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THEORETICAL TEMPERATURE FIELDS FOR THE STRIPA HEATER PROJECT

VOL. 2

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September 1978

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APPENDIX

COMPLETE SET OF FIGURES

This appendix contains a complete set of figures illustrating the detailed results of the various cases studied in the following order:

Test case: Fig. 6-12

Field cases

Model Series 1 (average granite properties): Fig. 13-48.

See Table 4, p. 26 above, for an index to the different cases in this series.

Model Series 2 (Stripa granite properties): Fig. 49-59.

Full-Scale Experiment 1 (3.6 kW): Fig. 49, 51, 52.
Full-Scale Experiment 2 (5 kW main heater with eight 0.72 kW peripheral heaters): Fig. 50, 53, 54.
Time-Scaled Experiment: Fig. 55-59.

Refer to Sections 7.1 and 7.2 of Volume 1 for discussion of the results.

FIGURE CAPTIONS

Fig. 1. Temperature rise at various distances from point, infinite line and plane heat sources. Subscript indicates time (years) after emplacement of the heat source. Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.1×10^{-6} m^2/s.

Fig. 2. Cut-away views of the LBL full-scale (a) and time-scaled (b) heater experiments at Stripa (after Witherspoon and Degerman, 1978).

Fig. 3. Configuration of full-scale Experiment 2.

Fig. 4. Configuration of time-scaled heater experiment (Experiment 3) illustrating the coordinate system adopted.

Fig. 5. System geometry and boundary conditions for CCC model of the test case. ABC - Newton's Law of Cooling with heat transfer coefficient 3.4 W/m^2°C; CDEF - isothermal or adiabatic boundary.

Fig. 6. Temperature rise in an infinite medium as a function of radial distance from a 1 kW, 2.5 m-long line heater at different times. Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 7. Temperature rise in an infinite medium due to a 1 kW, 2.5 m-long line heater as a function of time at various radial distances. Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 8. Temperature rise in an infinite medium as a function of axial distance from the mid-plane of a 1 kW, 2.5 m-long line heater at various radial distances two years after emplacement. Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 9. Isotherms of temperature rise on day 88 and day 364 for the model depicted in Fig. 5 with CDEF as isothermal boundary; vertical section. Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.15×10^{-6} m^2/s.

Fig. 10. Temperature rise as a function of radial distance along heater mid-plane for the same model as in Fig. 9, (a) linear scale, (b) semilog scale. Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.15×10^{-6} m^2/s.

Fig. 11. Axial profile of temperature rise near heater for the same model as Fig. 9. Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.15×10^{-6} m^2/s.

Fig. 12. Comparison of mid-plane radial profiles of temperature rise on day 364 as predicted by different models. Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 13. Isotherms of temperature rise (°C) in granite caused by one 3.6 kW full-scale heater at time = 1, 7, 30, 90, 365 and 730 days; vertical section, infinite medium model (1A). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 14. Isotherms of temperature rise (°C) in granite caused by one 3.6 kW full-scale heater at time = 1, 7, 30, 90, 365 and 730 days; vertical section, isothermal boundary model (1B). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 15. Isotherms of temperature rise (°C) in granite caused by one 3.6 kW full-scale heater at time = 1, 7, 30, 90, 365 and 730 days; vertical section, adiabatic boundary model (1C). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 16. Migration of the 50°C incremental isotherm as predicted by Model 1B. Thermal conductivity = 2.5 W/m°C; thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 17. Comparison of isotherms of temperature rise on day 365 as predicted by models 1A, 1B and 1C. Legend: .... 1A (infinite medium); —— 1B (isothermal boundary); ---- 1C (adiabatic boundary). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 18. Comparison of isotherms of temperature rise on day 730 as predicted by Models 1A, 1B and 1C. Legend: .... 1A (infinite medium); —— 1B (isothermal boundary); ---- 1C (adiabatic boundary). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 19. Comparison of radial profiles of temperature rise along heater mid-plane as predicted by Models 1A, 1B and 1C. Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 20. Isotherms of temperature rise (°C) in granite caused by a 5 kW full-scale central heater and a ring of eight 1 kW peripheral heaters (turned on simultaneously) at time = 1, 7, 30, 90, 365 and 730 days; vertical section through axes of central heater and one peripheral heater; infinite medium model (2A). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 21. Isotherms of temperature rise (°C) in granite caused by a 5 kW full-scale central heater and a ring of eight 1 kW peripheral heaters (turned on simultaneously) at time = 1, 7, 30, 90, 365 and 730 days; vertical section bisecting angle between two peripheral heaters; infinite medium model (2A). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 22. Isotherms of temperature rise (°C) in granite caused by a 5 kW full-scale central heater and a ring of eight 1 kW peripheral heaters (turned on simultaneously) at time = 1, 7, 30, 90, 365 and 730 days; horizontal section through mid-plane of heaters; infinite medium model (2A). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 23. Temperature rise as a function of time at various radial distances from main heater axis along mid-plane; Model 2A. Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 24. Isotherms of temperature rise (°C) in granite caused by a 5 kW full-scale central heater and a ring of eight 1 kW peripheral heaters (turned on simultaneously) at time = 1, 7, 30, 90, 365 and 730 days; vertical section through axes of central heater and one peripheral heater; isothermal boundary model (2B). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 25. Isotherms of temperature rise (°C) in granite caused by a 5 kW full-scale central heater and a ring of eight 1 kW peripheral heaters (turned on simultaneously) at time = 1, 7, 30, 90, 365 and 730 days; vertical section bisecting angle between two peripheral heaters; isothermal boundary model (2B). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 26. Migration of 50°C (vertical section) and 100°C (horizontal section), incremental isotherms as predicted by Model 2B. Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 27. Isotherms of temperature rise (°C) in granite caused by a 5 kW full-scale central heater and a ring of eight 1 kW peripheral heaters (turned on simultaneously) at time = 1, 7, 30, 90, 365 and 730 days; vertical section through axis of central heater and one peripheral heater; adiabatic boundary model (2C). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 28. Isotherms of temperature rise (°C) in granite caused by a 5 kW full-scale central heater and a ring of eight 1 kW peripheral heaters at time = 1, 7, 30, 90, 365 and 730 days; vertical section bisecting angle between two peripheral heaters; adiabatic boundary model (2C). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 29. Comparison of isotherms of temperature rise on day 365 as predicted by Models 2A, 2B and 2C. Legend: .... 2A (infinite medium); —— 2B (isothermal boundary); ---- 2C (adiabatic boundary). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078 × 10^{-6} m^2/s.

Fig. 30. Comparison of isotherms of temperature rise on day 730 as predicted by Models 2A, 2B and 2C. Legend: .... 2A (infinite medium); —— 2B (isothermal boundary); ---- 2C (adiabatic boundary). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078 × 10^{-6} m^2/s.

Fig. 31. Comparison of radial profiles of temperature rise along heater mid-plane as predicted by Models 2A, 2B and 2C. Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078 × 10^{-6} m^2/s.

Fig. 32. Isotherms of temperature rise (°C) in granite caused by a ring of eight 1 kW peripheral heaters at time = 1, 7, 30, 90, 365 and 730 days; vertical section through axis of one peripheral heater and the central axis of the ring; infinite medium model (2D). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078 × 10^{-6} m^2/s.

Fig. 33. Isotherms of temperature rise (°C) in granite caused by a ring of eight 1 kW peripheral heaters at time = 1, 7, 30, 90, 365 and 730 days; vertical section bisecting angle between two peripheral heaters; infinite medium model (2D). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078 × 10^{-6} m^2/s.

Fig. 34. Isotherms of temperature rise (°C) in granite caused by a ring of eight 1 kW peripheral heaters at time = 1, 7, 30, 90, 365 and 730 days; horizontal section through mid-plane of heaters; infinite medium model (2D). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078 × 10^{-6} m^2/s.

Fig. 35. Radial profile of temperature rise along mid-plane of ring of peripheral heaters at various times as predicted by Model 2D (infinite medium). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078 × 10^{-6} m^2/s.

Fig. 36. Isotherms of temperature rise (°C) in granite caused by a ring of eight 1 kW peripheral heaters at time = 1, 7, 20, 90, 365 and 730 days; vertical section through one peripheral heater and the central axis of the ring; isothermal boundary model (2E). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 37. Isotherms of temperature rise (°C) in granite caused by a ring of eight 1 kW peripheral heaters at time = 1, 7, 30, 90, 365 and 730 days; vertical section bisecting angle between two peripheral heaters; isothermal boundary model (2E). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 38. Isotherms of temperature rise (°C) in granite caused by a ring of eight 1 kW peripheral heaters at time = 1, 7, 30, 90, 365 and 730 days; vertical section through one peripheral heater and the central axis of the ring; adiabatic boundary model (2F). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 39. Isotherms of temperature rise (°C) in granite caused by a ring of eight 1 kW peripheral heaters at time = 1, 7, 30, 90, 365 and 730 days; vertical section bisecting angle between two heaters; adiabatic boundary model (2F). Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 40. Full-plane pattern of temperature rise in horizontal section through mid-plane of time-scaled experiment on day 730; constant source, Model 3A. Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 41. Isotherms of temperature rise (°C) in granite caused by an array of eight constant 1.125 kW time-scaled heaters; horizontal section through mid-plane of the heaters; Model 3A. Only one quadrant is plotted because of the symmetry resulting from assumed istropy. Isotherms are at 10°C intervals unless otherwise indicated. Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 42. Isotherms of temperature rise (°C) in granite caused by an array of eight constant 1.125 kW time-scaled heaters; horizontal section 0.2025 m above mid-plane of heaters; Model 3A. Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 43. Isotherms of temperature rise (°C) in granite caused by an array of eight constant 1.125 kW time-scaled heaters; horizontal section 0.405 m above mid-plane of heaters; Model 3A. Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^2/s.

Fig. 44. Isotherms of temperature rise (°C) in granite caused by an array of eight constant 1.125 kW time-scaled heaters; time = 7, 30, 90, 365 and 730 days; horizontal section 1 m above mid-plane of the heaters; Model 3A. Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.078×10^{-6} m^3/s.

Fig. 45. Model geometry and boundary conditions for Models 3B and 3C.

Fig. 46. Isotherms of temperature rise on day 90 as predicted by Models 3B and 3C. Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.15×10^{-6} m^2/s.

Fig. 47. Comparison of temperature rise on day 360 as predicted by Models 3B and 3C. Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.15×10^{-6} m^2/s.

Fig. 48. Comparison of temperature rise on day 730 as predicted by Models 3B and 3C. Thermal conductivity = 2.5 W/m°C, thermal diffusivity = 1.15×10^{-6} m^2/s.

Fig. 49. Temperature rise (°C) as a function of time at various radial distances along heater mid-plane, Stripa full-scale Experiment 1 (3.6 kW), Model Series 2, infinite medium model. Thermal conductivity = 3.2 W/m°C, thermal diffusivity = 1.47×10^{-6} m^2/s.

Fig. 50. Temperature rise (°C) as a function of time at various radial distances from axis of central heater along a radius passing through one peripheral heater, Stripa full-scale Experiment 2 (5 kW with eight 0.72 kW peripheral heaters), Model Series 2, infinite medium model. Thermal conductivity = 3.2 W/m°C, thermal diffusivity = 1.47×10^{-6} m^2/s.

Fig. 51. Isotherms of temperature rise (°C) in Stripa full-scale Experiment 1 (3.6 kW) at time = 1, 7, 30, 90, 360 and 730 days; vertical section, Model Series 2, infinite medium model. Thermal conductivity = 3.2 W/m°C, thermal diffusivity = 1.47×10^{-6} m^2/s.

Fig. 52. Isotherms of temperature rise (°C) in Stripa full-scale Experiment 1 (3.6 kW) at time = 1, 7, 30, 90, 360 and 730 days; vertical section, Model Series 2, isothermal boundary model. Thermal conductivity = 3.2 W/m°C, thermal diffusivity = 1.47×10^{-6} m^2/s.

Fig. 53. Isotherms of temperature rise (°C) in Stripa full-scale Experiment 2 (5 kW with eight 0.72 kW peripheral heaters) at time = 1, 7, 30, 90, 180, 181, 187, 210, 270, 360 and 730 days; vertical section through axes of central heater and one peripheral heater, Model Series 2, infinite medium model. Thermal conductivity = 3.2 W/m°C, thermal diffusivity = 1.47×10^{-6} m^2/s.

Fig. 54. Isotherms of temperature rise (°C) in Stripa full-scale Experiment 2 (5 kW with eight 0.72 kW peripheral heaters) at time = 1, 7, 30, 90, 180, 181, 187, 210, 270, 360 and 730 days; vertical section through axes of central heater and one peripheral heater, Model Series 2, isothermal boundary model. Thermal conductivity = 3.2 W/m°C, thermal diffusivity = 1.47×10^{-6} m^2/s.

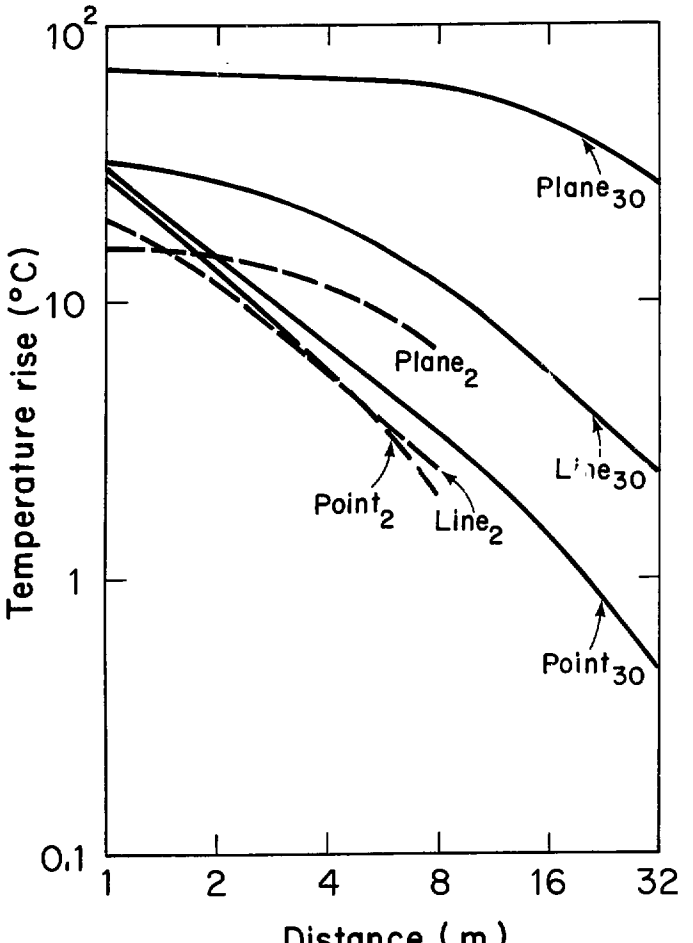
Fig. 55. Isotherms of temperature rise (°C) in Stripa time-scaled experiment (constant power 1.125 kW) at time ≈ 1, 7, 30, 90, 180, 360 and 730 days; horizontal section through mid-plane of the heaters, Model Series 2. Thermal conductivity = 3.2 W/m°C, thermal diffusivity = 1.47×10^{-6} m^2/s.

Fig. 56. Isotherms of temperature rise (°C) in Stripa time-scaled experiment (constant power 1.125 kW) at the end of 730 days; horizontal section at vertical distances of 1, 2, 3, 4, 6, 7, 8 m from mid-plane, Model Series 2. Thermal conductivity = 3.2 W/m°C, thermal diffusivity = 1.47×10^{-6} m^2/s.

Fig. 57. Isotherms of temperature rise (°C) in Stripa time-scaled experiment (constant power 1.125 kW) at time ≈ 1, 7, 30, 90, 180, 360, 730 days; vertical section (y = 0 plane) through major axis of heaters (i.e., through H1, H2, H3 and H4), Model Series 2. Thermal conductivity = 3.2 W/m°C, thermal diffusivity = 1.47×10^{-6} m^2/s.

Fig. 58. Isotherms of temperature rise (°C) in Stripa time-scaled experiment (constant power 1.125 kW) at time ≈ 1, 7, 30, 90, 180, 360, 730 days; vertical section through H3, H6 and H8 (i.e., x = 3.5 m plane), Model Series 2. Thermal conductivity = 3.2 W/m°C, thermal diffusivity = 1.47×10^{-6} m^2/s.

Fig. 59. Isotherms of temperature rise (°C) in Stripa time-scaled experiment (constant power 1.125 kW) at time = 730 days, vertical section (a) through H5 and H6 (y = 3 m plane), and (b) through E1 and E4 (x = 0 plane), Model Series 2. Thermal conductivity = 3.2 W/m°C, thermal diffusivity = 1.47×10^{-6} m^2/s.



XBL 782-234

Fig. 1

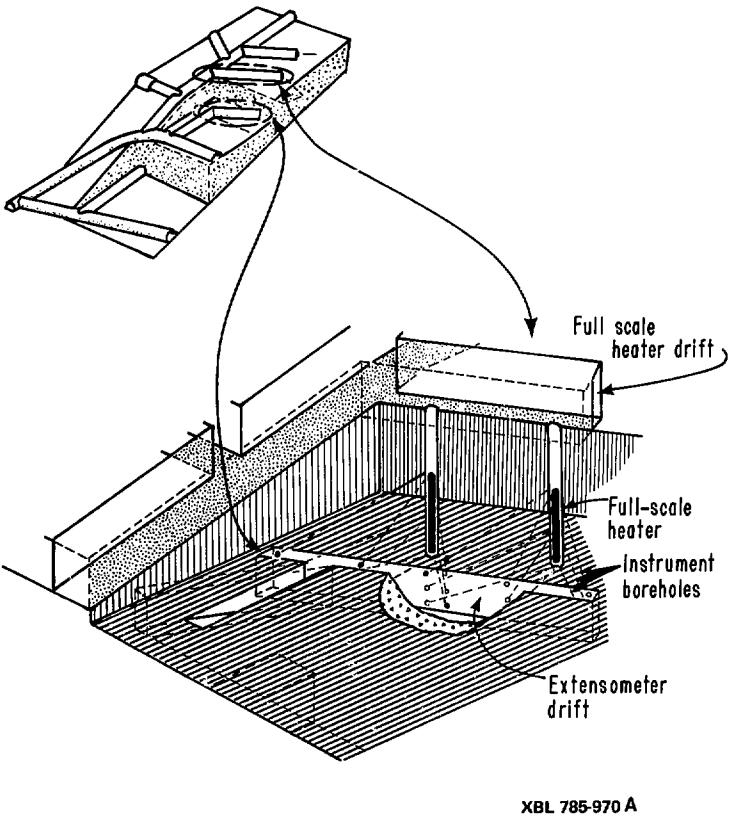

Full scale
heater drift
Full-scale
heater
Instrument
boreholes
Extensometer
drift
XBL 785-970 A

Fig. 2a

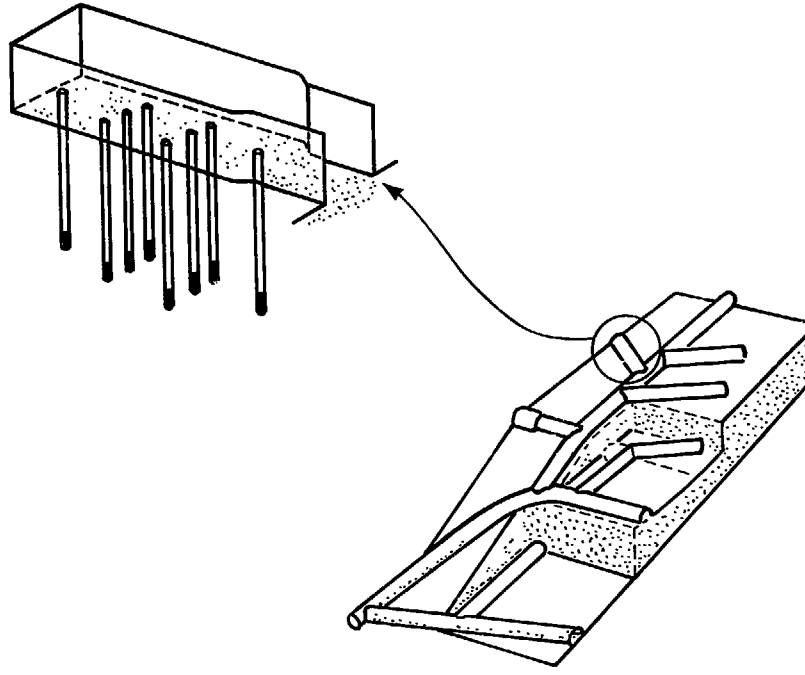


Fig. 2b

XBL 785-969

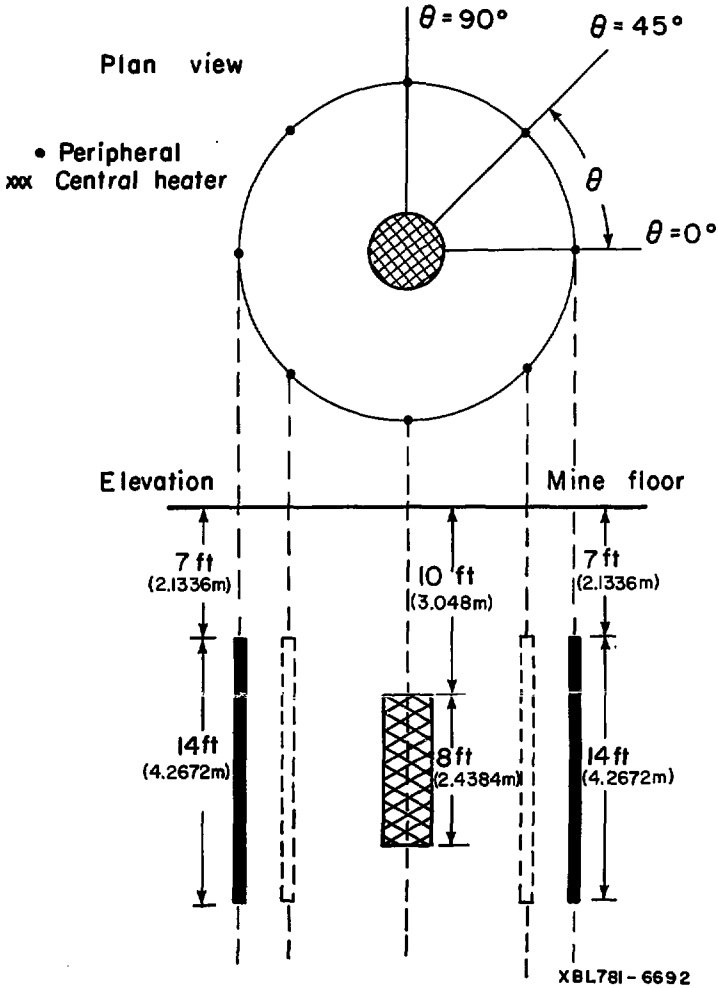
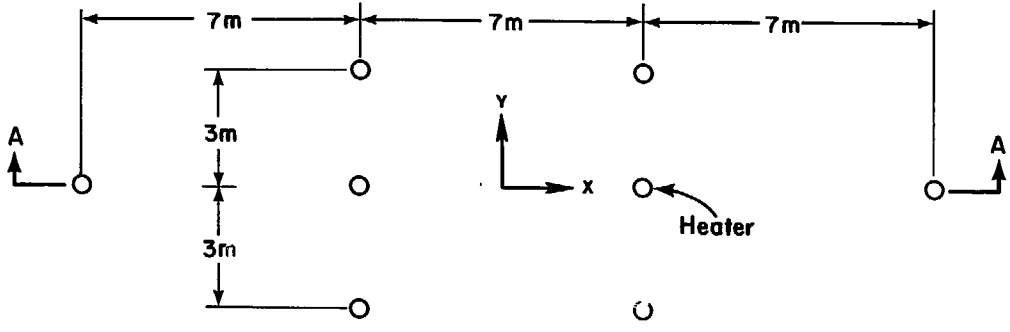

θ = 90°
θ = 45°
Plan view
• Peripheral
xxx Central heater
θ
θ = 0°
Elevation
Mine floor
7 ft
(2.1336m)
10 ft
(3.048m)
7 ft
(2.1336m)
14 ft
(4.2672m)
8 ft
(2.4384m)
14 ft
(4.2672m)
XBL781-6692

Fig. 3



XBL 782-230

Fig. 4a

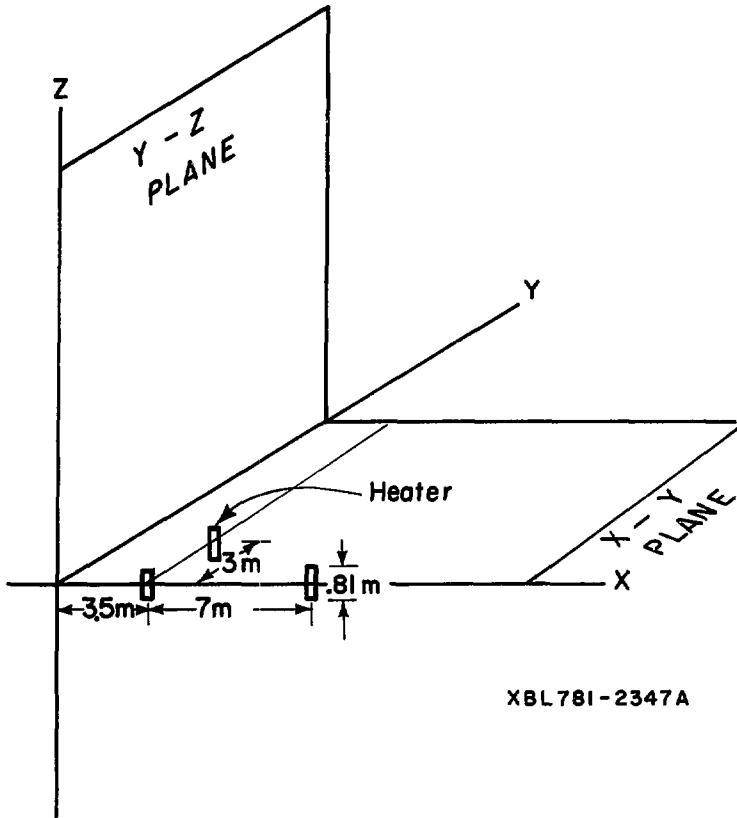
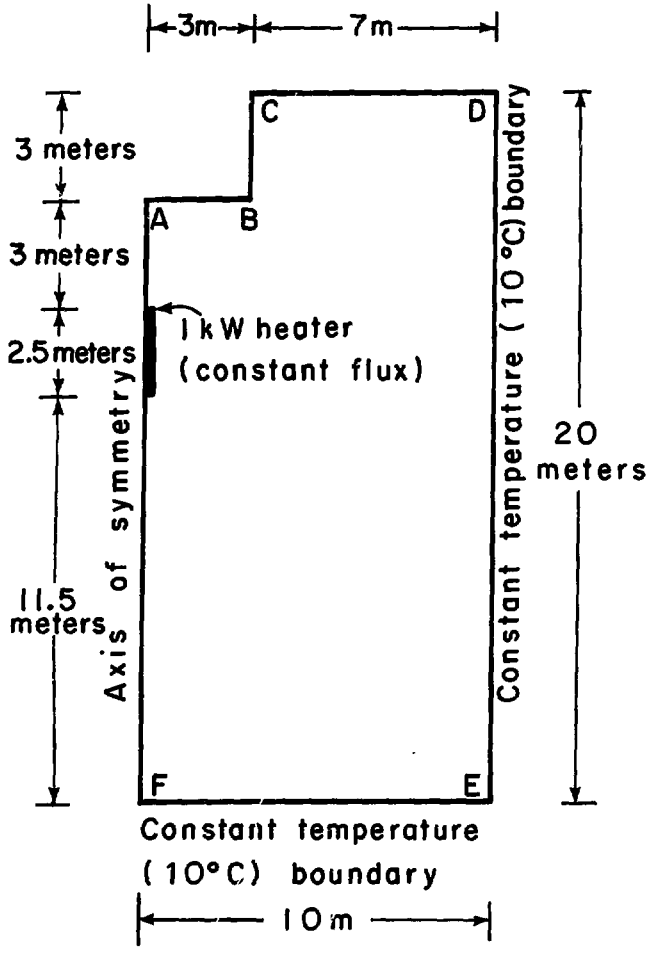


Fig. 4b



XBL782-232

Fig. 5

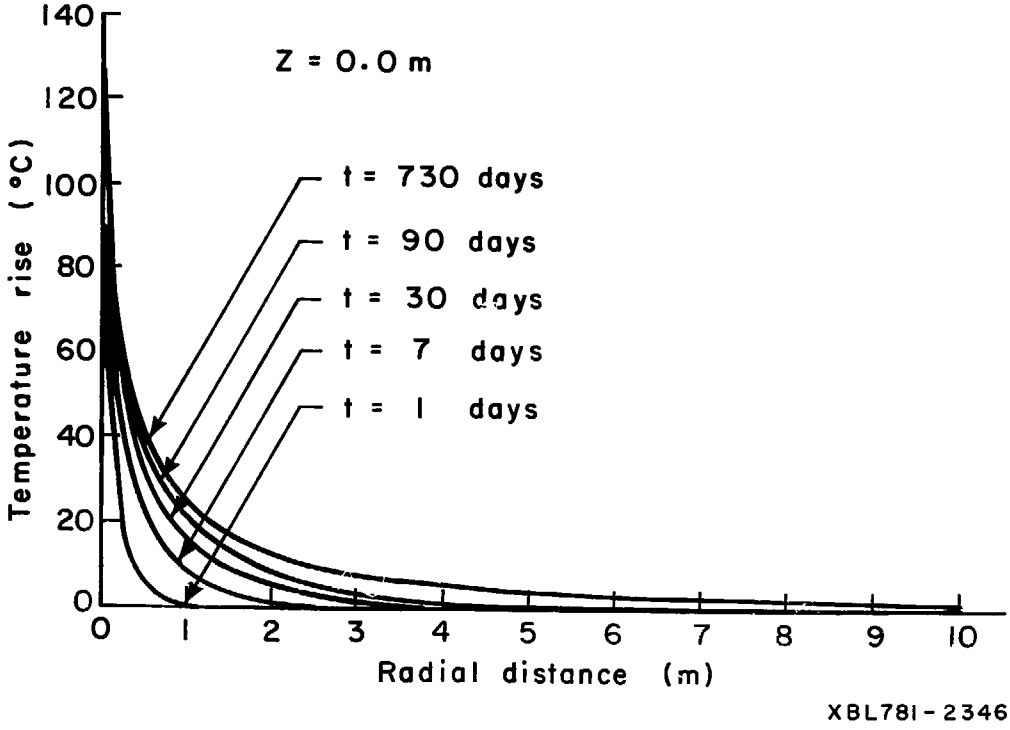

Z = 0.0 m
t = 730 days
t = 90 days
t = 30 days
t = 7 days
t = 1 days
Temperature rise (°C)
140
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
9
10
Radial distance (m)
XBL781-2346

Fig. 6

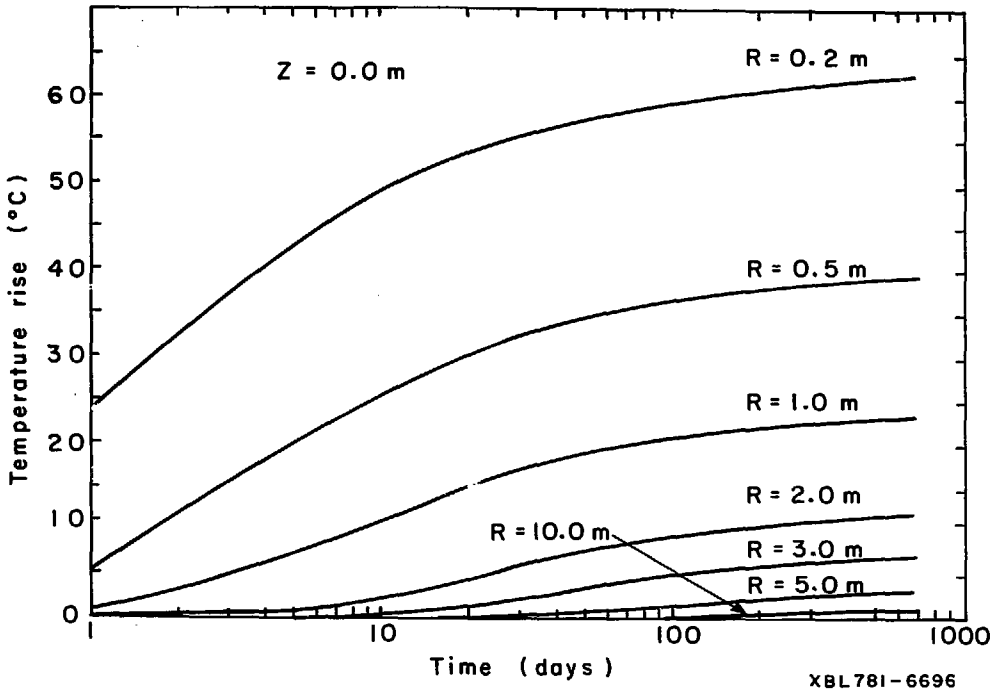

Z = 0.0 m
R = 0.2 m
R = 0.5 m
R = 1.0 m
R = 2.0 m
R = 3.0 m
R = 5.0 m
R = 10.0 m
Temperature rise (°C)
0
10
20
30
40
50
60
1
10
100
1000
Time (days)
XBL781-6696

Fig. 7

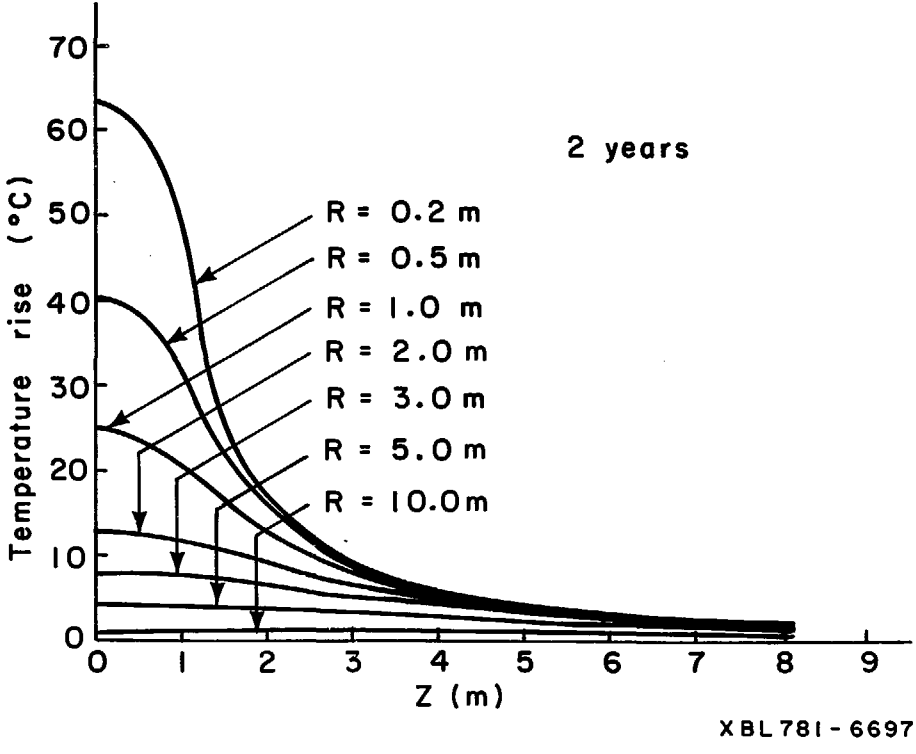

2 years
R = 0.2 m
R = 0.5 m
R = 1.0 m
R = 2.0 m
R = 3.0 m
R = 5.0 m
R = 10.0m
Temperature rise (°C)
Z (m)
0
10
20
30
40
50
60
70
0
1
2
3
4
5
6
7
8
9
XBL 781-6697

Fig. 8

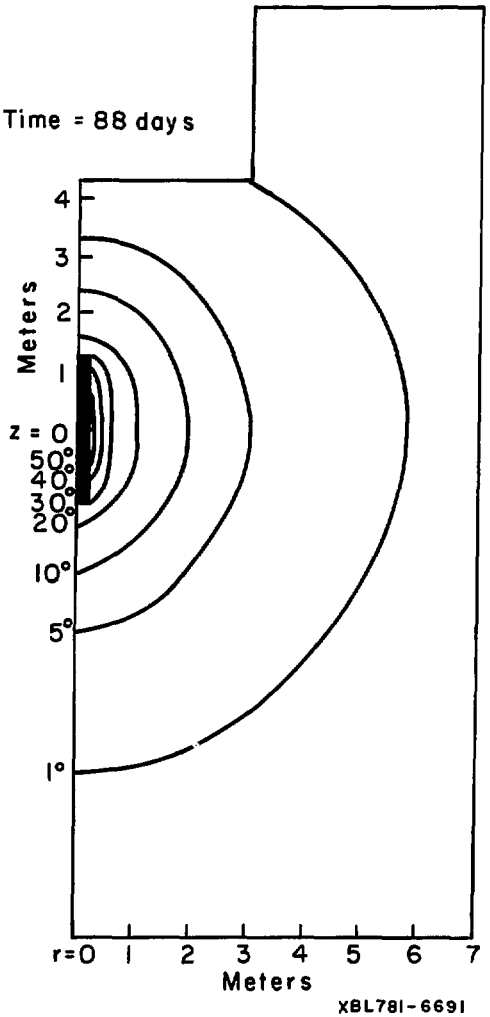
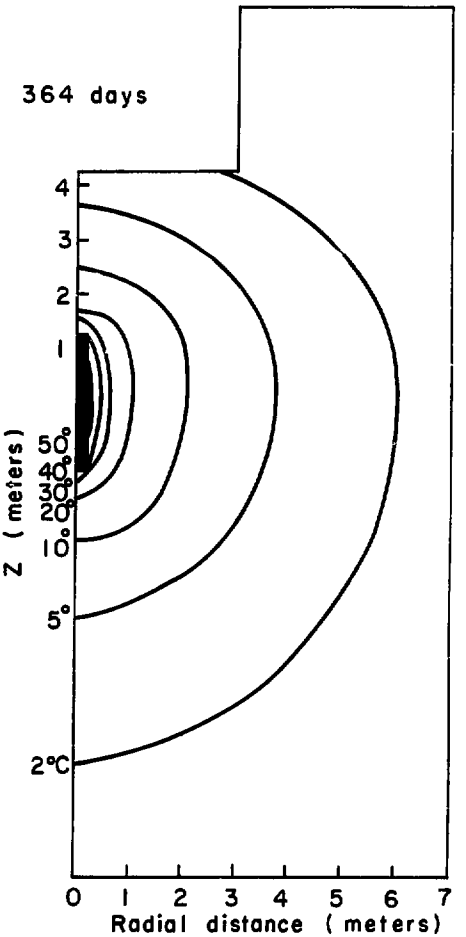

