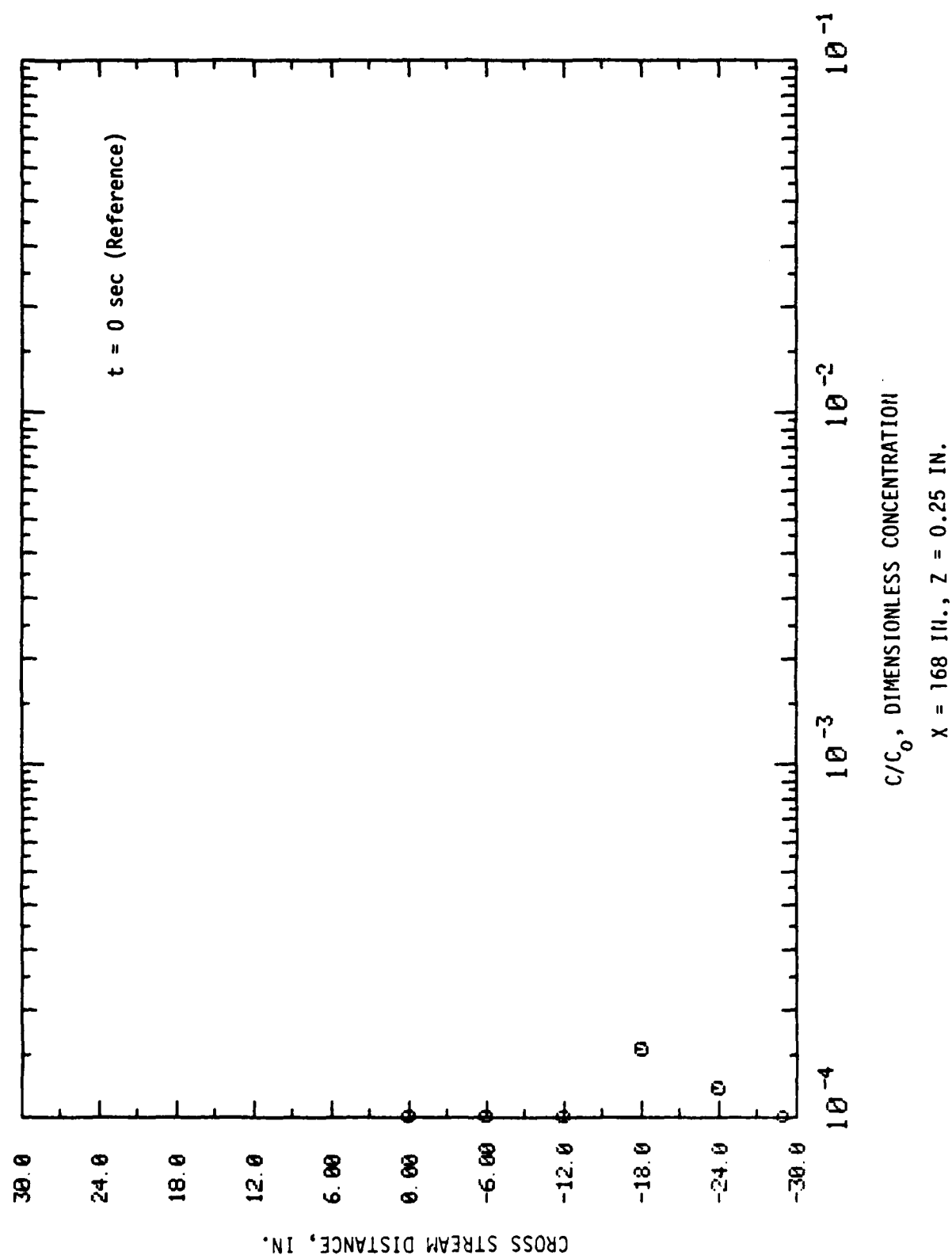


FIGURE B-2 . RUN II.1.1-2 CROSS STREAM CONCENTRATION PROFILE

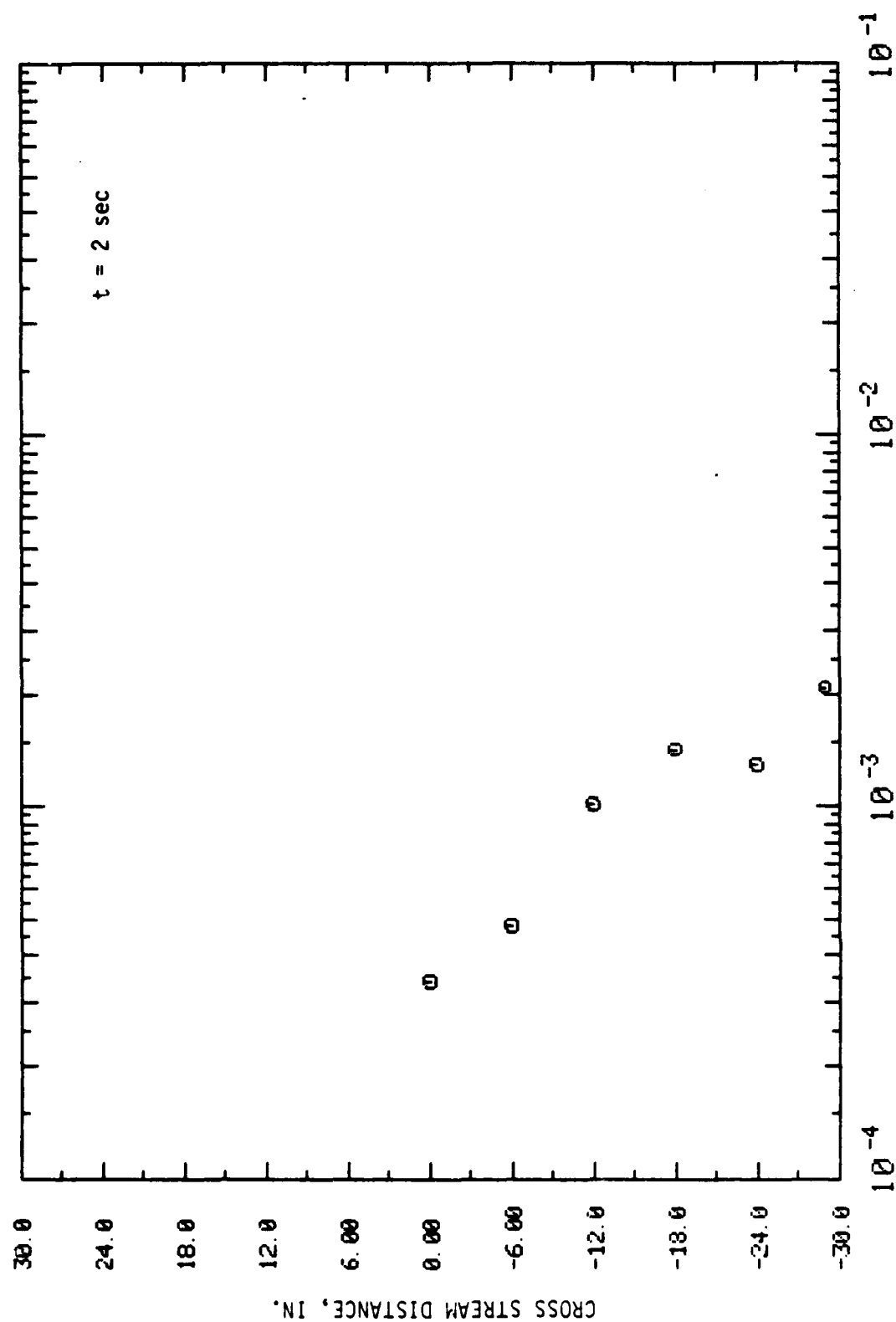
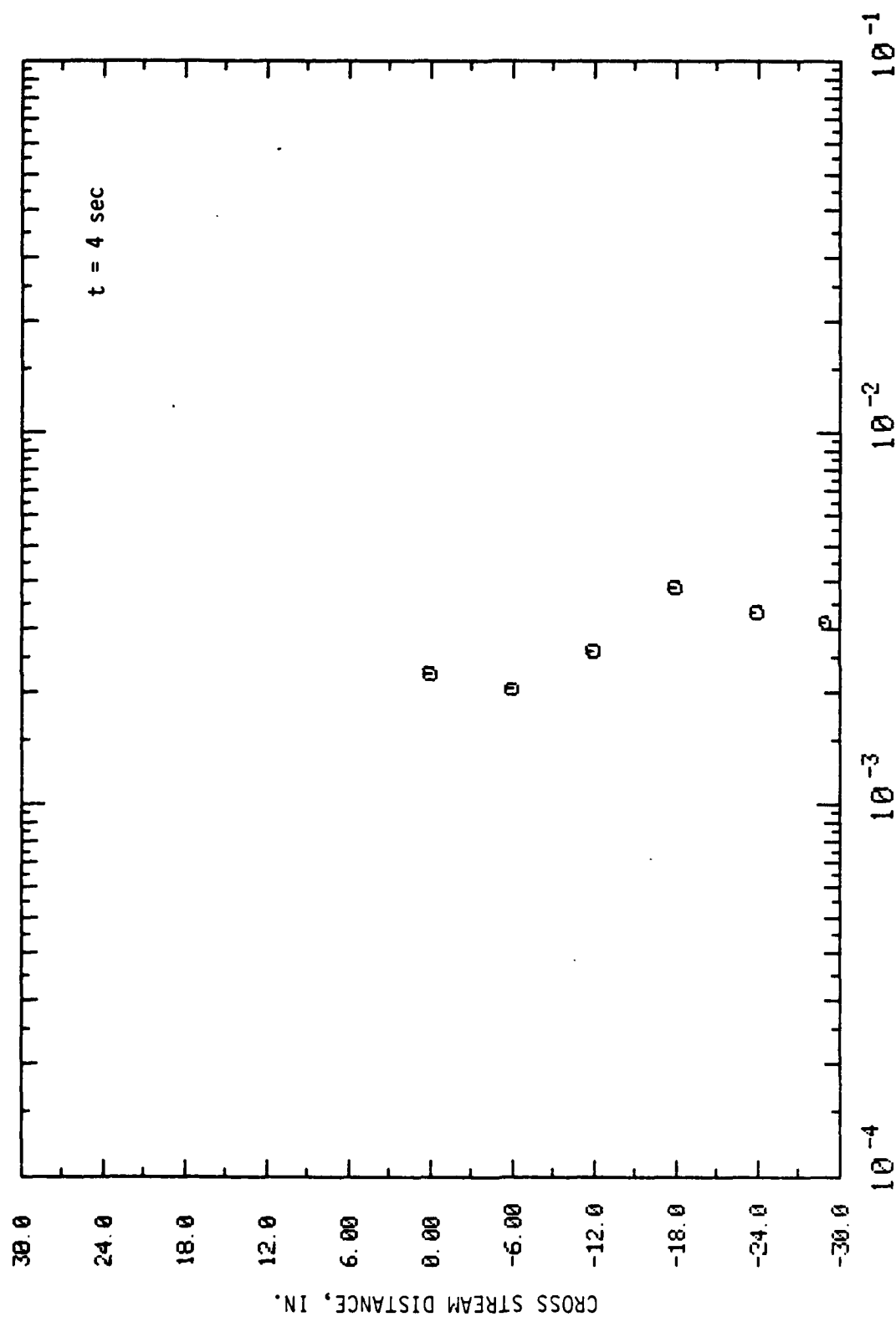


FIGURE B-3 . RUN II.1.1-2 CROSS STREAM CONCENTRATION PROFILE

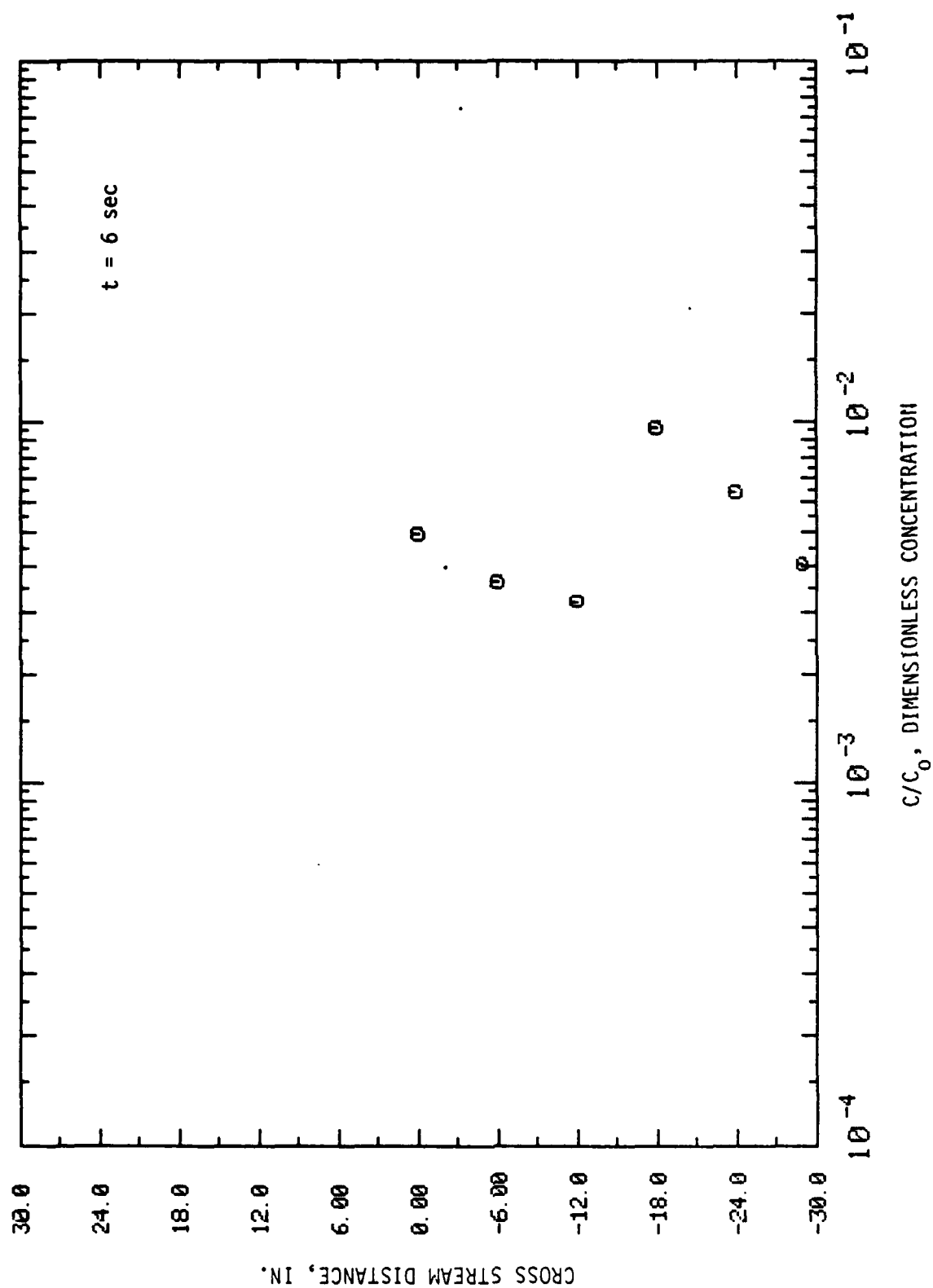
$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

FIGURE B-4 . RUN II.1.1-2 CROSS STREAM CONCENTRATION PROFILE



$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

FIGURE B-5 . RUN II.1-2 CROSS STREAM CONCENTRATION PROFILE

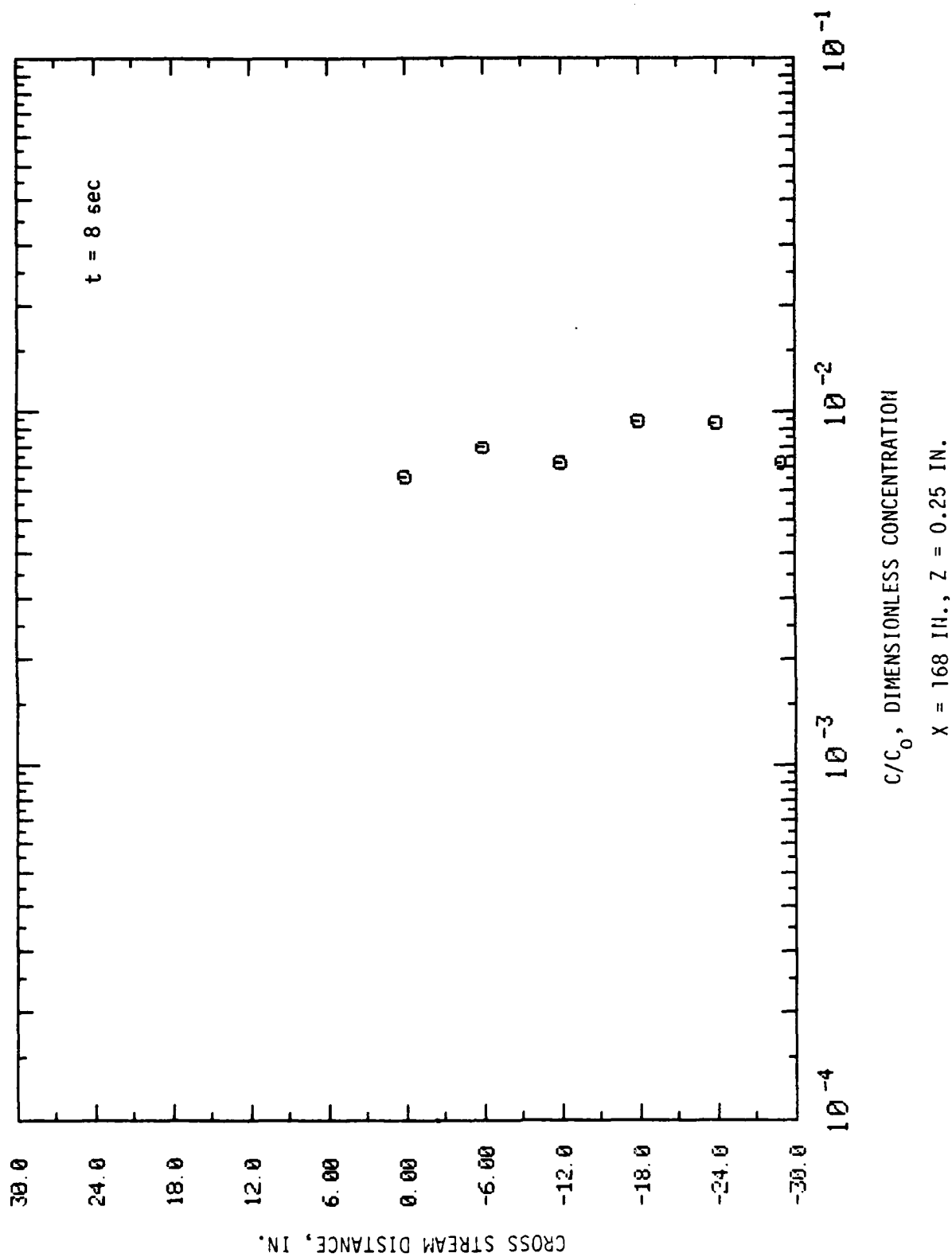


FIGURE B-6 . RUN II.1.1-2 CROSS STREAM CONCENTRATION PROFILE

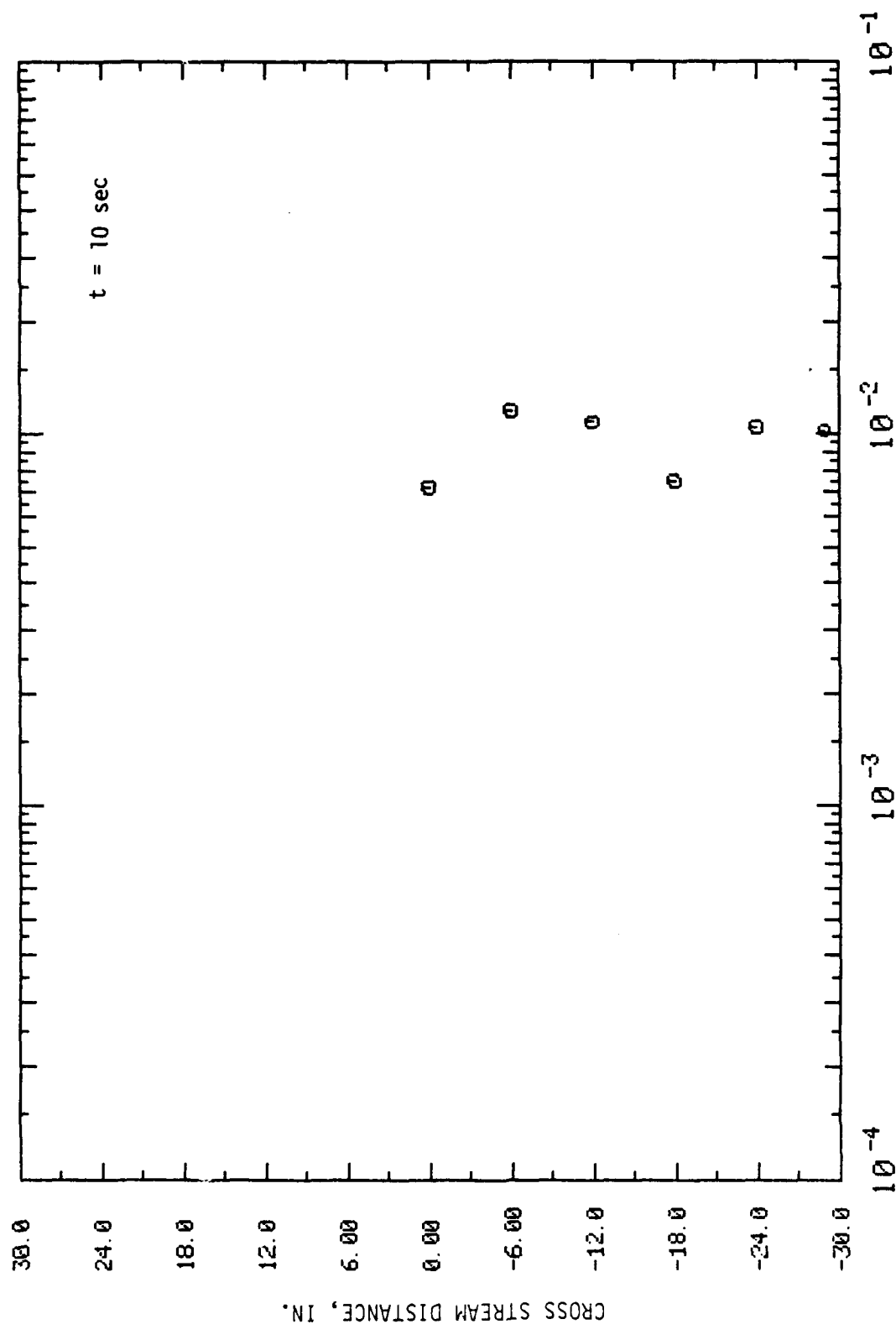
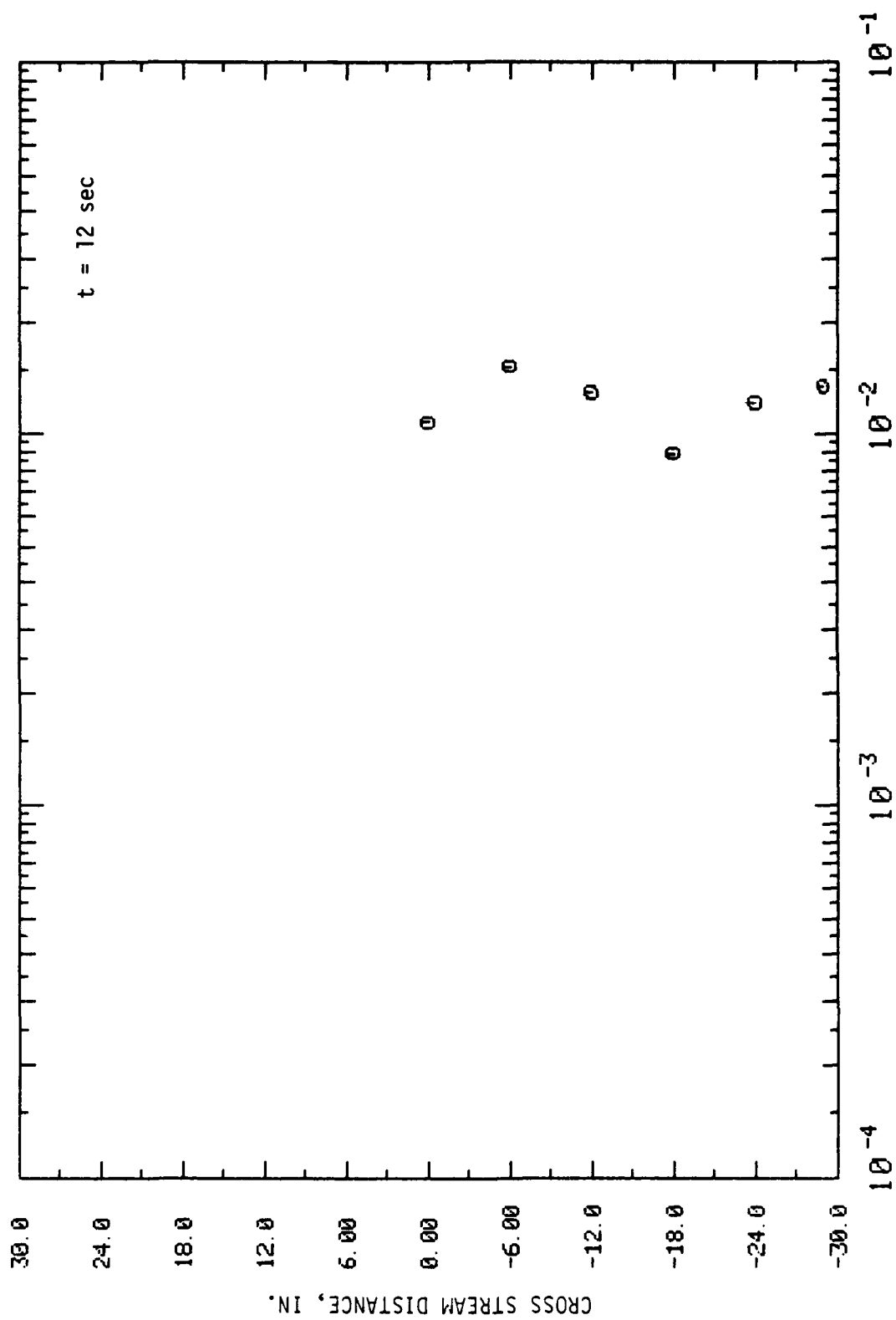


FIGURE B-7 . RUN II.1.1-2 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

FIGURE B-8 . RUN II.1.1-2 CROSS STREAM CONCENTRATION PROFILE

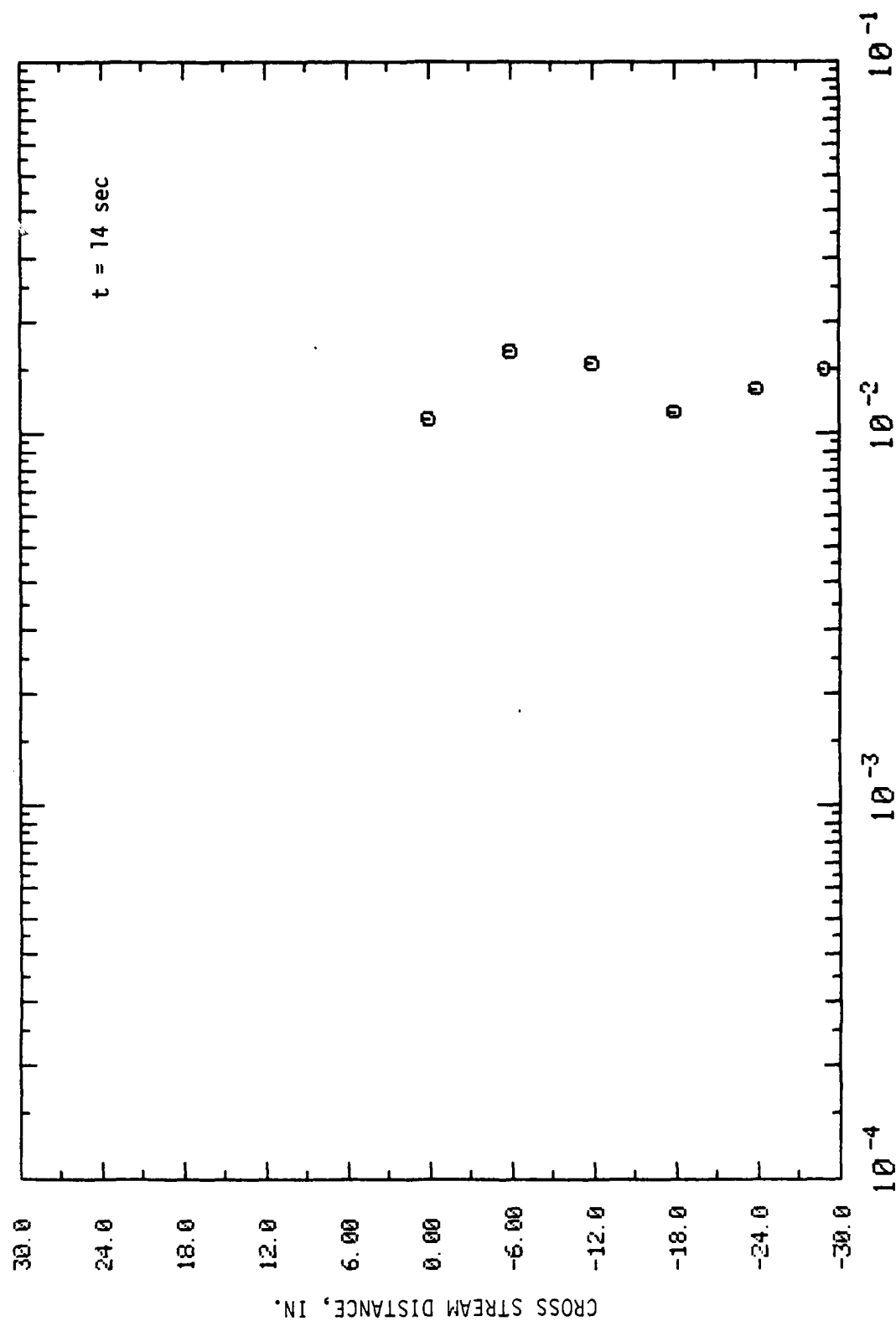


FIGURE B-9 . RUN II.1-2 CROSS STREAM CONCENTRATION PROFILE

C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

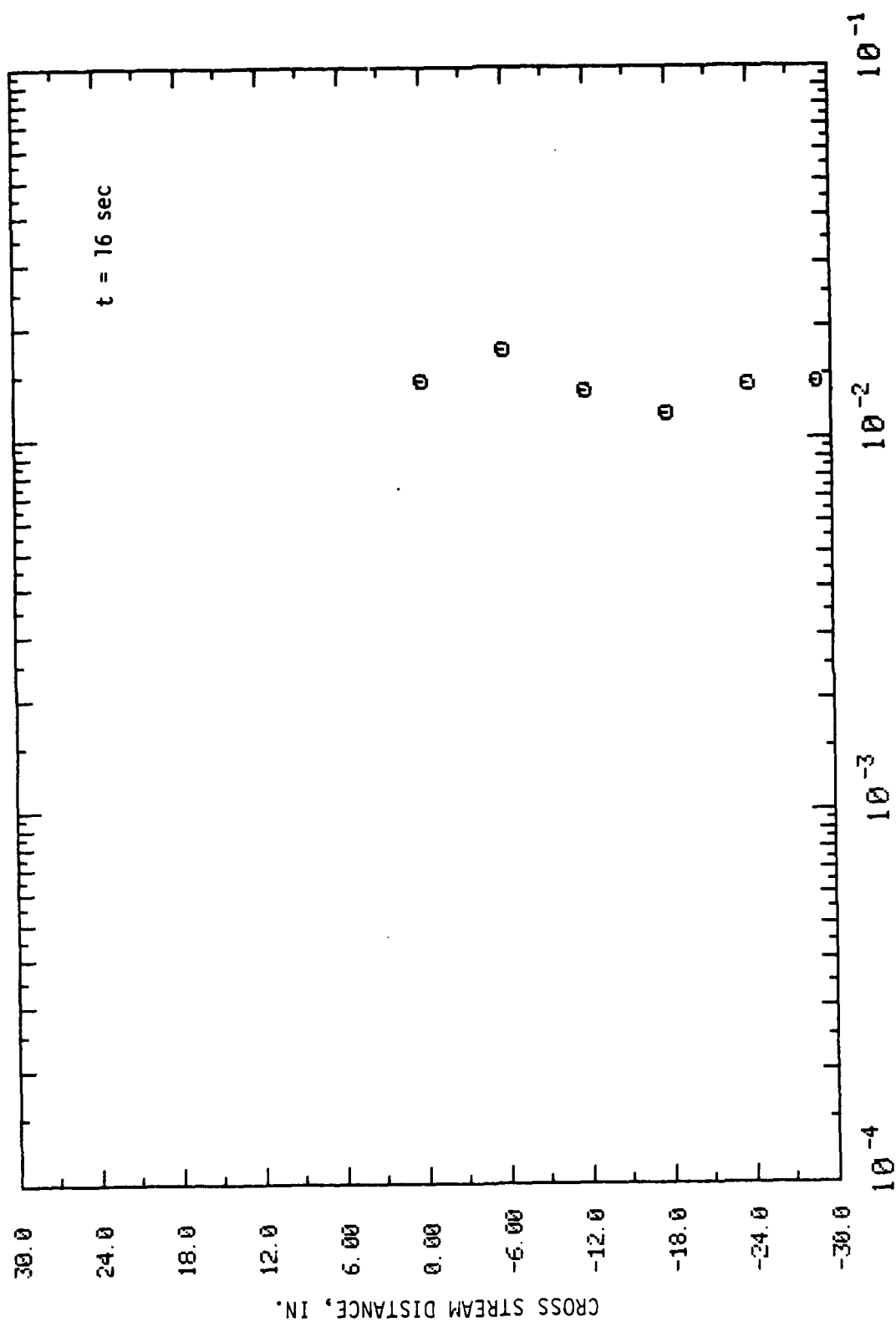
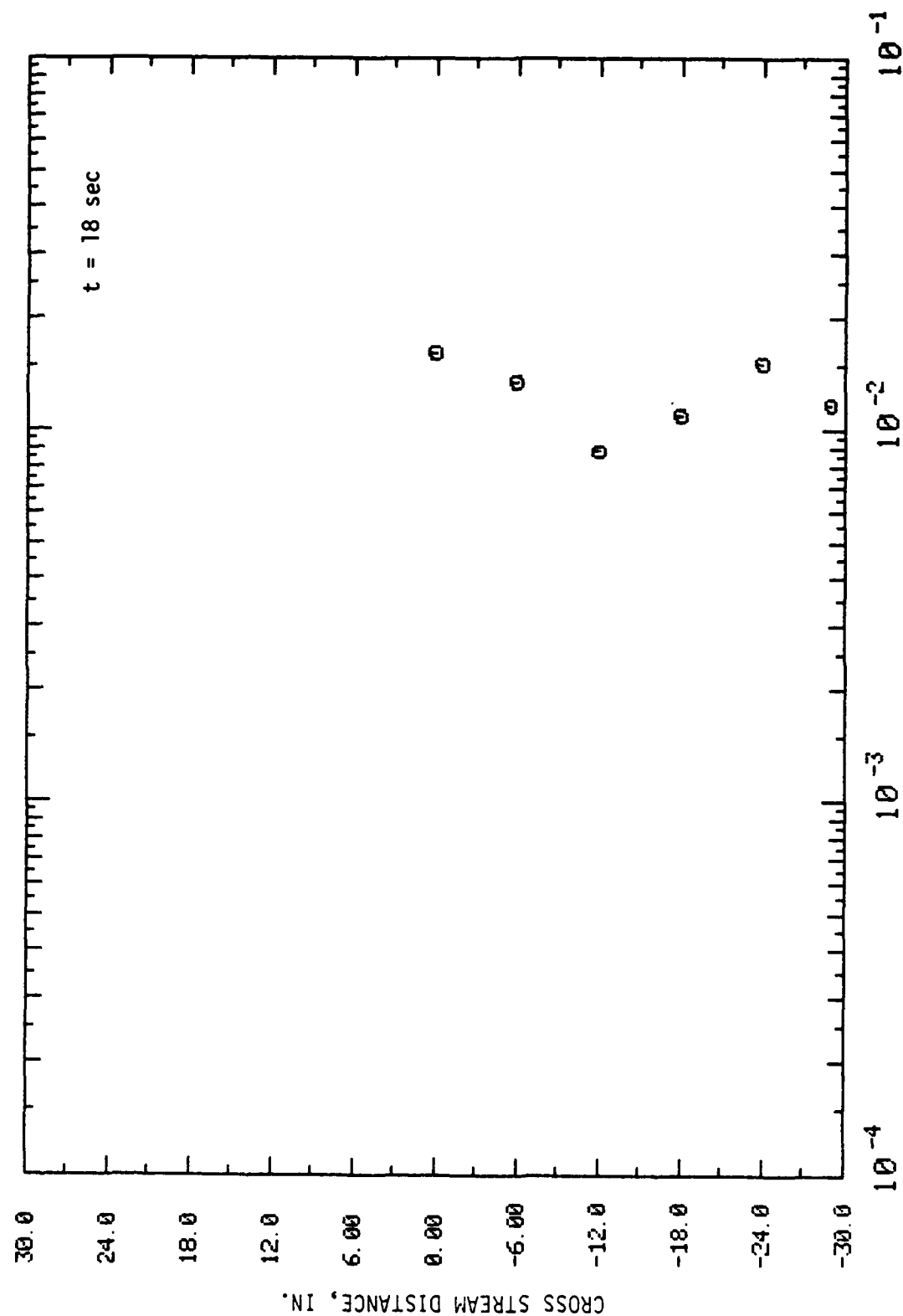


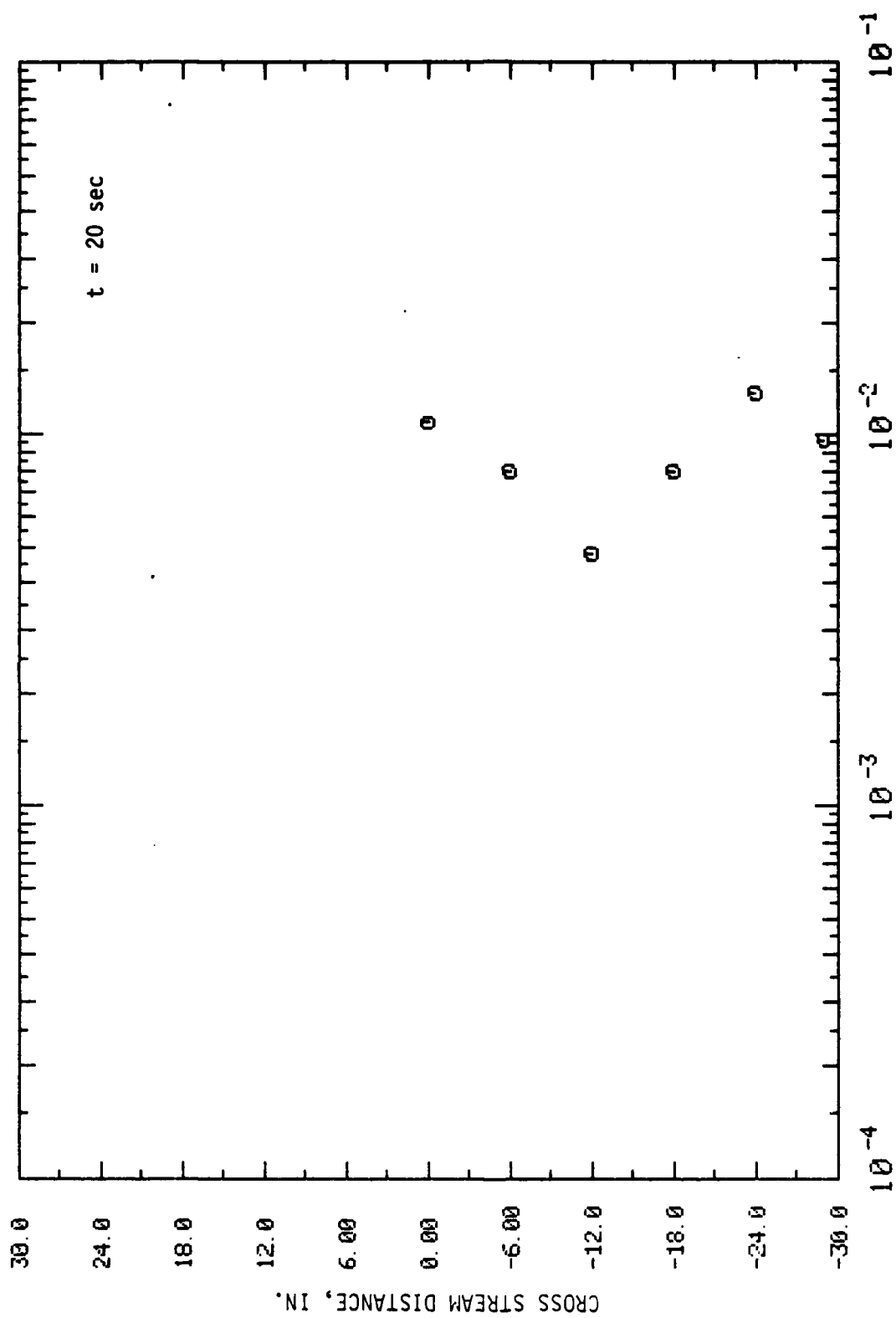
FIGURE B-10. RUN II.1-2 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IH.}, Z = 0.25 \text{ IN.}$

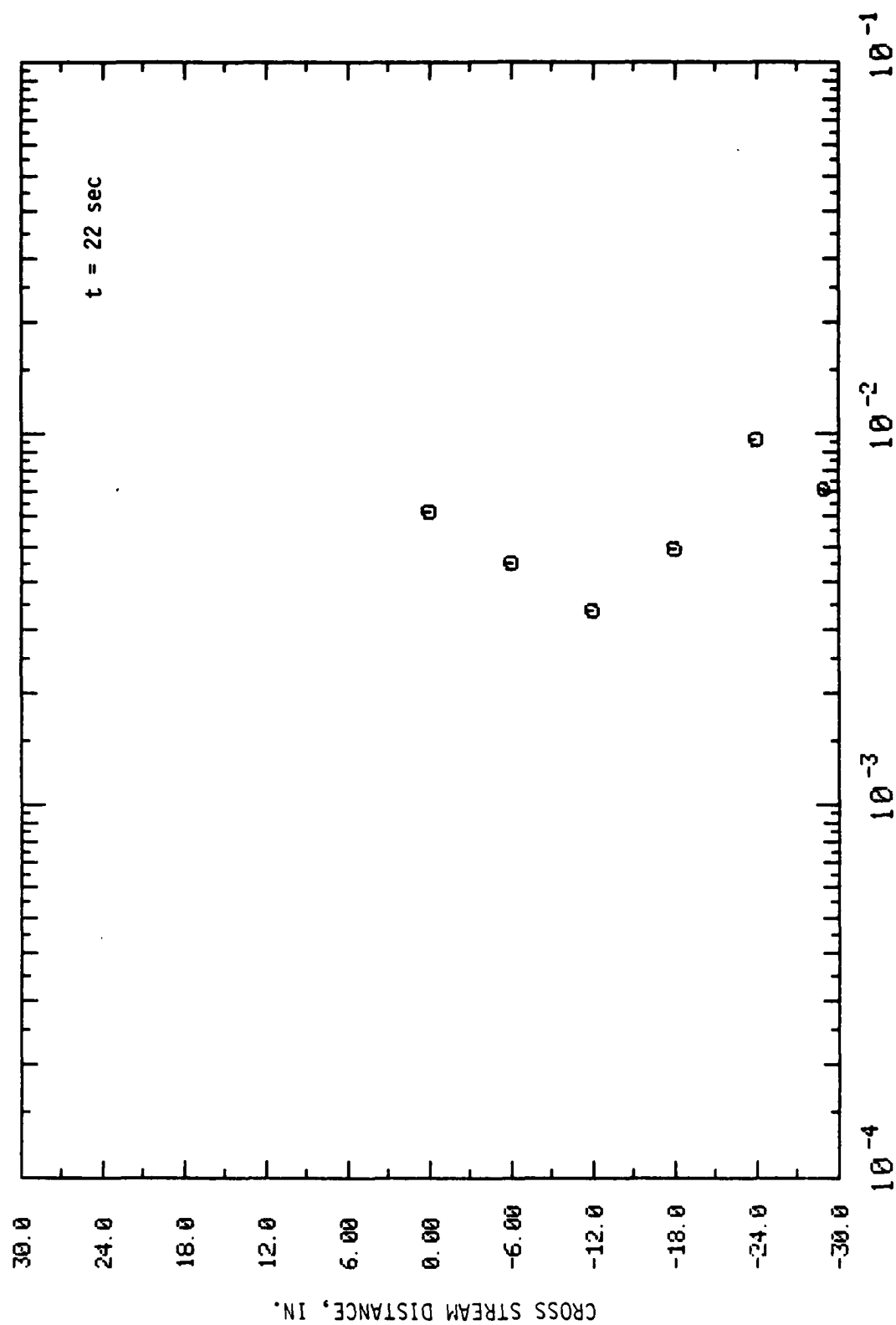
FIGURE B-11. RUN II.1-2 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

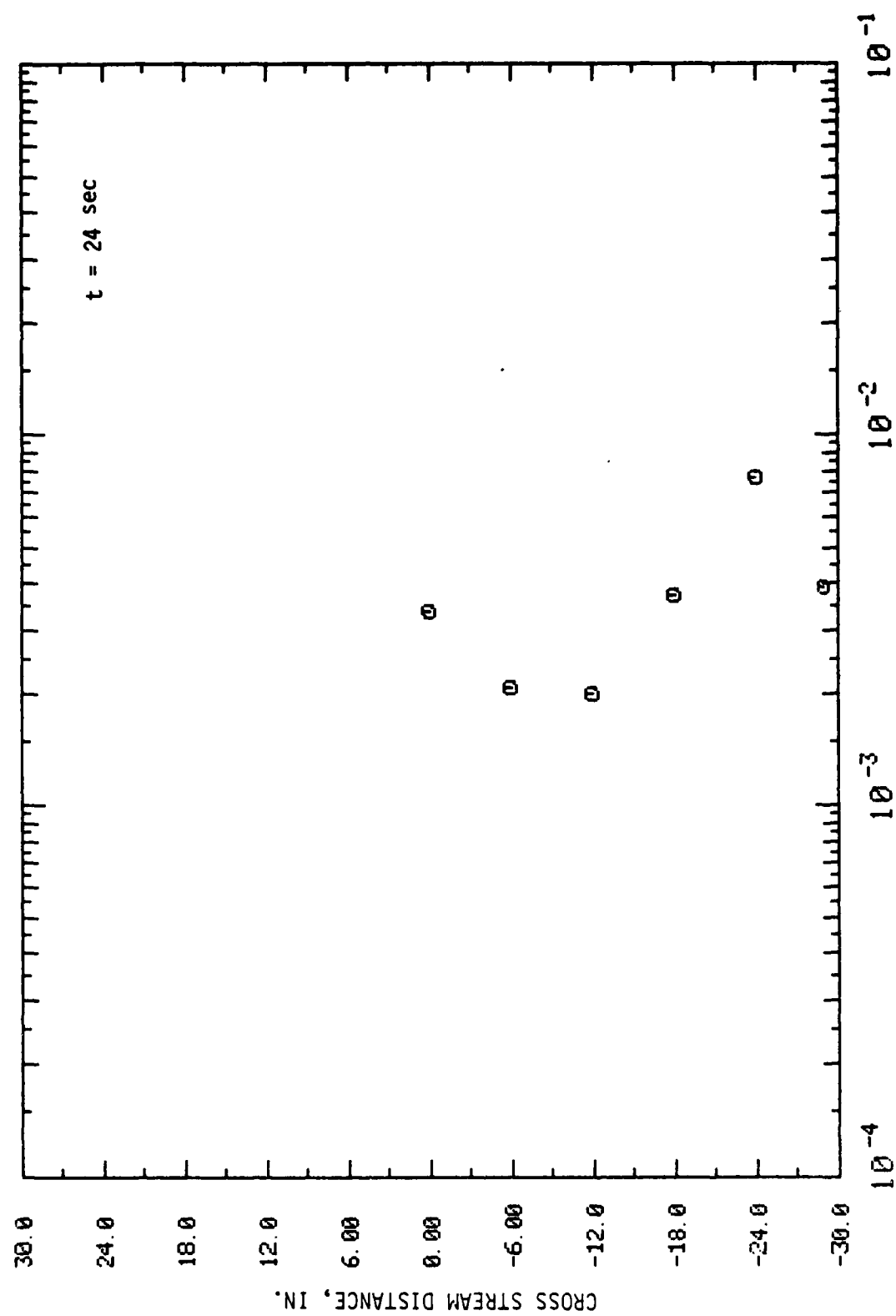
FIGURE B-12. RUN II.1.1-2 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

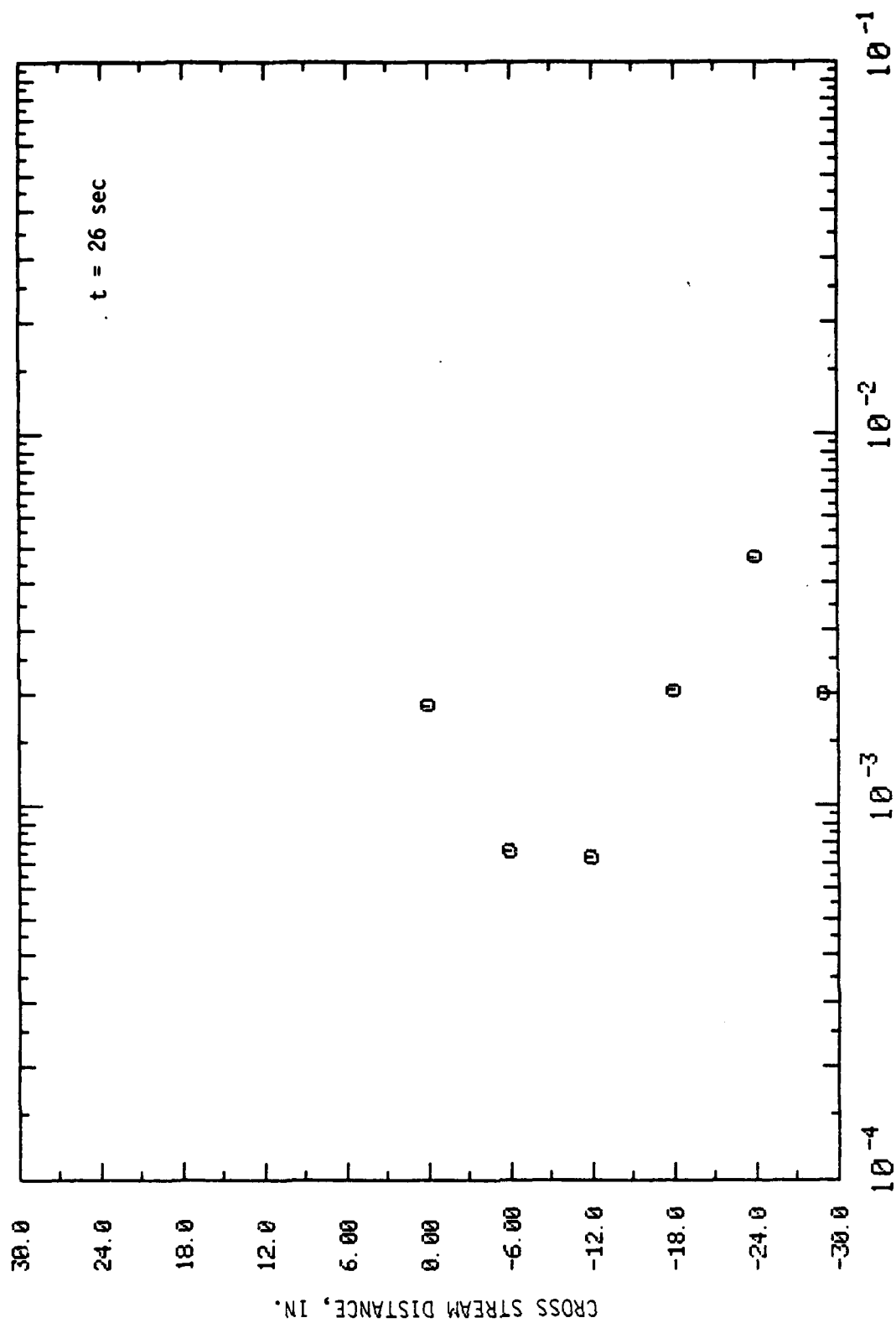
FIGURE B-13. RUN II.1-2 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

FIGURE B-14. RUN 11.1-2 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 0.25 \text{ IN.}$

FIGURE B-15. RUN II.1-2 CROSS STREAM CONCENTRATION PROFILE

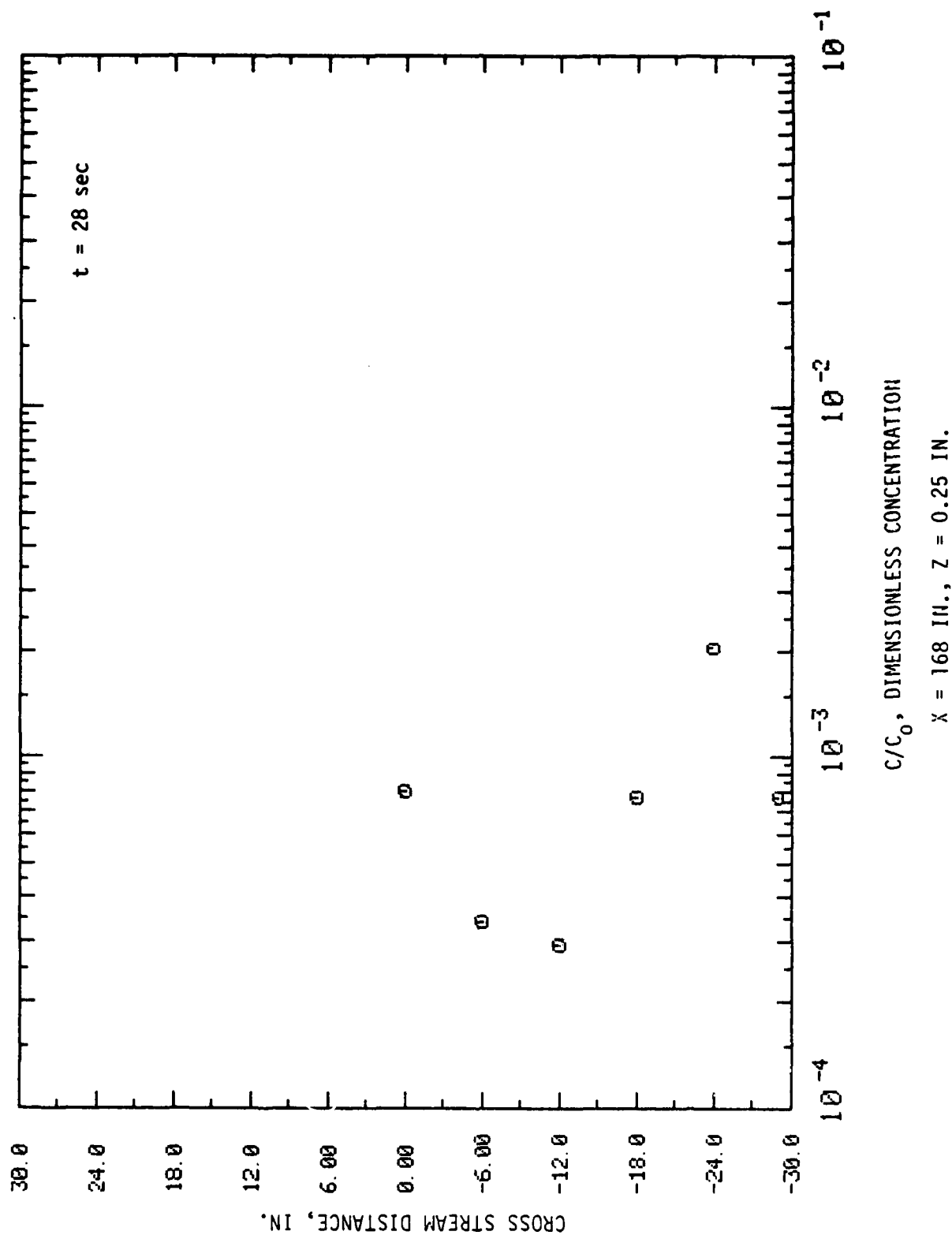
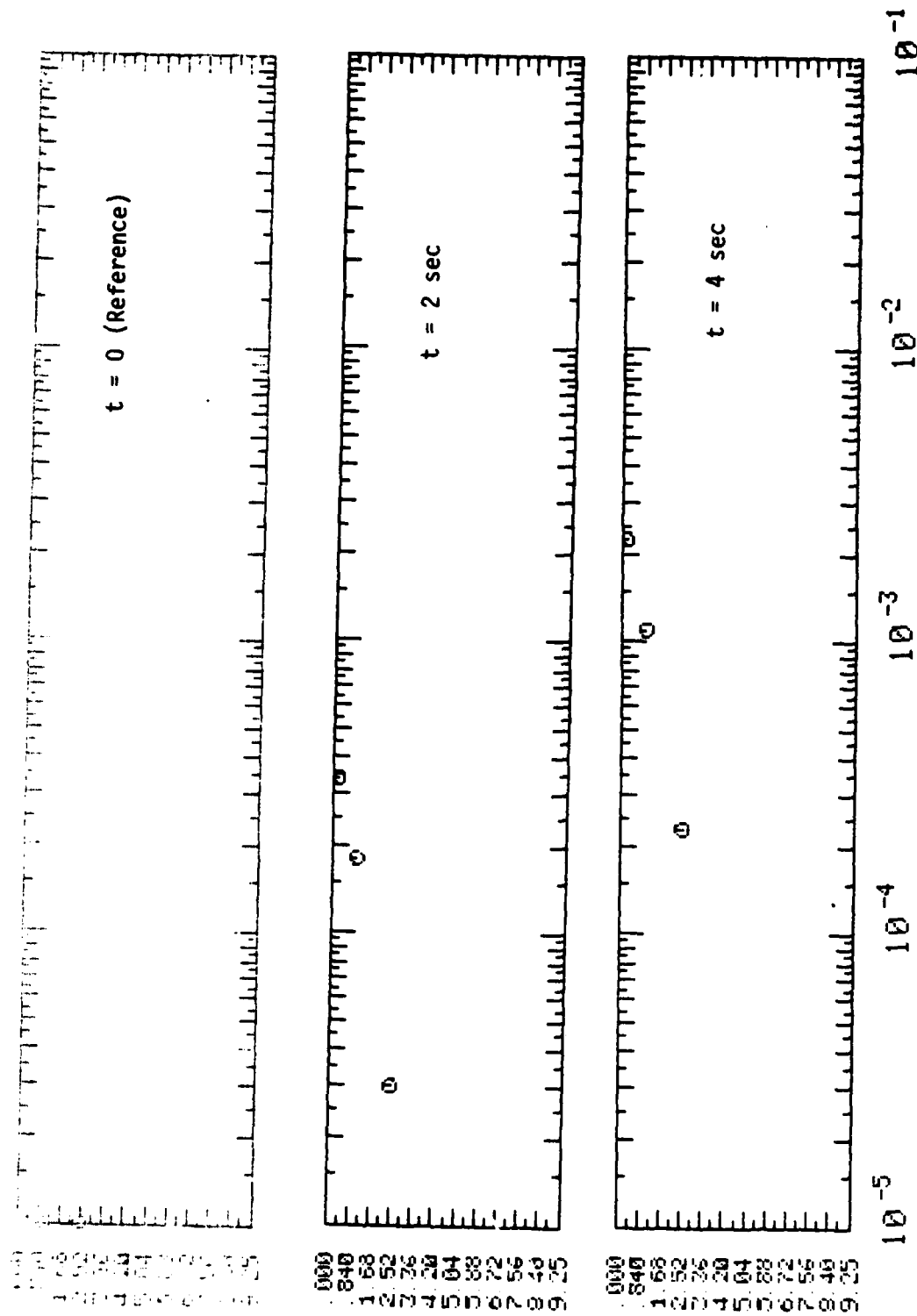


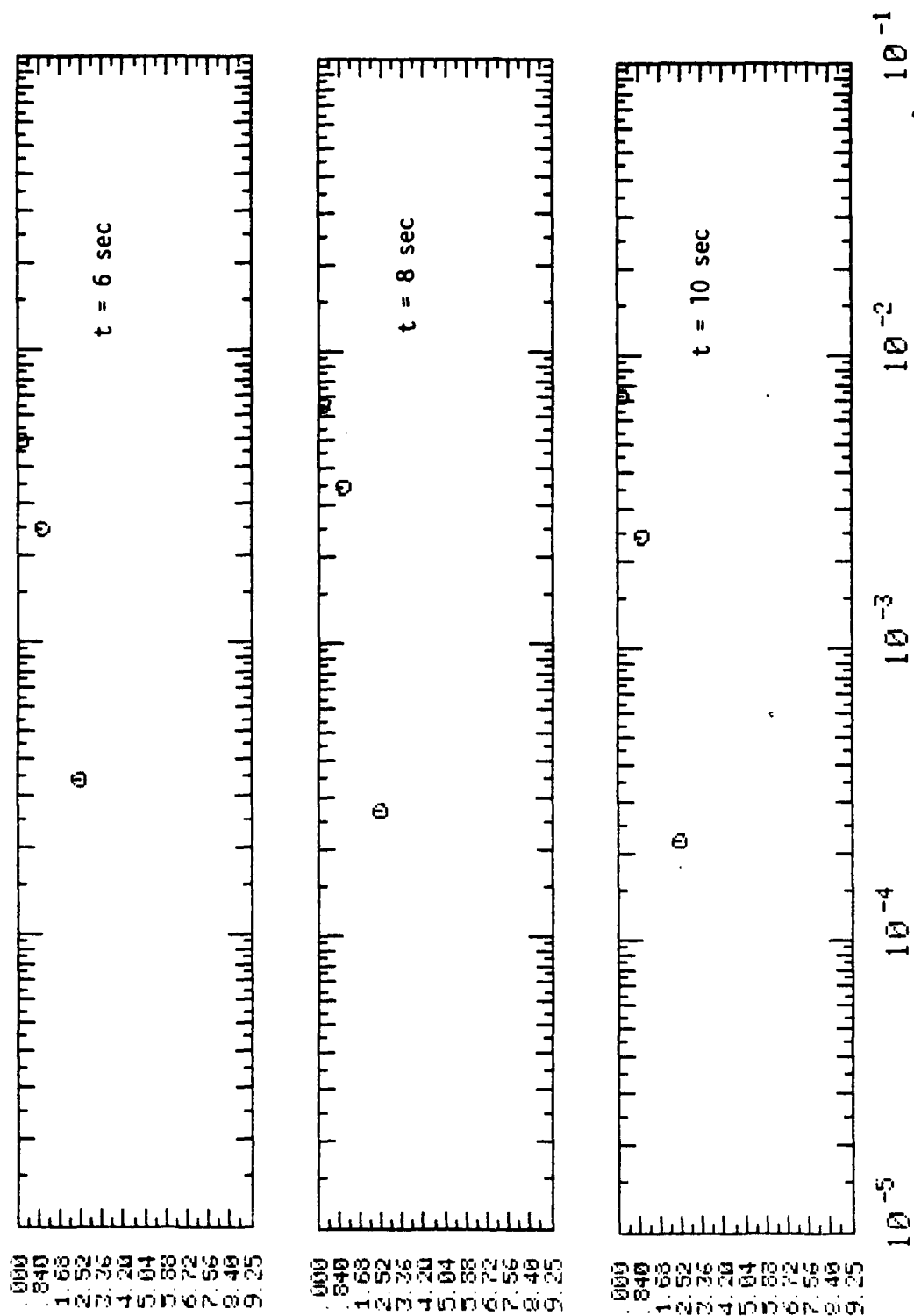
FIGURE B-16. RUN II.1-2 CROSS STREAM CONCENTRATION PROFILE

DISTANCE FROM FREE SURFACE, IN.

C/C₀, DIMENSIONLESS CONCENTRATION

X = 168 IN., Y = 0 IN.

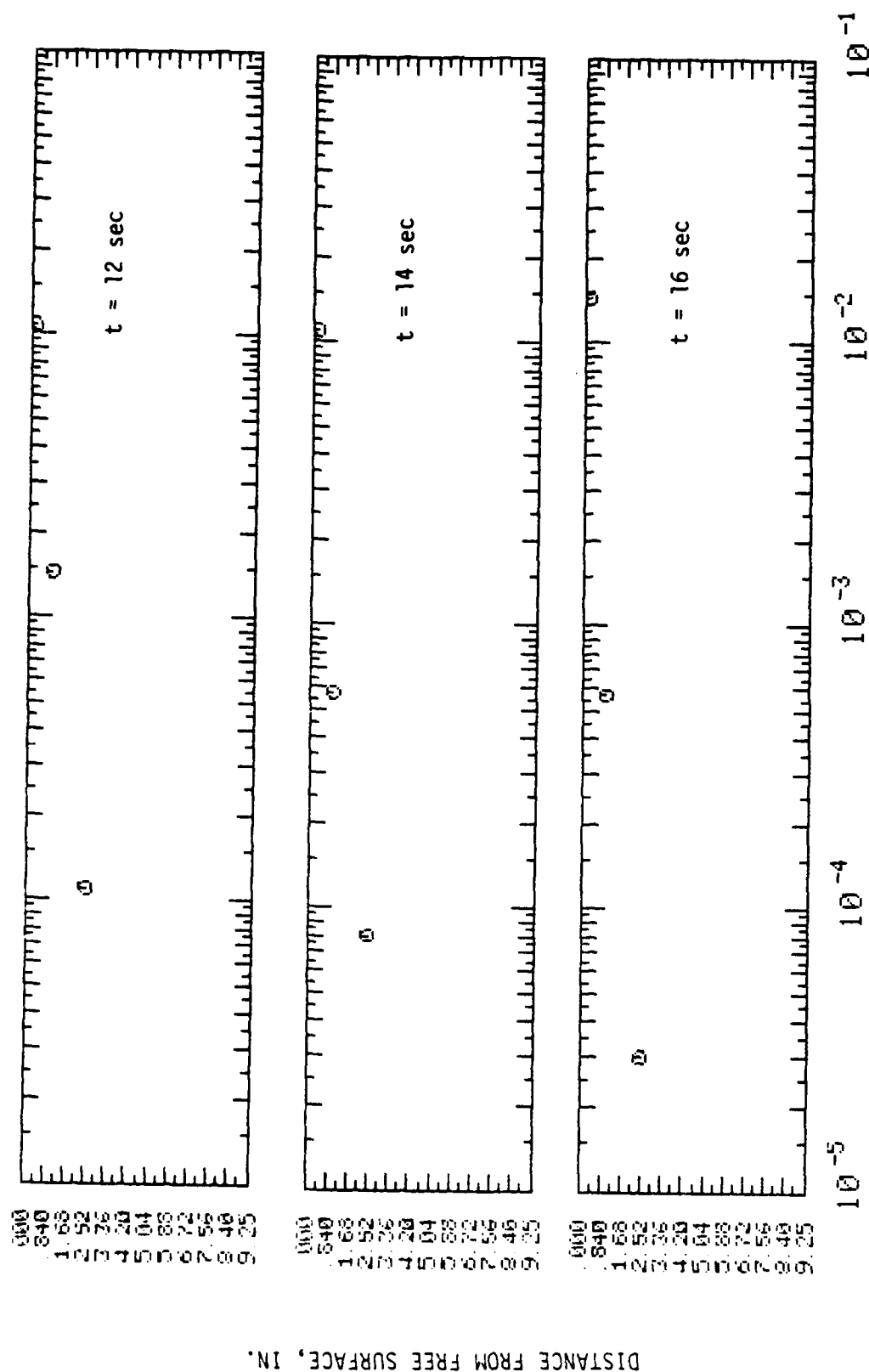
FIGURE B-17. RUN 11.1-2 VERTICAL CONCENTRATION PROFILES



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$ IN.

FIGURE B-18. RUN 11.1-2 VERTICAL CONCENTRATION PROFILES



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$ IN.

FIGURE B-19. RUN II.1-2 VERTICAL CONCENTRATION PROFILES

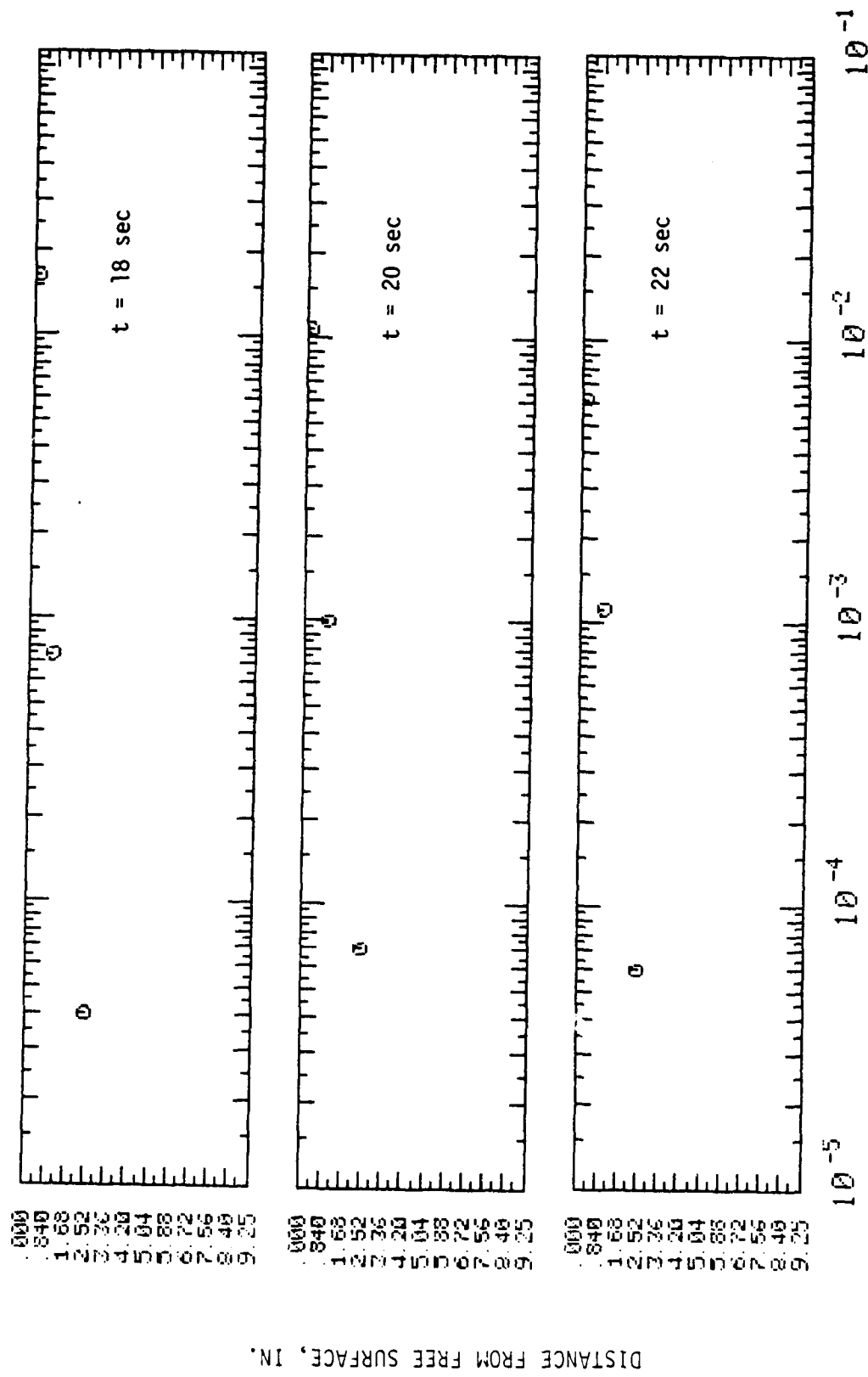
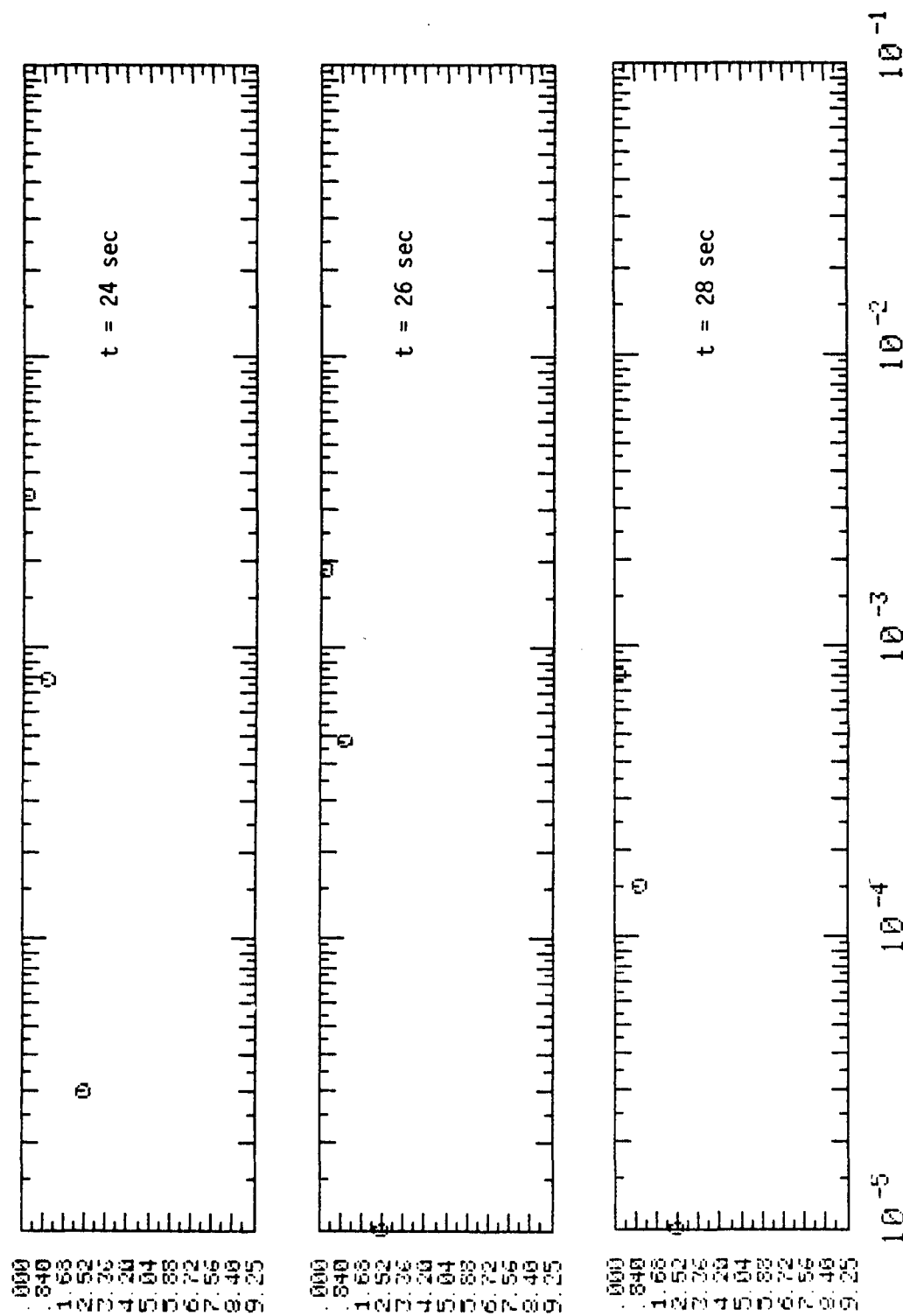


FIGURE B-20. RUN II.1-2 VERTICAL CONCENTRATION PROFILES

DISTANCE FROM FREE SURFACE, IN.