Time = 88 days
4
3
2
1
Meters
z = 0
50°
40°
30°
20°
10°
5°
1°
r=0
1
2
3
4
5
6
7
Meters
XBL781-6691

Fig. 9a



XBL 786-9156

Fig. 9b

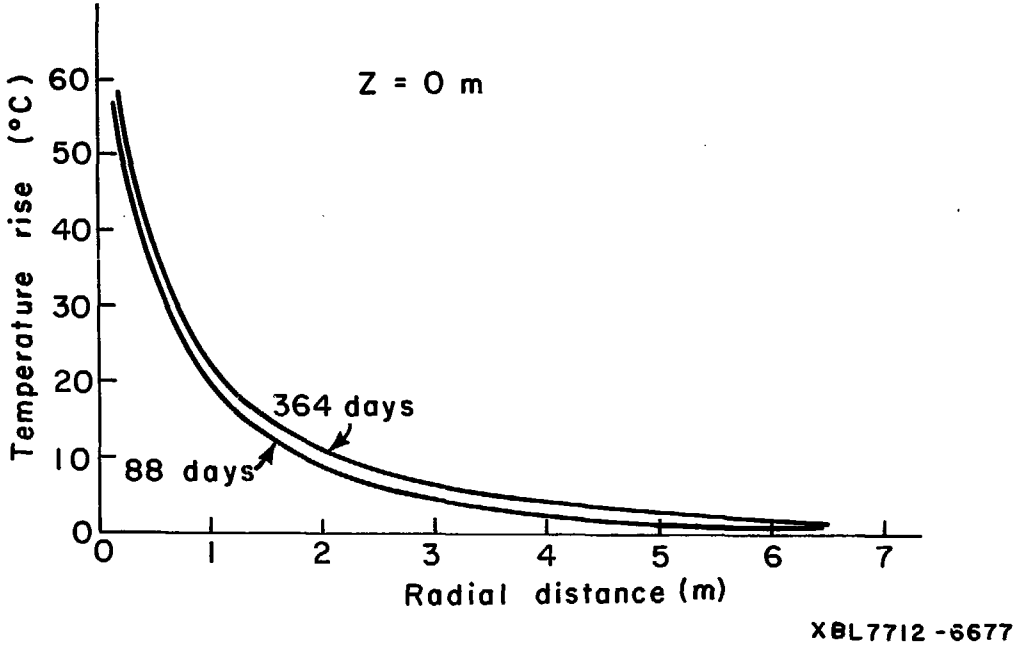
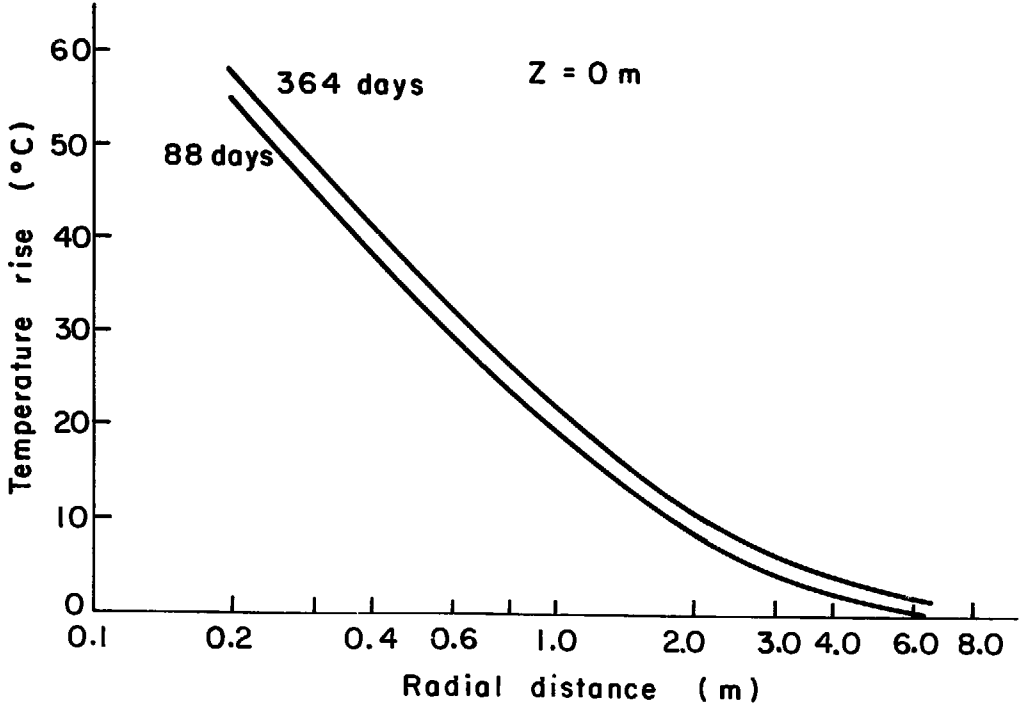
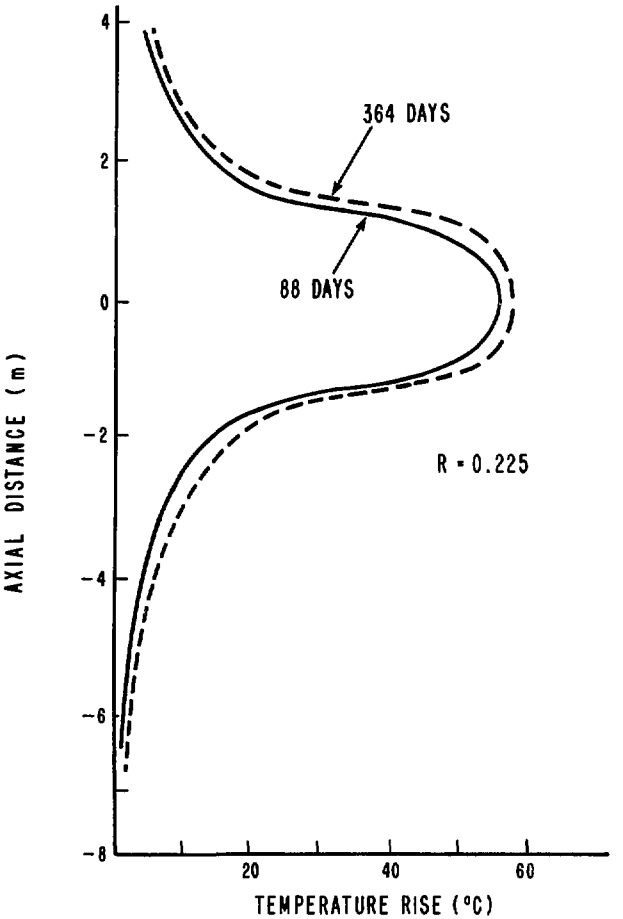

Z = 0 m
Temperature rise (°C)
60
50
40
30
20
10
0
364 days
88 days
0
1
2
3
4
5
6
7
Radial distance (m)
XBL7712-6677

Fig. 10a



XBL7712-6675

Fig. 10b



XBL 788-2022

Fig. 11

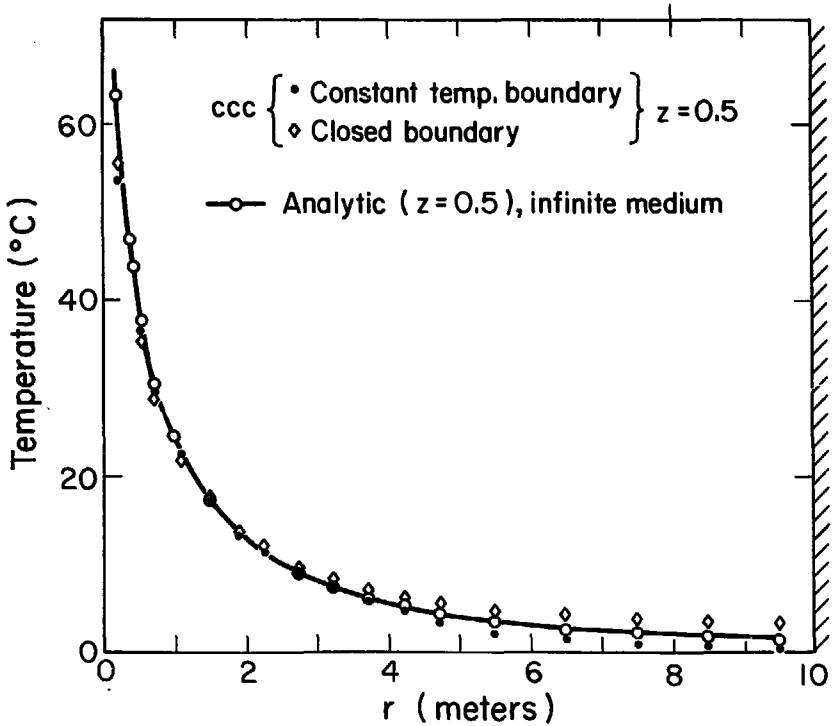
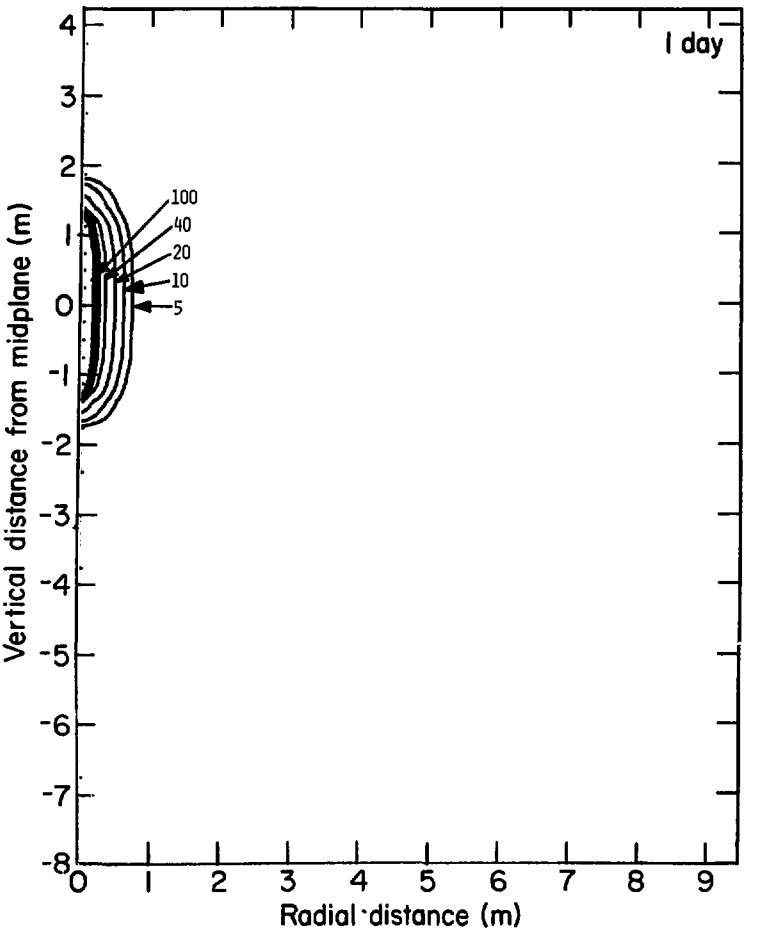


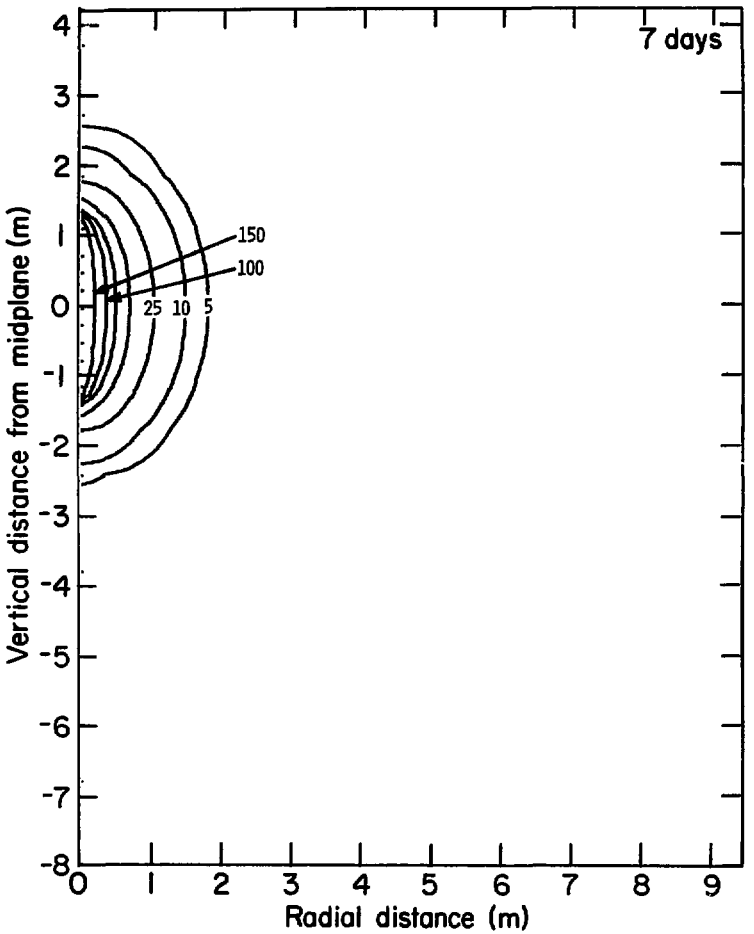
Fig. 12

XBL 782-228



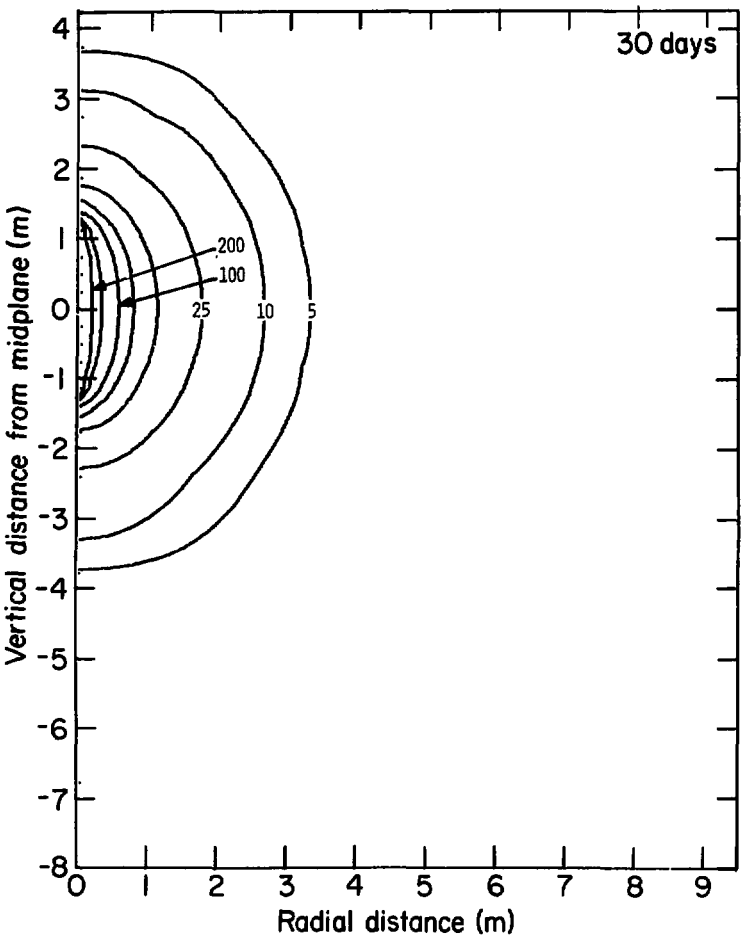
XBL 785-8547

Fig. 13a



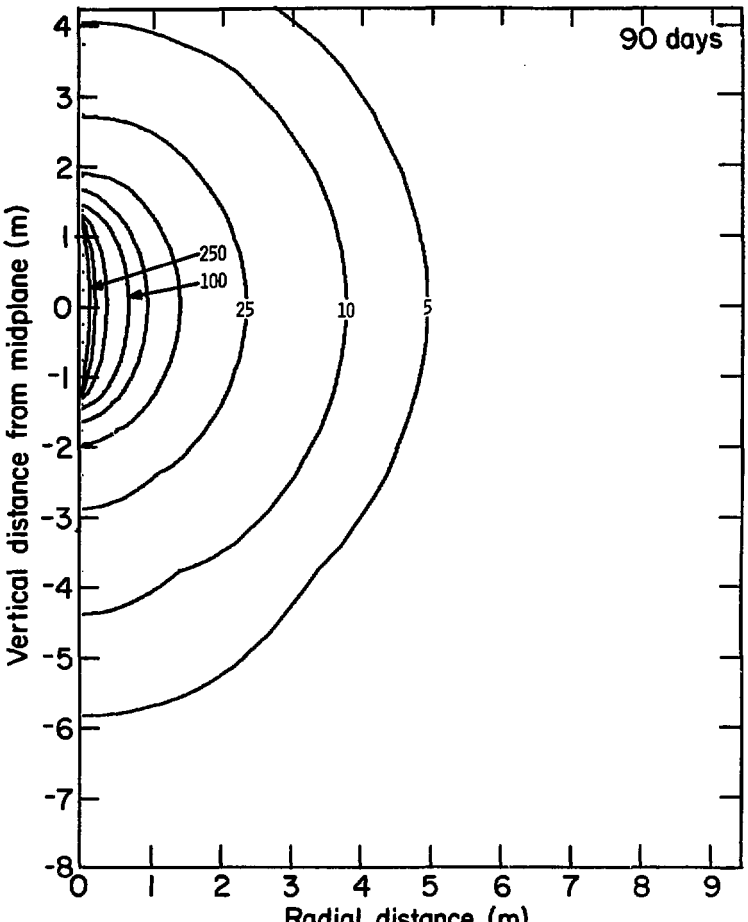
XBL 785-8548

Fig. 13b



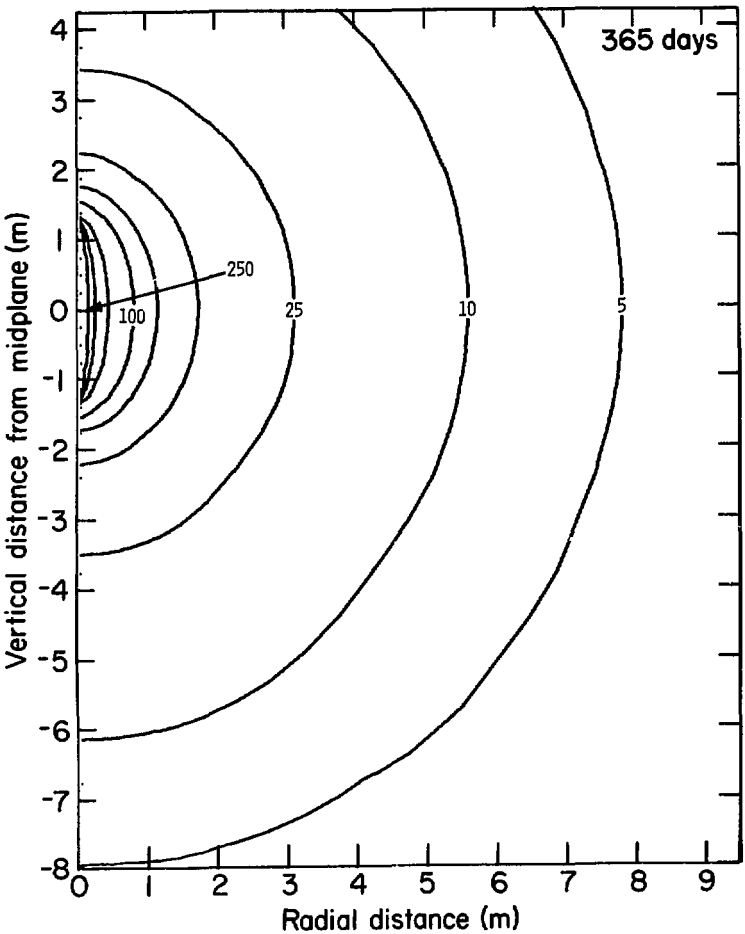
XBL 785-8549

Fig. 13c



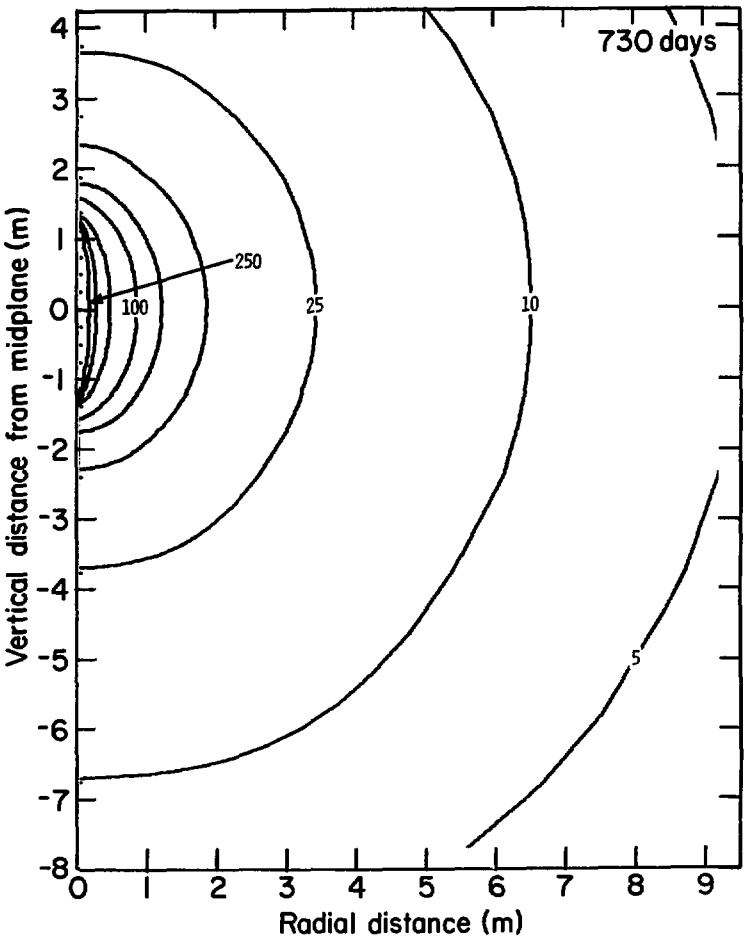
XBL 785-8550

Fig. 13d



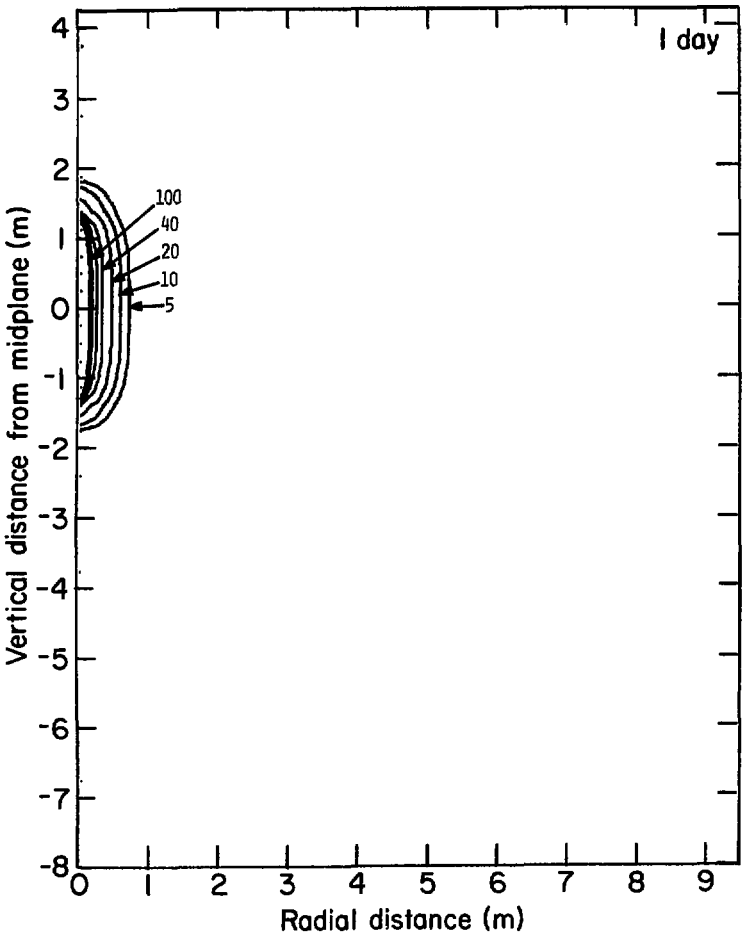
XBL 785-8551

Fig. 13e



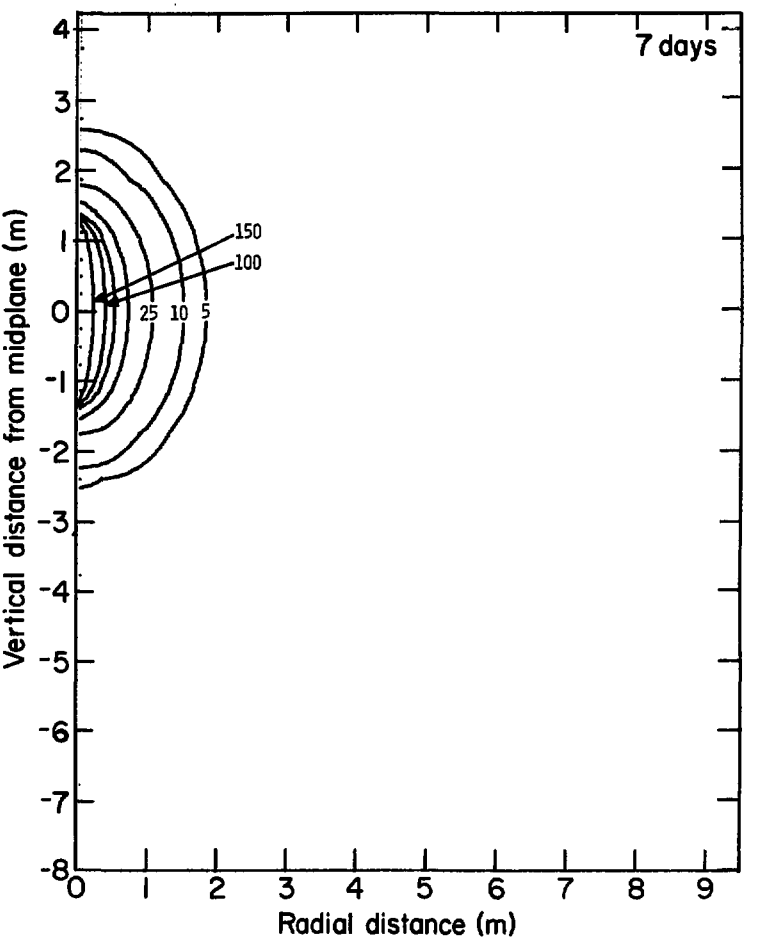
XBL 785-8552

Fig. 13f



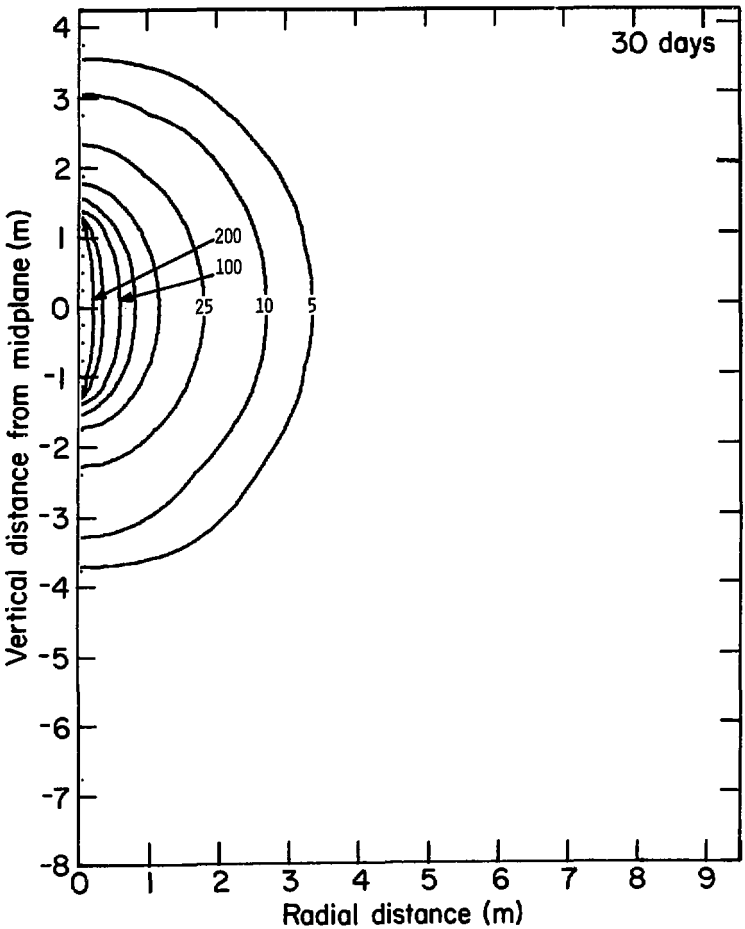
XBL 785-8535

Fig. 14a



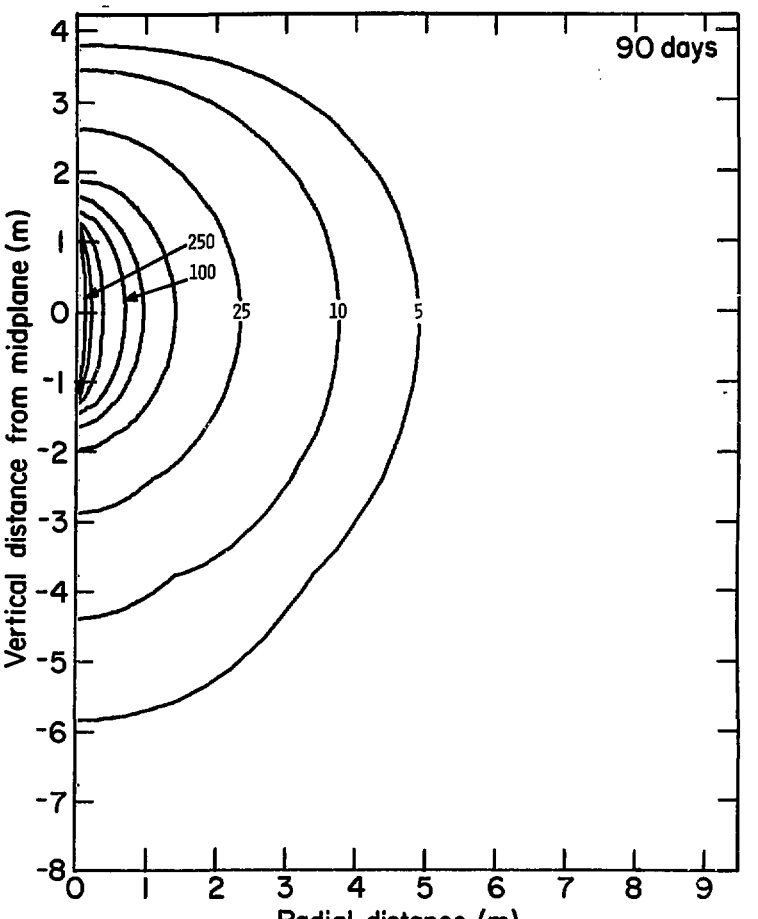
XBL 785-8536

Fig. 14b



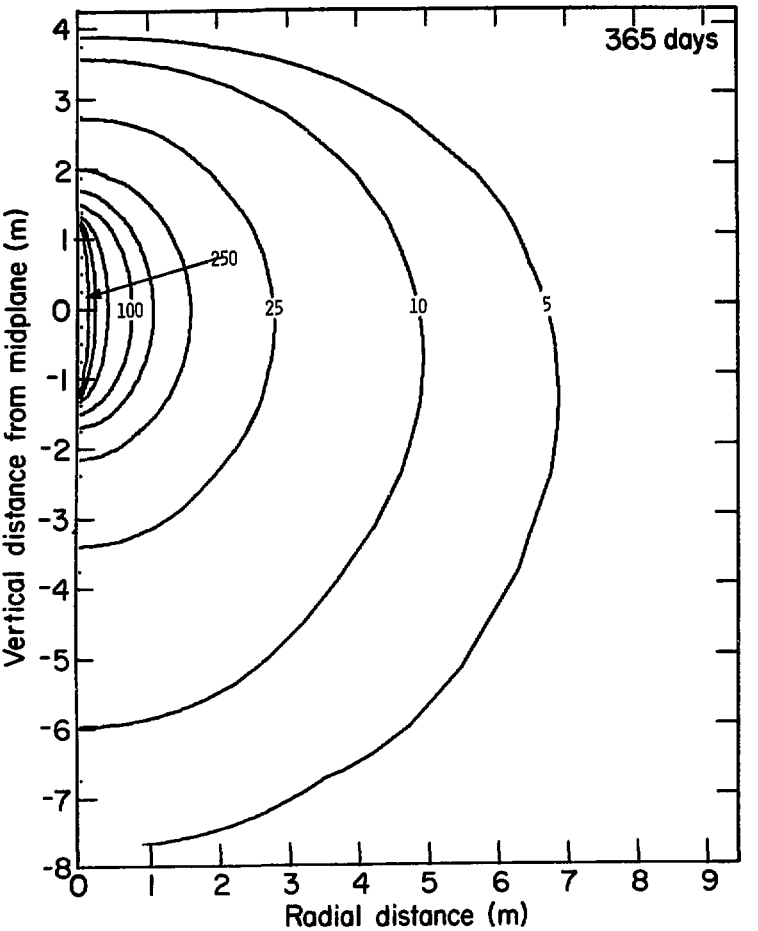
XBL 785-8537

Fig. 14c



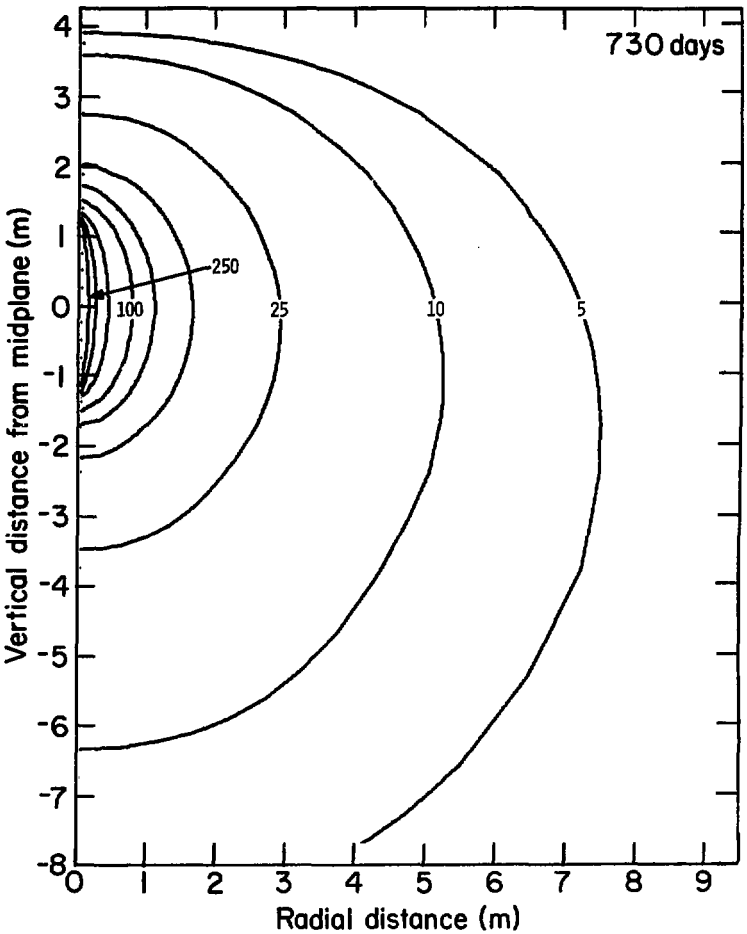
XBL 785-8538

Fig. 14d



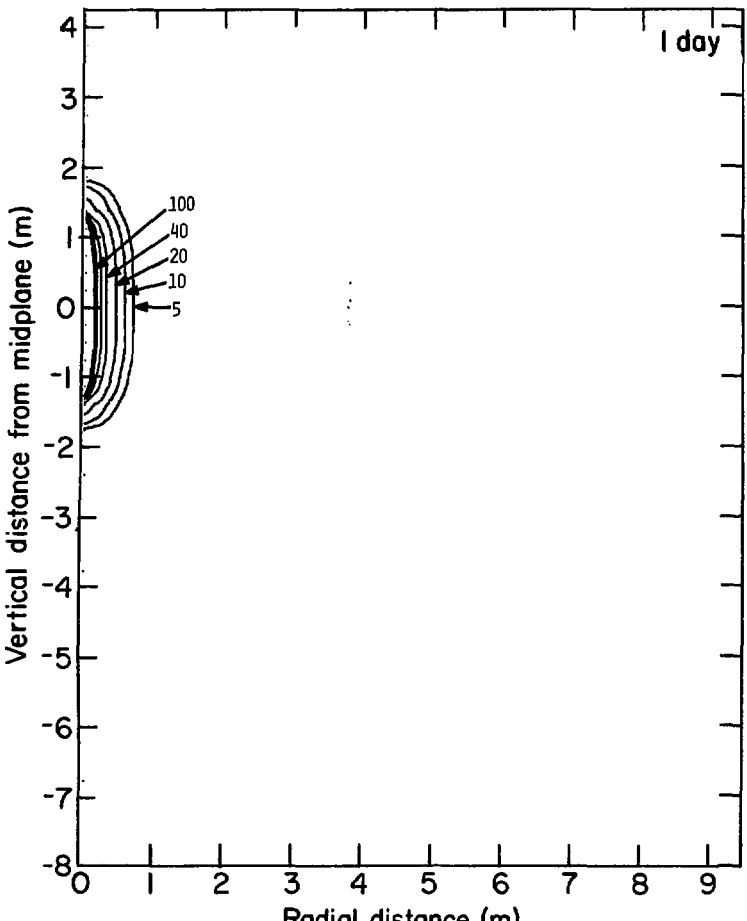
XBL 785-8539

Fig. 14e



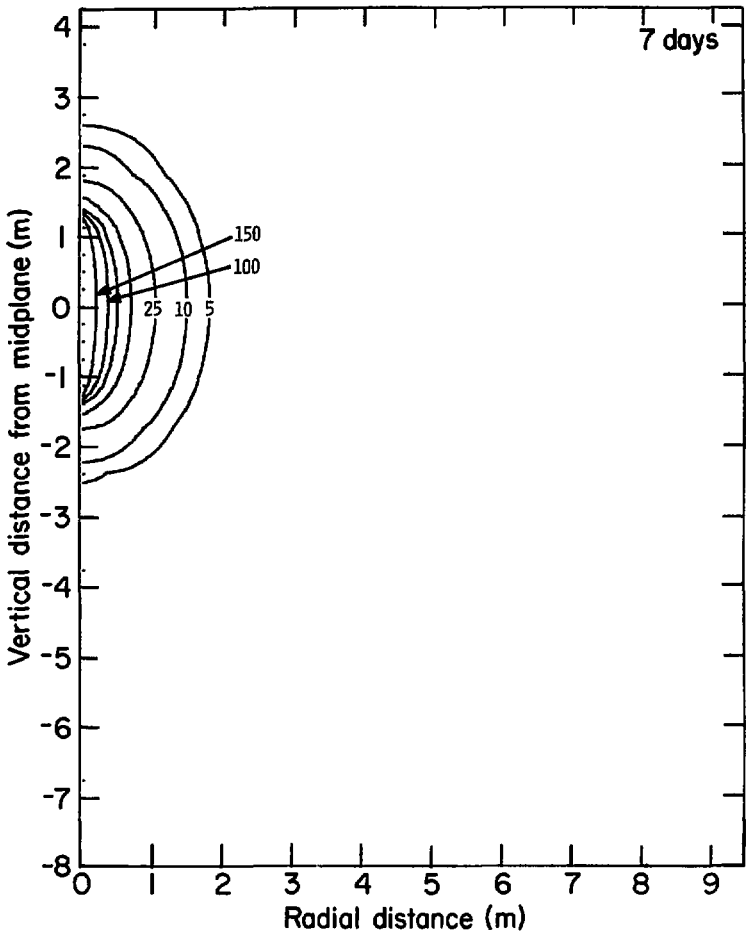
XBL 785-8540

Fig. 14f



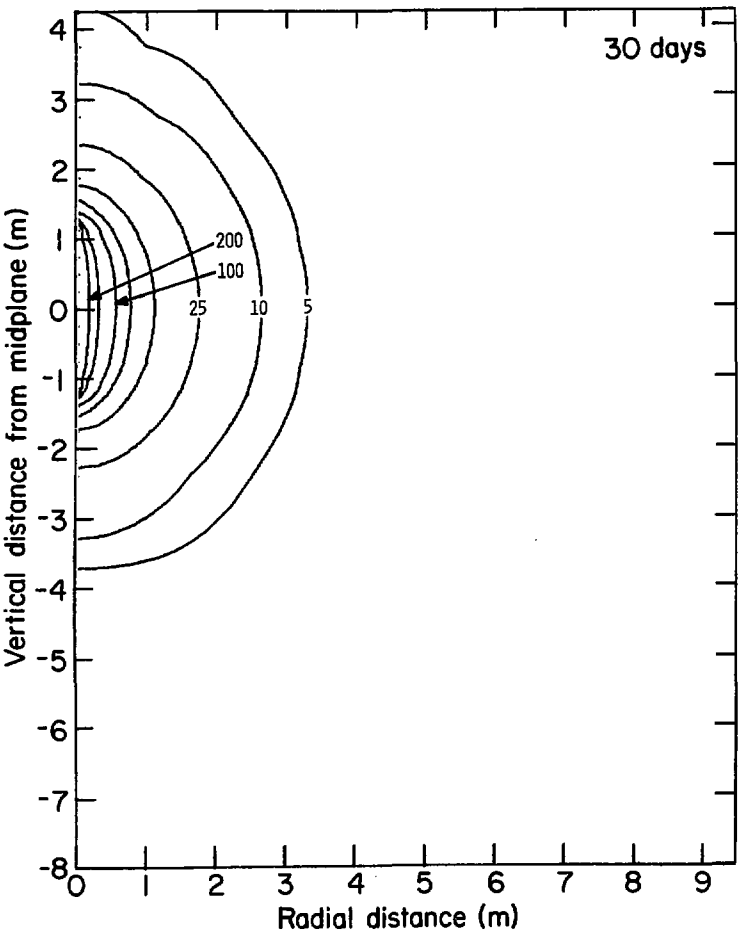
XBL 735-3541

Fig. 15a



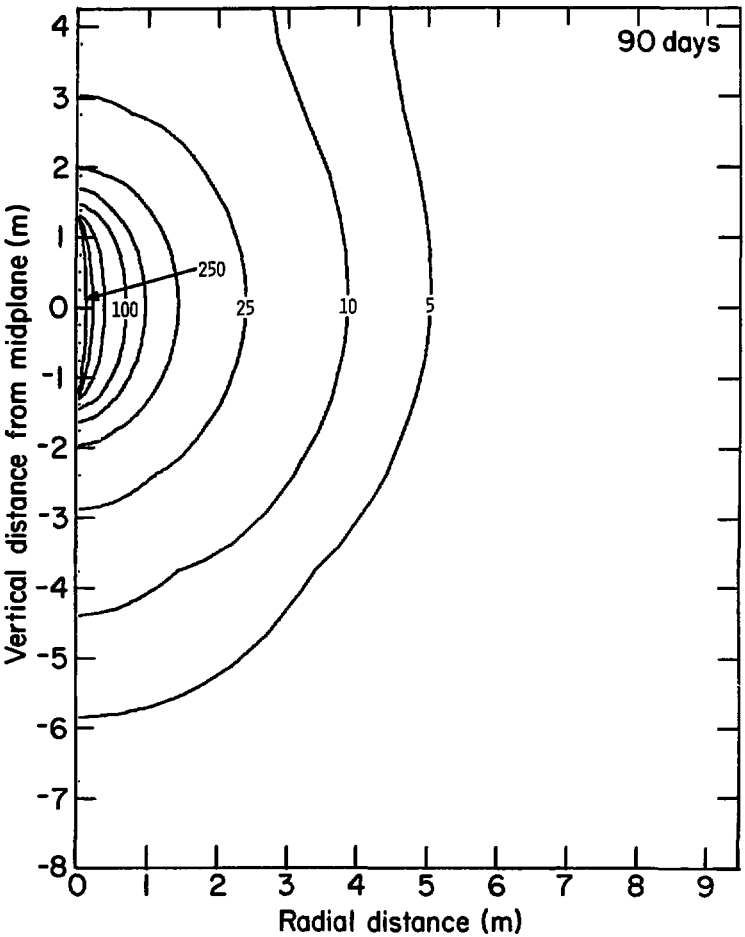
XBL 785-2542

Fig. 15b



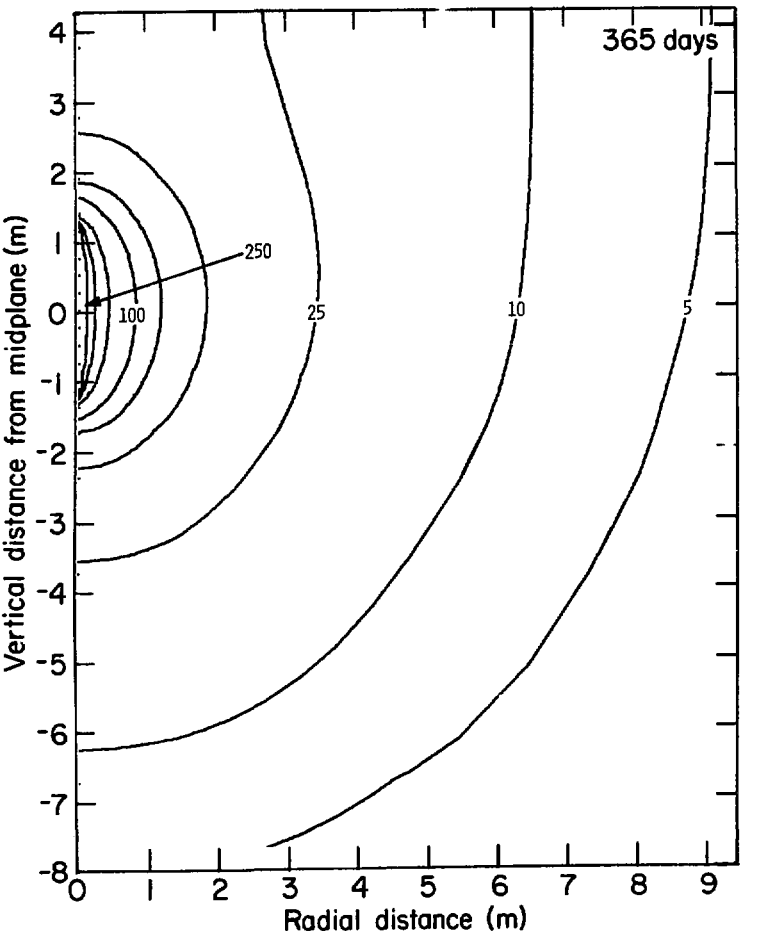
XBL 785-8543

Fig. 15c



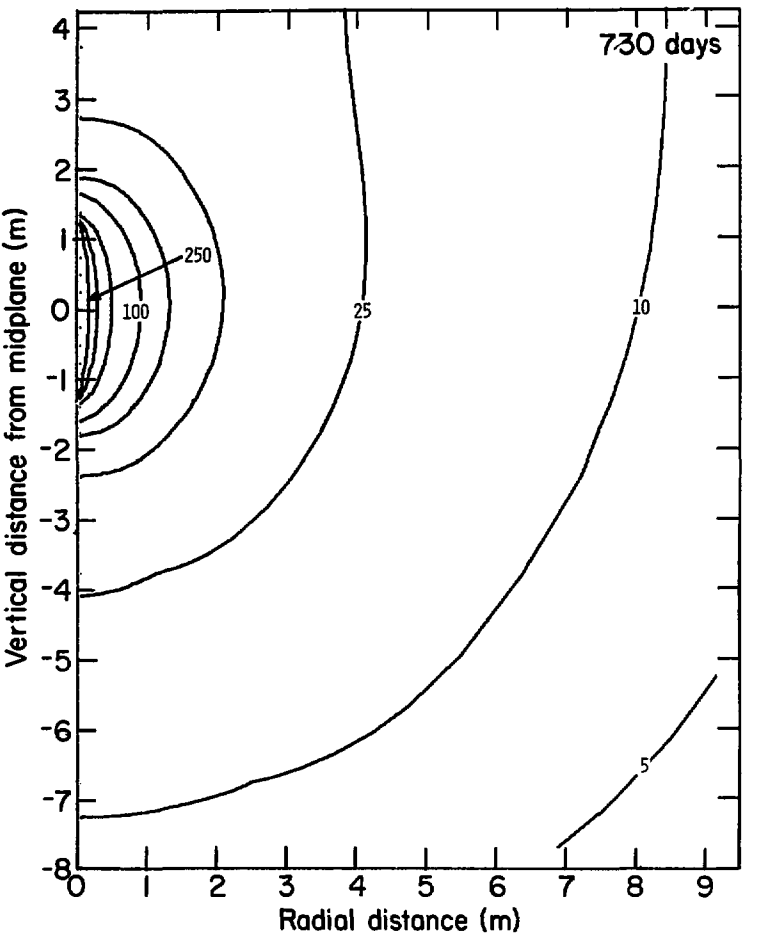
XBL 785-8544

Fig. 15d



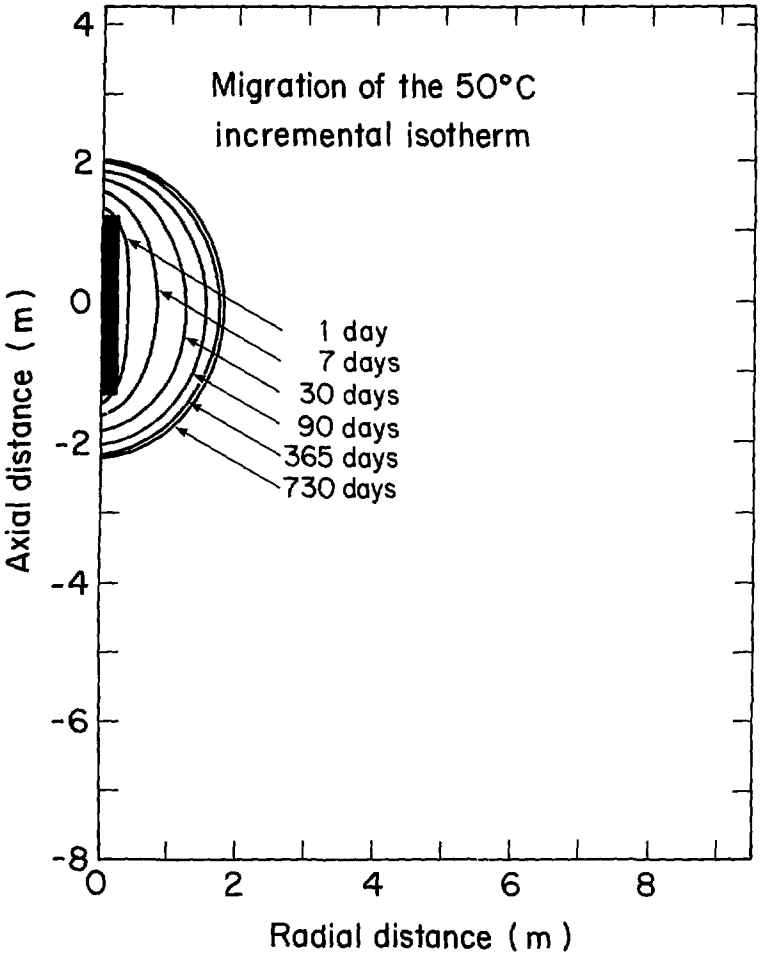
XBL 785-8545

Fig. 15e



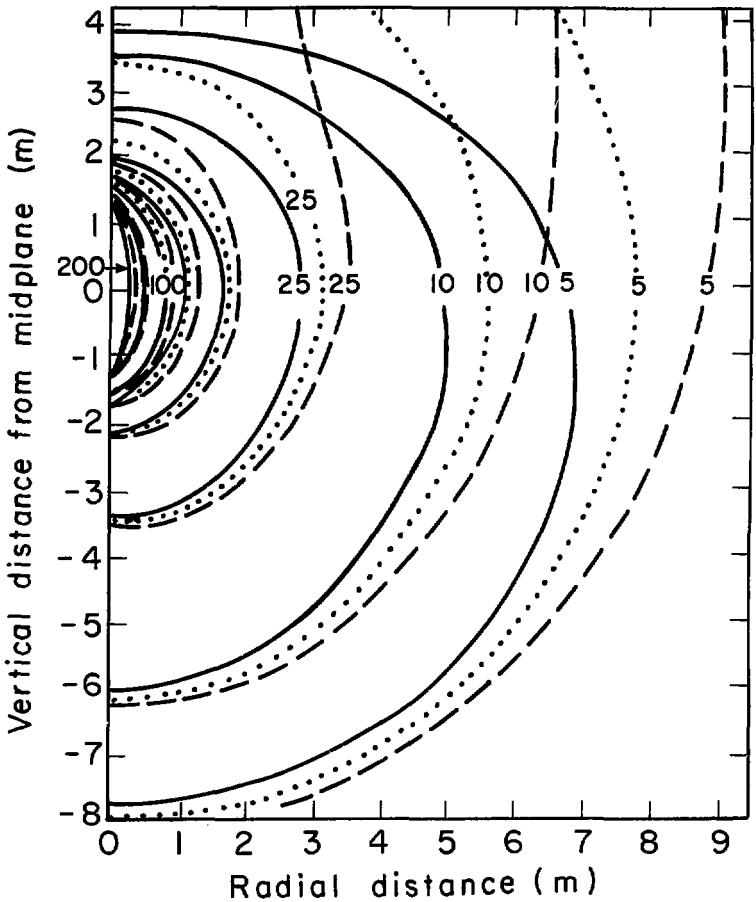
XBL 785-8546

Fig. 15f



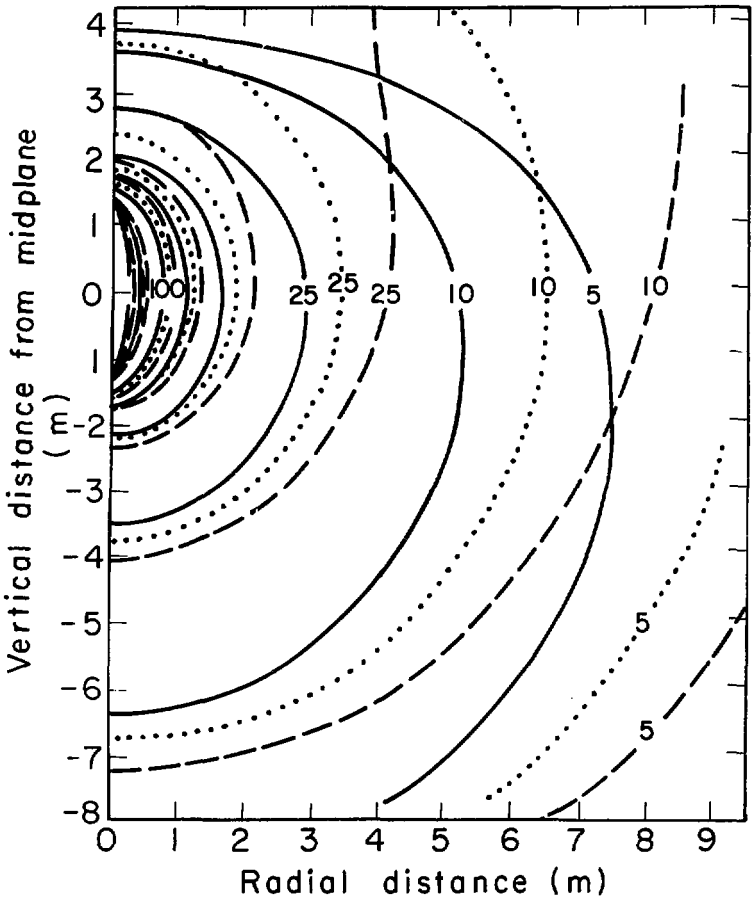
XBL782-231

Fig. 16



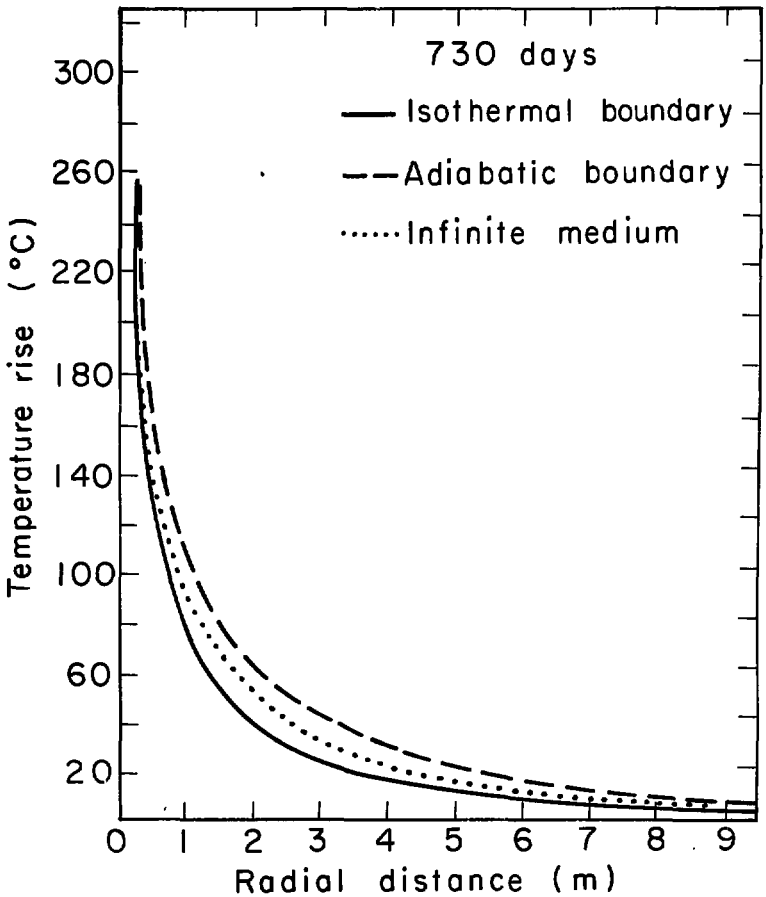