B-21



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$ IN.

FIGURE B-21. RUN II.1-2 VERTICAL CONCENTRATION PROFILES

APPENDIX C
CONCENTRATION PROFILES FOR
RUN II.1-7A

$$\rho_c/\rho = 1.05 \text{ (Sucrose)}$$

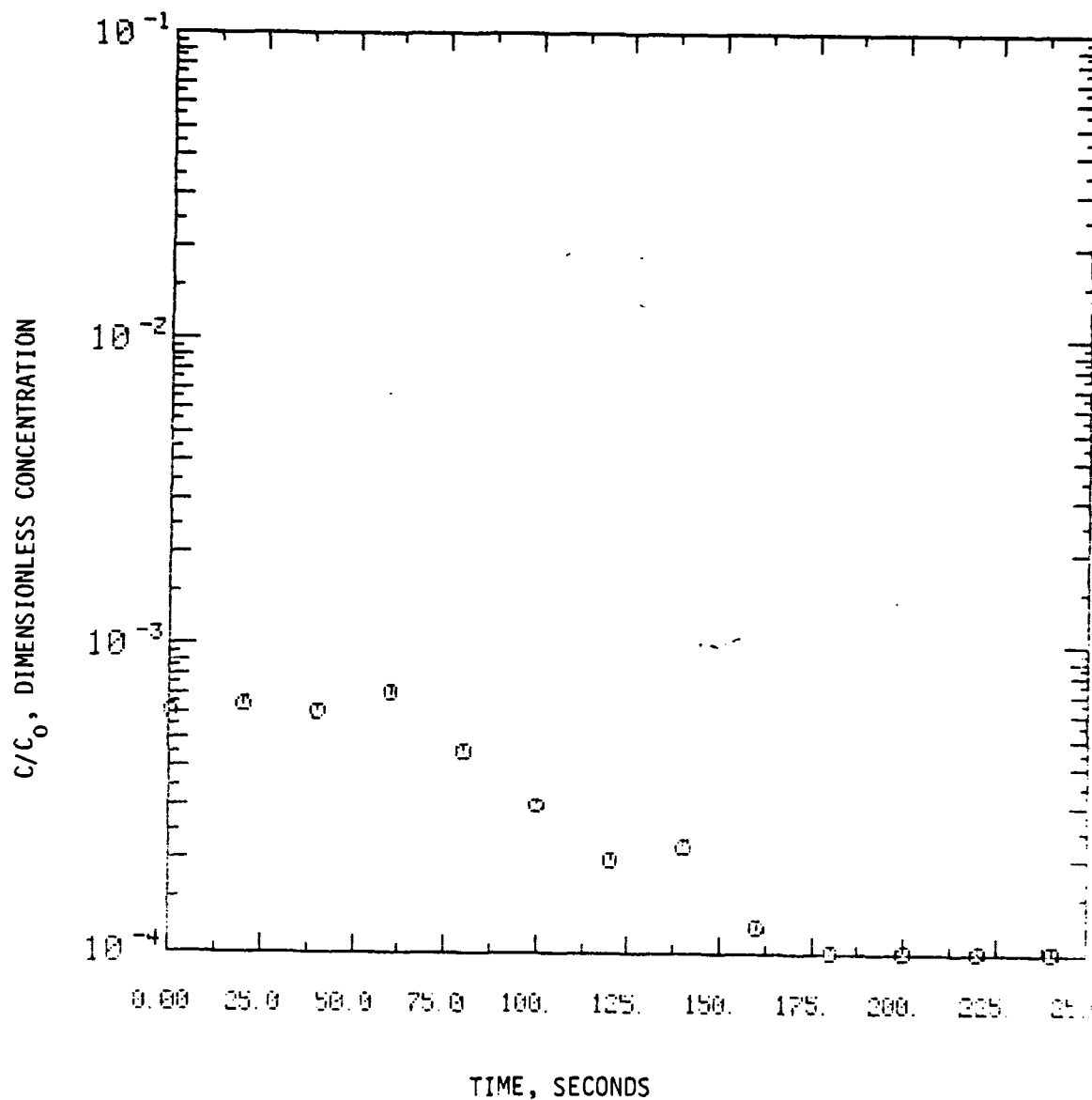
$$r_i/d = 0.125$$

$$u_\tau/U = 0.05$$

$$U(\text{cm/sec}) = 3.5$$

Time elapsed from spill to $t=0$ (Reference) for:

time history graph (horizontal)	145 sec.
cross stream profile	145 sec.
time history graph (vertical)	103 sec.
vertical profile	103 sec.



X = 168 IN., Y = 0, Z = 9.25 IN.

FIGURE C-1. RUN II.1-7A (HORIZONTAL) CONCENTRATION TIME HISTORY

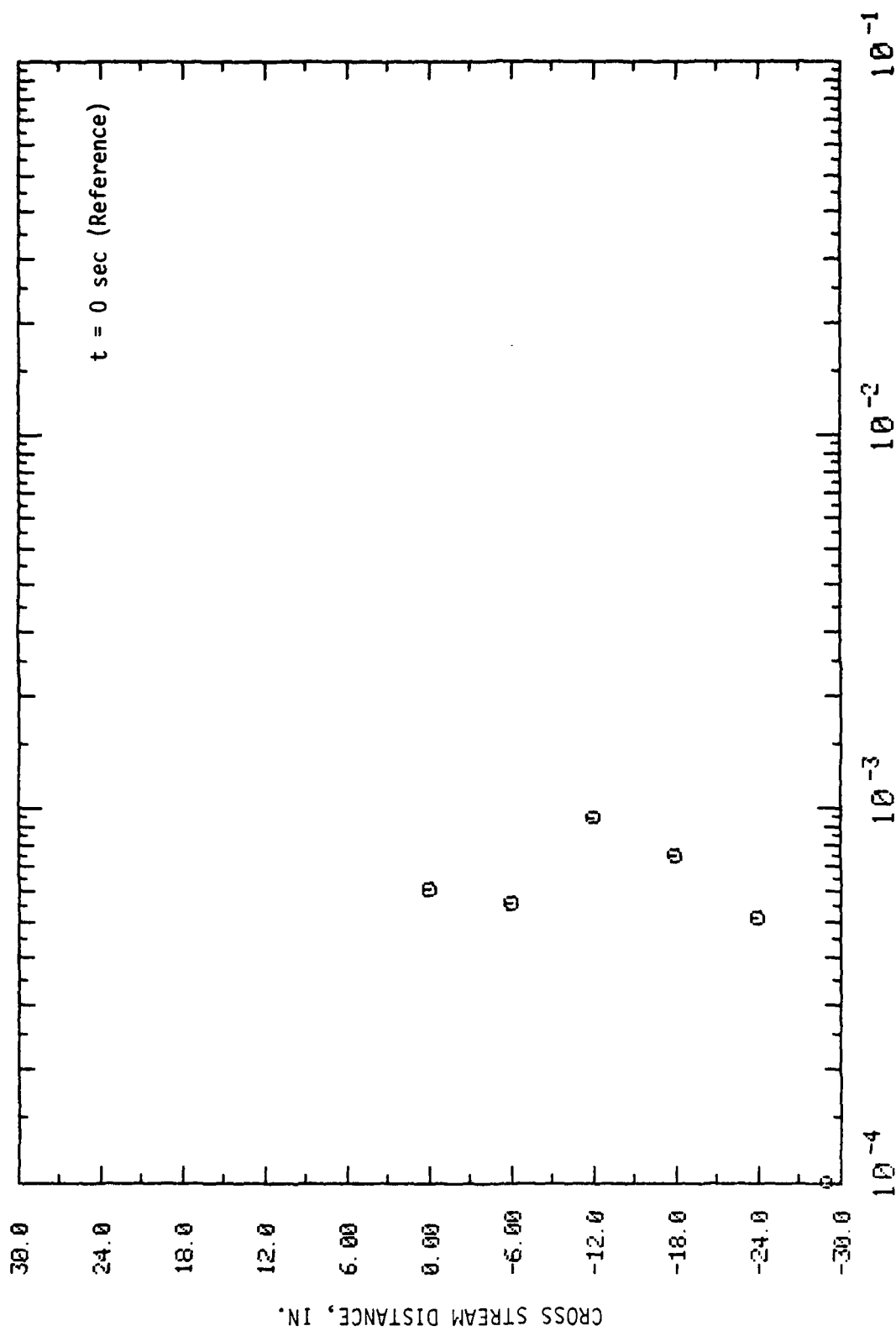


FIGURE C-2. RUN II.1-7A CROSS STREAM CONCENTRATION PROFILE

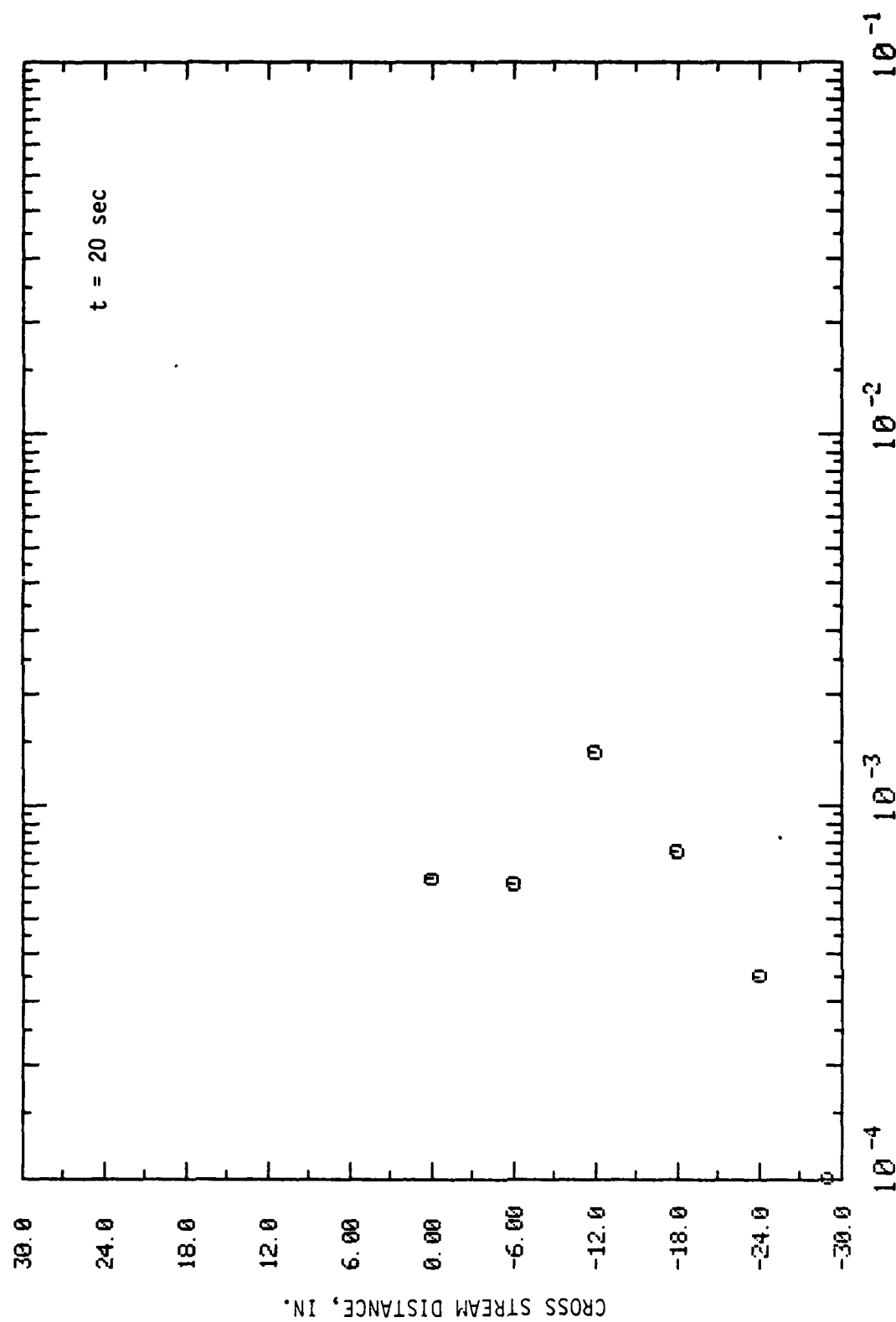


FIGURE C-3. RUN II.1-7A CROSS STREAM CONCENTRATION PROFILE

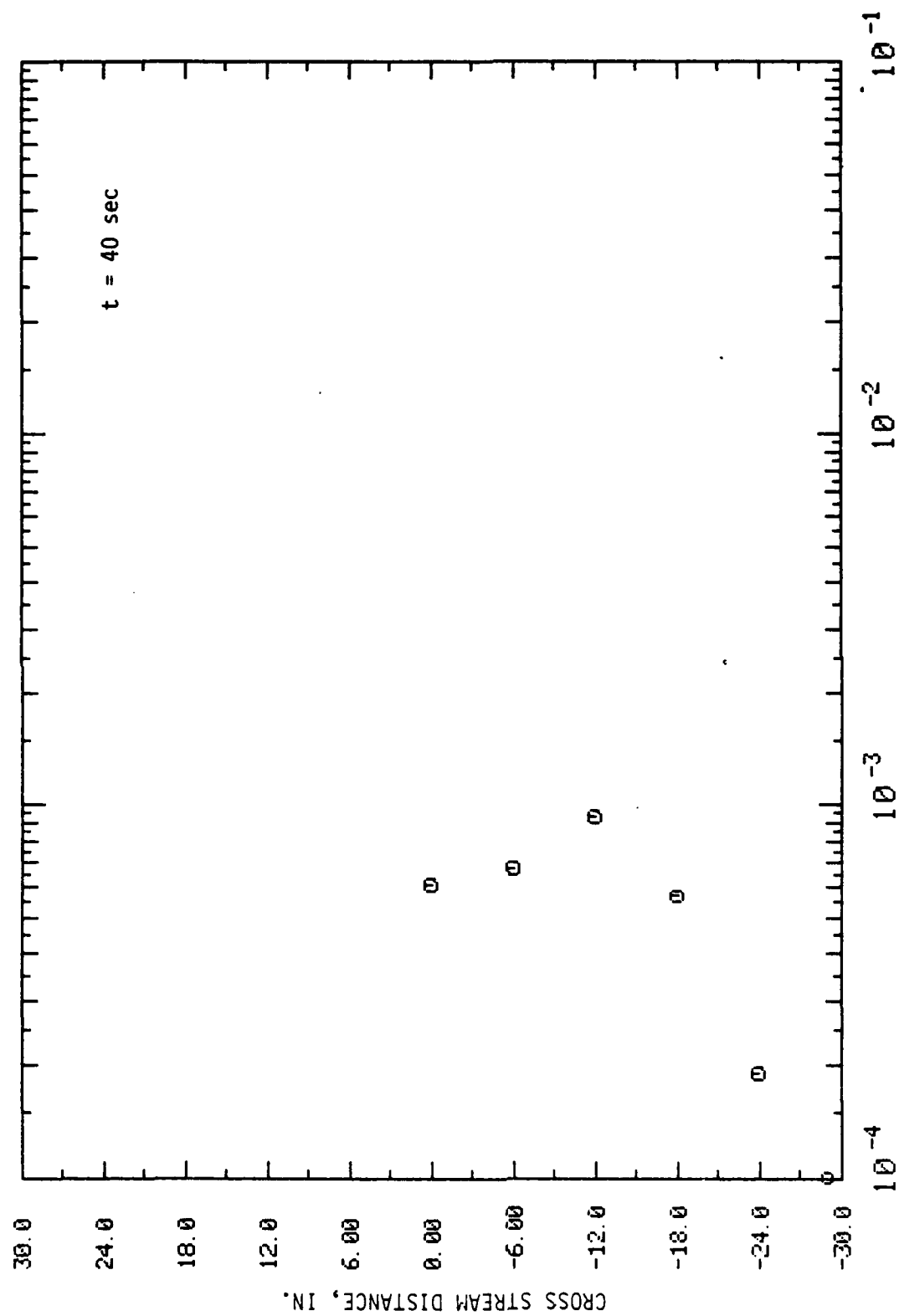


FIGURE C-4. RUN II.1-7A CROSS STREAM CONCENTRATION PROFILE

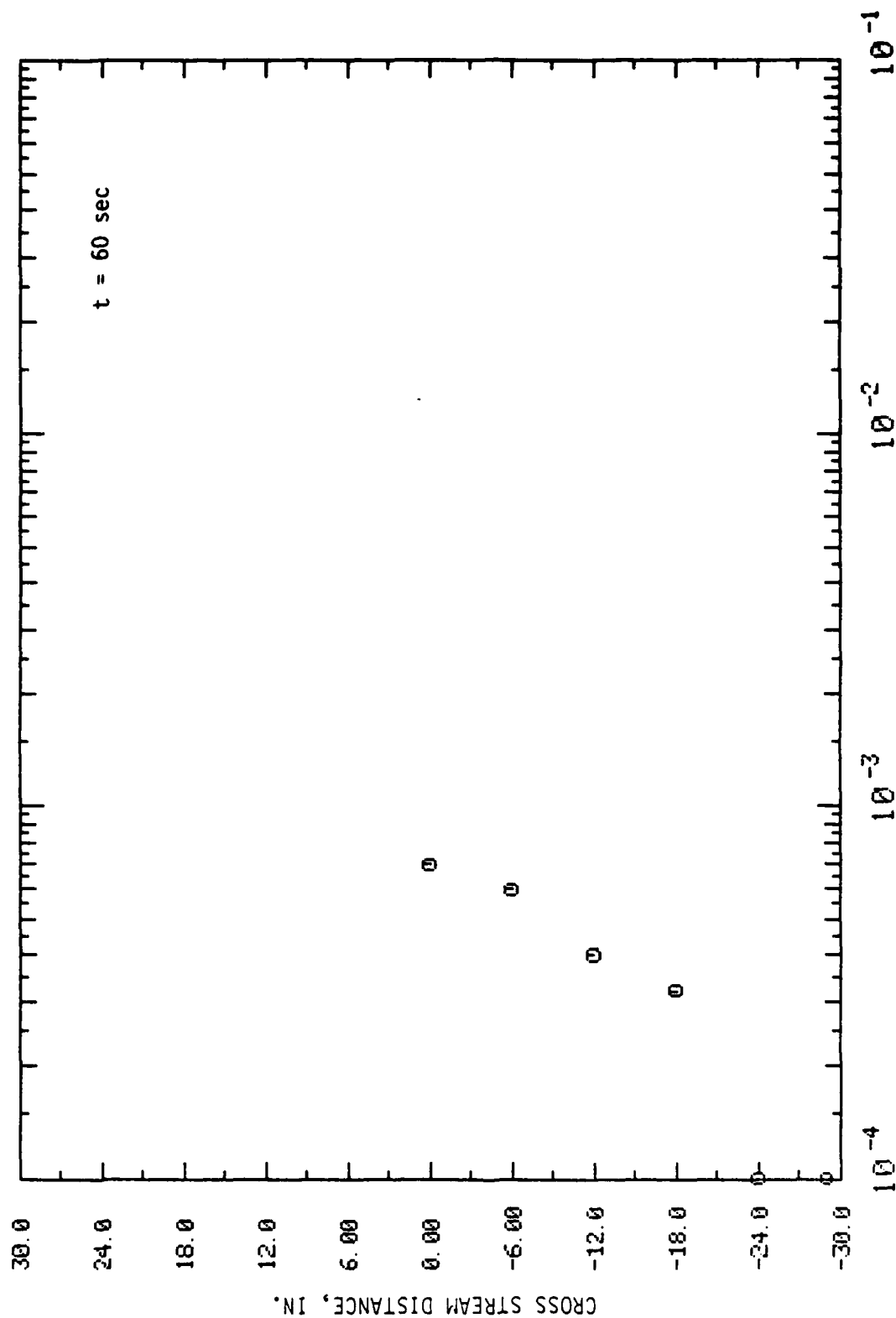


FIGURE C-5. RUN II.1-7A CROSS STREAM CONCENTRATION PROFILE

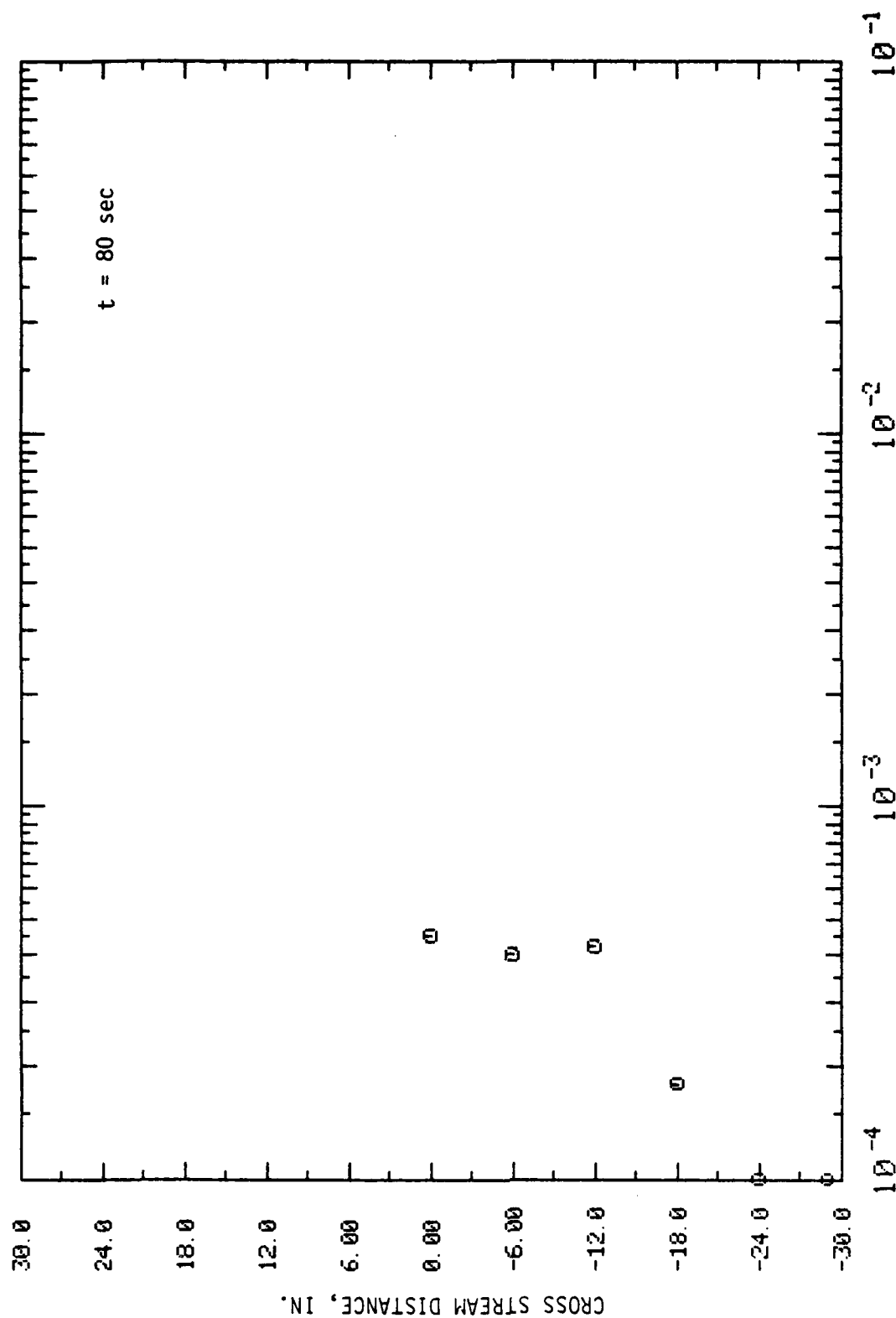


FIGURE C-6. RUN 11.1-7A CROSS STREAM CONCENTRATION PROFILE

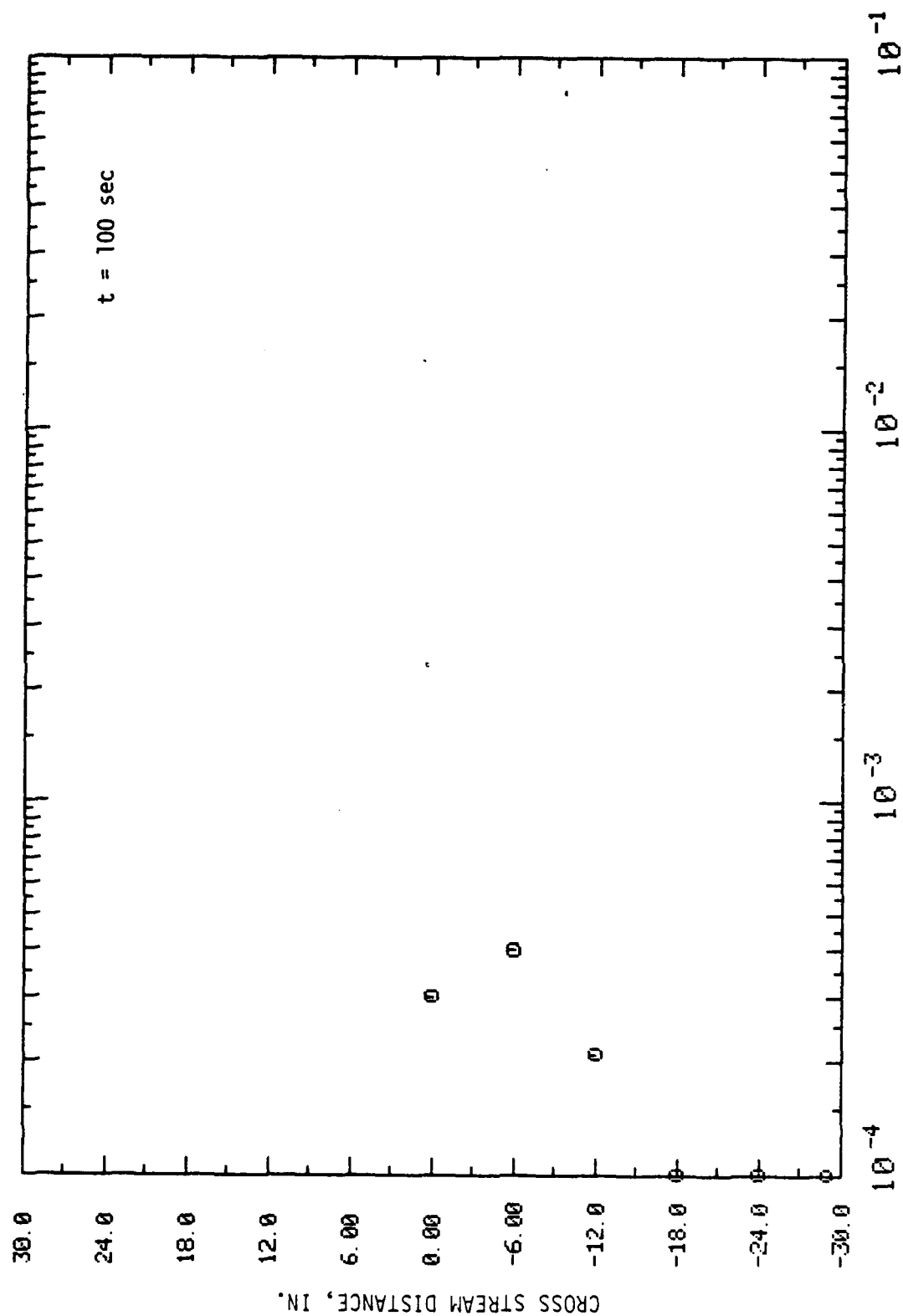
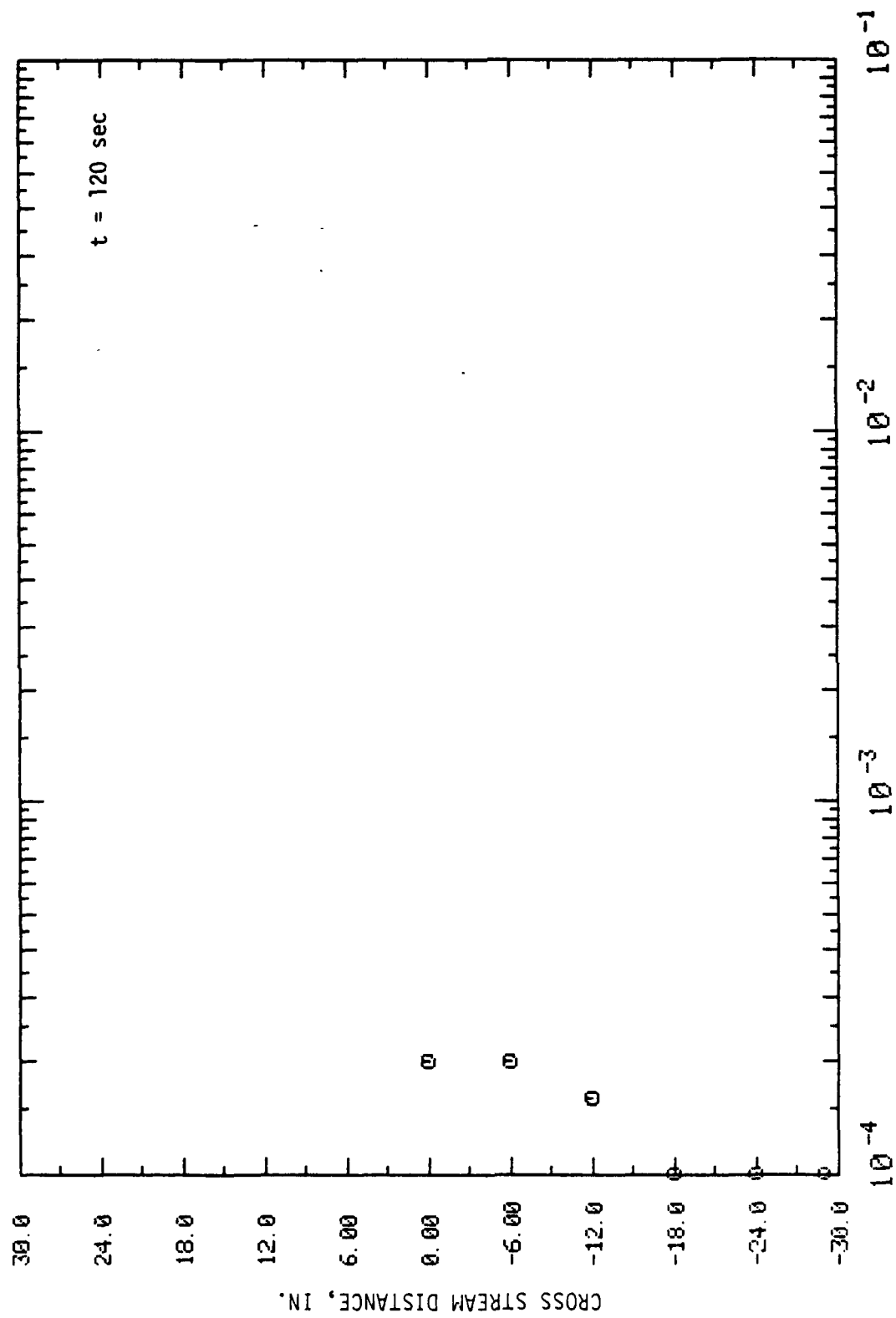


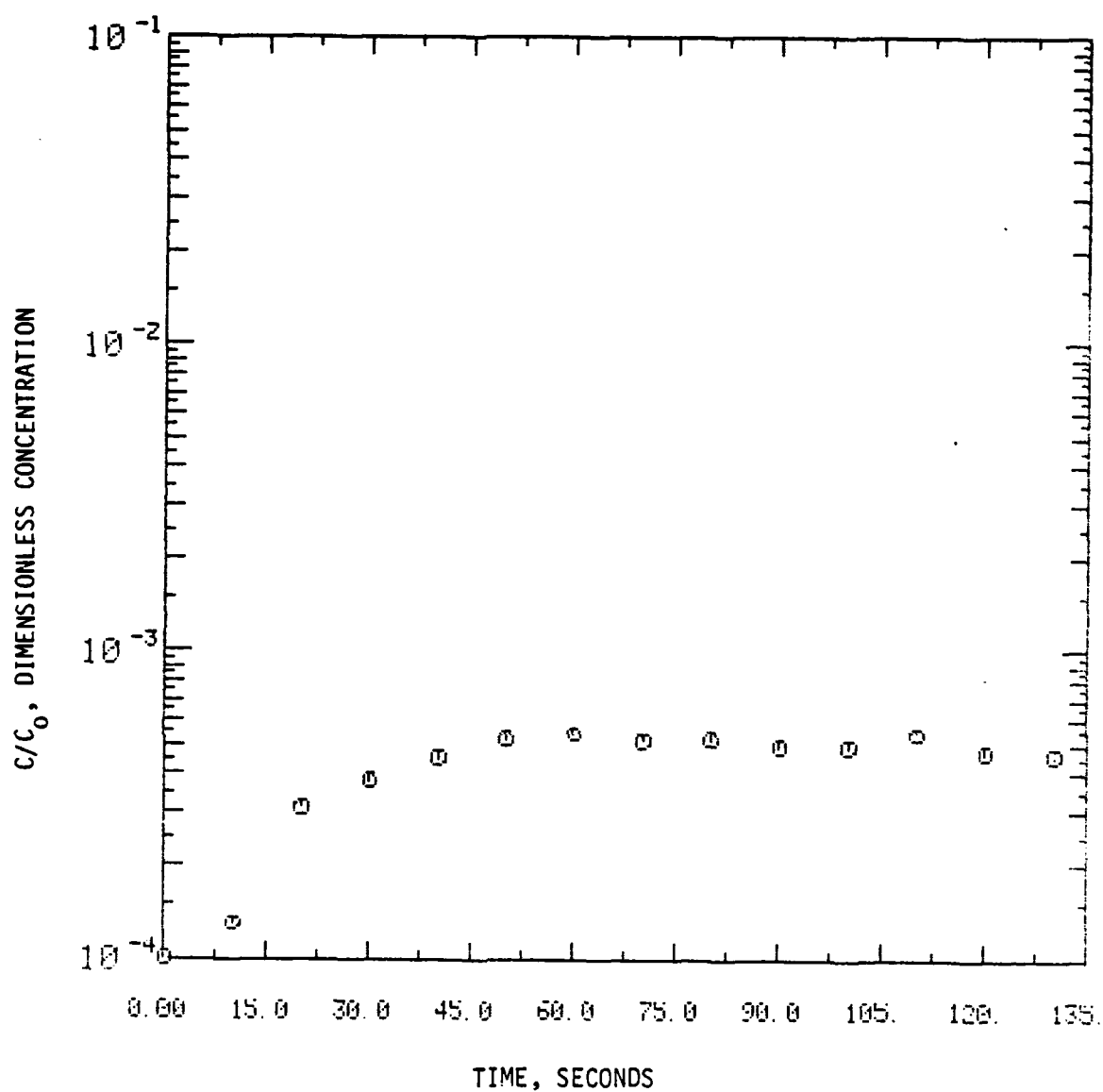
FIGURE C-7. RUN II.1-7A CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE C-8. RUN II.1-7A CROSS STREAM CONCENTRATION PROFILE



X = 168 IN., Y = 0, Z = 9.25 IN.

FIGURE C-9. RUN II.1-7A (VERTICAL) CONCENTRATION TIME HISTORY

DISTANCE FROM FREE SURFACE, IN.

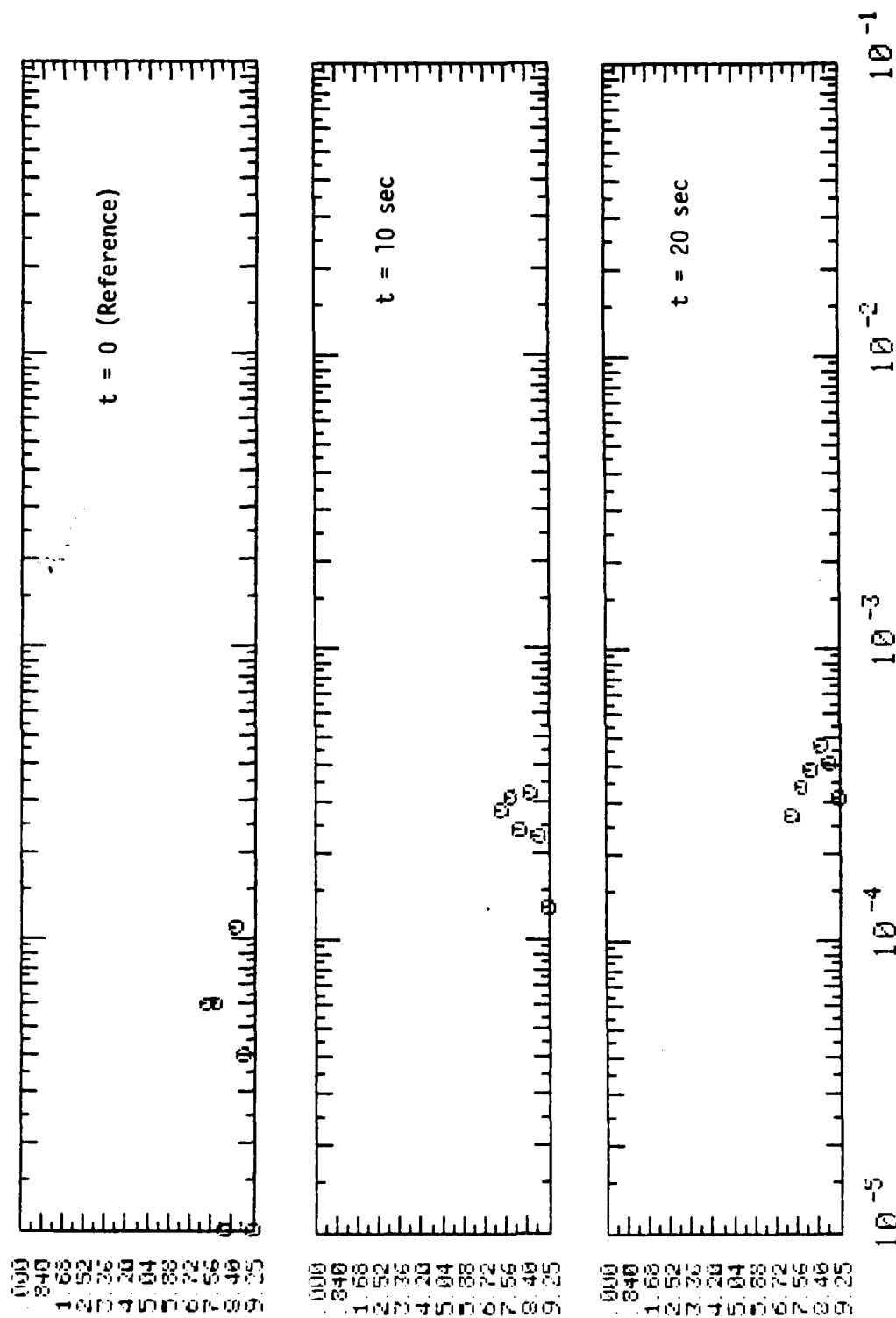
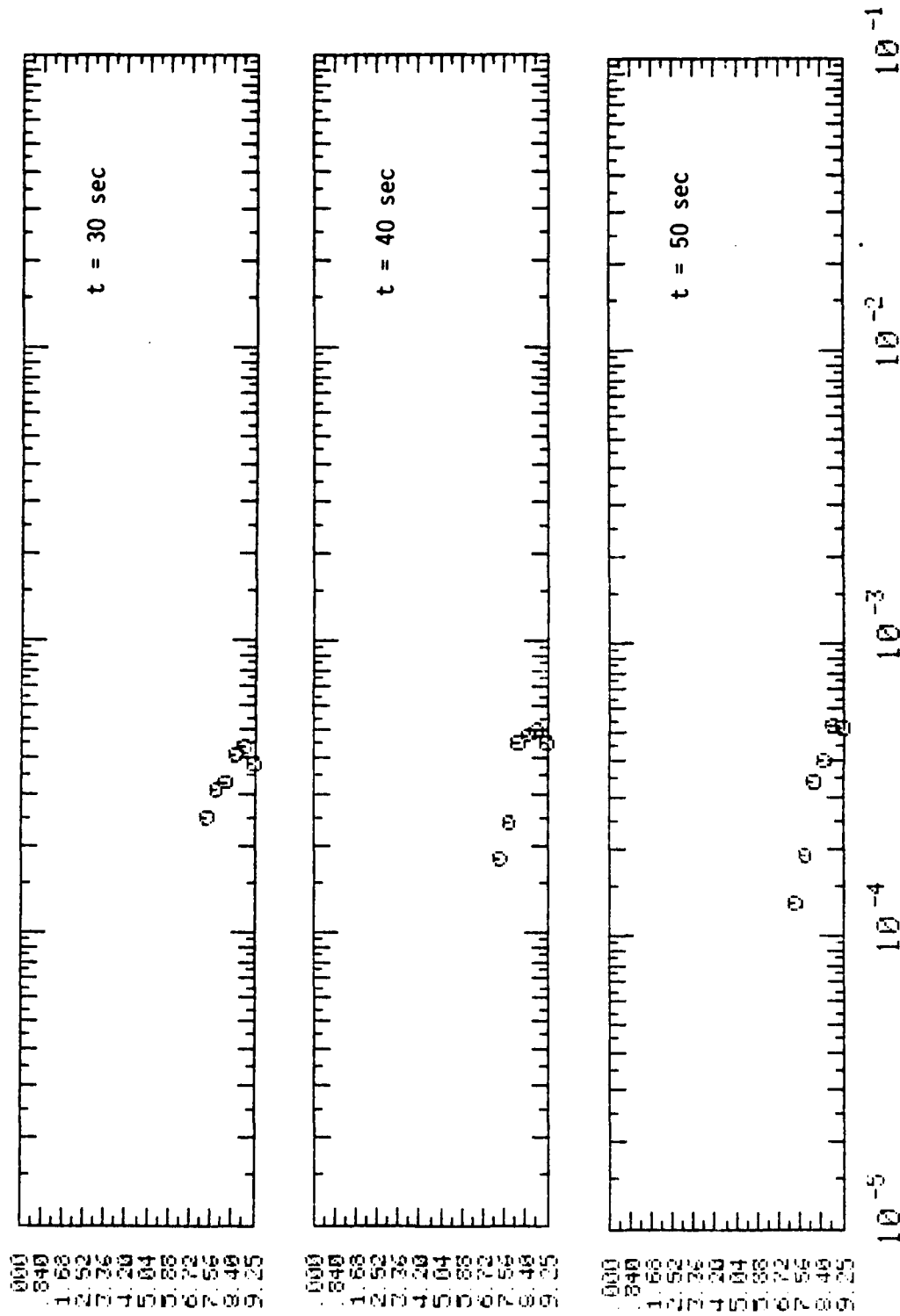
 C/C_0 , DIMENSIONLESS CONCENTRATION $X = 168$ IN., $Y = 0$ IN.

FIGURE C-10. RUN II.1-7A VERTICAL CONCENTRATION PROFILES

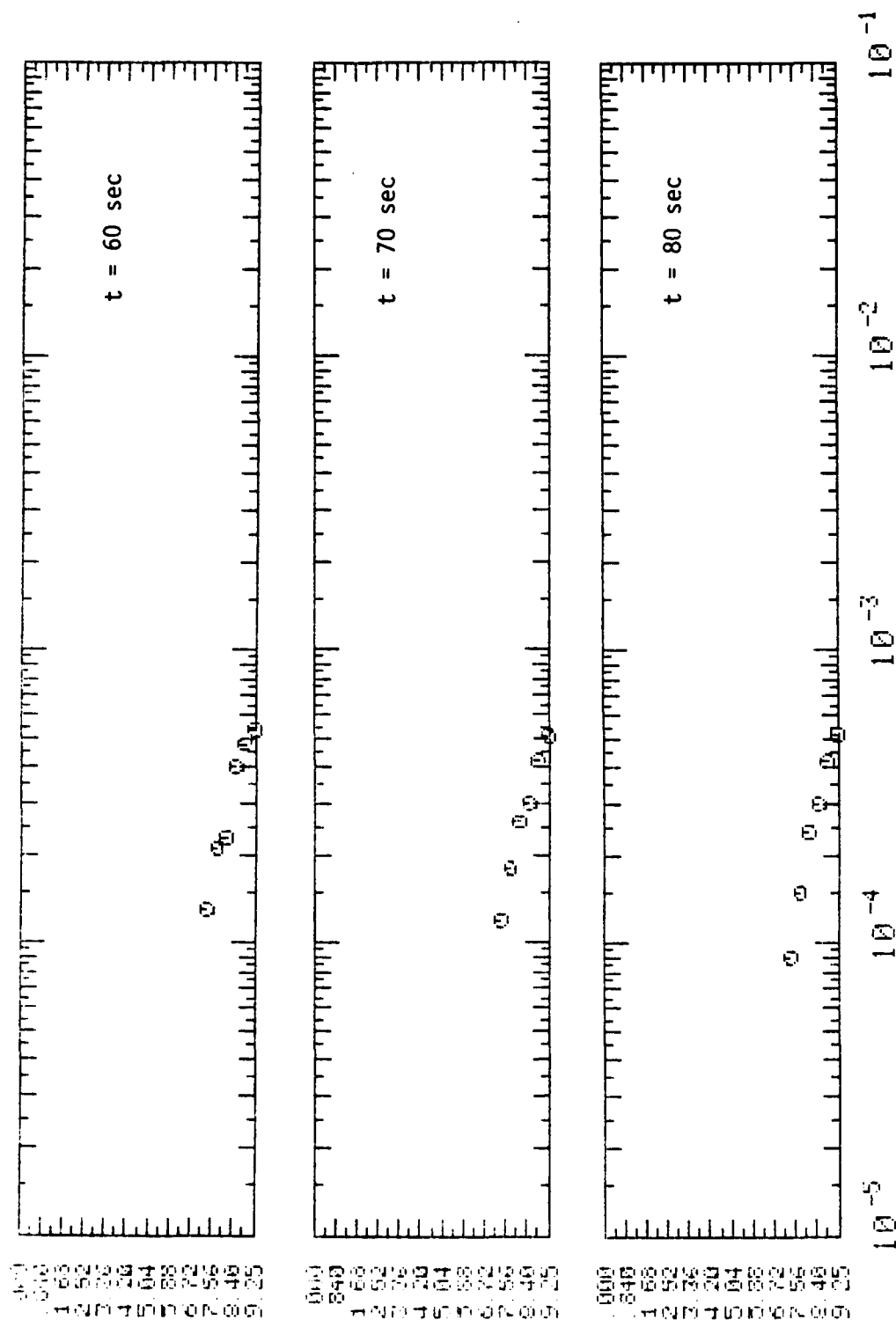
DISTANCE FROM FREE SURFACE, IN.



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$ IN.

FIGURE C-11. RUN II.1-7A VERTICAL CONCENTRATION PROFILES



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$ IN.

FIGURE C-12. RUN II.1-7A VERTICAL CONCENTRATION PROFILES

DISTANCE FROM FREE SURFACE, IN.

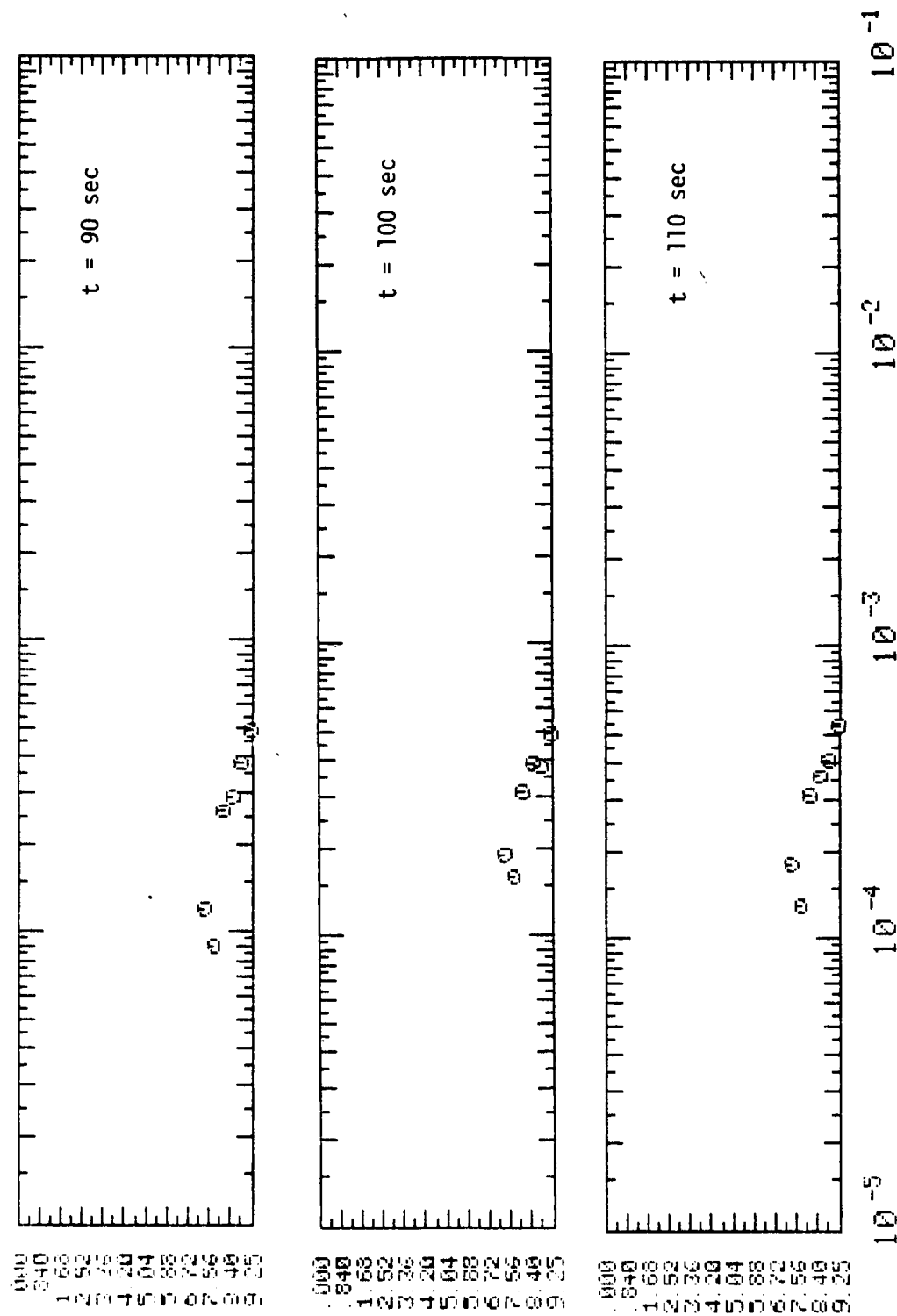
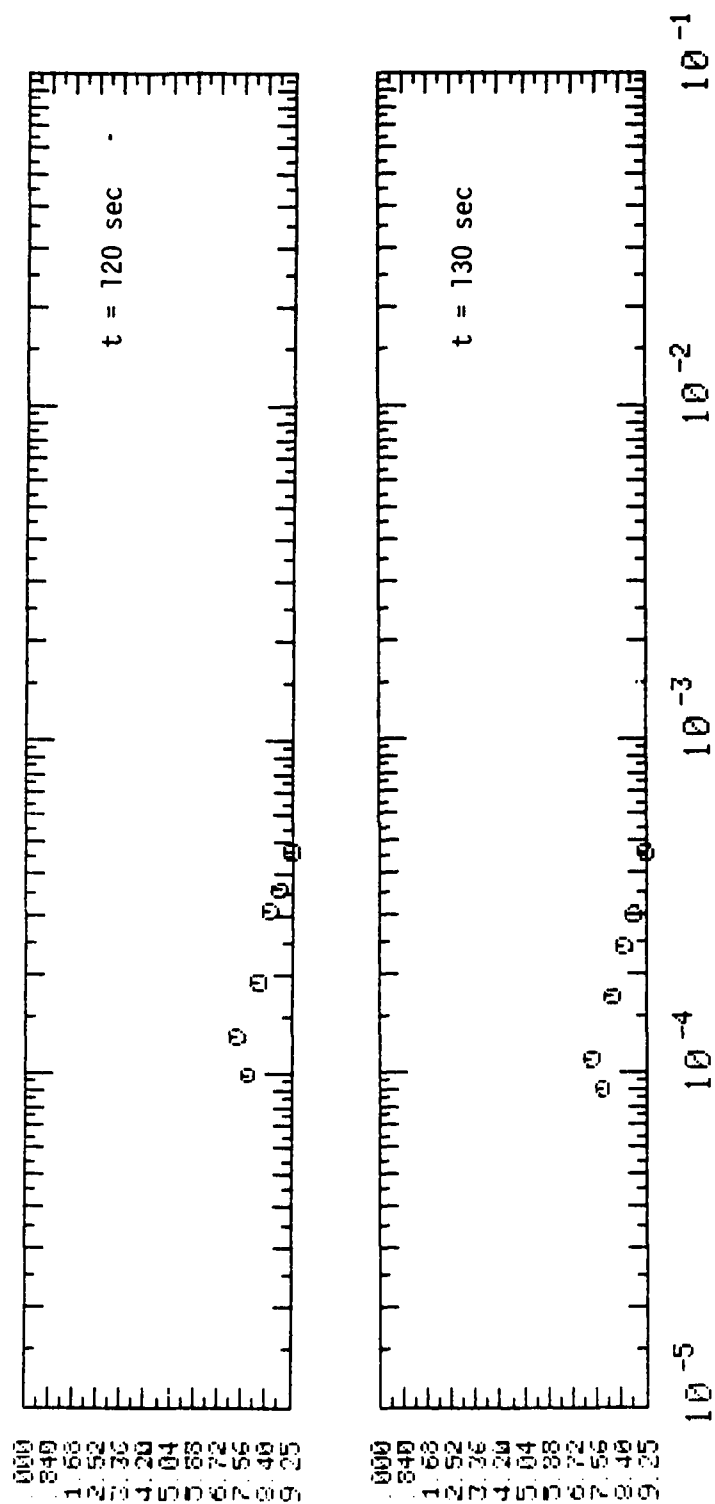
 C/C_0 , DIMENSIONLESS CONCENTRATION $X = 168$ IN., $Y = 0$ IN.

FIGURE C-13. RUN 11.1-7A VERTICAL CONCENTRATION PROFILES



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$ IN.

FIGURE C-14. RUN II.1-7A VERTICAL CONCENTRATION PROFILES

APPENDIX D

CONCENTRATION PROFILES FOR RUN II.1-7B

$$\rho_c/\rho = 1.05 \text{ (Sucrose)}$$

$$r_i/d = 0.125$$

$$u_r/U = 0.05$$

$$U(\text{cm/sec}) = 14.1$$

Time elapsed from spill to t=0 (Reference) for:

time history graph	31 sec.
cross stream profiles	31 sec.
vertical profiles	31 sec.

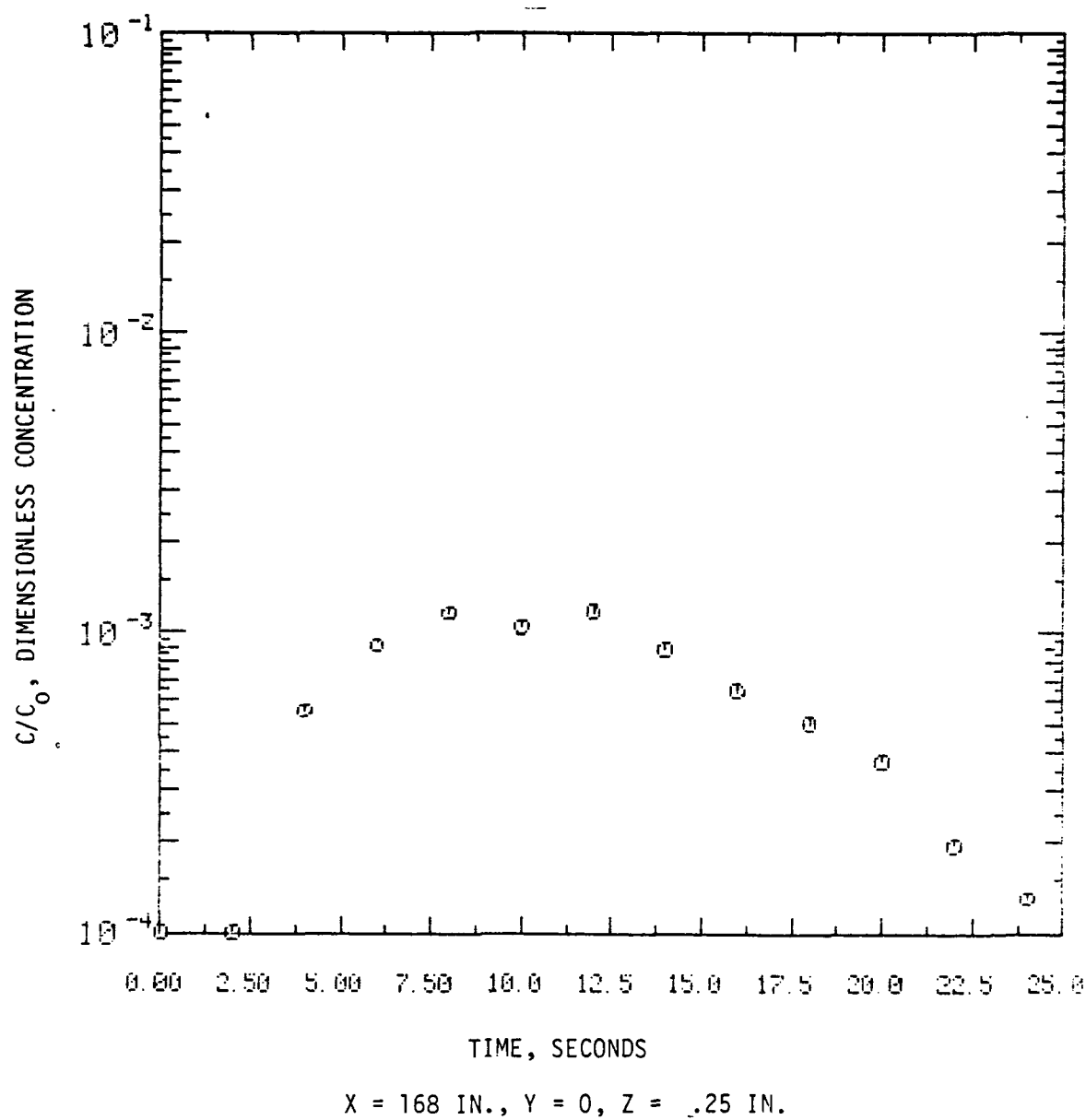


FIGURE D-1. RUN II.1-7B CONCENTRATION TIME HISTORY

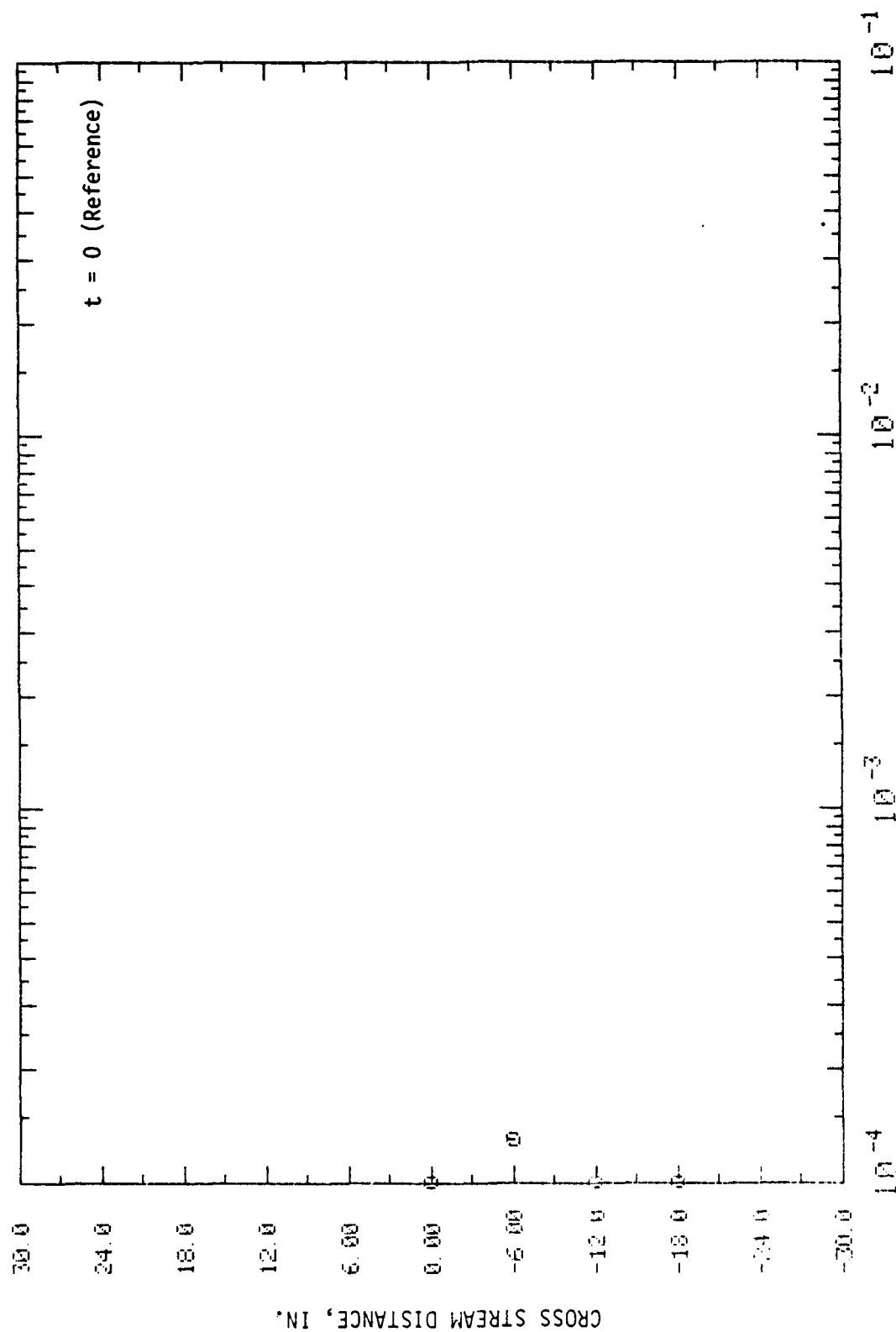


FIGURE D-2. RUN II.1-7B CROSS STREAM CONCENTRATION PROFILE

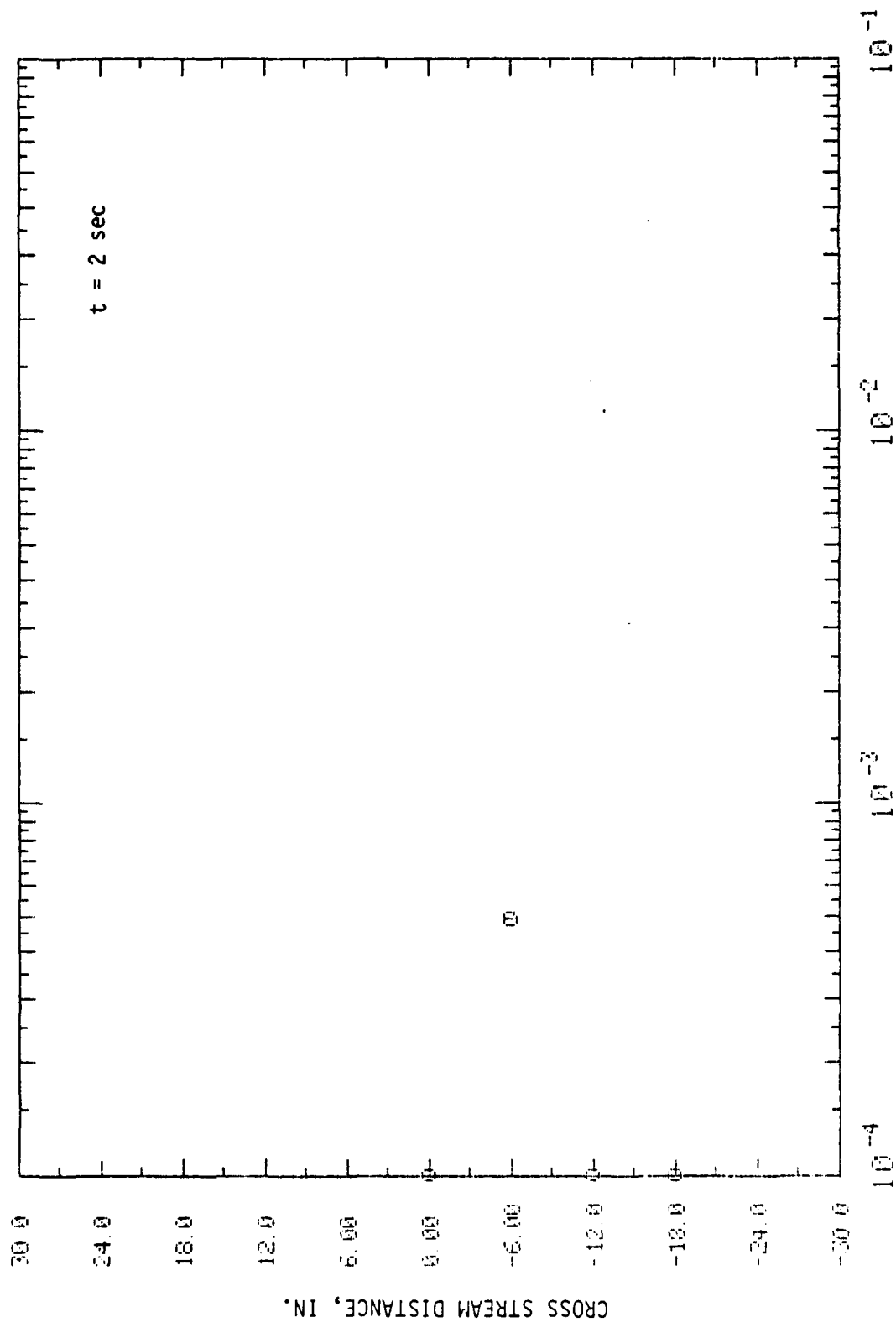
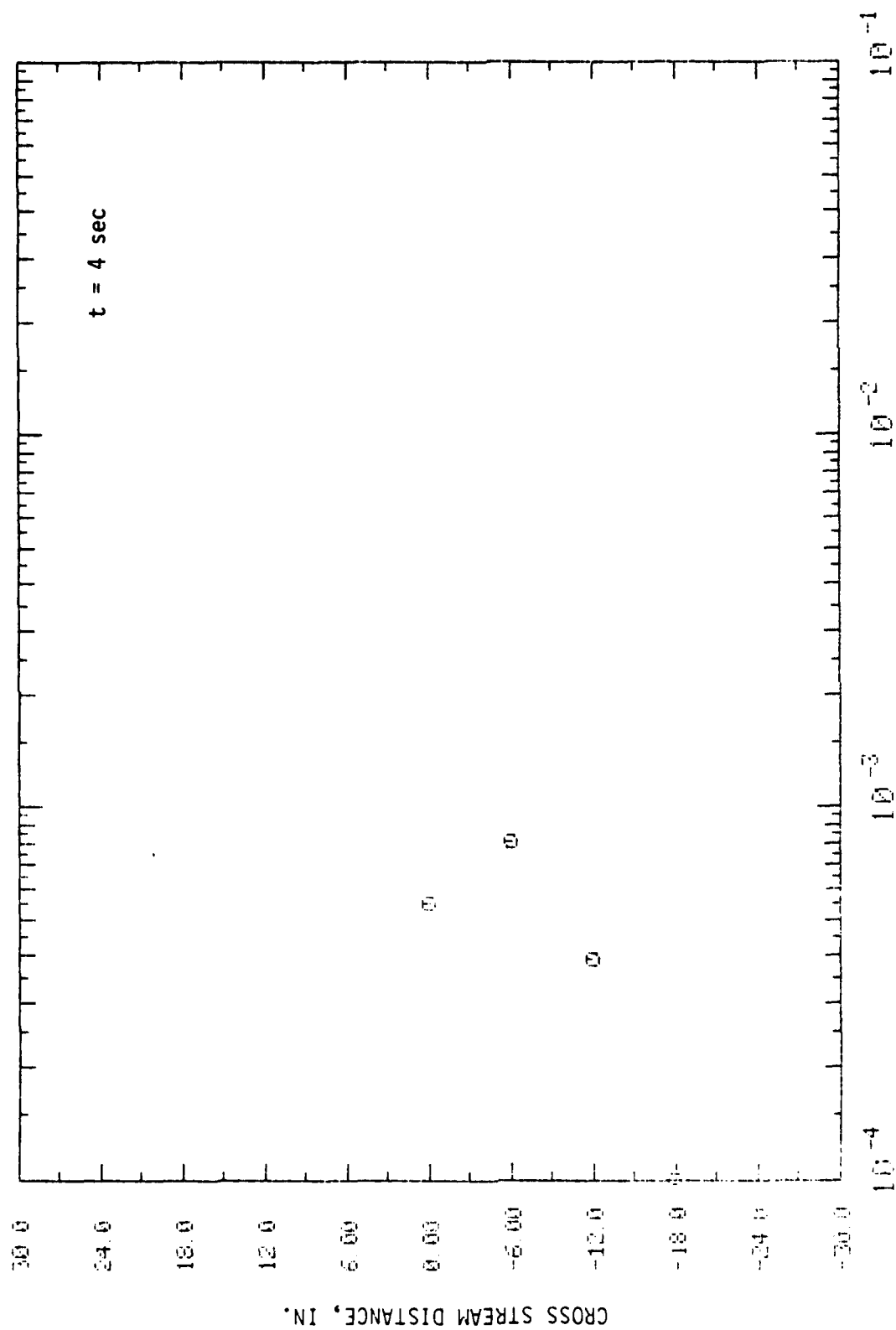