XBL 786-1083

Fig. 17



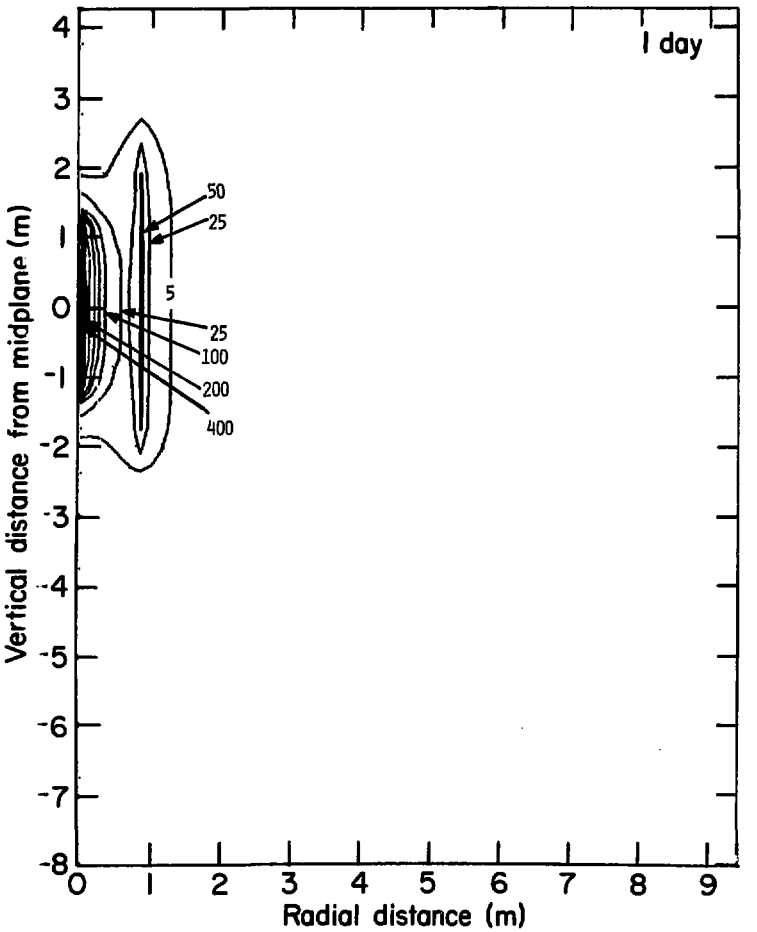
XBL796-1085

Fig. 18



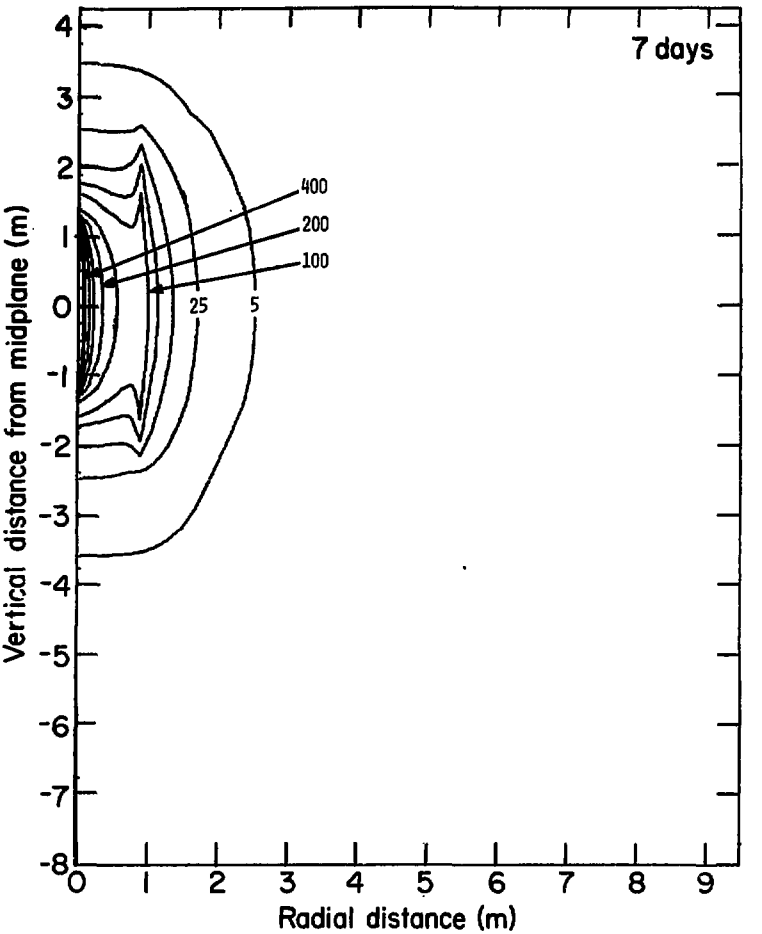
XBL786-1088

Fig. 19



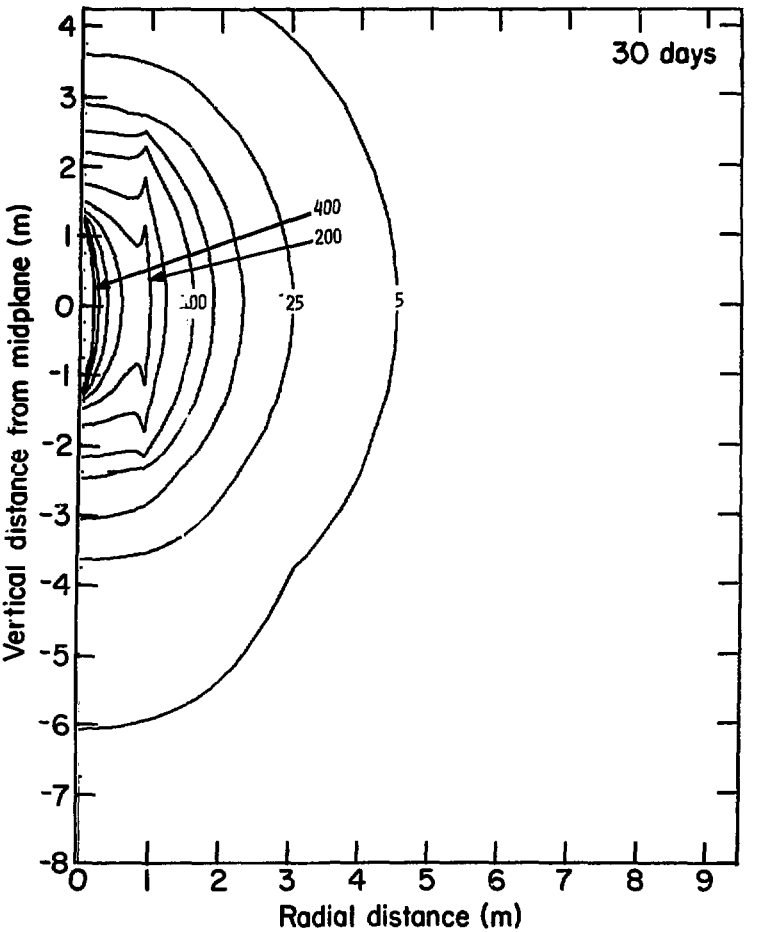
XBL 785-8453

Fig. 20a



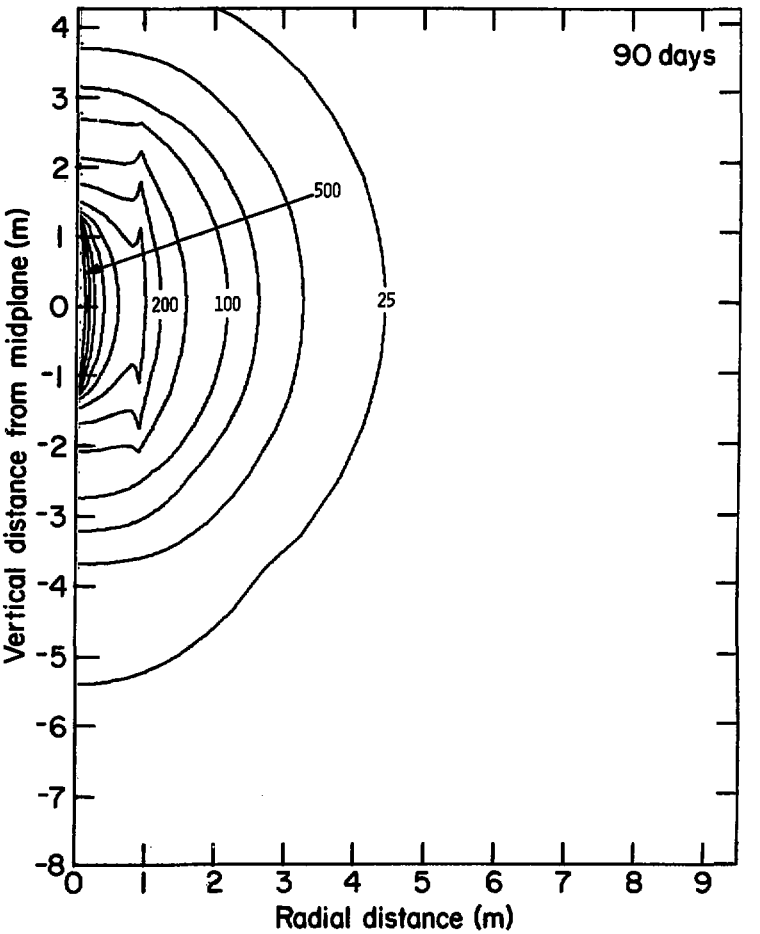
XBL 765-8454

Fig. 20b



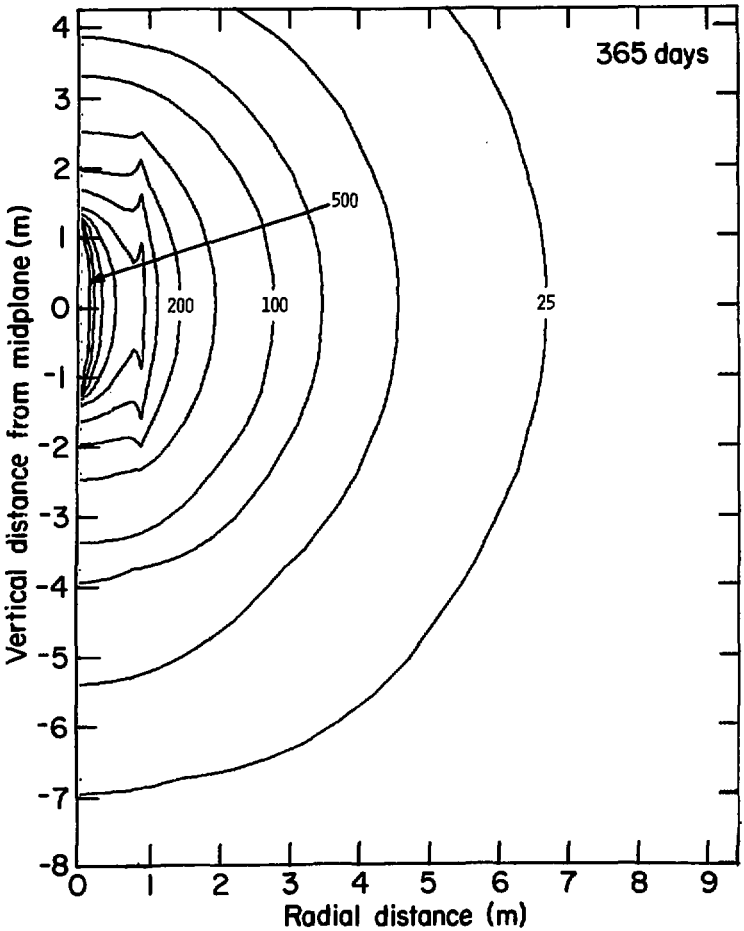
XBL 785-8455

Fig. 20c



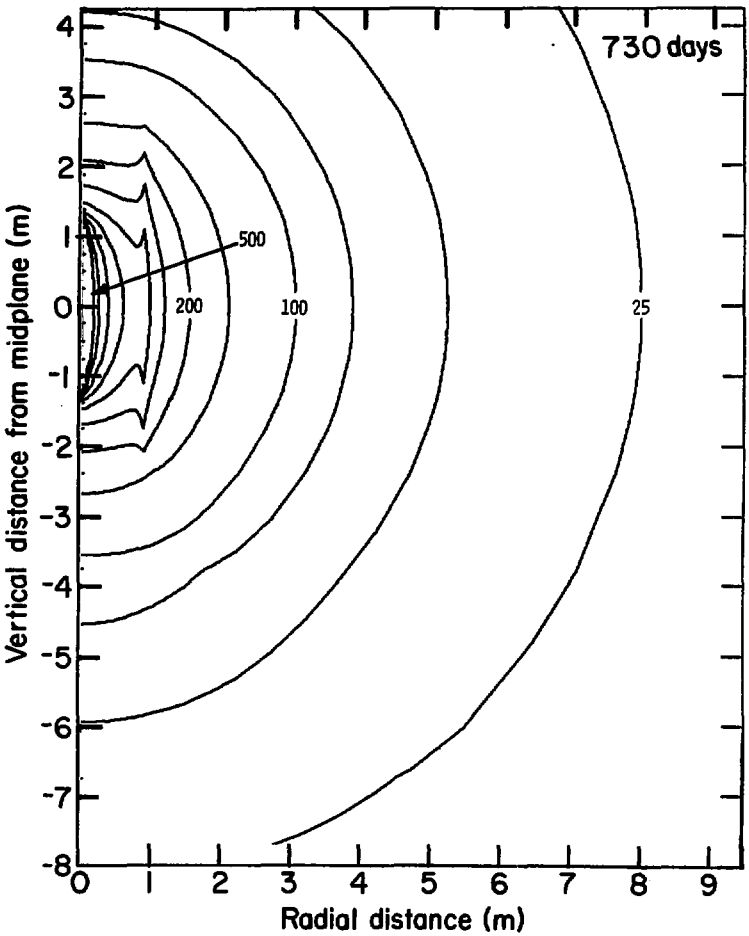
XBL 785-8456

Fig. 20d



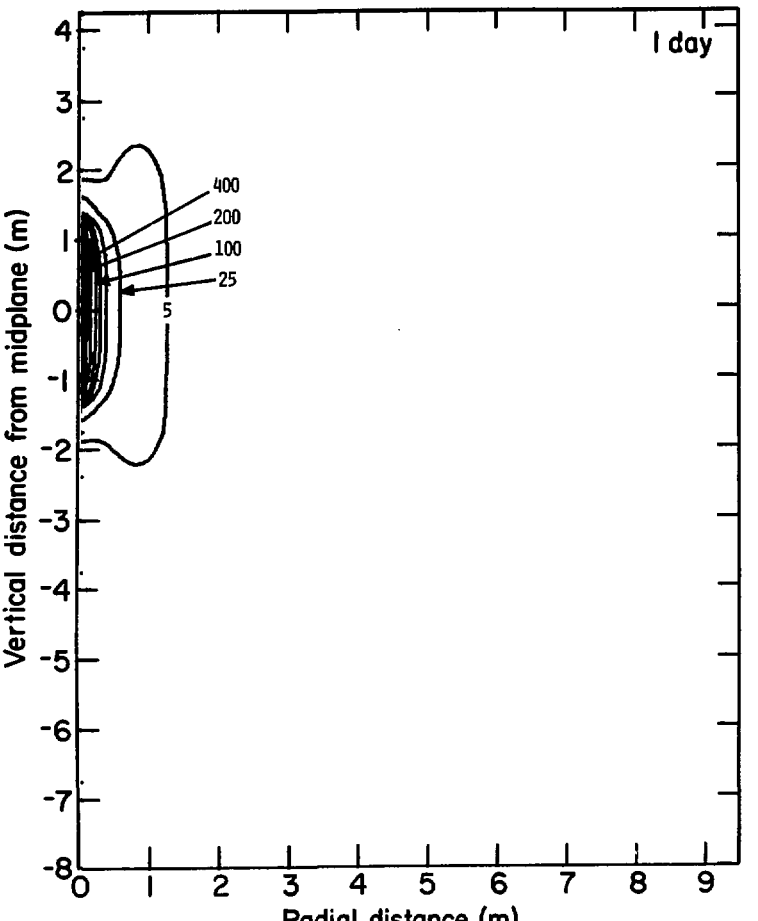
XBL 785-8457

Fig. 20e



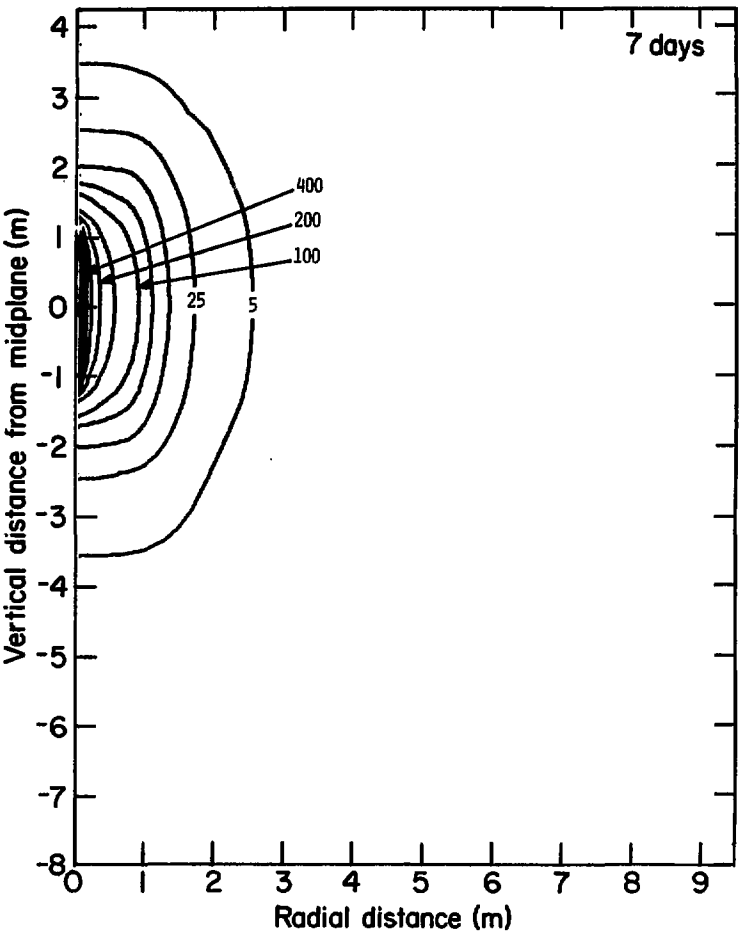
XBL 785-8458

Fig. 20f



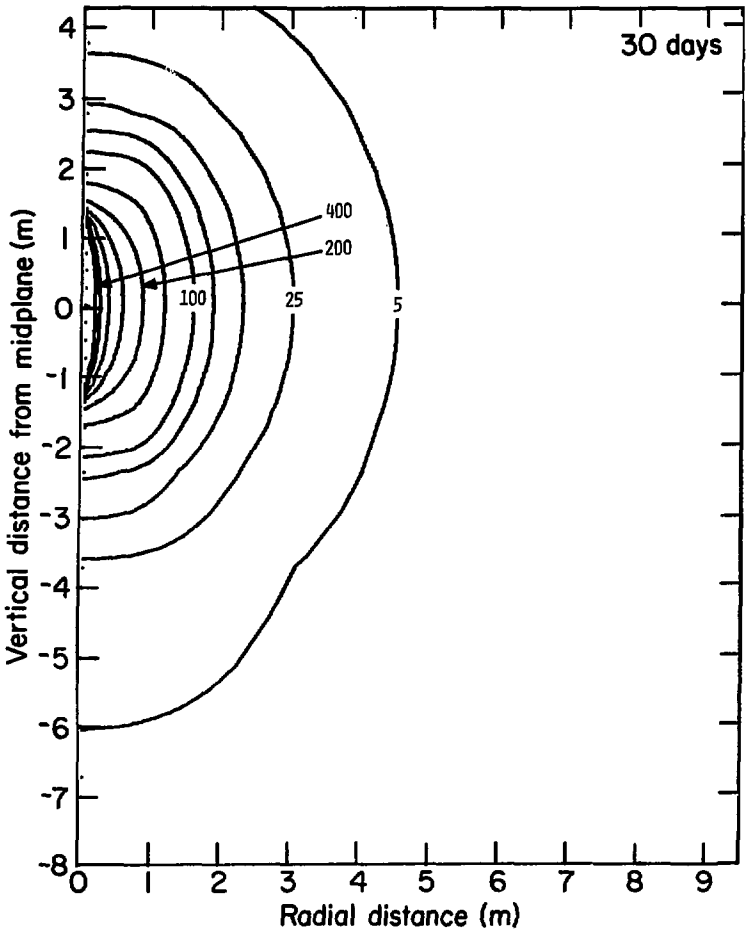
XBL 785-8459

Fig. 21a



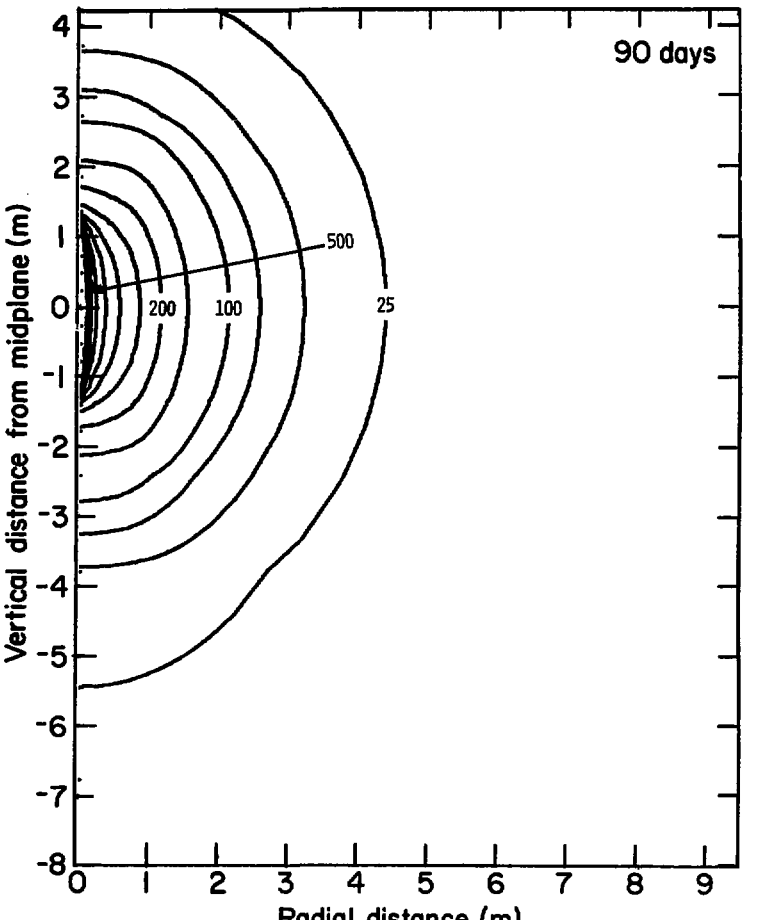
XBL 785-8460

Fig. 21b



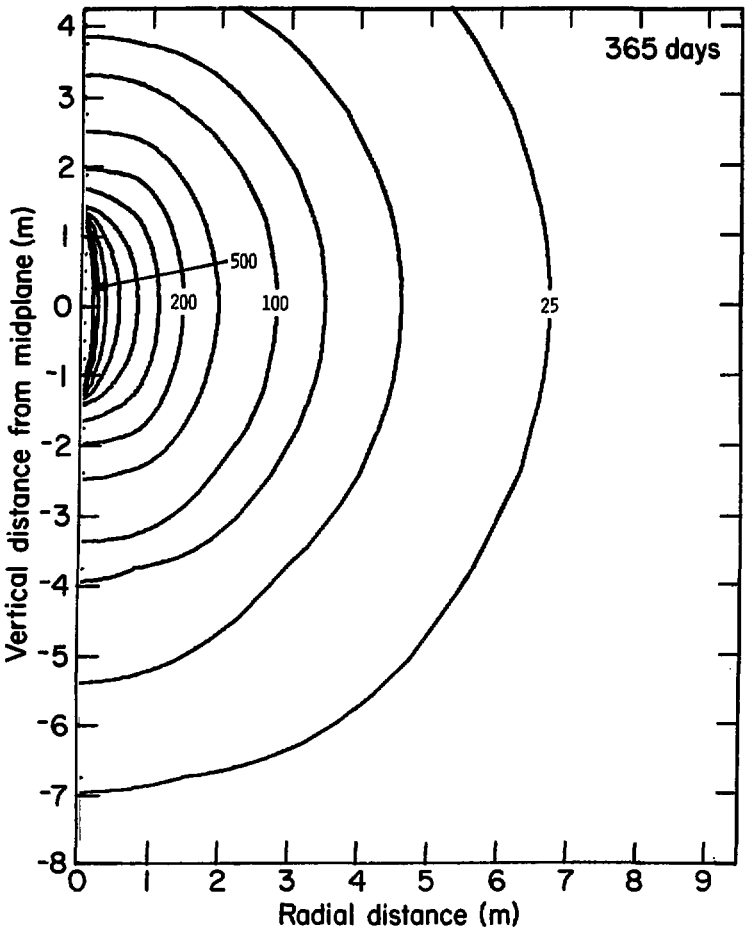
XBL 785-8461

Fig. 21c



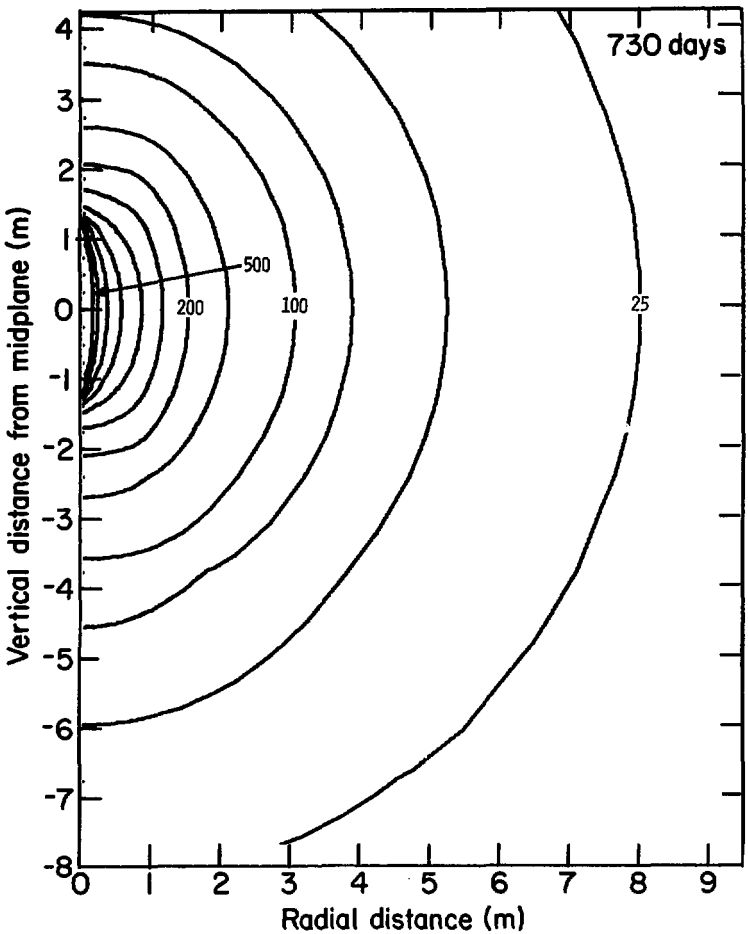
XBL 785-8462

Fig. 21d



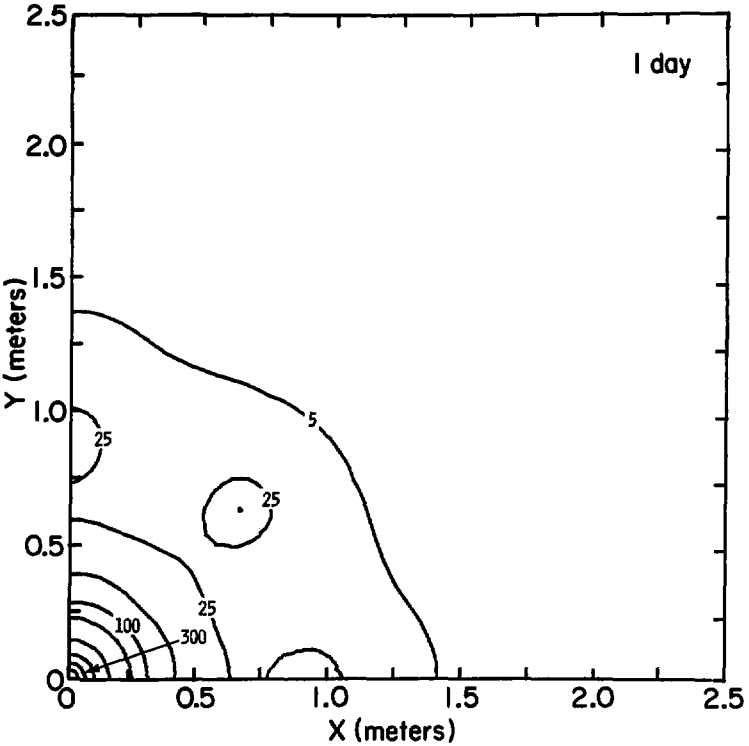
XBL 785-8463

Fig. 21e



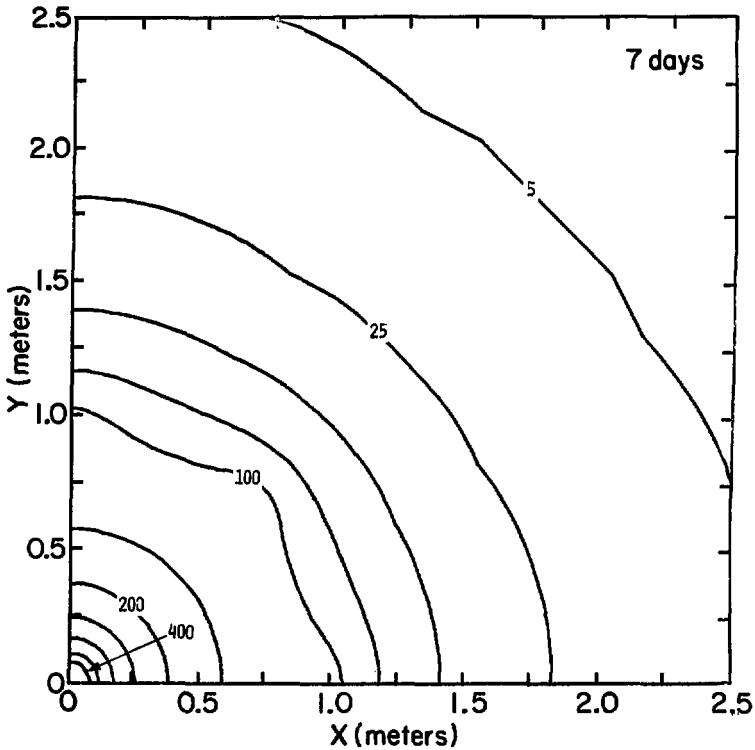
XBL 785-8464

Fig. 21f



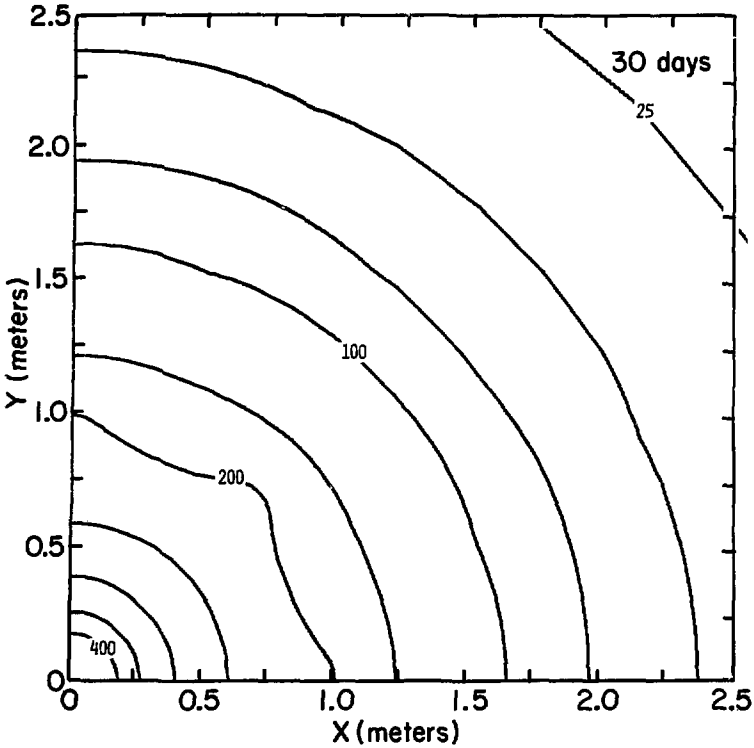
XBL 785-8477

Fig. 22a



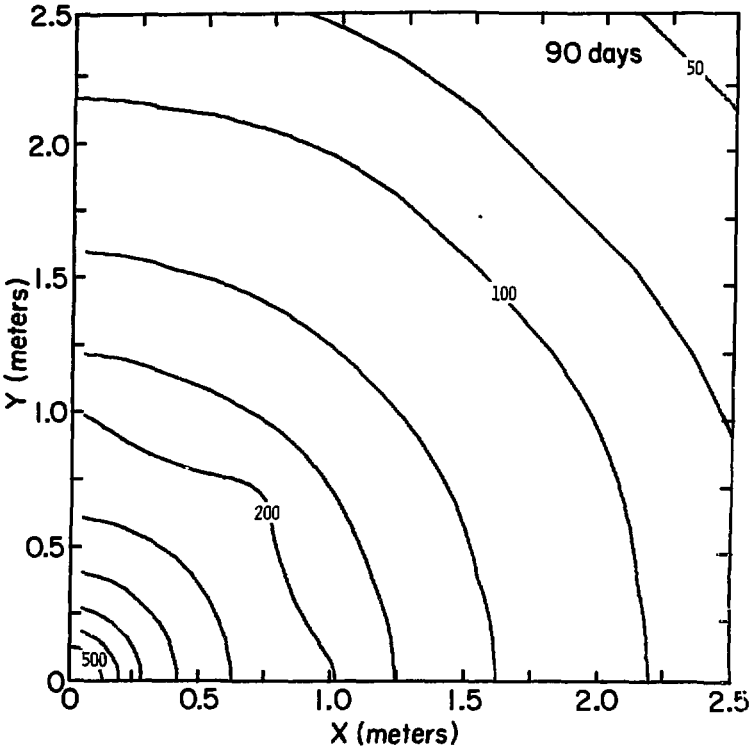
XBL 785-8478

Fig. 22b



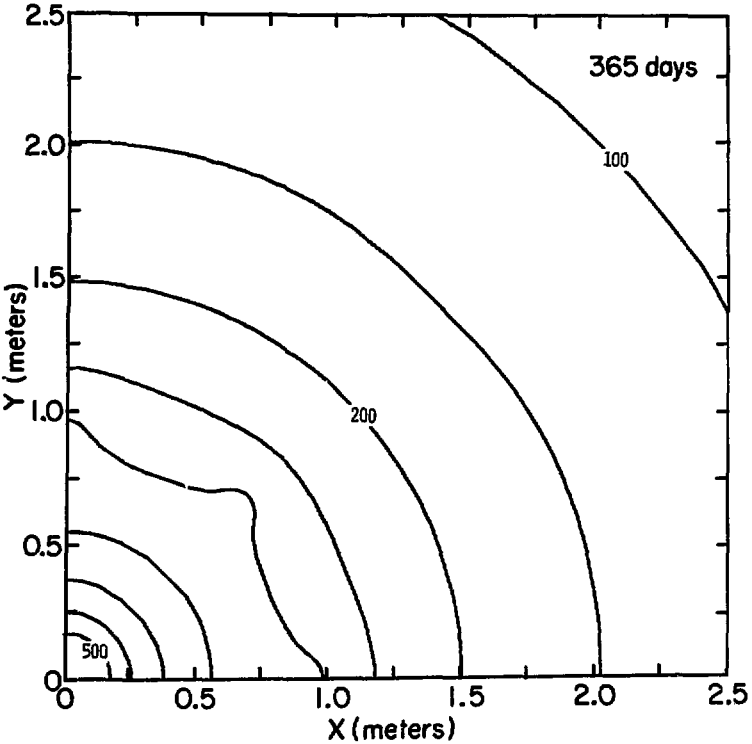
XBL 785-8479

Fig. 22c



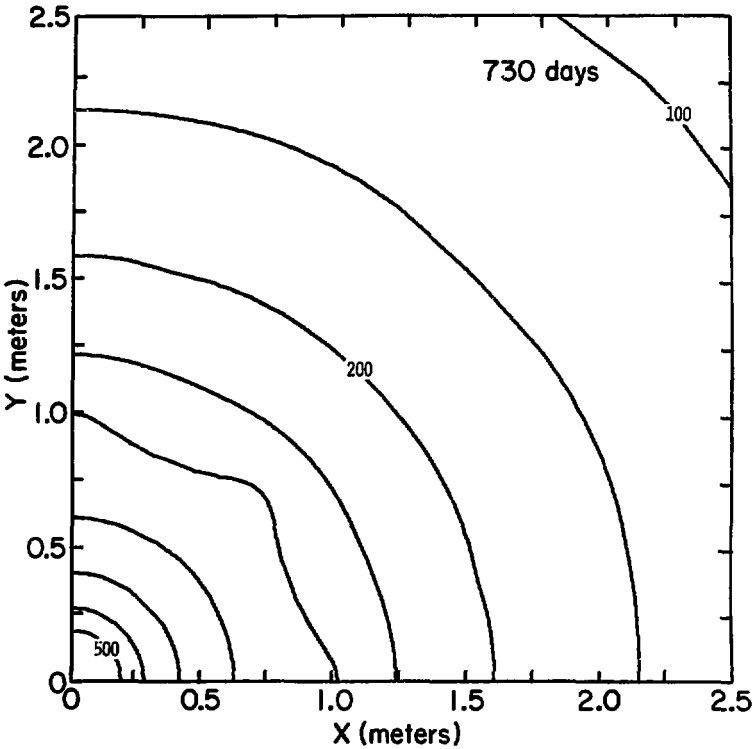
XBL 785-8480

Fig. 22d



XBL 785-8481

Fig. 22e



XBL 785-8482

Fig. 22f

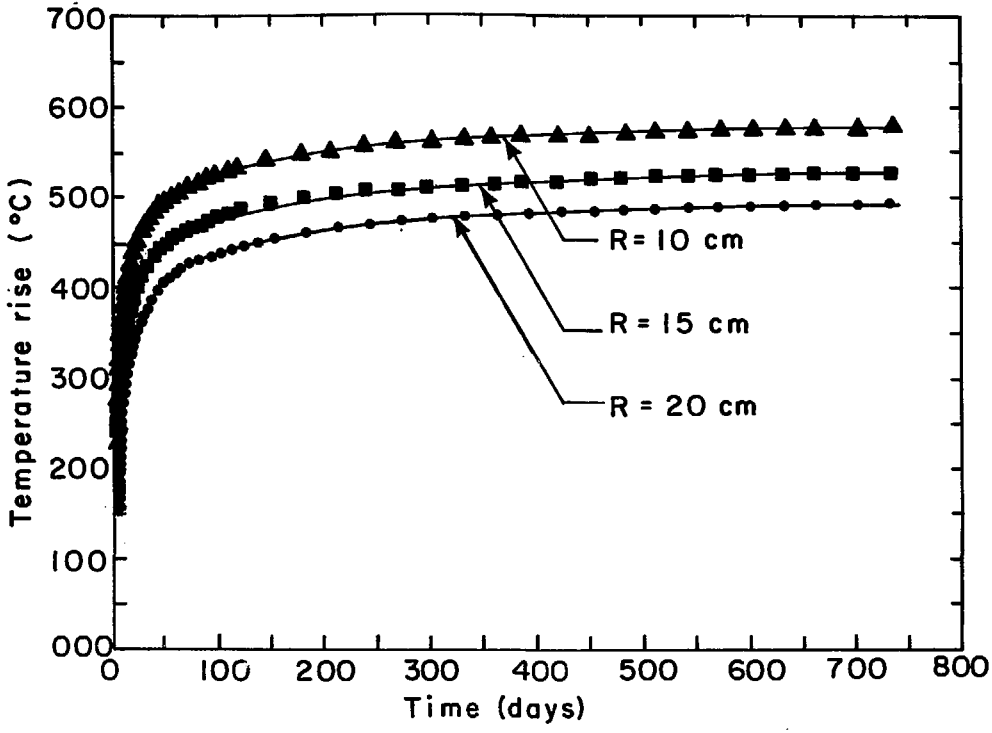
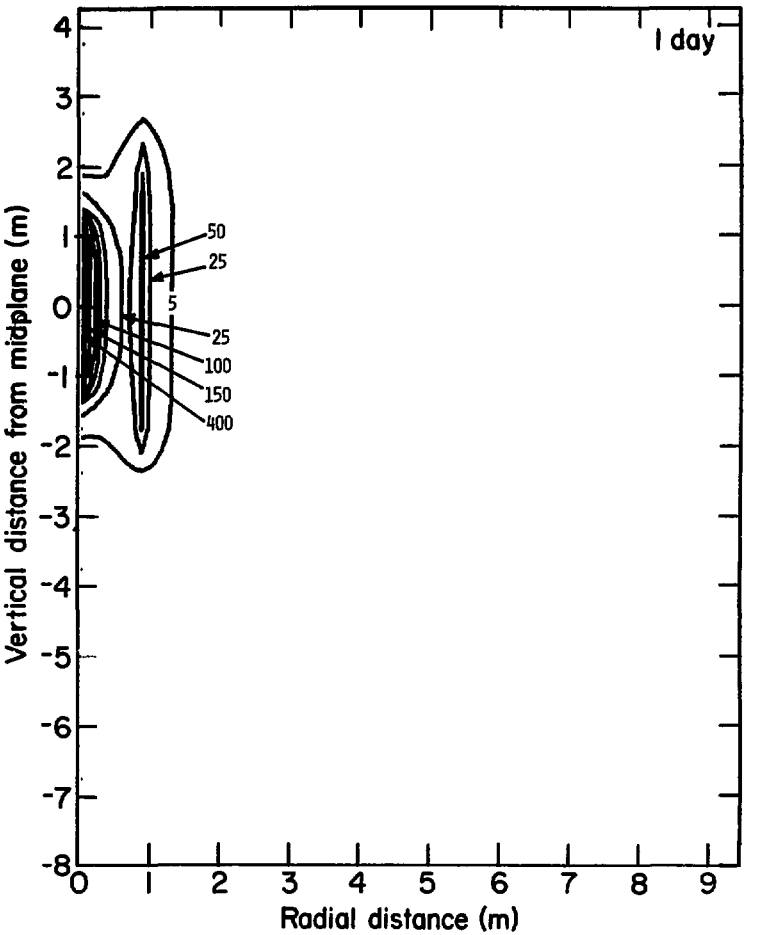