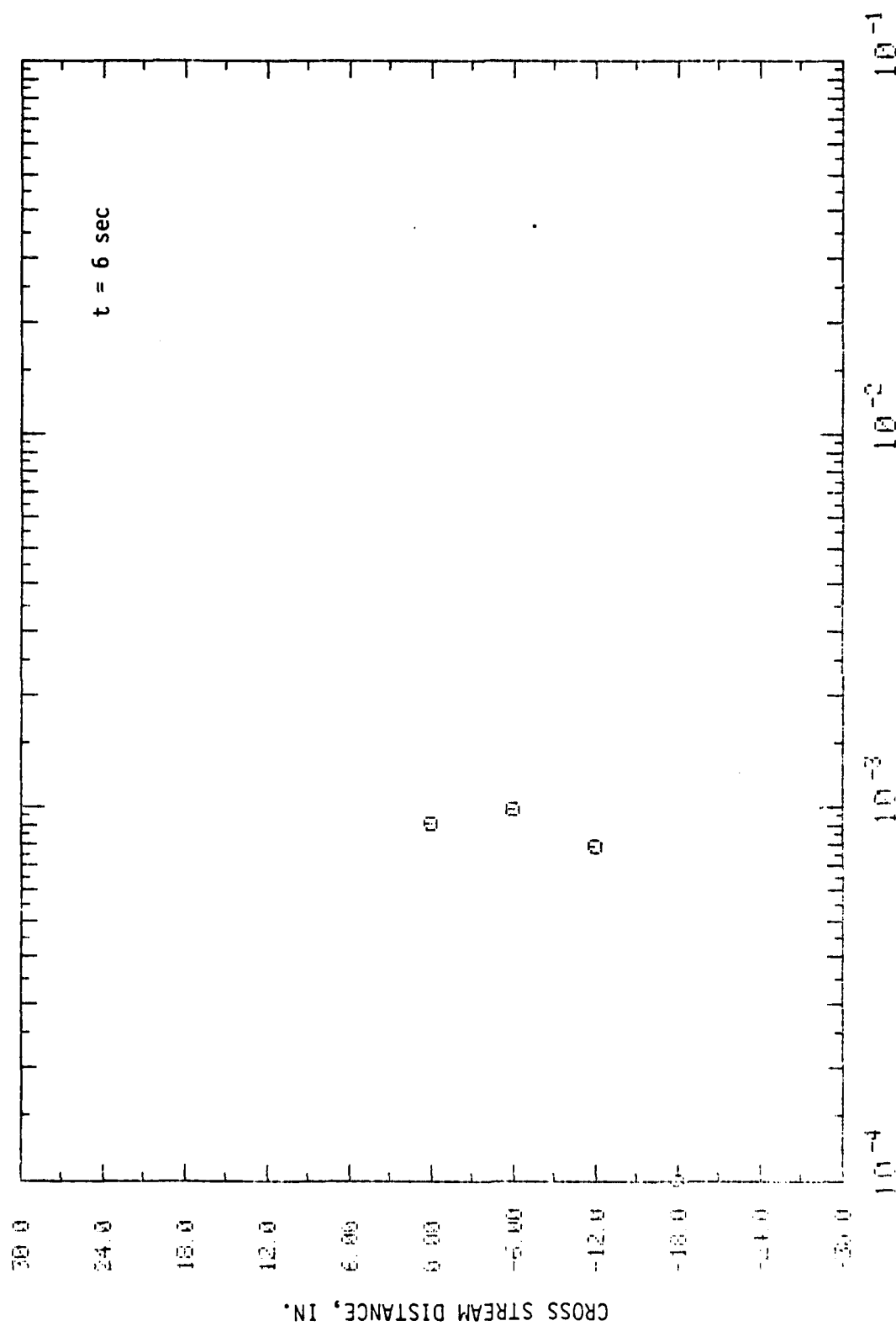
FIGURE D-3. RUN 11.1-7B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

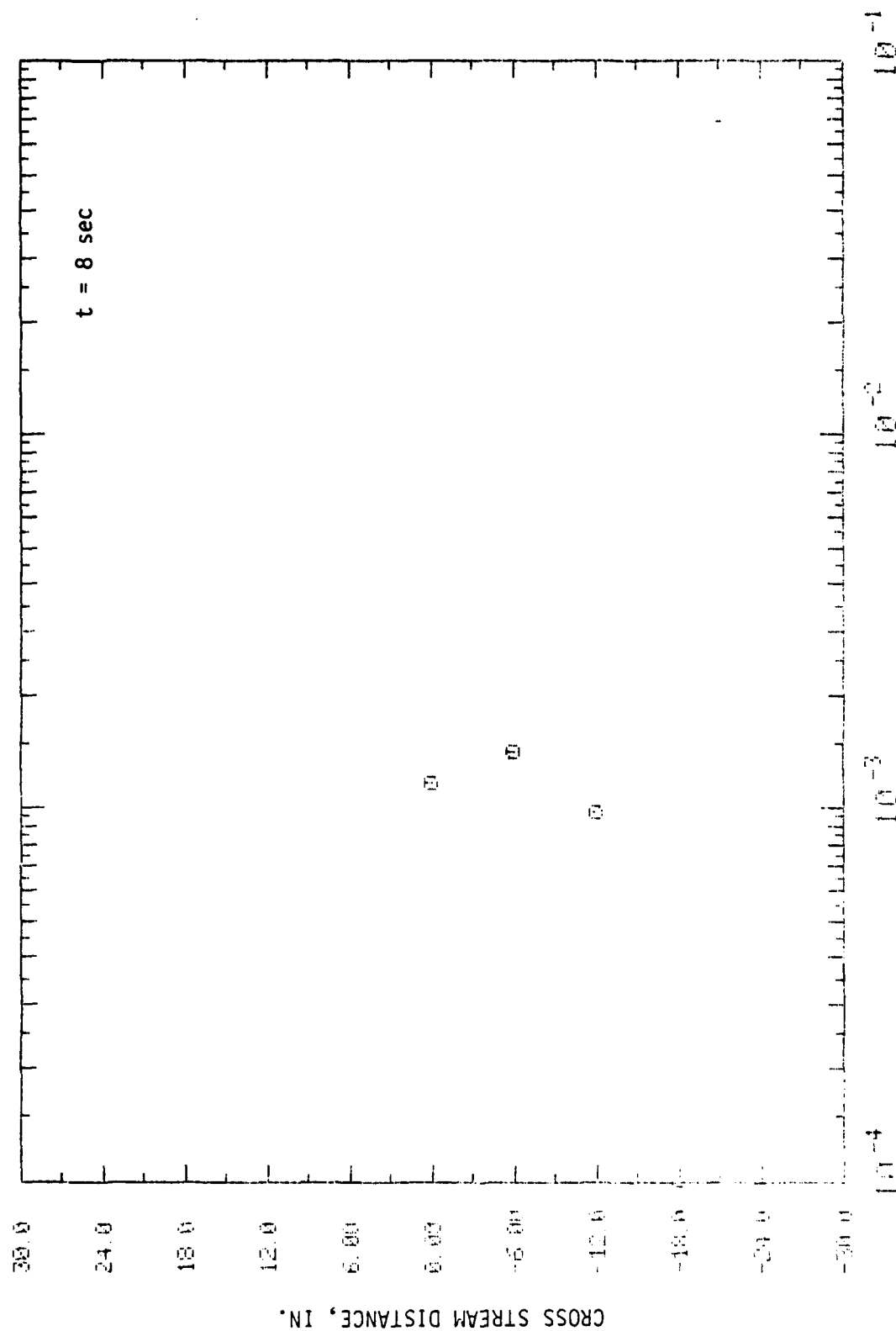
FIGURE D-4. RUN 11.1-7B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

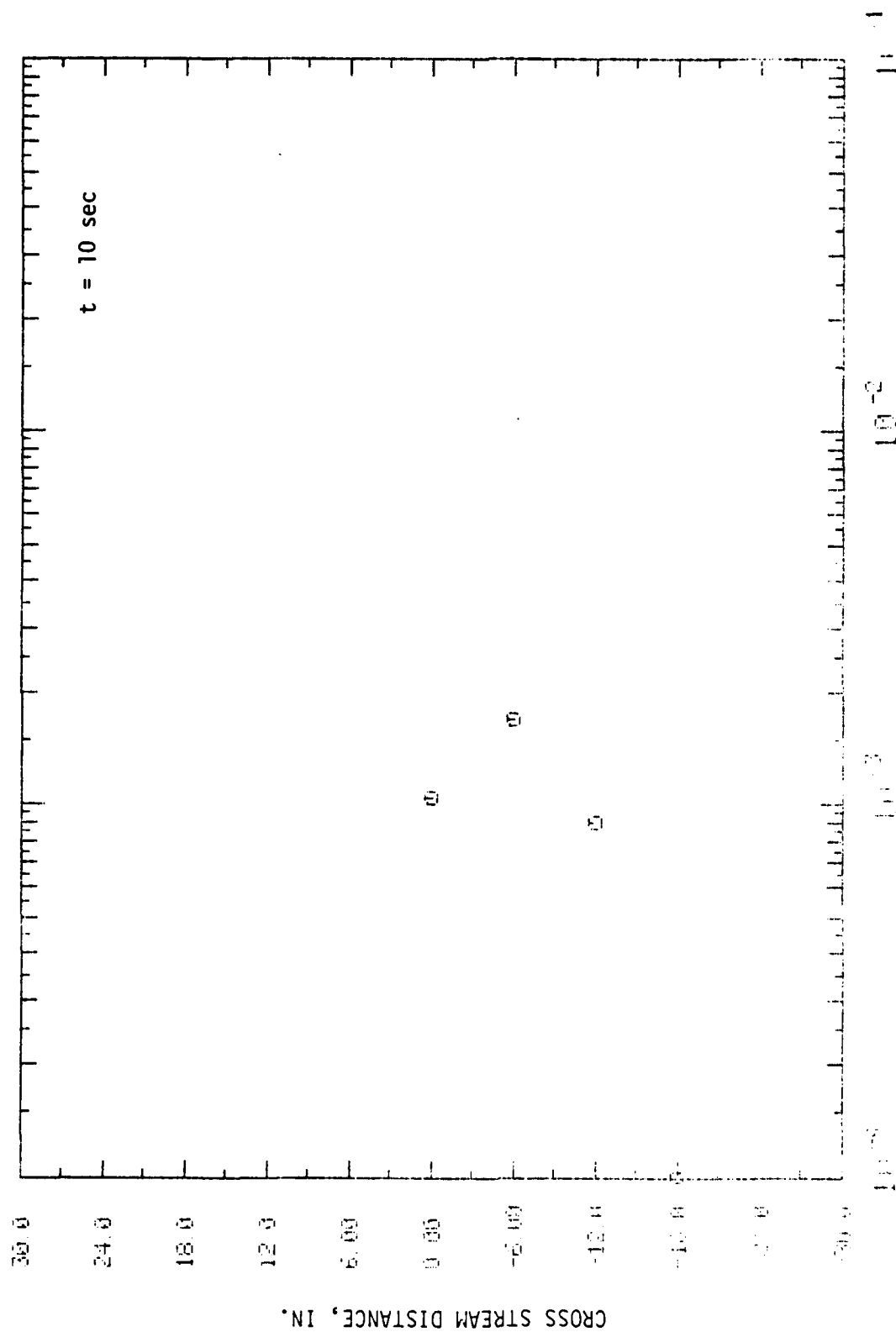
FIGURE D-5. RUN II.1-7B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENS ONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE D-6 . RUN II.1.1-7B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE D-7. RUN II.1-7B CROSS STREAM CONCENTRATION PROFILE

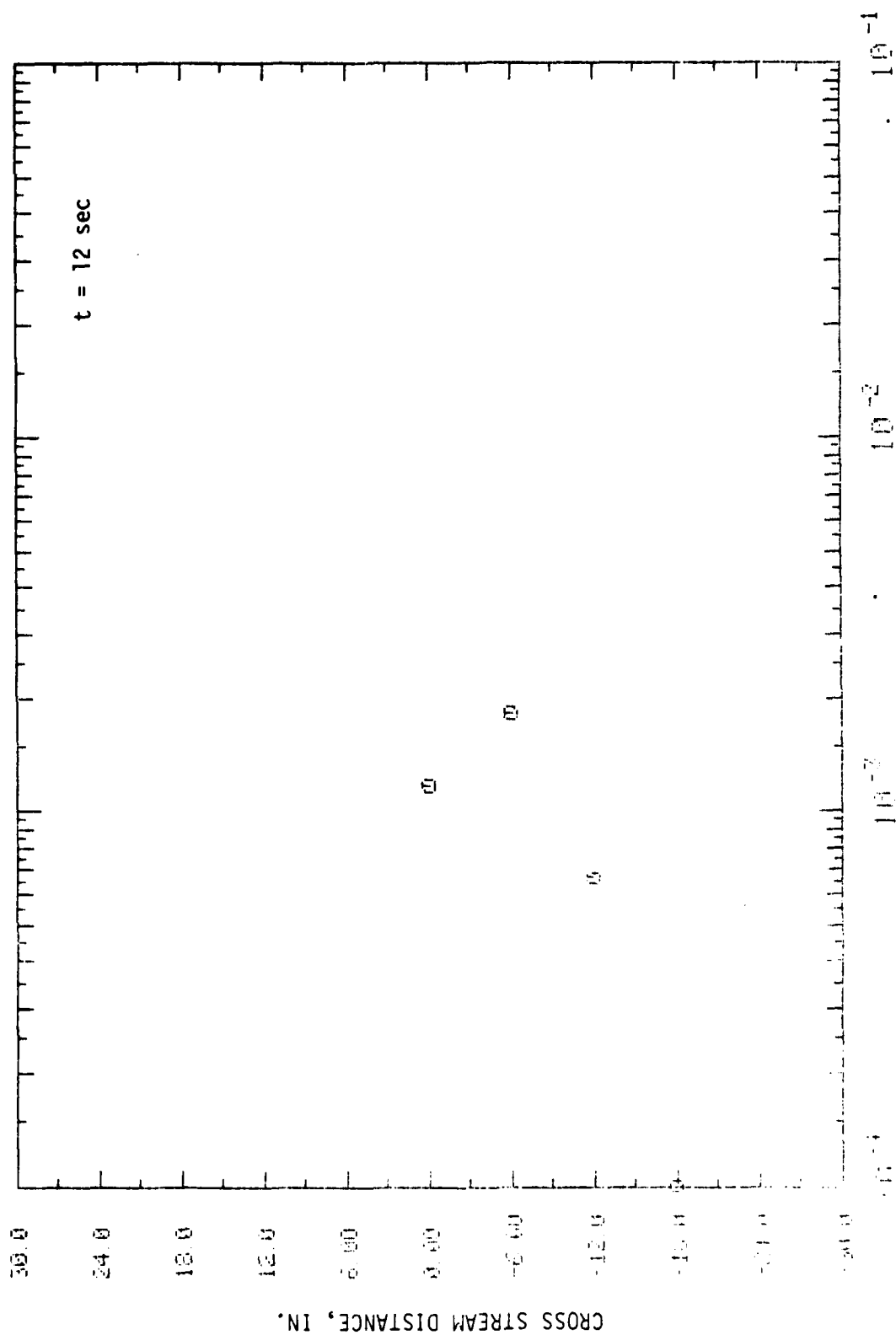
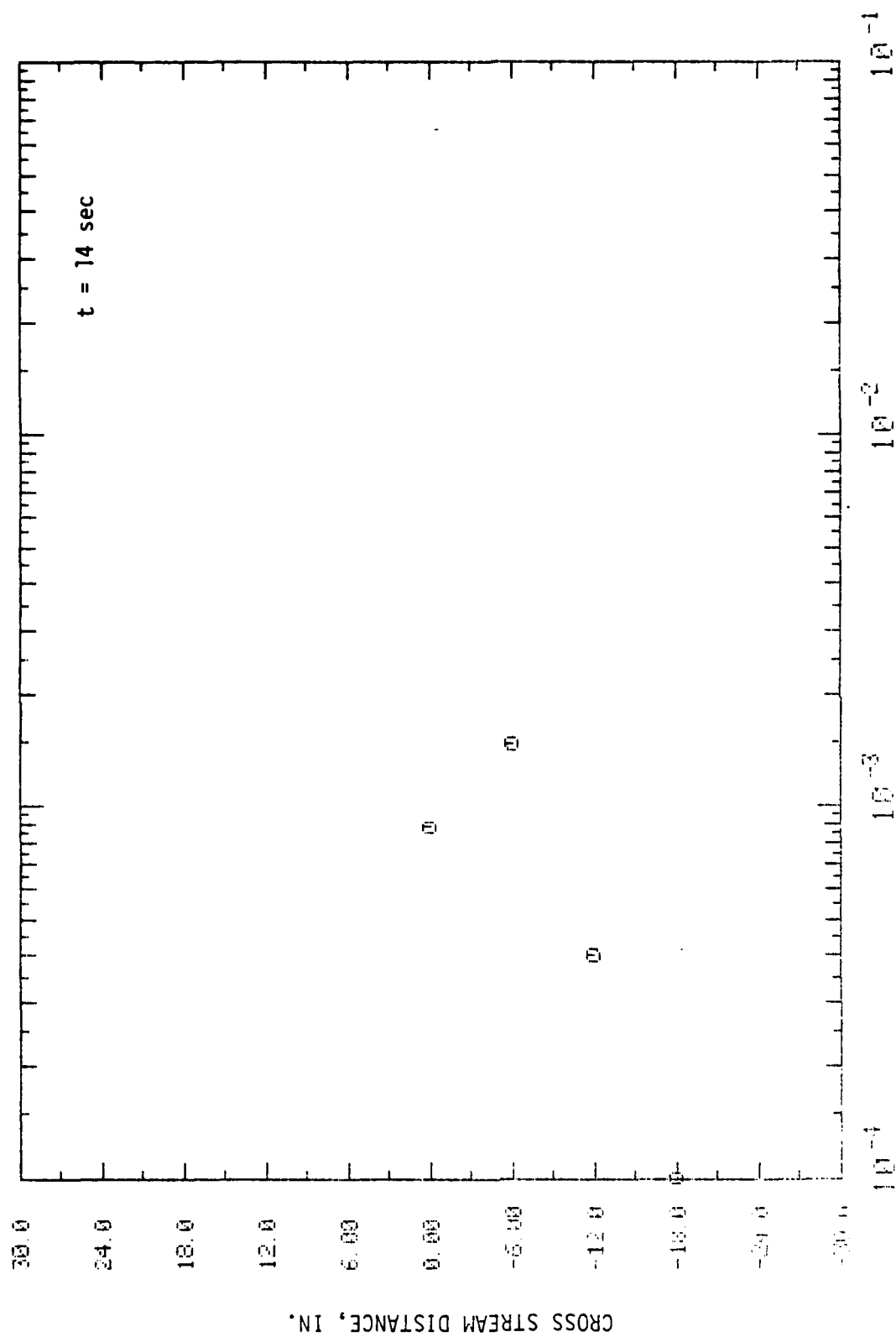


FIGURE D-8. RUN II.1-7B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE D-9. RUN II.1-7B CROSS STREAM CONCENTRATION PROFILE

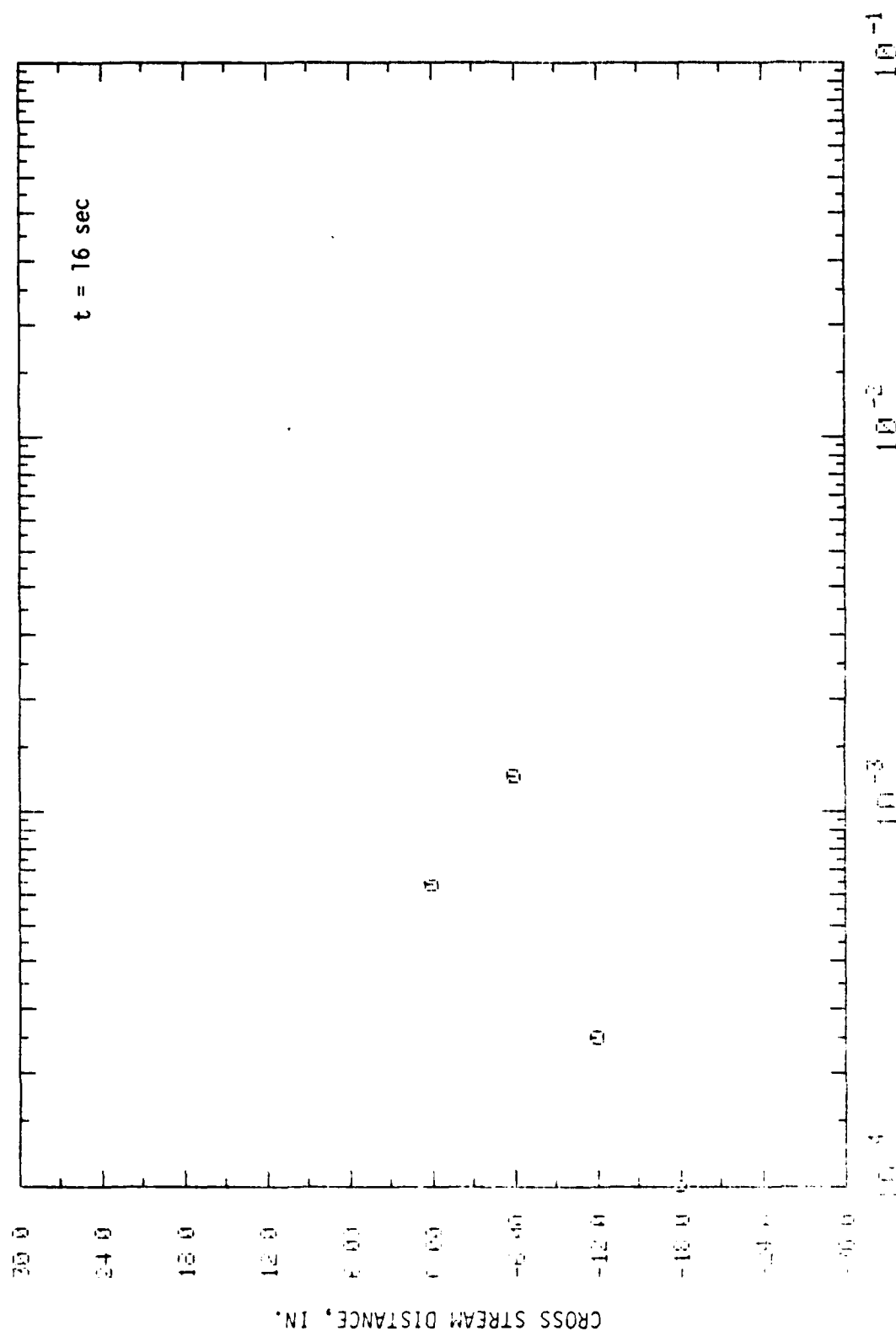
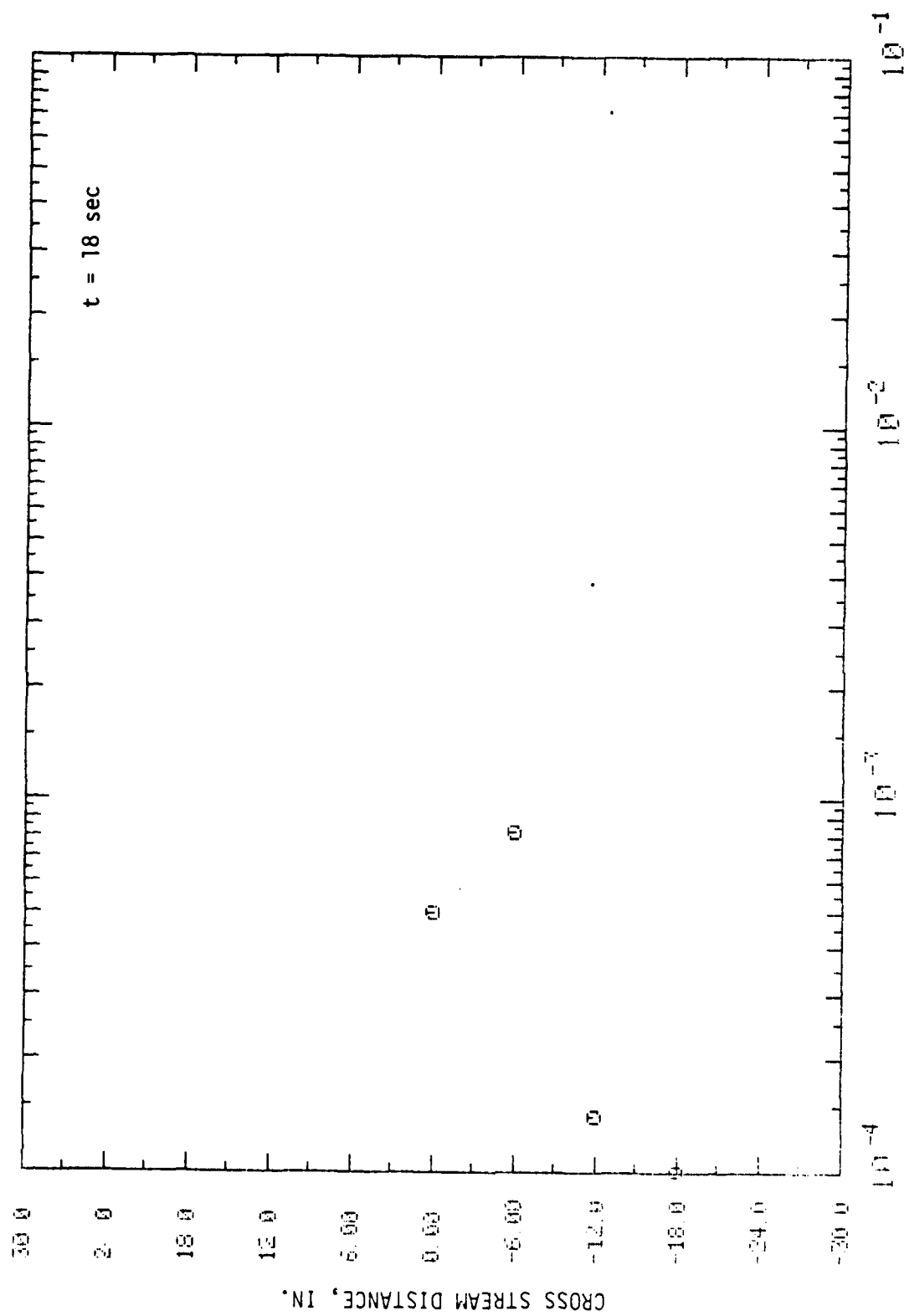


FIGURE D-10. RUN II.1-7B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Z = 9.25$ IN.

FIGURE D-11. RUN II.1-7B CROSS STREAM CONCENTRATION PROFILE

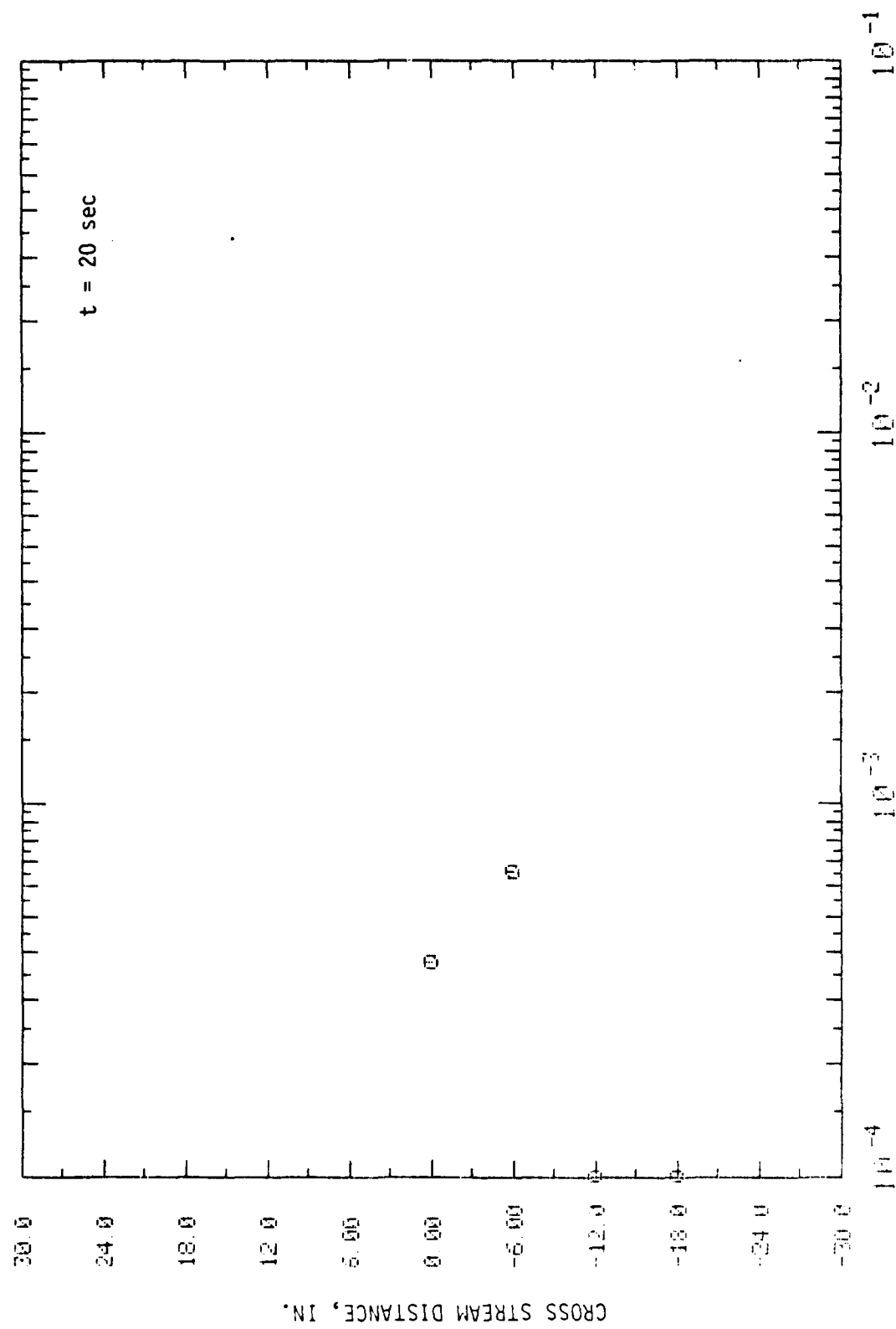
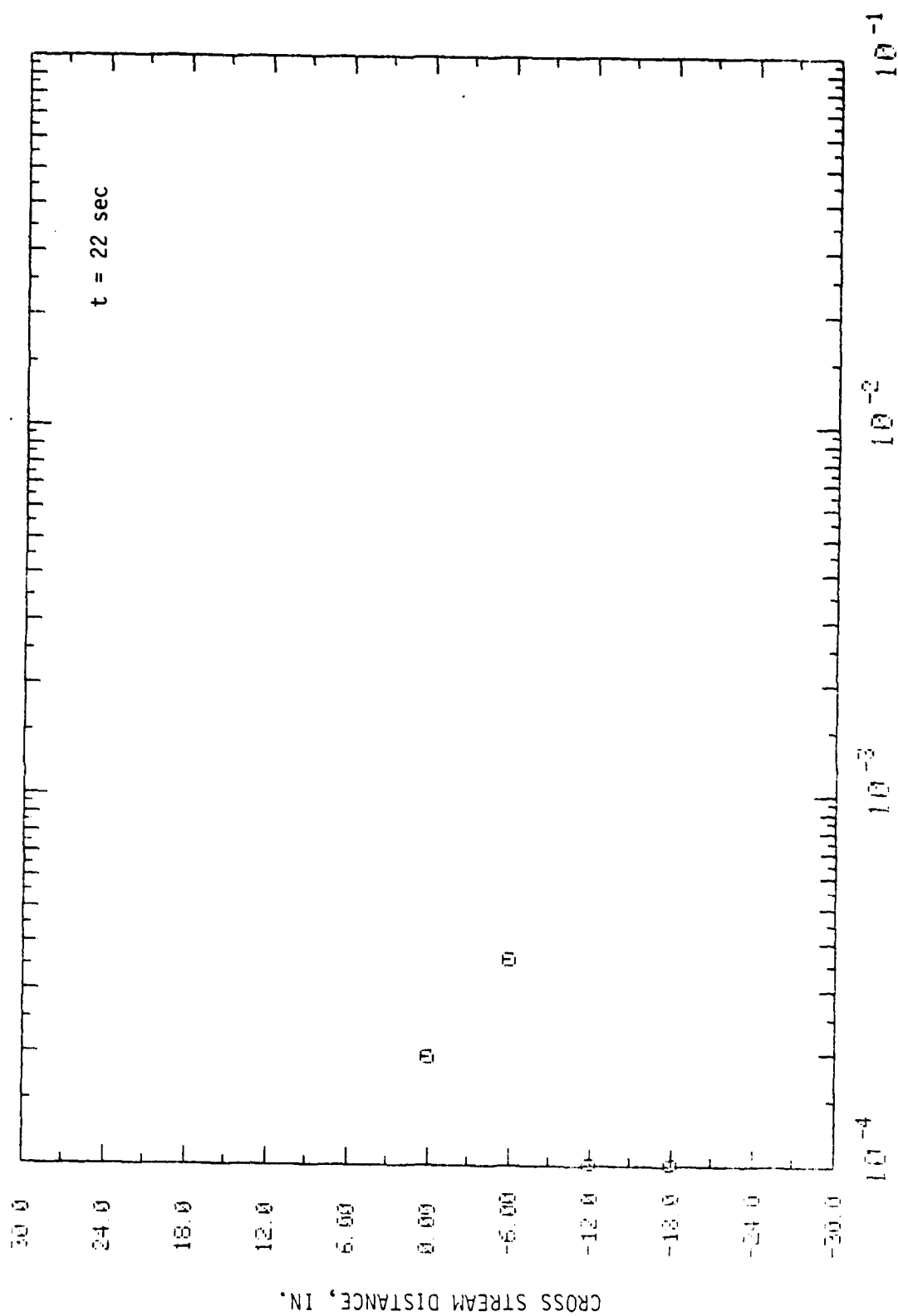


FIGURE D-12. RUN II.1-7B (CROSS STREAM CONCENTRATION PROFILE)



D-13

FIGURE D-13. RUN II.1-7B CROSS STREAM CONCENTRATION PROFILE

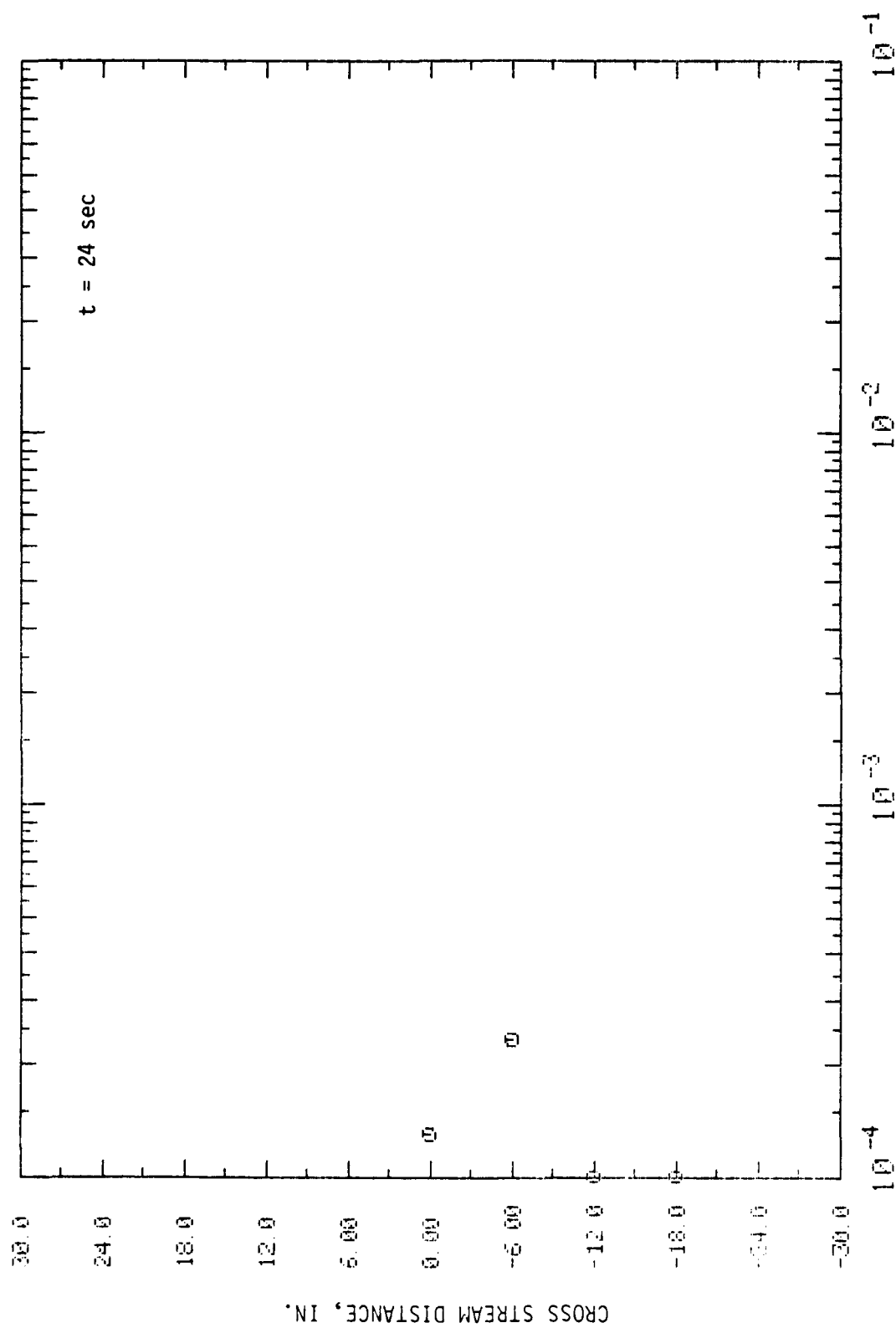


FIGURE D-14 . RUN II.1-7B CROSS STREAM CONCENTRATION PROFILE

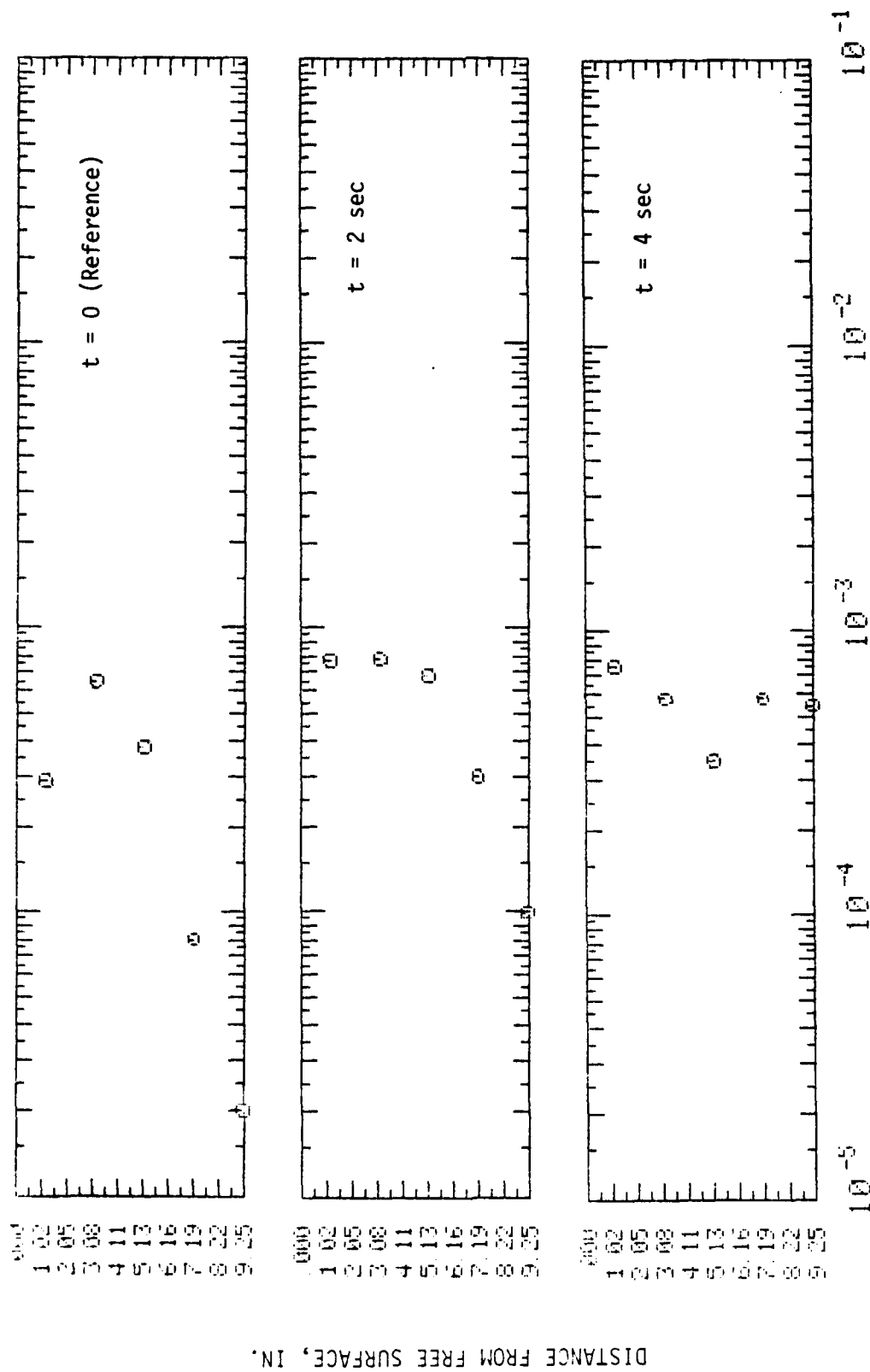
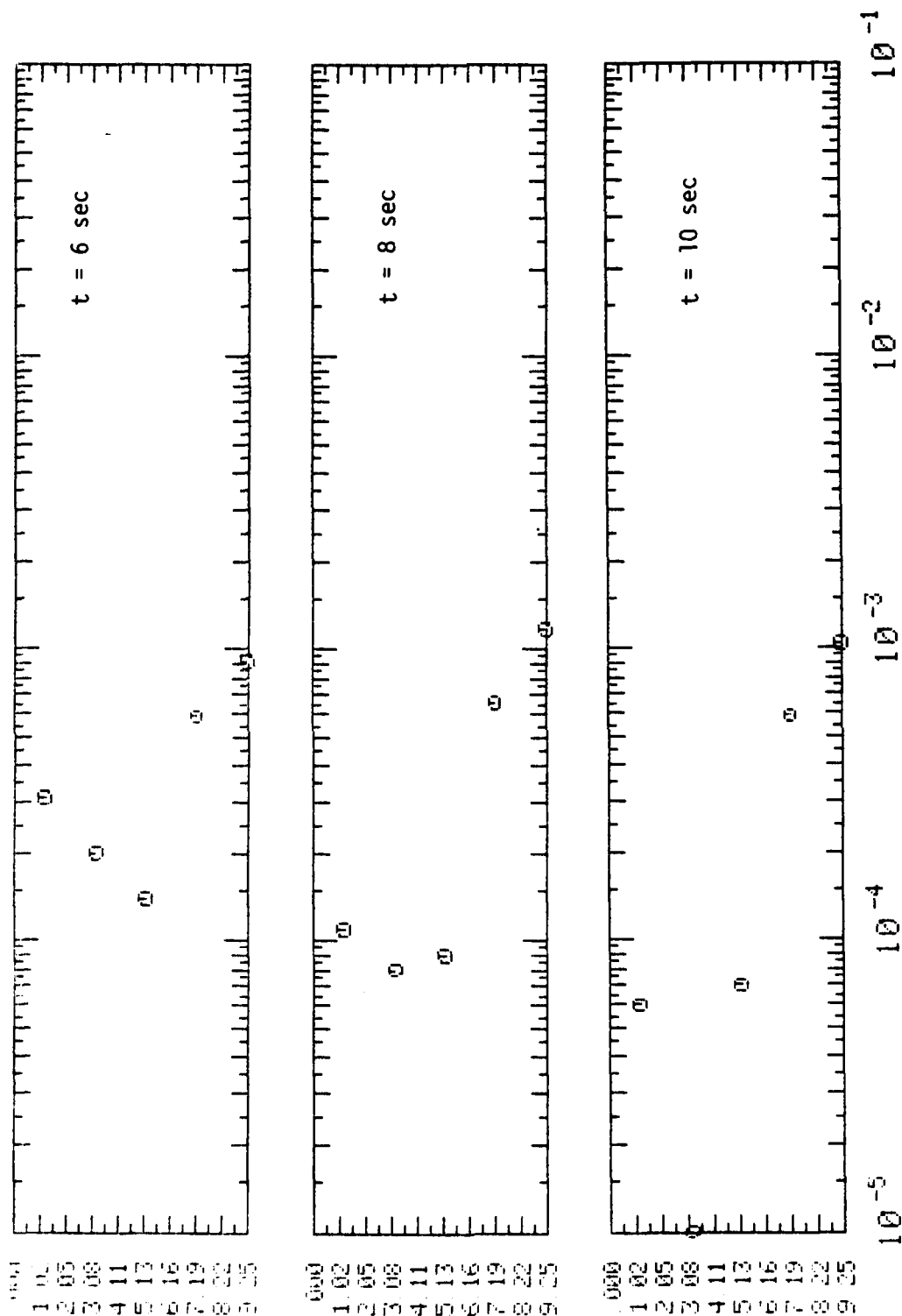


FIGURE D-15. RUN II.1-7B VERTICAL CONCENTRATION PROFILES

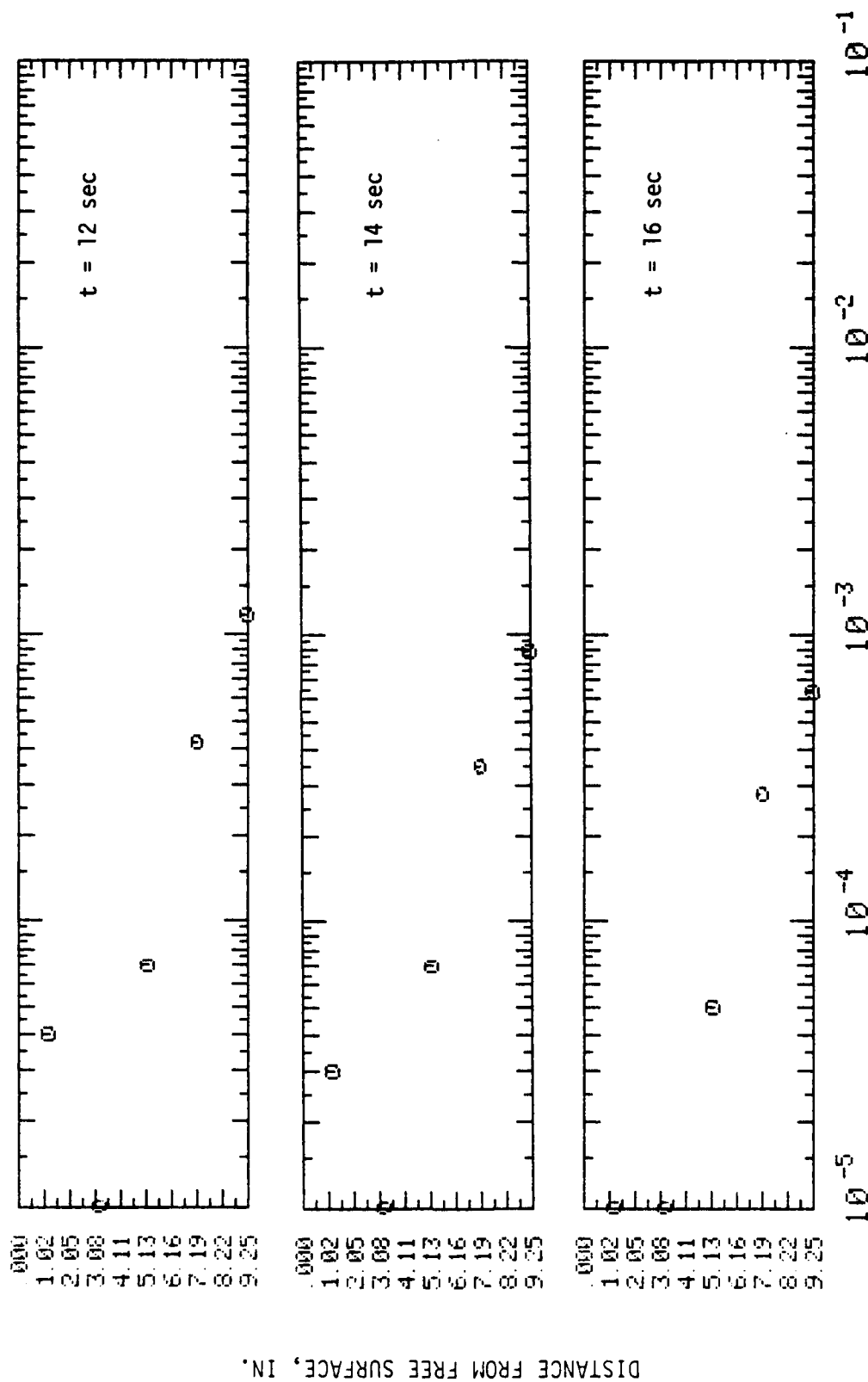
DISTANCE FROM FREE SURFACE, IN.



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$ IN.

FIGURE D-16. RUN II.1-7B VERTICAL CONCENTRATION PROFILES



C/C₀, DIMENSIONLESS CONCENTRATION

X = 168 IN., Y = 0 IN.

FIGURE D-17. RUN II.1-7B VERTICAL CONCENTRATION PROFILES

DISTANCE FROM FREE SURFACE, IN.

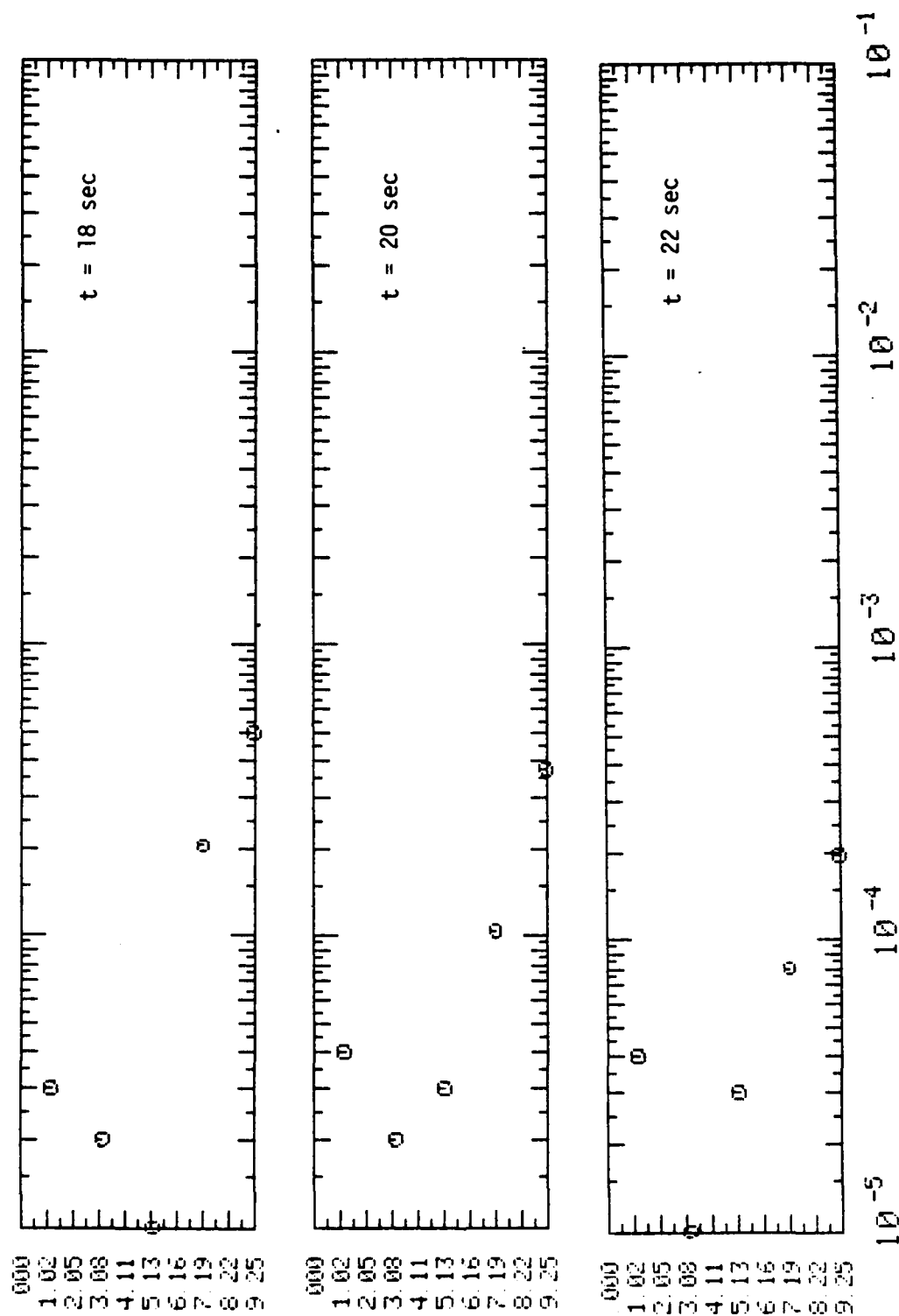
 C/C_0 , DIMENSIONLESS CONCENTRATION $X = 168$ IN., $Y = 0$ IN.

FIGURE D-18. RUN 11.1-7B VERTICAL CONCENTRATION PROFILES

APPENDIX E
CONCENTRATION PROFILES FOR
RUN II.1-8A

$$\rho_c/\rho = 1.05 \text{ (Sucrose)}$$

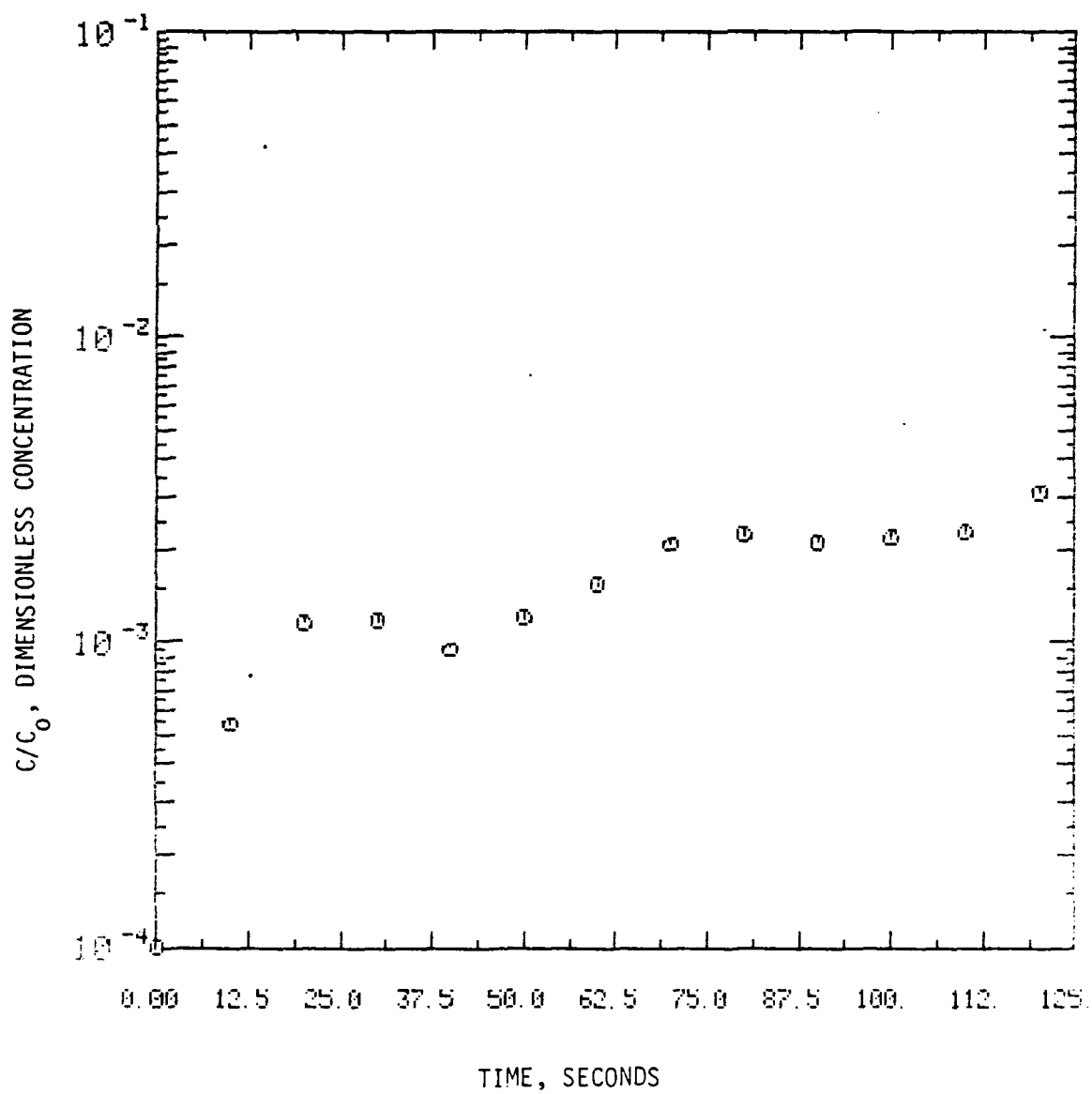
$$r_i/d = 0.23$$

$$u_\tau/U = 0.05$$

$$U(\text{cm/sec}) = 3.5$$

Time elapsed from spill to $t=0$ (Reference) for:

time history graph	97 sec.
vertical profiles	97 sec.



X = 168 IN., Y = 0, Z = 9.25 IN.

FIGURE E-1. RUN II.1-8A CONCENTRATION TIME HISTORY

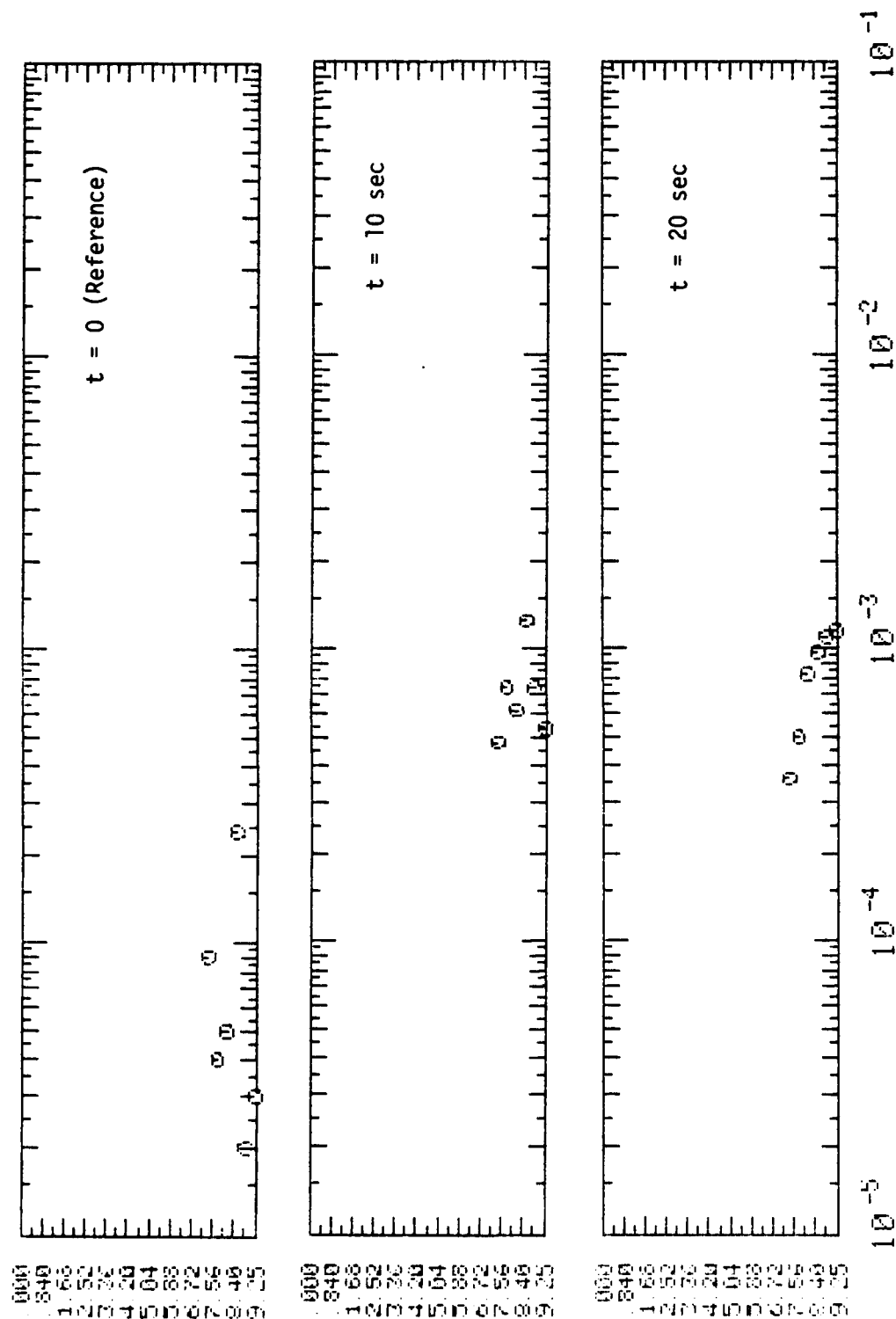


FIGURE E-2. RUN II.1-8A VERTICAL CONCENTRATION PROFILES

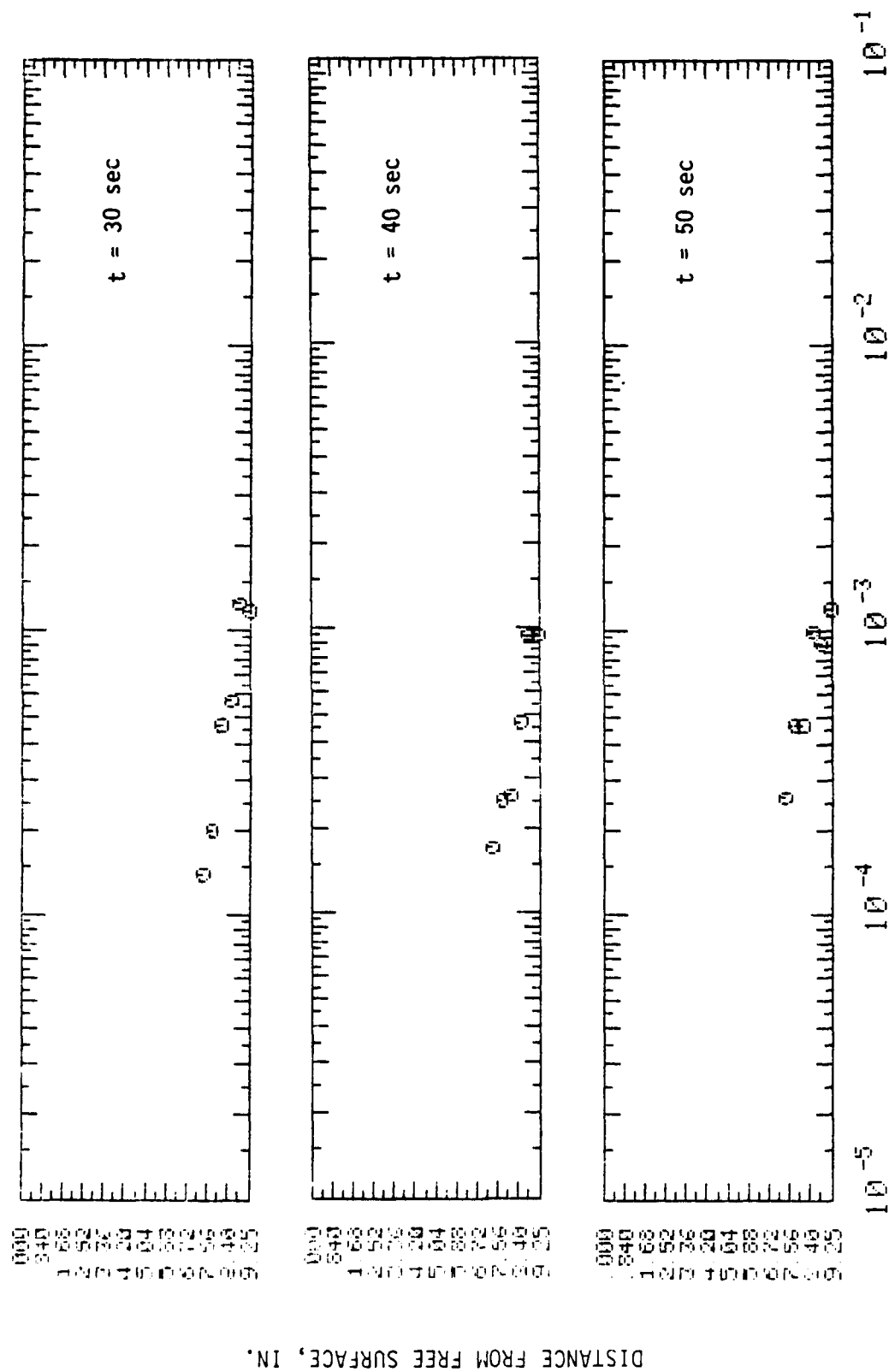
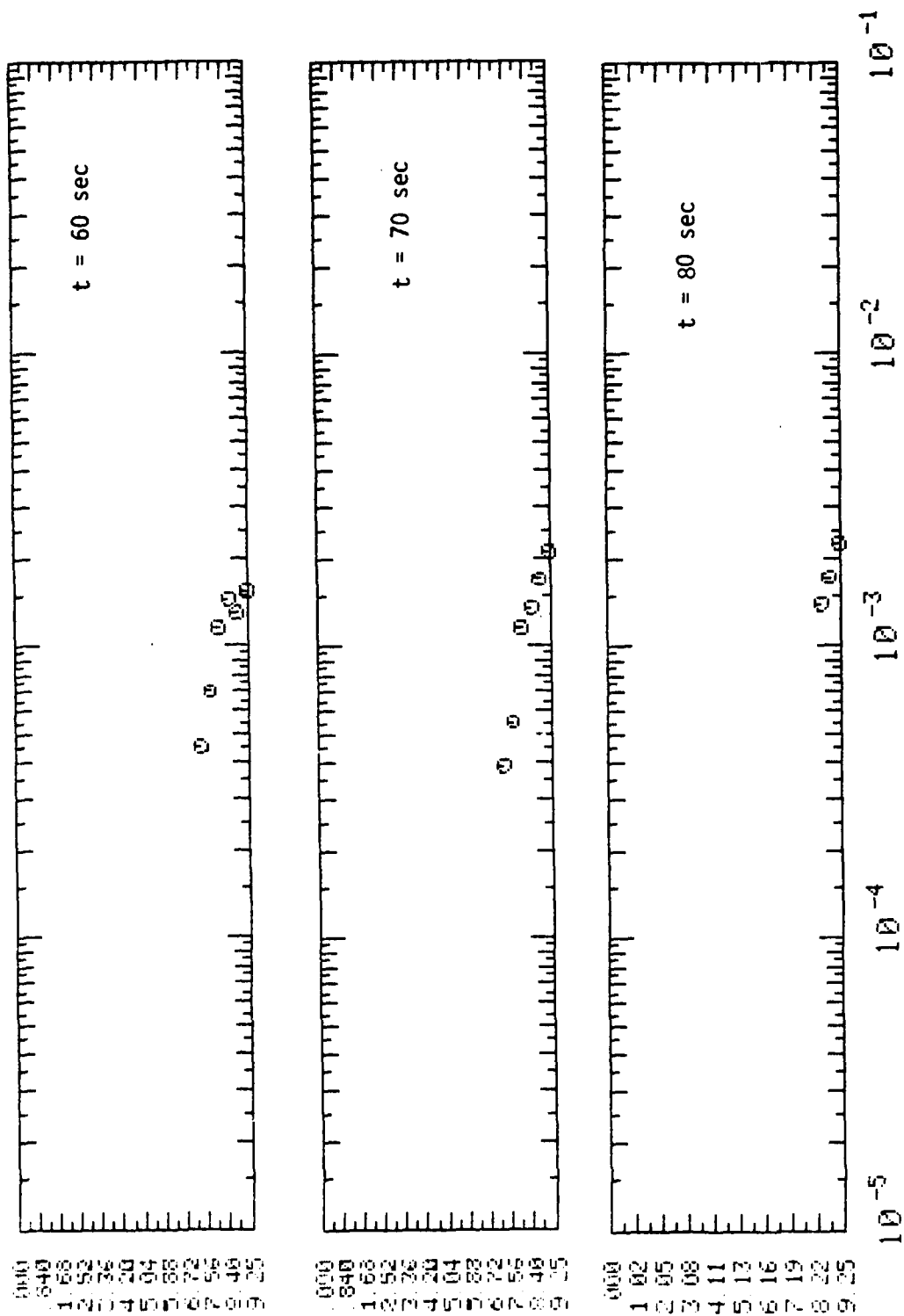


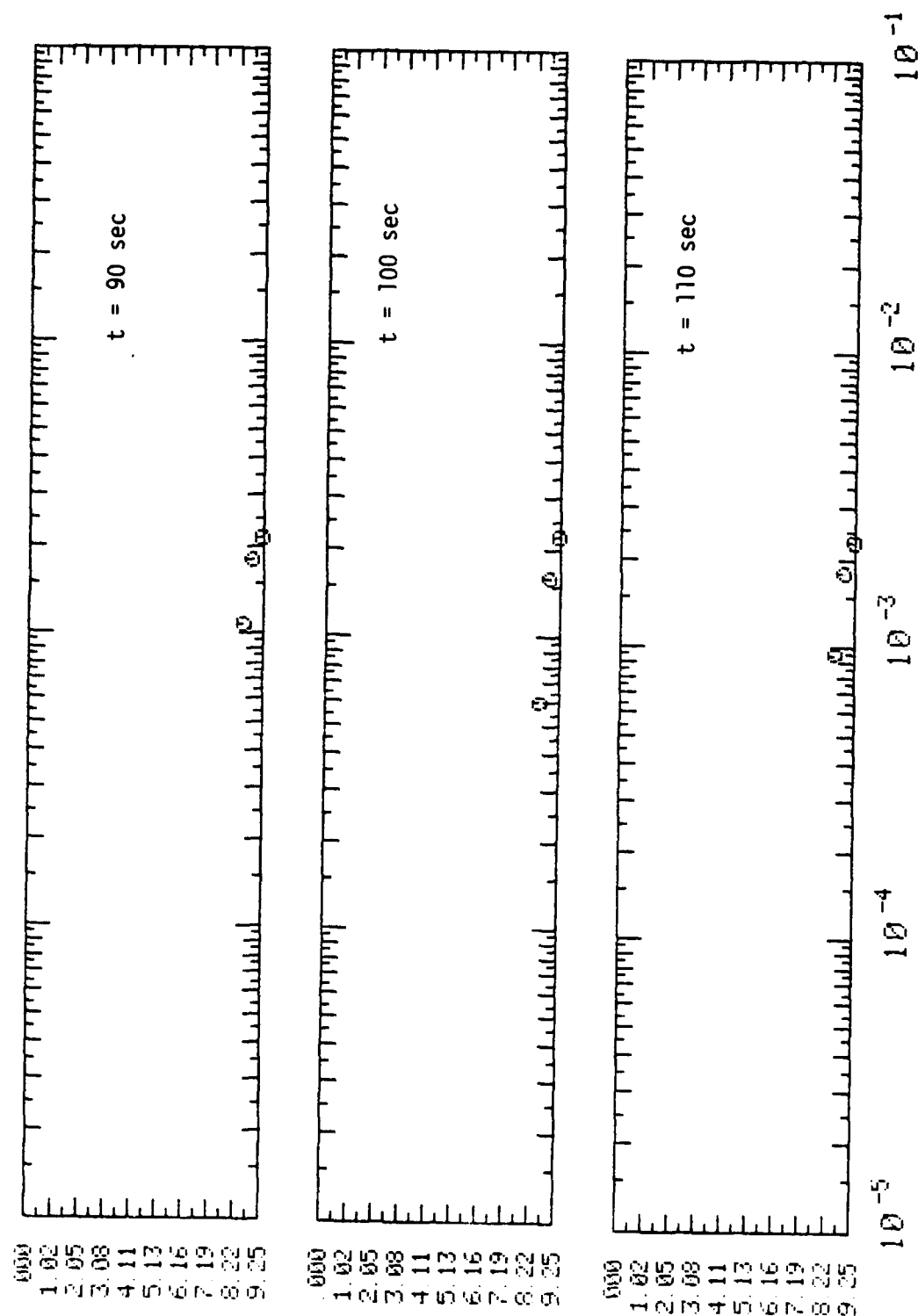
FIGURE E-3. RUN II.1-8A VERTICAL CONCENTRATION PROFILES



C/C₀, DIMENSIONLESS CONCENTRATION

X = 168 IN., Y = 0 IN.

FIGURE E-4. RUN II.1-8A VERTICAL CONCENTRATION PROFILES



C/C₀, DIMENSIONLESS CONCENTRATION

X = 168 IN., Y = 0 IN.

FIGURE E-5. RUN II.1.1-8A VERTICAL CONCENTRATION PROFILES

DISTANCE FROM FREE SURFACE, IN.

E-6

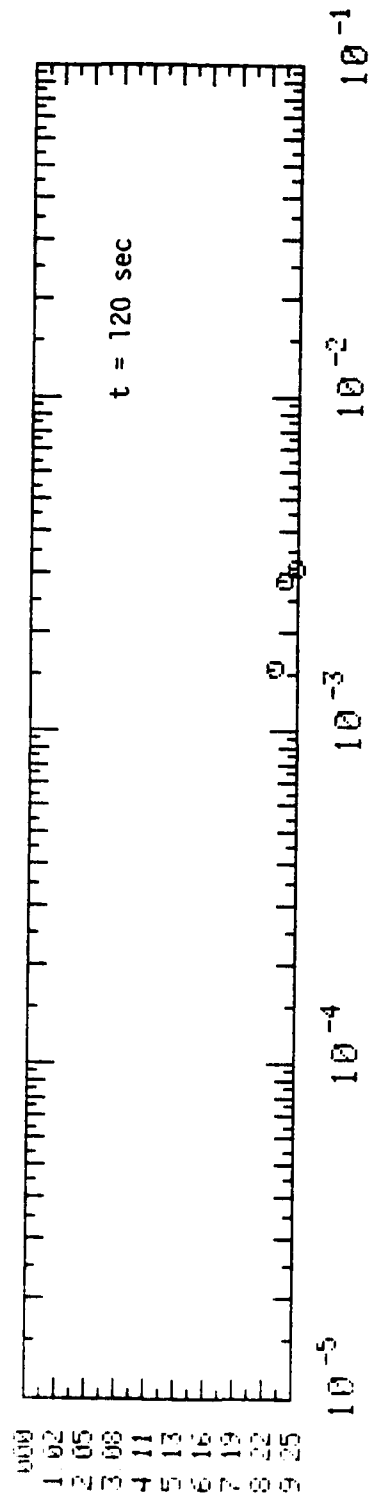


FIGURE E-6. RUN 11.1-8A VERTICAL CONCENTRATION PROFILES

APPENDIX F

CONCENTRATION PROFILES FOR RUN II.1-8B

$$\rho_c/\rho = 1.05 \text{ (Sucrose)}$$

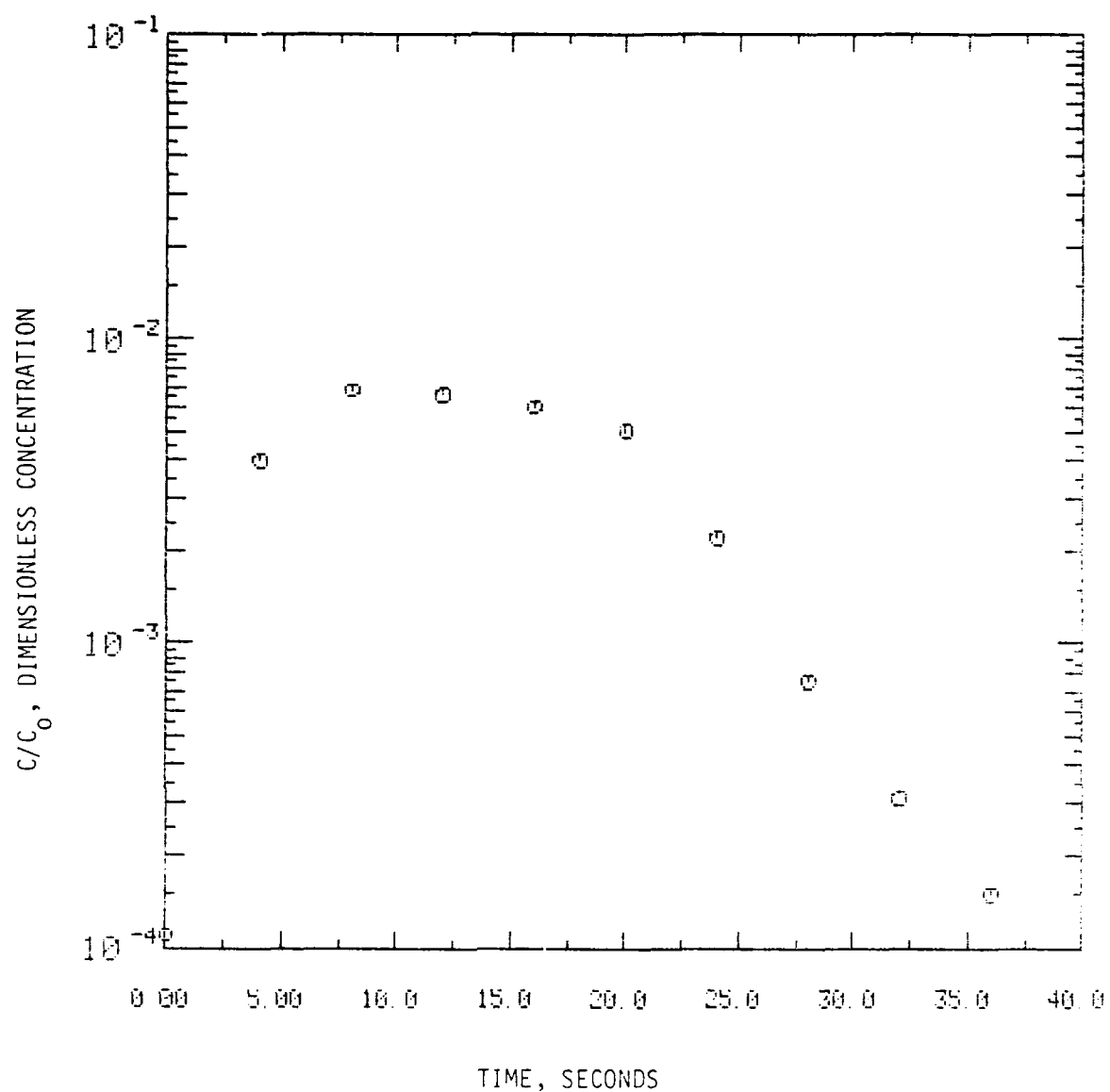
$$r_i/d = 0.23$$

$$u_\tau/U = 0.05$$

$$U(\text{cm/sec}) = 14.1$$

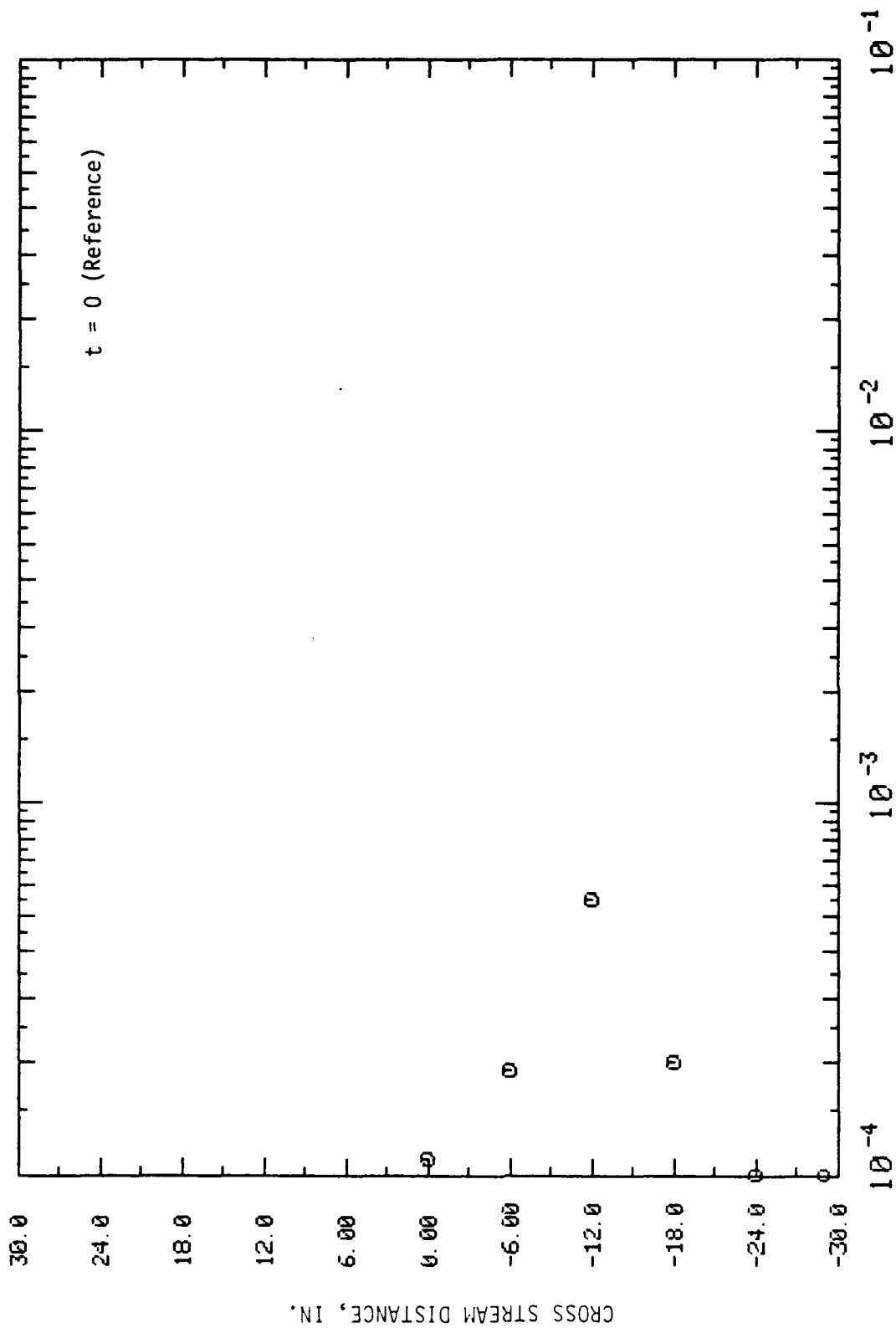
Time elapsed from spill to $t=0$ (Reference) for:

time history graph	27 sec.
cross stream profiles	27 sec.
vertical profiles	27 sec.



X = 168 IN., Y = 0, Z = 9.25 IN.

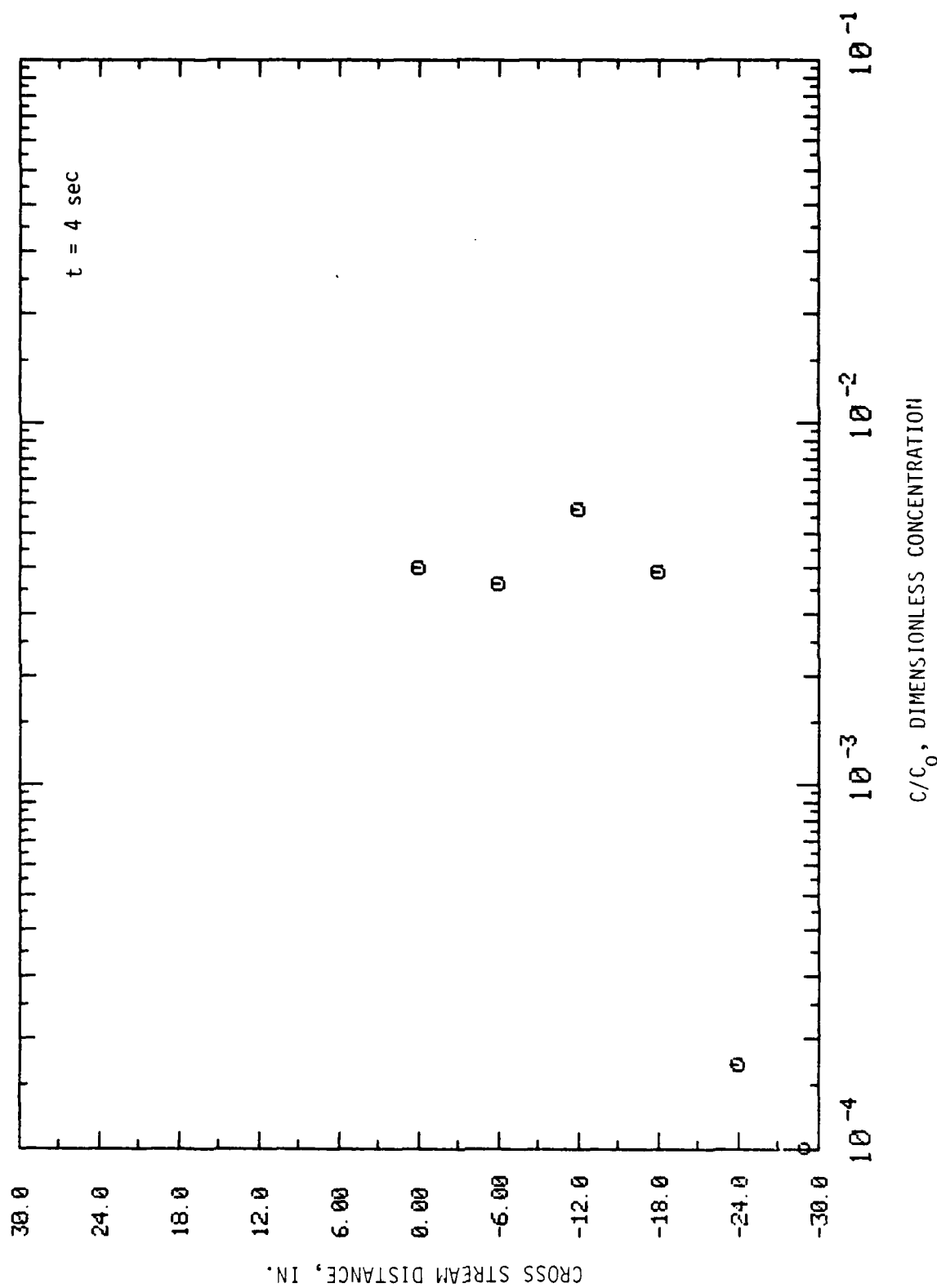
FIGURE F-1. RUN II.1-8B CONCENTRATION TIME HISTORY



C/C_0 , DIMENSIONLESS CONCENTRATION

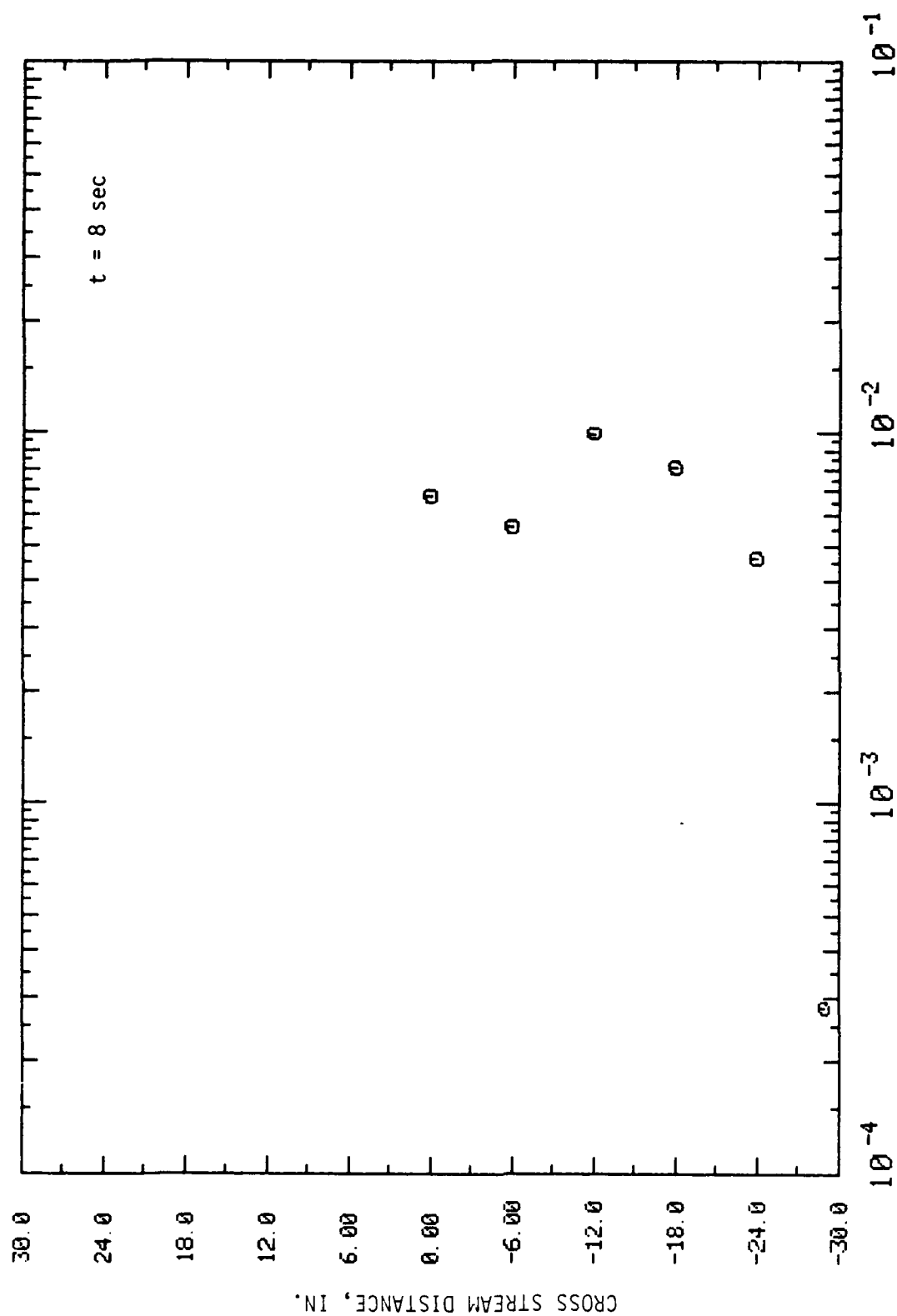
$X = 168$ IN., $Z = 9.25$ IN.

FIGURE F-2. RUN 11.1-8B CROSS STREAM CONCENTRATION PROFILE



$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

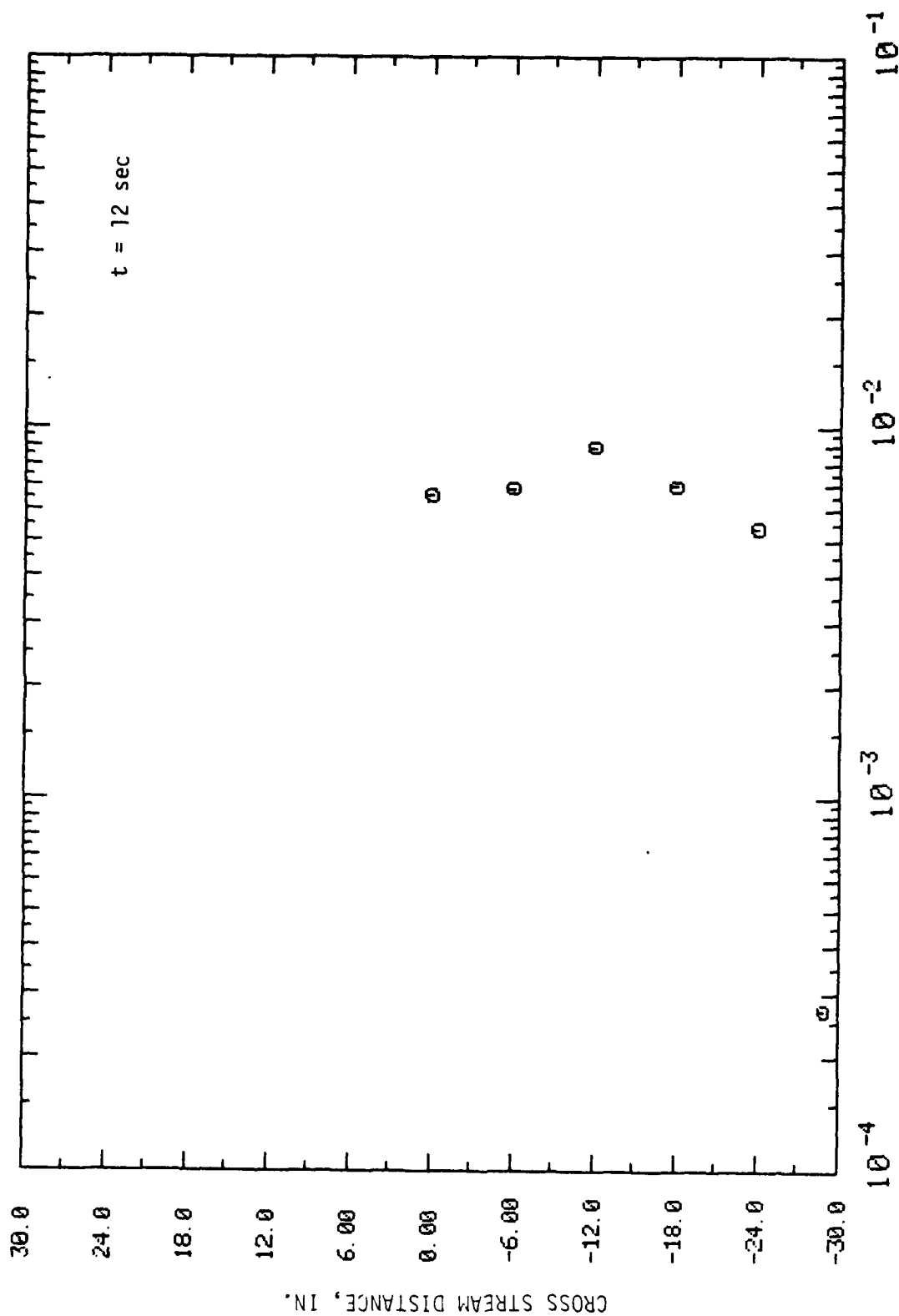
FIGURE F-3 . RUN II.1-8B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

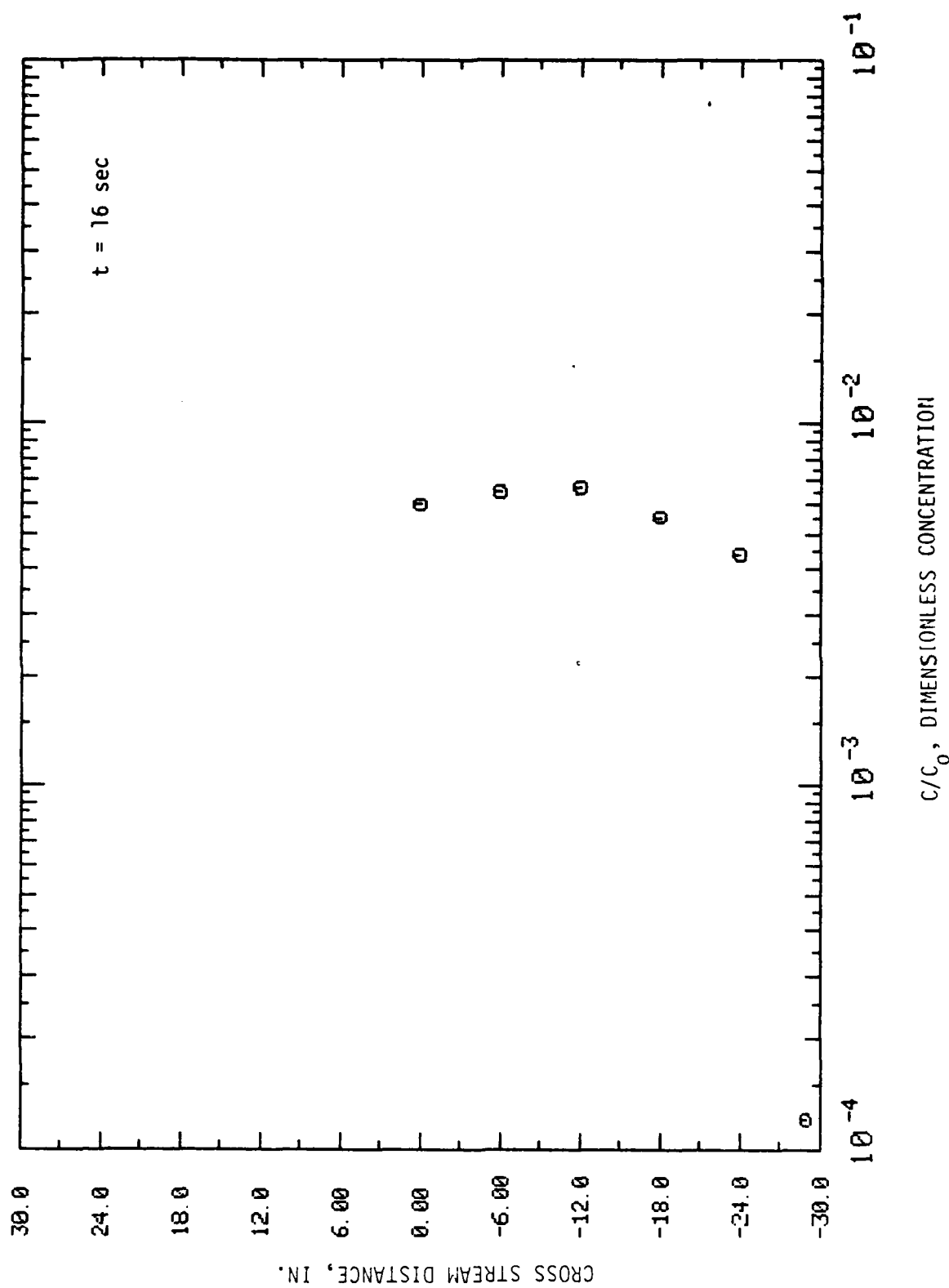
FIGURE F-4. RUN II.1-8B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

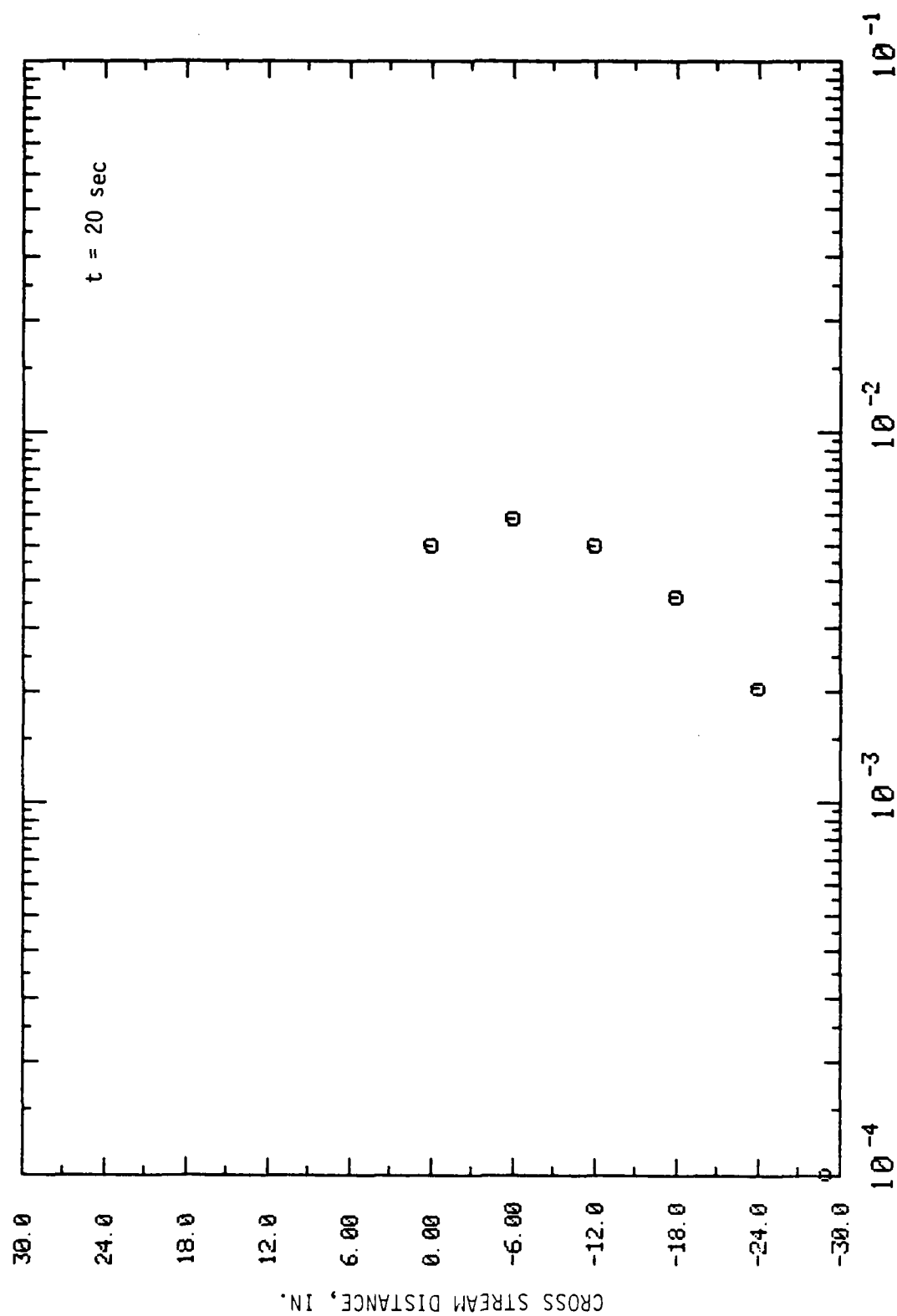
$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE F-5 . RUN II.1-8B CROSS STREAM CONCENTRATION PROFILE



$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

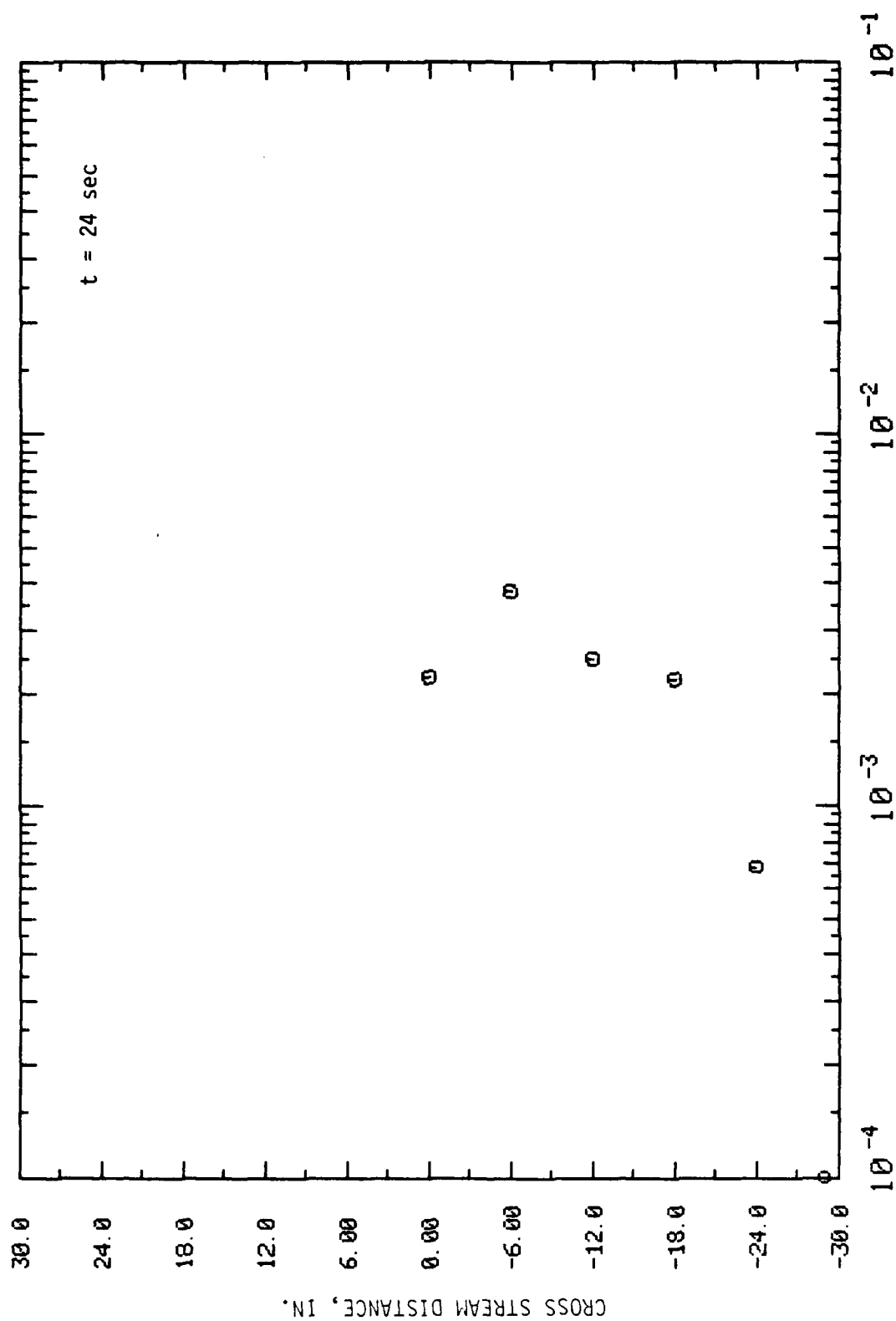
FIGURE F-6 . RUN 11.1-8B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE F-7. RUN 11.1-88 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE F-8 . RUN II.1-88 CROSS STREAM CONCENTRATION PROFILE

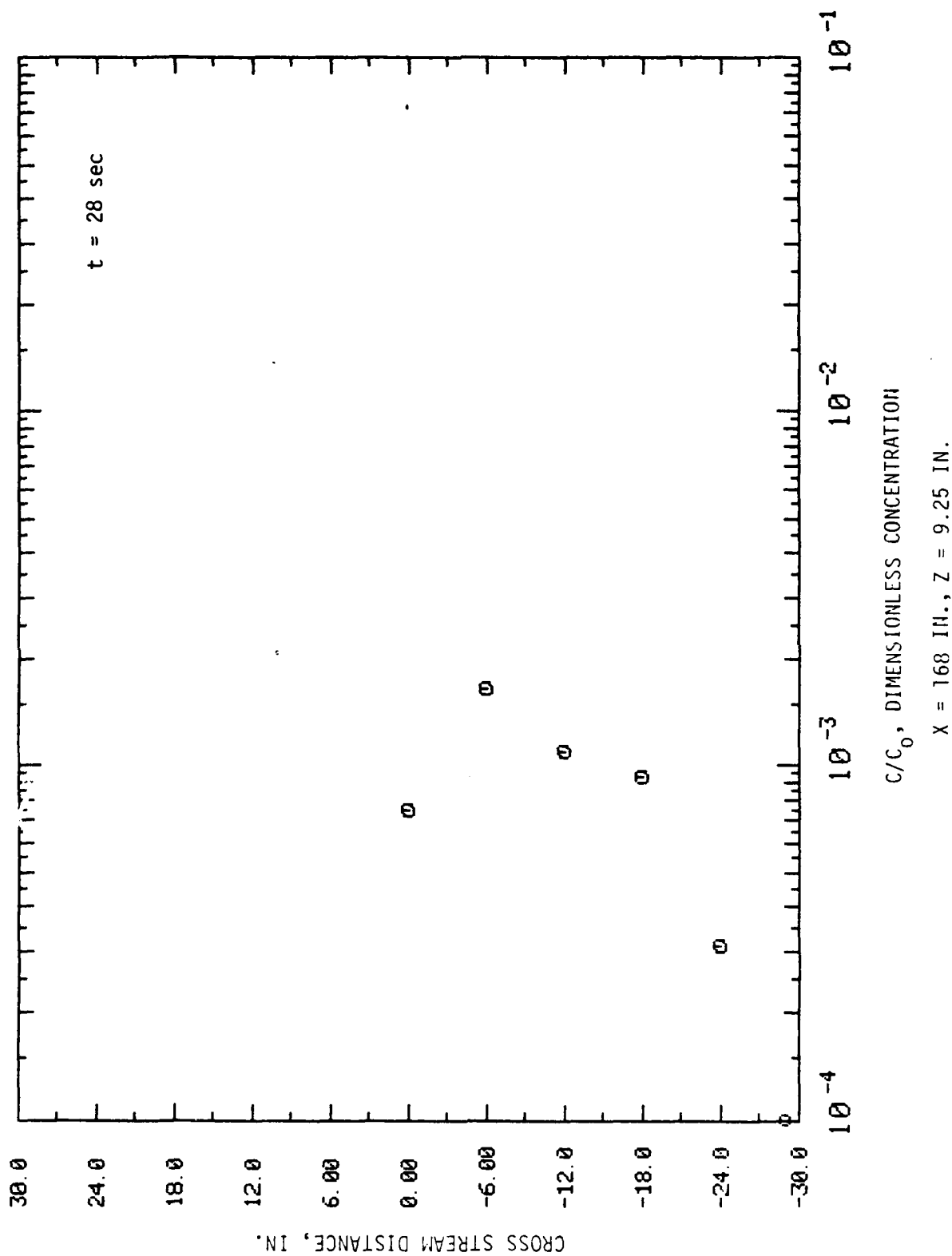
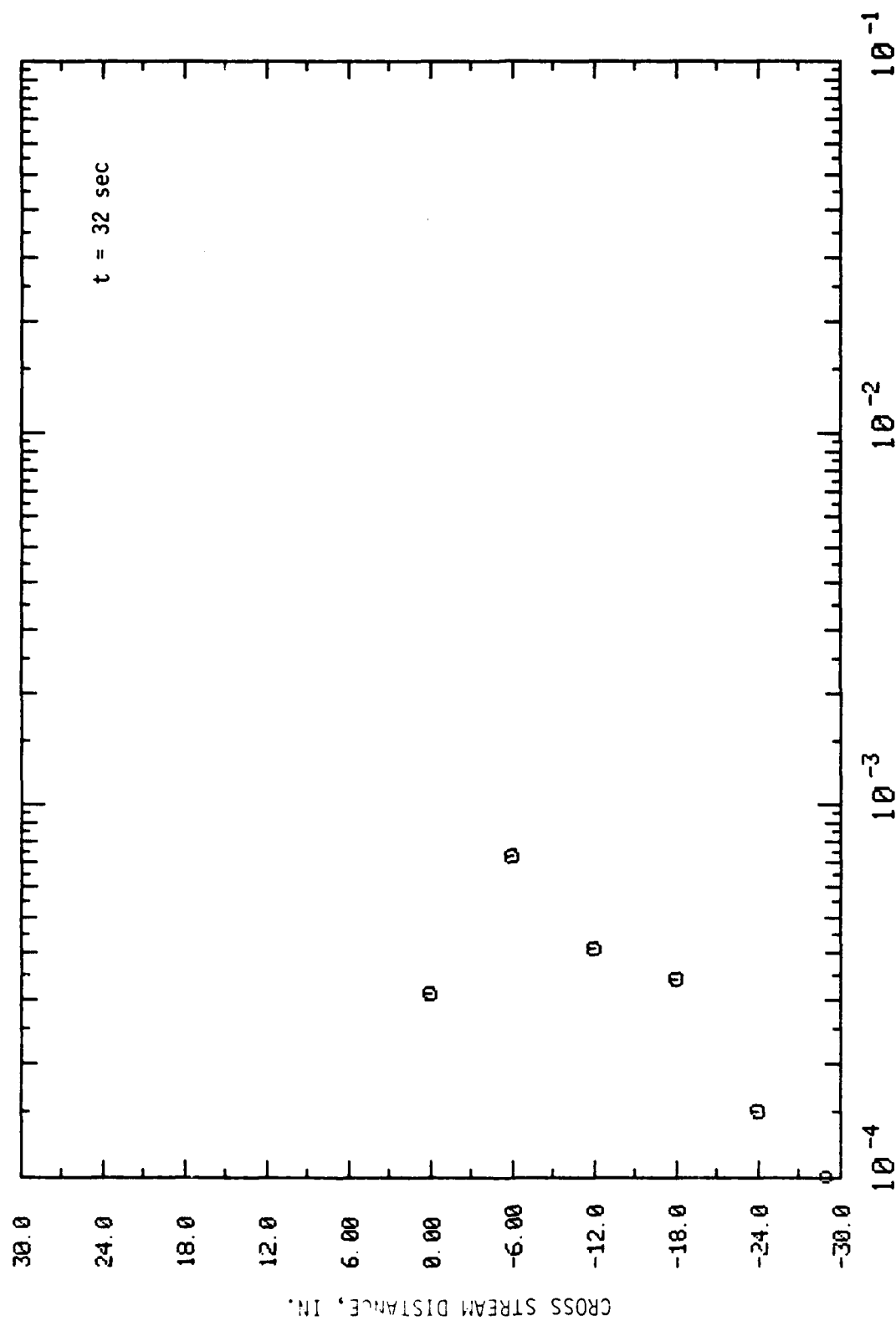


FIGURE F-9. RUN 11.1-8B CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE F-10. RUN II.1-8B CROSS STREAM CONCENTRATION PROFILE

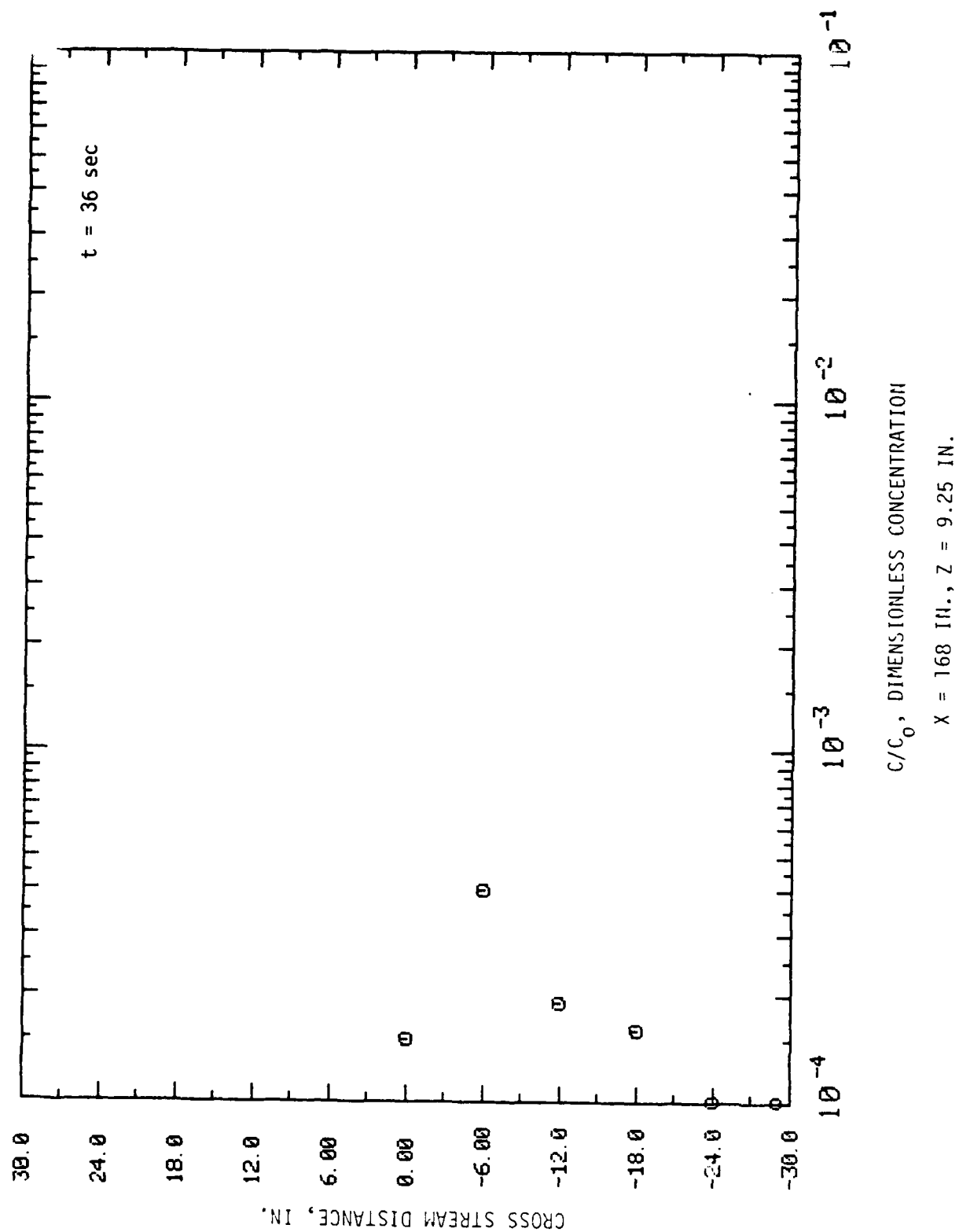


FIGURE F-11. RUN II.1-8B CROSS STREAM CONCENTRATION PROFILE

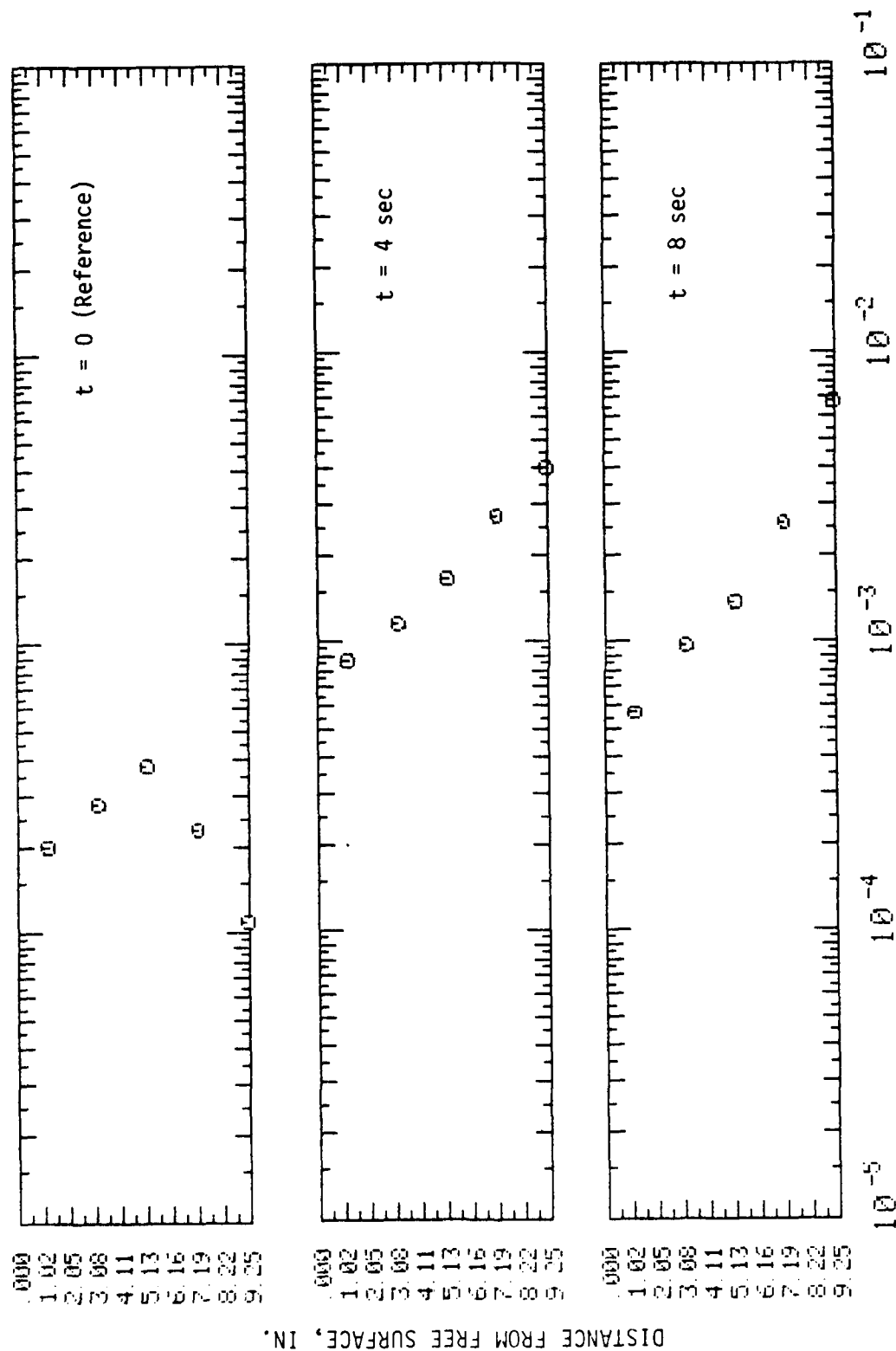
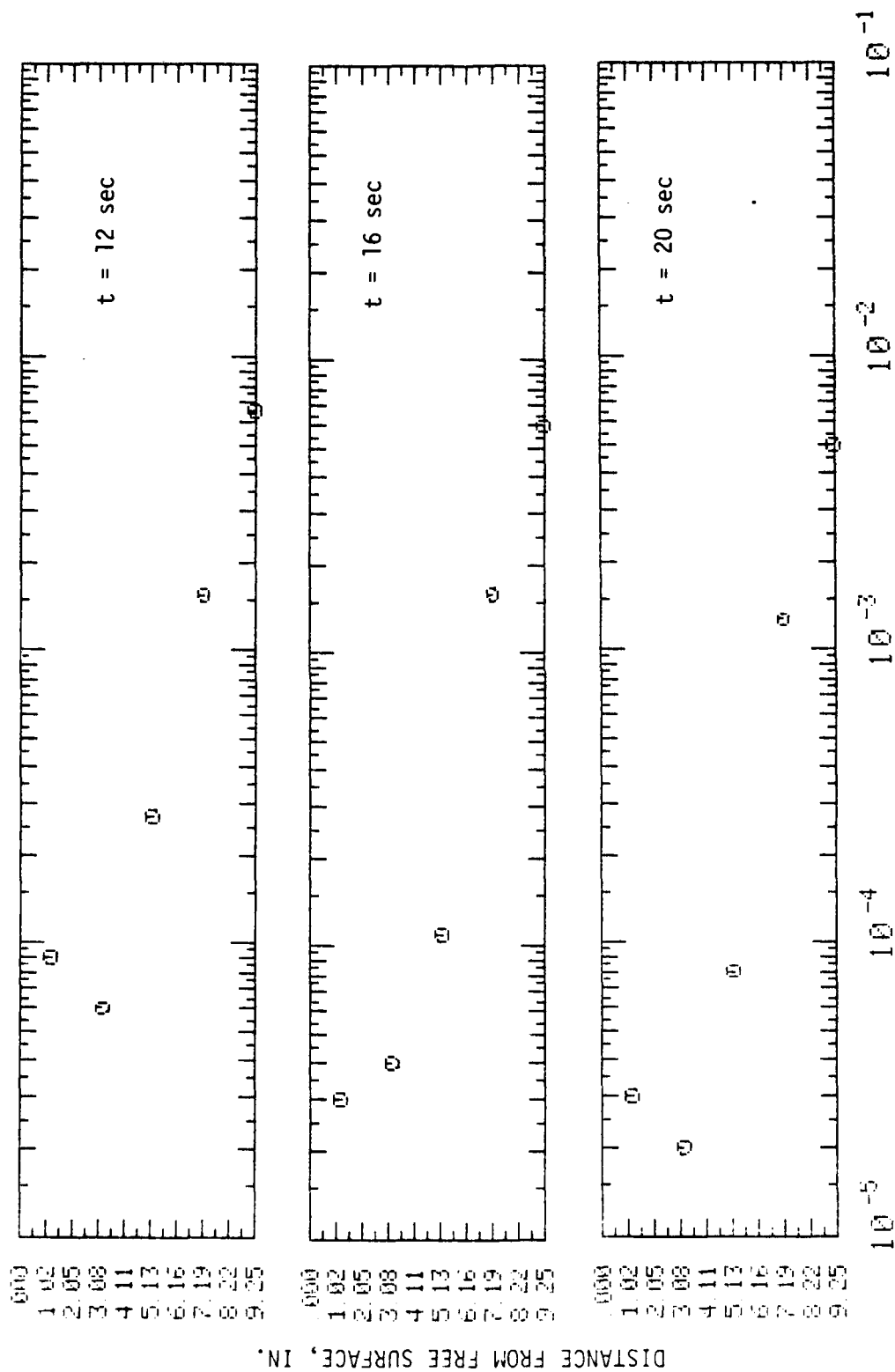


FIGURE F-12. RUN II.1-83 VERTICAL CONCENTRATION PROFILES



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$

FIGURE F-13. RUN II.1-88 VERTICAL CONCENTRATION PROFILES

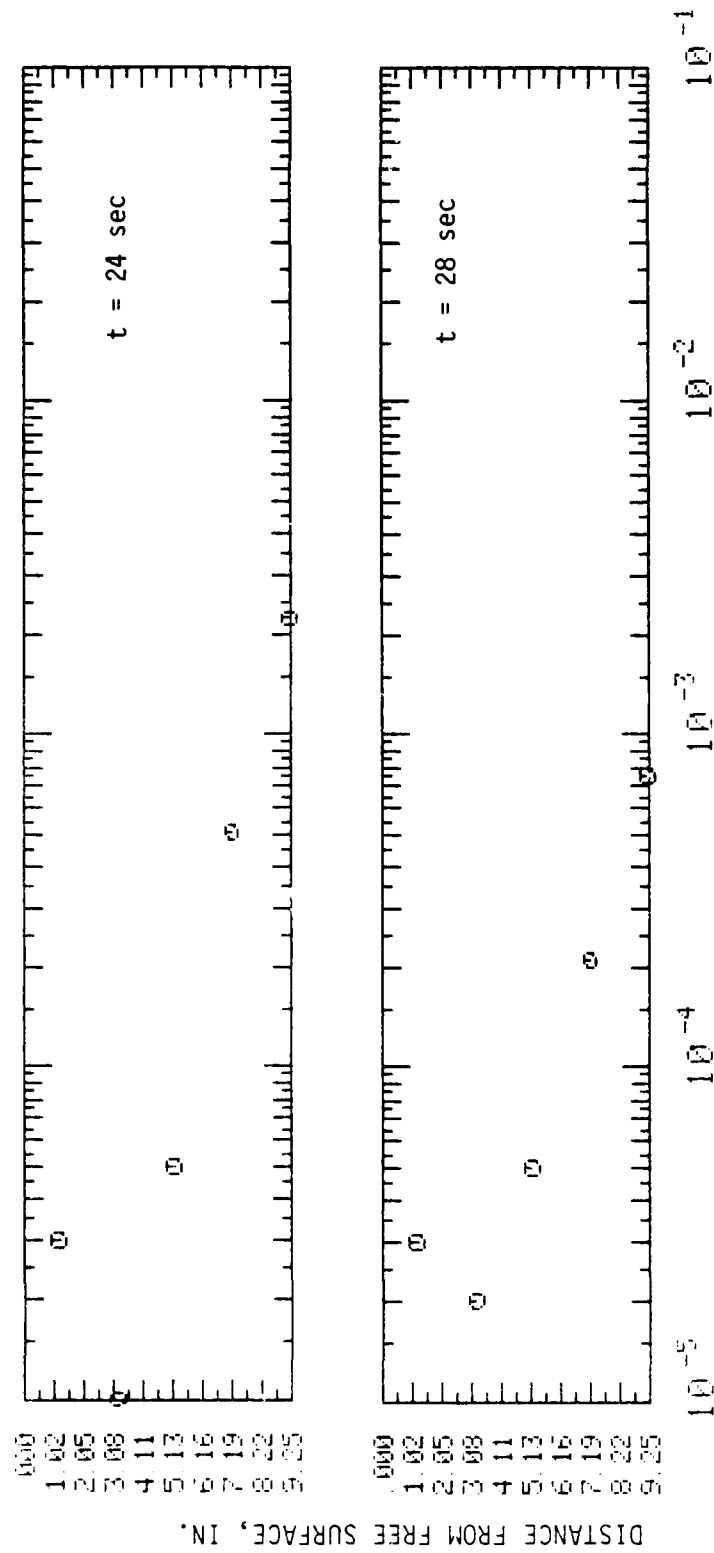


FIGURE F-14. RUN 11.1-88 VERTICAL CONCENTRATION PROFILES

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ANALYTICAL AND EXPERIMENTAL STUDY TO IMPROVE COMPUTER
MODELS FOR MIXING R. (U) SOUTHWEST RESEARCH INST SAN
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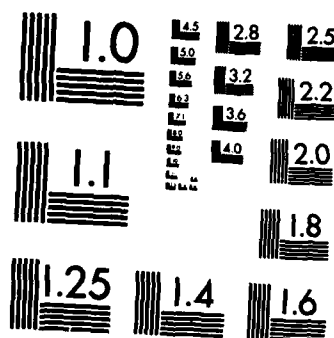
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APPENDIX G

CONCENTRATION PROFILES FOR RUN II.1-13

$$\rho_c/\rho = 1.40 \text{ (Sodium Silicate)}$$

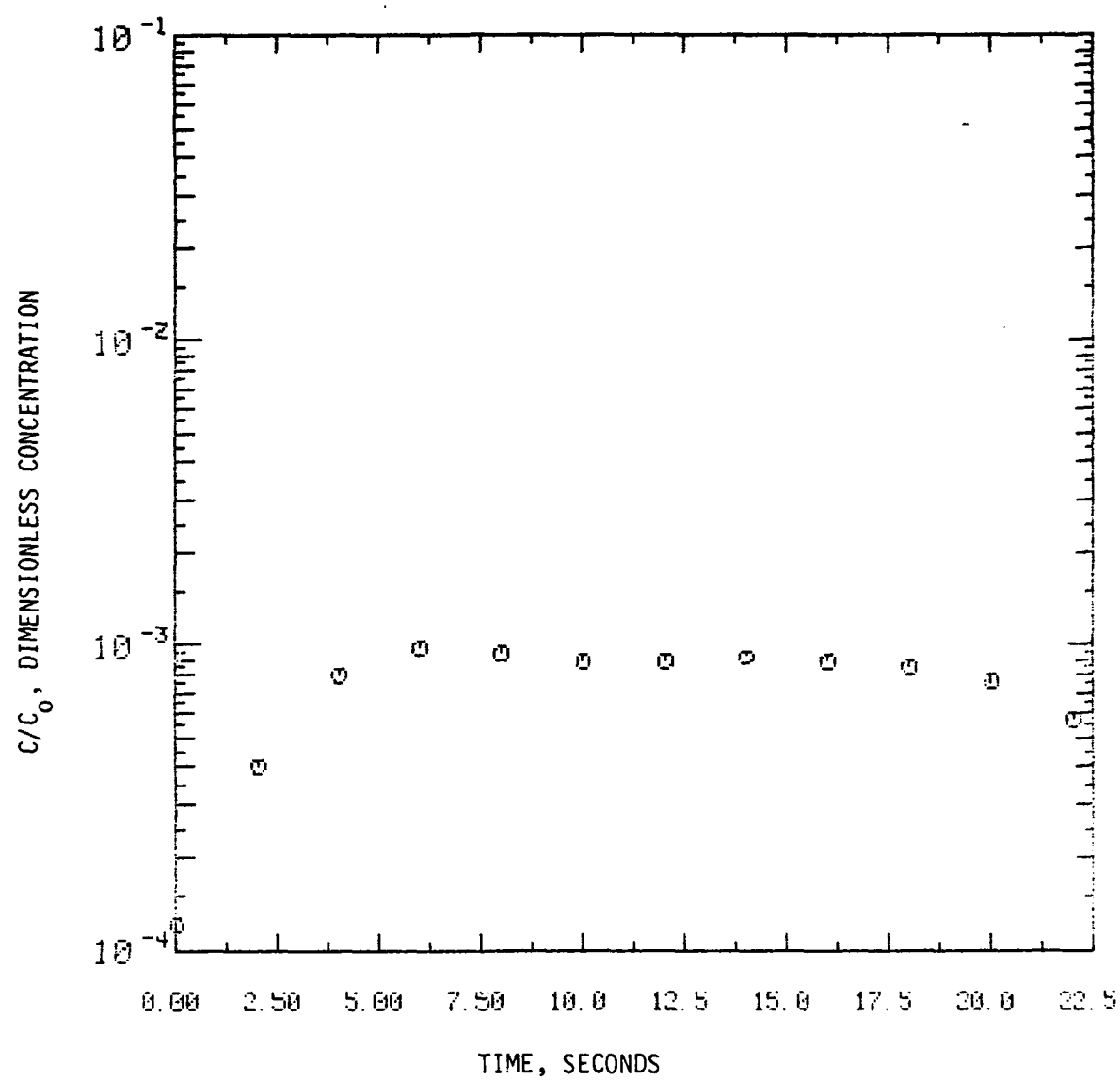
$$r_i/d = 0.125$$

$$u_r/U = 0.05$$

$$U(\text{cm/sec}) = 14.1$$

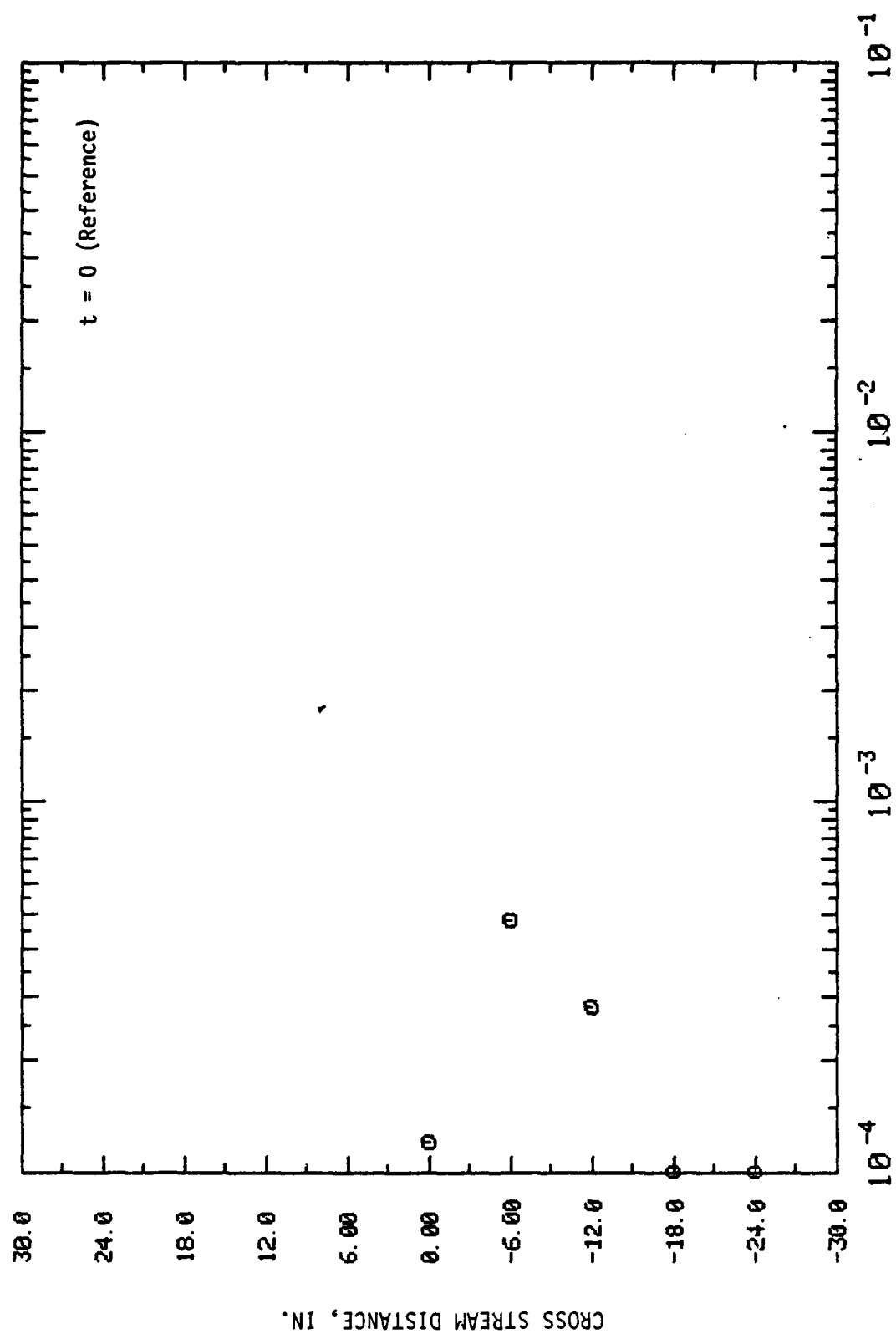
Time elapsed from spill to $t=0$ (Reference) for:

time history graph	31 sec.
cross stream profiles	31 sec.
vertical profiles	29 sec.



X = 168 IN., Y = 0, Z = 9.25 IN.

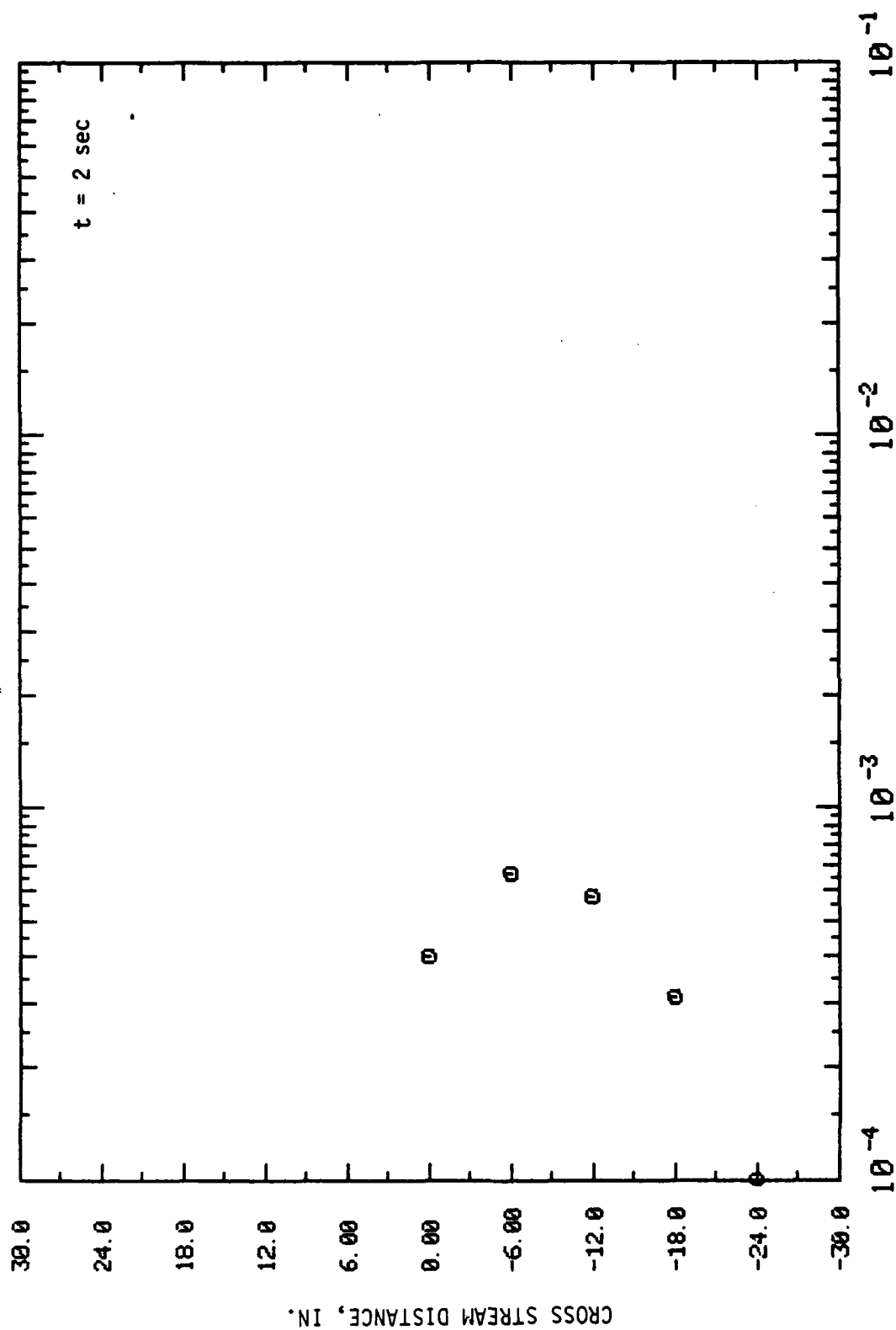
FIGURE G-1. RUN II.1-13 CONCENTRATION TIME HISTORY



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Z = 9.25$ IN.

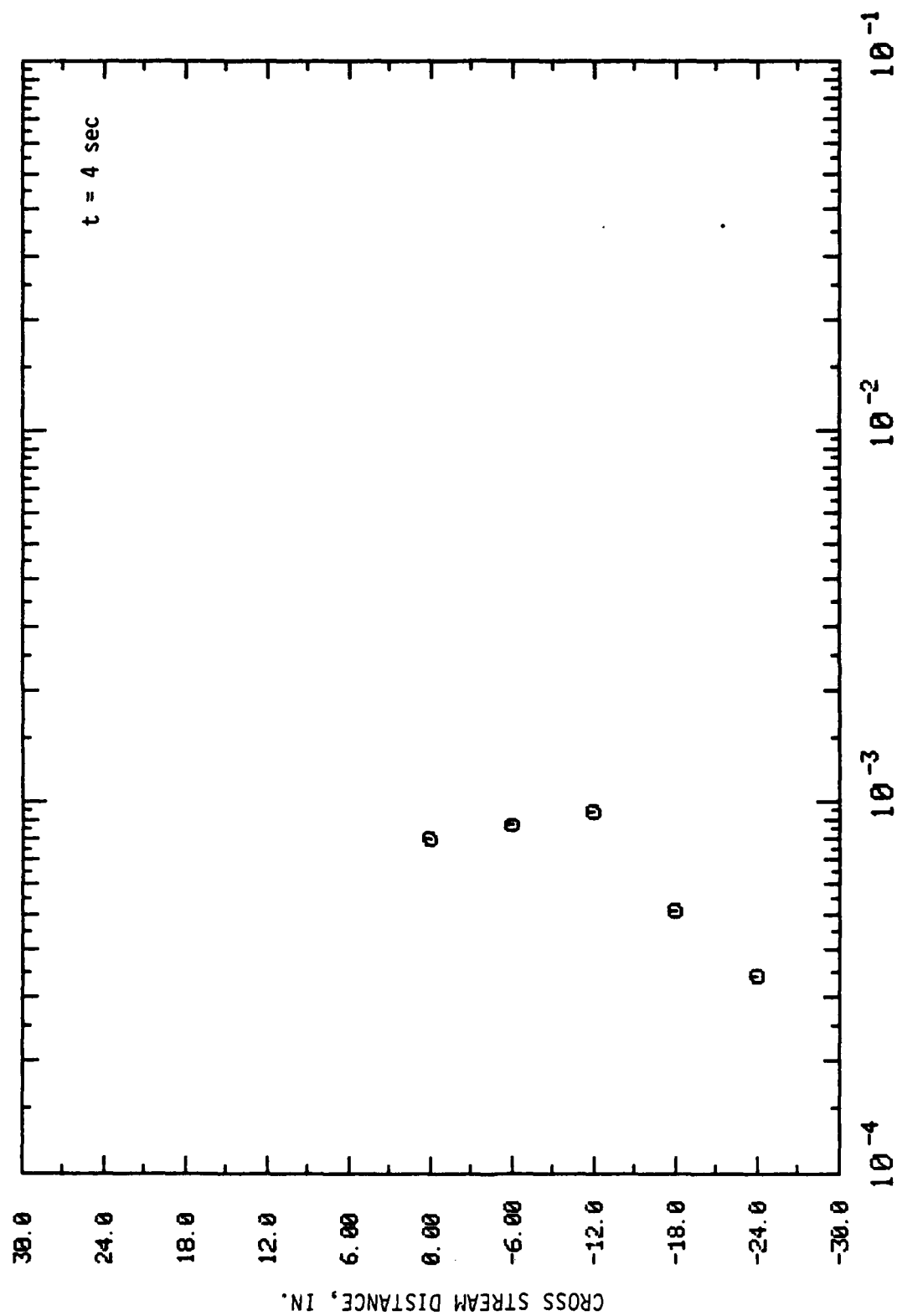
FIGURE G-2. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

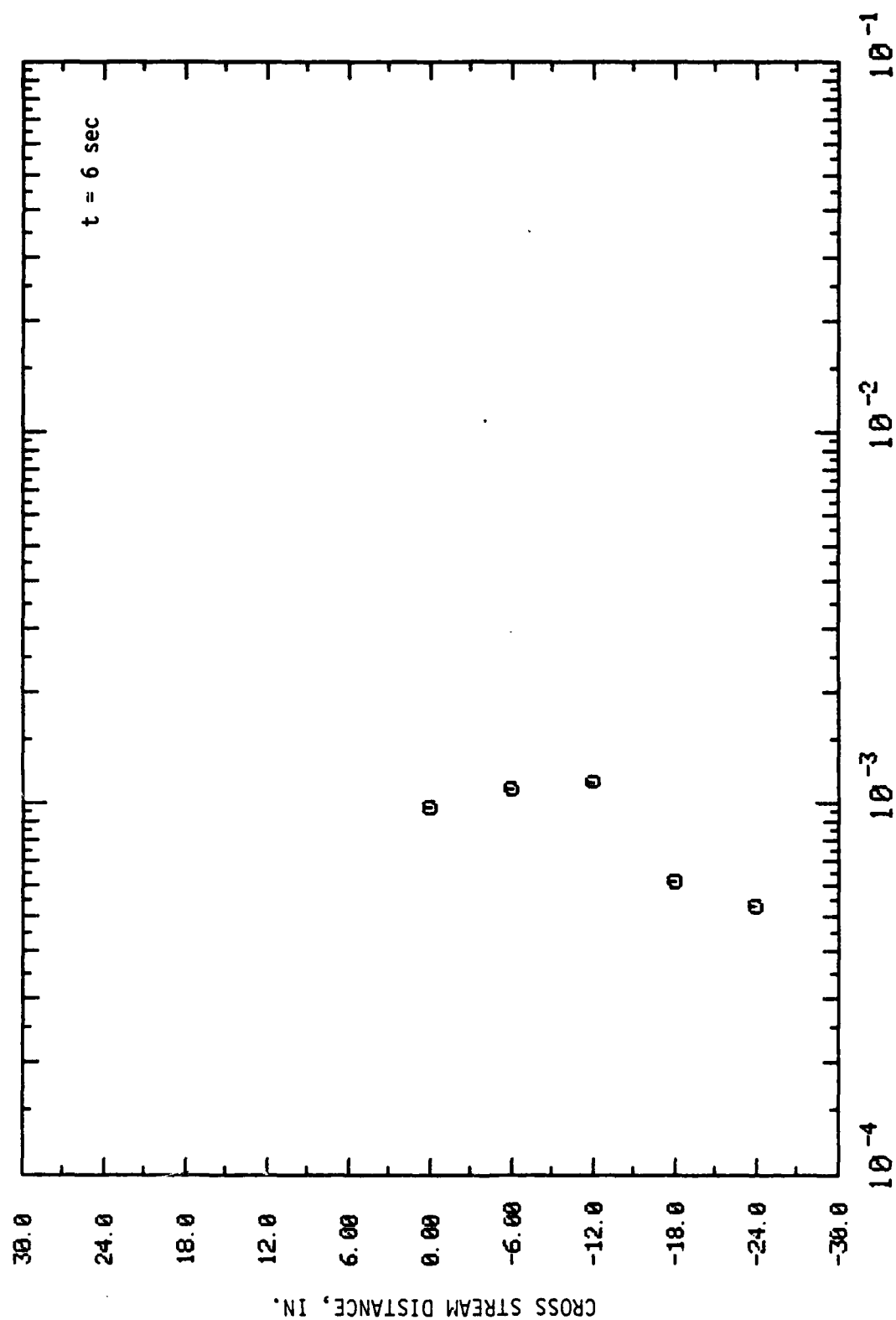
FIGURE G-3. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE G-4. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Z = 9.25$ IN.