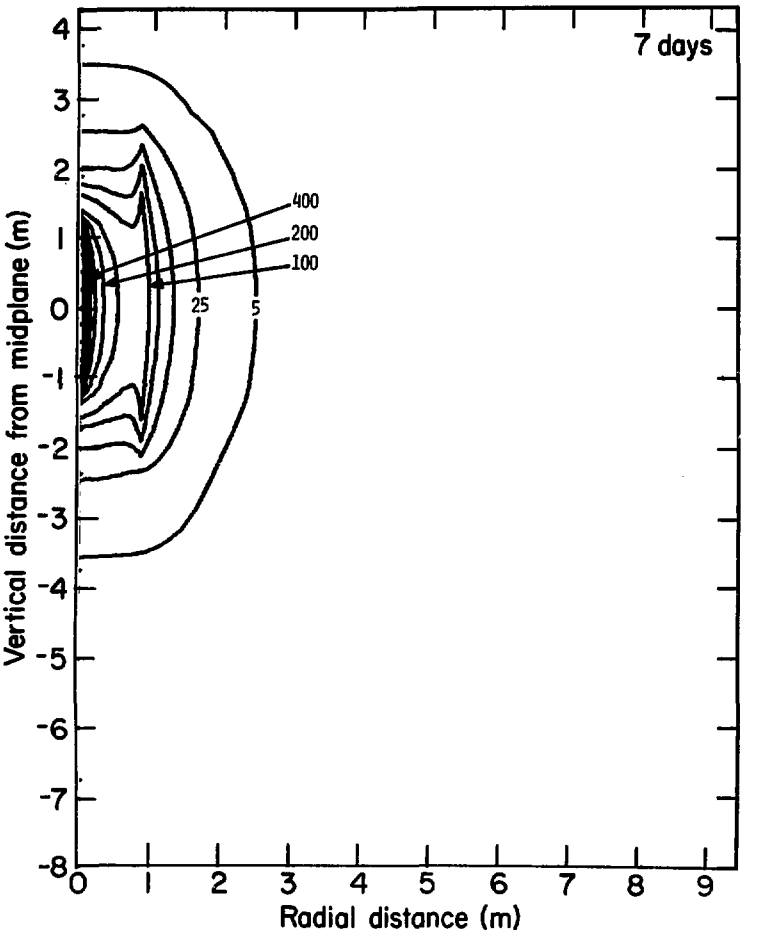
Fig. 23

XBL 781 - 6699



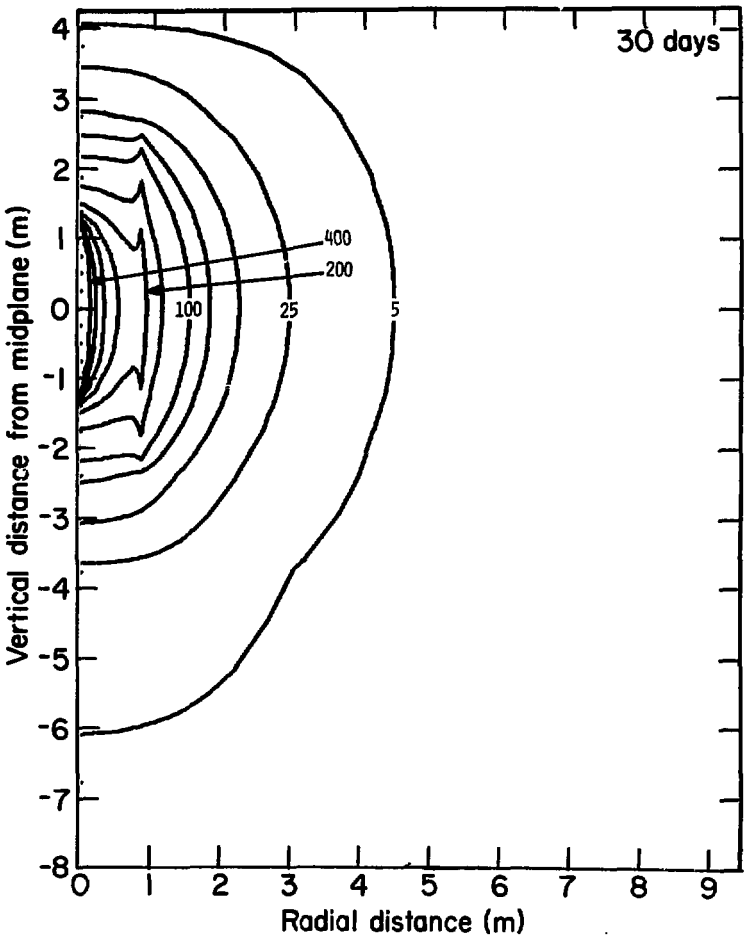
XBL 785-8489

Fig. 24a



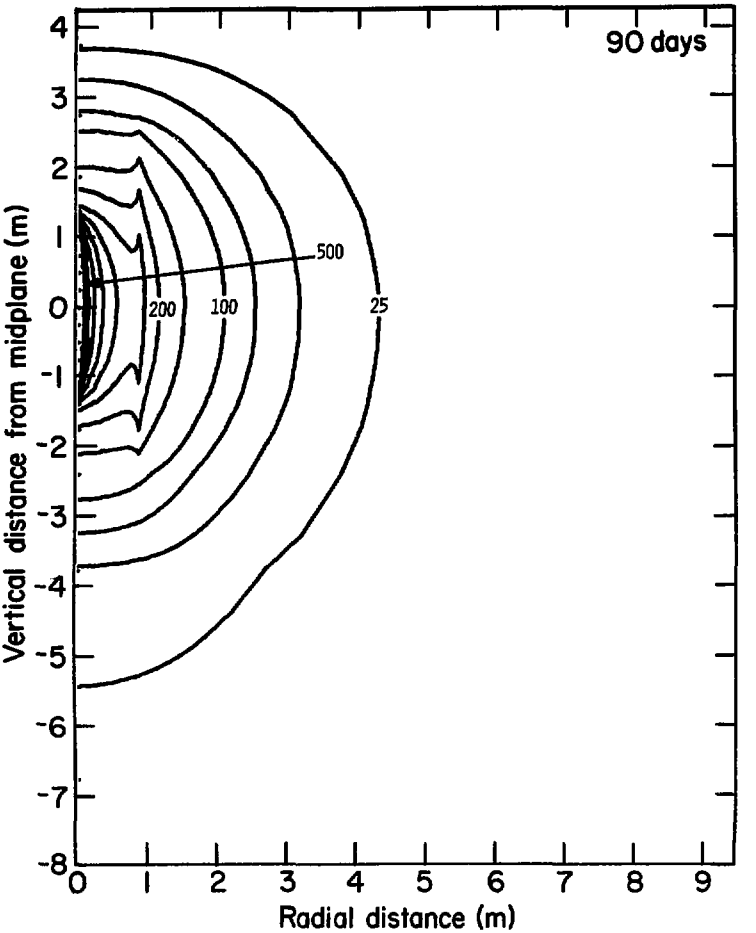
XBL 785-8490

Fig. 24b



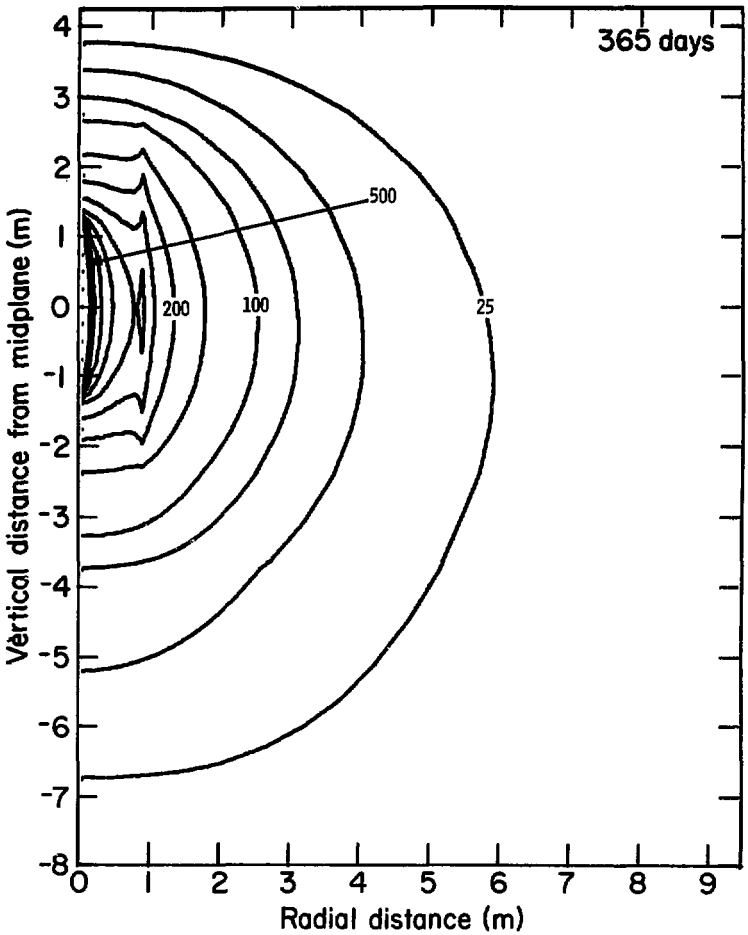
XBL 785-8491

Fig. 24c



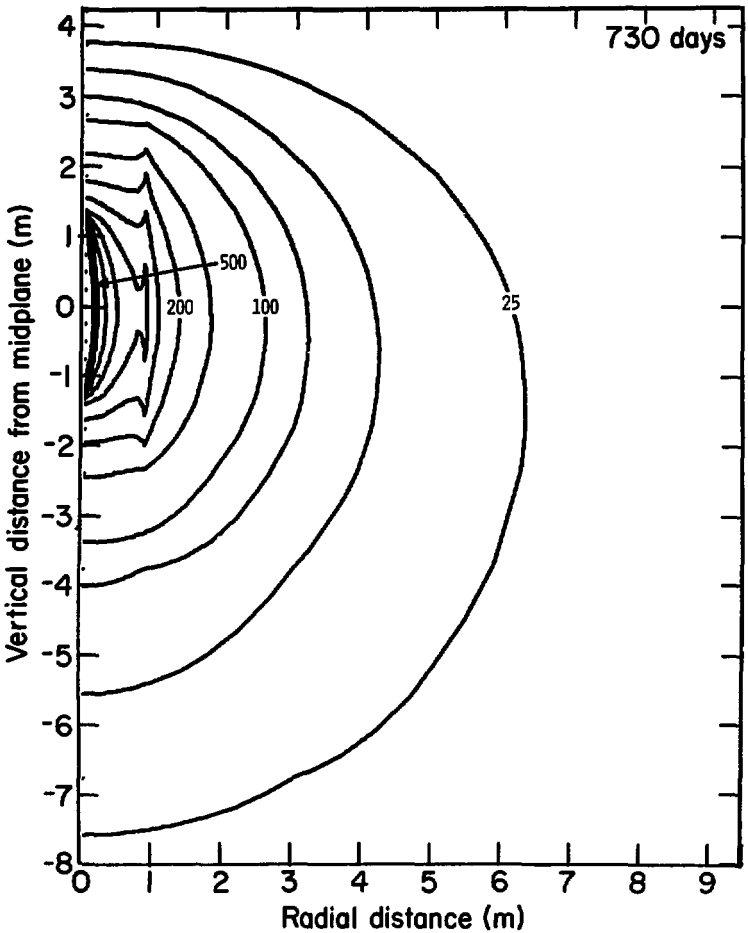
XBL 785-8492

Fig. 24d



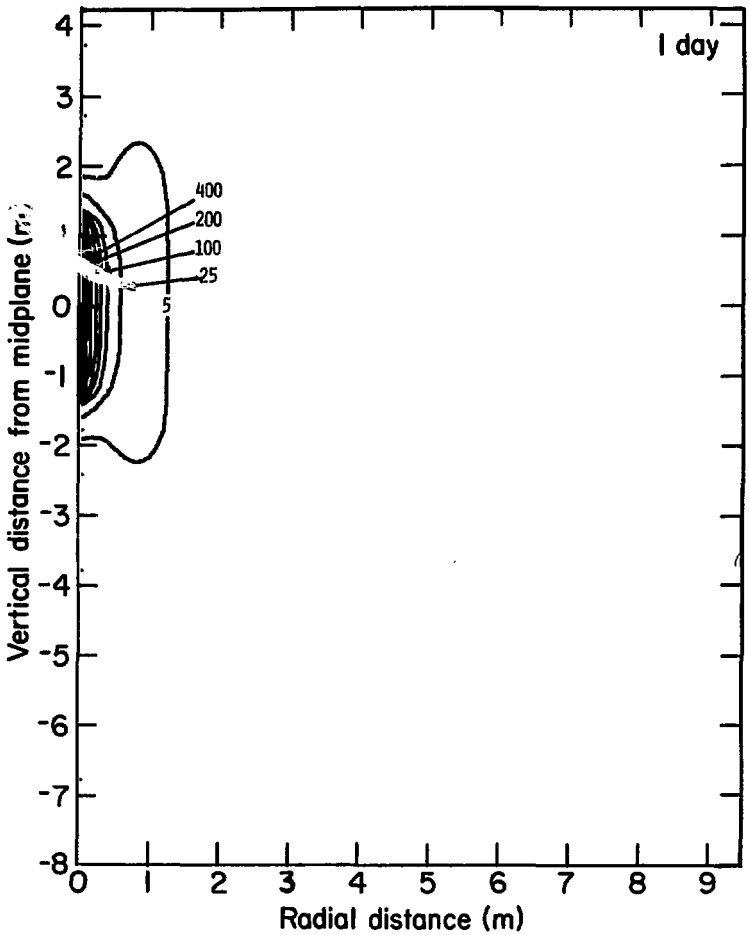
XBL 785-8493

Fig. 24e



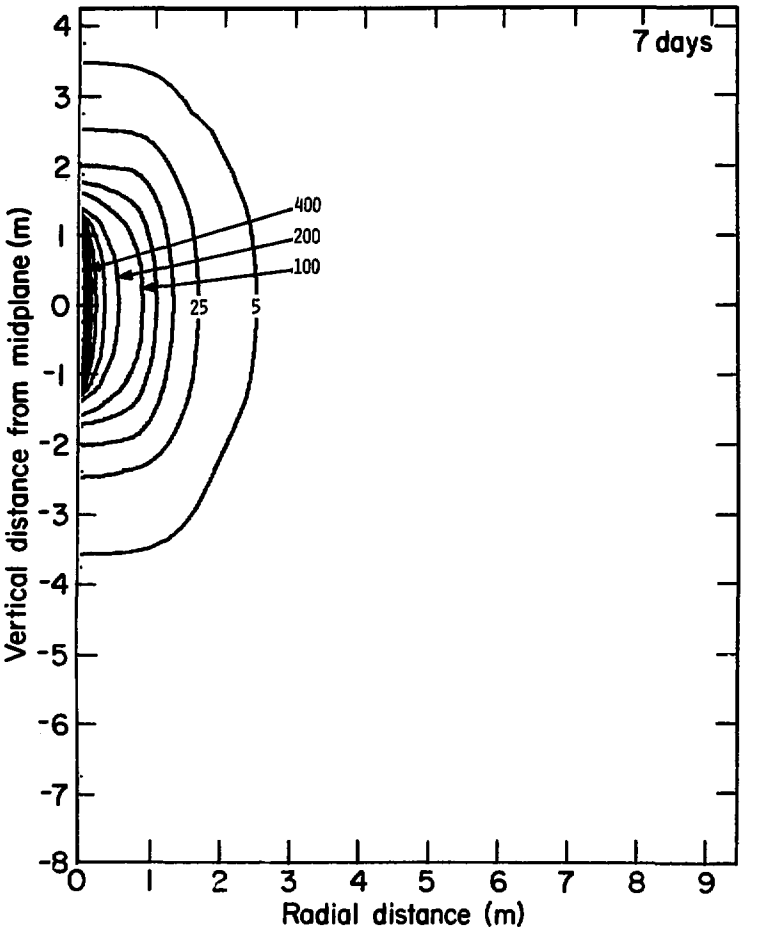
XBL 783-7741

Fig. 24f



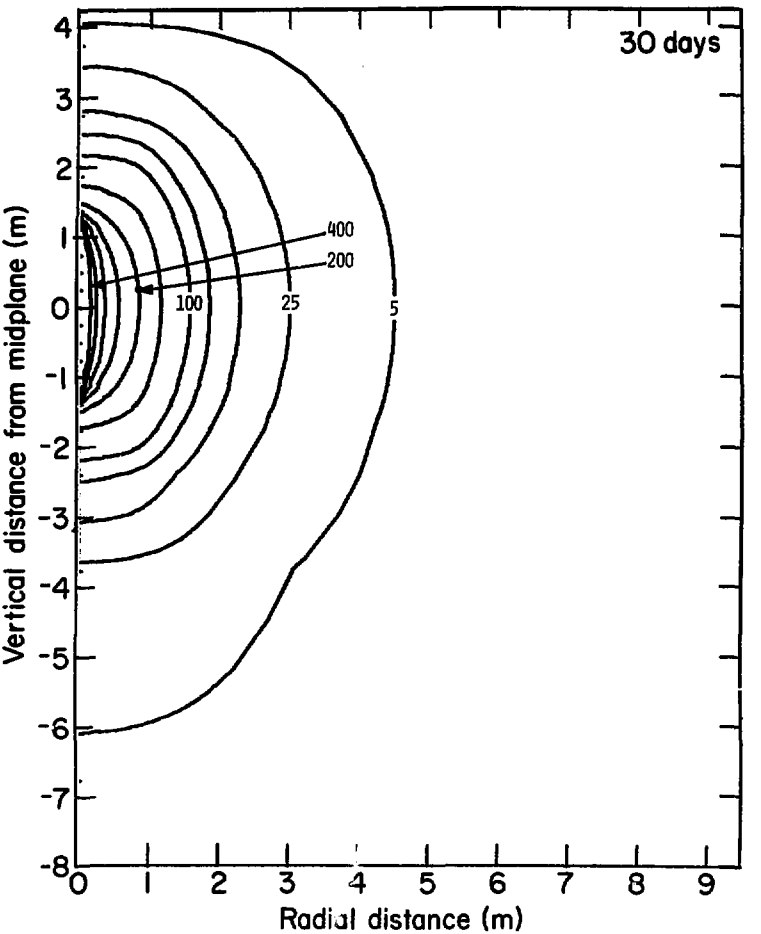
XBL 785-8500

Fig. 25a



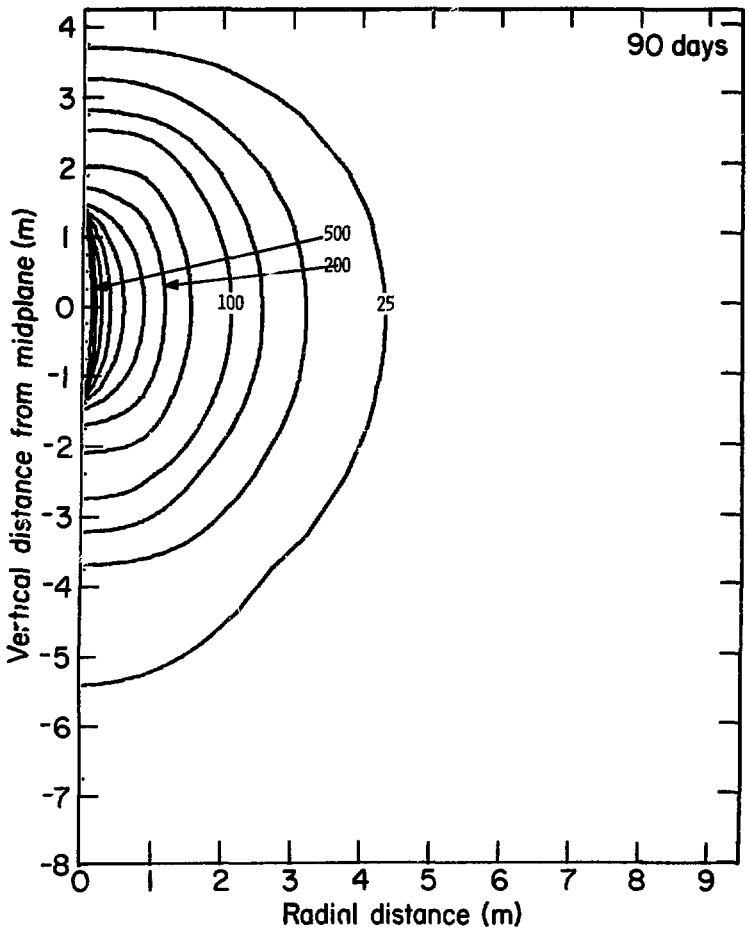
XBL 785-8501

Fig. 25b



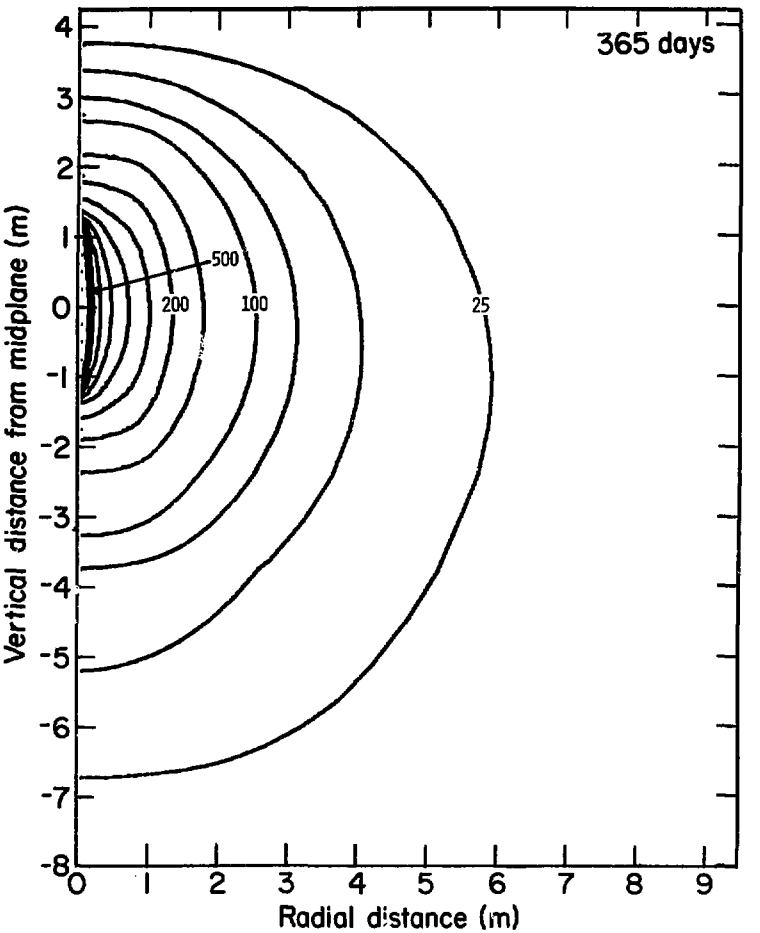
XBL 785-8502

Fig. 25c



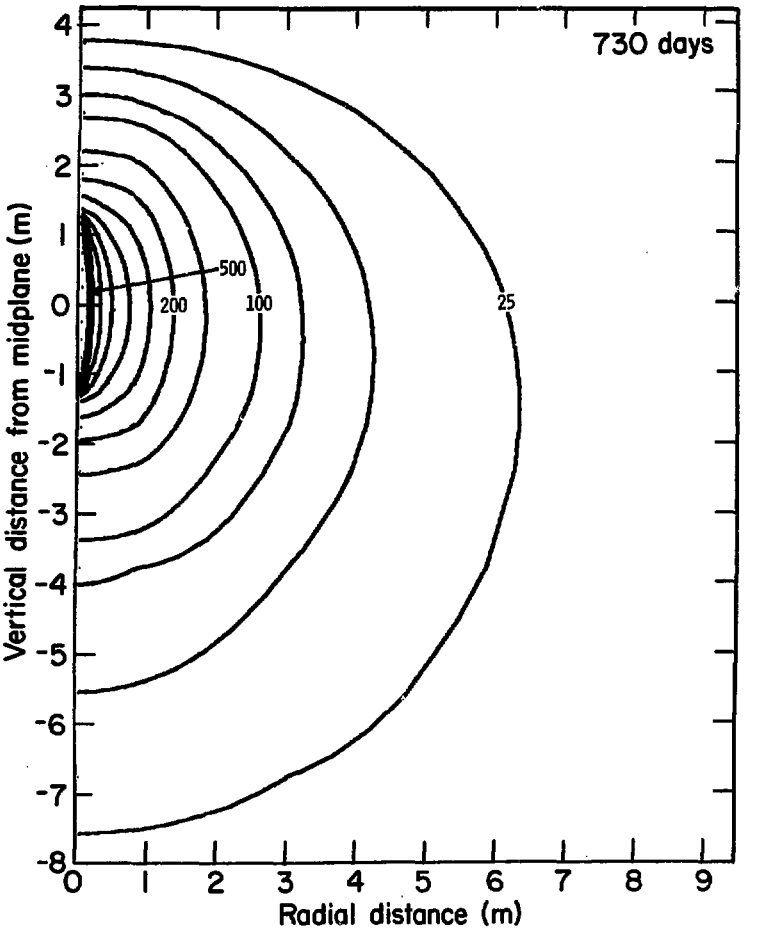
XBL 785-8503

Fig. 25d



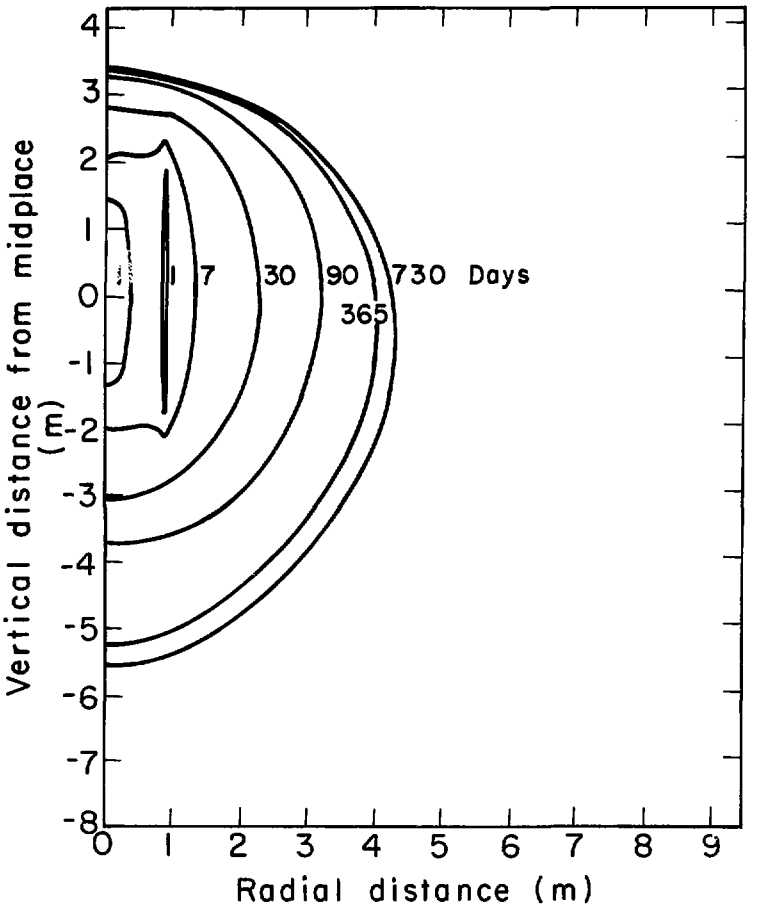
XBL 785-8504

Fig. 25e



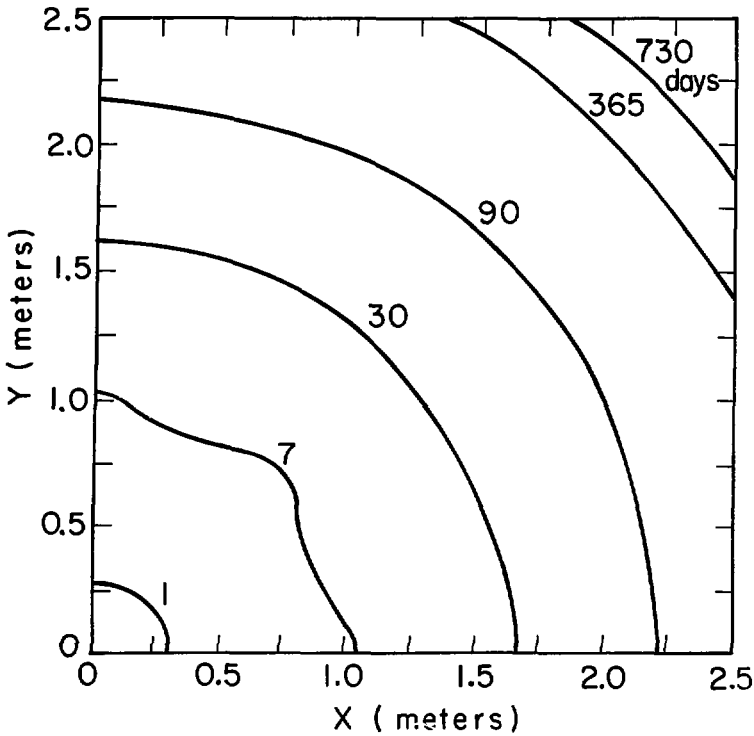
XBL 785-8505

Fig. 25f



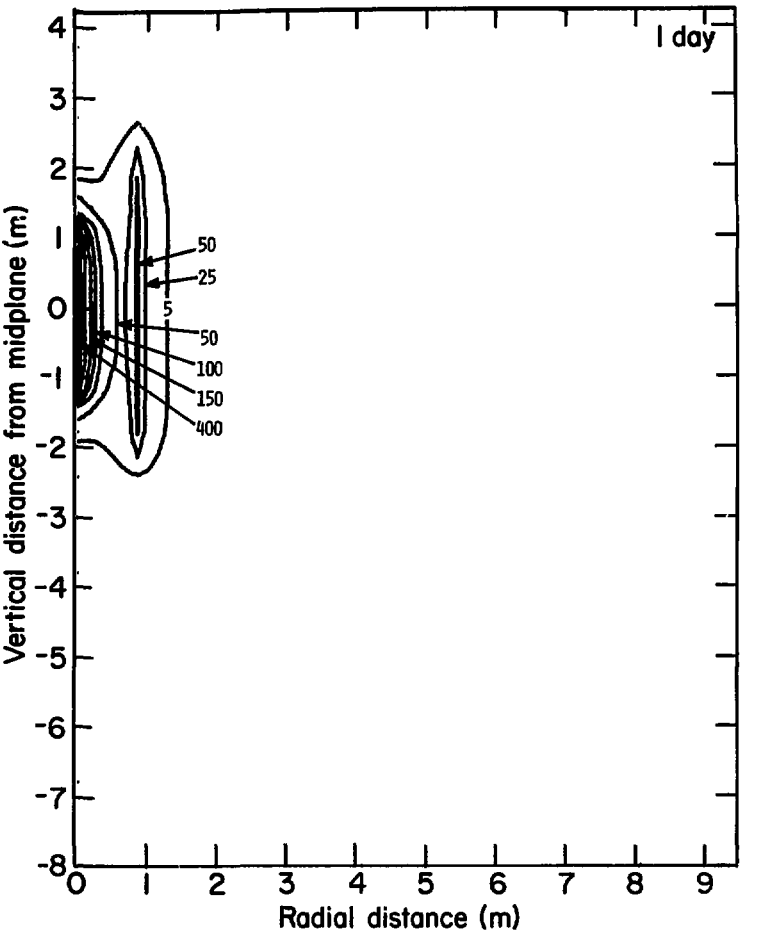
XBL 786-1084

Fig. 26a



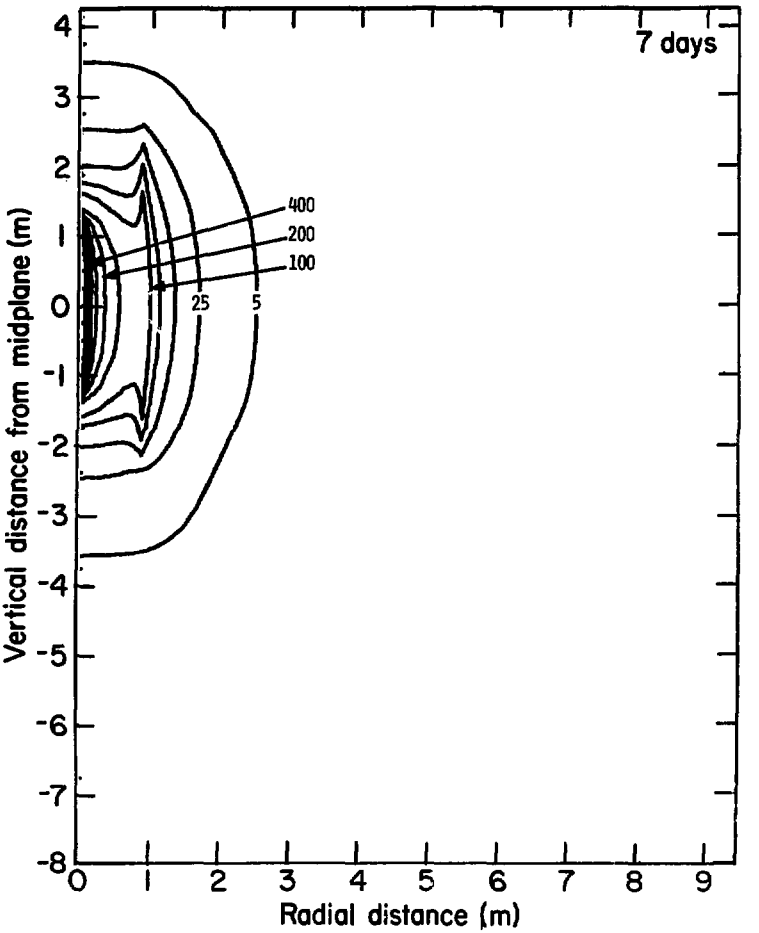
XBL 786-1095

Fig. 26b



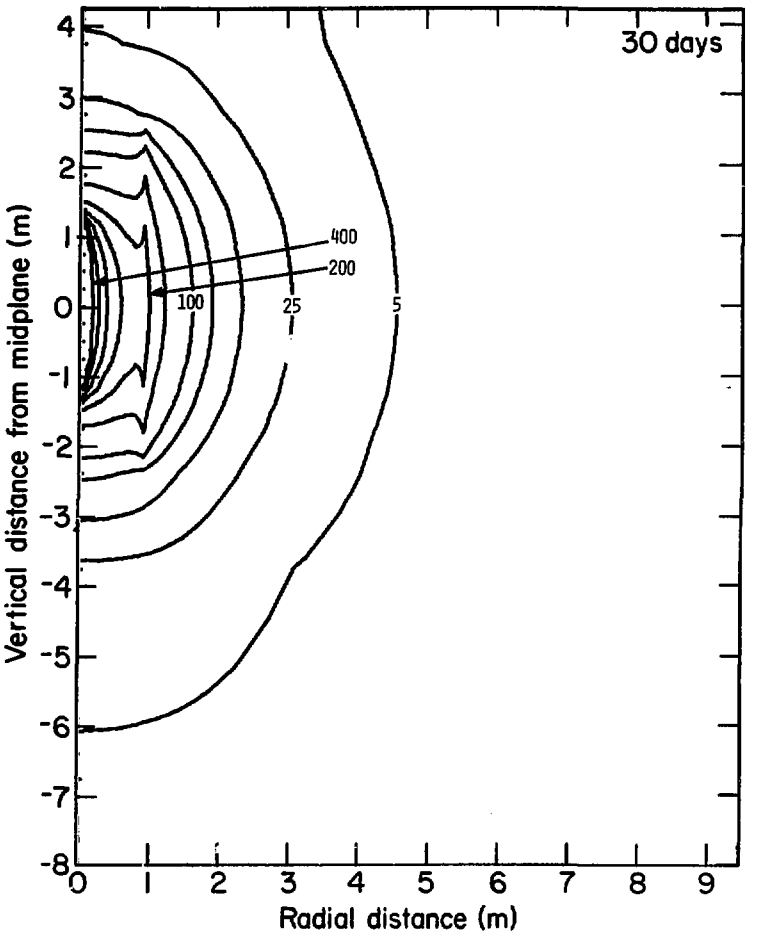
XBL 785-8494

Fig. 27a



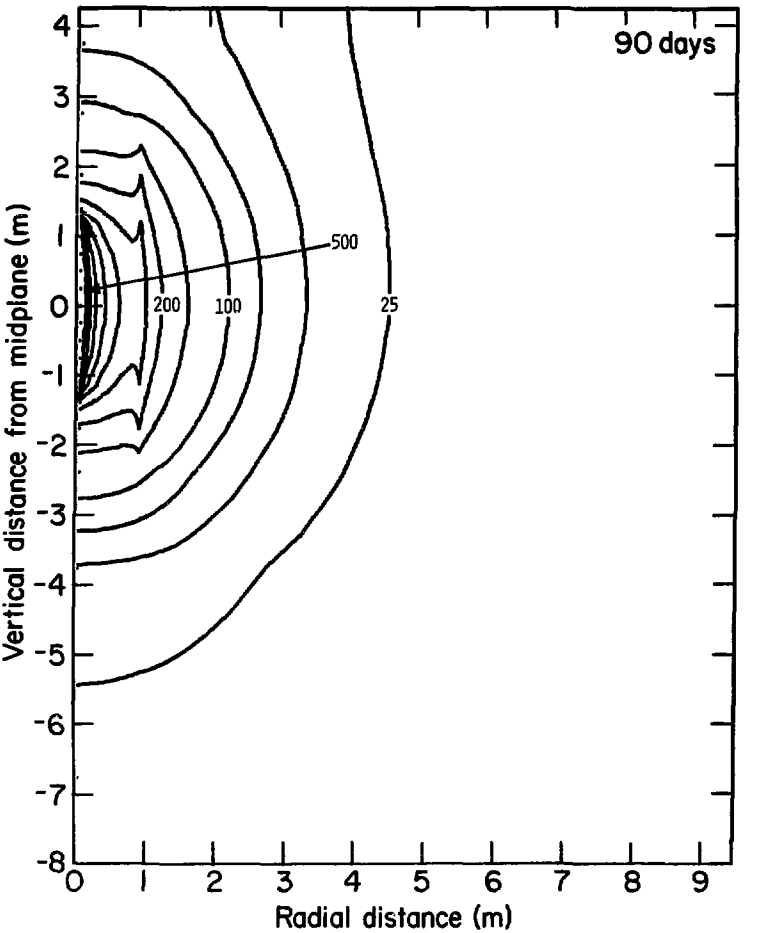
XBL 785-8495

Fig. 27b



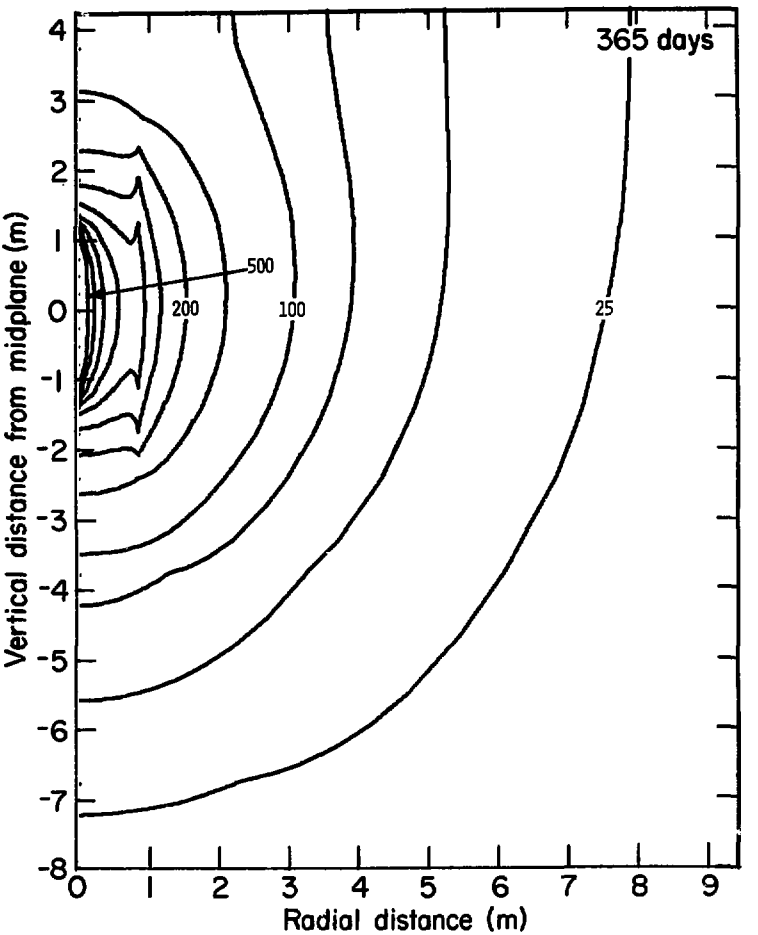
XBL 785-8496

Fig. 27c