FIGURE G-5. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE

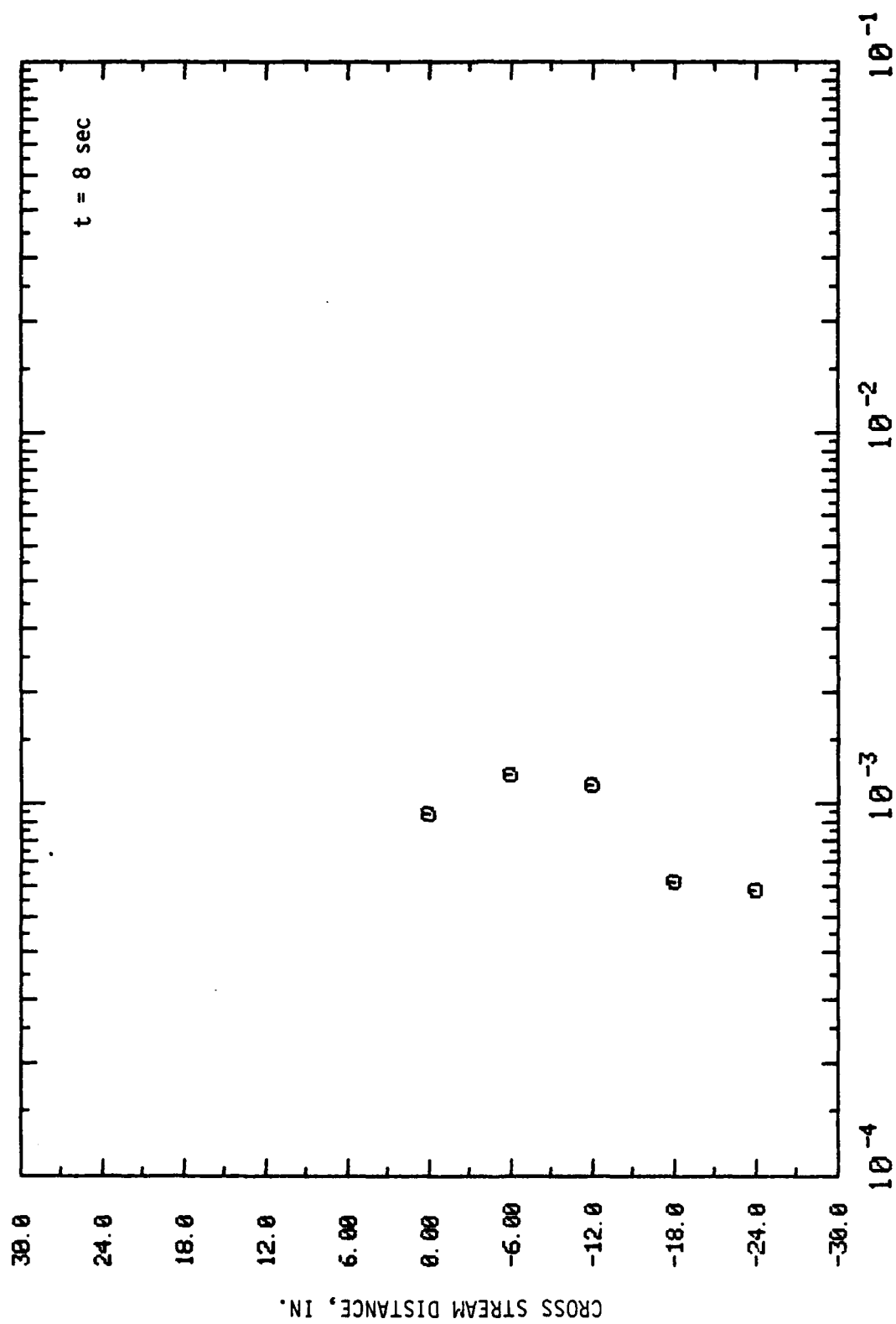


FIGURE G-6. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE

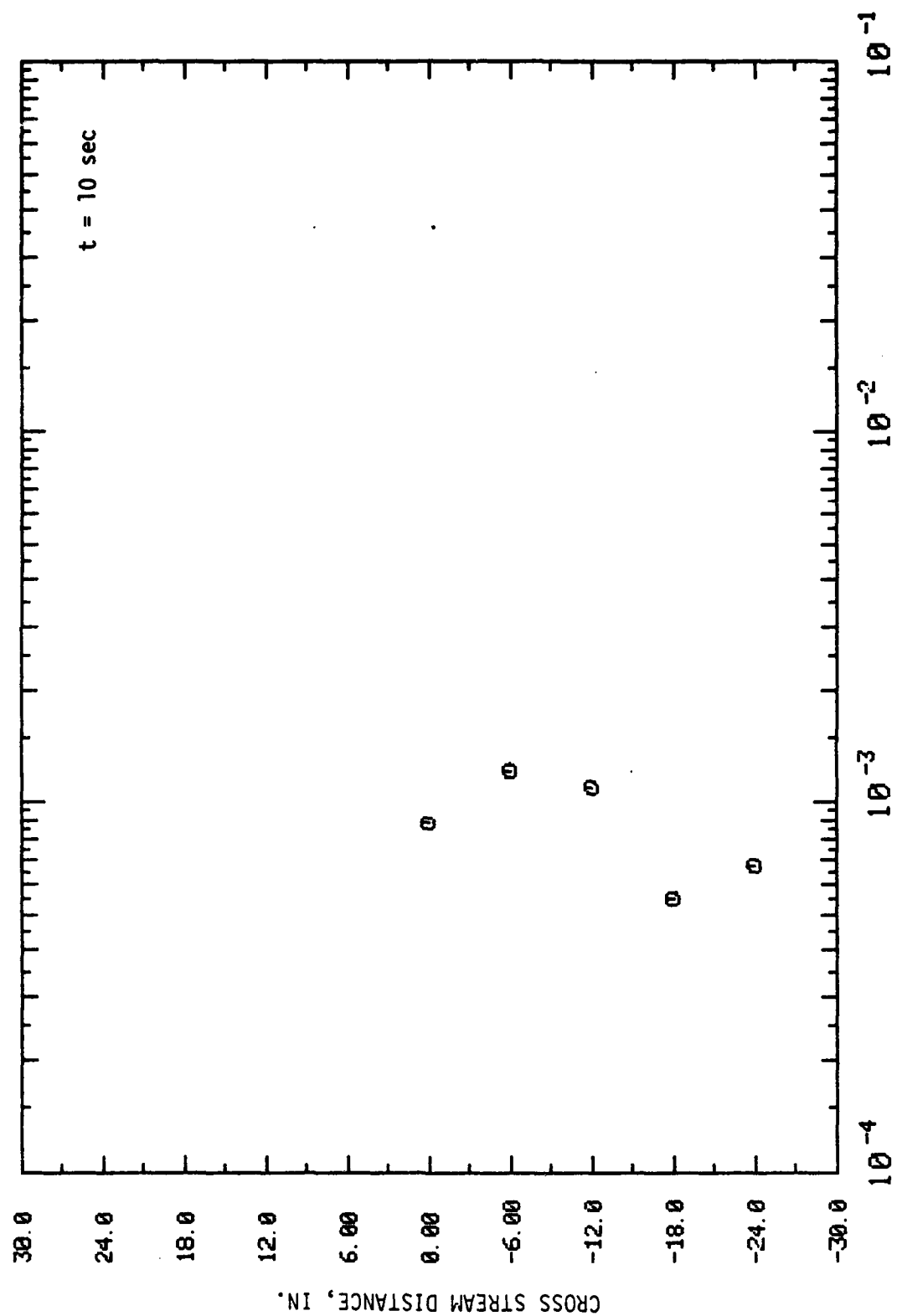
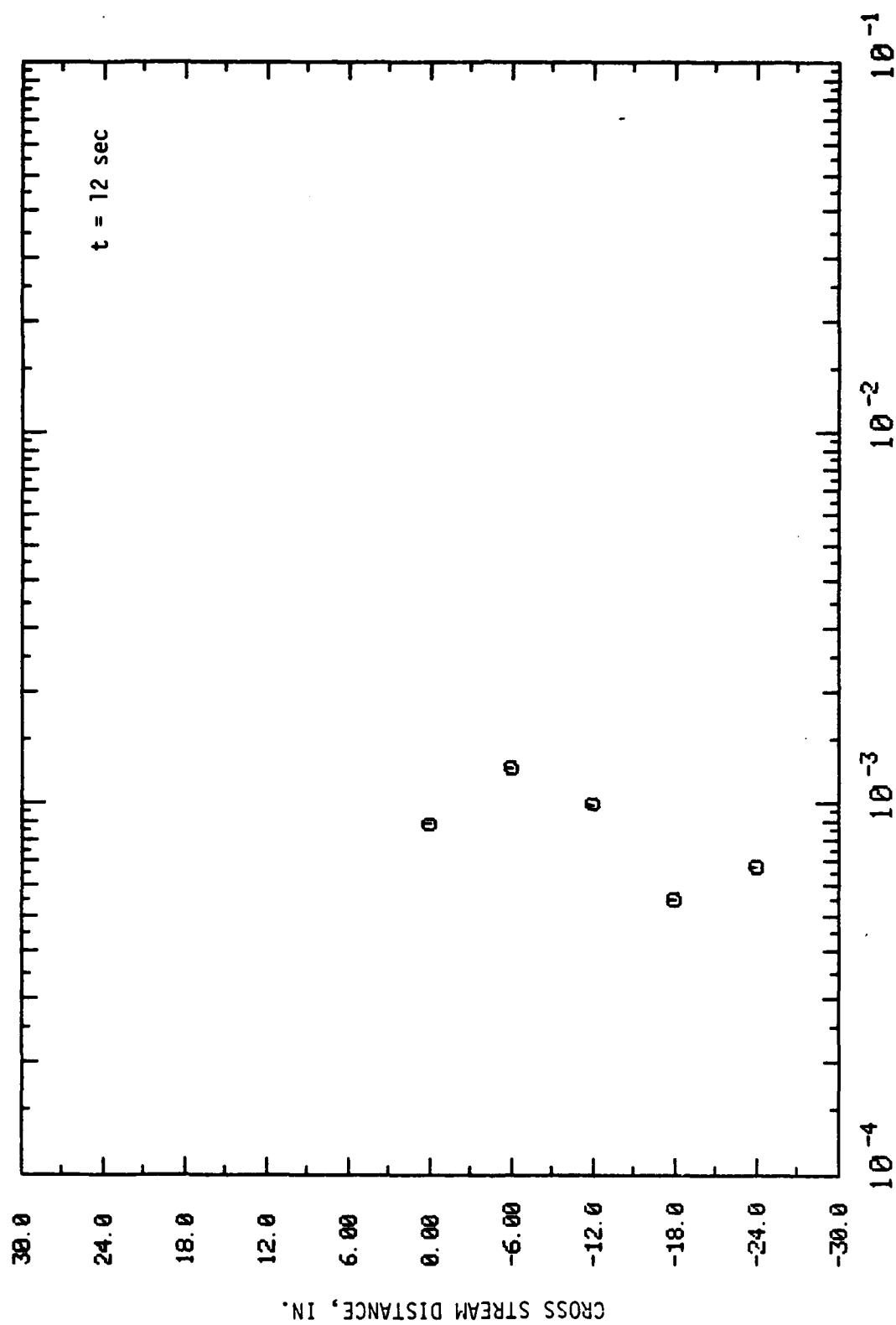


FIGURE G-7. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE G-8. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE

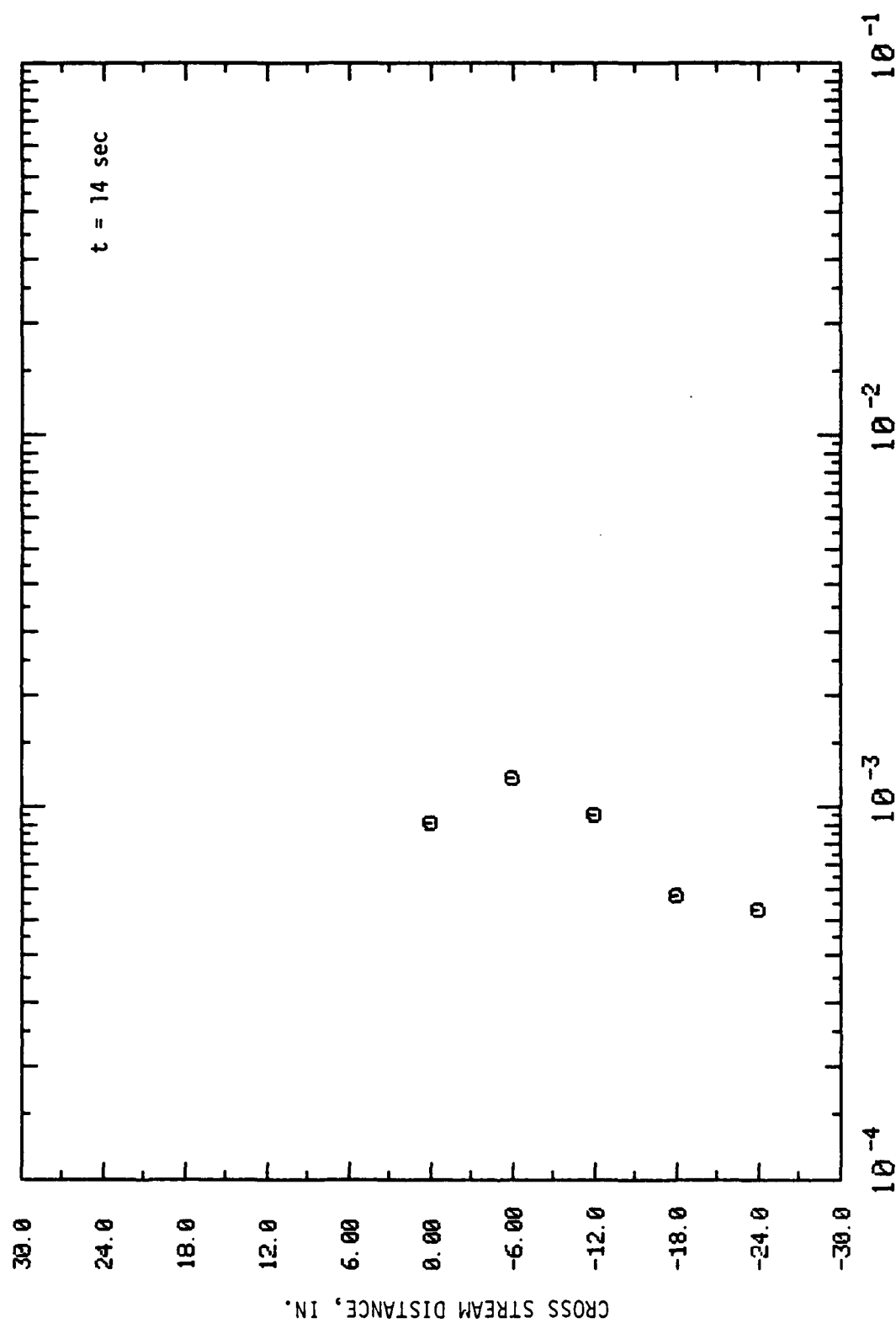


FIGURE G-9. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE

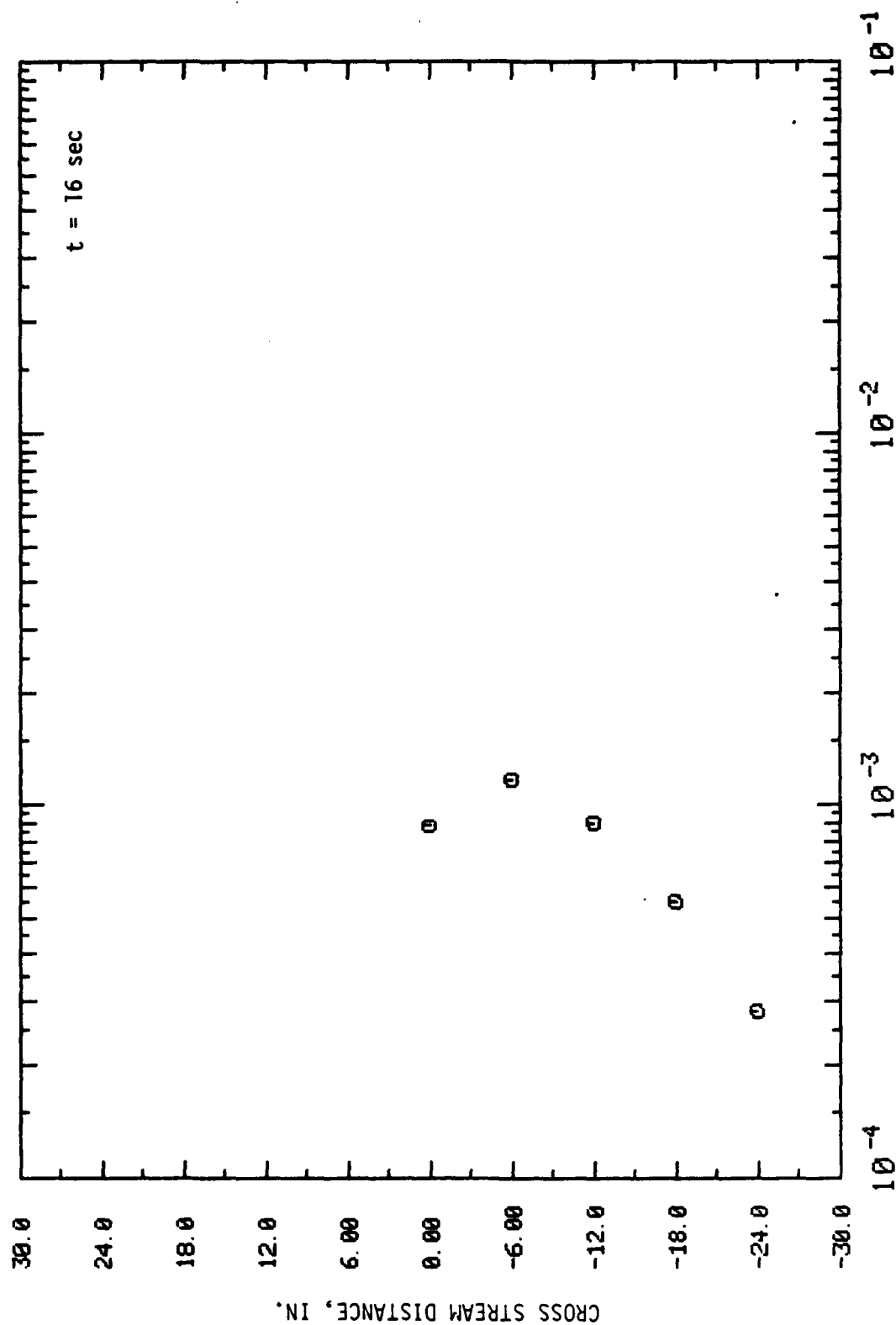
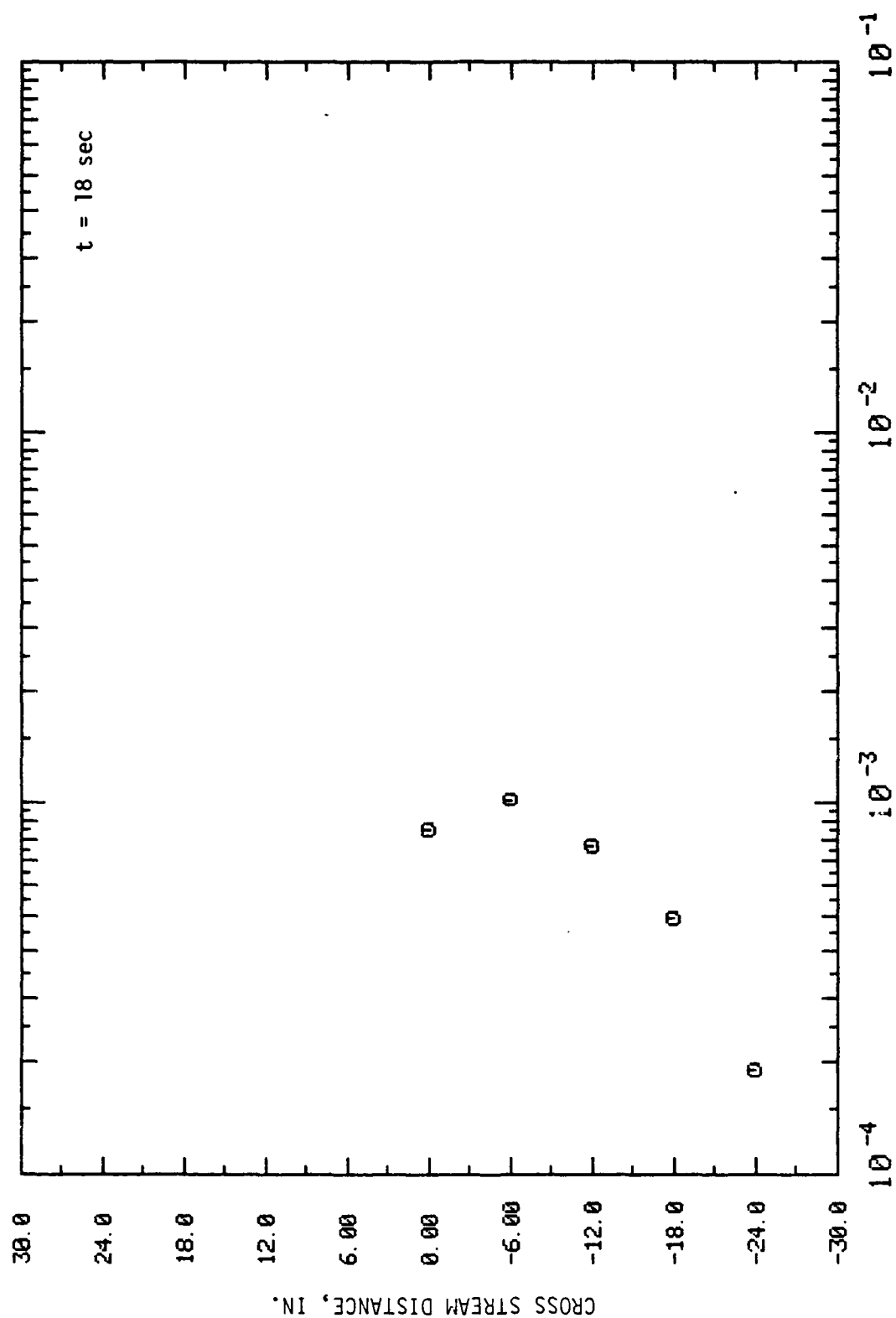


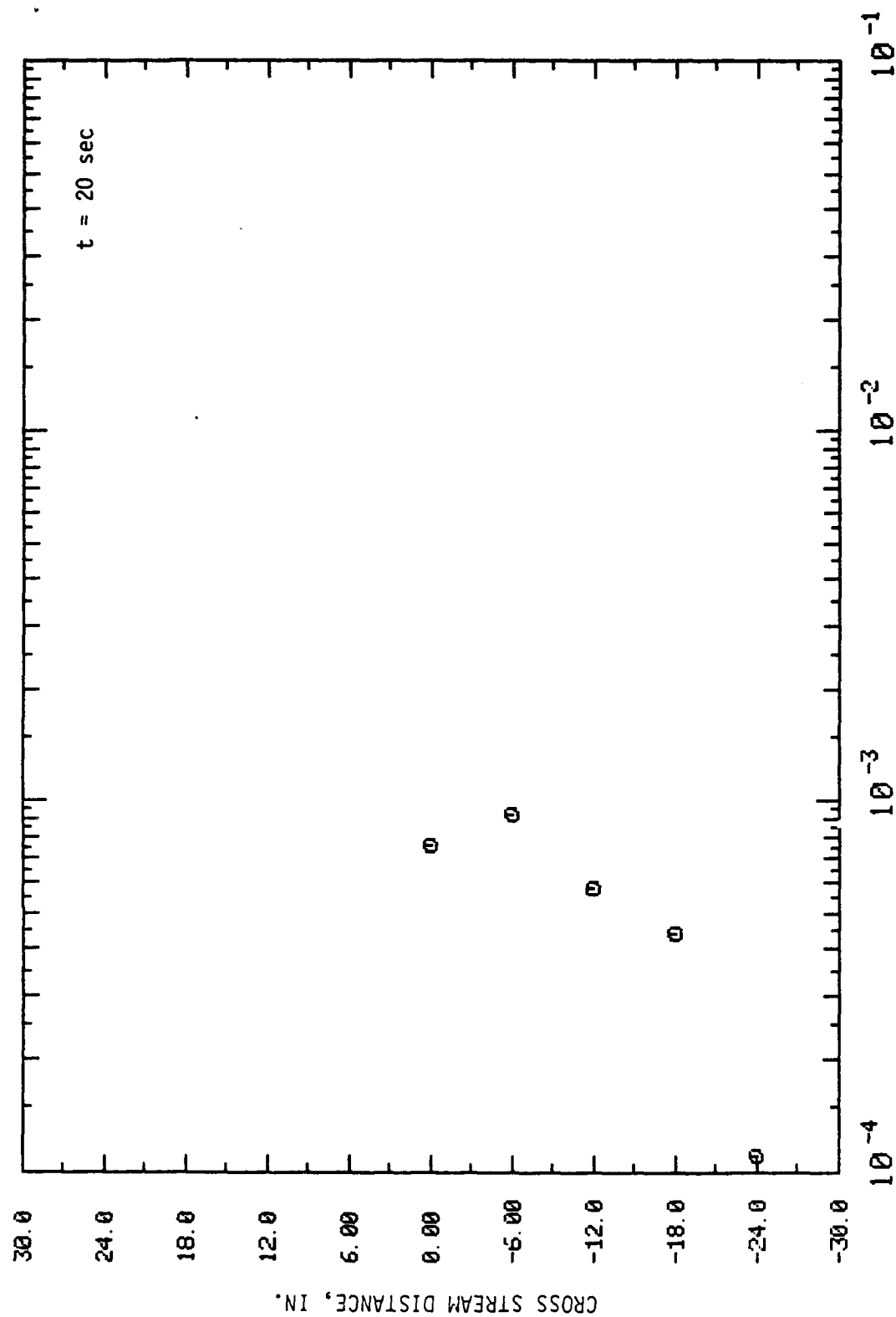
FIGURE G-10. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

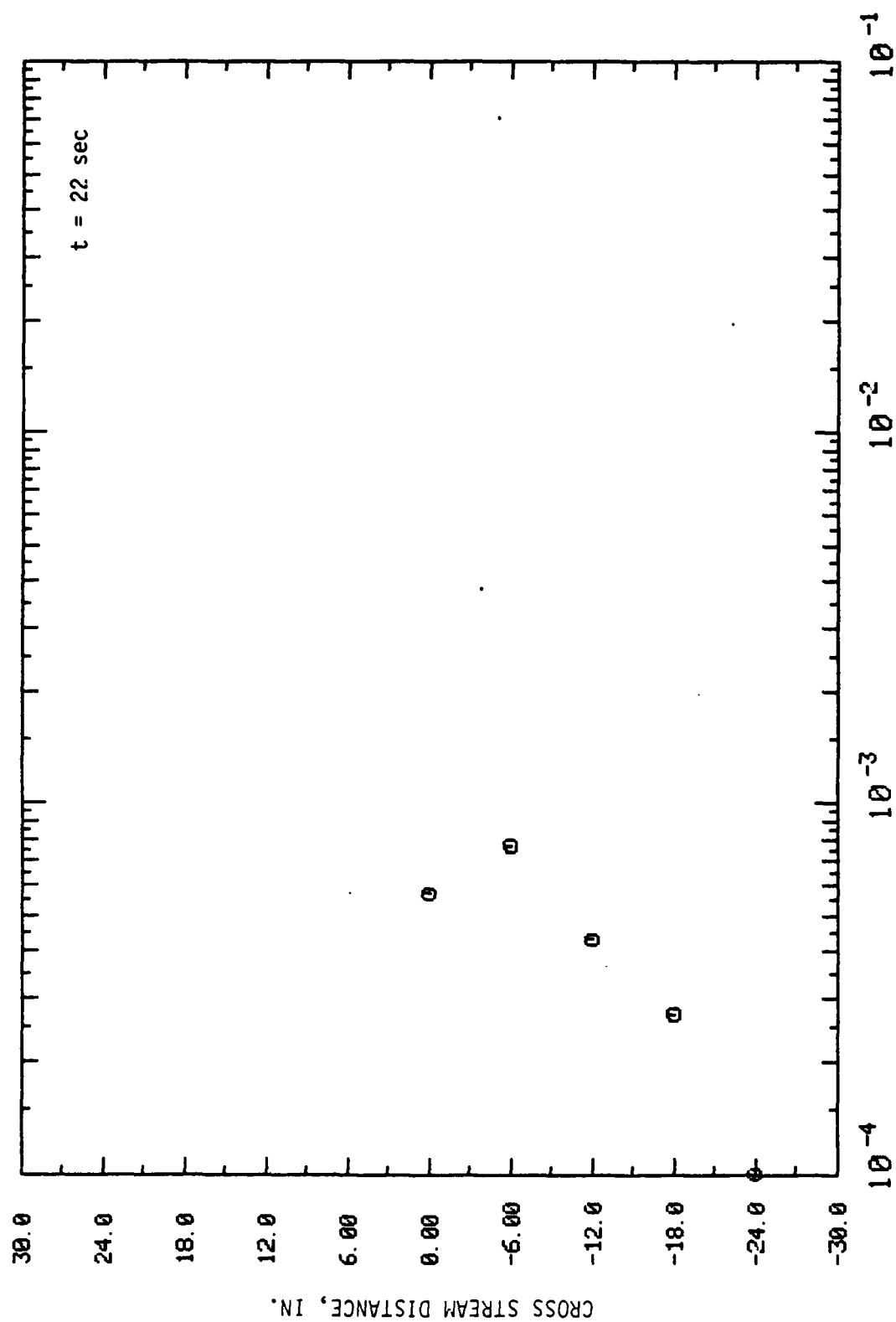
FIGURE G-11. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

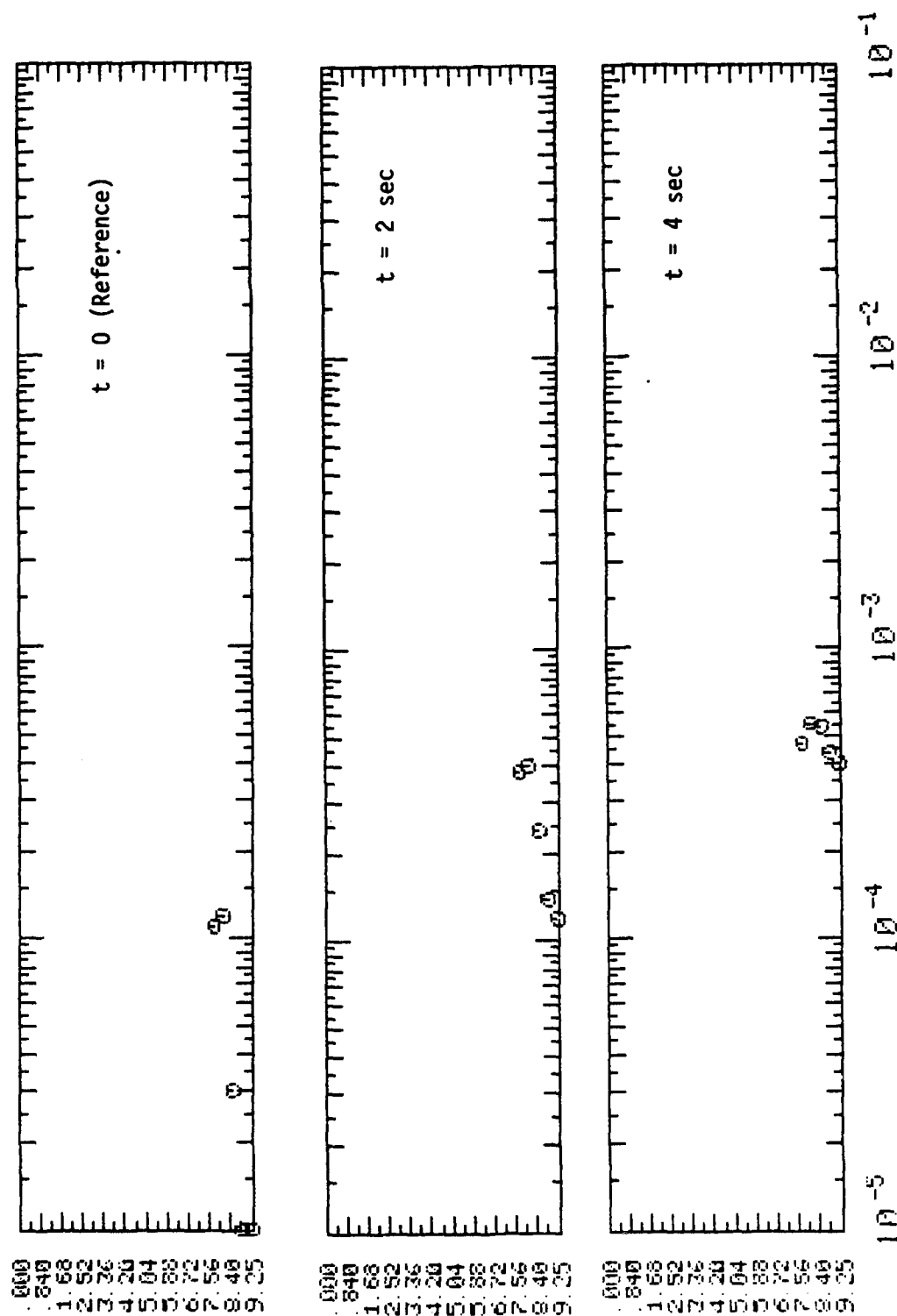
FIGURE G-12. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE



C/C₀, DIMENSIONLESS CONCENTRATION

X = 168 IN., Z = 9.25 IN.

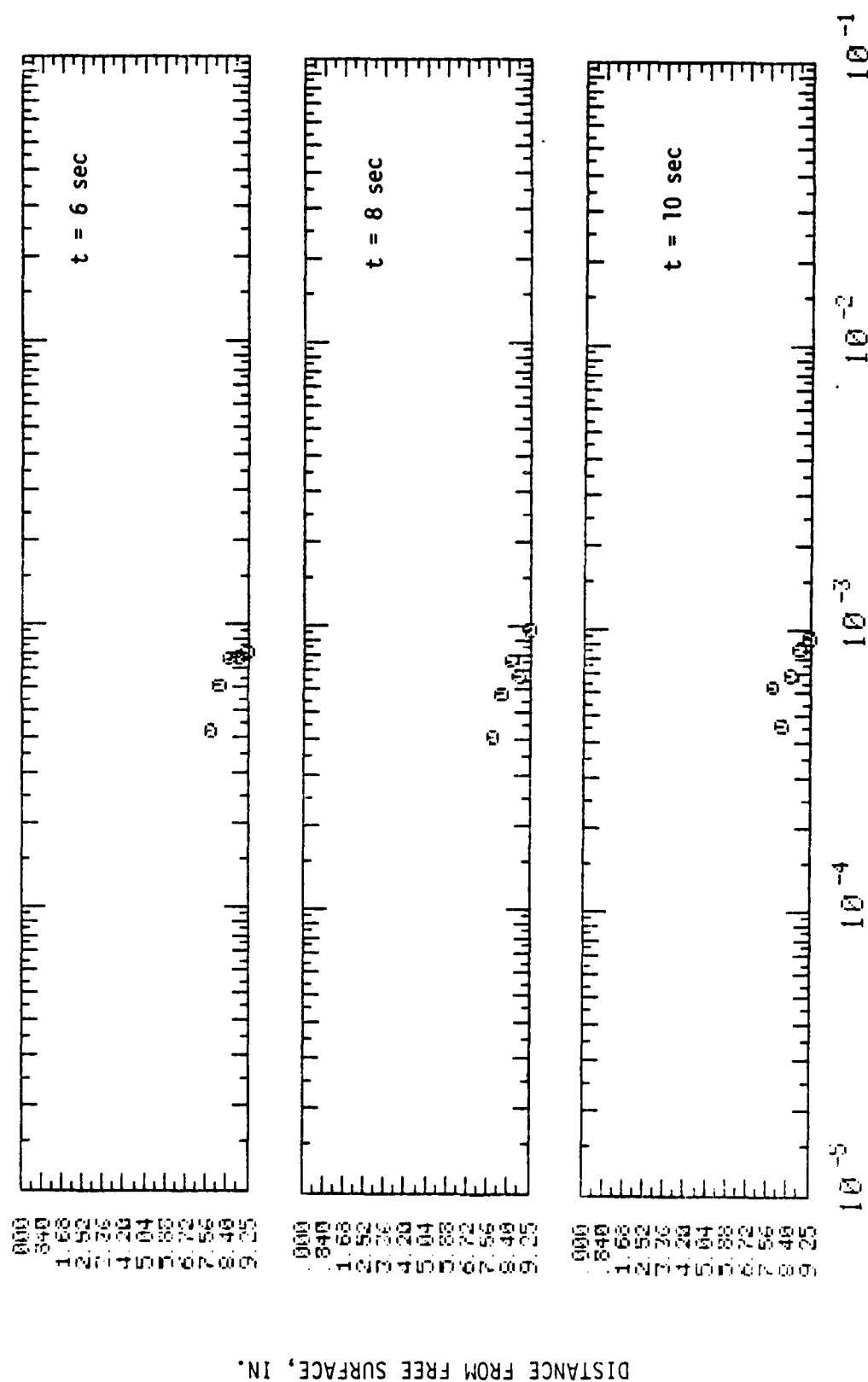
FIGURE G-13. RUN II.1-13 CROSS STREAM CONCENTRATION PROFILE



C/C₀, DIMENSIONLESS CONCENTRATION

X = 168 IN., Y = 0

FIGURE G-14. RUN II.1-13 VERTICAL CONCENTRATION PROFILES

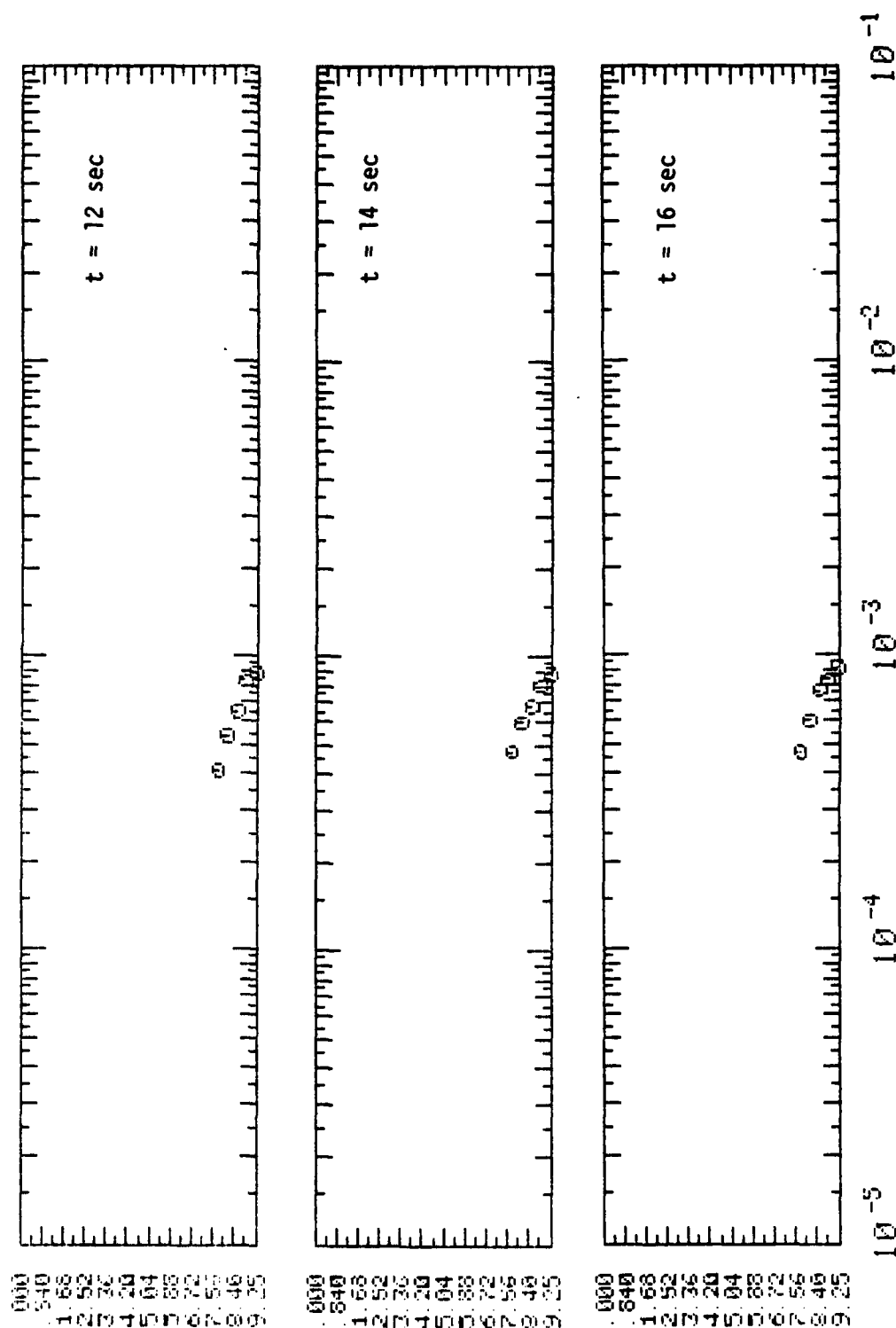


C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$

FIGURE G-15. RUN II.1-13 VERTICAL CONCENTRATION PROFILES

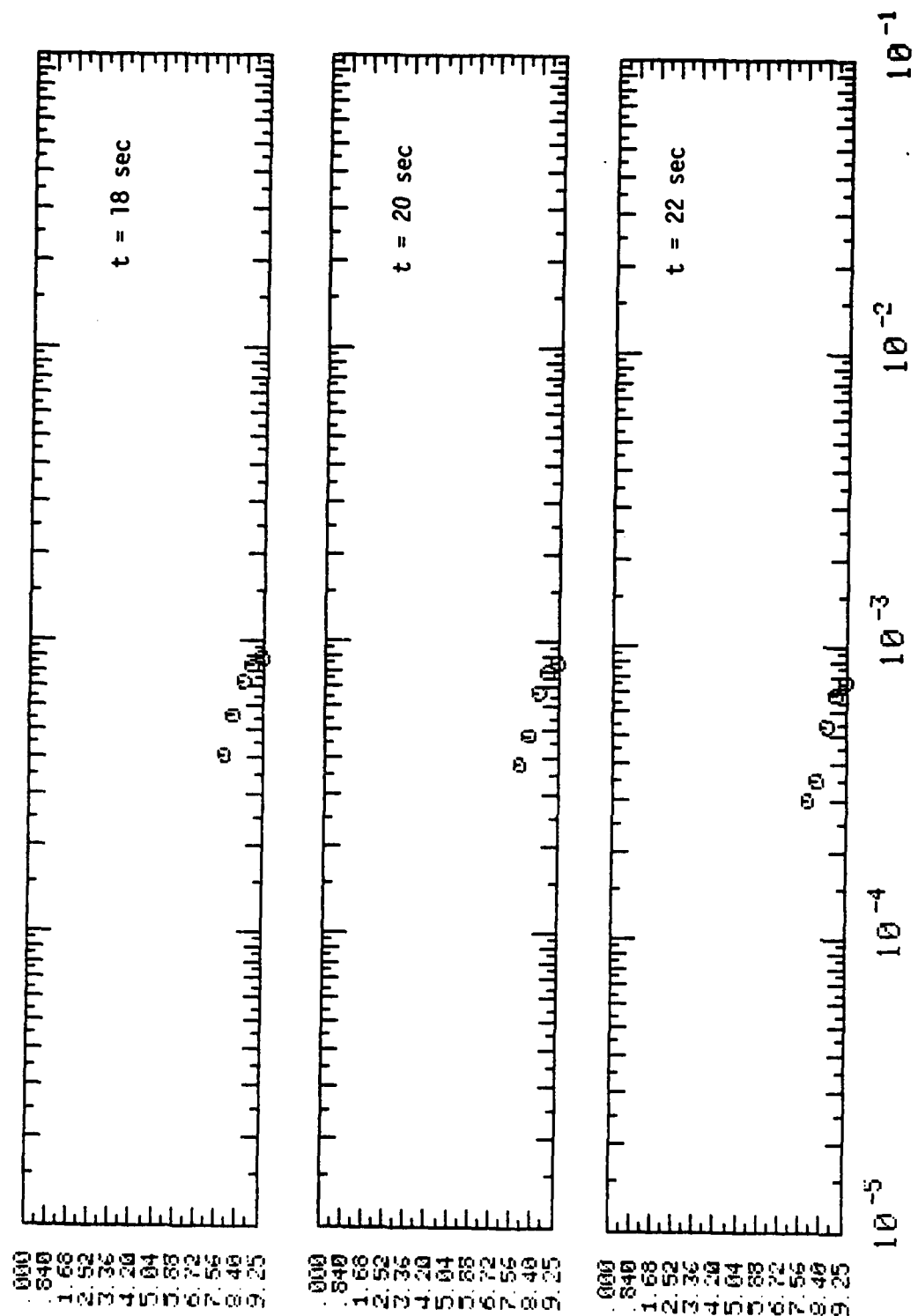
DISTANCE FROM FREE SURFACE, IN.



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$

FIGURE G-16. RUN II.1-13 VERTICAL CONCENTRATION PROFILES

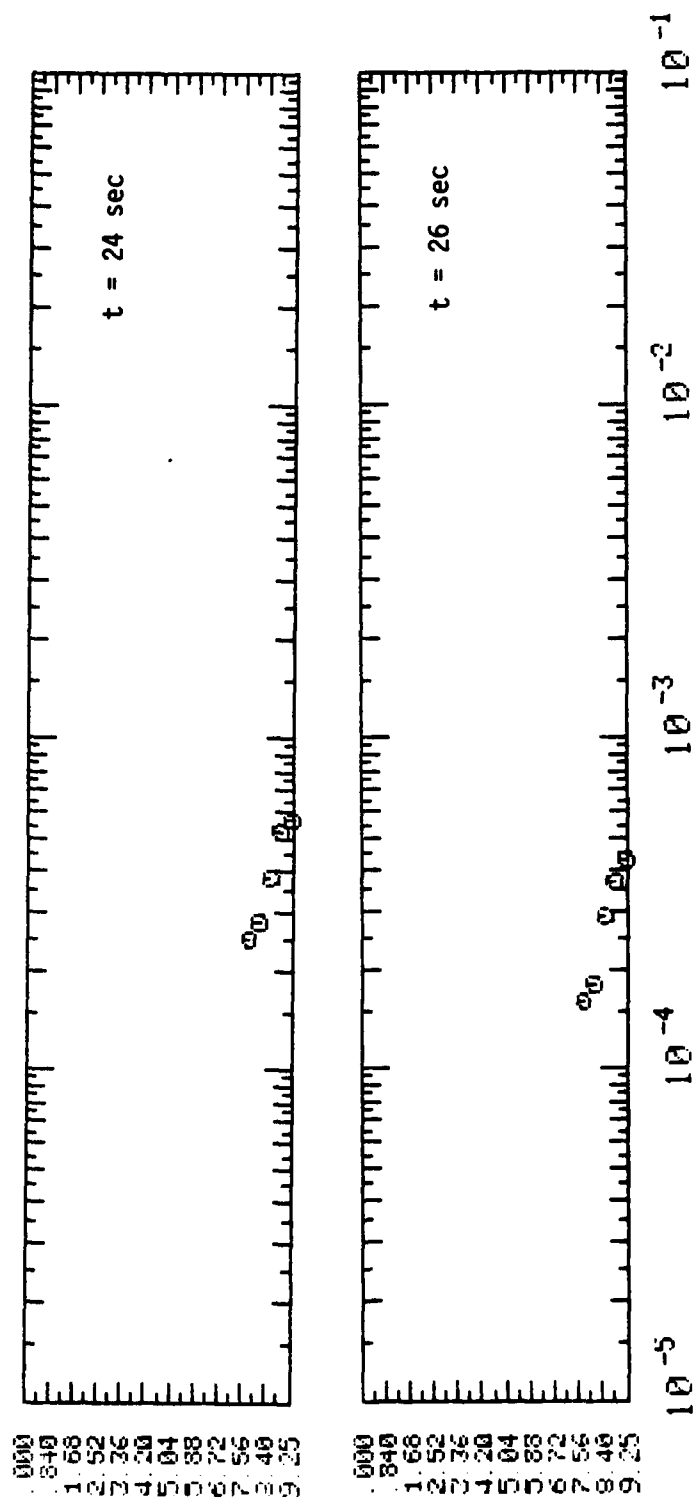


C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$

FIGURE G-17. RUN II.1-13 VERTICAL CONCENTRATION PROFILES

DISTANCE FROM FREE SURFACE, IN.



C/C_0 , DIMENSIONLESS CONCENTRATION

$x = 168$ IN., $y = 0$

FIGURE 6-18. RUN II.1-13 VERTICAL CONCENTRATION PROFILES

DISTANCE FROM FREE SURFACE, IN.

APPENDIX H

CONCENTRATION PROFILES FOR RUN II.1-14

$$\rho_c/\rho = 1.40 \text{ (Sodium Silicate)}$$

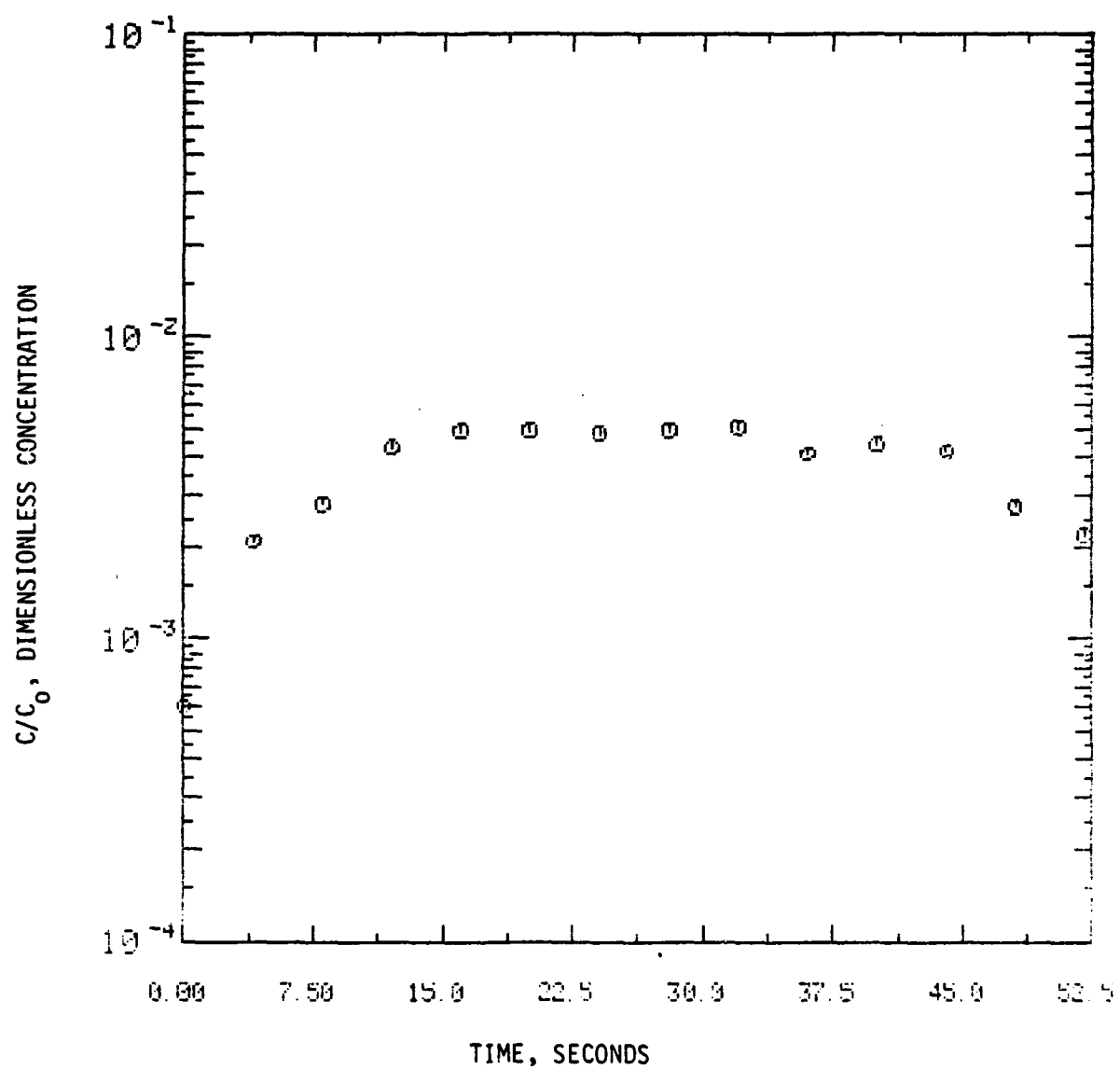
$$r_j/d = 0.23$$

$$u_\tau/U = 0.05$$

$$U(\text{cm/sec}) = 14.1$$

Time elapsed from spill to $t=0$ (Reference) for:

time history graph	31 sec.
cross stream profiles	31 sec.
vertical profiles	31 sec.



X = 168 IN., Y = 0, Z = 9.25 IN.

FIGURE H-1 . RUN II.1-14 CONCENTRATION TIME HISTORY

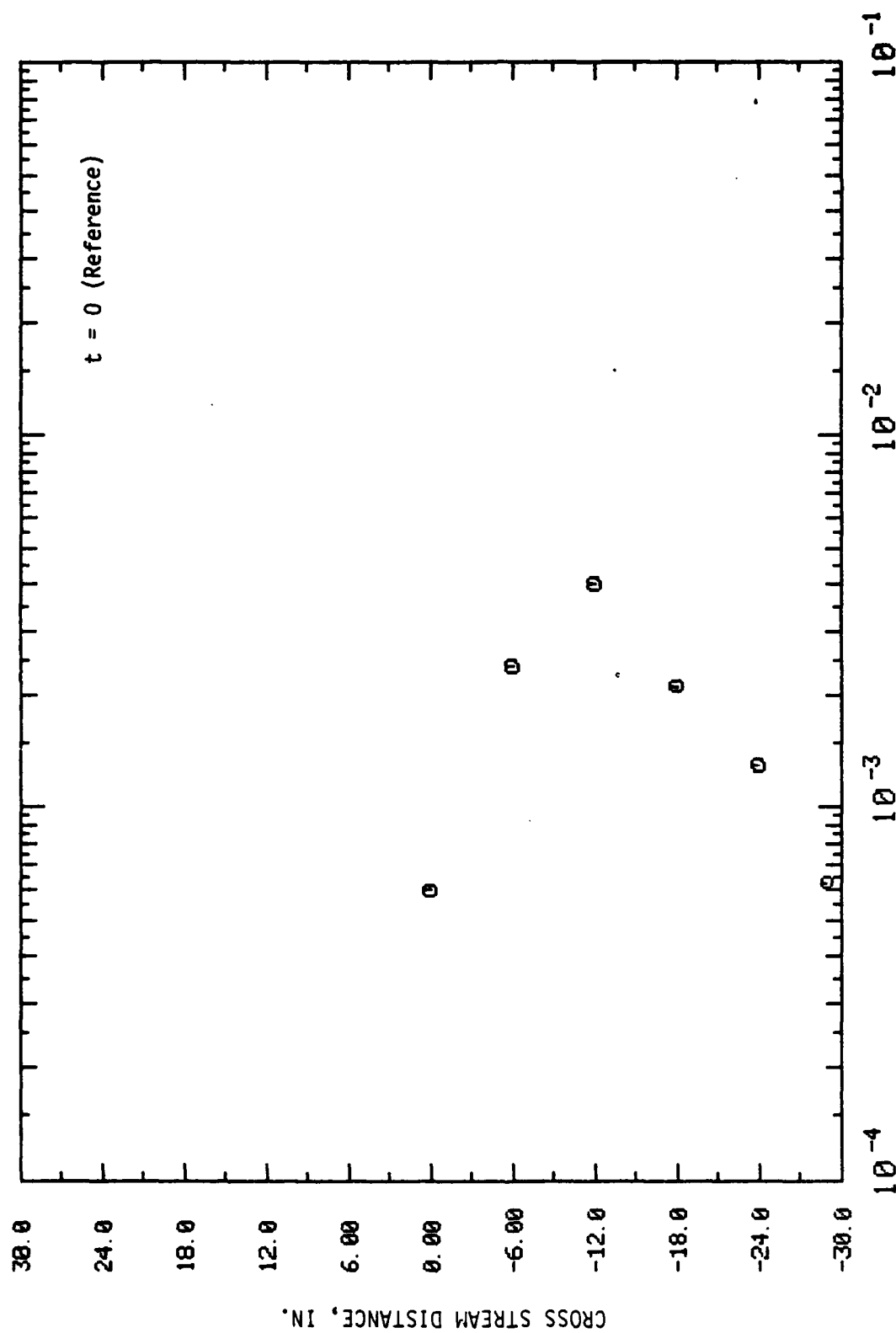


FIGURE H-2 . RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

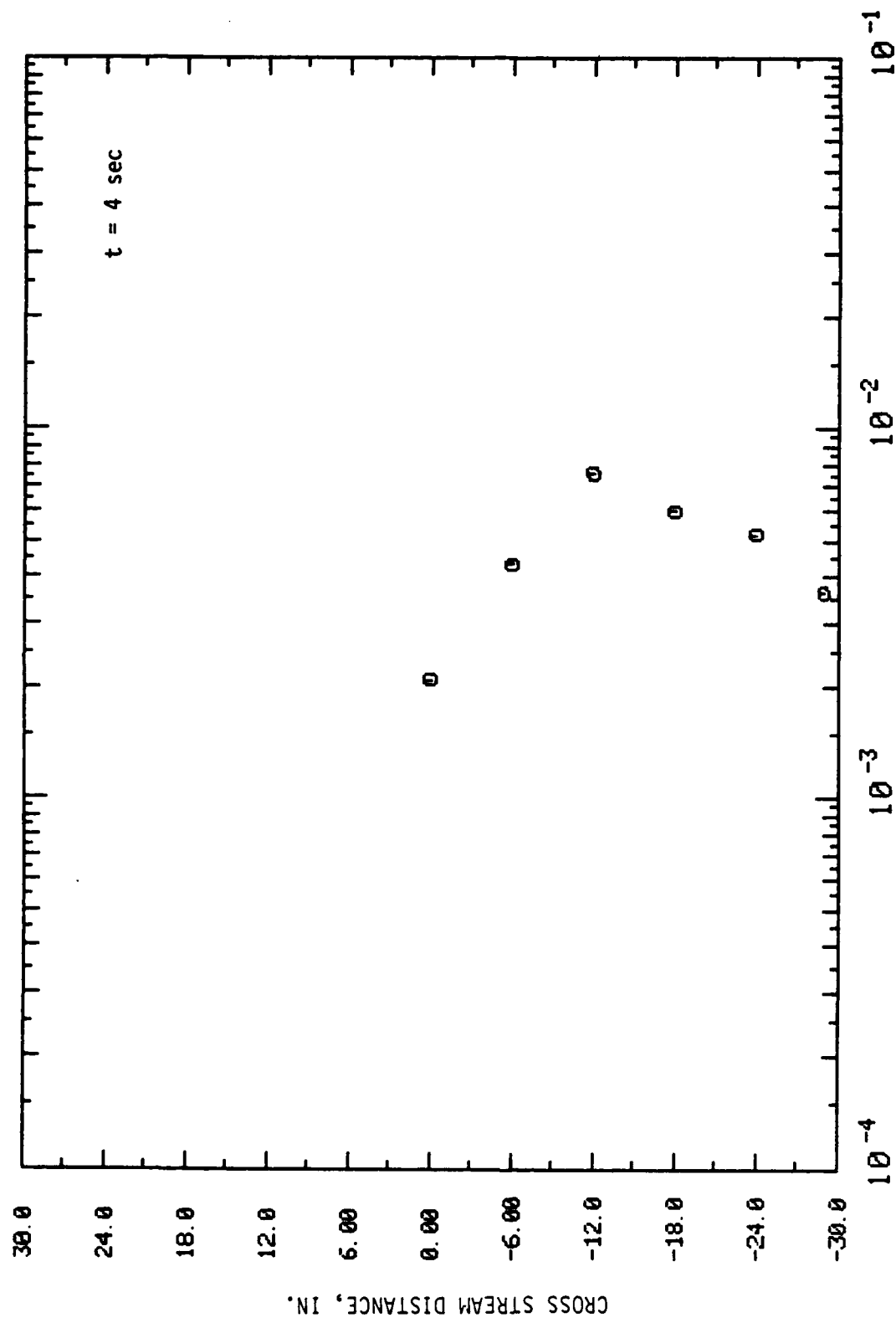


FIGURE H-3. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

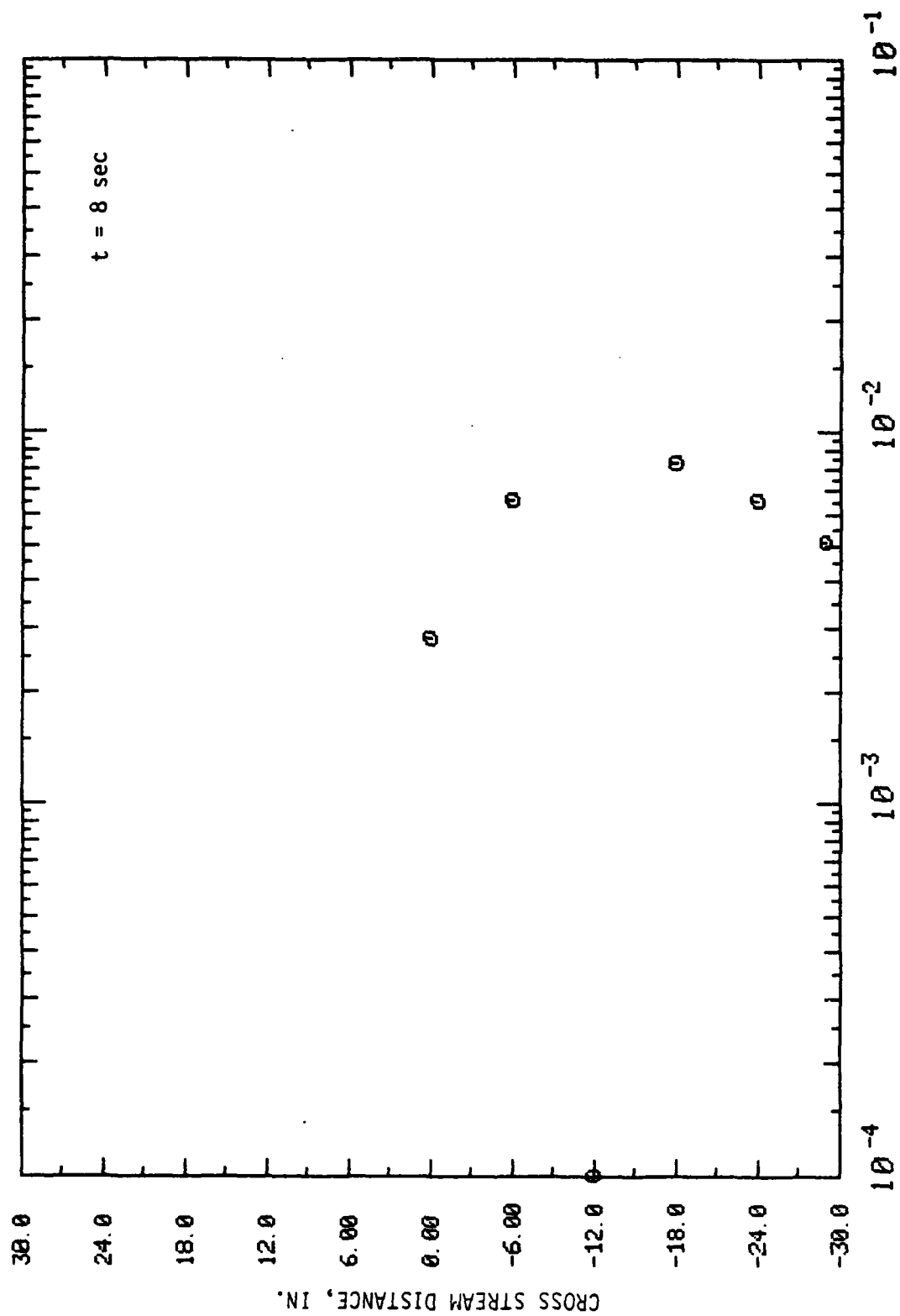


FIGURE H-4 . RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

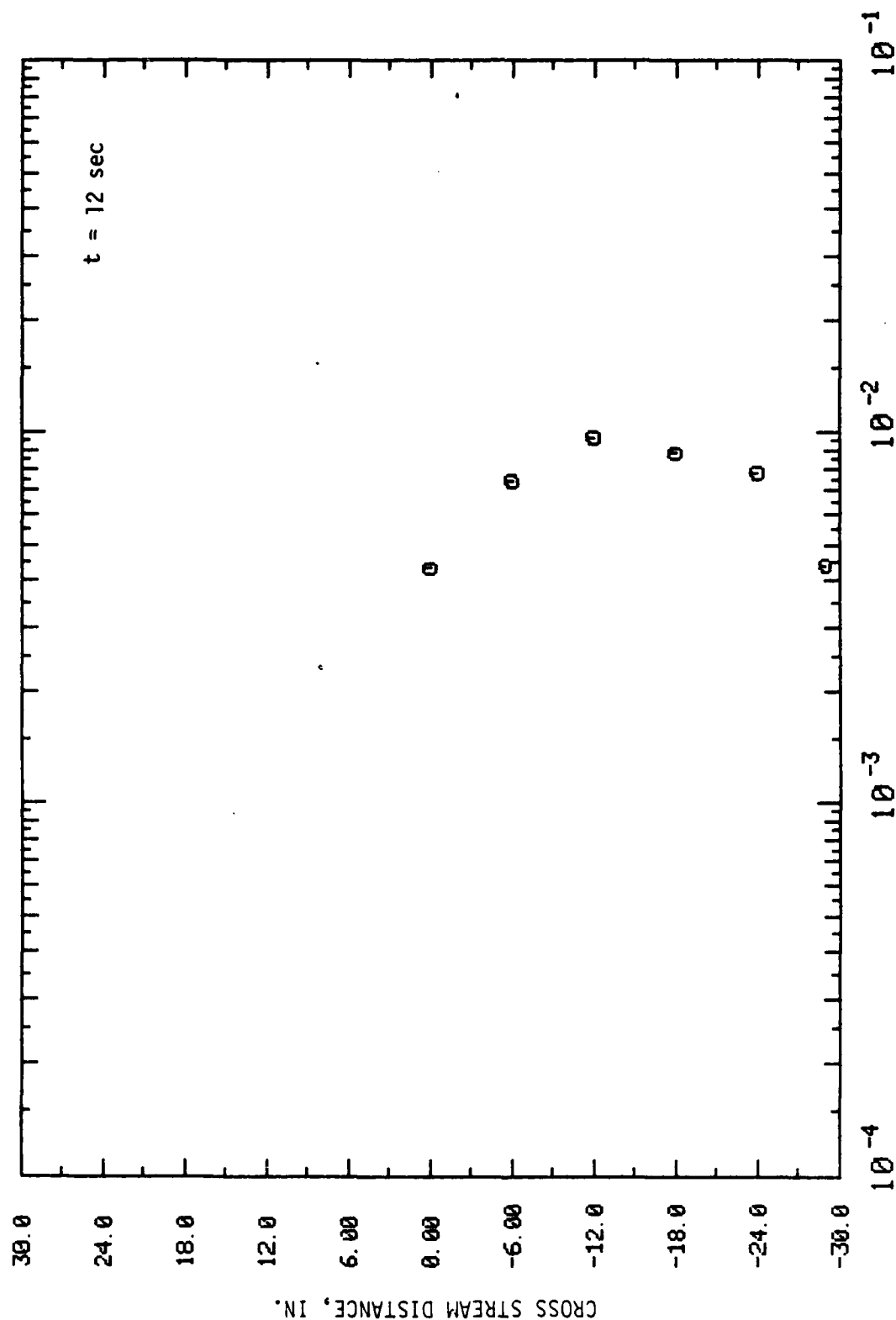


FIGURE H-5 . RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

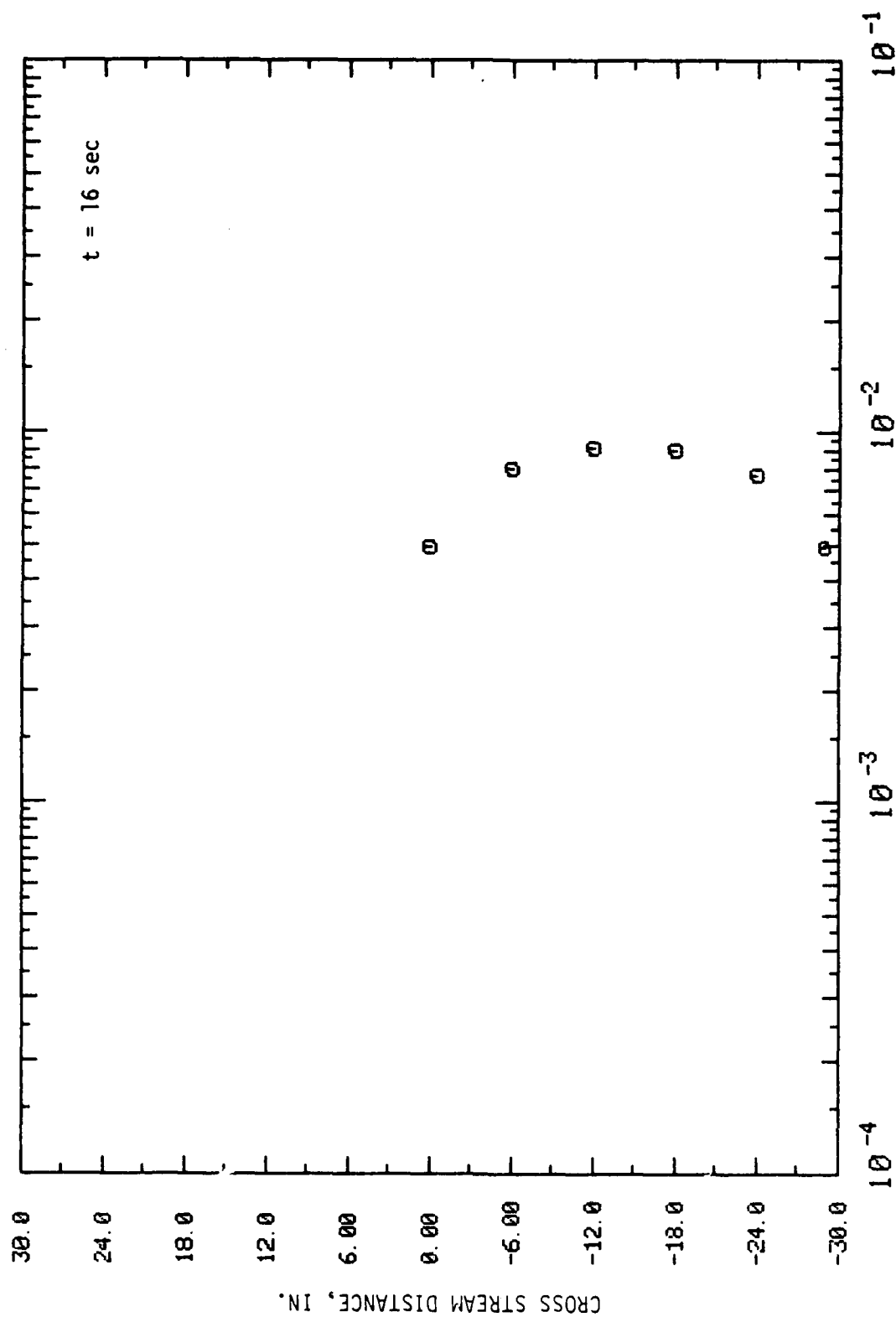


FIGURE H-6. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

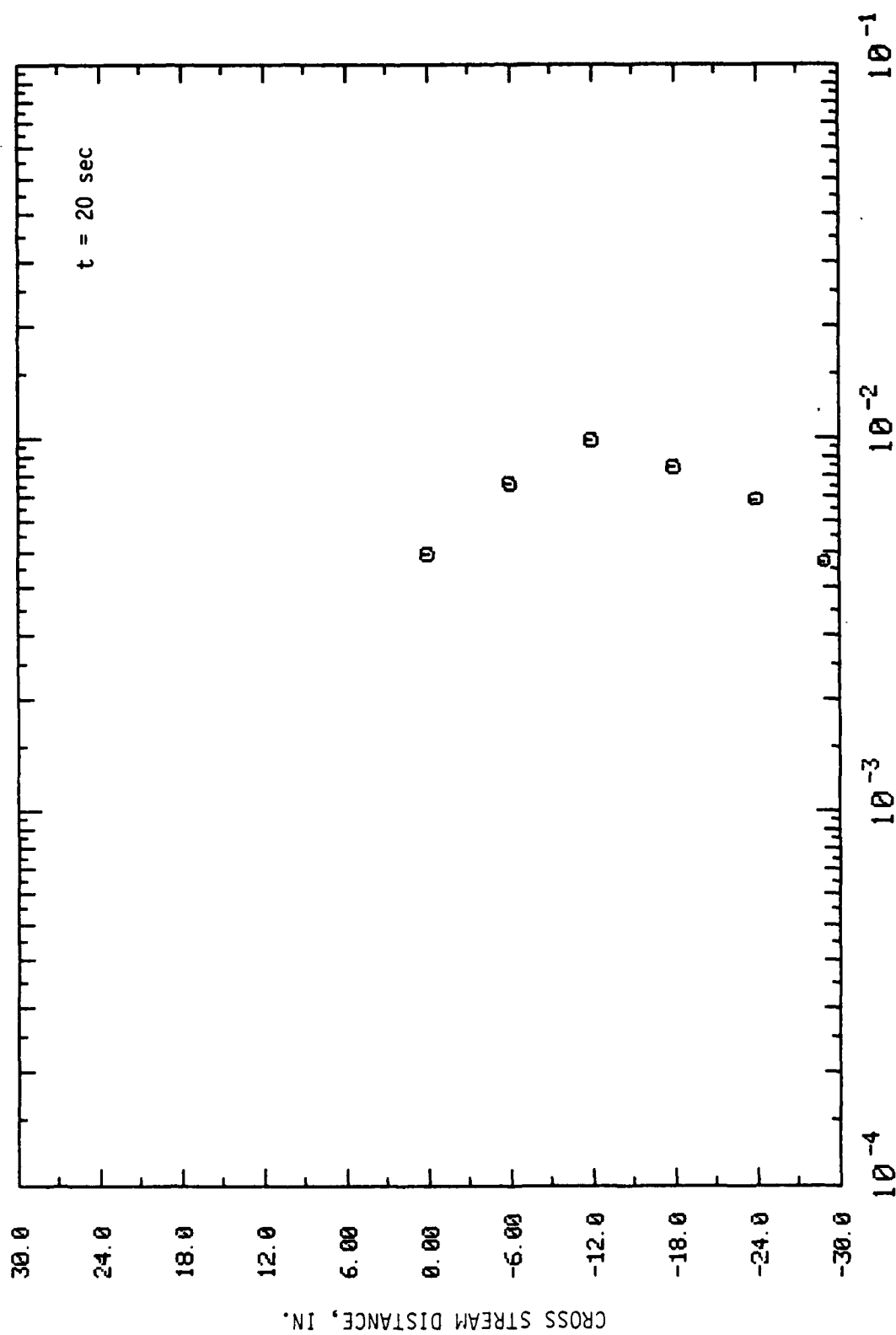


FIGURE H-7. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

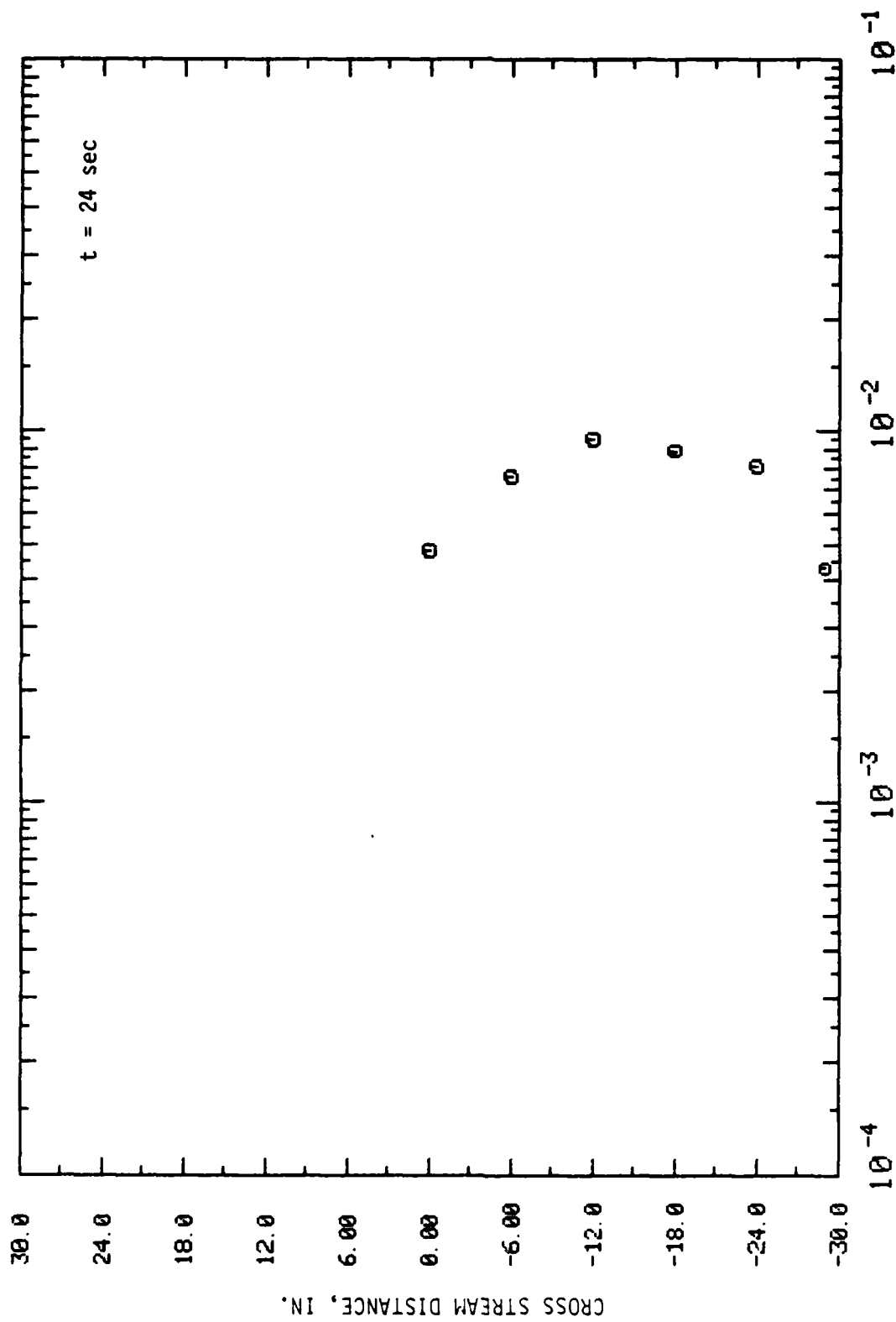


FIGURE H-8. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

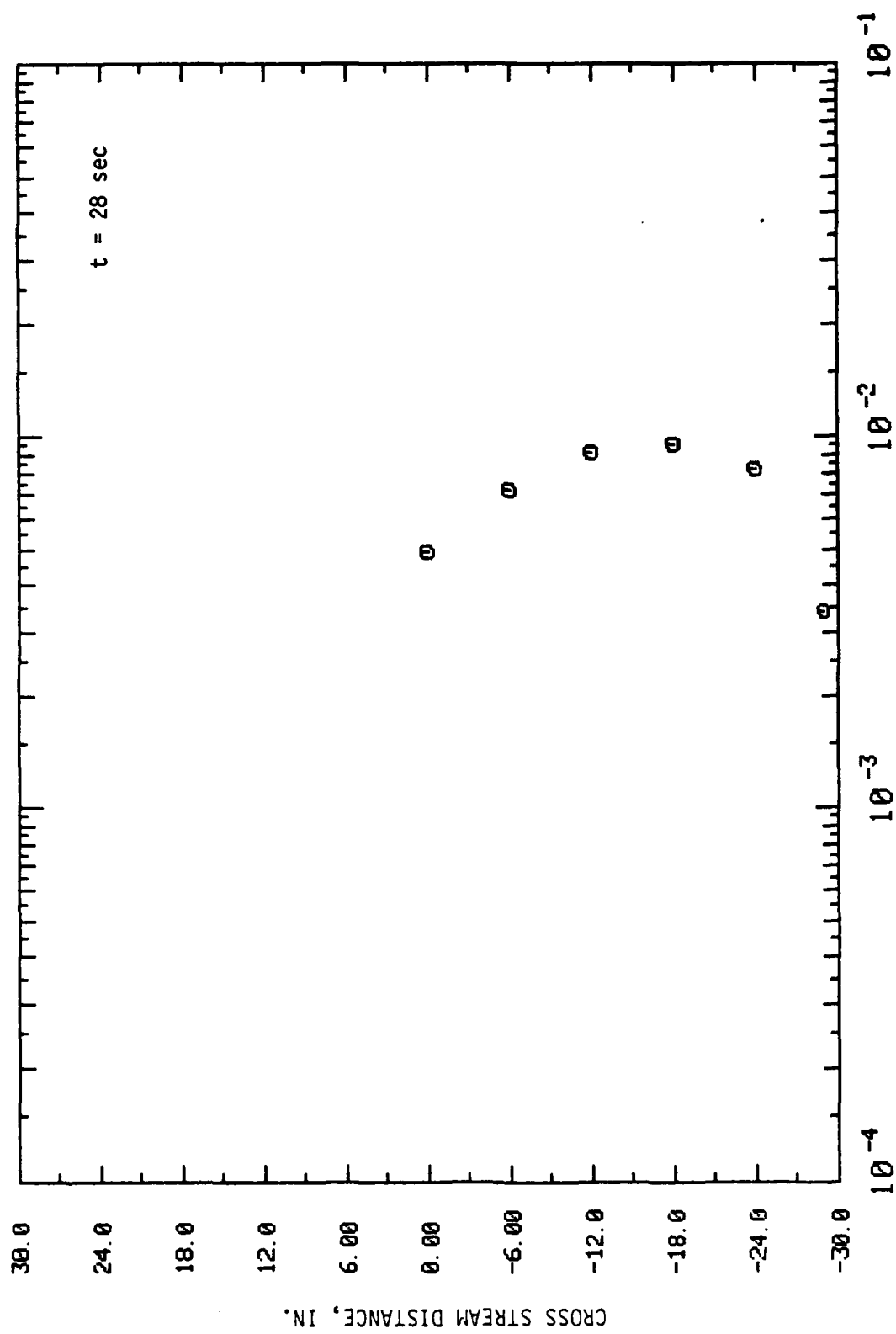


FIGURE H-9. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

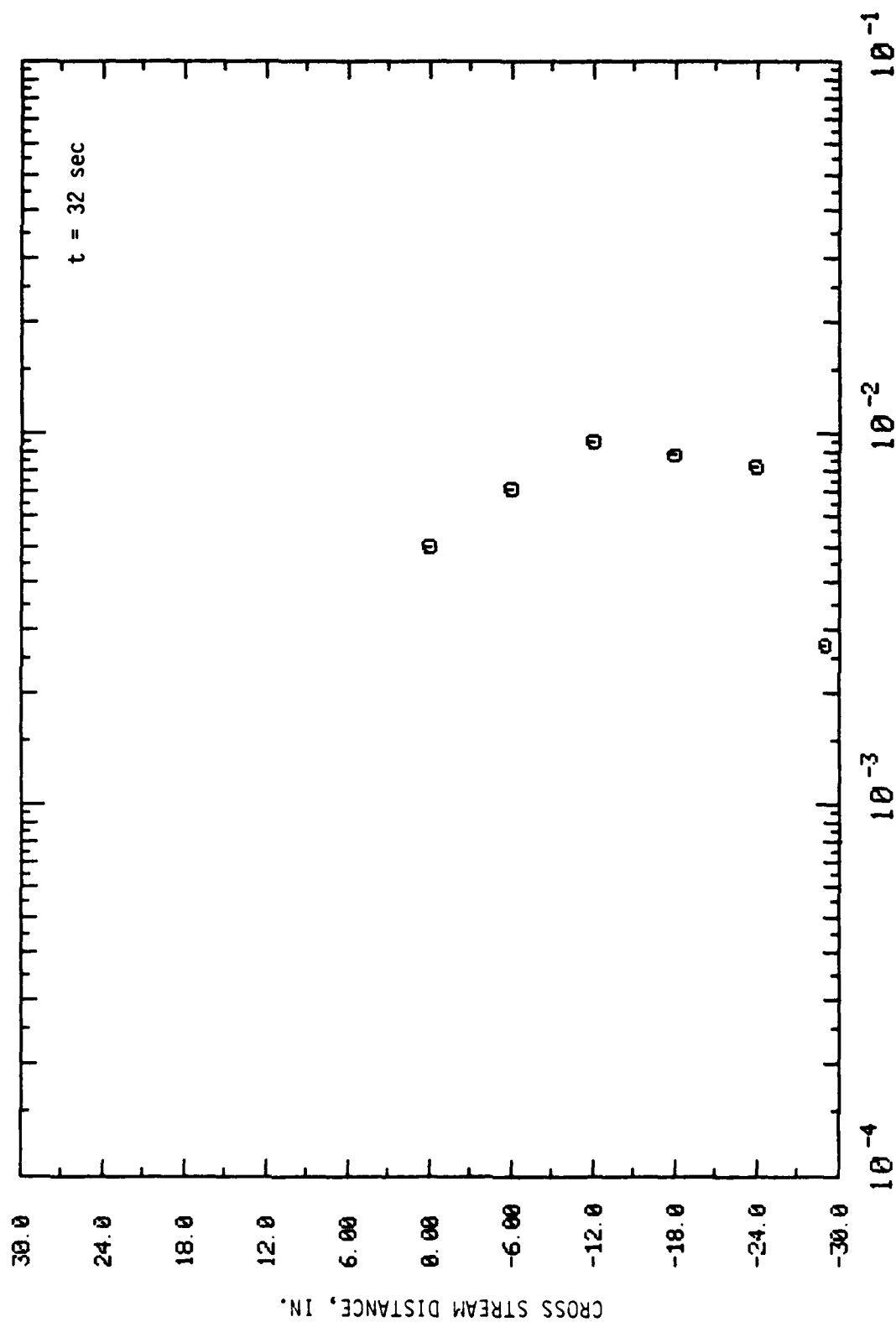


FIGURE H-10. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

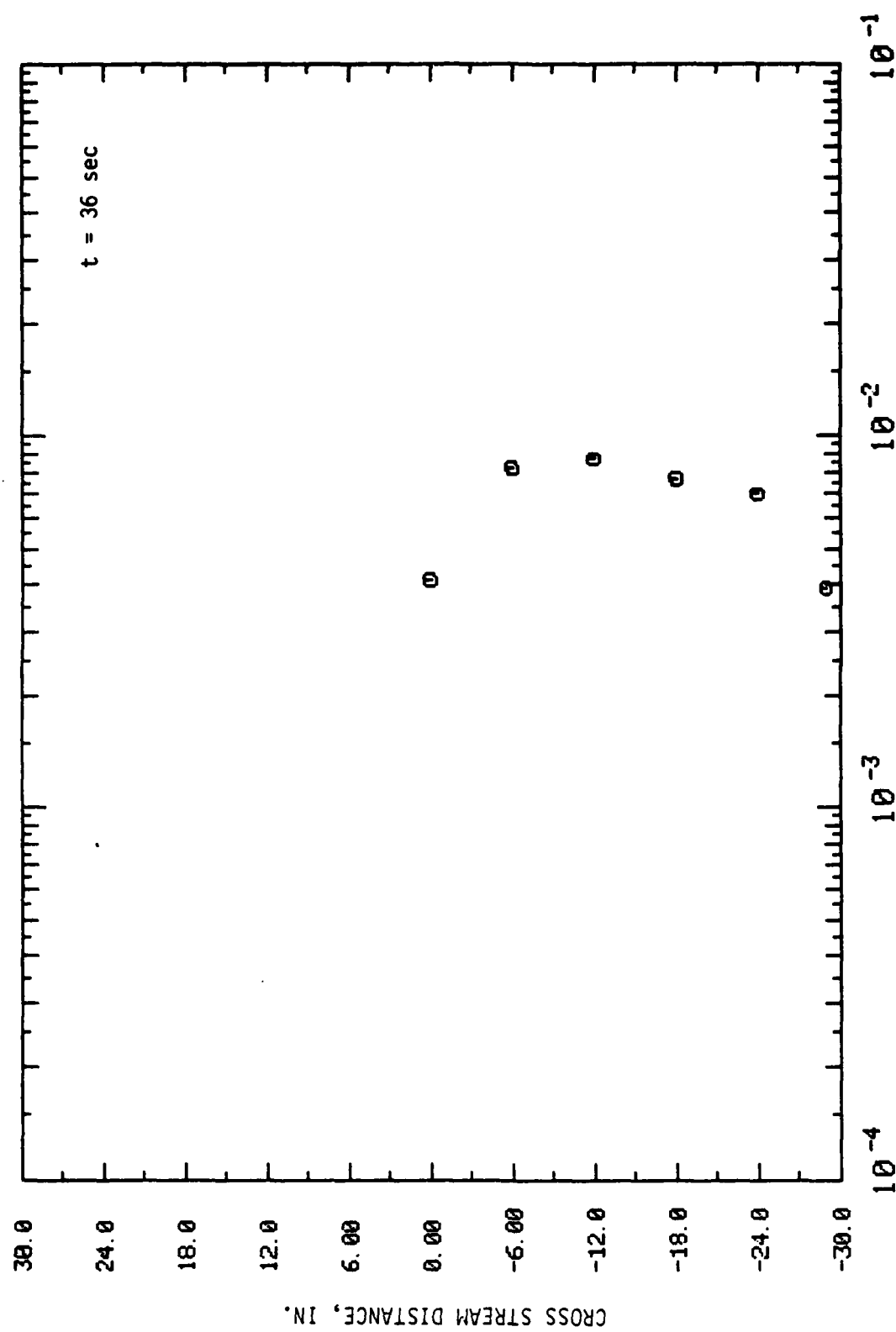
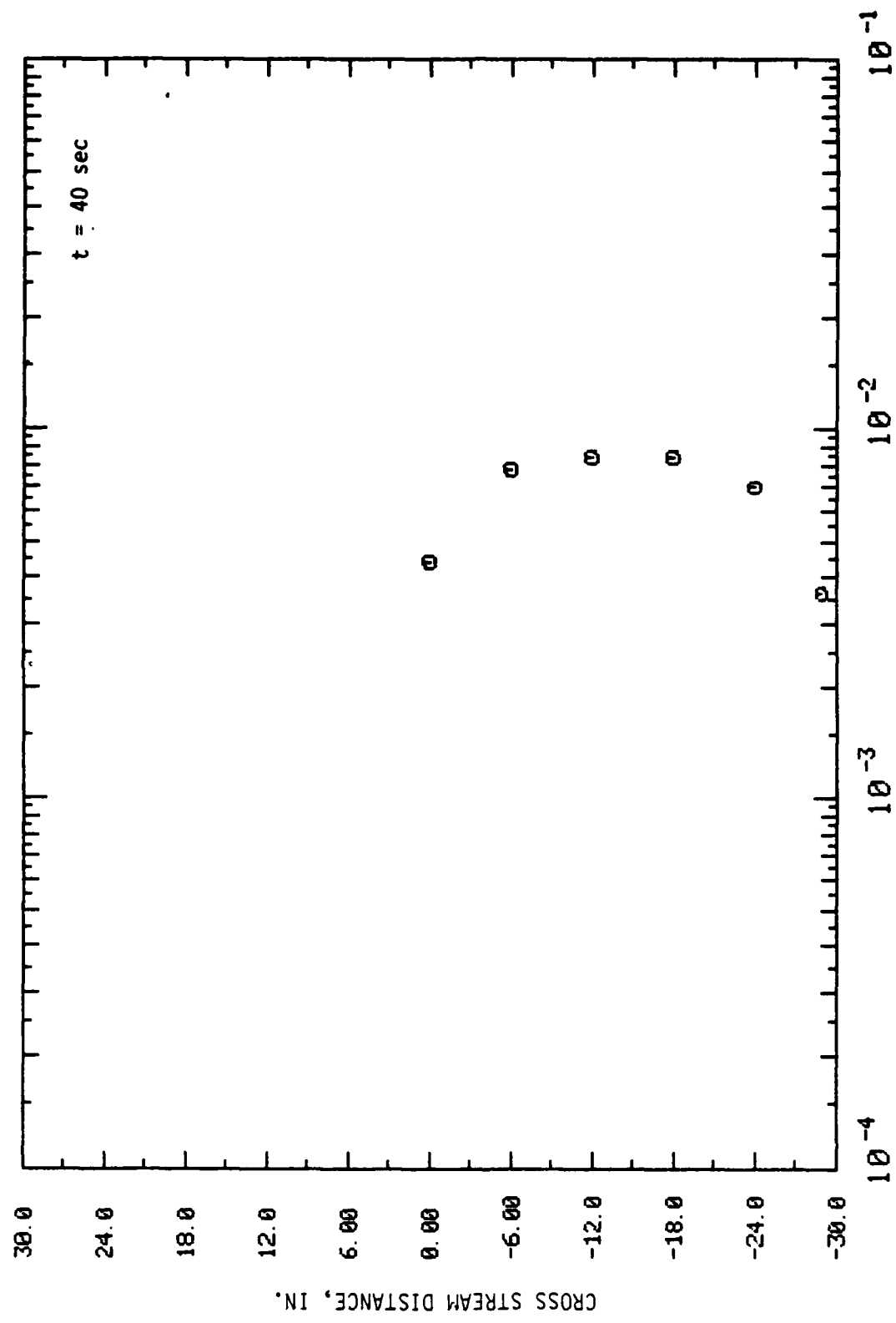


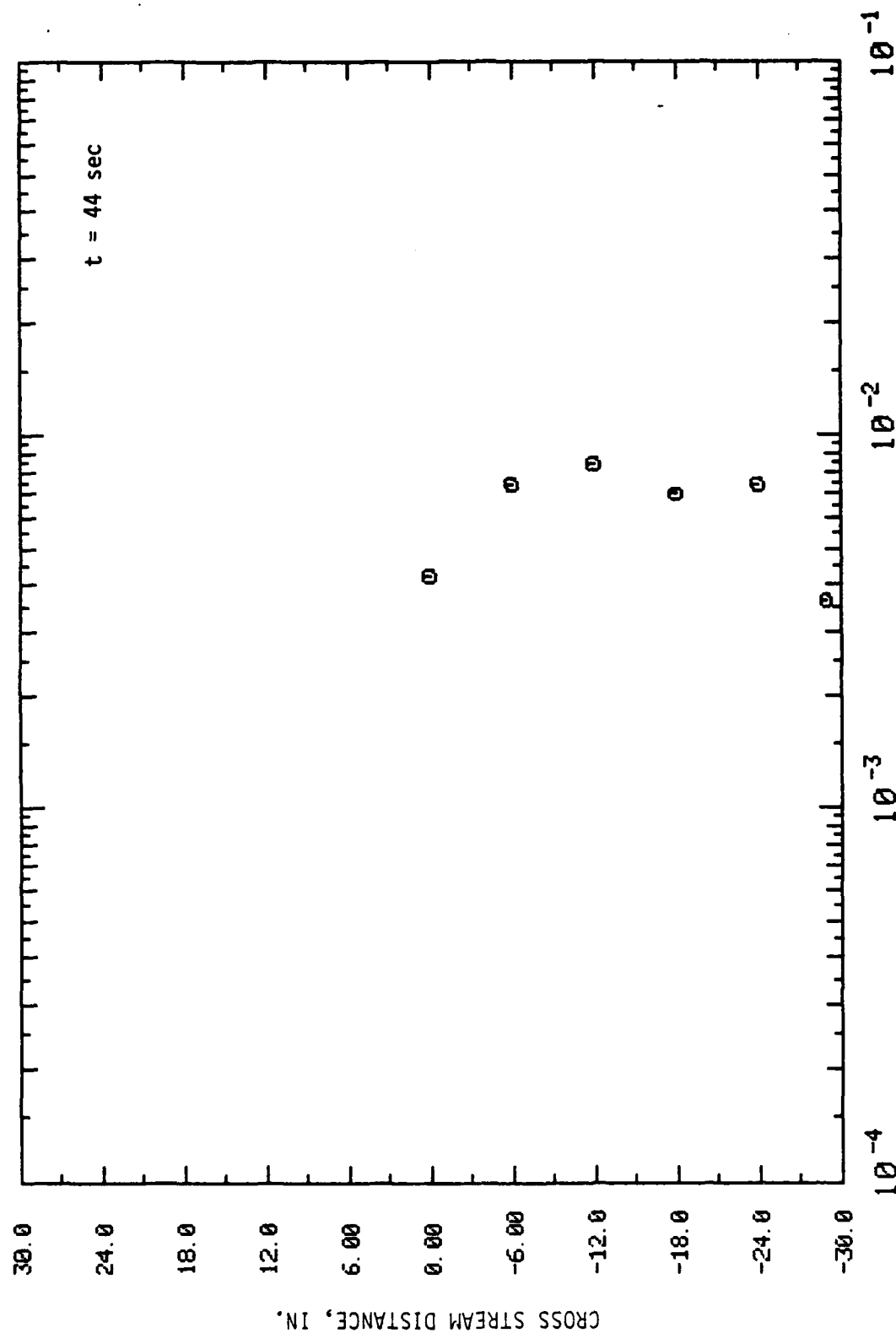
FIGURE H-11. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE H-12. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Z = 9.25 \text{ IN.}$

FIGURE H-13. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

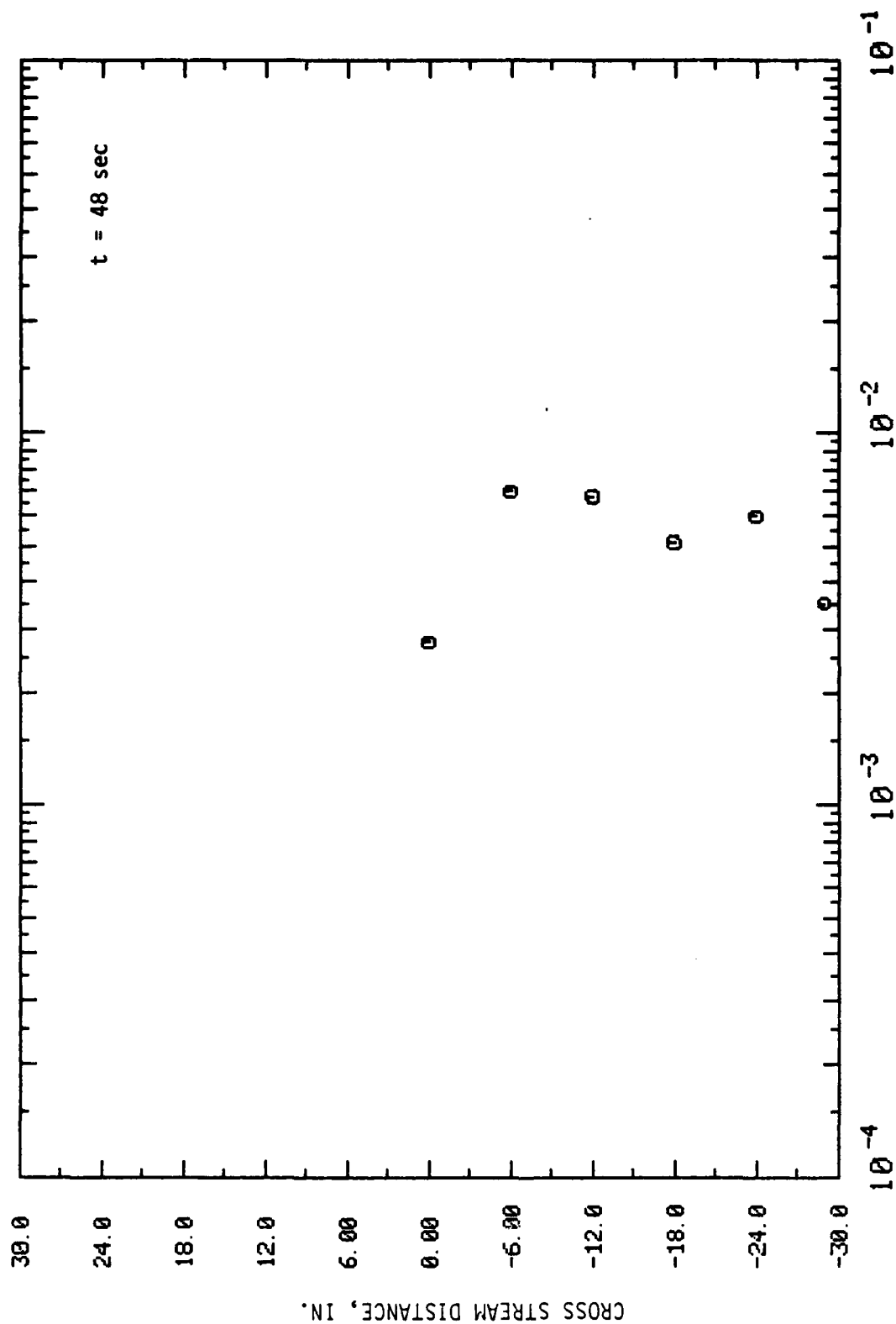
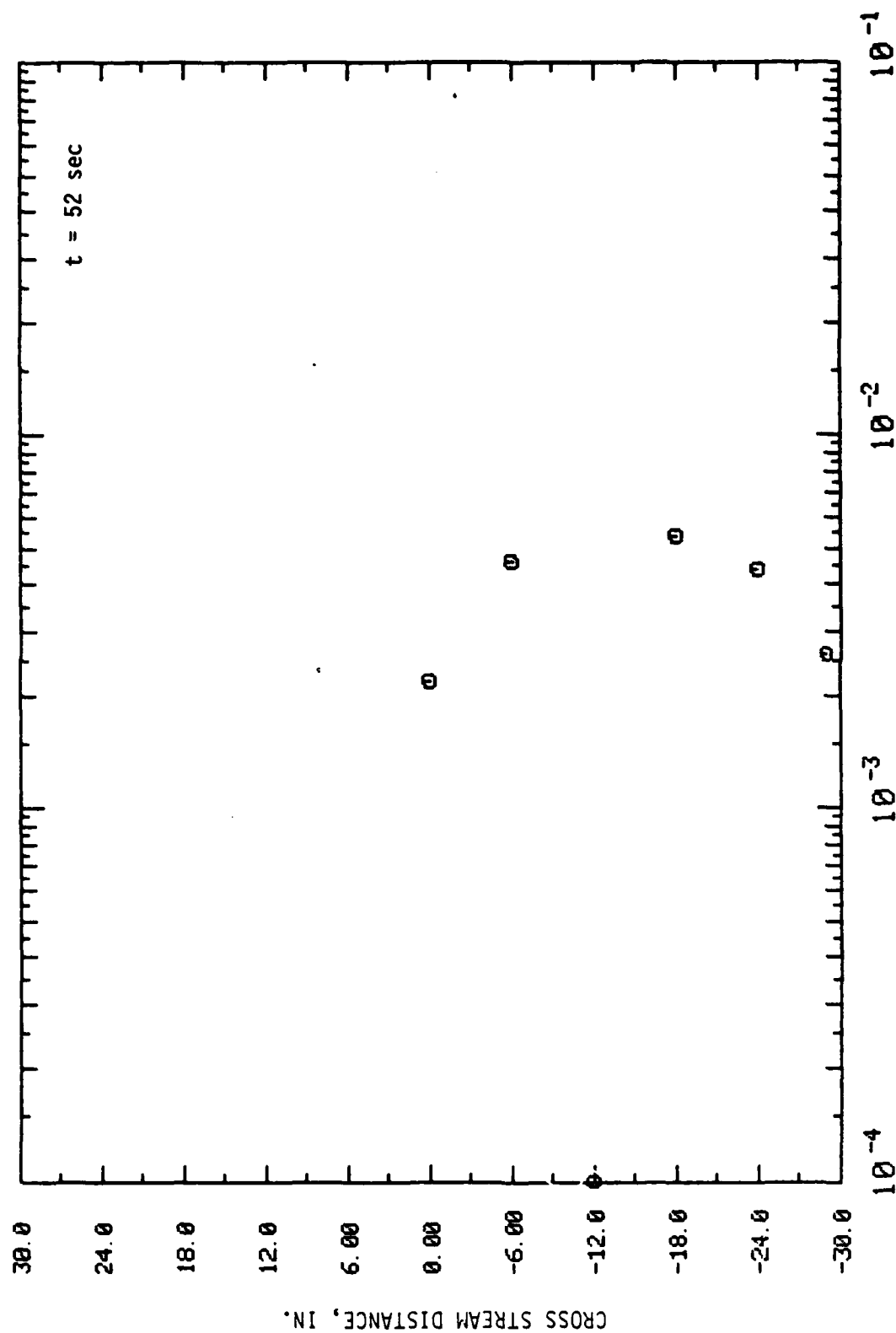


FIGURE H-14. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

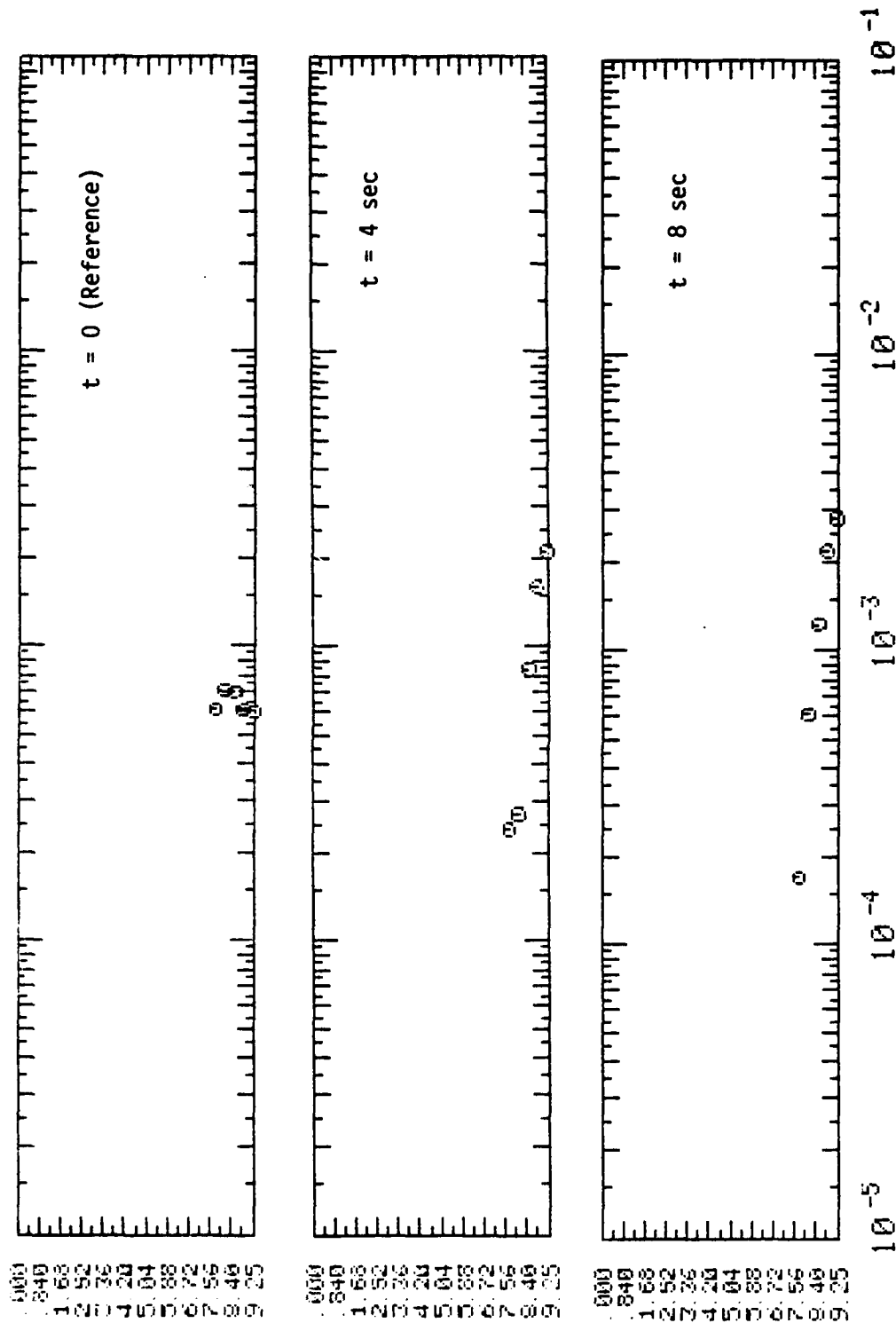


C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Z = 9.25$ IN.

FIGURE H-15. RUN II.1-14 CROSS STREAM CONCENTRATION PROFILE

DISTANCE FROM FREE SURFACE, IN.

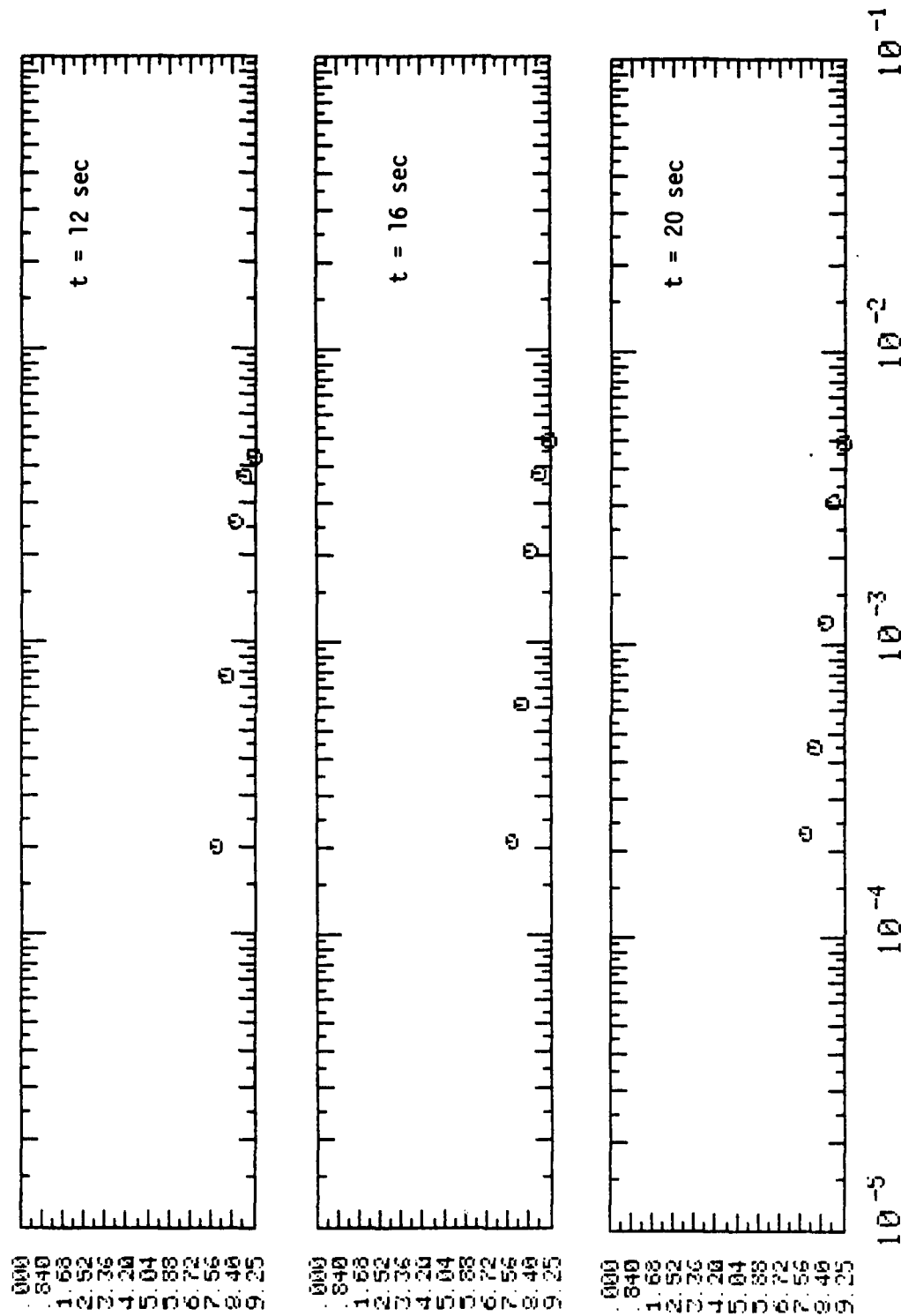


C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$

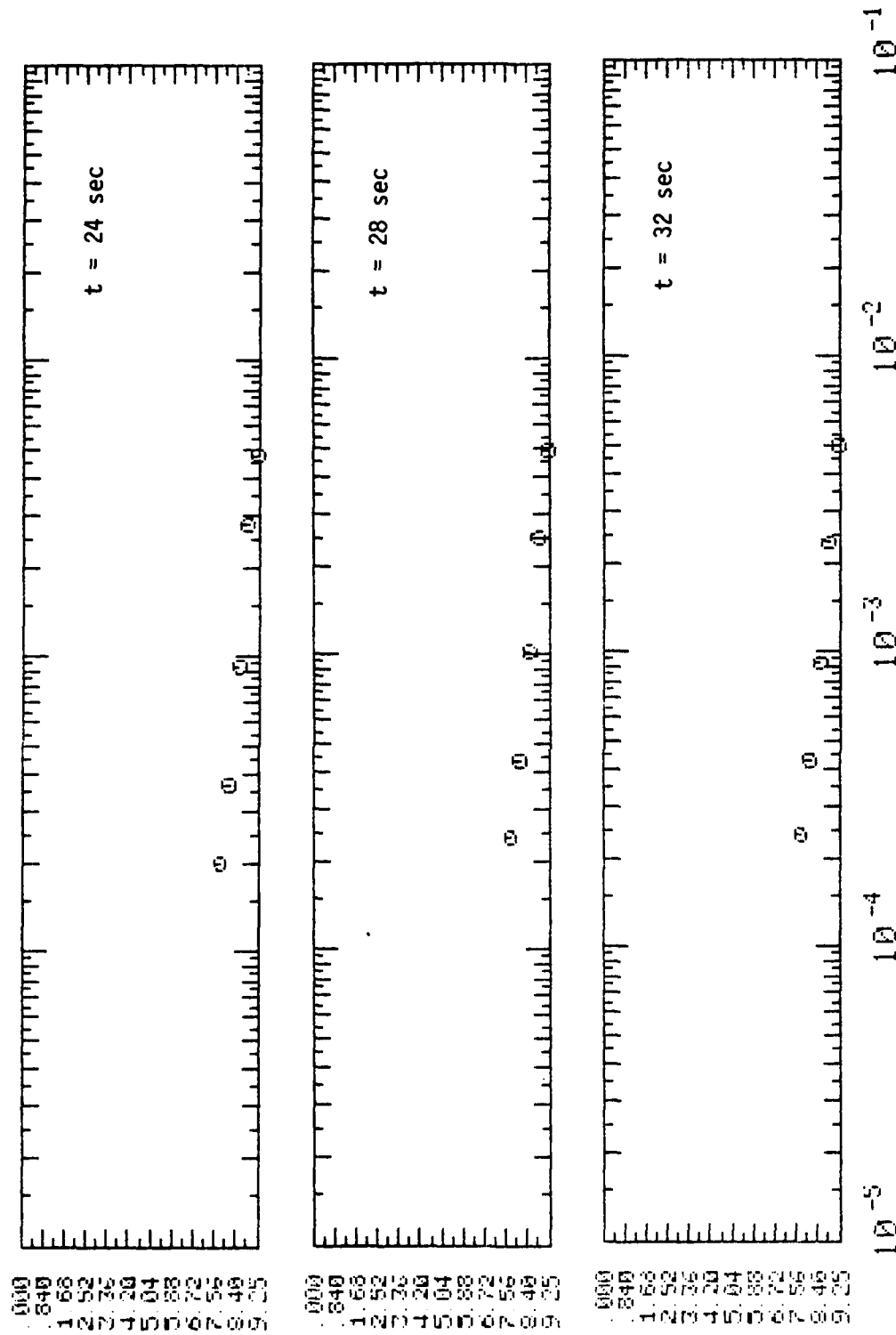
FIGURE H-16. RUN II.1-14 VERTICAL CONCENTRATION PROFILES

DISTANCE FROM FREE SURFACE, IN.

C/C₀, DIMENSIONLESS CONCENTRATION

X = 168 IN., Y = 0

FIGURE H-17. RUN II.1-14 VERTICAL CONCENTRATION PROFILES



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$

FIGURE H-18. RUN II.1-14 VERTICAL CONCENTRATION PROFILES

DISTANCE FROM FREE SURFACE, IN.

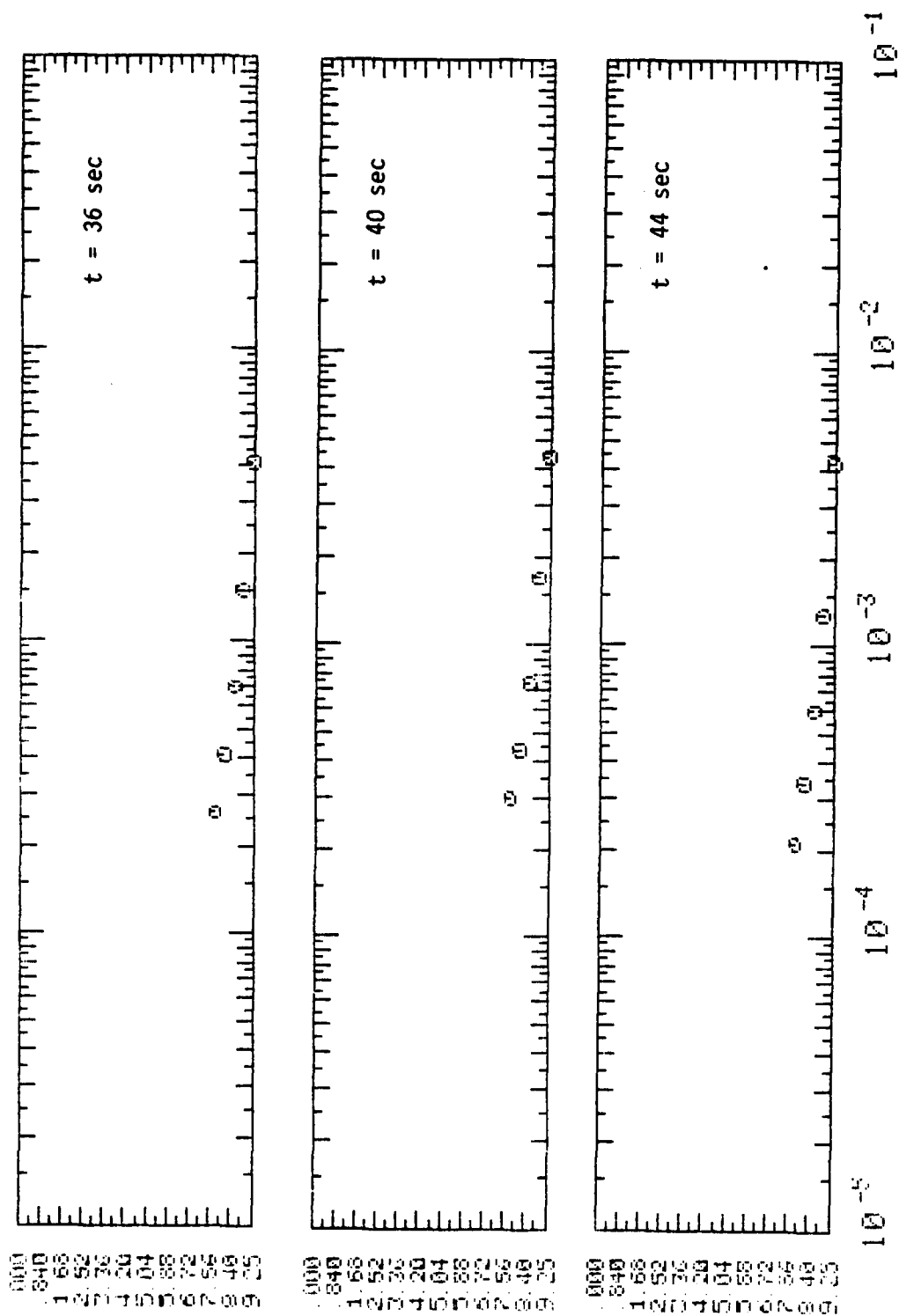
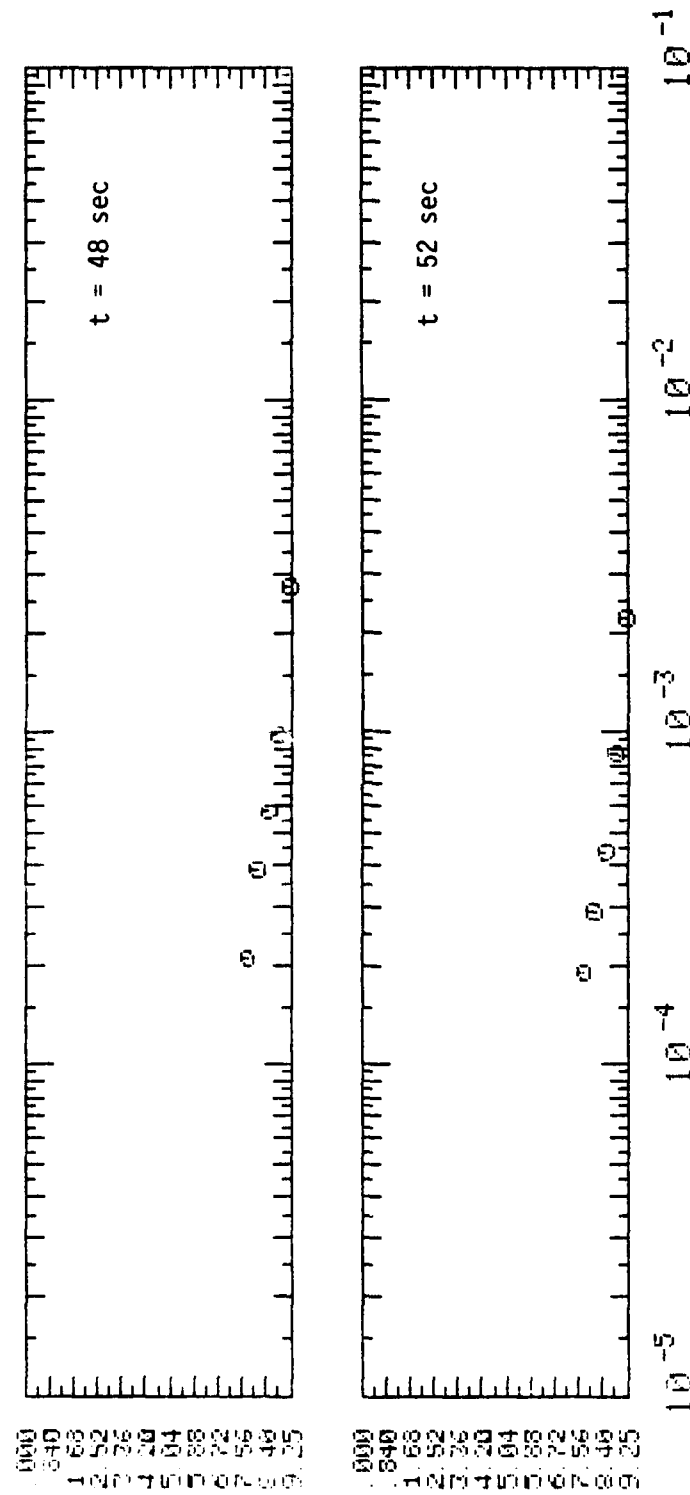
 C/C_0 , DIMENSIONLESS CONCENTRATION $X = 168 \text{ IN.}, Y = 0$

FIGURE H-19. RUN II.1-14 VERTICAL CONCENTRATION PROFILES

DISTANCE FROM FREE SURFACE, IN.



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Y = 0$

FIGURE H-20. RUN II.1-14 VERTICAL CONCENTRATION PROFILES

APPENDIX I

CONCENTRATION PROFILES FOR RUN II.1-19

$$\rho_c/\rho = 1.00 \text{ (Water)}$$

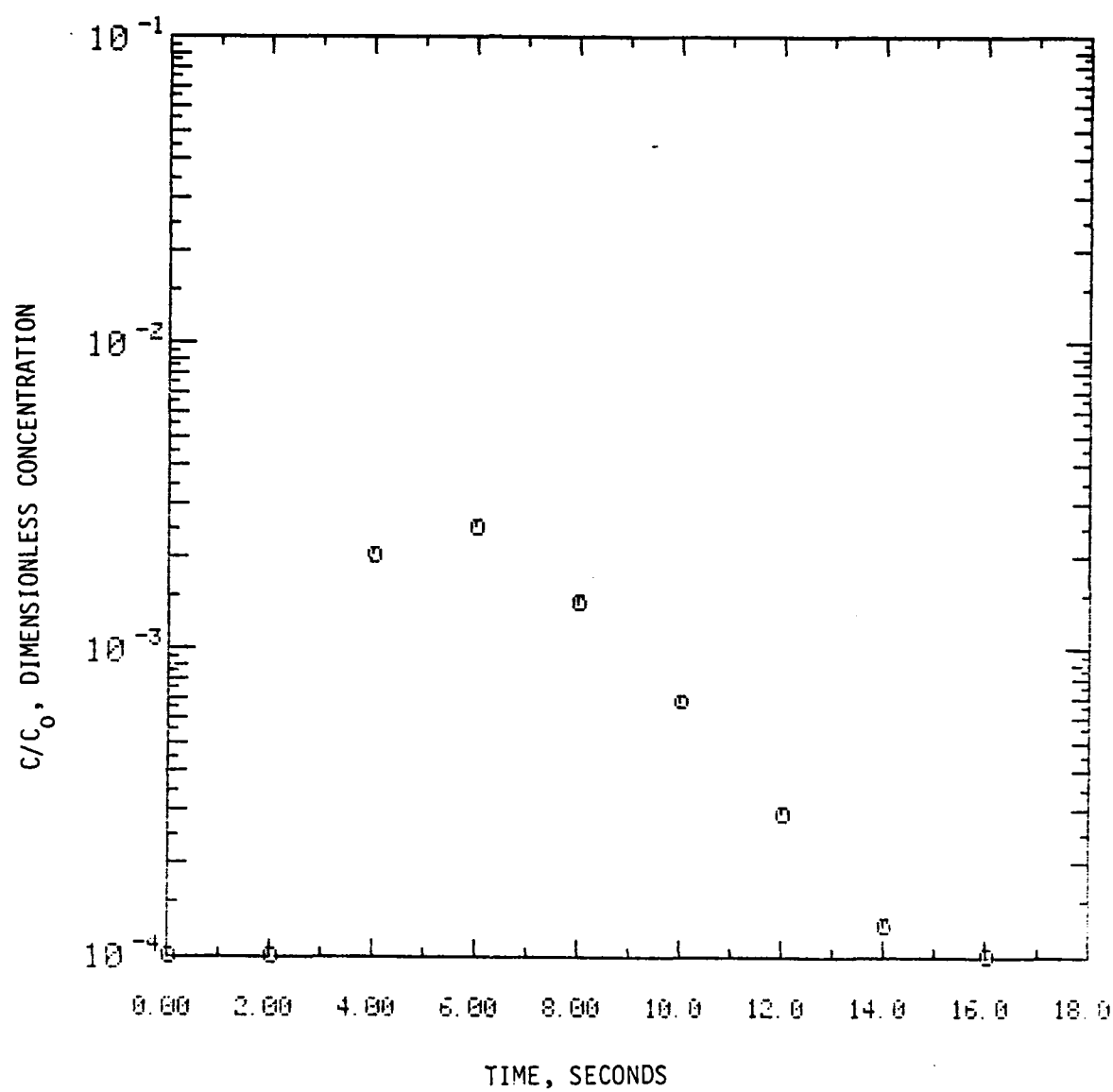
$$r_i/d = 0.125$$

$$u_t/U = 0.05$$

$$U(\text{cm/sec}) = 14.1$$

Time elapsed from spill to $t=0$ (Reference) for:

time history graph	27 sec.
vertical profiles	31 sec.



X = 168 IN., Y = 0, Z = 1.25 IN.

FIGURE I-1. RUN II.1-19 CONCENTRATION TIME HISTORY

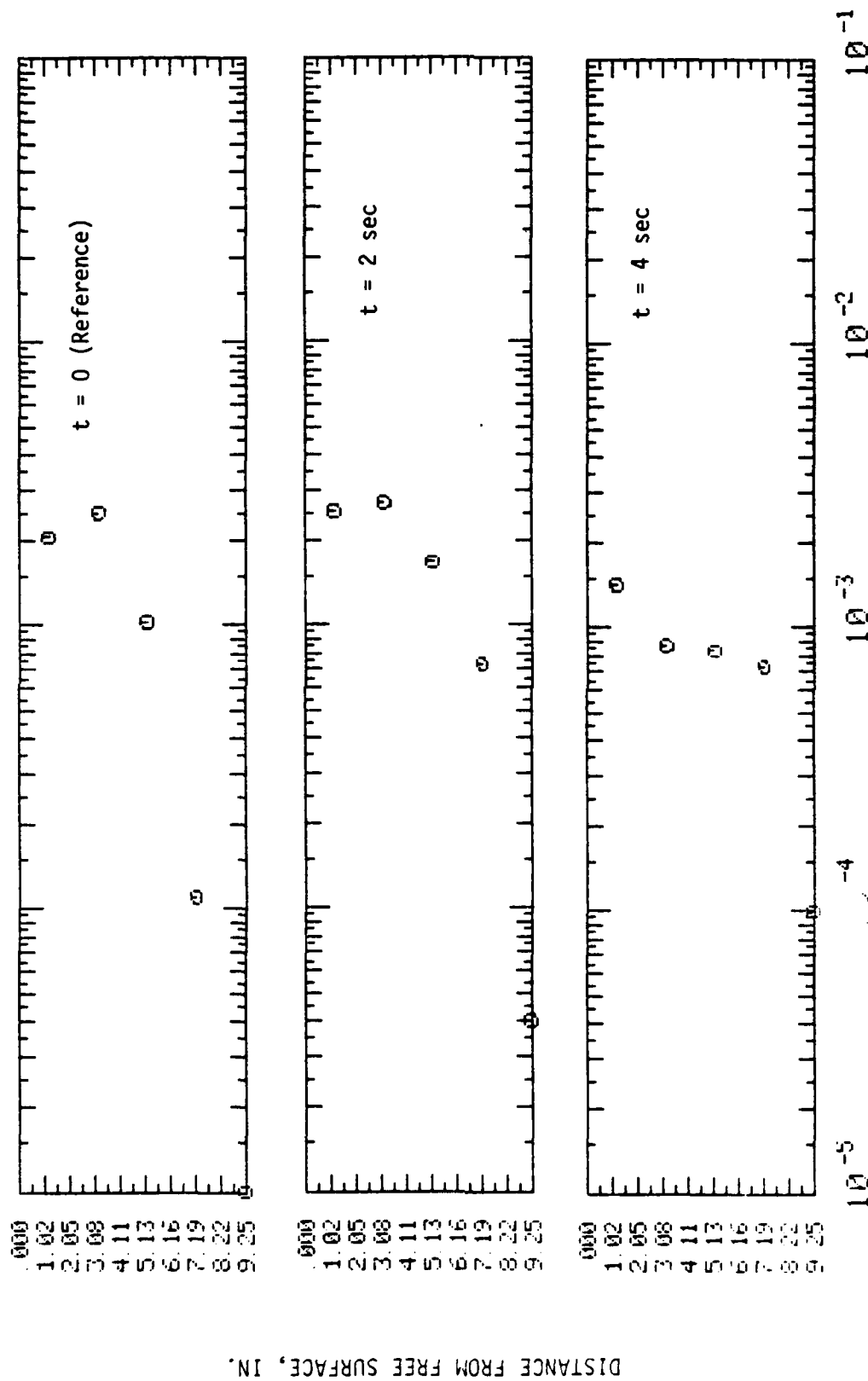
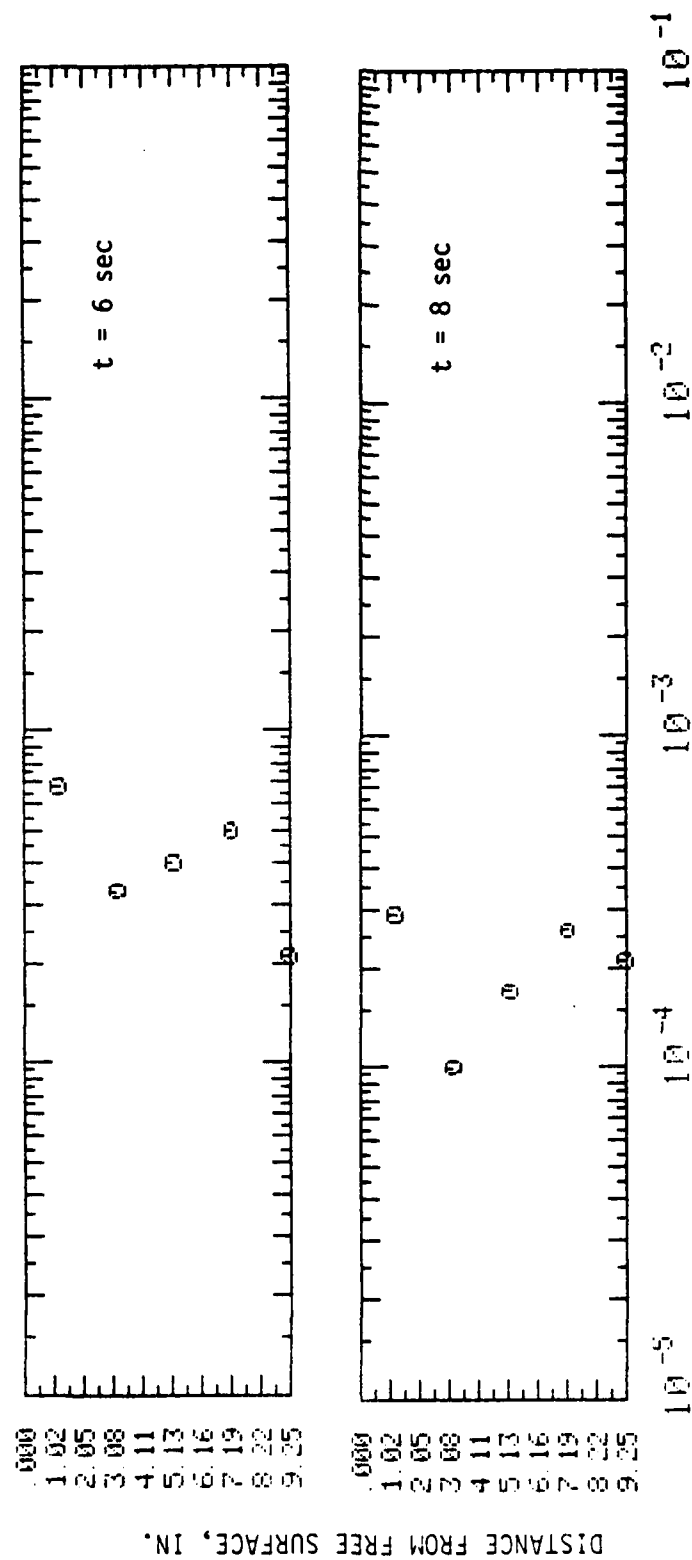


FIGURE I-2. RUN II.1-19 VERTICAL CONCENTRATION PROFILES



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Y = 0$

FIGURE I-3. RUN II.1-19 VERTICAL CONCENTRATION PROFILES

APPENDIX J

CONCENTRATION PROFILES FOR RUN II.1-20

$$\rho_c/\rho = 1.00 \text{ (Water)}$$

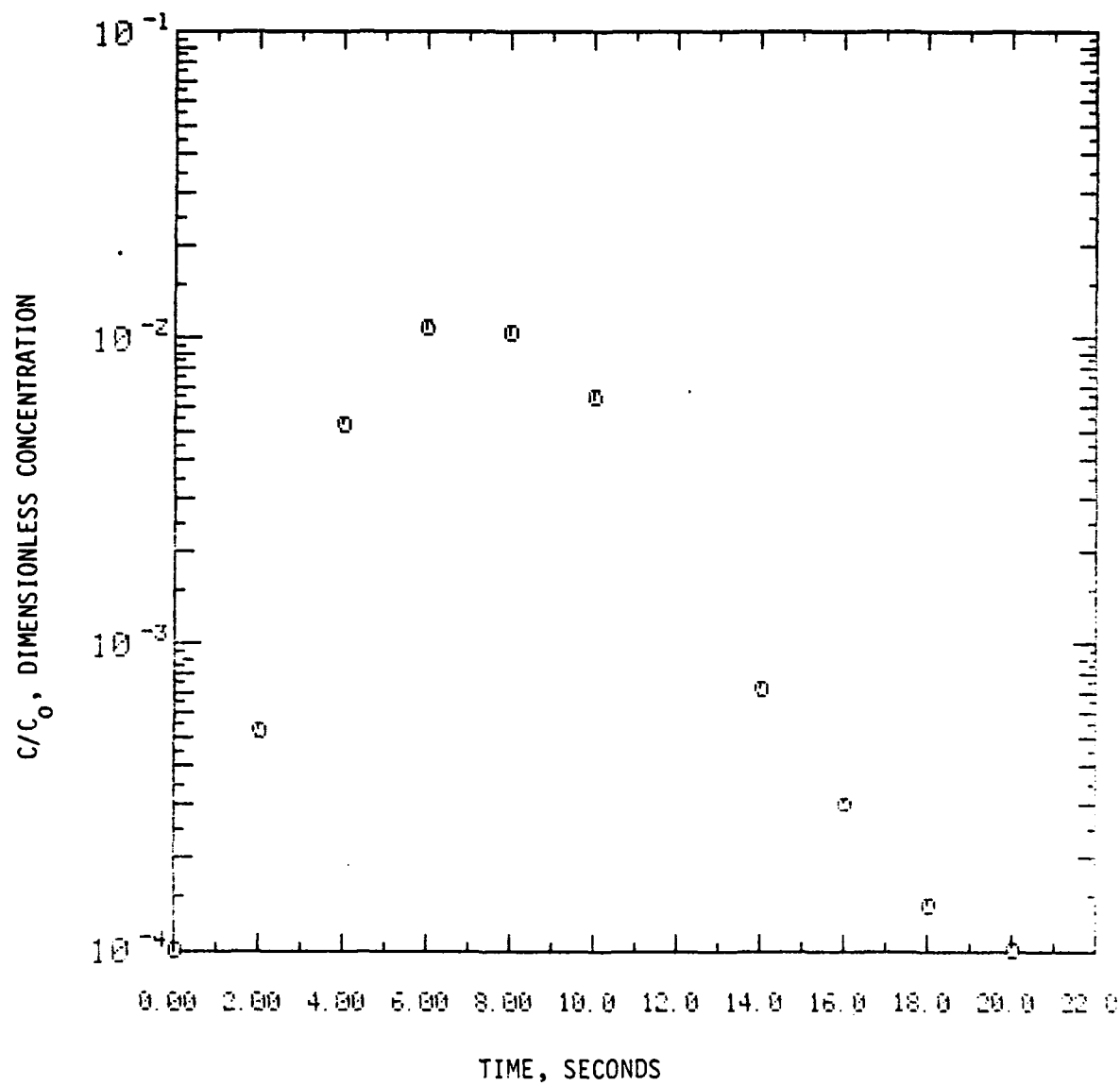
$$r_i/d = 0.23$$

$$u_\tau/U = 0.05$$

$$U(\text{cm/sec}) = 14.1$$

Time elapsed from spill to $t=0$ (Reference) for:

time history graph	27 sec.
vertical profiles	31 sec.



X = 168 IN., Y = 0, Z = 1.25 IN.