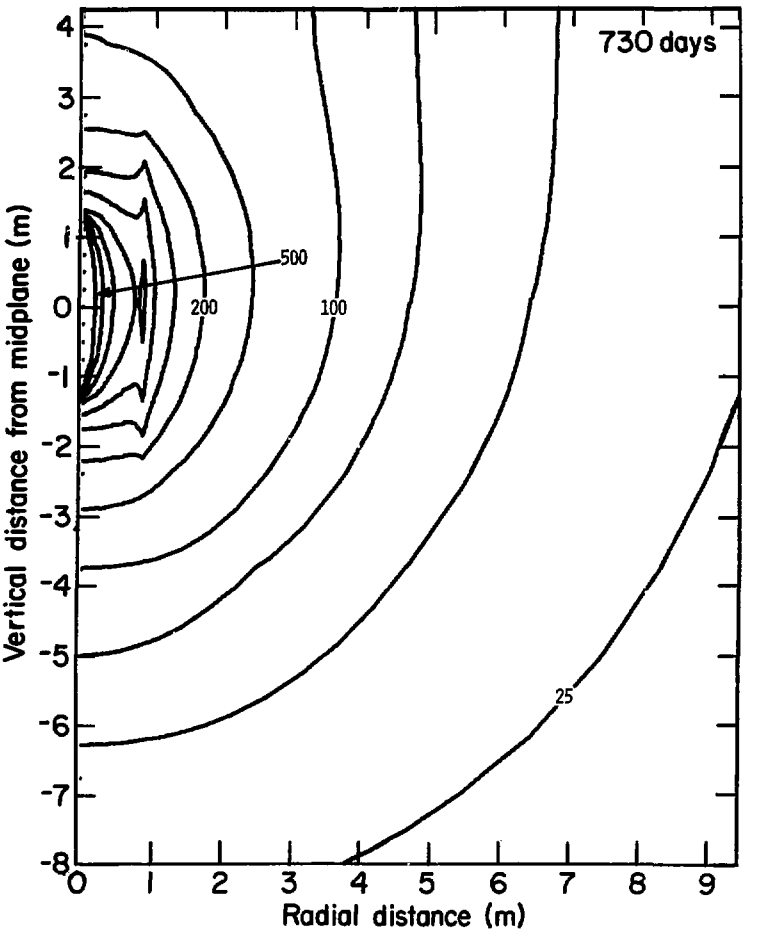
XBL 785-8497

Fig. 27d



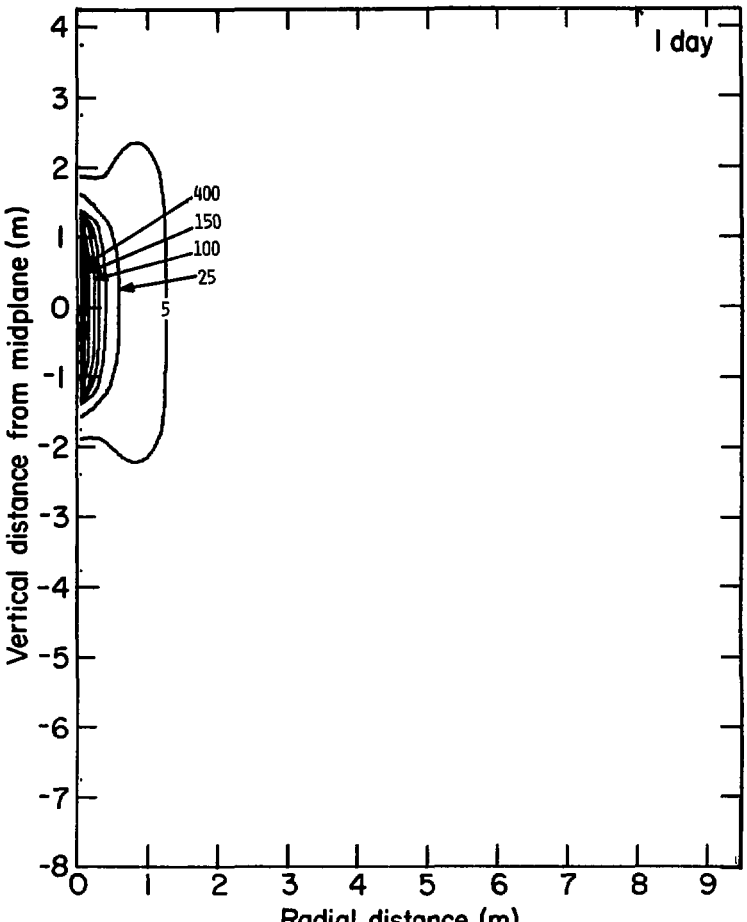
XBL 785-8496

Fig. 27e



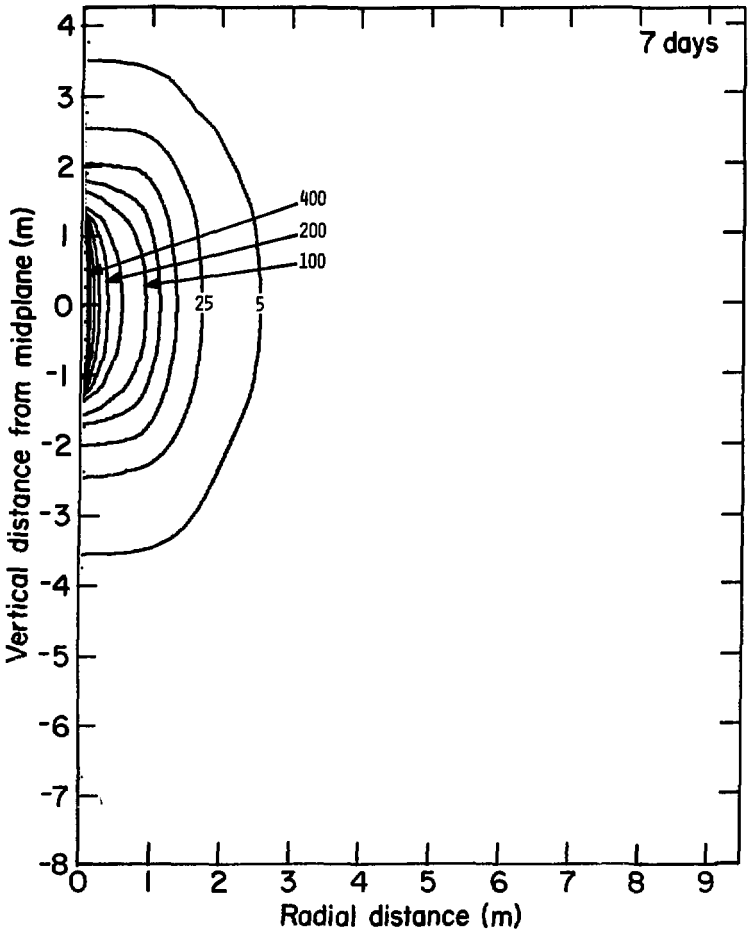
XBL 785-8499

Fig. 27f



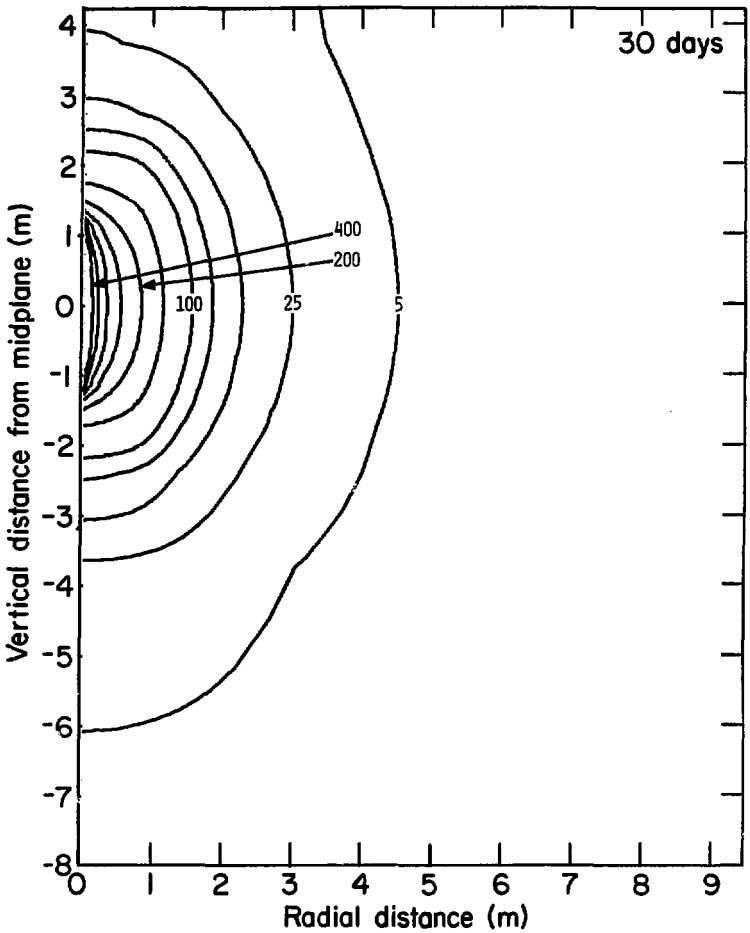
XBL 785-8506

Fig. 28a



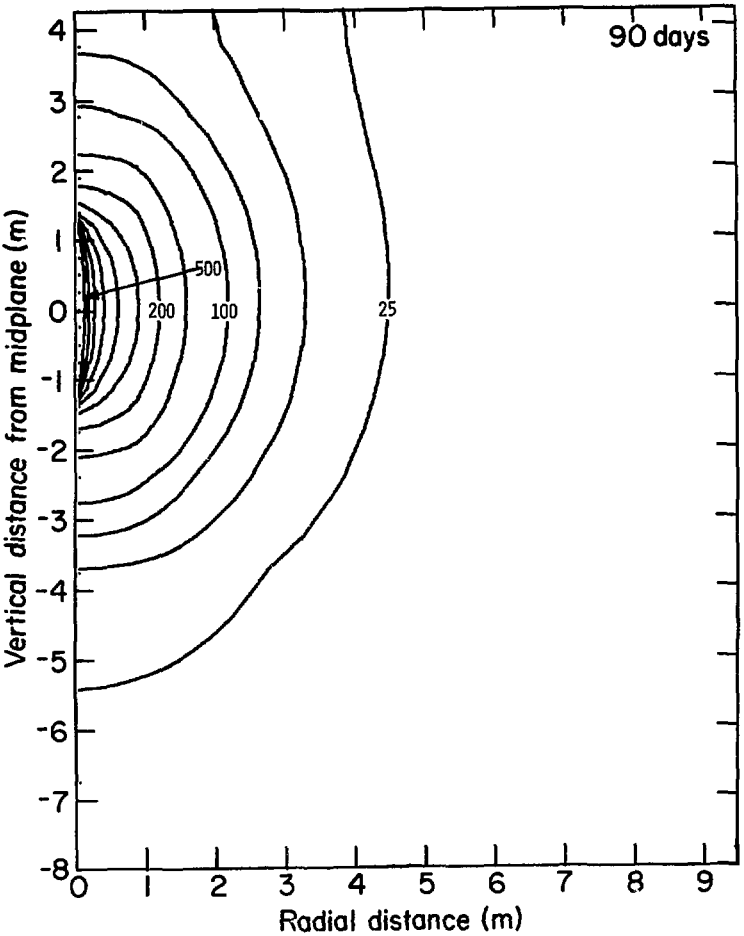
XBL 785-8507

Fig. 28b



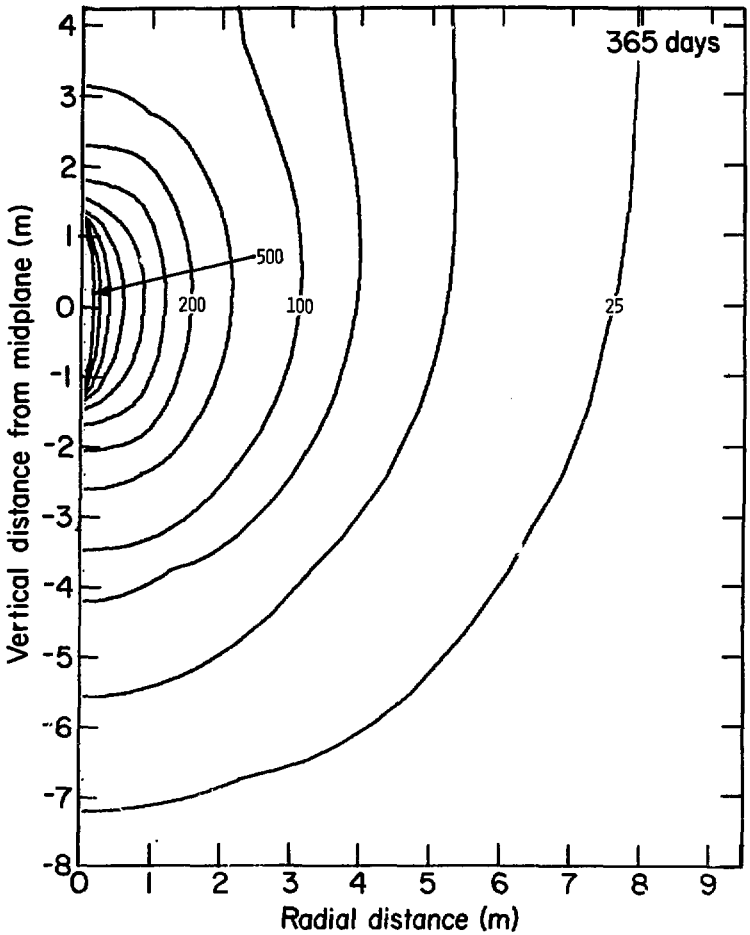
XBL 785-8508

Fig. 28c



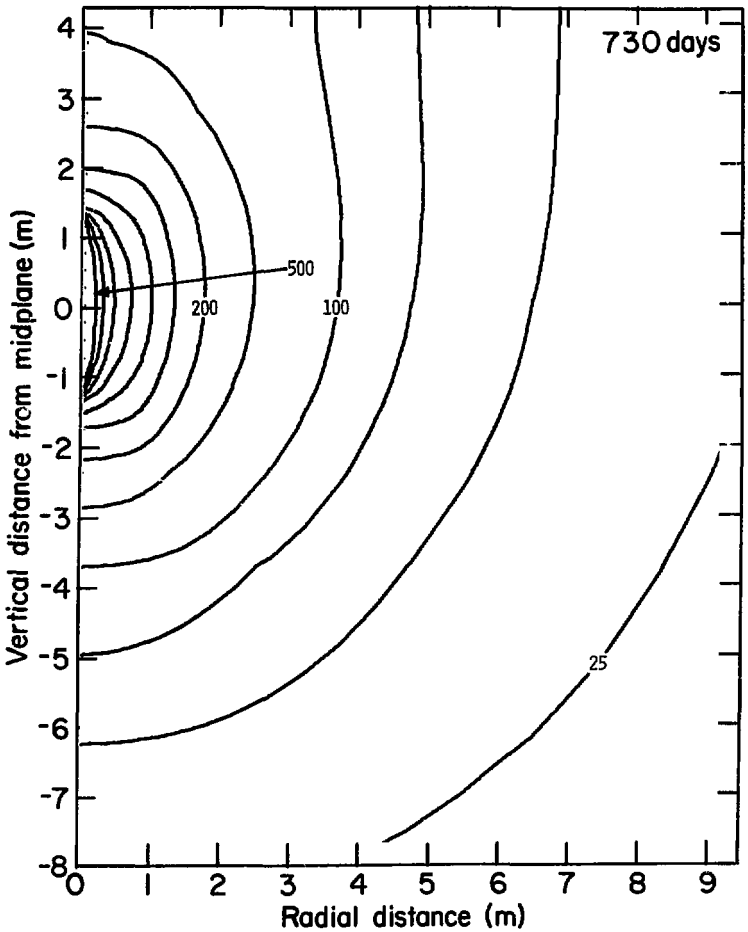
XBL 785-8509

Fig. 28d



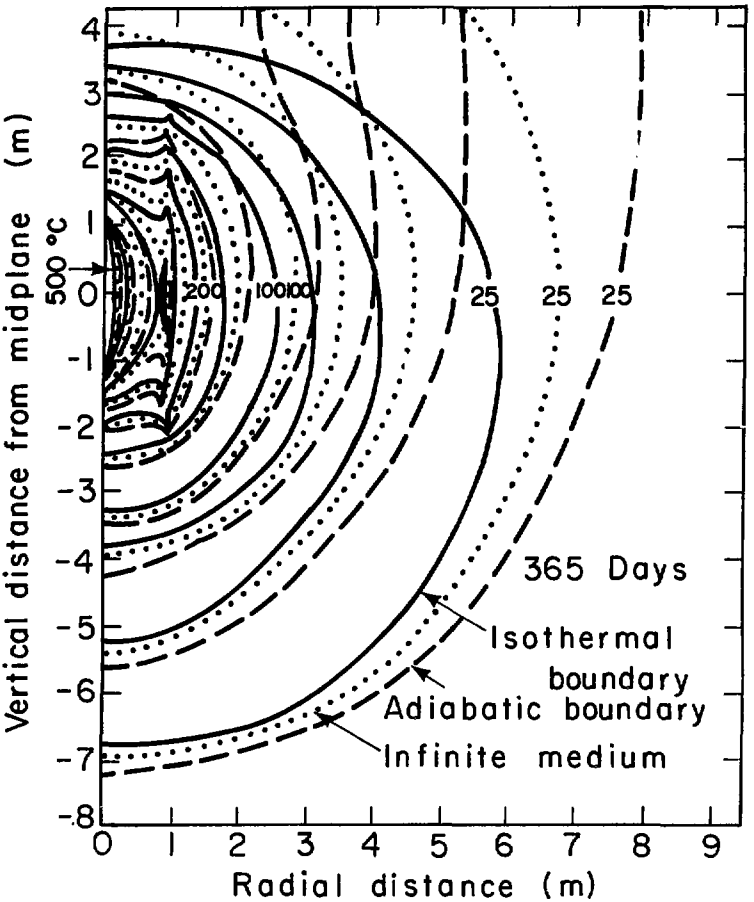
XBL 785-8510

Fig. 28e



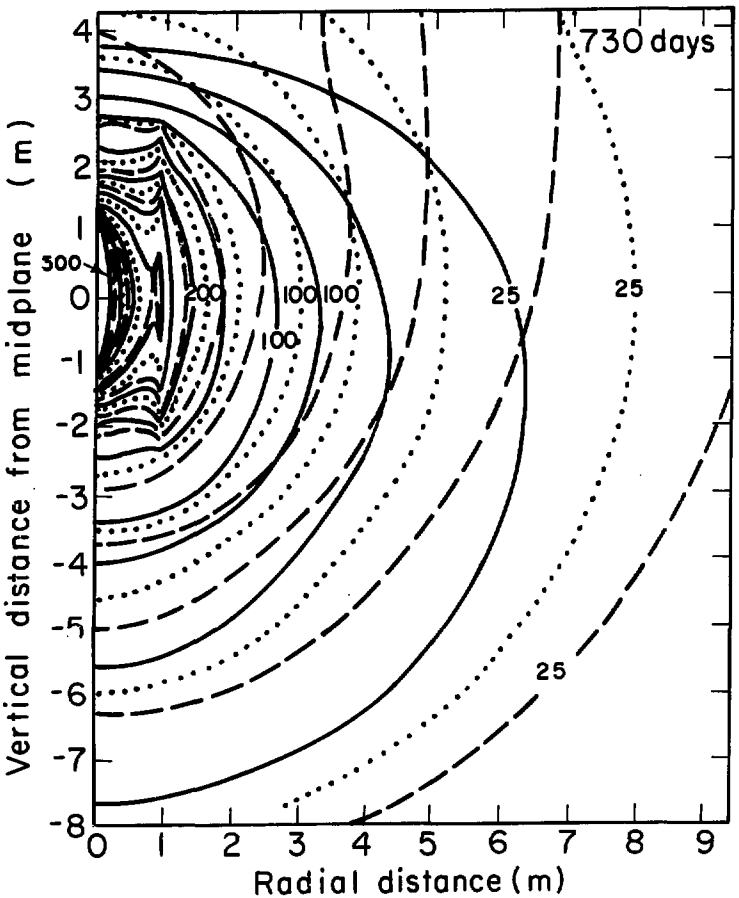
XBL 785-8511

Fig. 28f



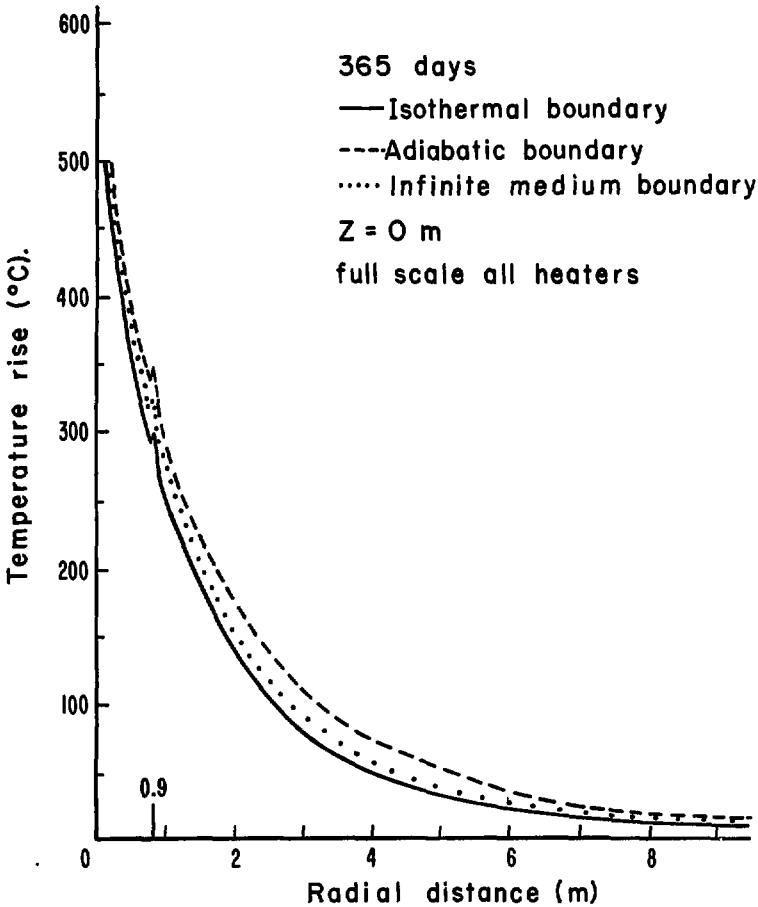
XBL786-1086

Fig. 29



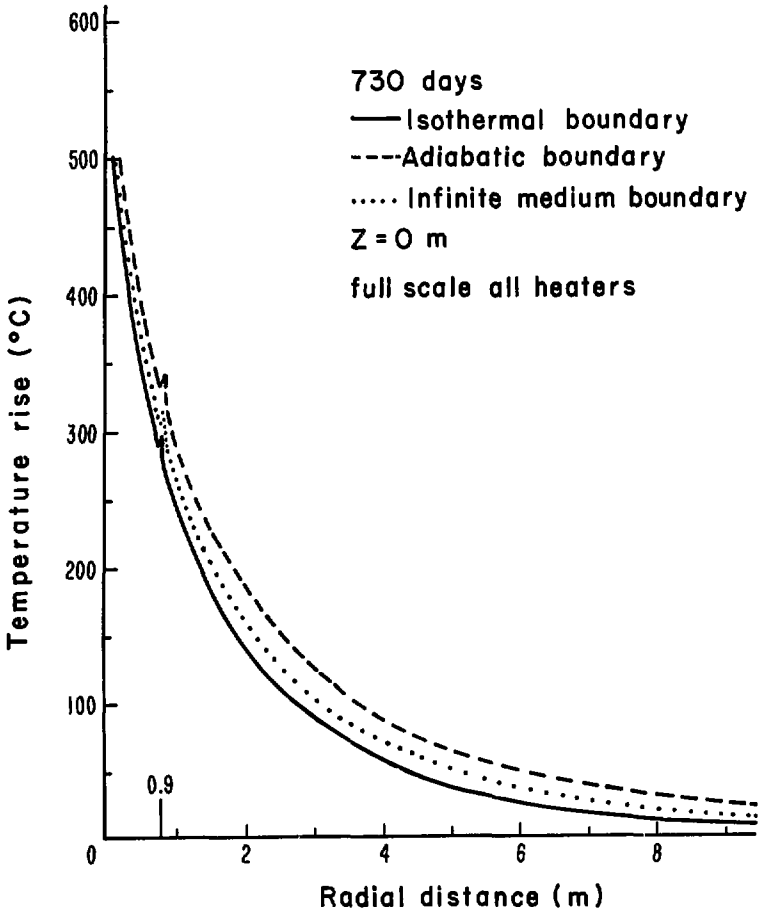
XBL786-1082

Fig. 30



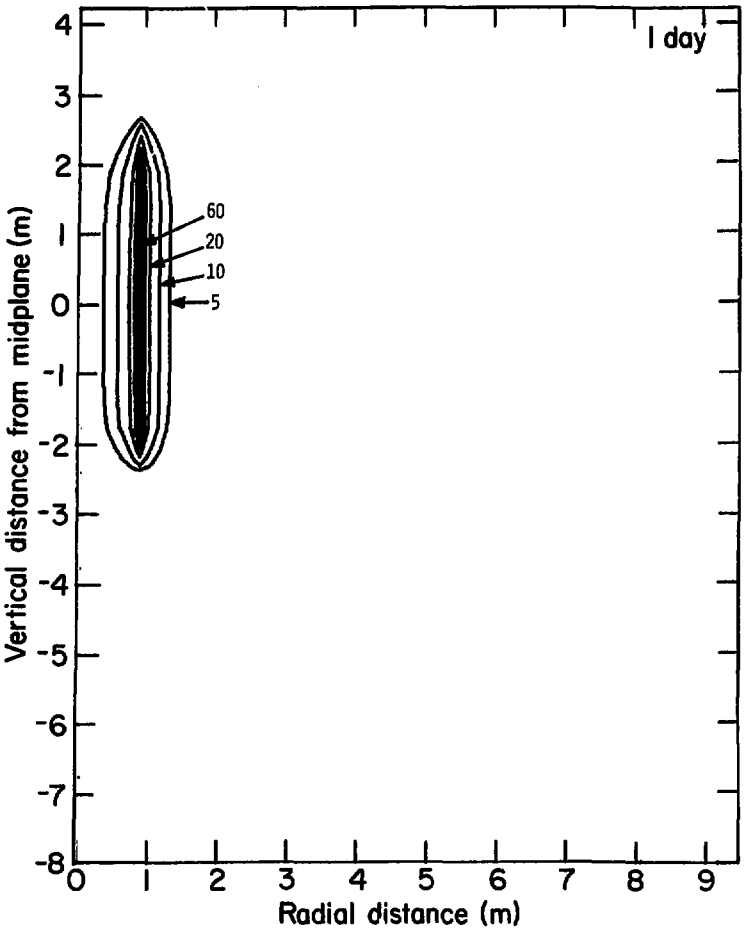
XBL 788-2024

Fig. 31a



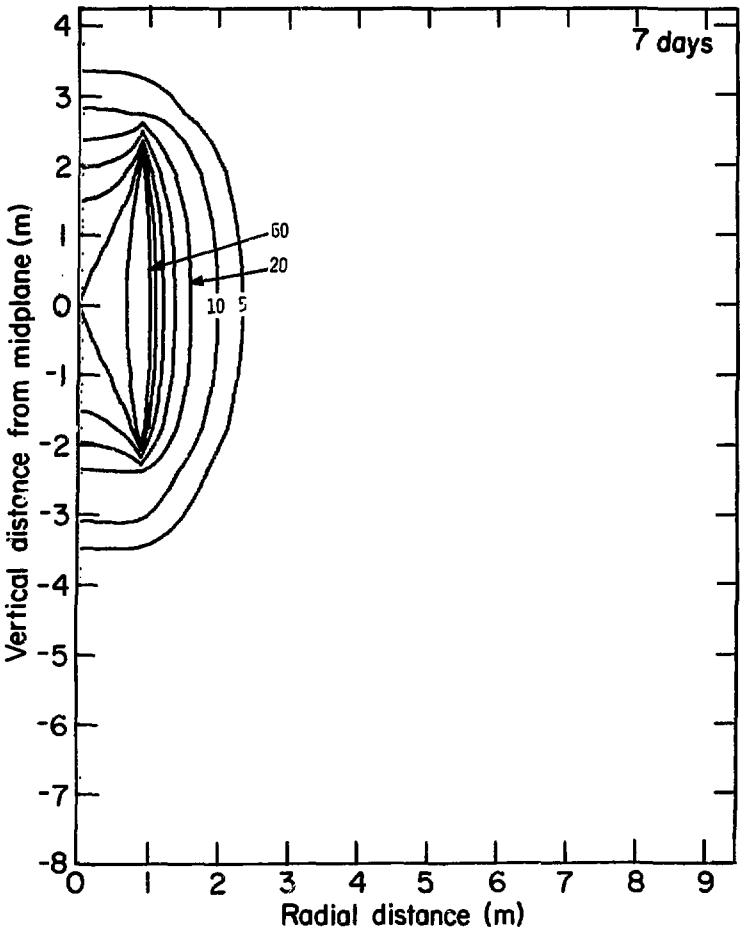
XBL 788-2023

Fig. 31b



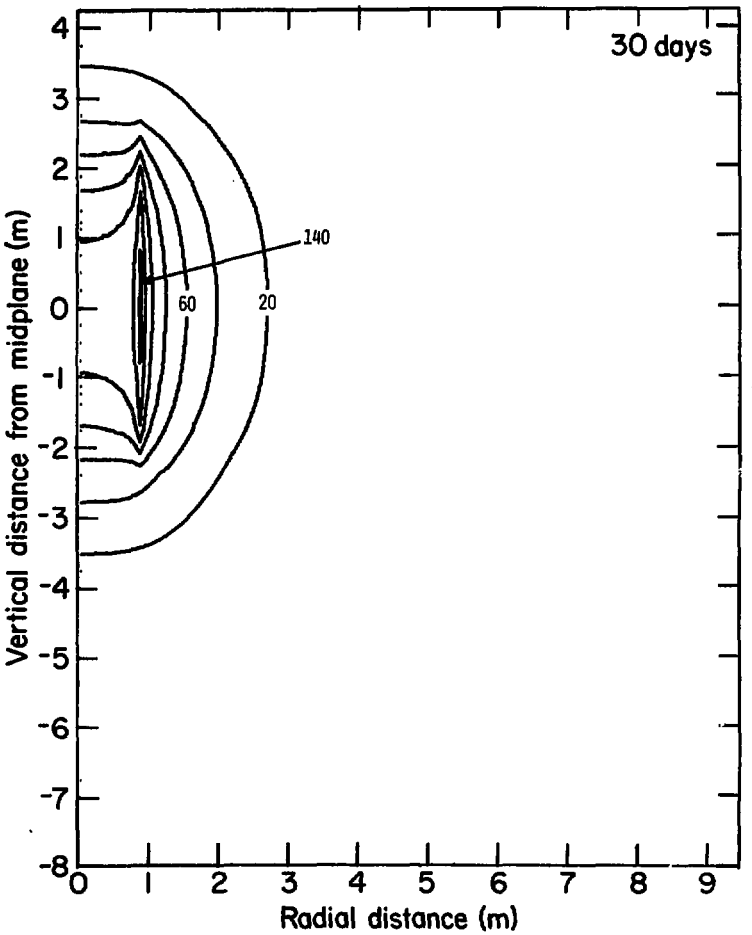
XBL 785-8465

Fig. 32a



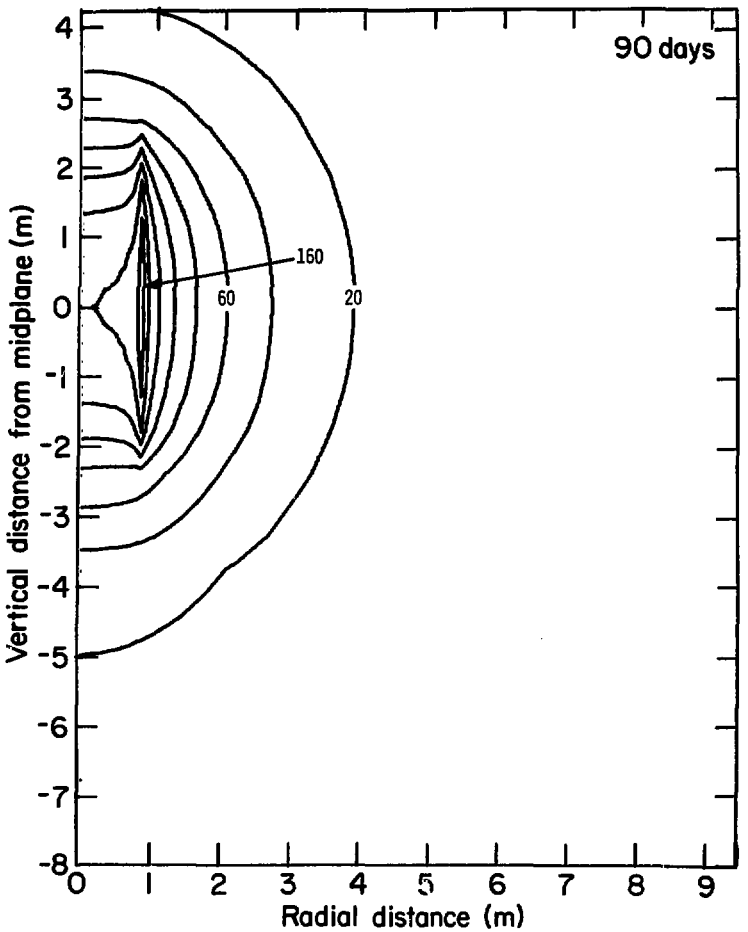
XBL 785-8466

Fig. 32b



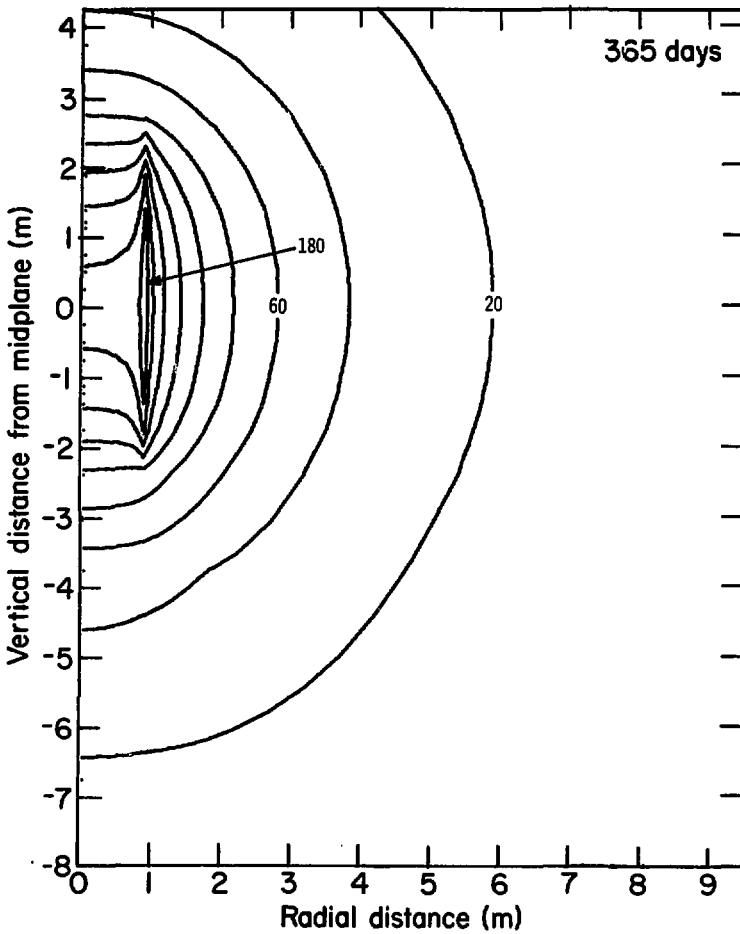
XBL 785-8467

Fig. 32c



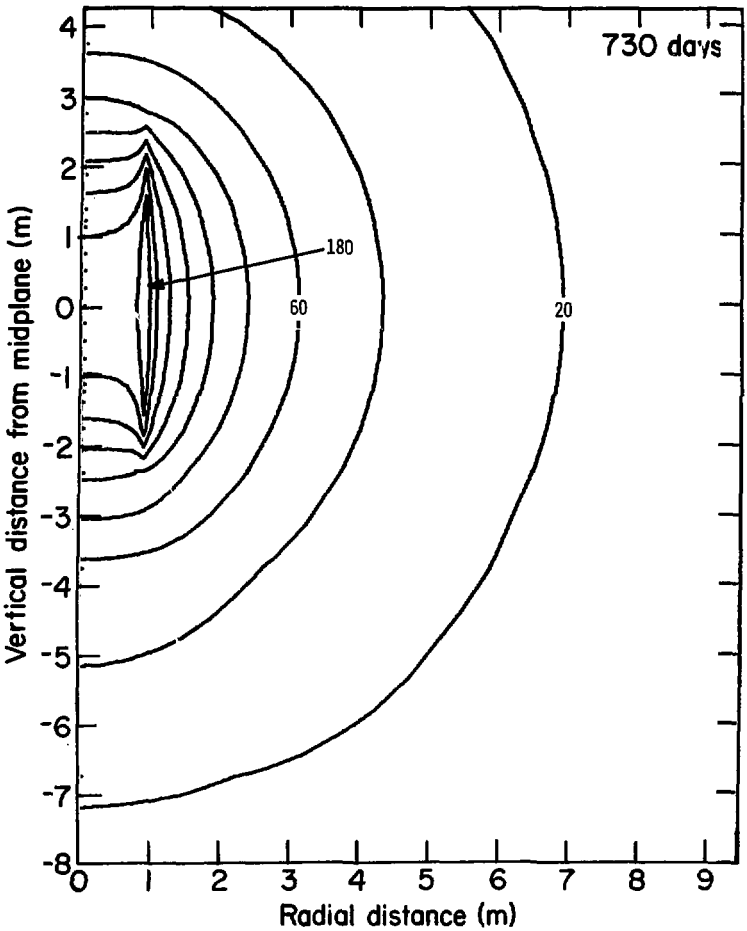
XBL 785-8468

Fig. 32d



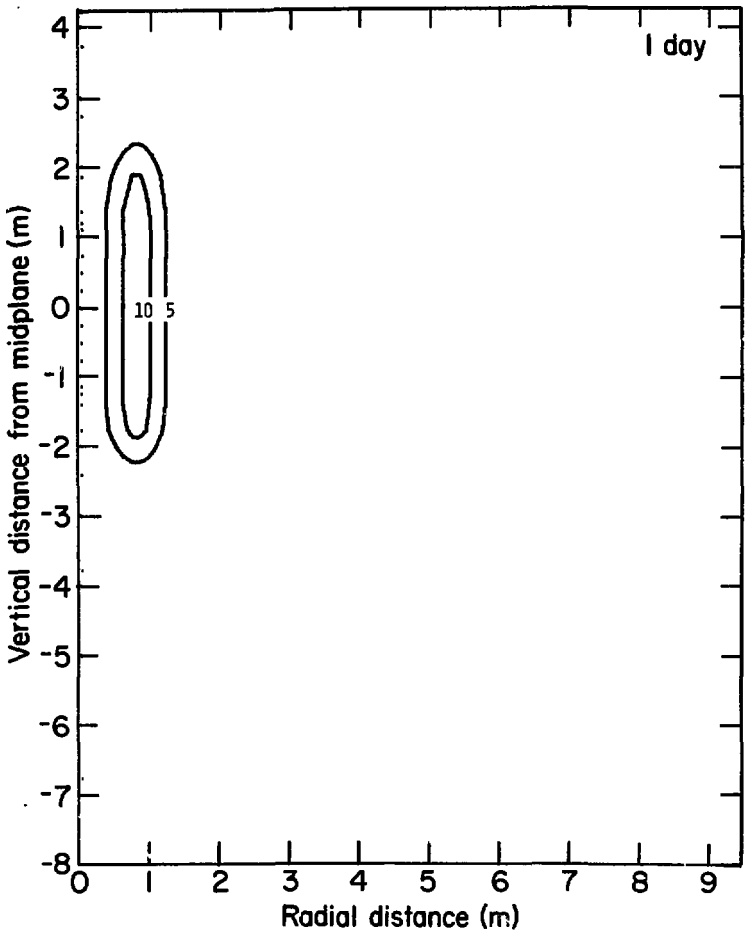
XBL 785-8469

Fig. 32e



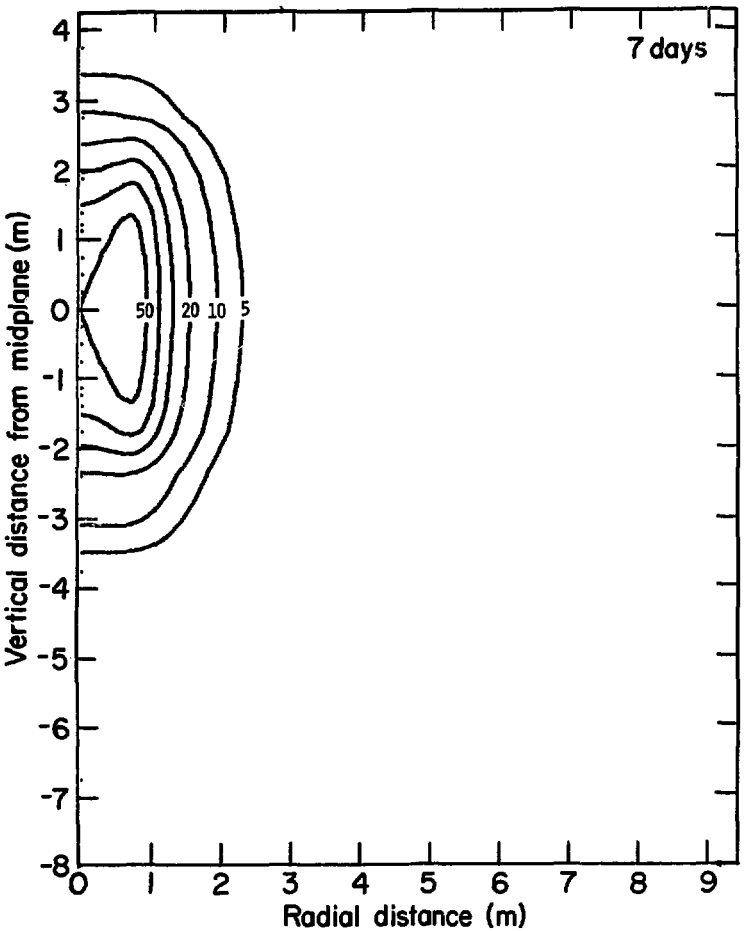
XBL 785-8470

Fig. 32f



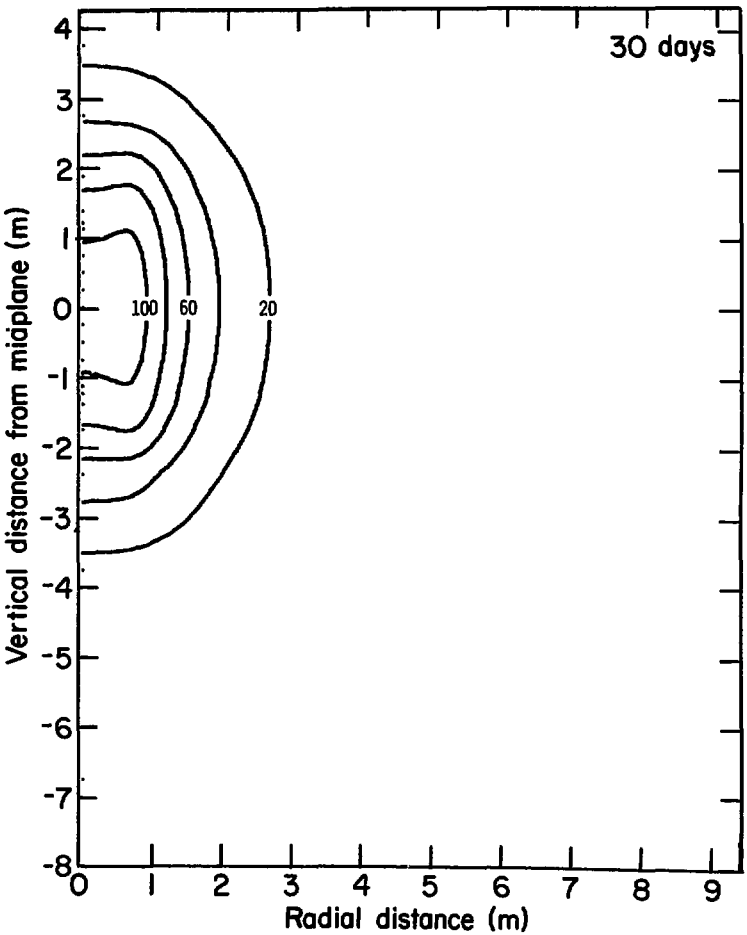
XBL 785-8471

Fig. 33a



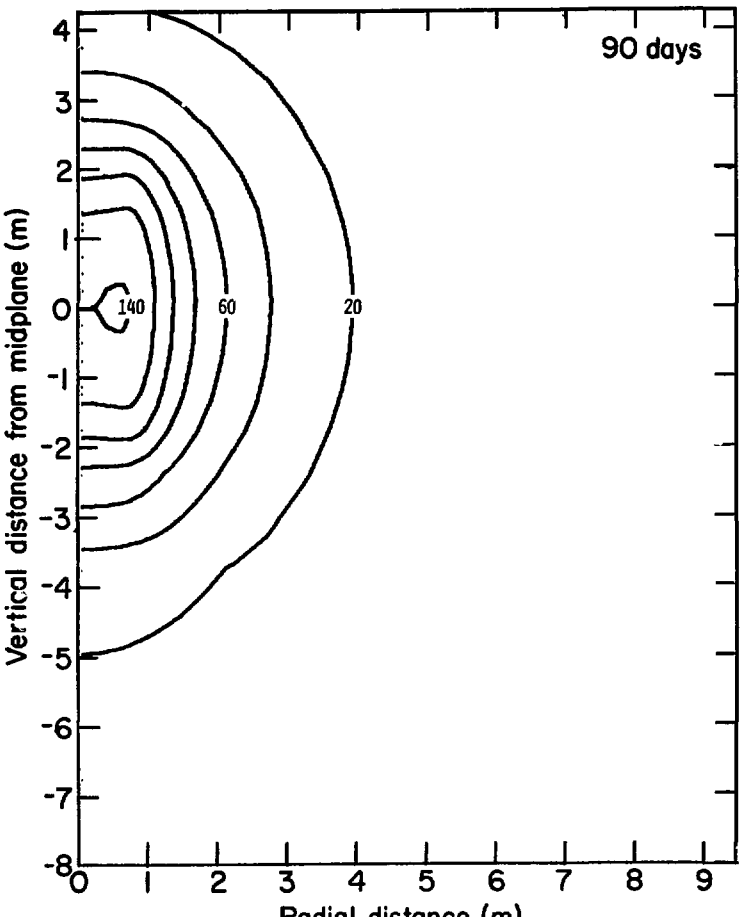
XBL 785-8472

Fig. 33b



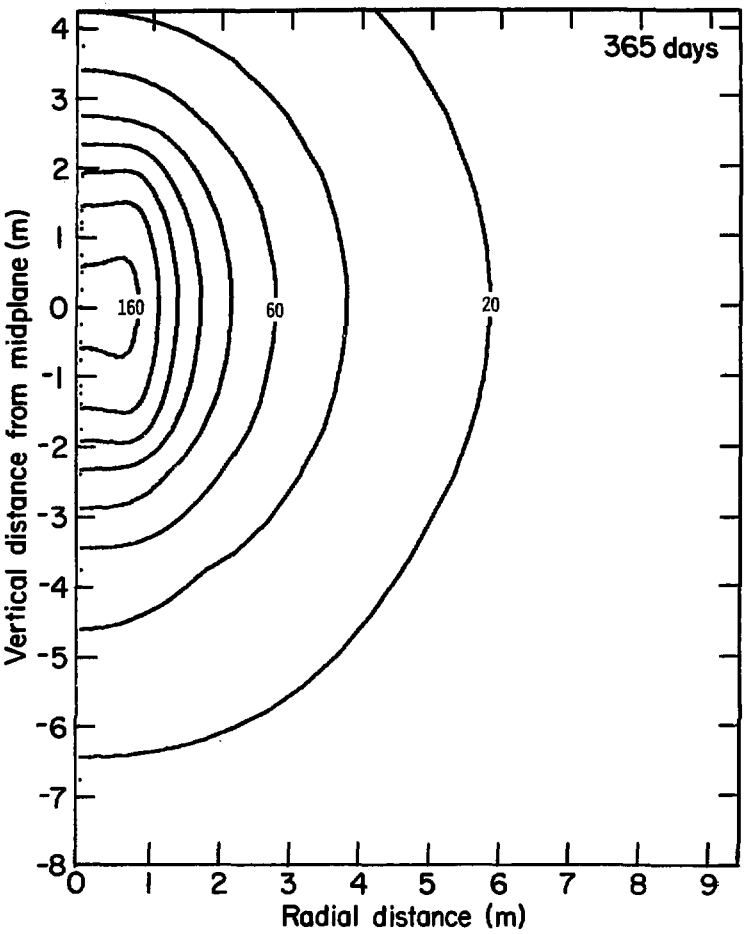
XBL 785-8473

Fig. 33c



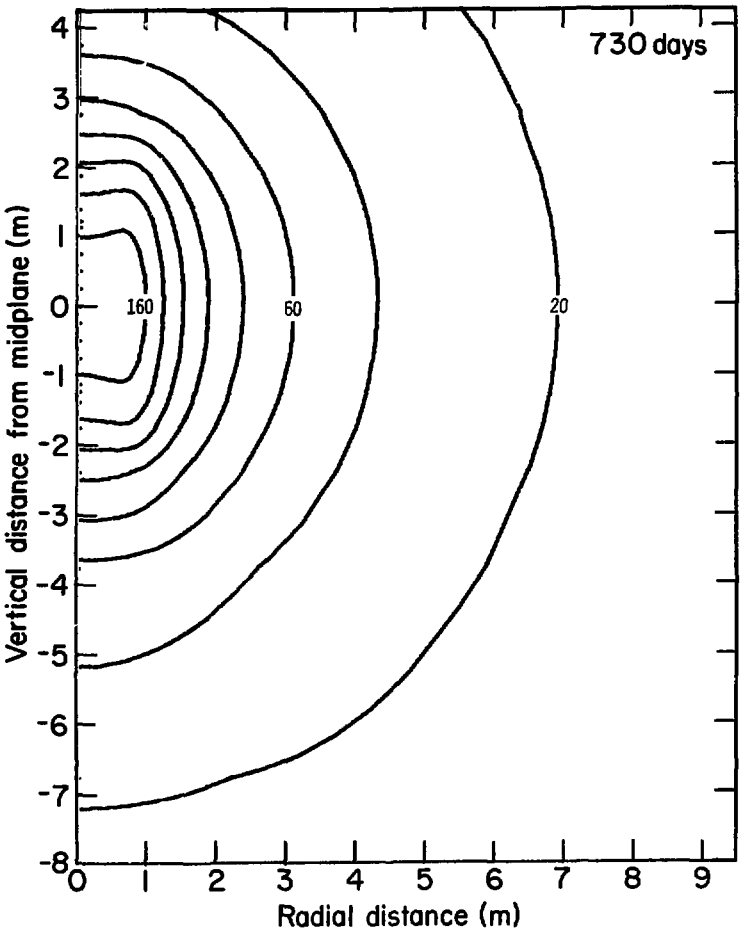
XBL 785-8474

Fig. 33d



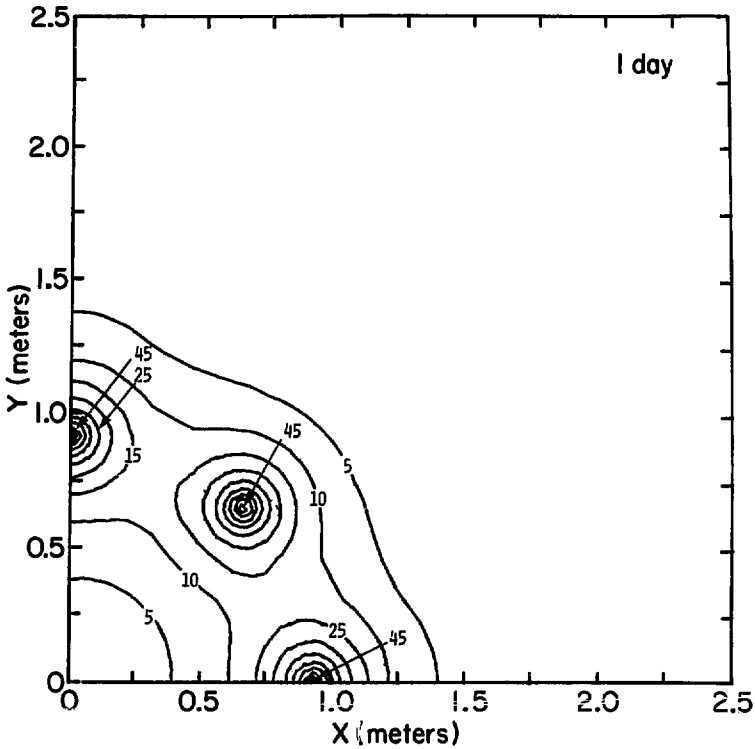
XBL 785-8475

Fig. 33e



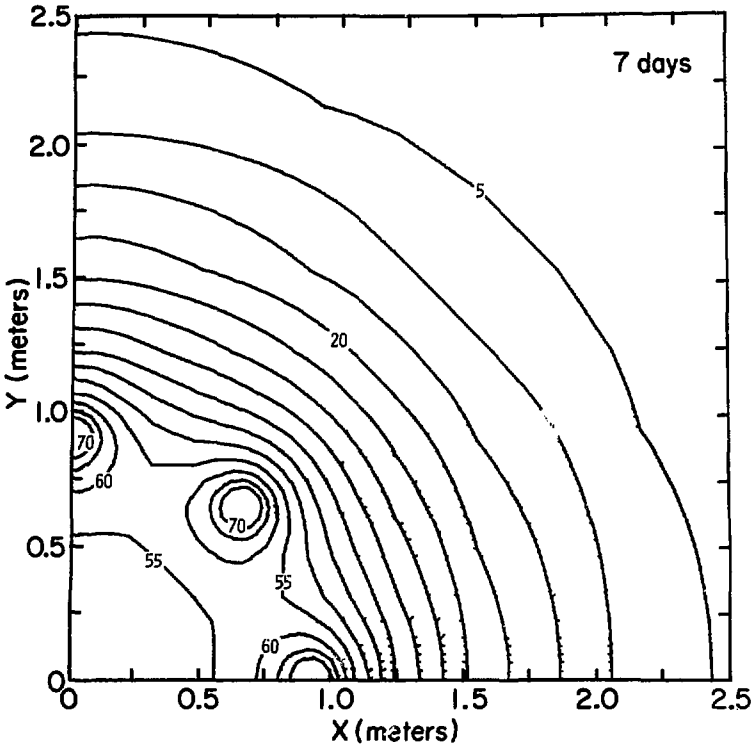
XBL 785-8476

Fig. 33f



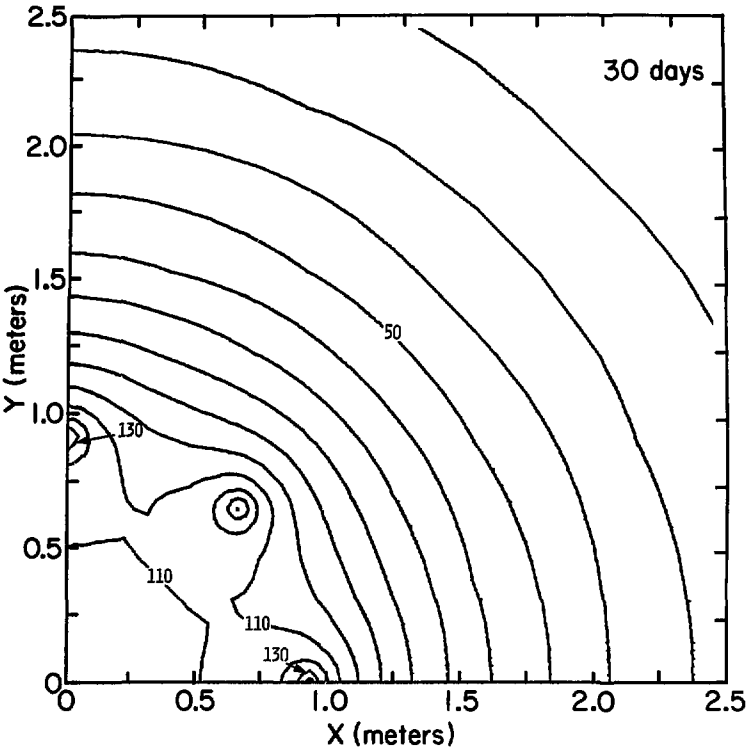
XBL 785-8483

Fig. 34a



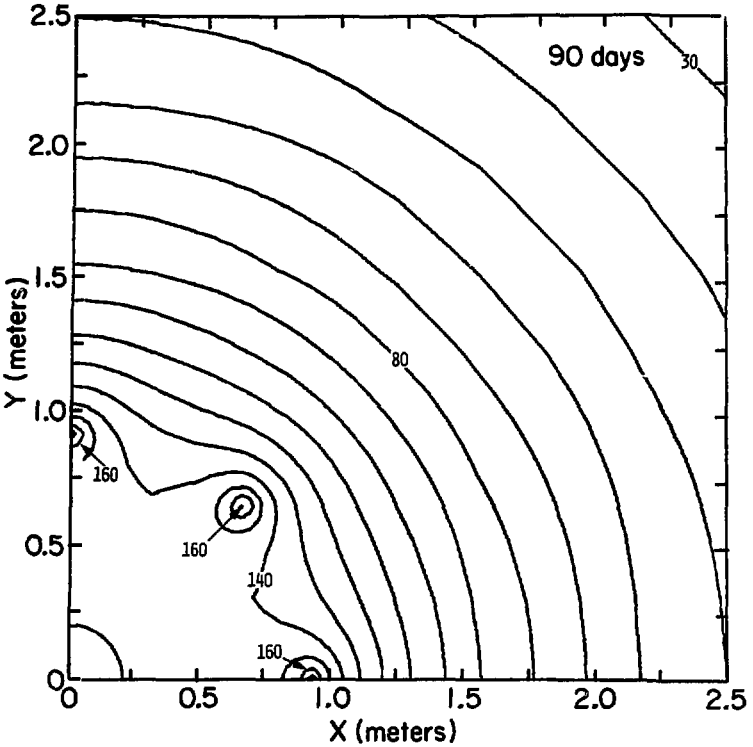
XBL 785-8484

Fig. 34b



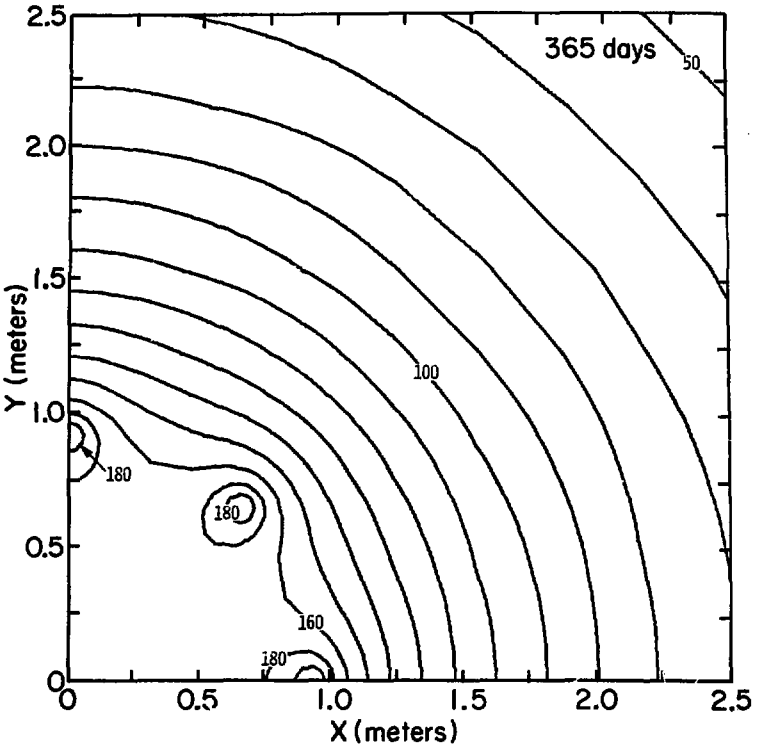
XBL 785-8485

Fig. 34c



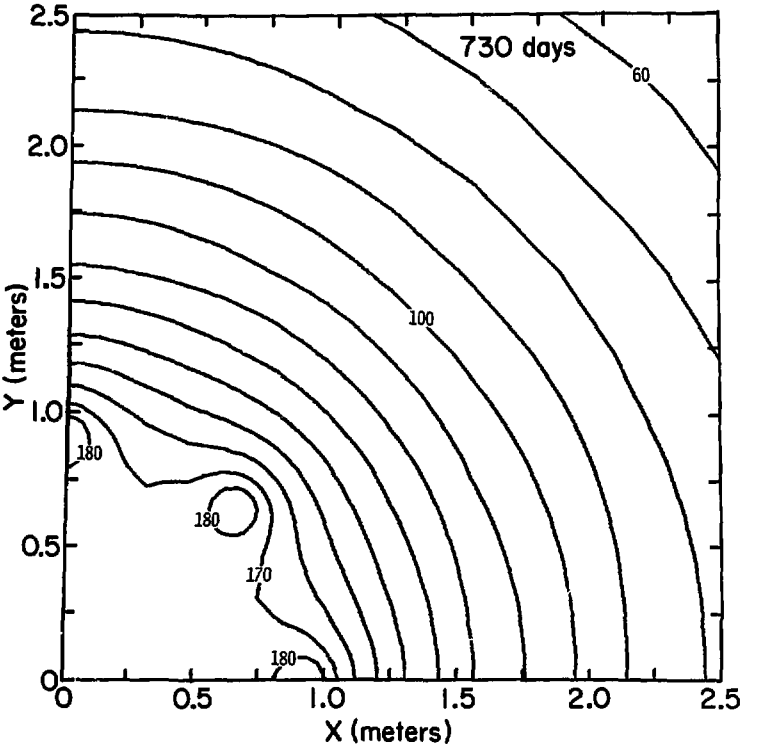
XBL 785-8486

Fig. 34d



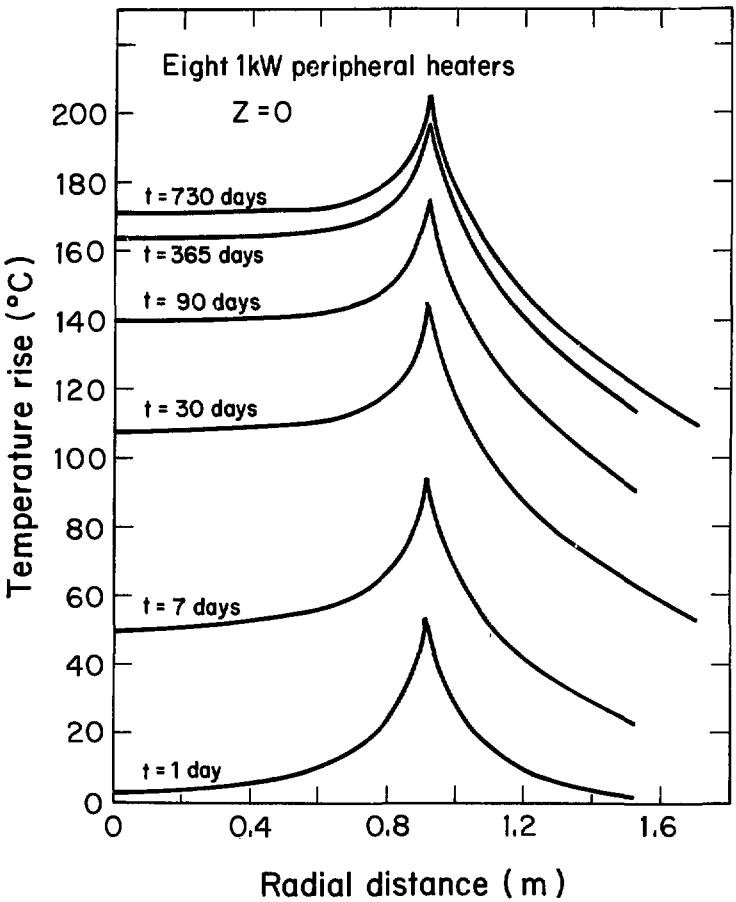
XBL 785-8487

Fig. 34e



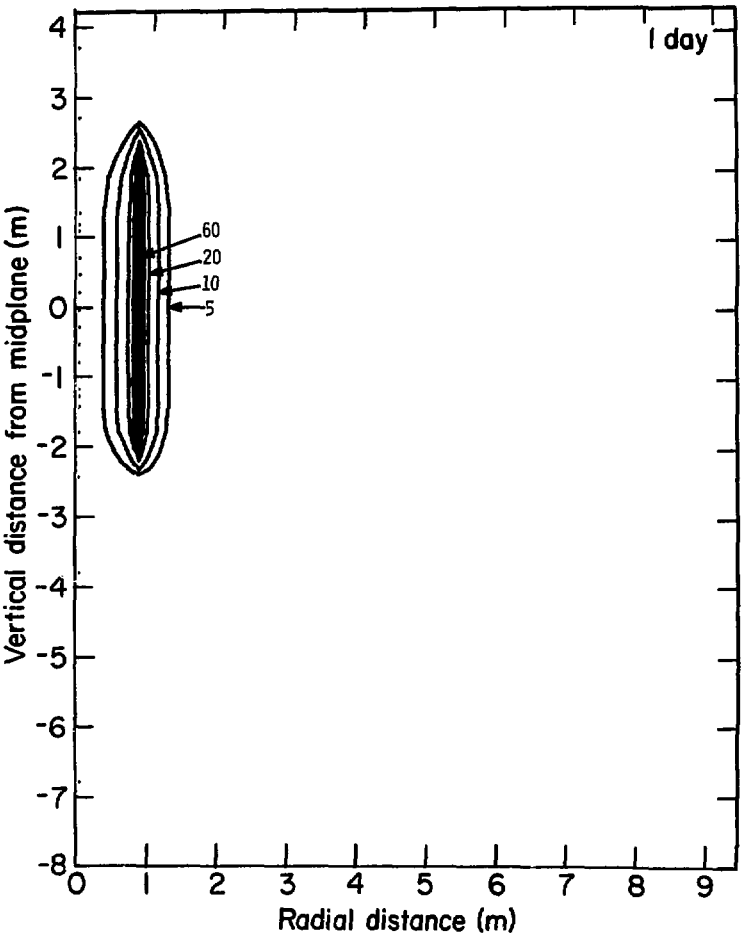
XBL 785-8488

Fig. 34f



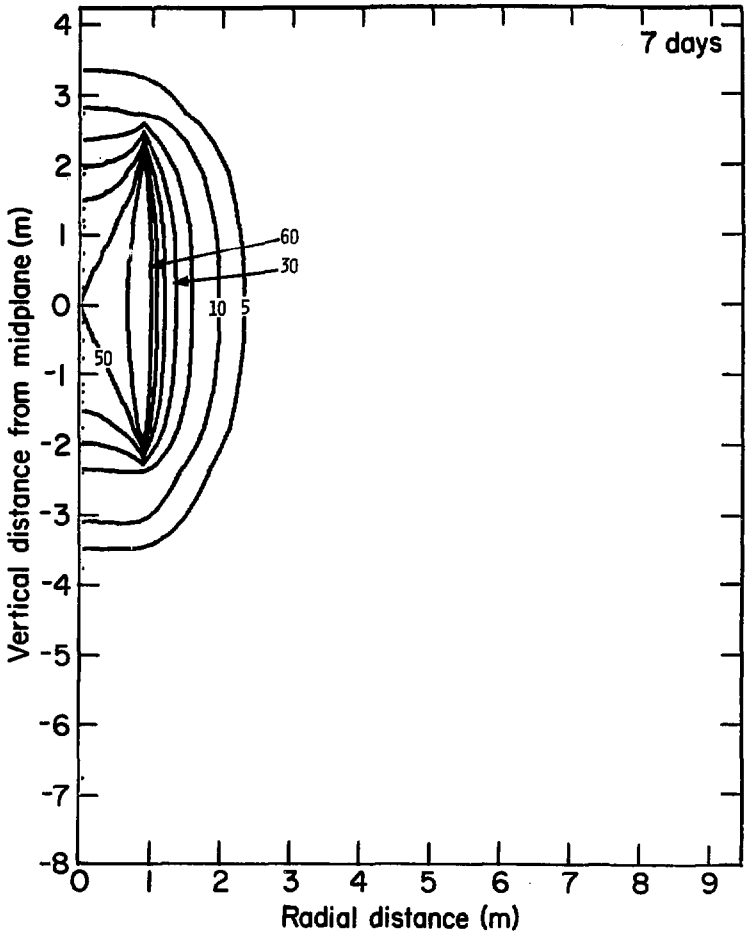
XBL 781-229

Fig. 35



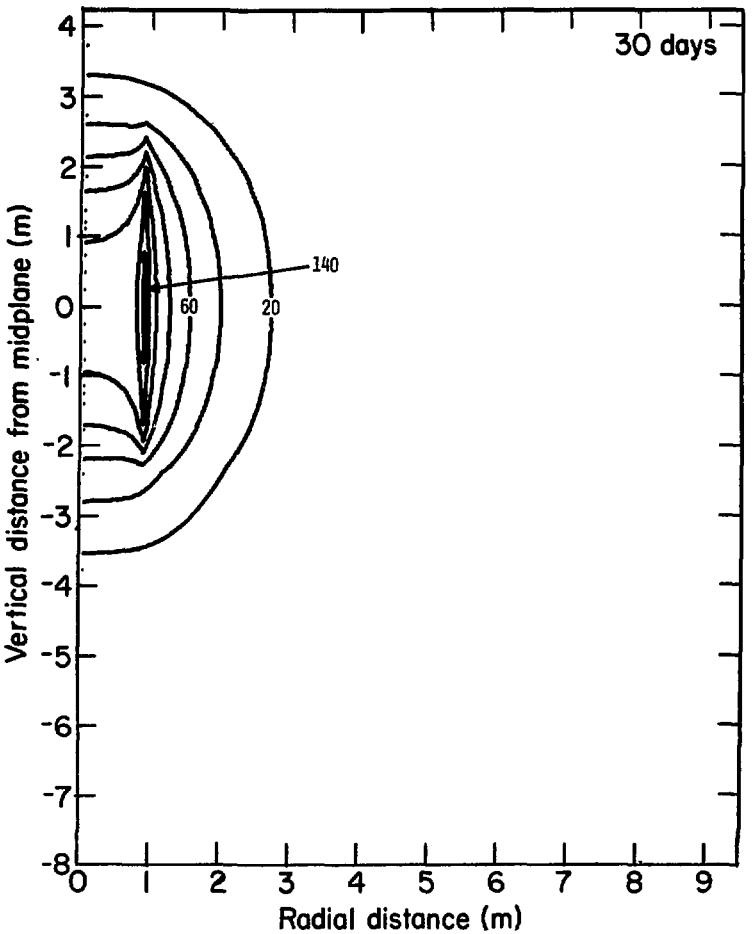
XBL 785-8512

Fig. 36a



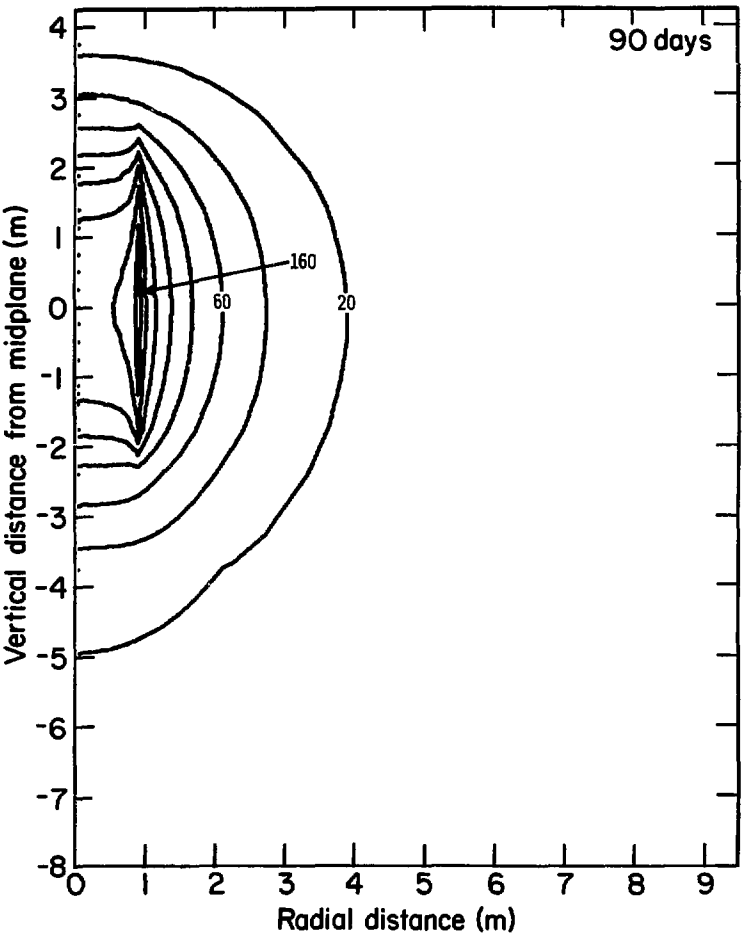
XBL 785-8513

Fig. 36b



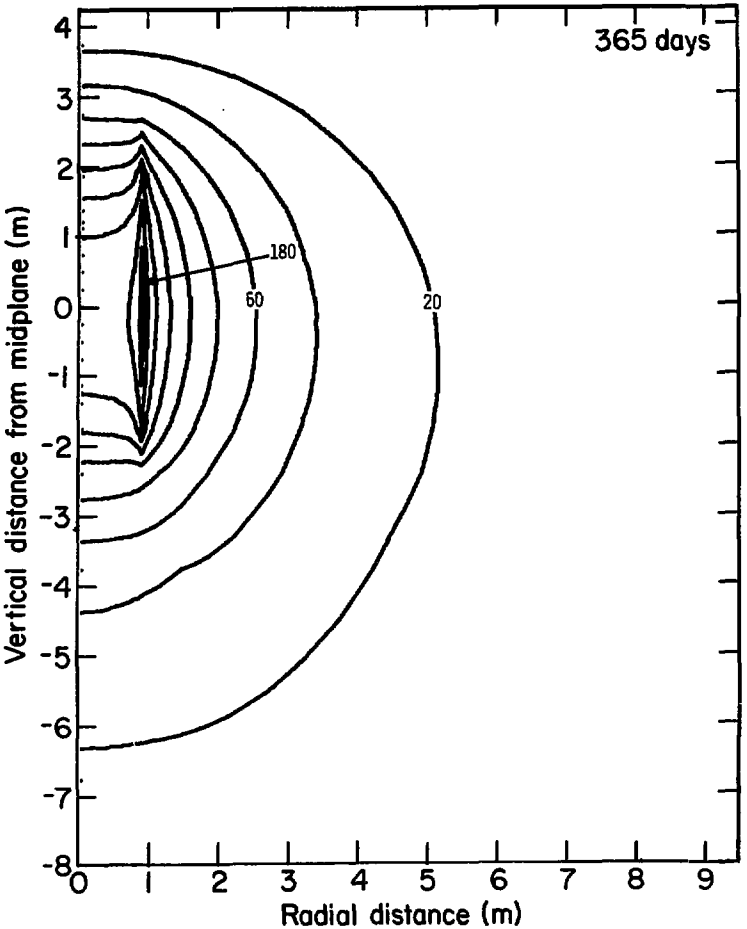
XBL 785-8514

Fig. 36c



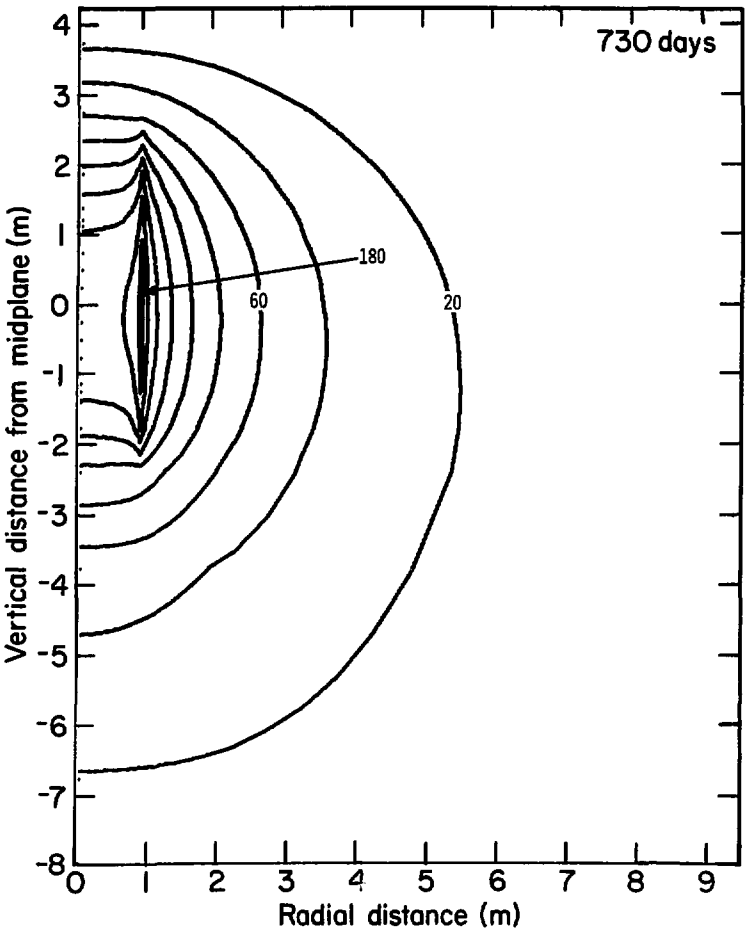
XBL 785-8515

Fig. 36d



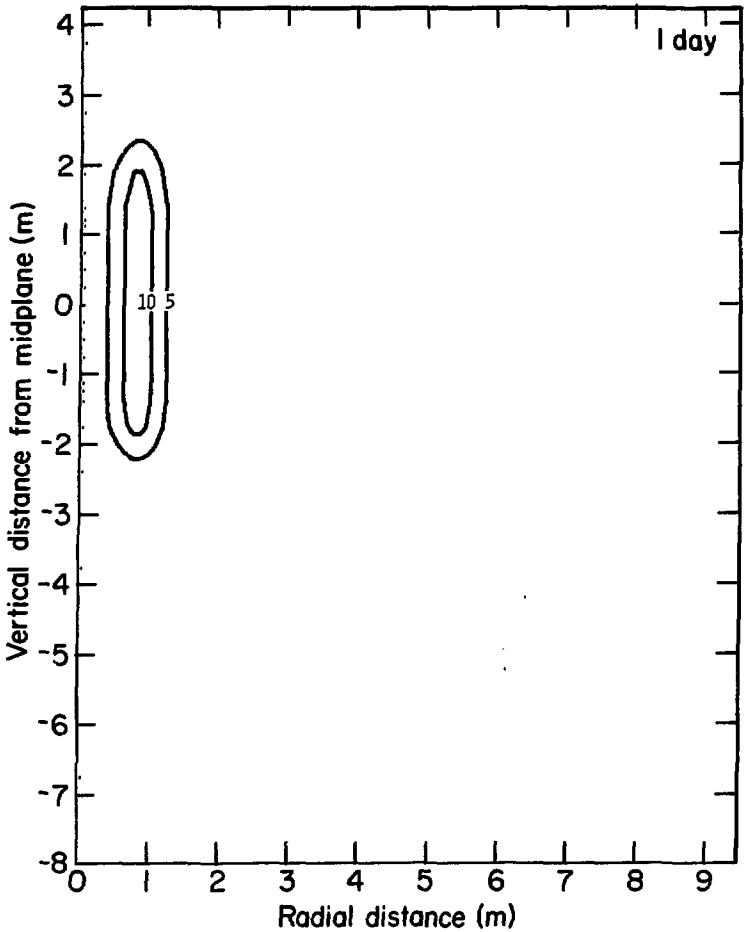
XBL 785-8516