FIGURE J-1. RUN II.1-20 CONCENTRATION TIME HISTORY

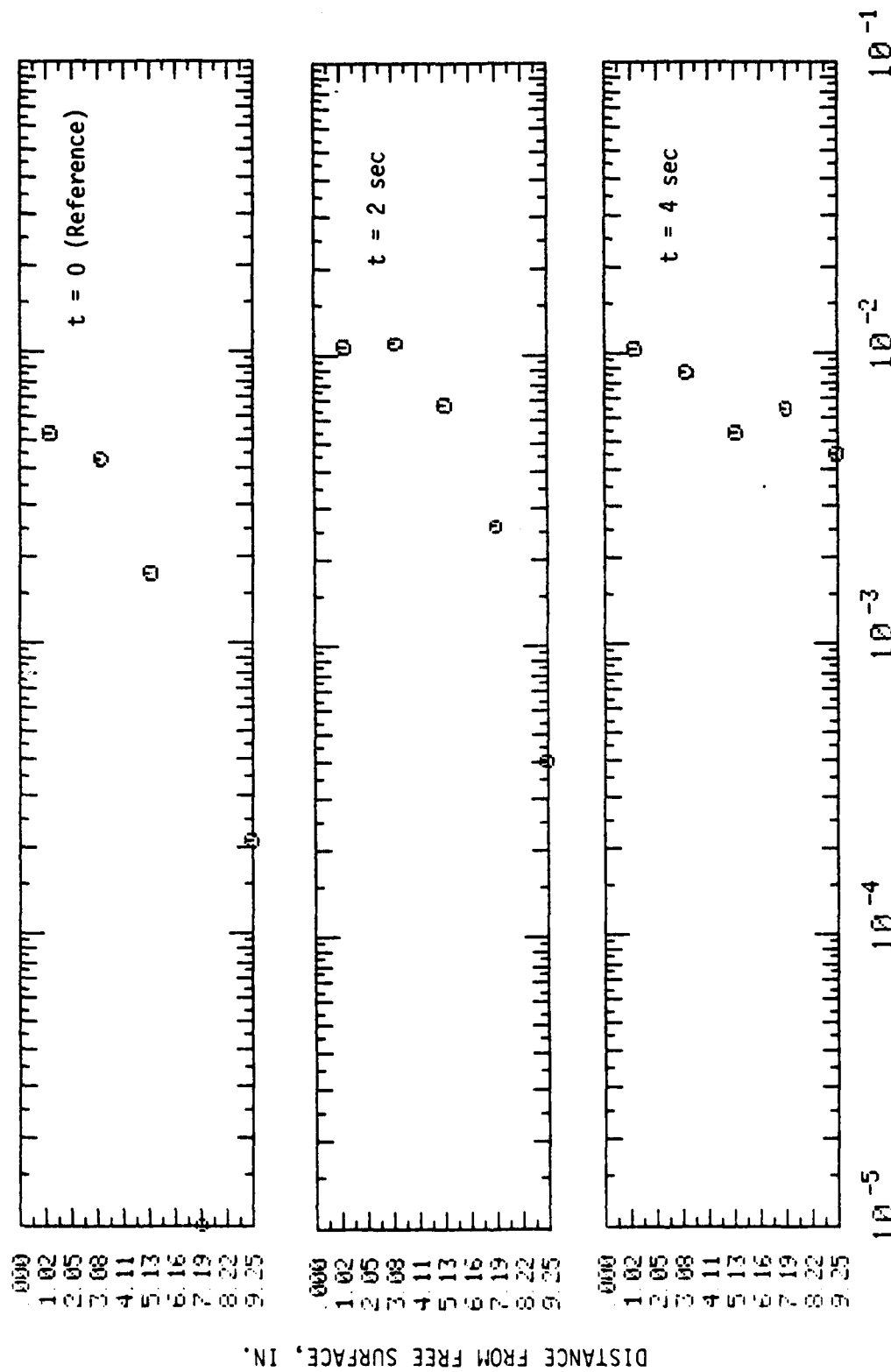
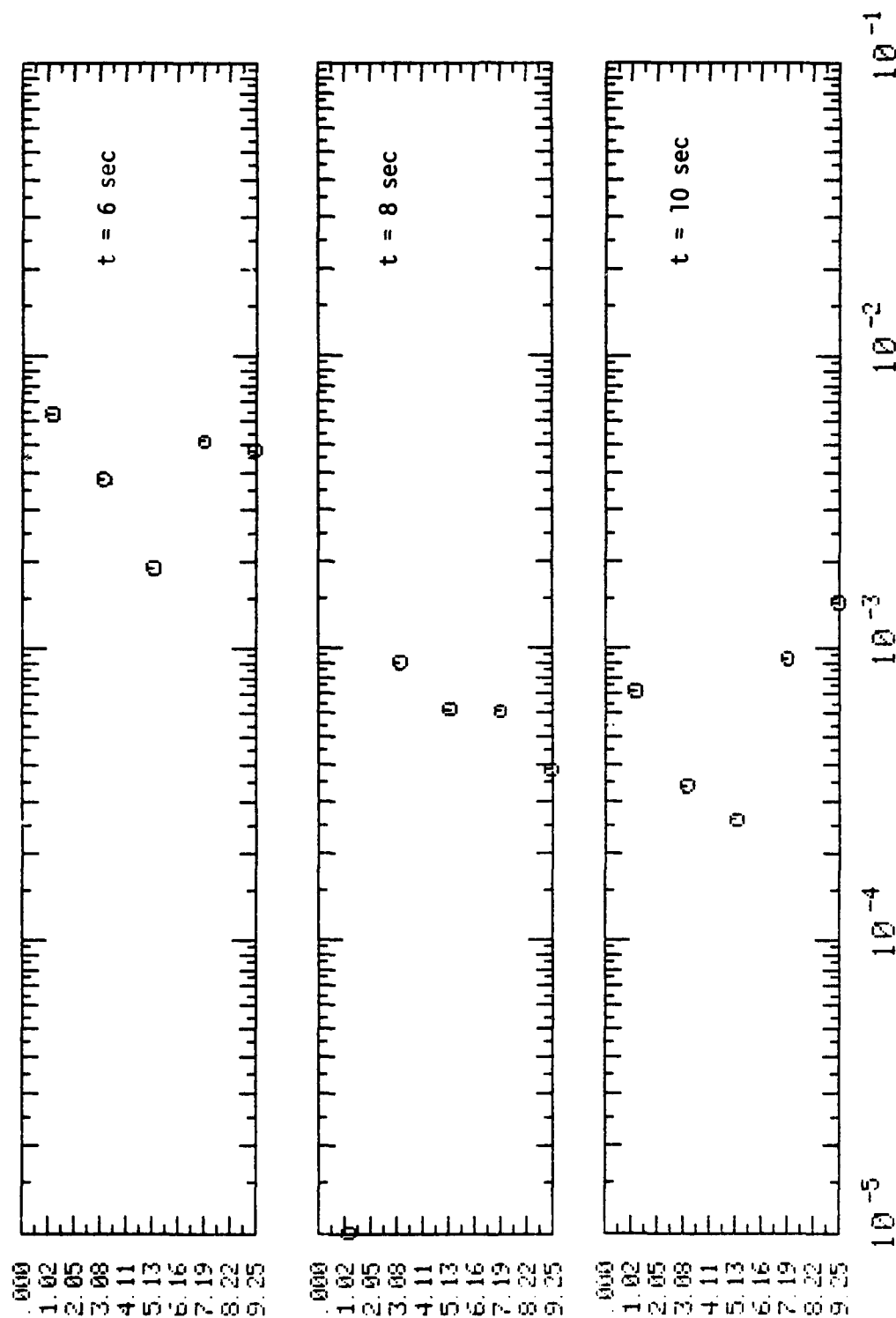


FIGURE J-2. RUN II.1-20 VERTICAL CONCENTRATION PROFILES

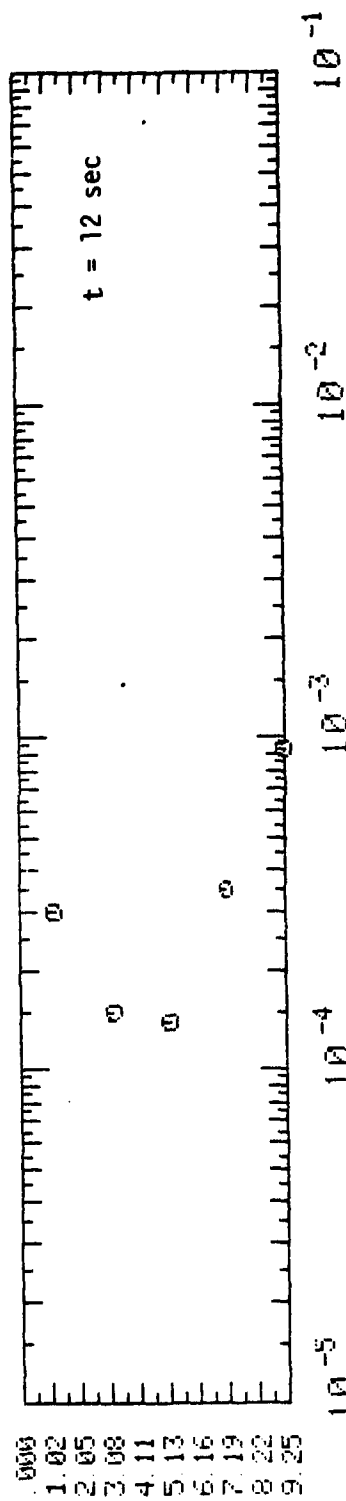


C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168$ IN., $Y = 0$

FIGURE J-3. RUN II.1-20 VERTICAL CONCENTRATION PROFILES

J-4



C/C_0 , DIMENSIONLESS CONCENTRATION

$X = 168 \text{ IN.}, Y = 0$

FIGURE J-4. RUN II.1-20 VERTICAL CONCENTRATION PROFILES

APPENDIX K

CONCENTRATION PROFILES FOR
RUN I.2-3 AT X = 48 IN., 120 IN.

$$\rho_c/\rho = 0.79$$

$$J = 0.79$$

$$Fr = -0.97$$

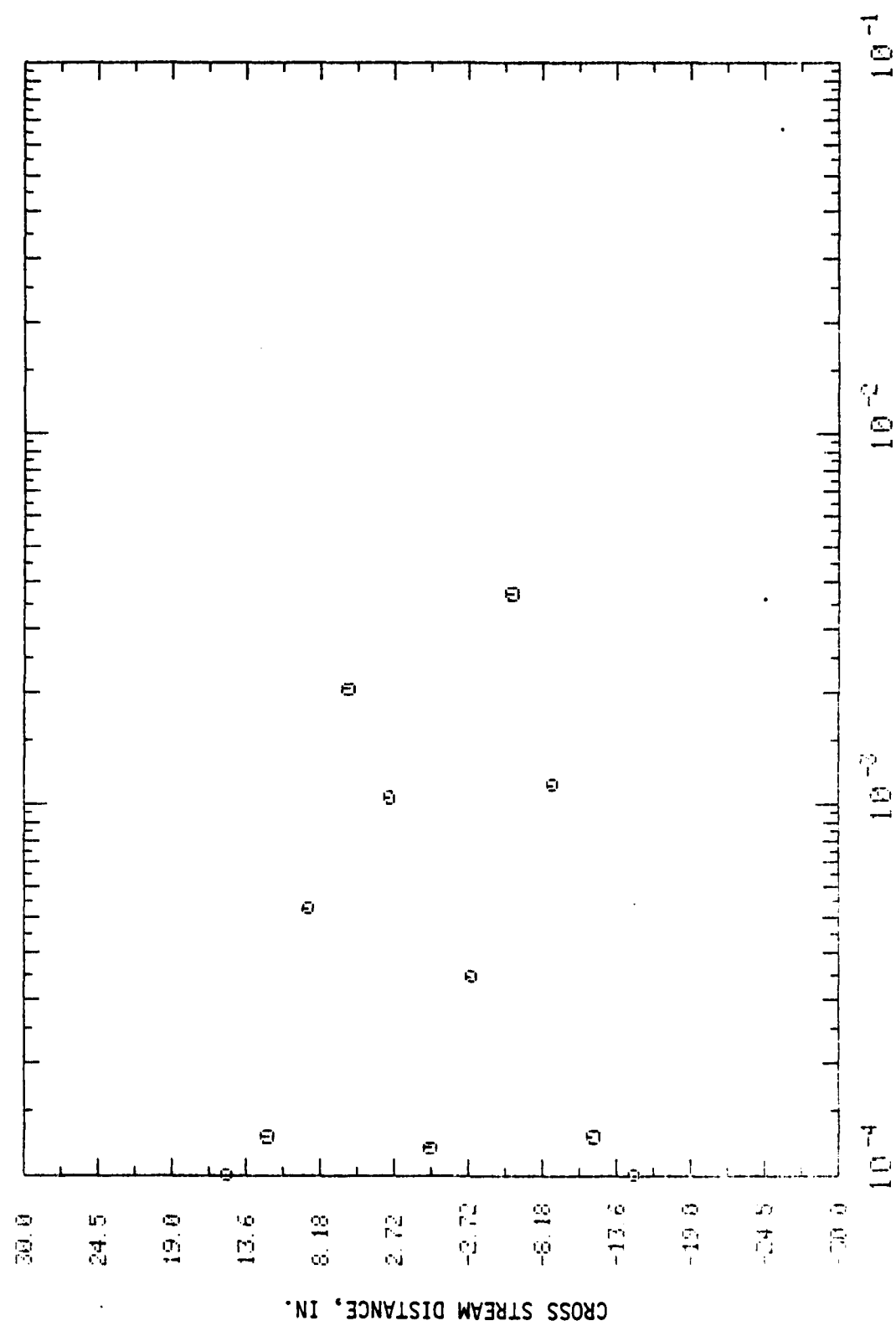


FIGURE K-1. RUN I. 2-3 CROSS STREAM CONCENTRATION PROFILE

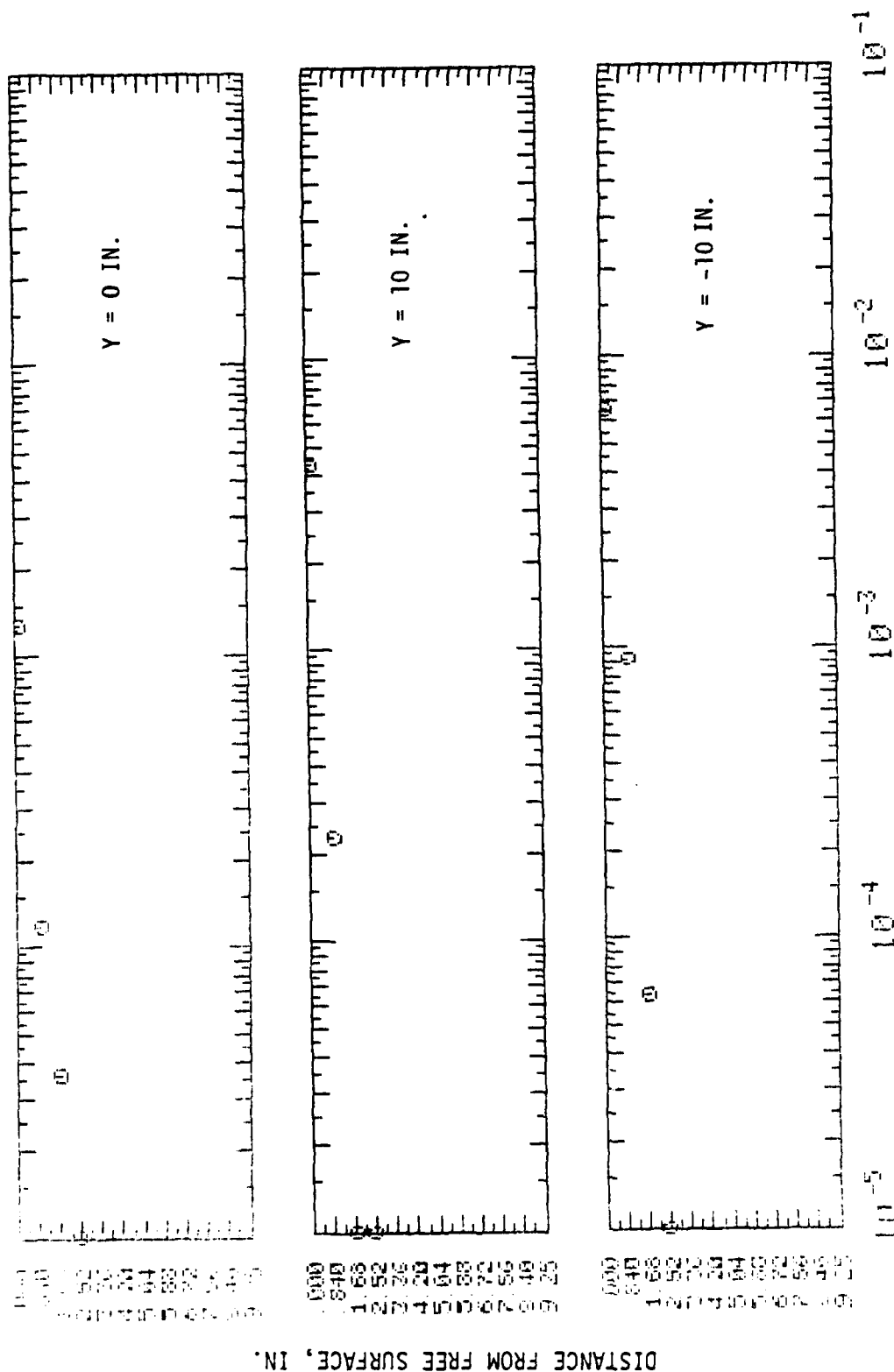
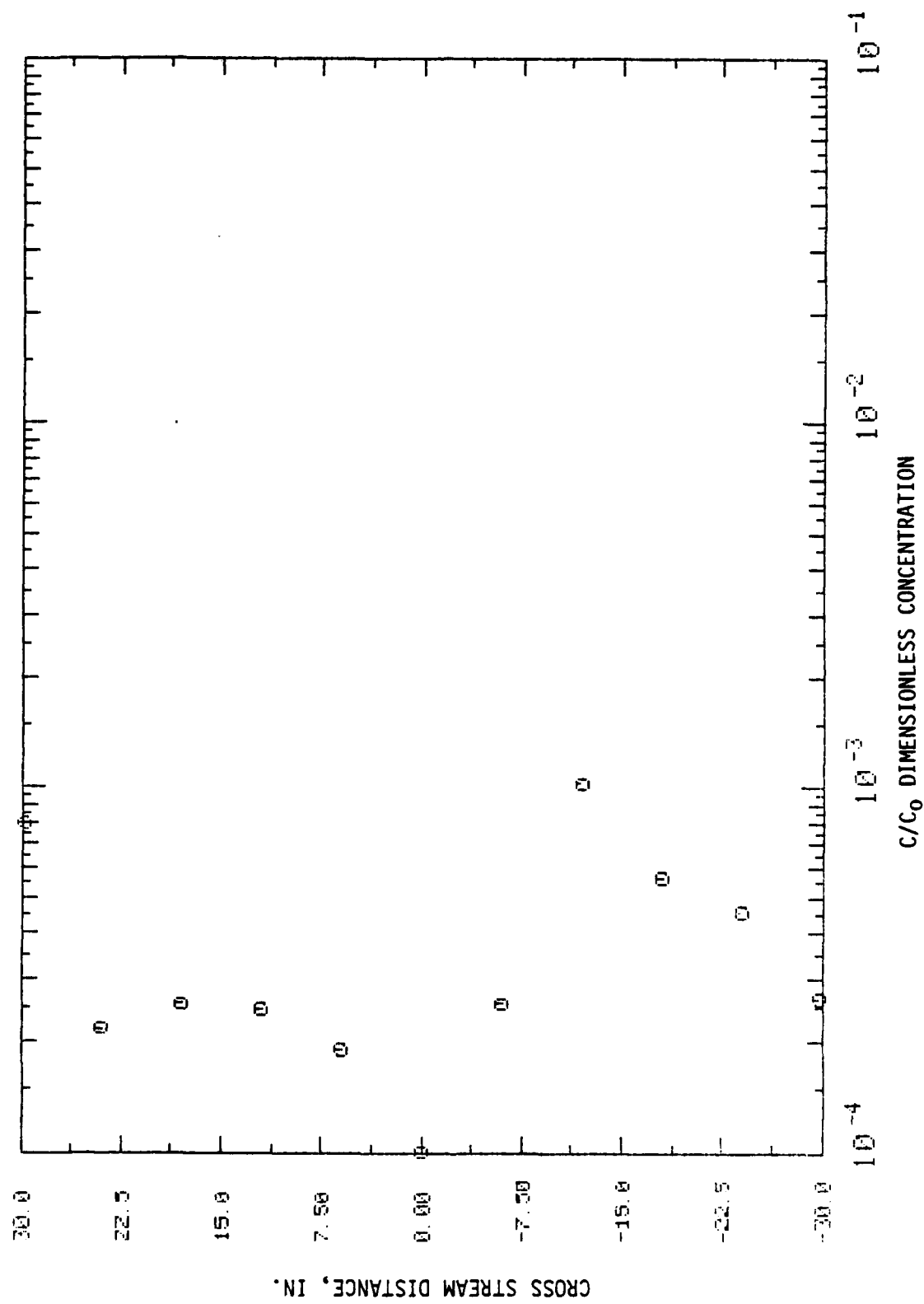


FIGURE K-2. RUN I. 2-3 VERTICAL CONCENTRATION PROFILES



$X = 120$ IN., $Z = 1$ IN.

FIGURE K-3. RUN I. 2-3 CROSS STREAM CONCENTRATION PROFILE

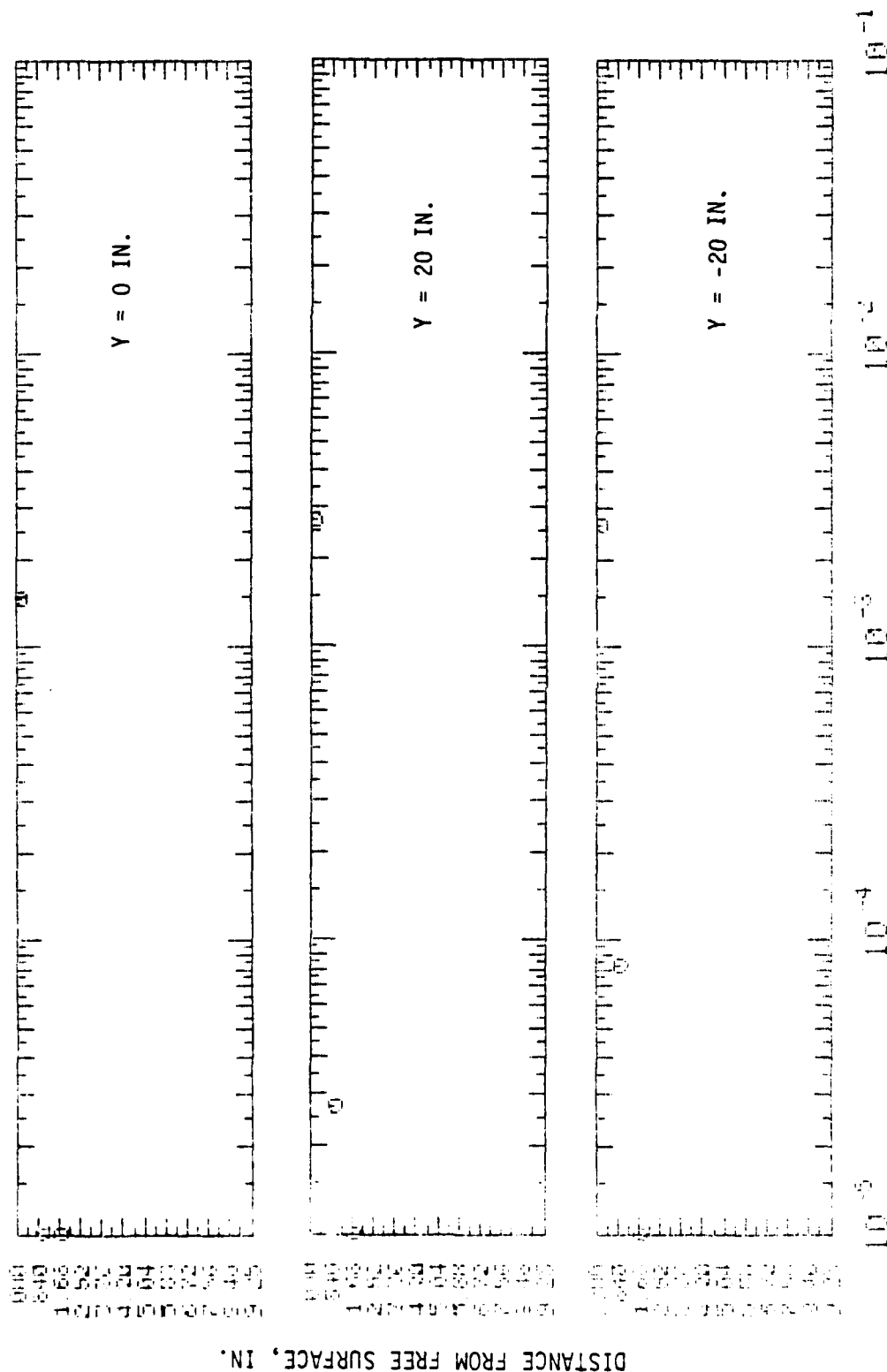


FIGURE K-4. RUN I. 2-3 VERTICAL CONCENTRATION PROFILES

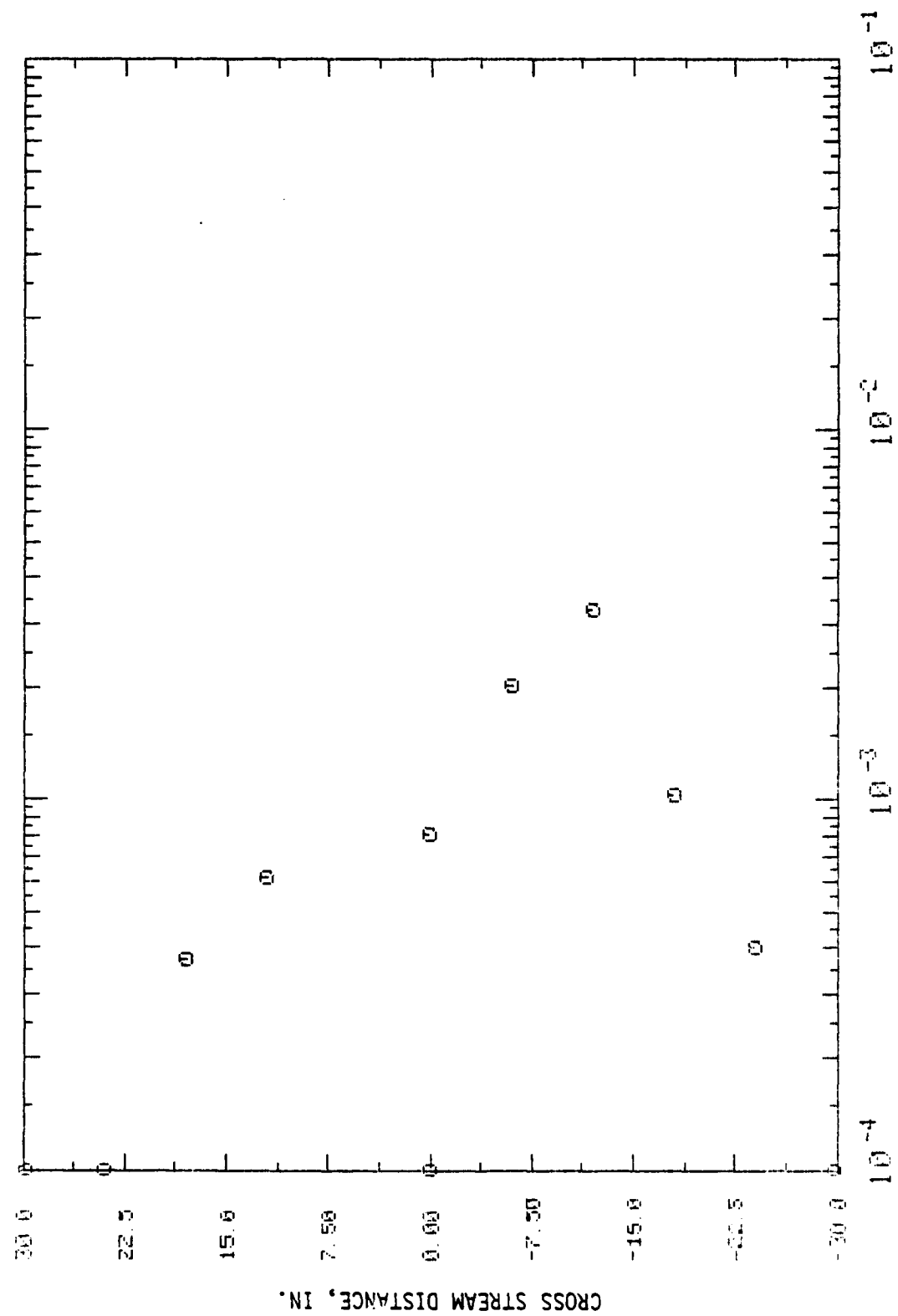
APPENDIX L

CONCENTRATION PROFILES FOR
RUN I.2-4 AT X = 48 IN., 120 IN.

$$\rho_c/\rho = 0.79$$

$$J = 12.6$$

$$Fr = -0.97$$



C/C_0 DIMENSIONLESS CONCENTRATION

$X = 48$ IN., $Z = 1$ IN.

FIGURE L-1. RUN I. 2-4 CROSS STREAM CONCENTRATION PROFILE

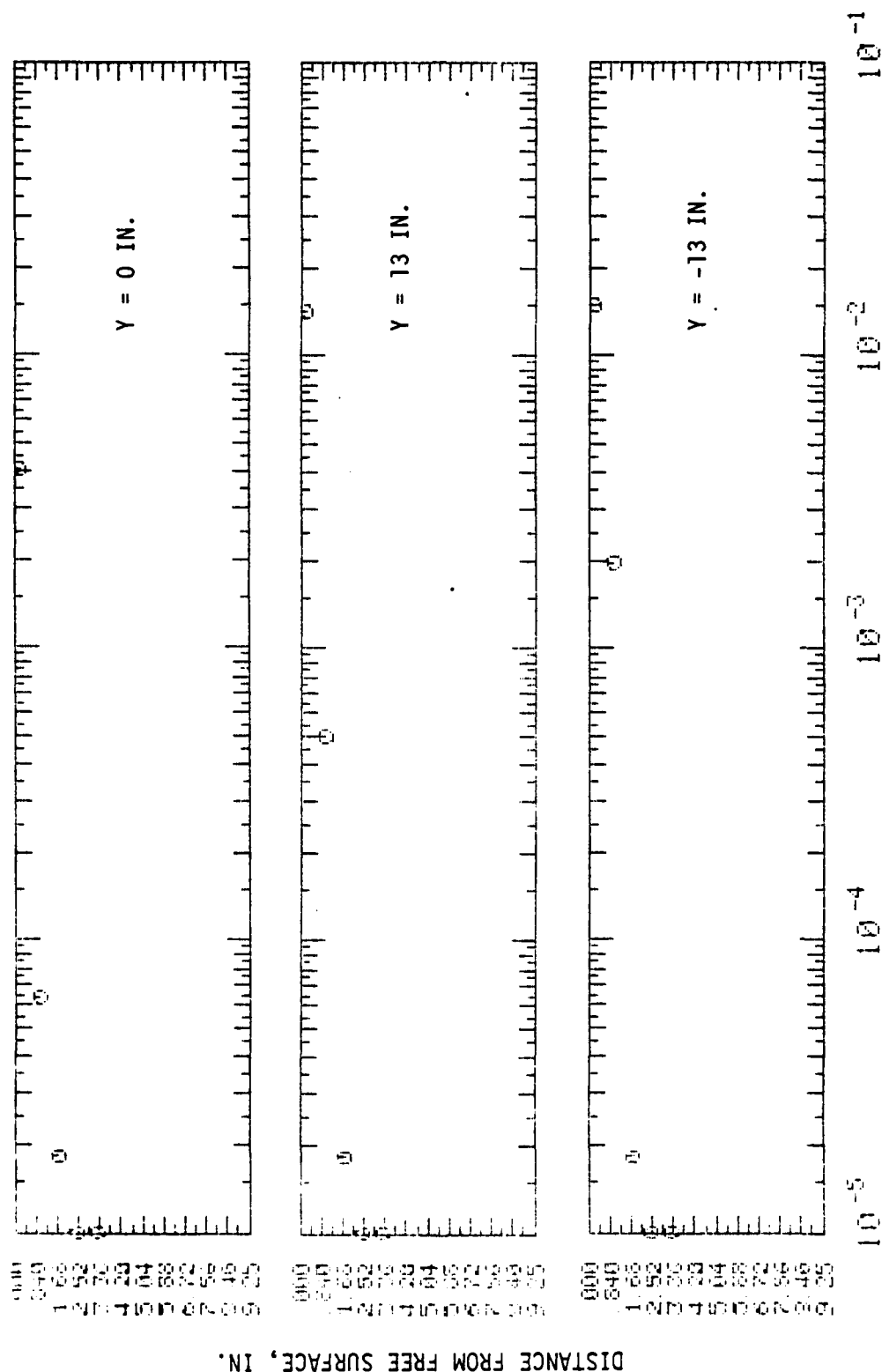
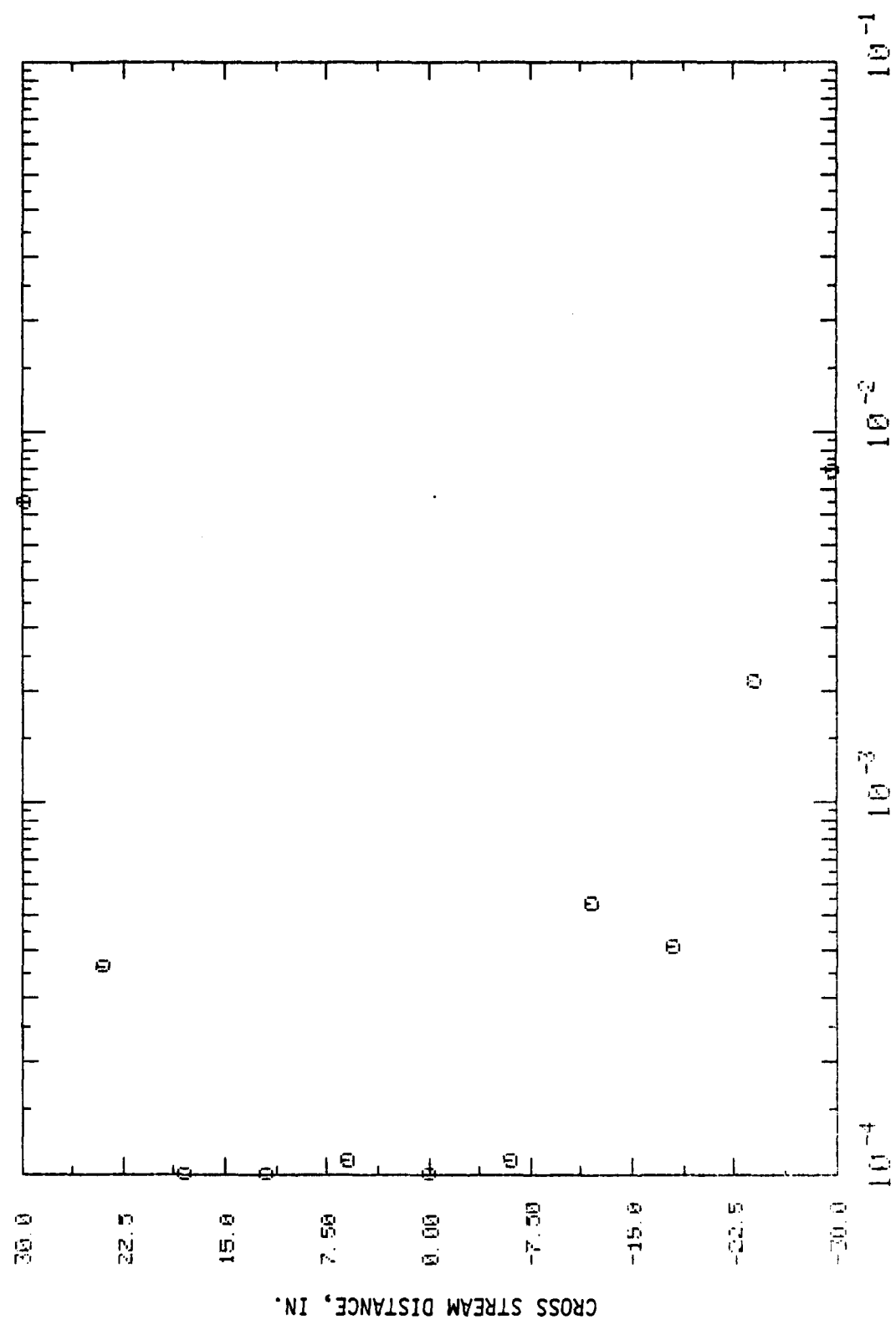


FIGURE L-2. RUN I. 2-4 VERTICAL CONCENTRATION PROFILES



C/C₀ DIMENSIONLESS CONCENTRATION

X = 120 IN., Z = 1 IN.

FIGURE L-3. RUN I. 2-4 CROSS STREAM CONCENTRATION PROFILE

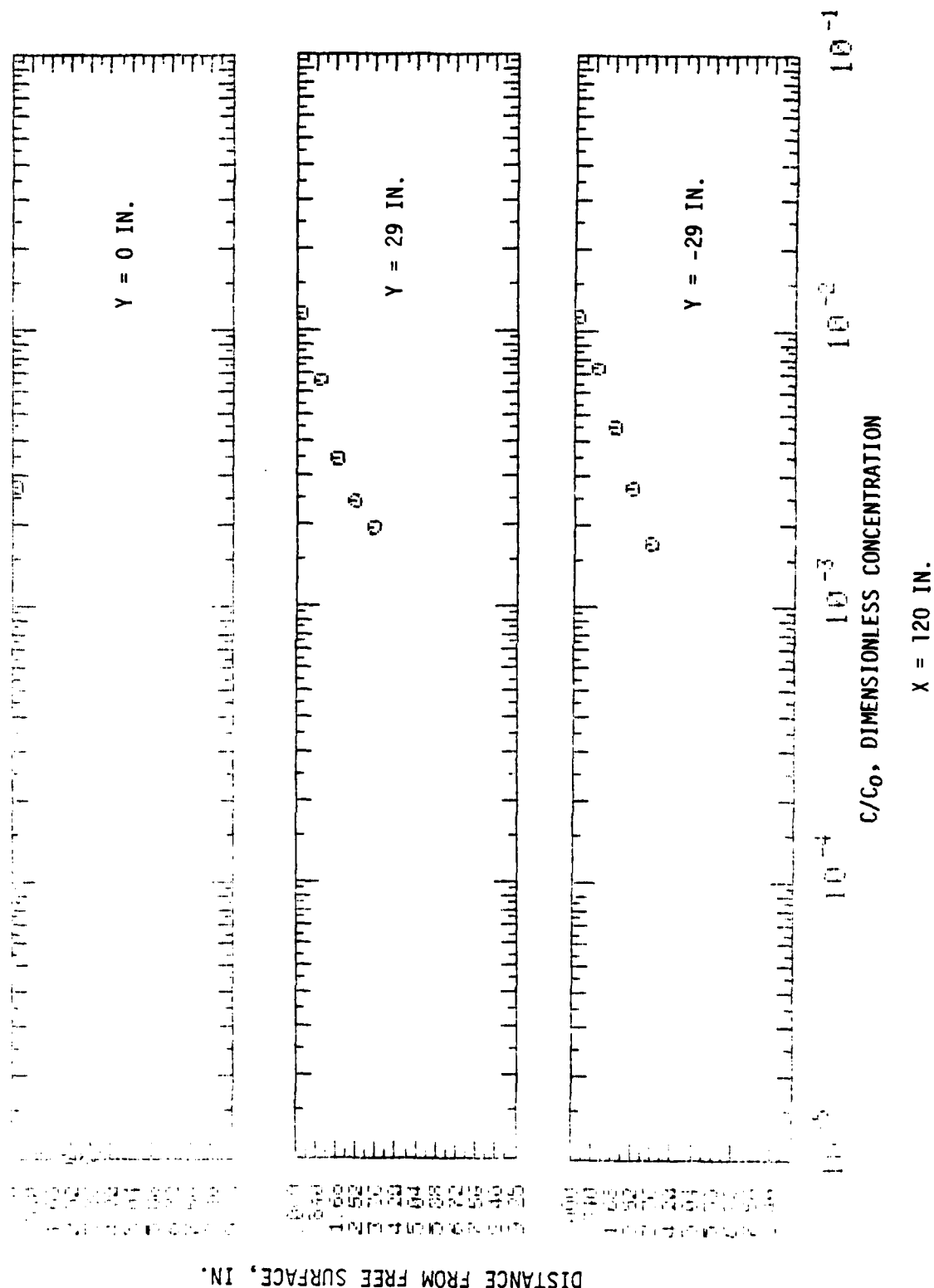


FIGURE L-4. RUN I. 2-4 VERTICAL CONCENTRATION PROFILES

APPENDIX M

CONCENTRATION PROFILES FOR
RUN I.2-9 AT X = 48 IN., 120 IN.

$$\rho_c/\rho = 1.05$$

$$J = 16.8$$

$$Fr = 0.26$$

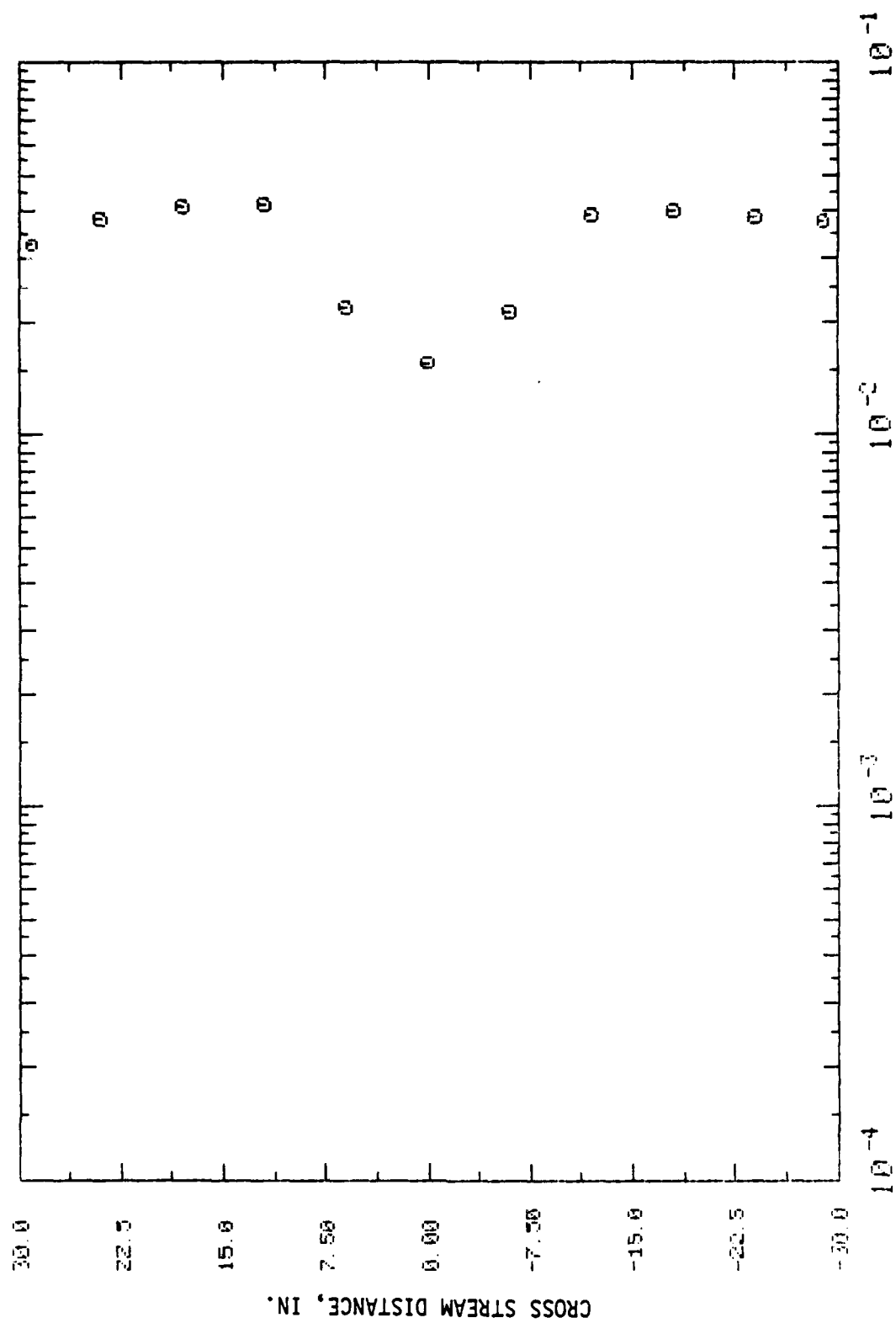


FIGURE M-1. RUN I. 2-9 CROSS STREAM CONCENTRATION PROFILE

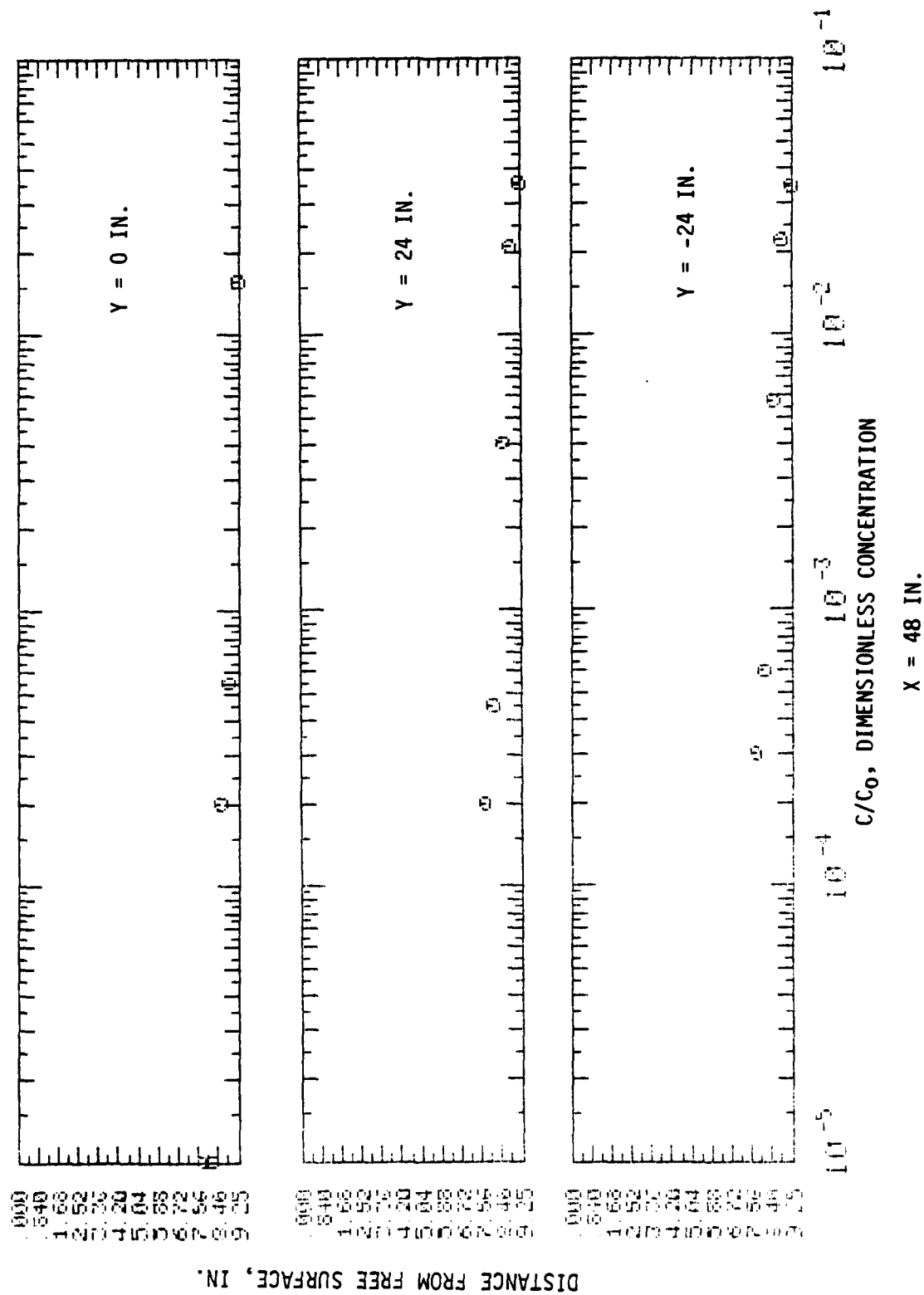


FIGURE M-2. RUN I. 2-9 VERTICAL CONCENTRATION PROFILES

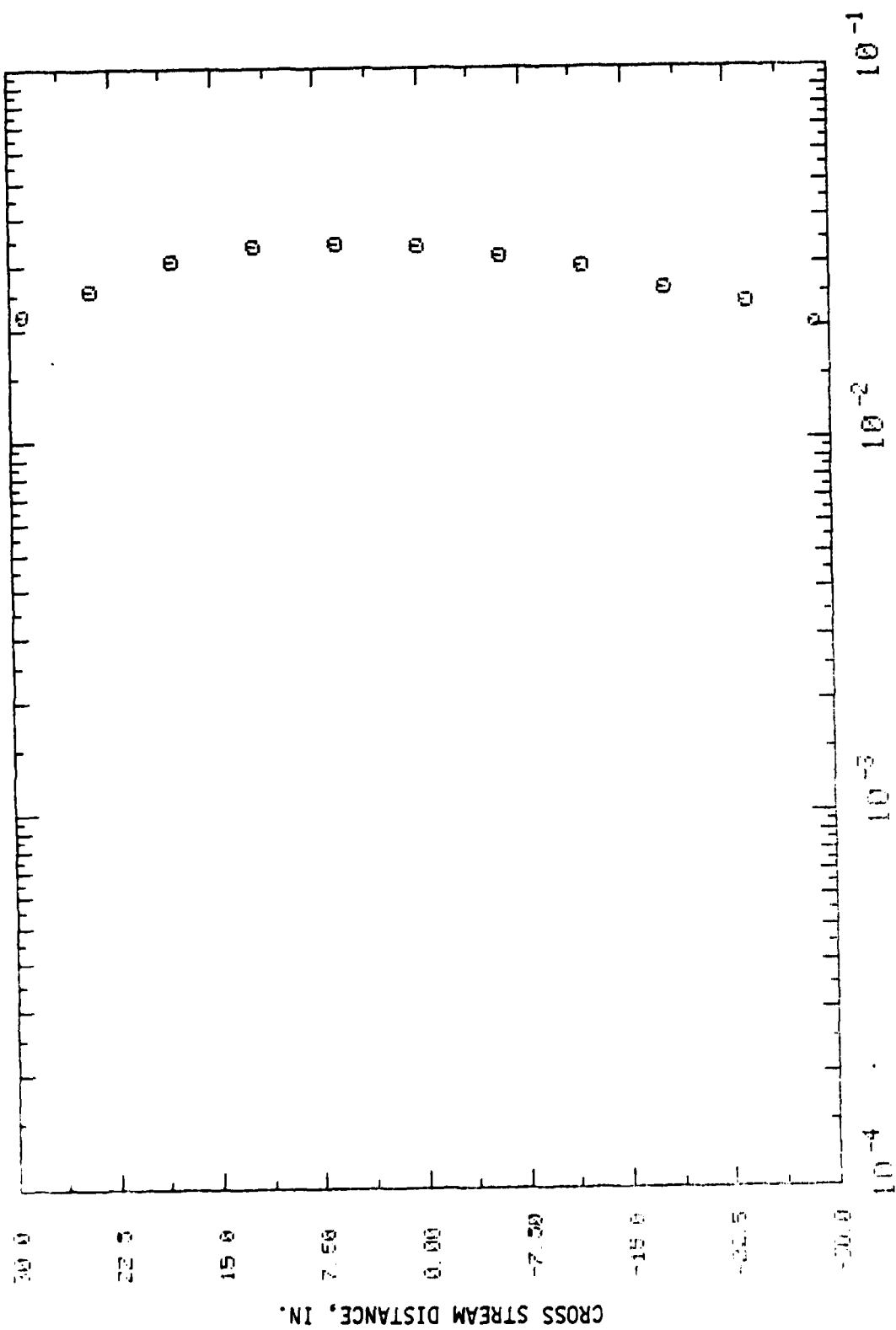


FIGURE M-3. RUN I. 2-9 CROSS STREAM CONCENTRATION PROFILE

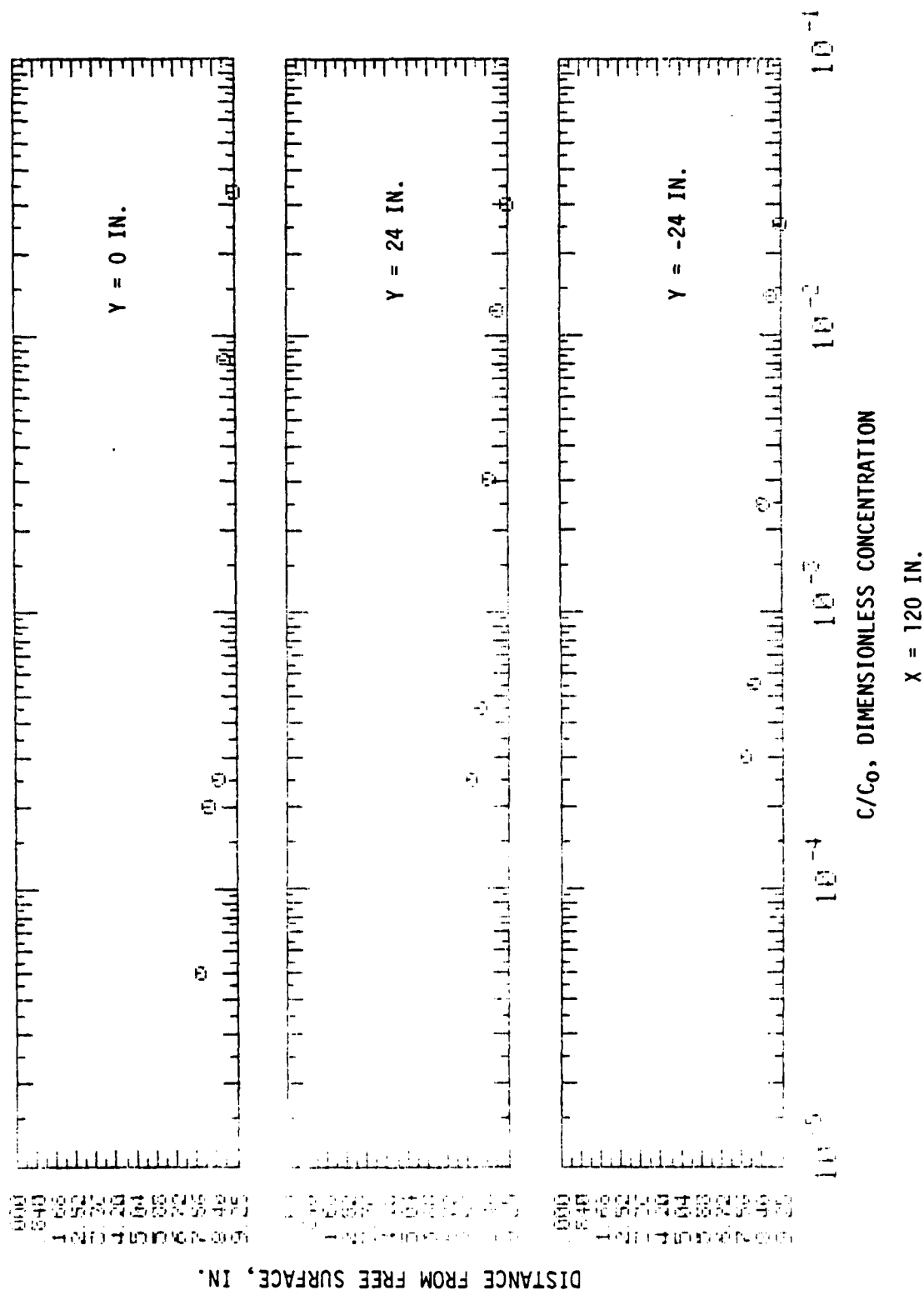


FIGURE M-4. RUN I. 2-9 VERTICAL CONCENTRATION PROFILES

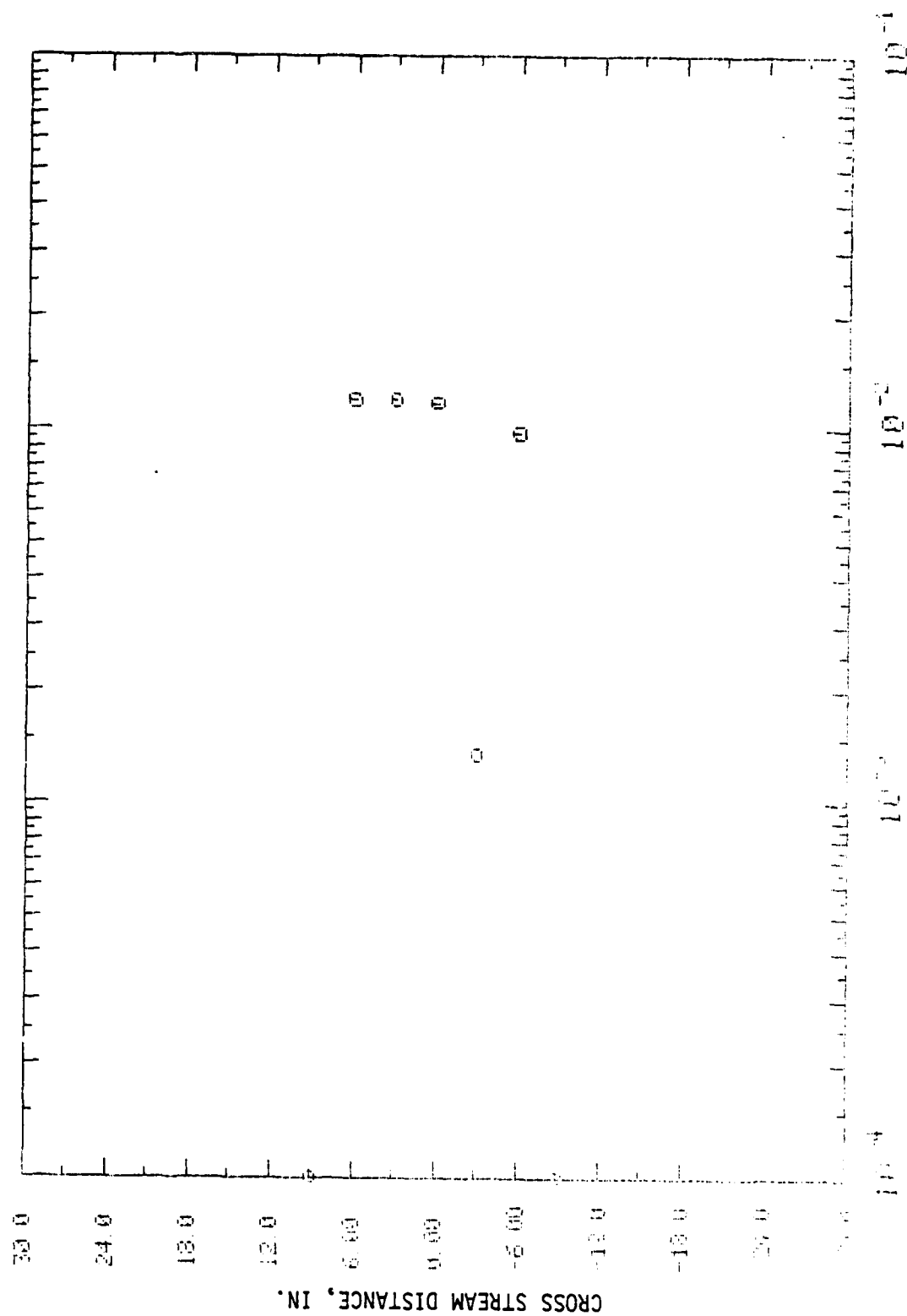
APPENDIX N

CONCENTRATION PROFILES FOR
RUN I.2-11 AT X = 48 IN., 120 IN.

$$\rho_c/\rho = 1.05$$

$$J = 1.05$$

$$Fr = 4.1$$



X = 48 IN., Z = 9.25 IN.

FIGURE N-1. RUN I. 2-11 CROSS STREAM CONCENTRATION PROFILE

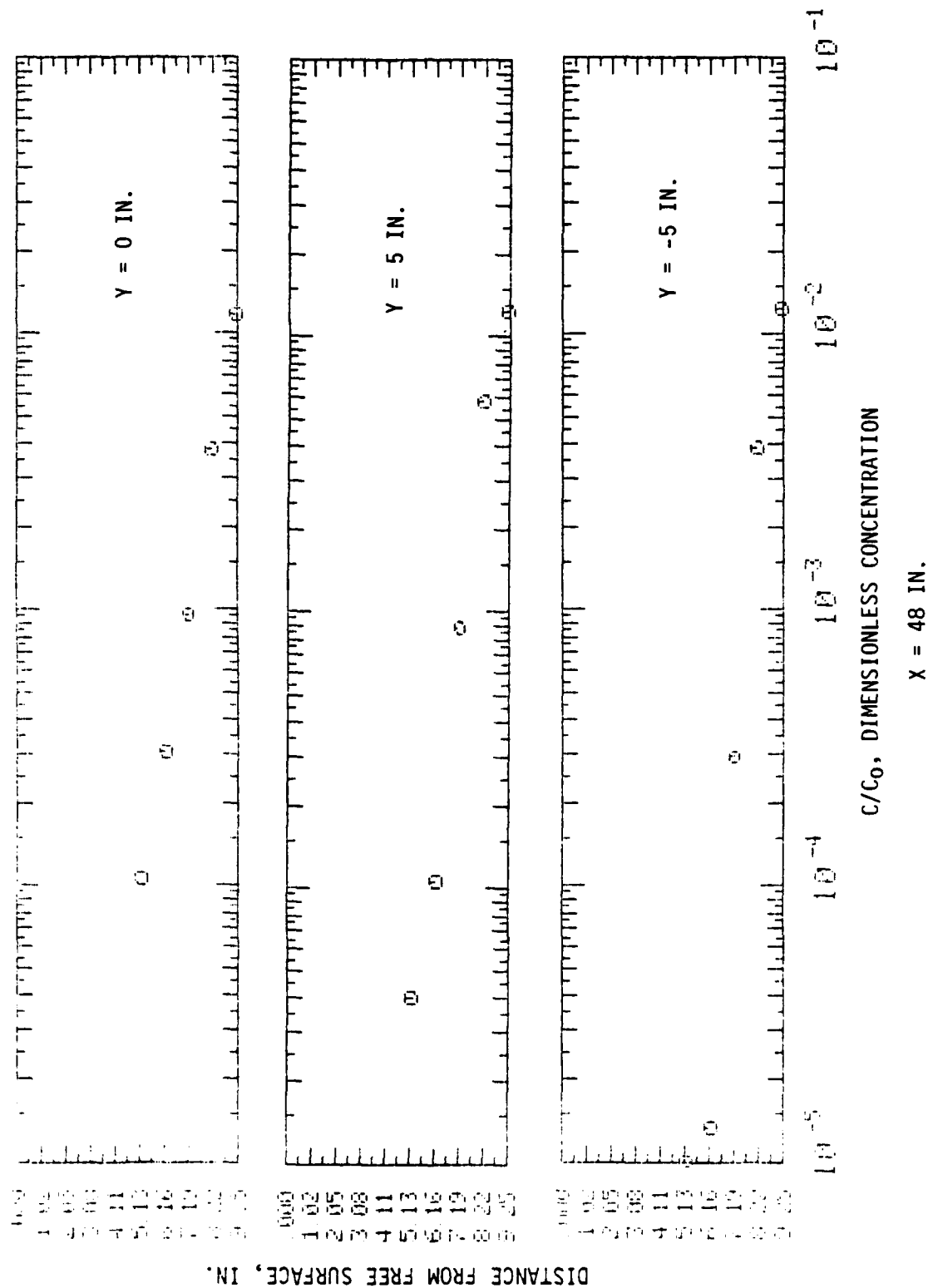
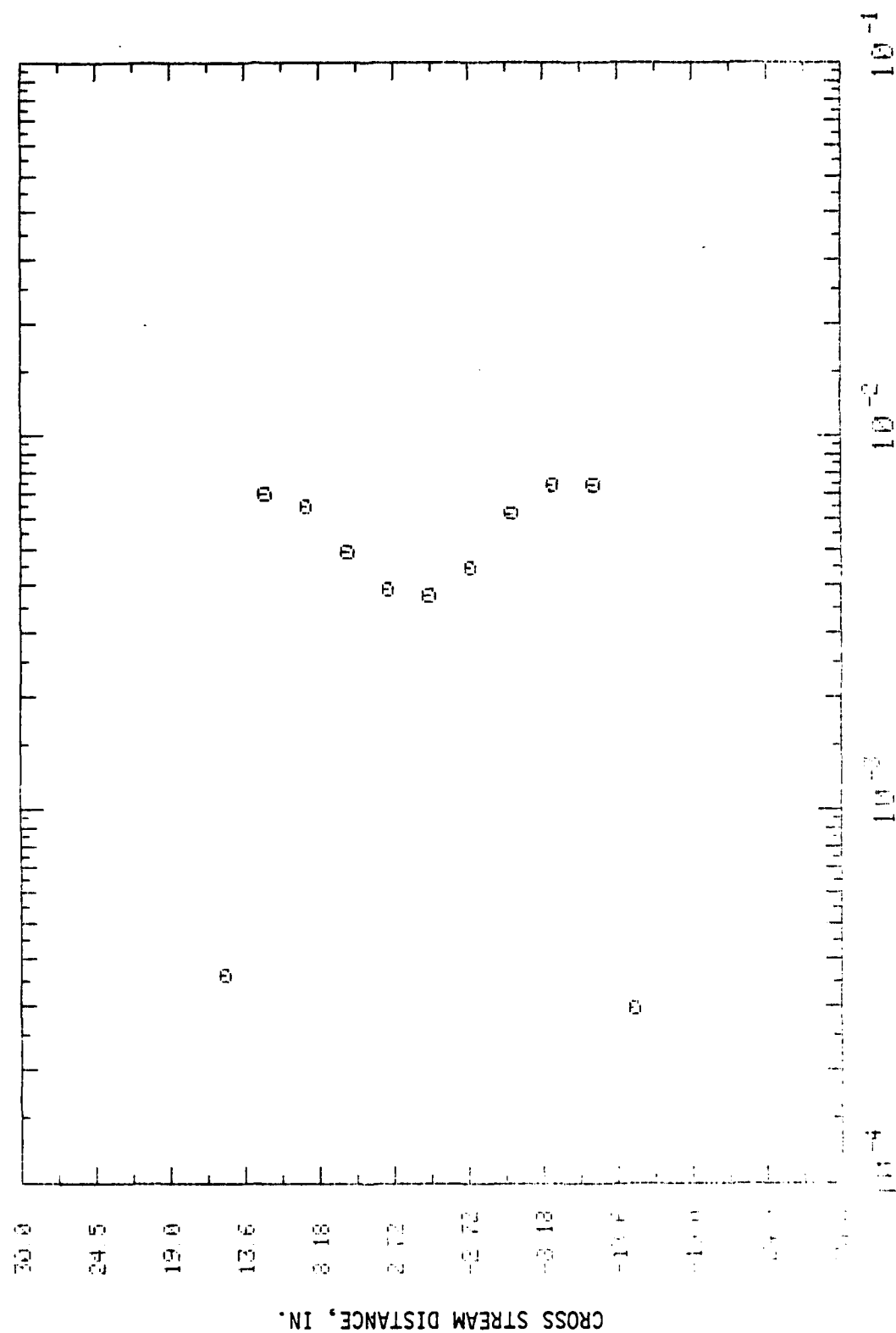


FIGURE N-2. RUN I. 2-11 VERTICAL CONCENTRATION PROFILES



C/C₀ DIMENSIONLESS CONCENTRATION

X = 120 IN., Z = 9.25 IN.

FIGURE N-3. RUN 1. 2-11 CROSS STREAM CONCENTRATION PROFILE

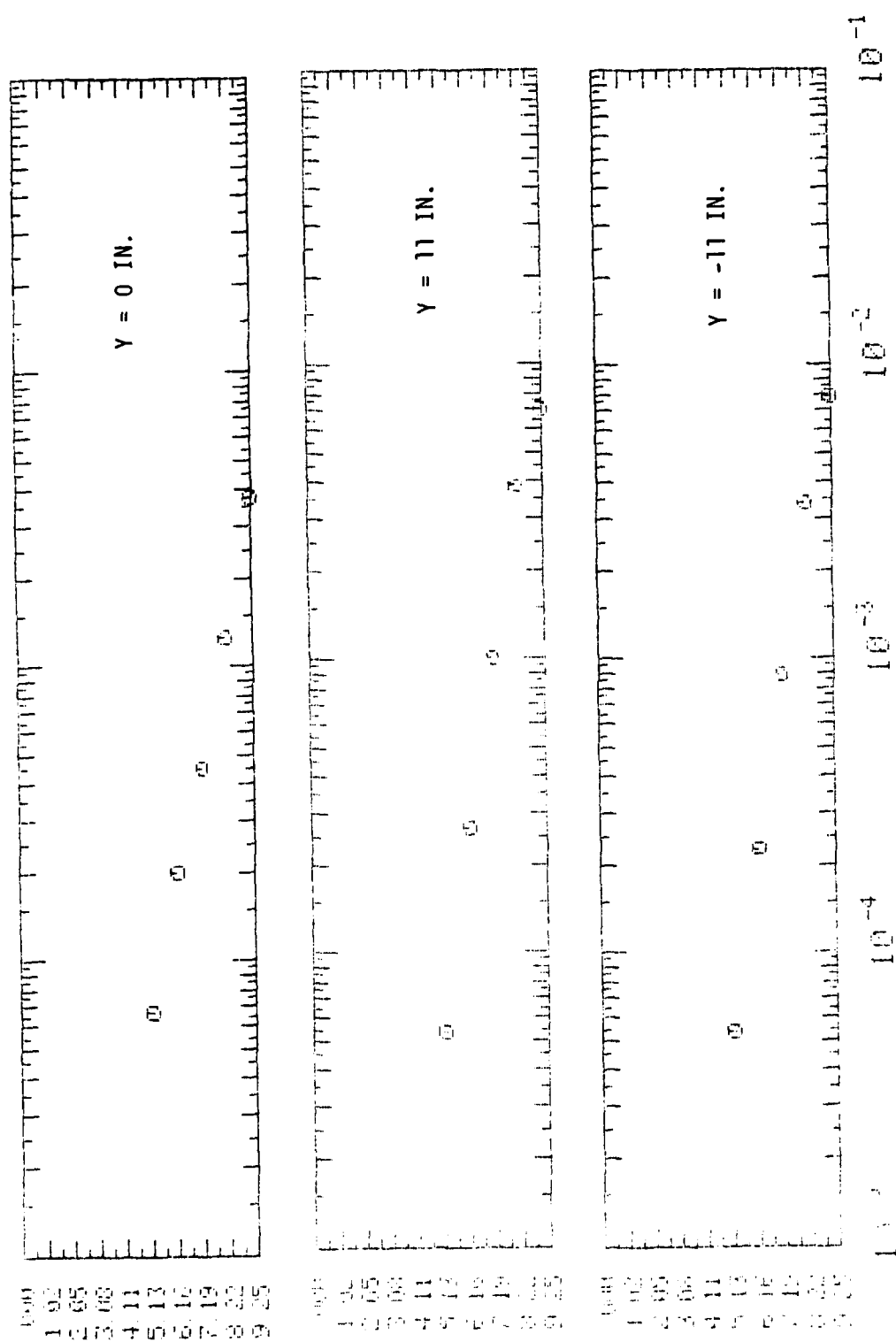


FIGURE N-4. RI² 1.2-11 VERTICAL CONCENTRATION PROFILES

DISTANCE FROM FREE SURFACE, IN.

APPENDIX O

CONCENTRATION PROFILES FOR
RUN I.2-12 AT X = 48 IN., 120 IN.,
240 IN., 288 IN., 336 IN., 432 IN.

$$\rho_c/\rho = 1.05$$

$$J = 16.8$$

$$Fr = 14.1$$

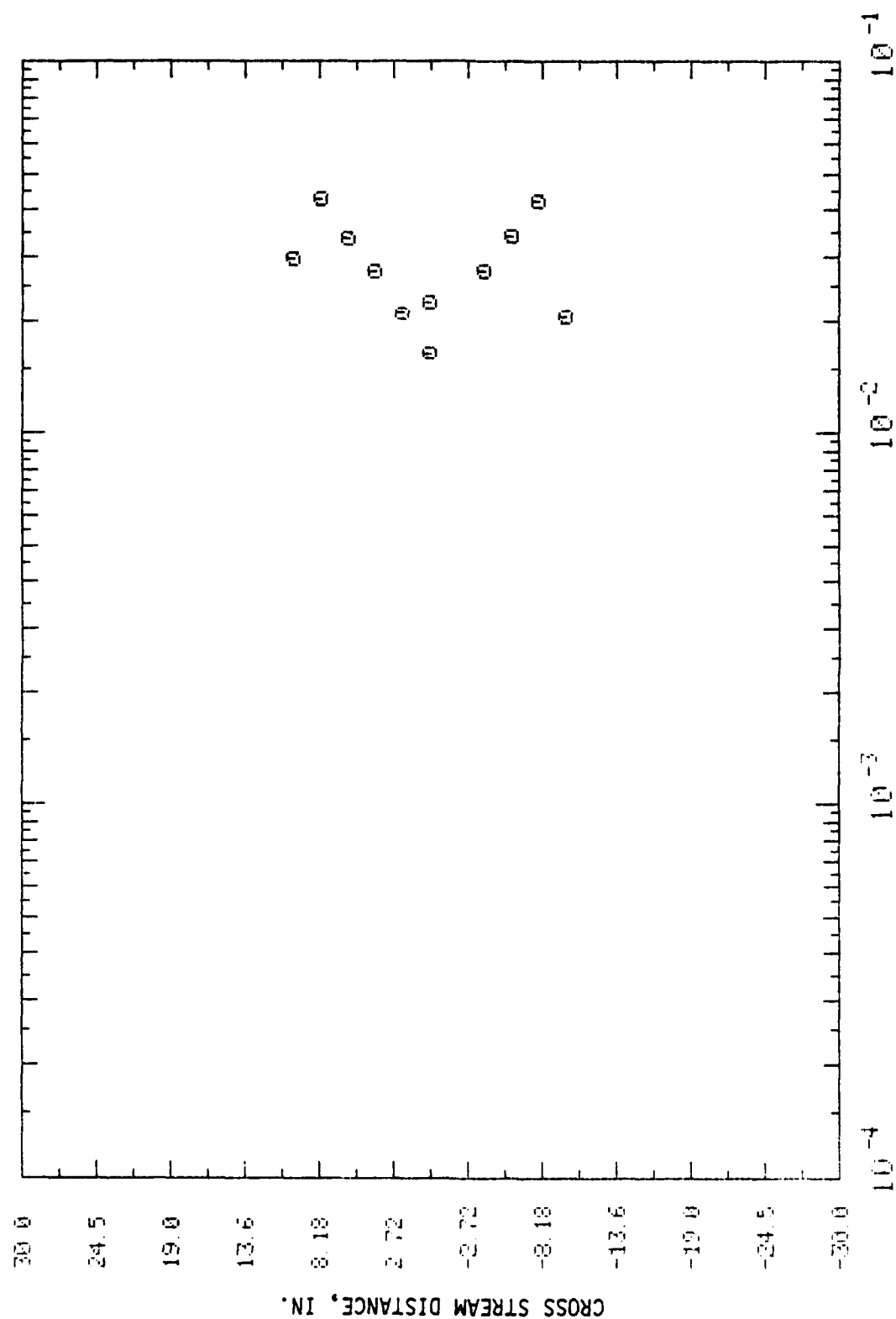


FIGURE 0-1. RUN I.2-12 CROSS STREAM CONCENTRATION PROFILE

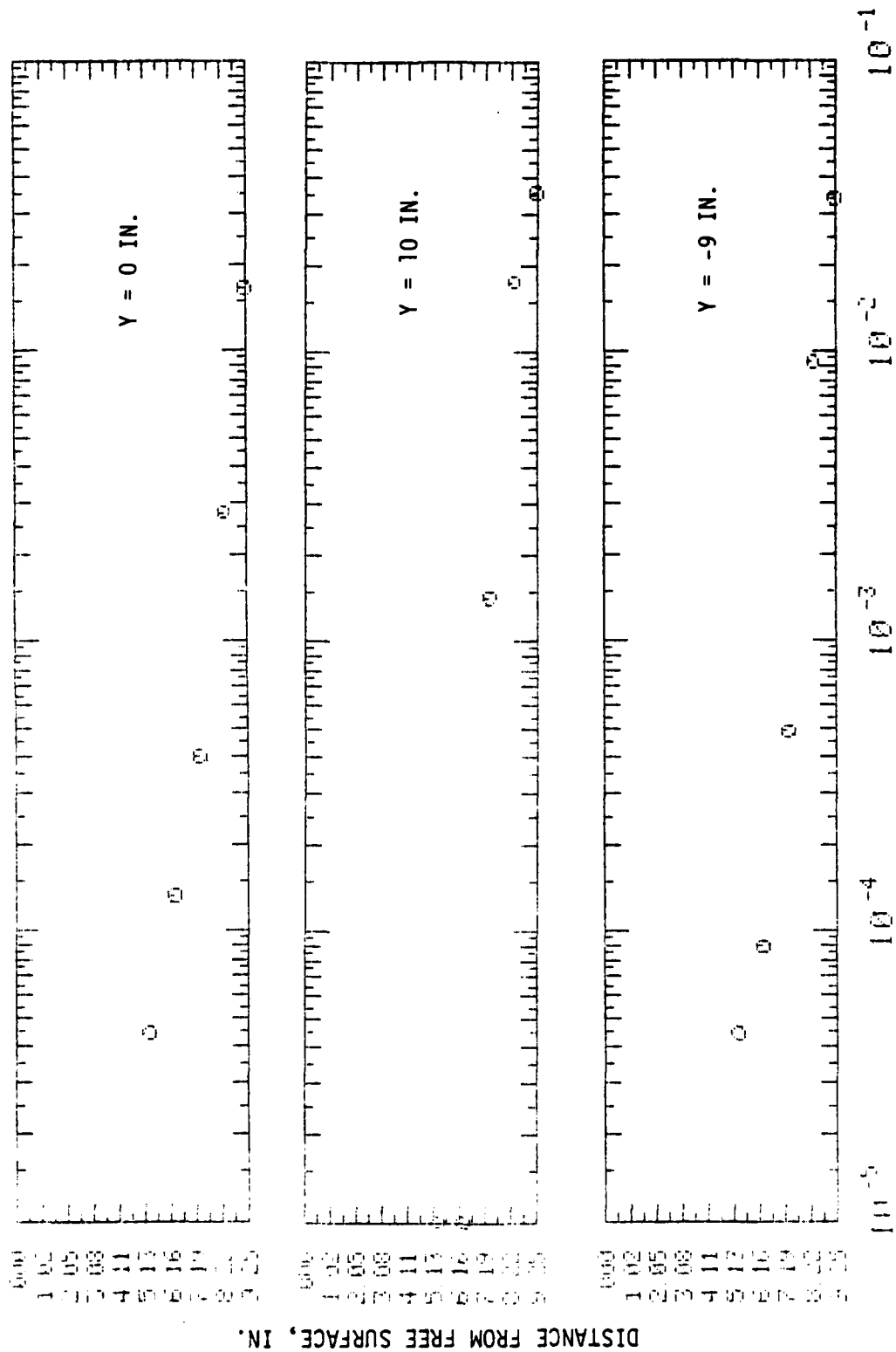


FIGURE 0-2. RUN I.2-12 VERTICAL CONCENTRATION PROFILES

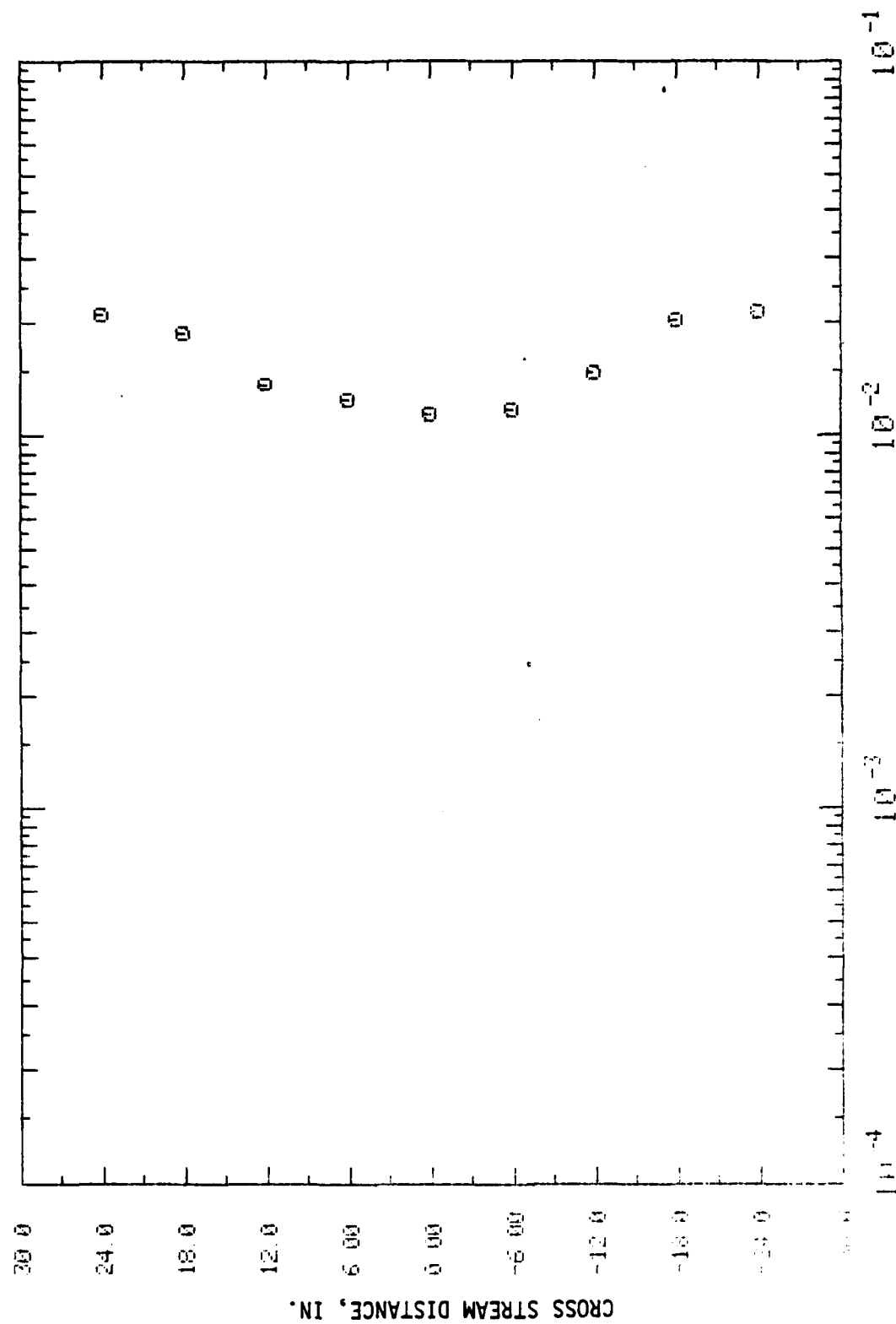


FIGURE 0-3. RUN 1.2-12 CROSS STREAM CONCENTRATION PROFILE

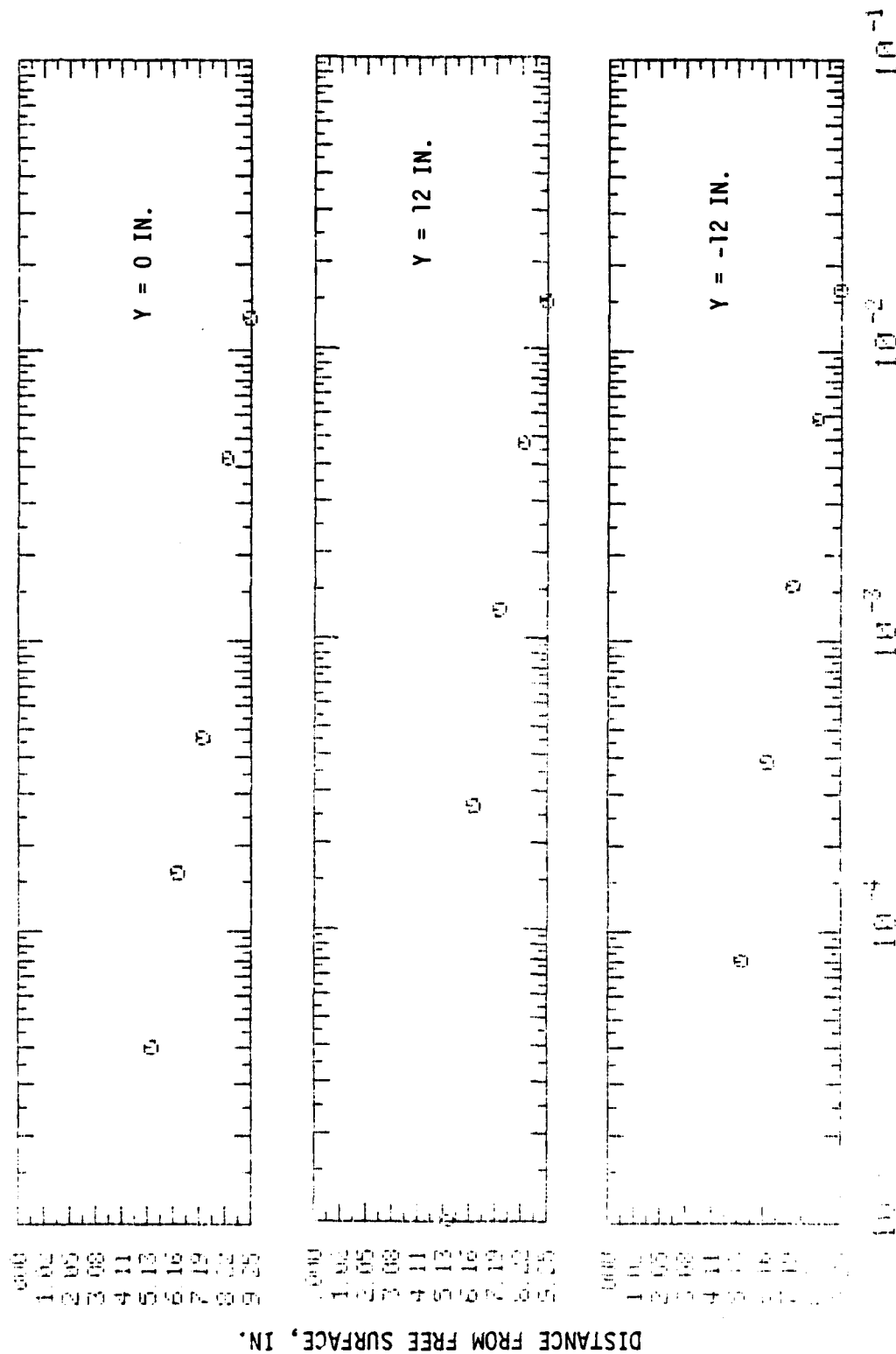


FIGURE 0-4. RUN I. 2-12 VERTICAL CONCENTRATION PROFILES

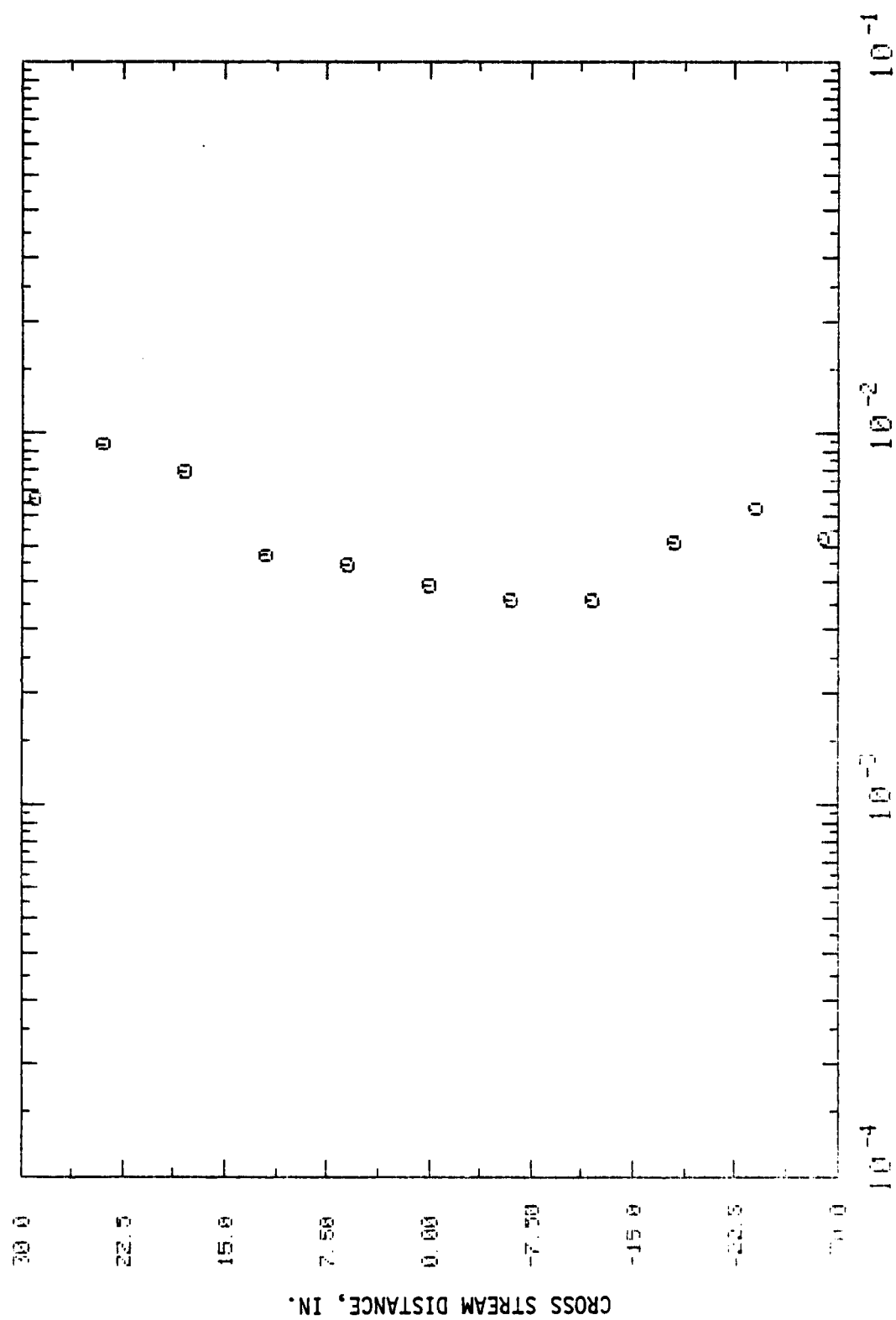


FIGURE 0-5. RUN 1.2-12 CROSS STREAM CONCENTRATION PROFILE

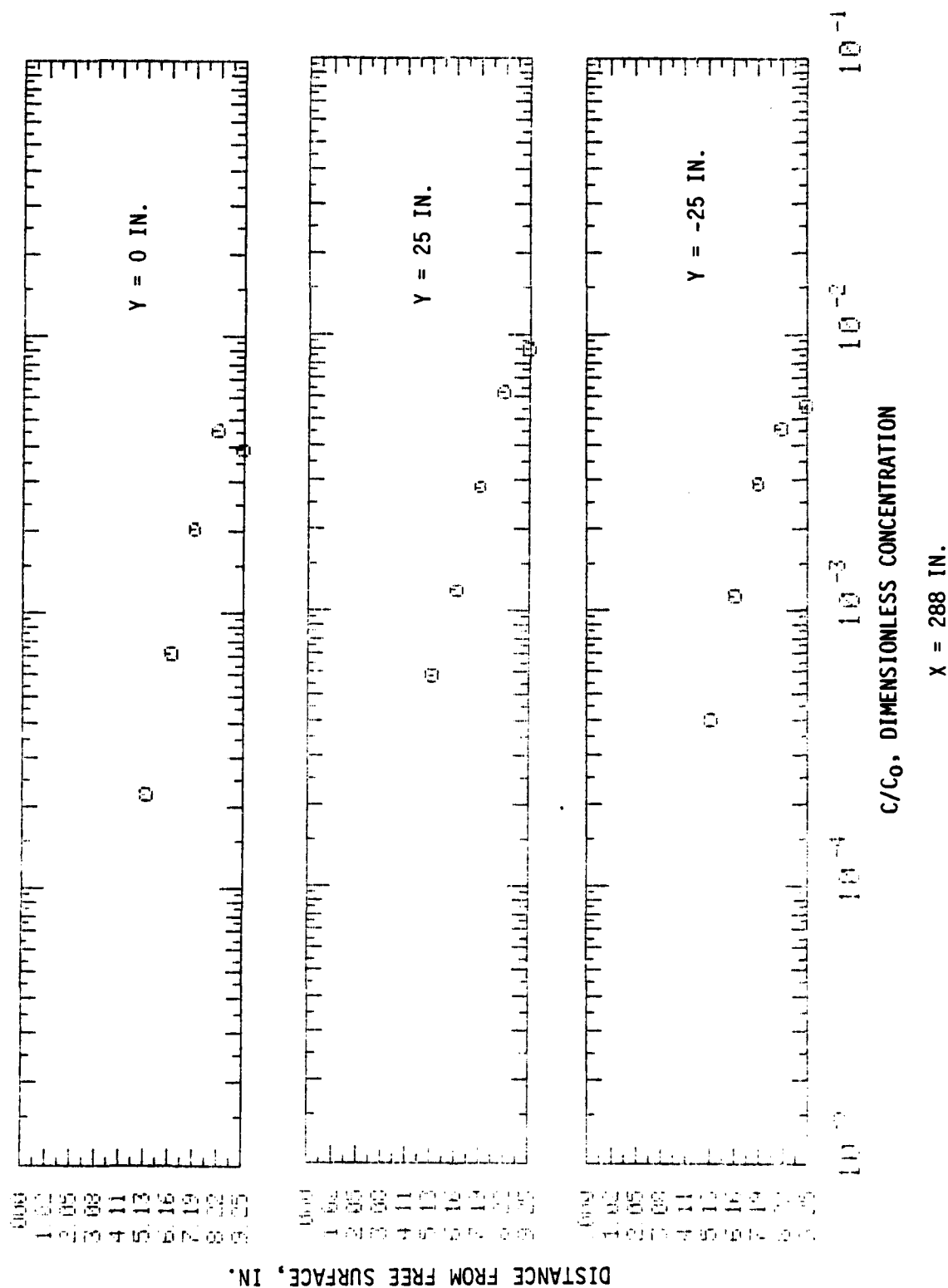


FIGURE 0-6. RUN I. 2-12 VERTICAL CONCENTRATION PROFILES

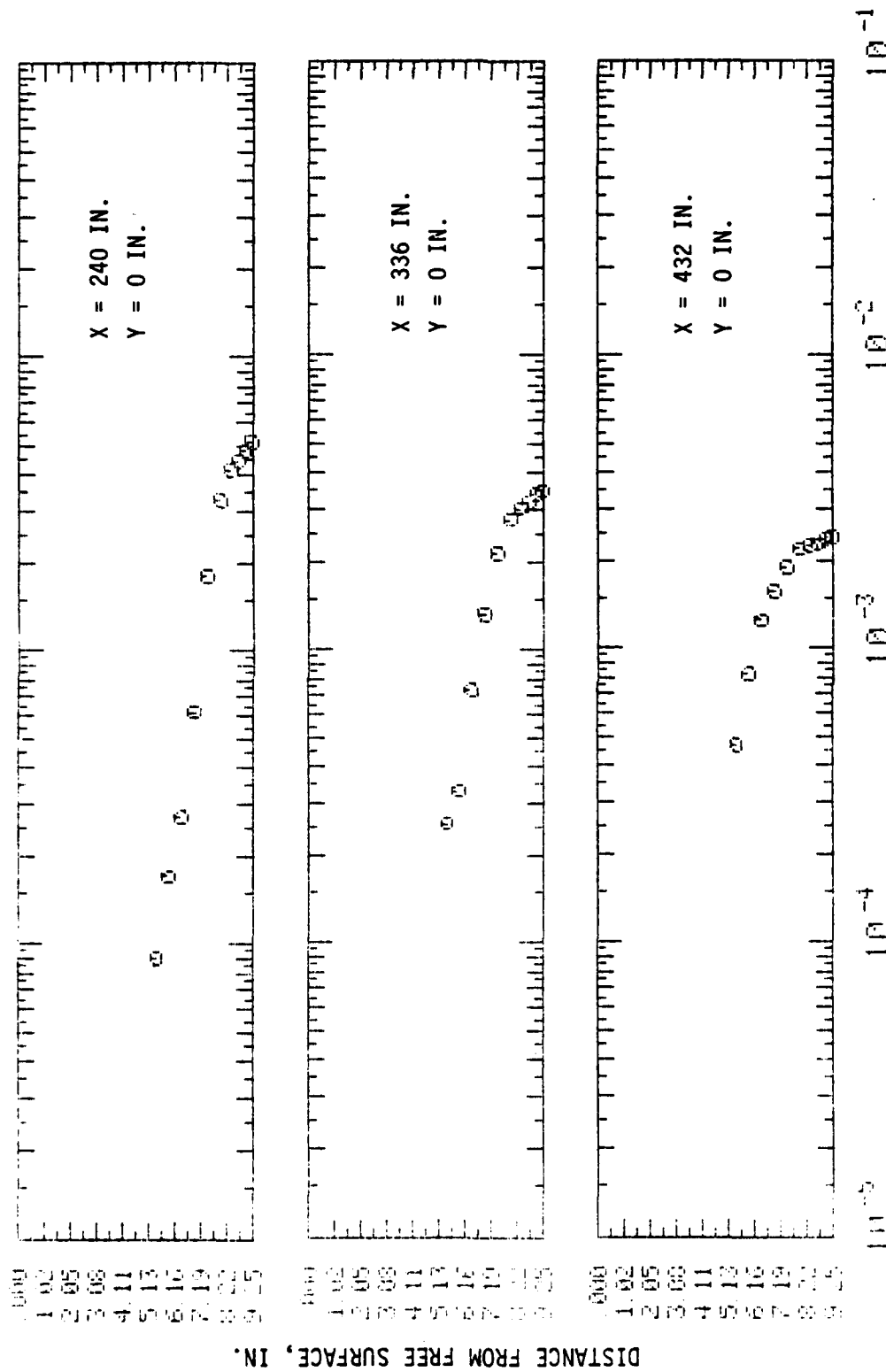


FIGURE 0-7. RUN I.2-12 VERTICAL CONCENTRATION PROFILES

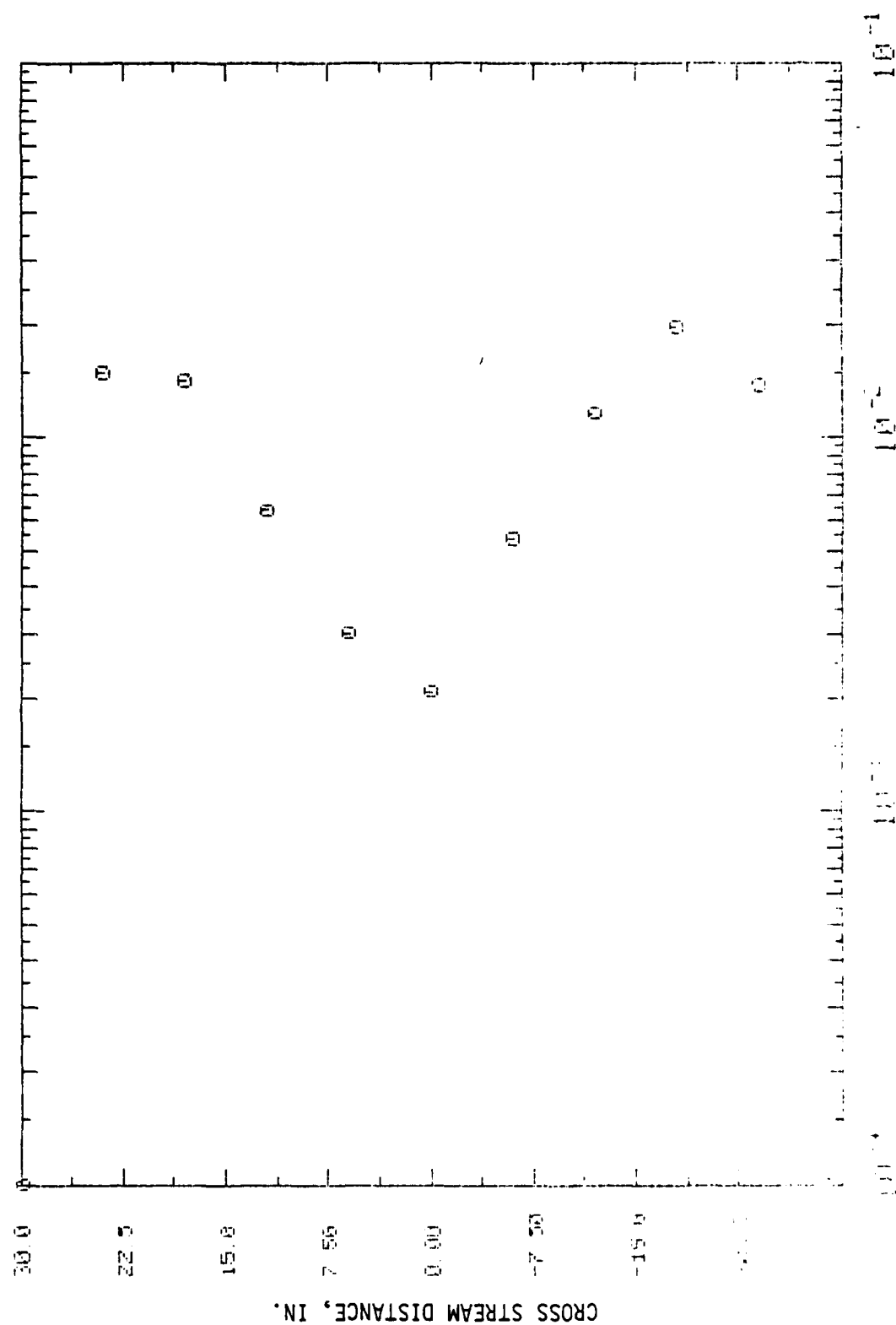
APPENDIX P

CONCENTRATION PROFILES FOR
RUN I.2-19 AT X = 48 IN., 120 IN.

$$\rho_c/\rho = 1.4$$

$$J = 1.4$$

$$Fr = 0.51$$



C/C₀ DIMENSIONLESS CONCENTRATION

X = 48 IN., Z = 9.25 IN.

FIGURE P-1. RUN 1. 2-19 CROSS STREAM CONCENTRATION PROFILE

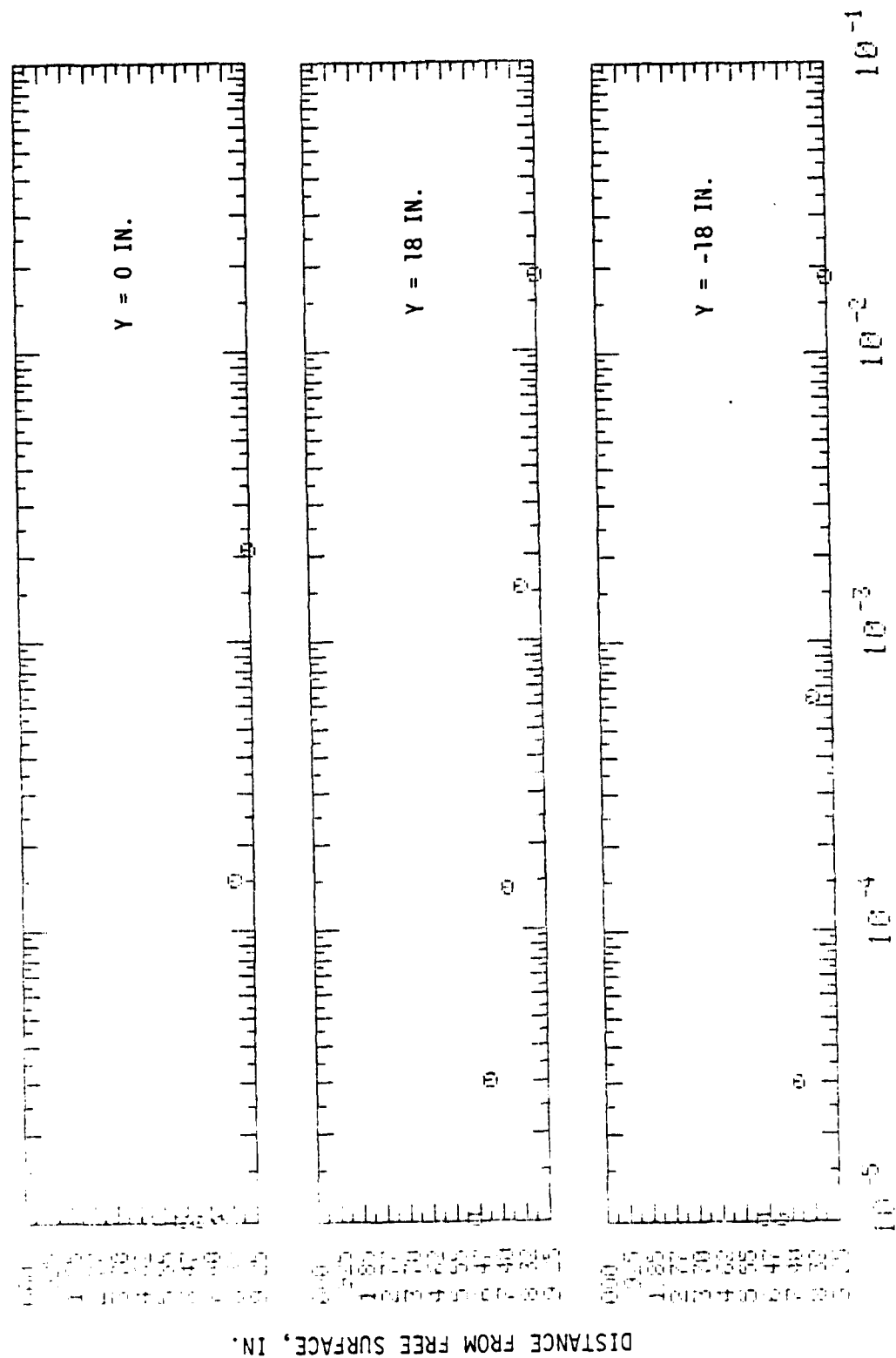
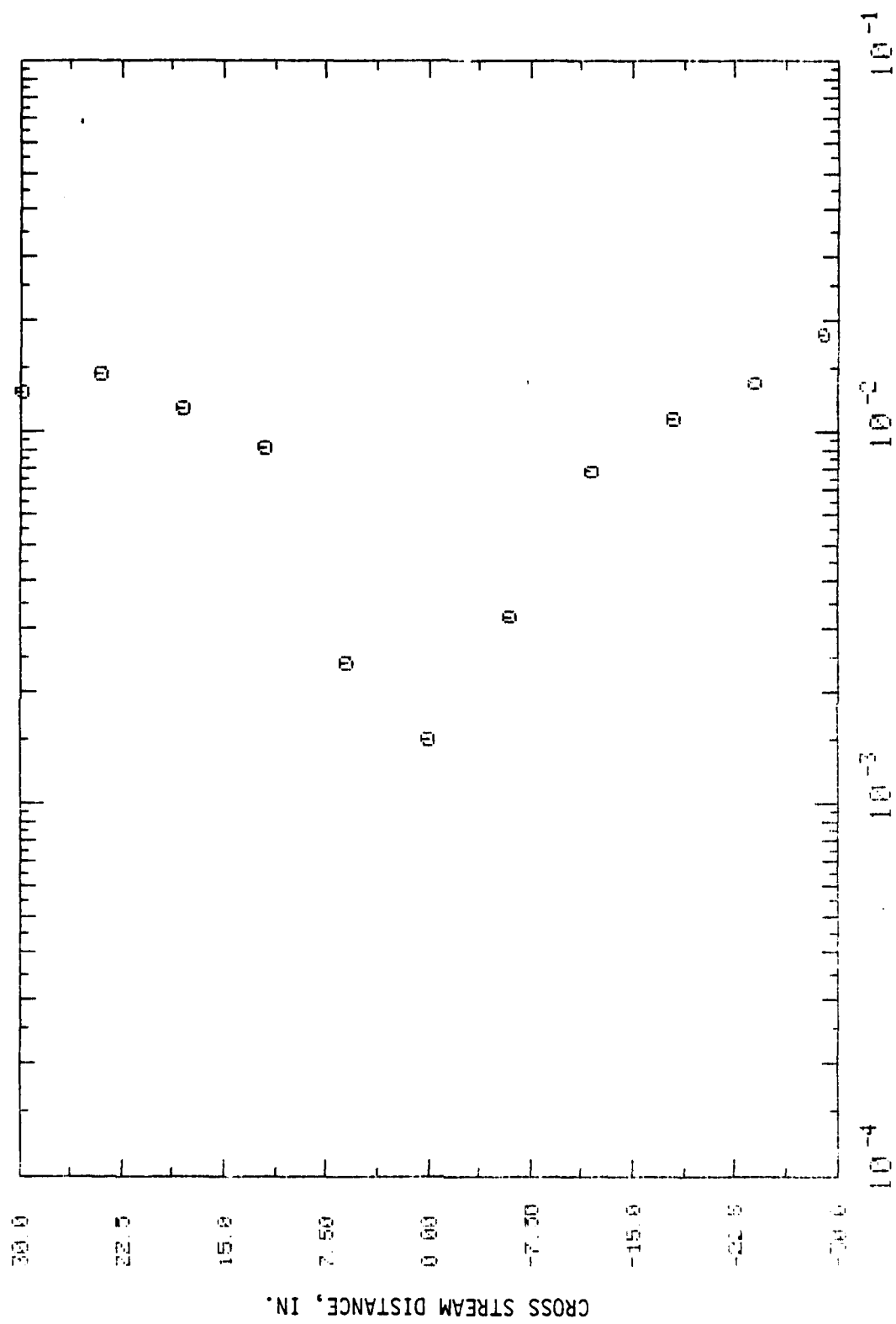


FIGURE P-2. RUN I. 2-19 VERTICAL CONCENTRATION PROFILES



C/C₀ DIMENSIONLESS CONCENTRATION

X = 120 IN., Z = 9.25 IN.

FIGURE P-3. RUN 1. 2-19 CROSS STREAM CONCENTRATION PROFILE

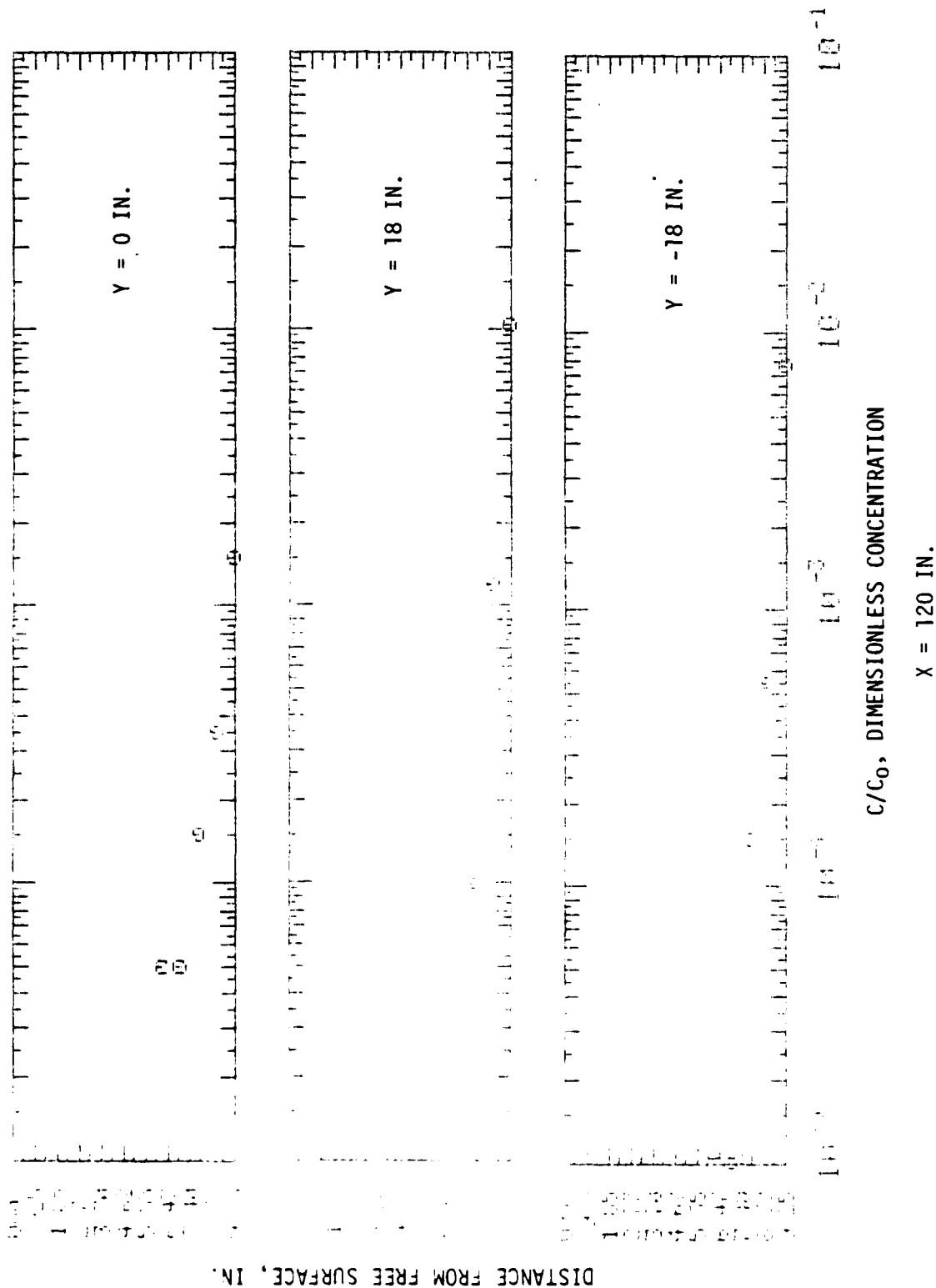


FIGURE P-4. RUN I. 2-19 VERTICAL CONCENTRATION PROFILES

APPENDIX Q

CONCENTRATION PROFILES FOR
RUN I.2-20 AT X = 48 IN., 120 IN.,
240 IN., 336 IN., 432 IN.

$$\rho_c/\rho = 1.4$$

$$J = 22.4$$

$$Fr = 0.51$$

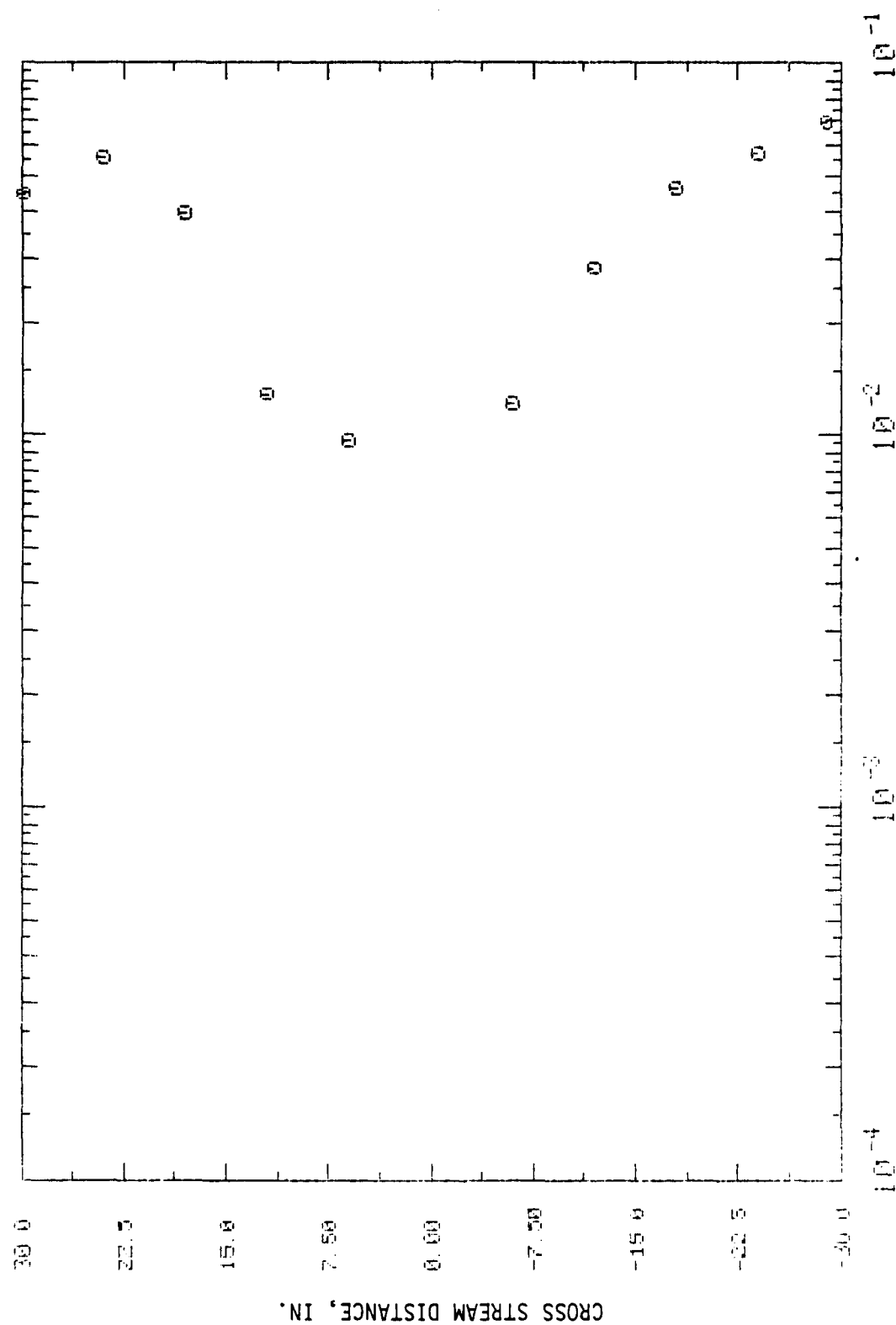


FIGURE Q-1. RUN I. 2-20 CROSS STREAM CONCENTRATION PROFILE

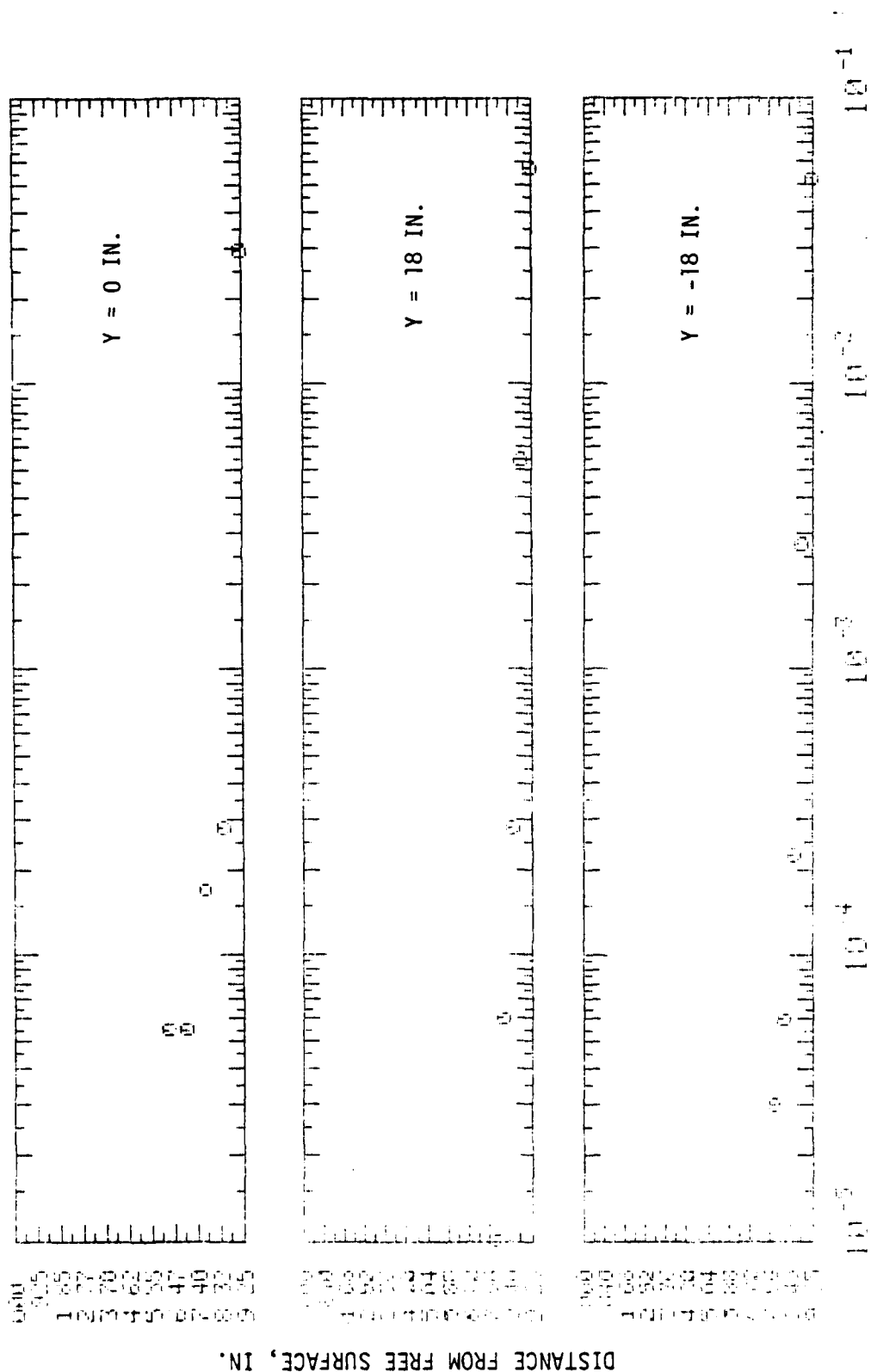


FIGURE Q-2. RUN I. 2-20 VERTICAL CONCENTRATION PROFILES

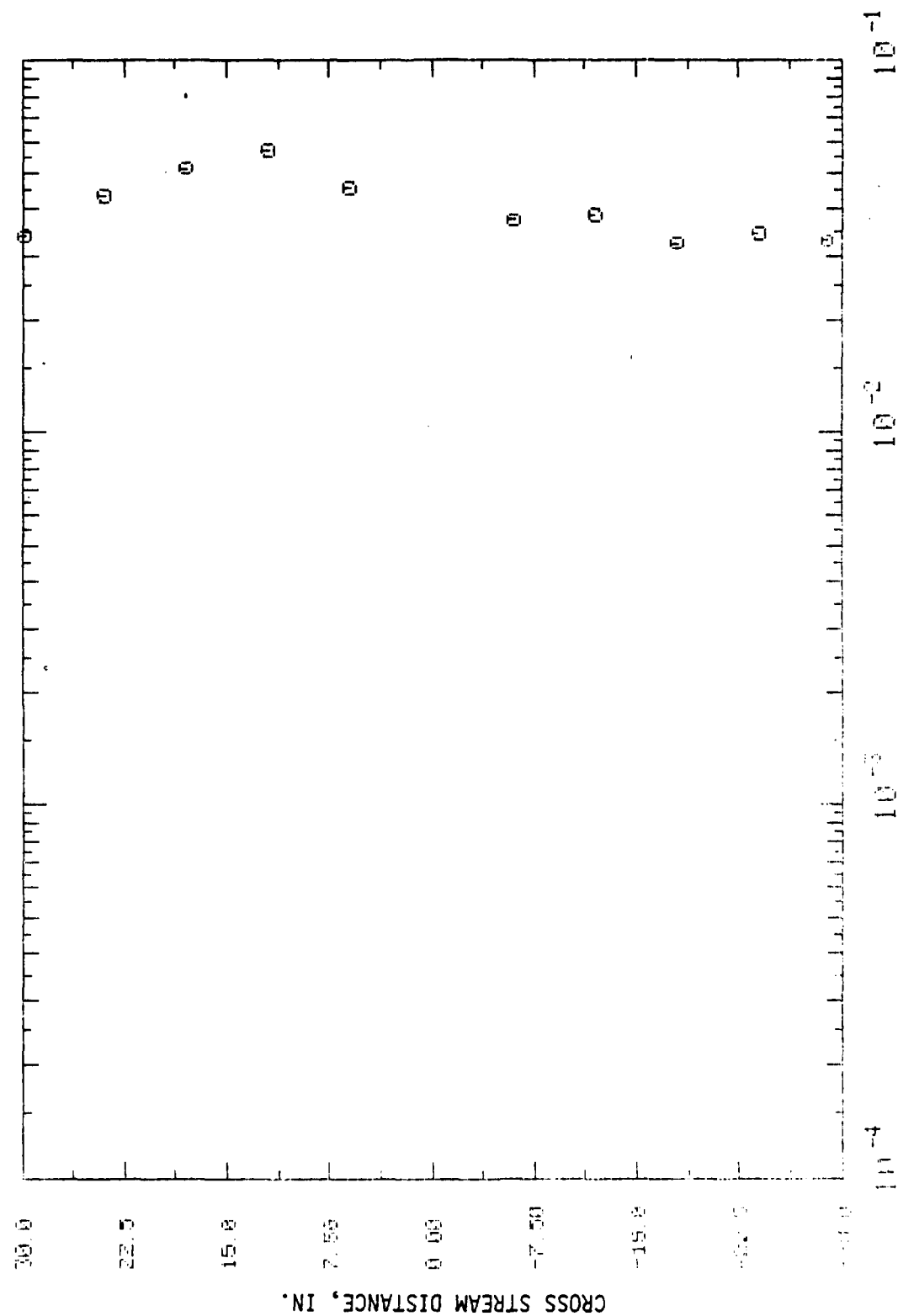


FIGURE Q-3. RUN 1. 2-20 CROSS STREAM CONCENTRATION PROFILE

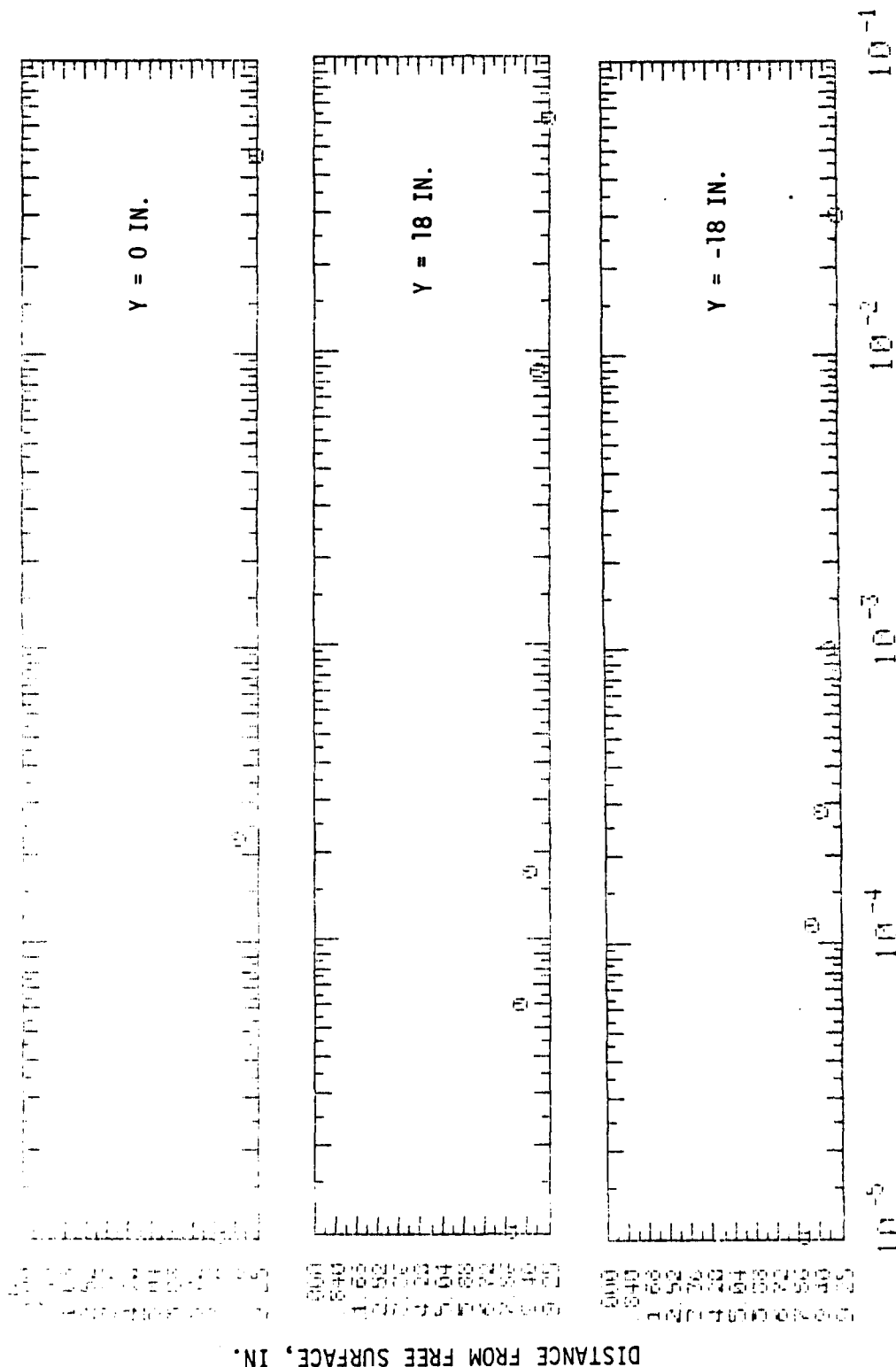


FIGURE Q-4. RUN I. 2-20 VERTICAL CONCENTRATION PROFILES

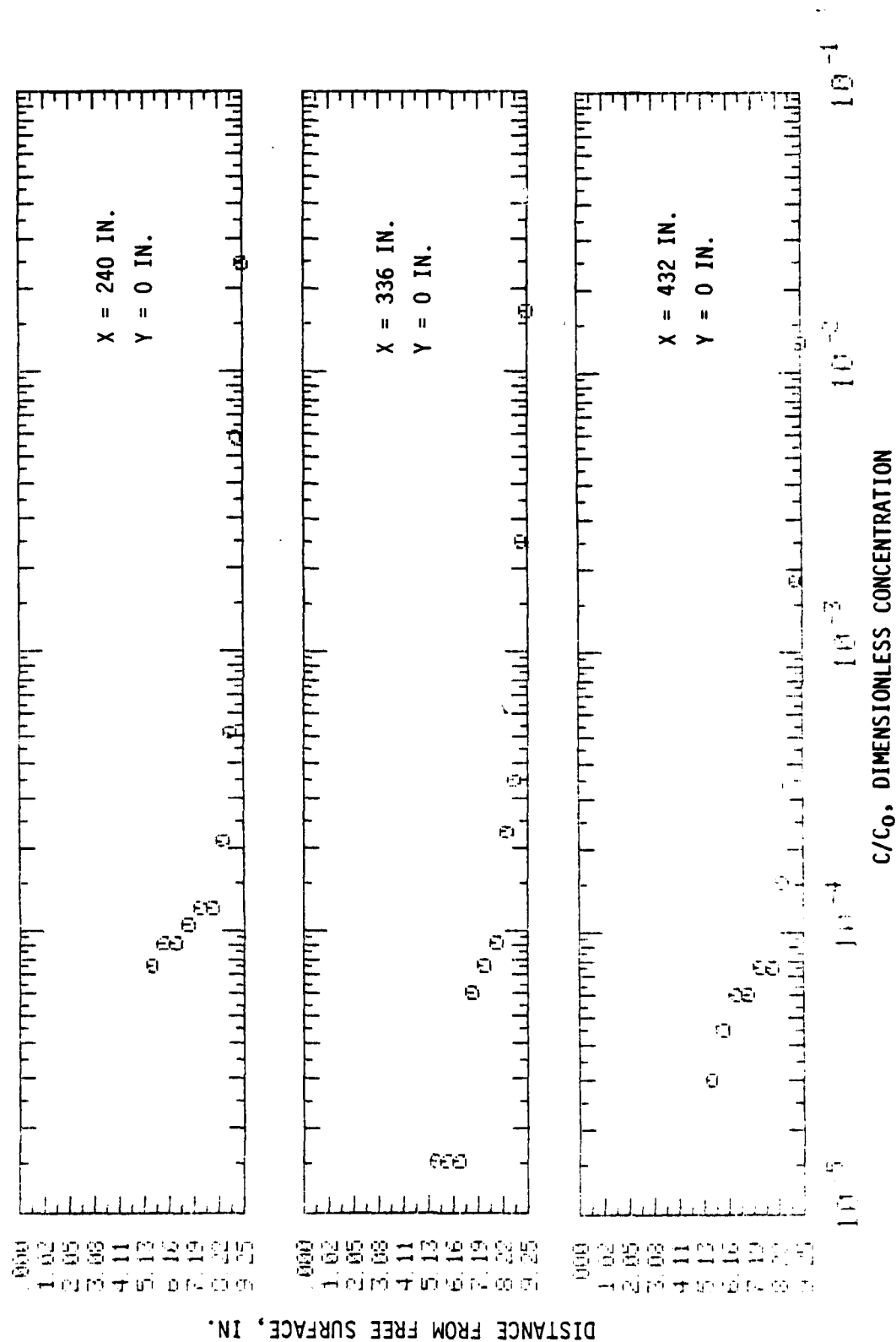


FIGURE Q-5. RUN I.2-20 VERTICAL CONCENTRATION PROFILES

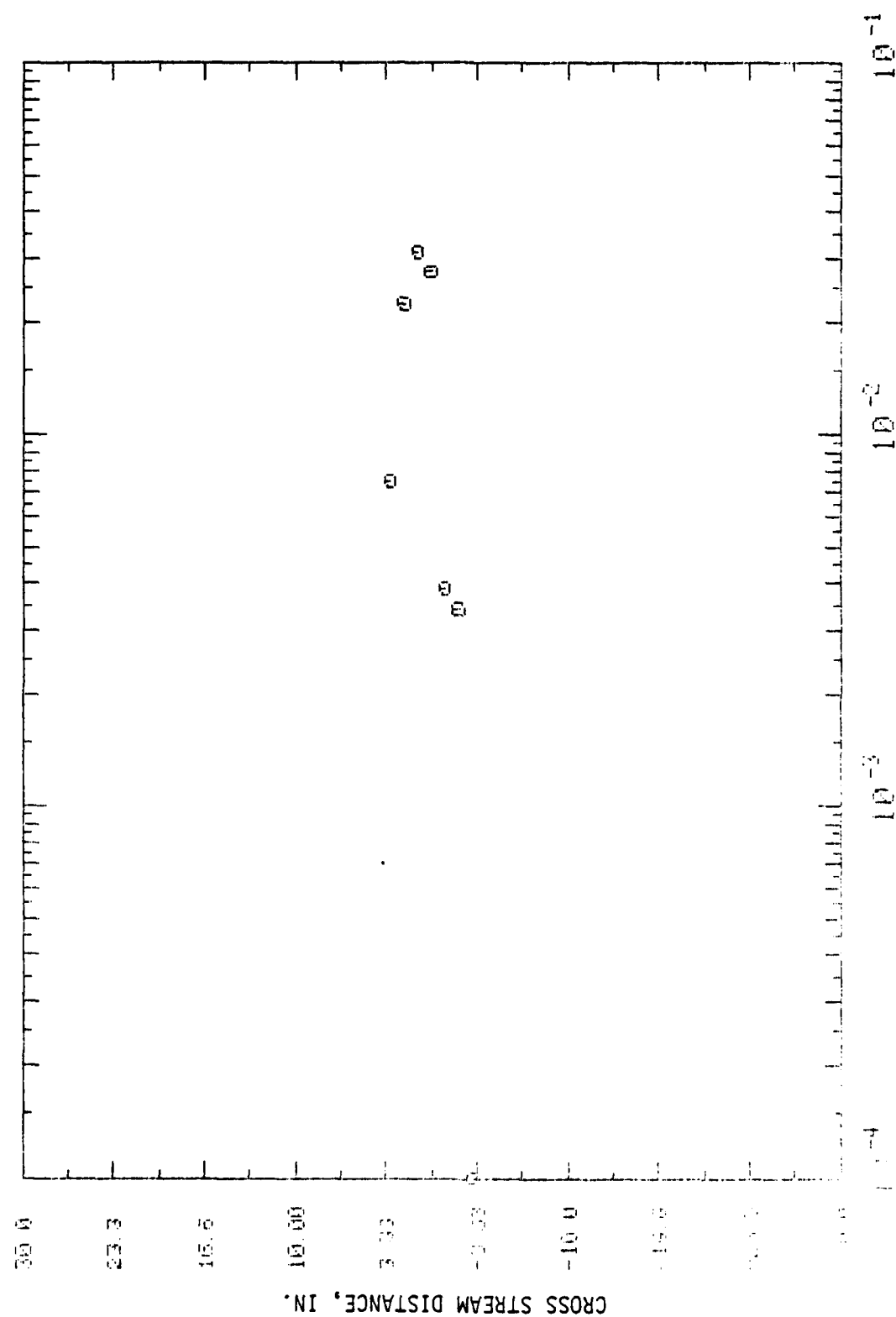
APPENDIX R

CONCENTRATION PROFILES FOR
RUN I.2-26 AT X = 48 IN., 120 IN.

$$\rho_c/\rho = 1.0$$

$$J = 16.0$$

$$Fr = \text{Infinite}$$



C/C₀ DIMENSIONLESS CONCENTRATION

X = 48 IN., Z = 3.75 IN.

FIGURE R-1. RUN I. 2-26 CROSS STREAM CONCENTRATION PROFILE

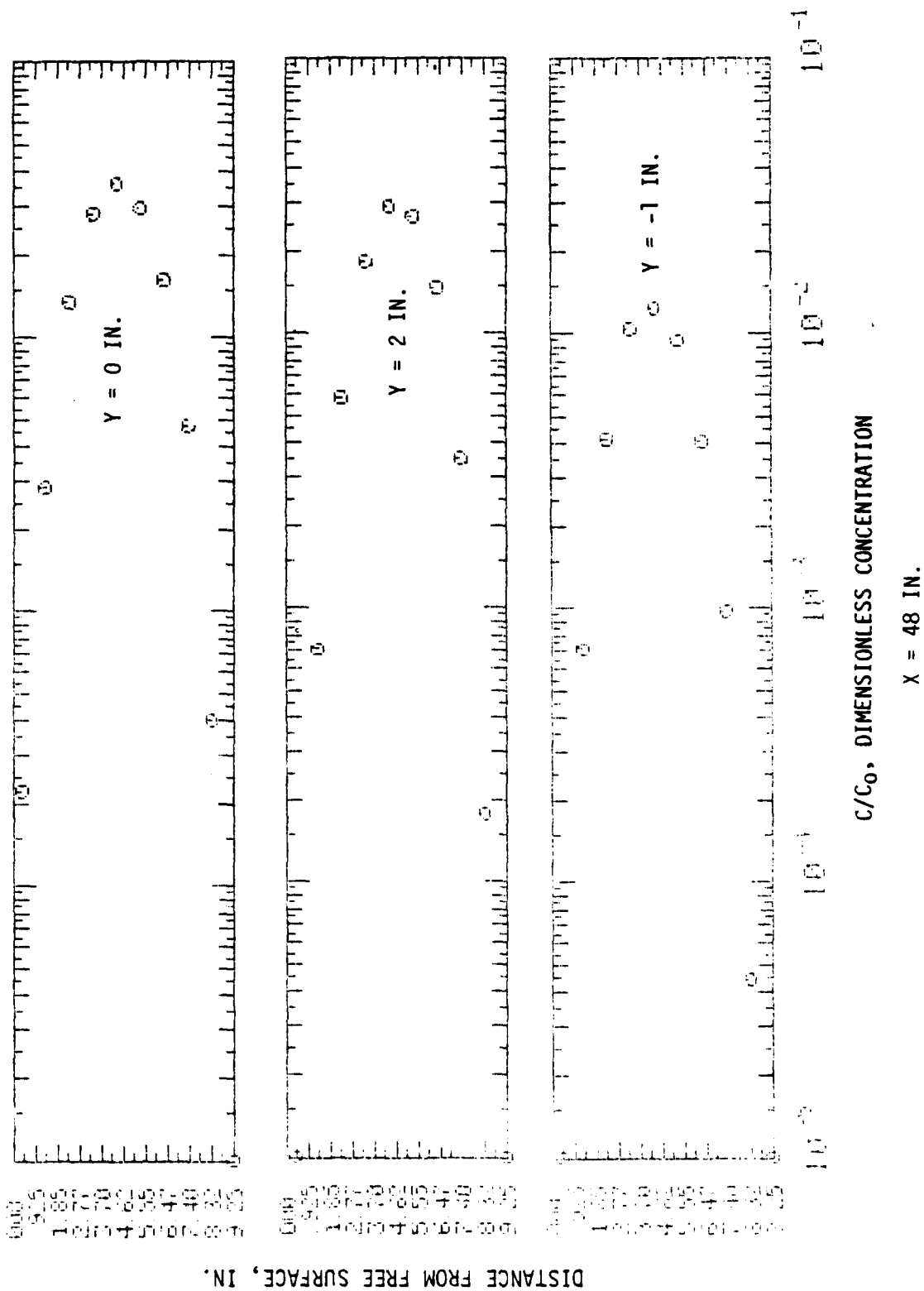
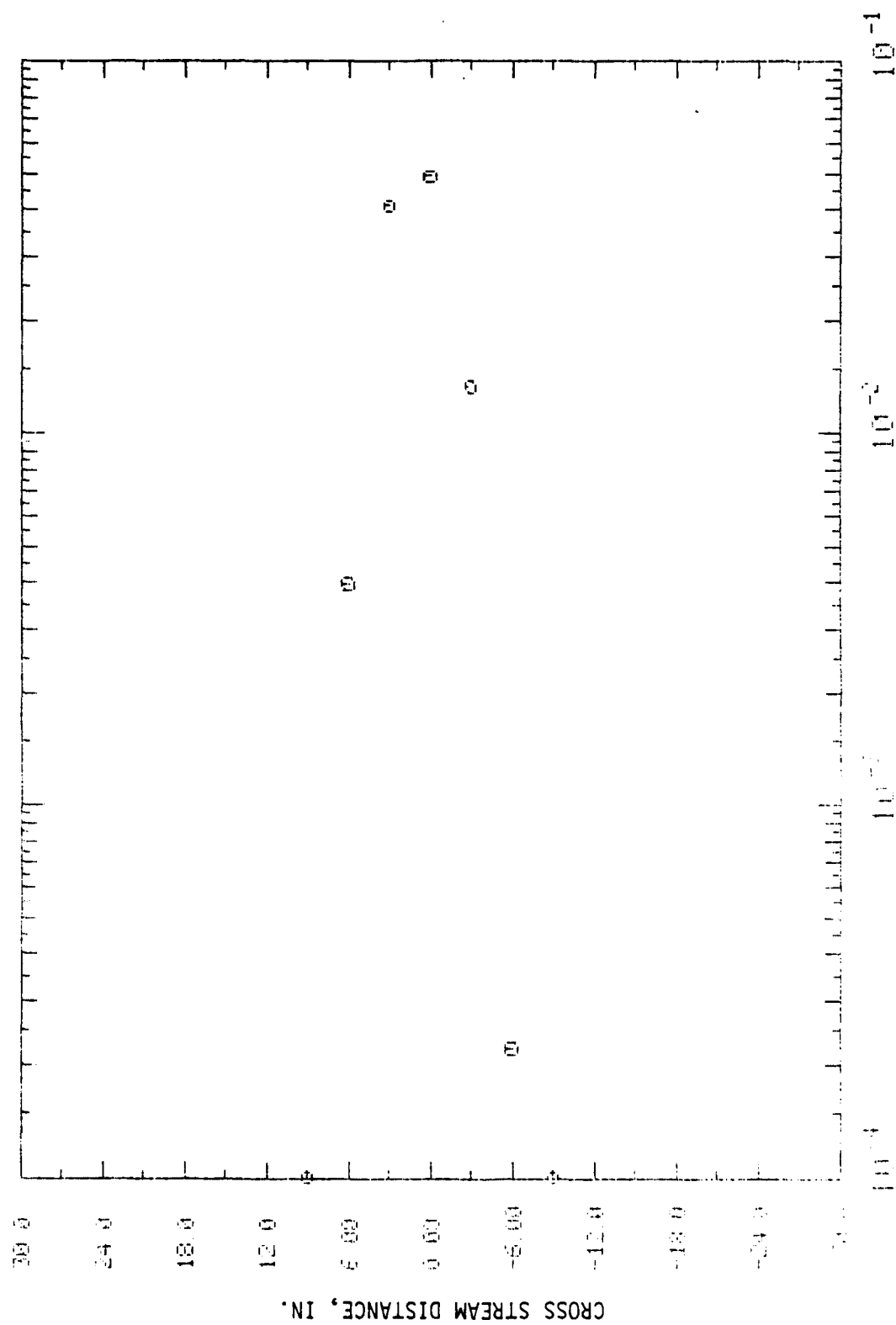


FIGURE R-2. RUN I. 2-26 VERTICAL CONCENTRATION PROFILES



C/C₀ DIMENSIONLESS CONCENTRATION

X = 120 IN., Z = 3.75 IN.

FIGURE R-3. RUN I.2-26 CROSS STREAM CONCENTRATION PROFILE

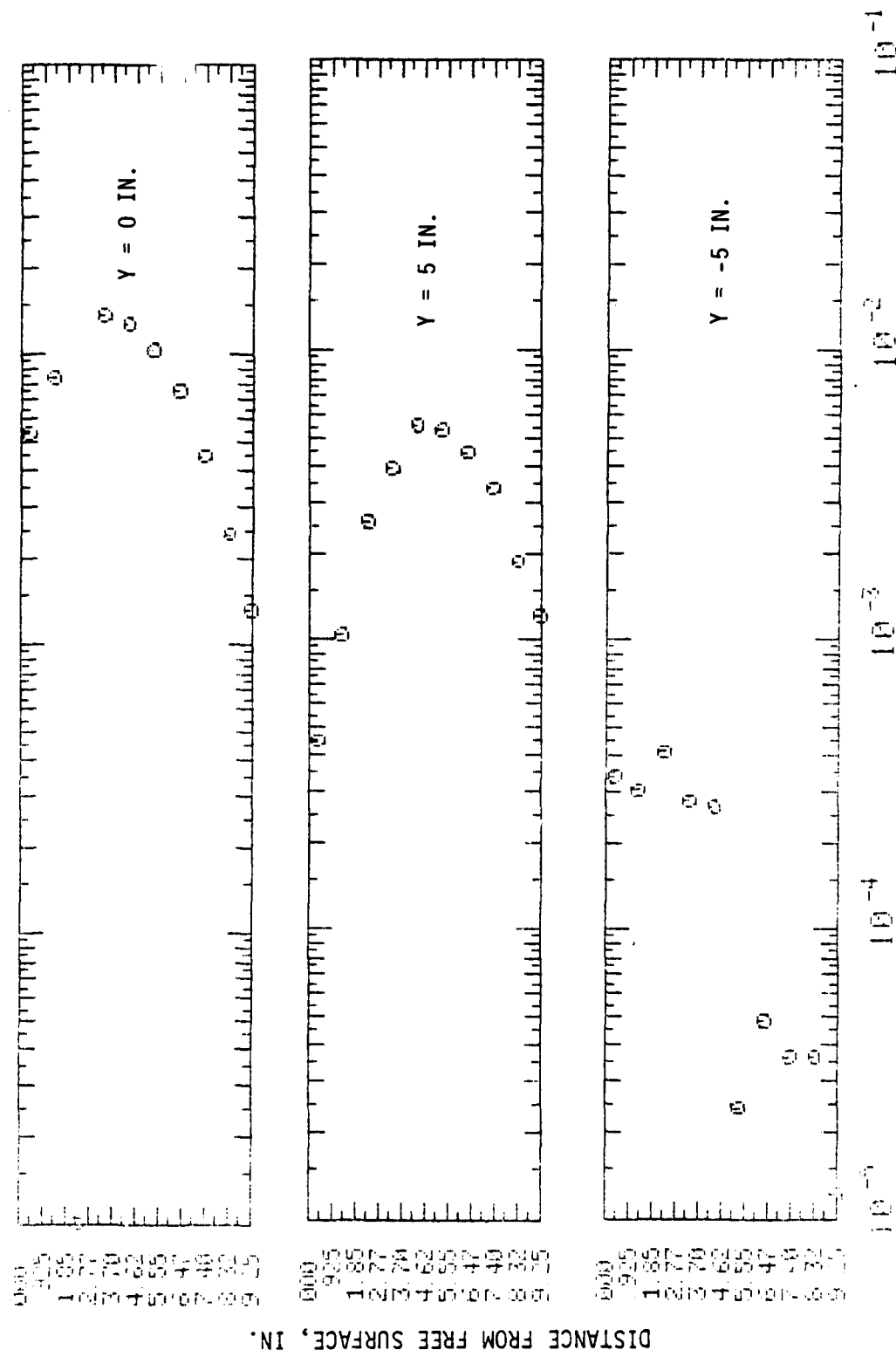


FIGURE R-4. RUN I. 2-26 VERTICAL CONCENTRATION PROFILES

APPENDIX S

CONCENTRATION PROFILES FOR
RUN I.2-27 AT X = 120 IN.,
240 IN., 432 IN.

$$\rho_c/\rho = 1.05$$

$$J = 7.5$$

$$Fr = 0.51$$

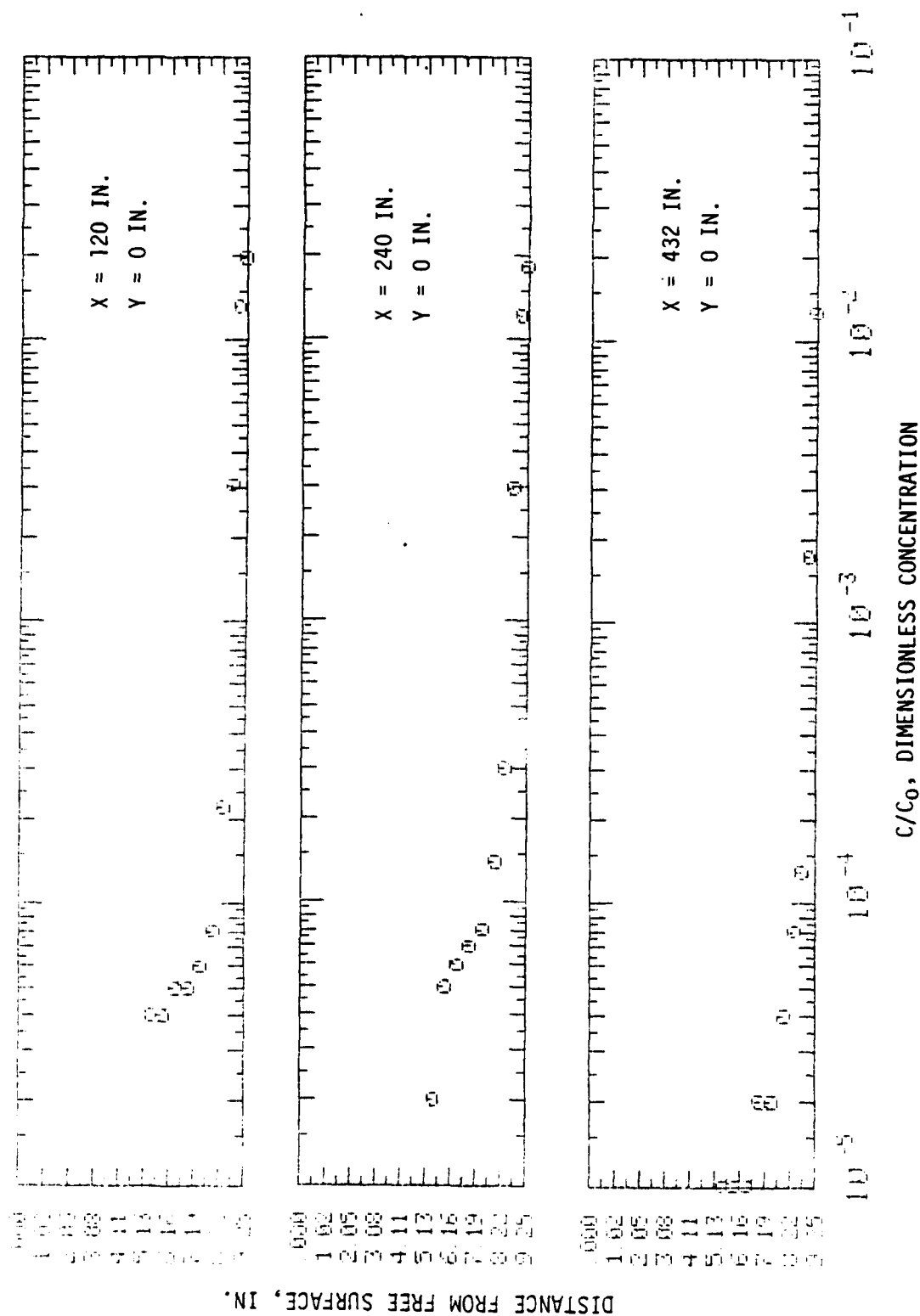


FIGURE S-1. RUN I.2-27 VERTICAL CONCENTRATION PROFILES