Fig. 36e



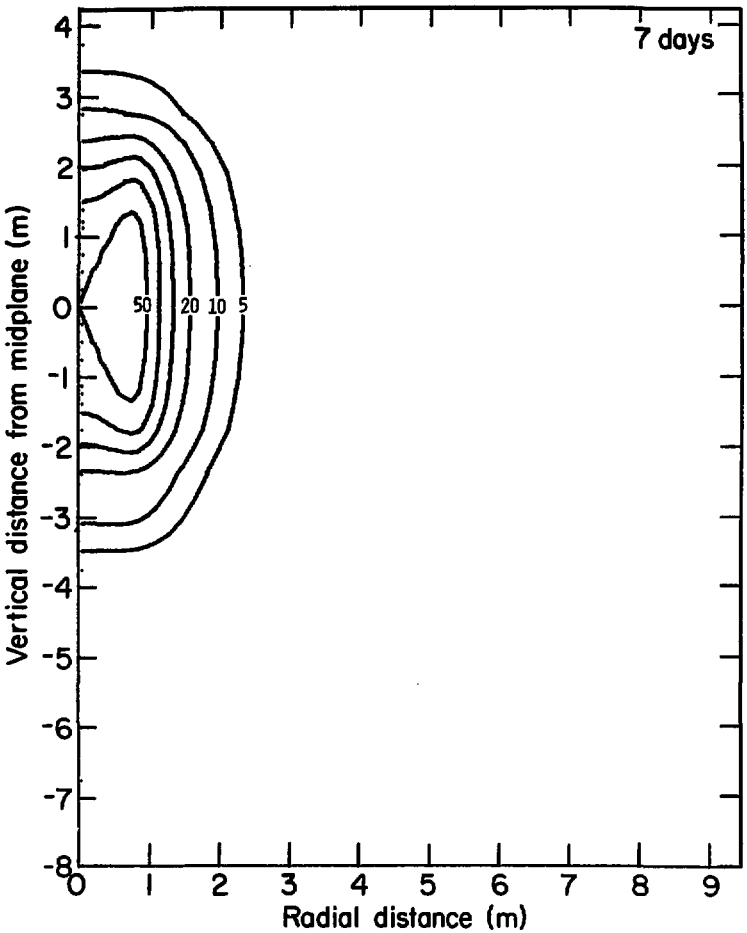
XBL 785-8517

Fig. 36f



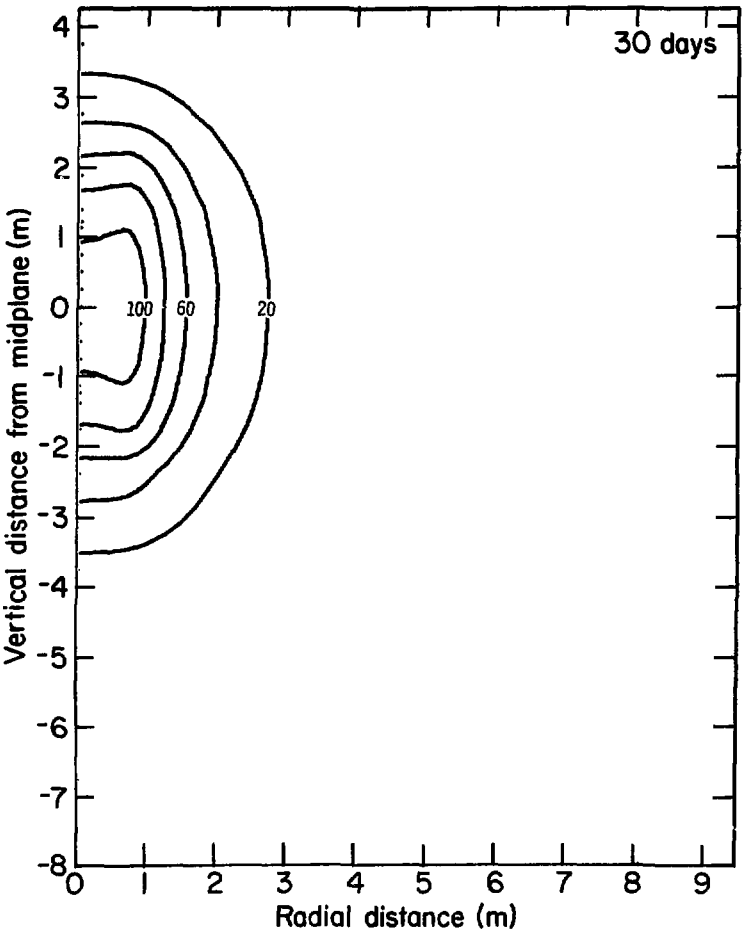
XBL 785-8523

Fig. 37a



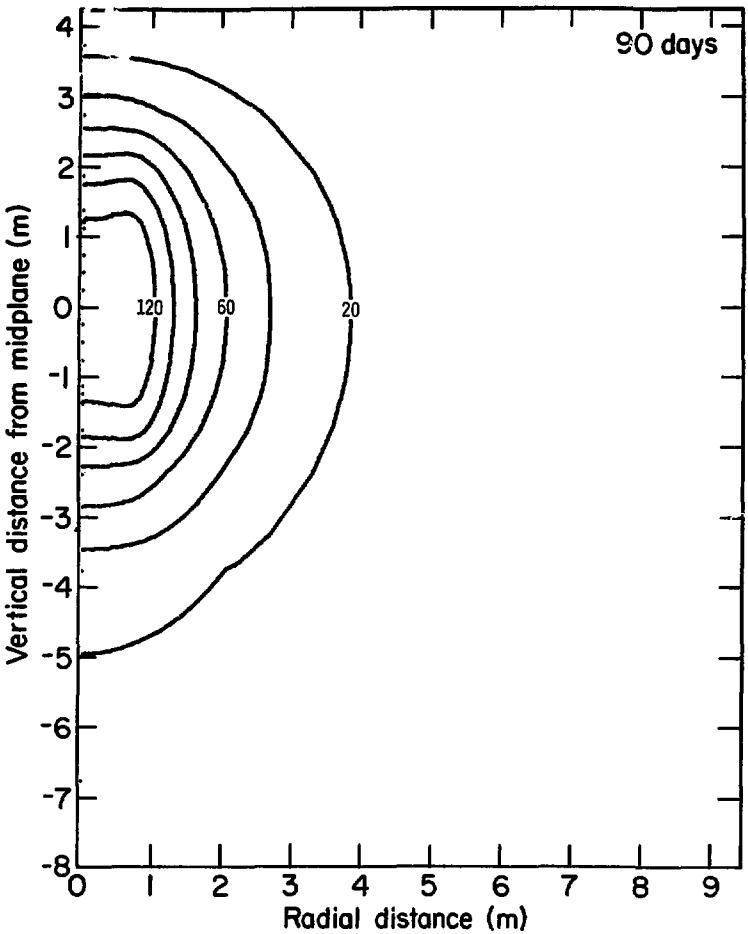
XBL 785-8524

Fig. 37b



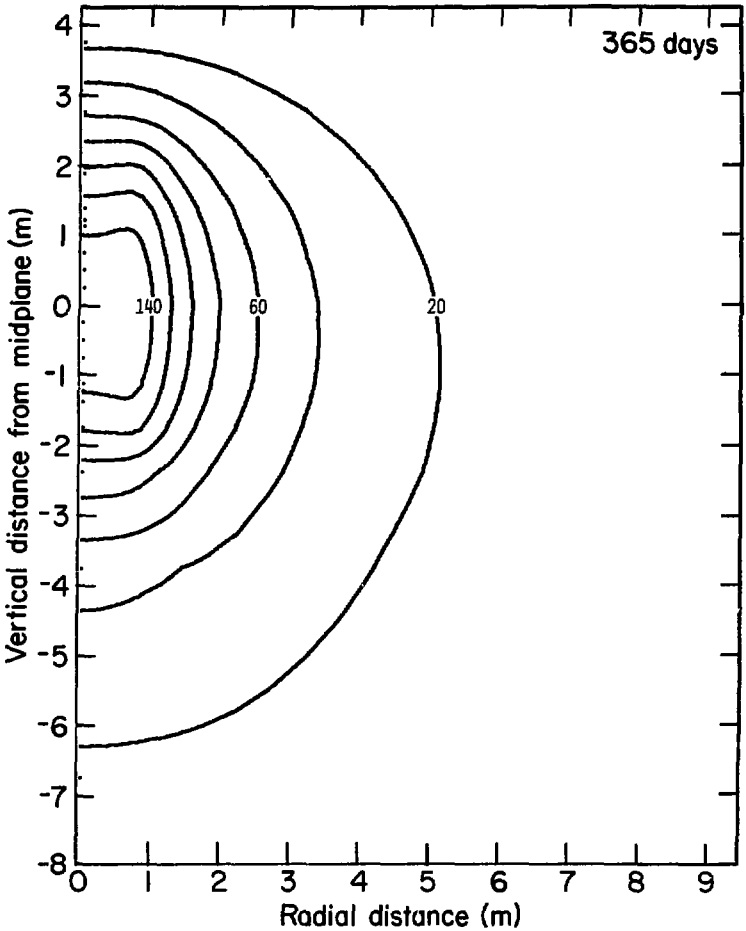
XBL 785-8525

Fig. 37c



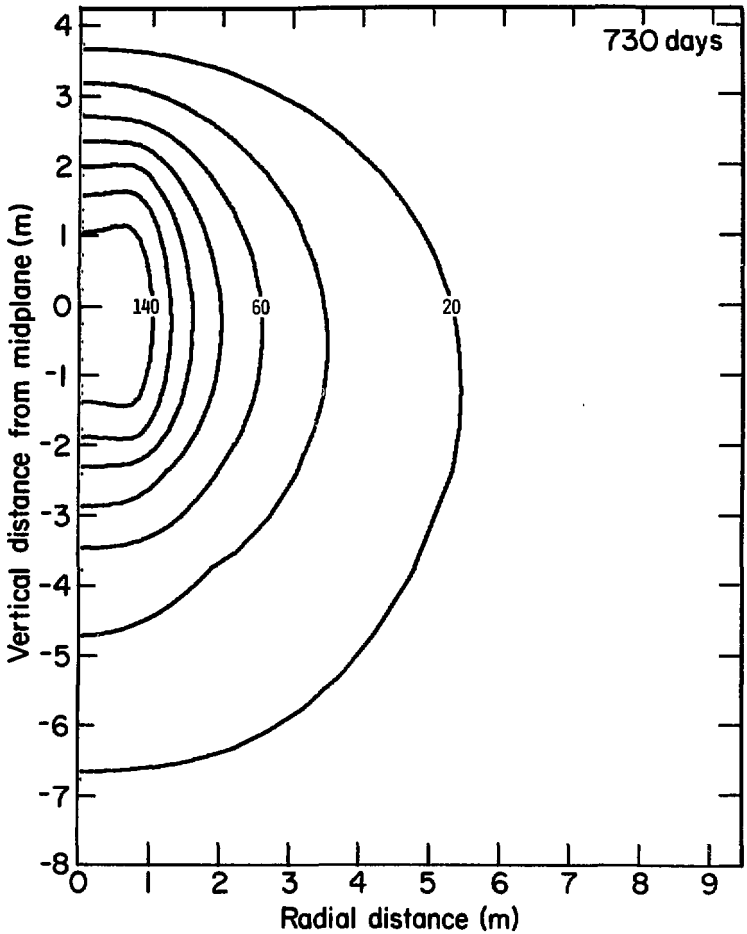
XBL 785-8526

Fig. 37d



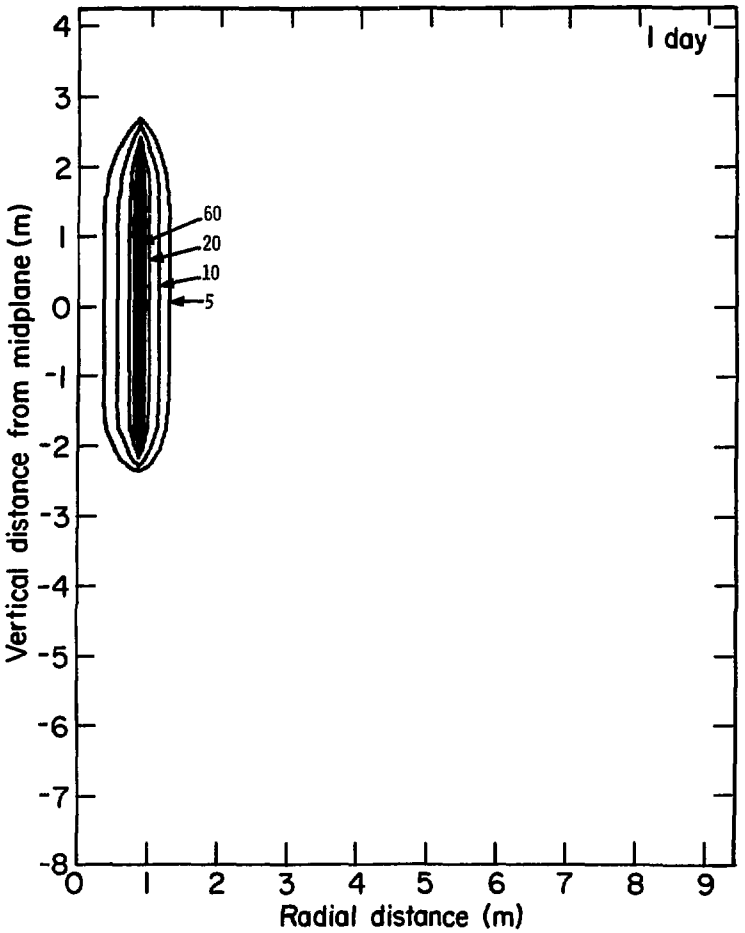
XBL 785-8527

Fig. 37e



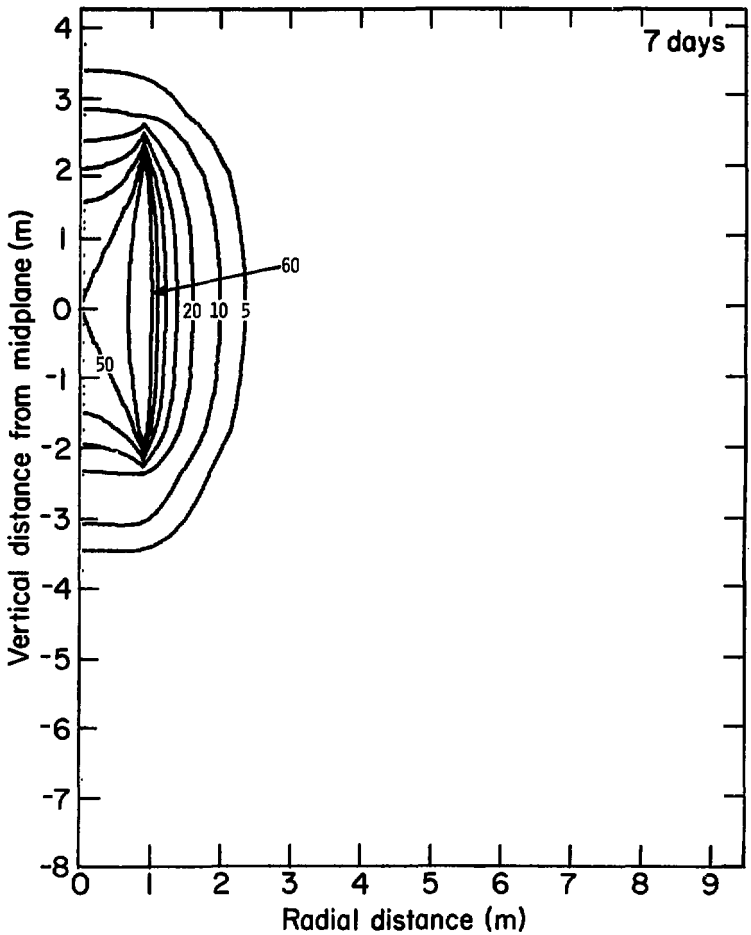
XBL 785-8528

Fig. 37f



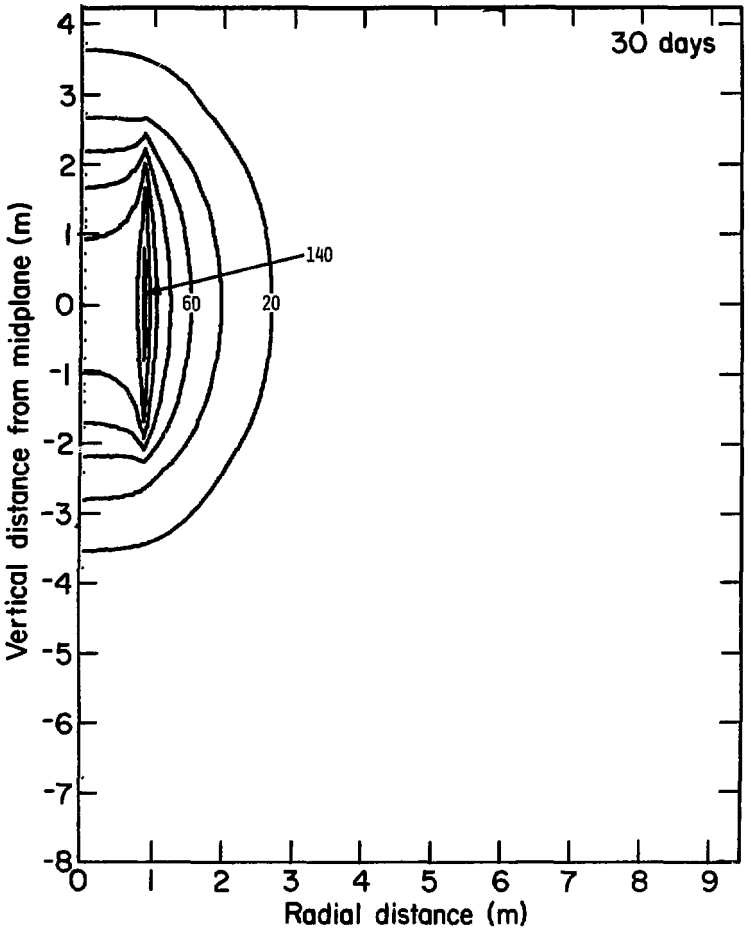
XBL 785-8518

Fig. 38a



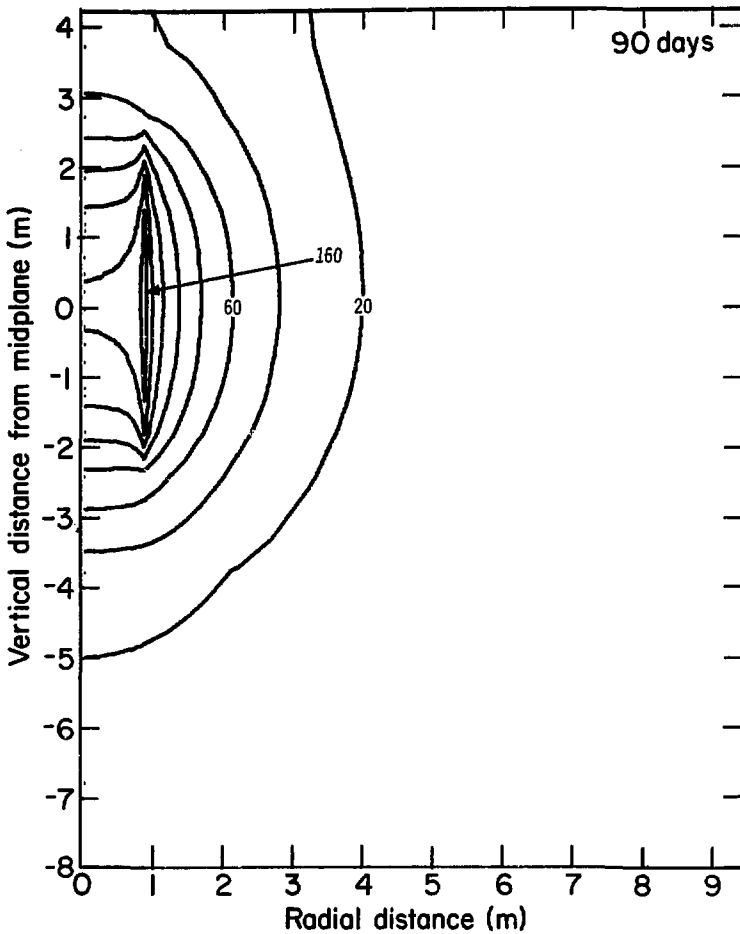
XBL 785-8519

Fig. 38b



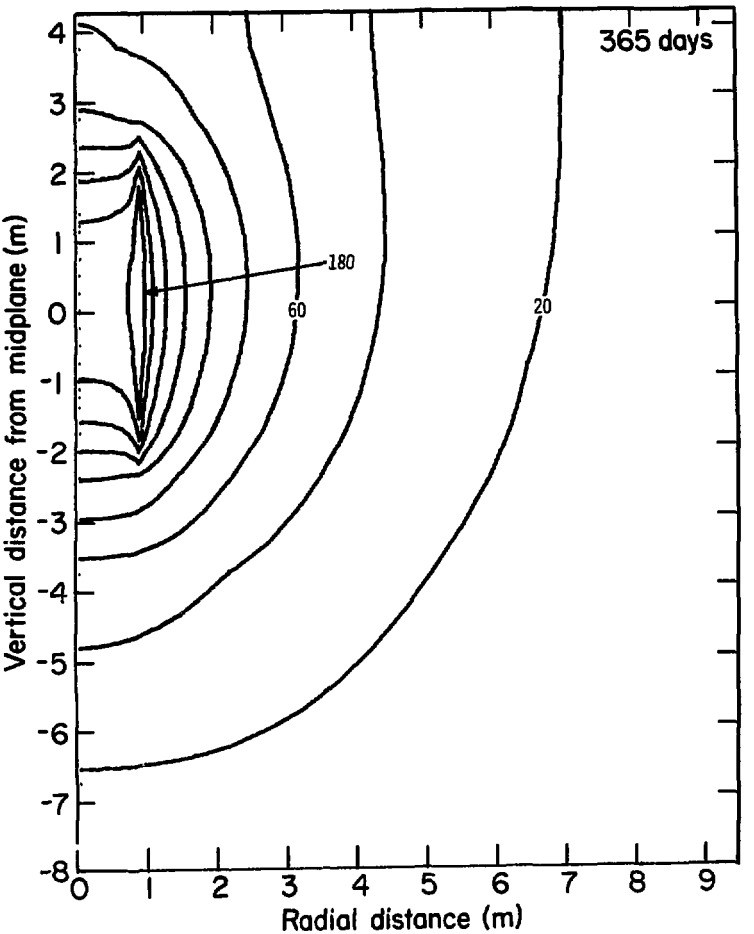
XBL 783-7742

Fig. 38c



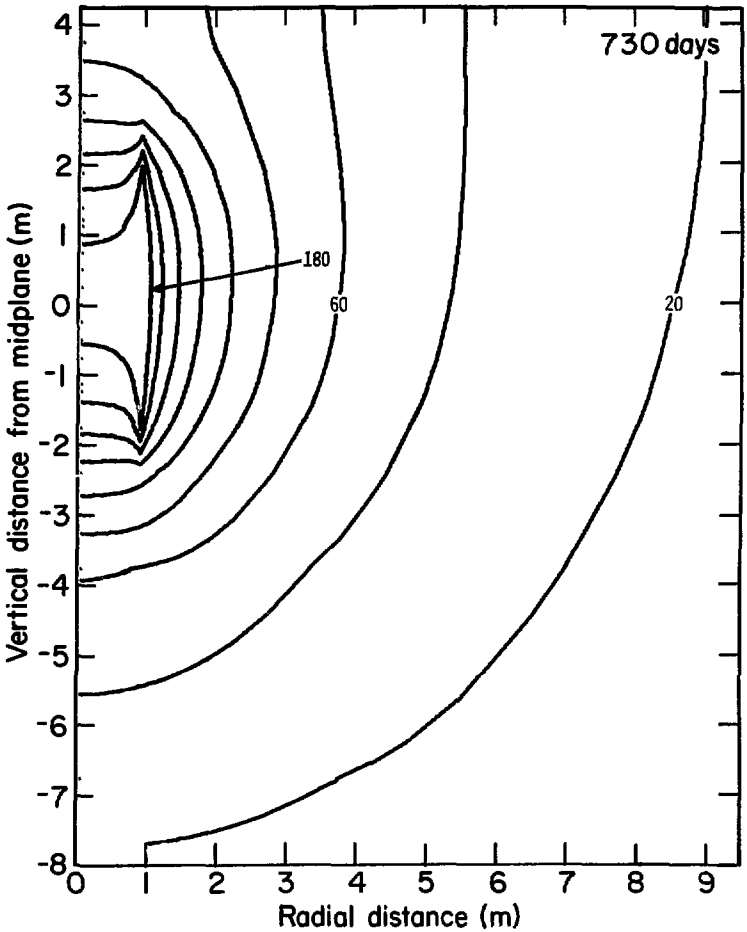
XBL 785-8520

Fig. 38d



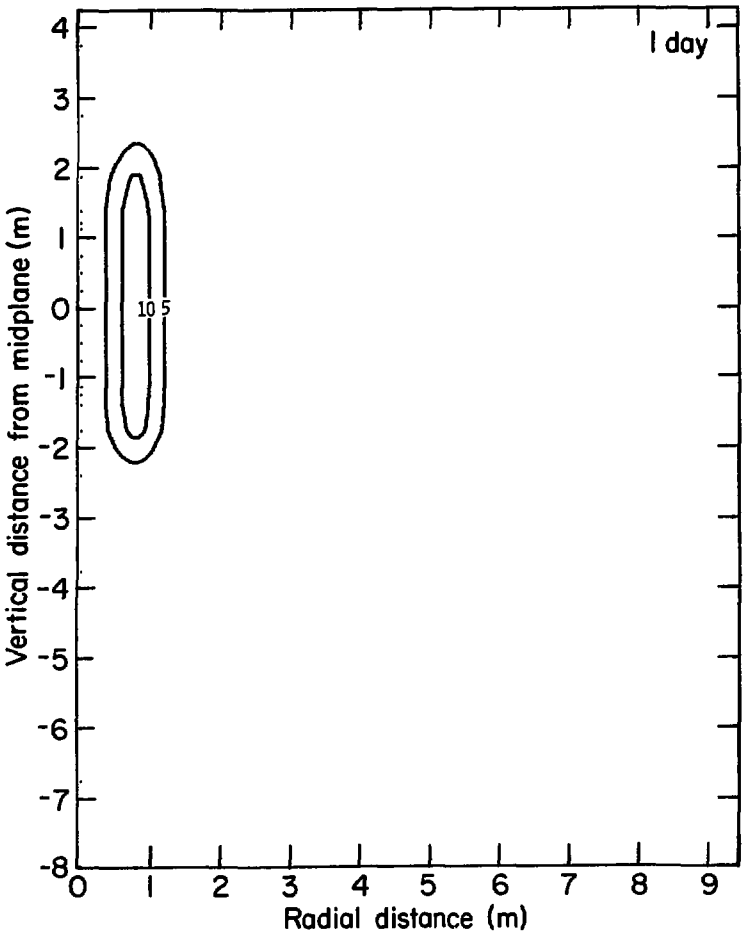
XBL 785-8521

Fig. 38e



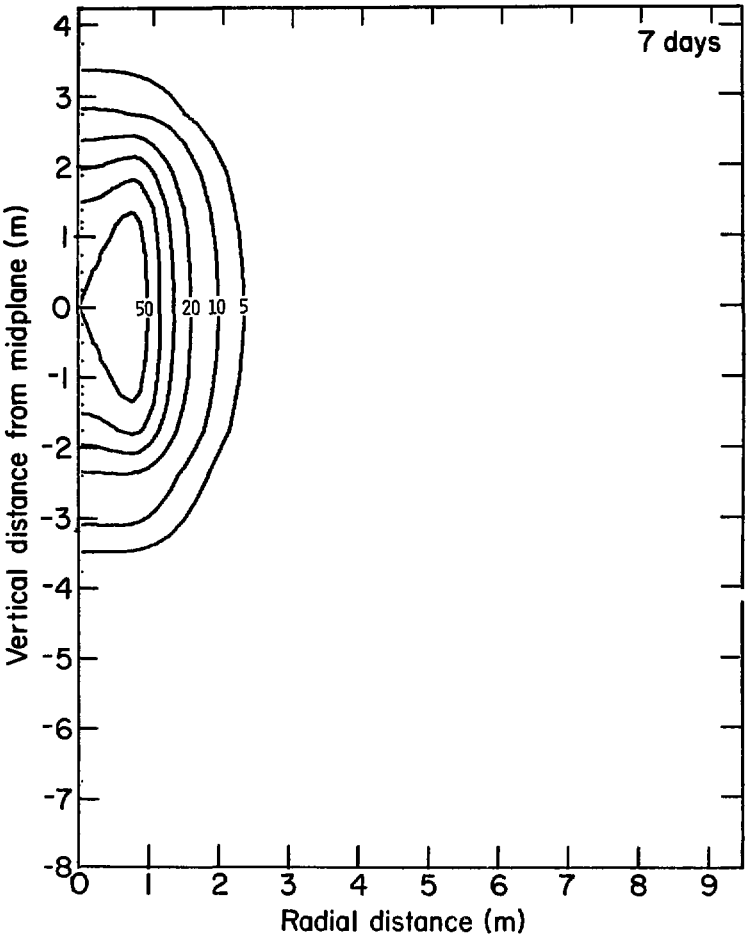
XBL 785-8522

Fig. 38f



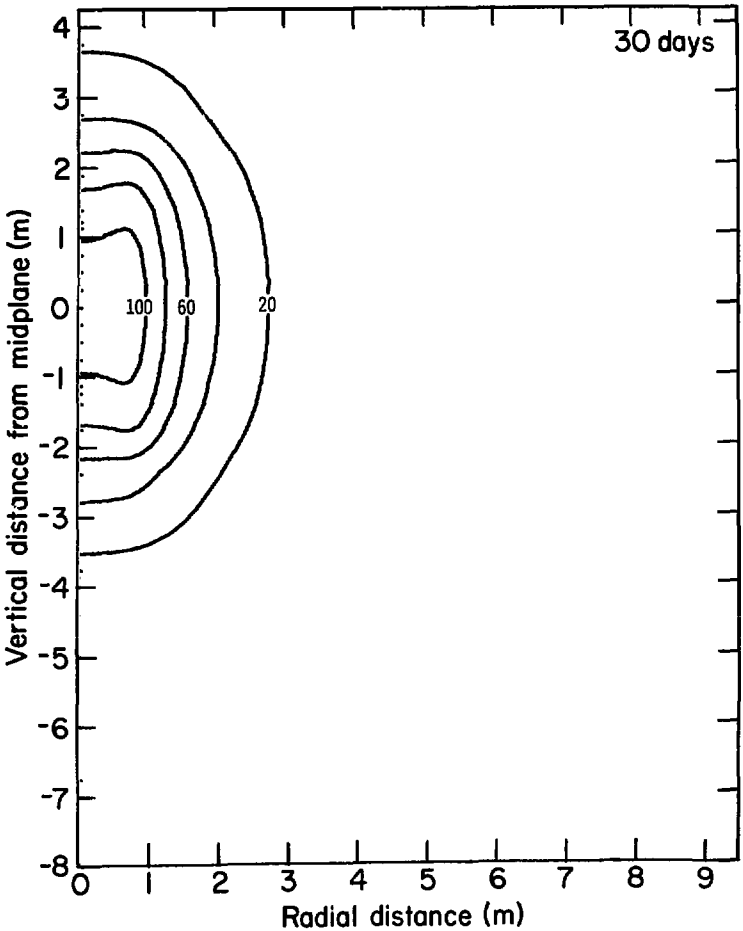
XBL 785-8529

Fig. 39a



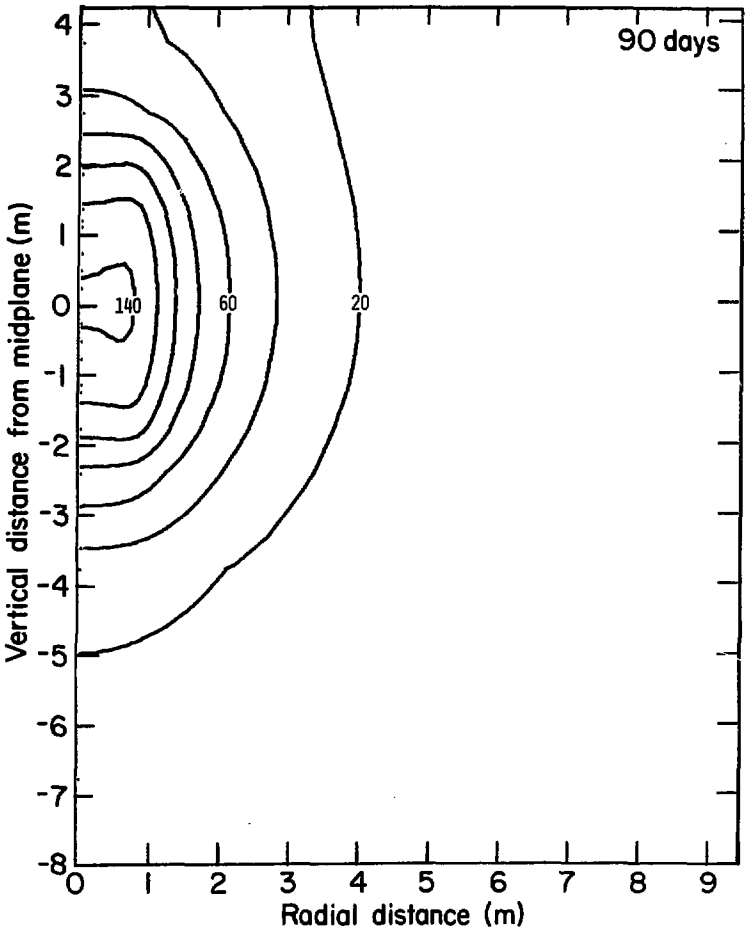
XBL 785-8530

Fig. 39b



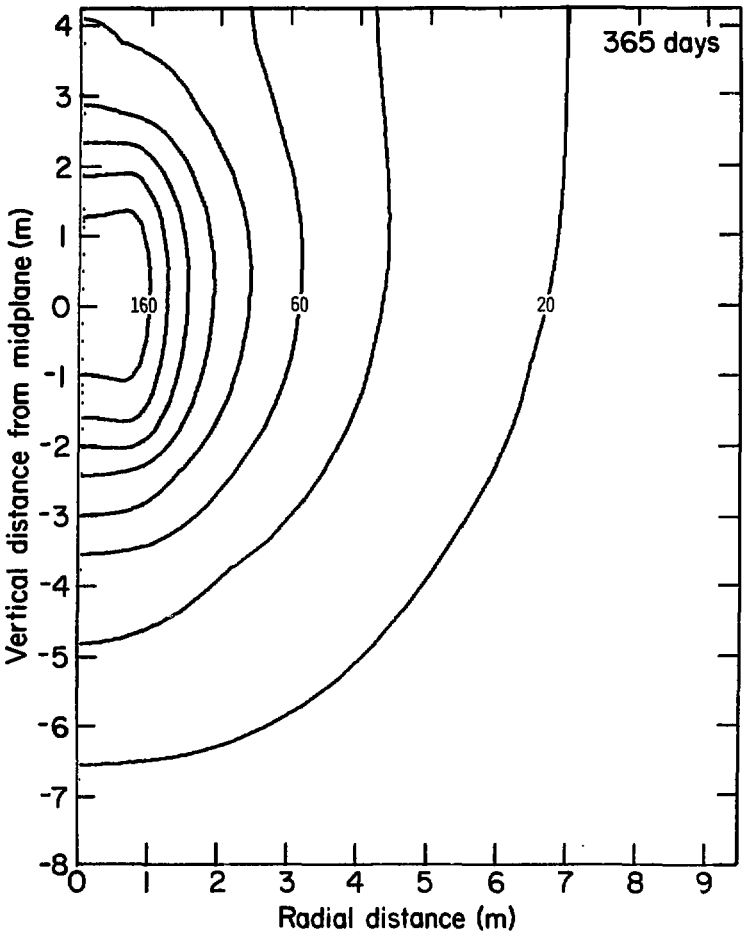
XBL 785-8531

Fig. 39c



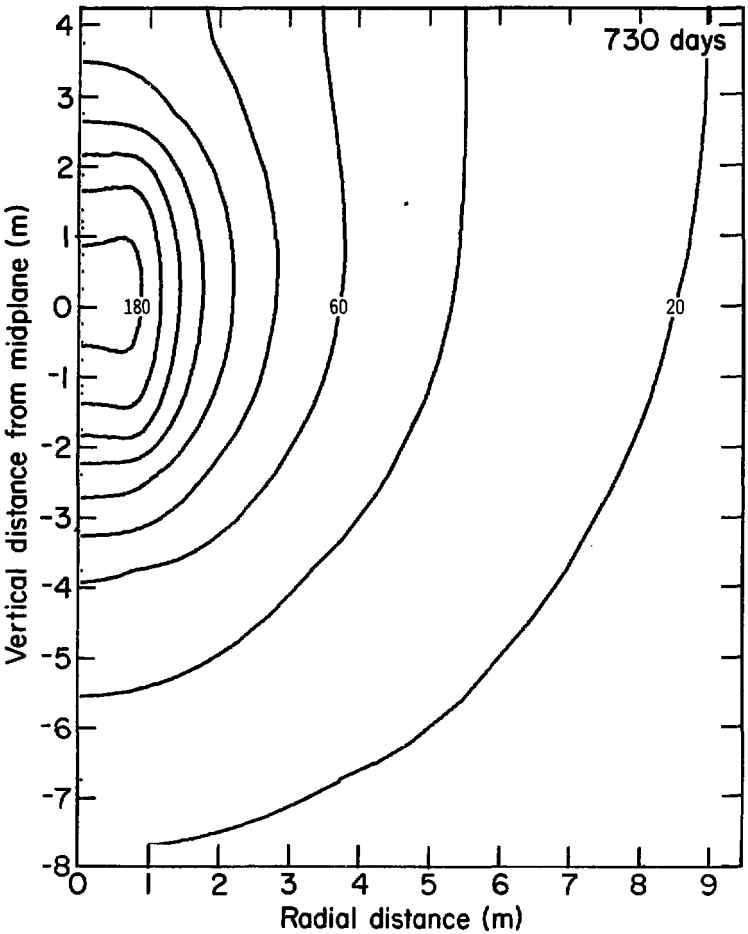
XBL 785-8532

Fig. 39d



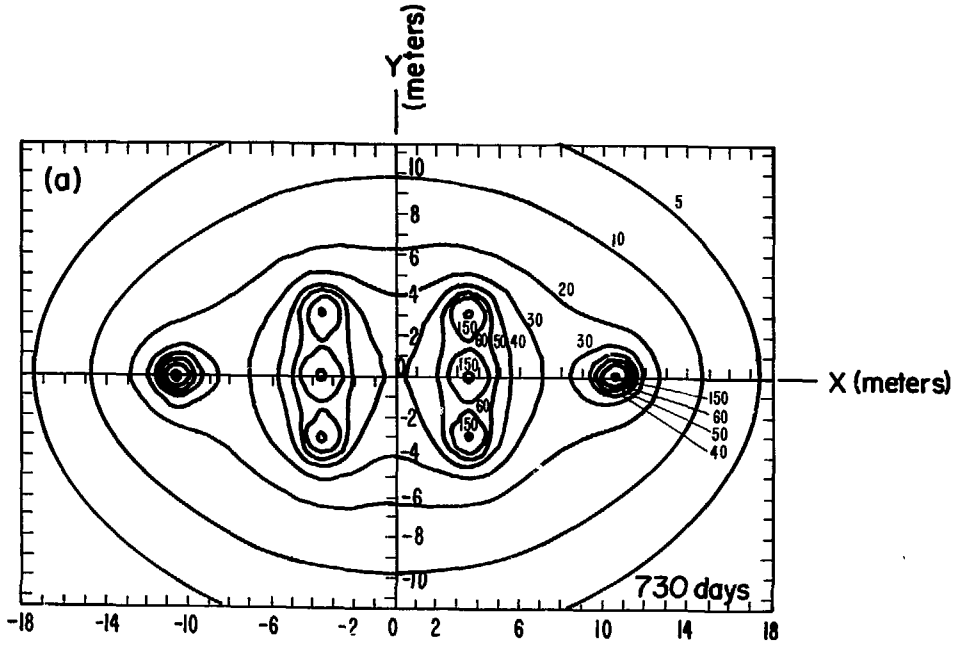
XBL 785-8533

Fig. 39e



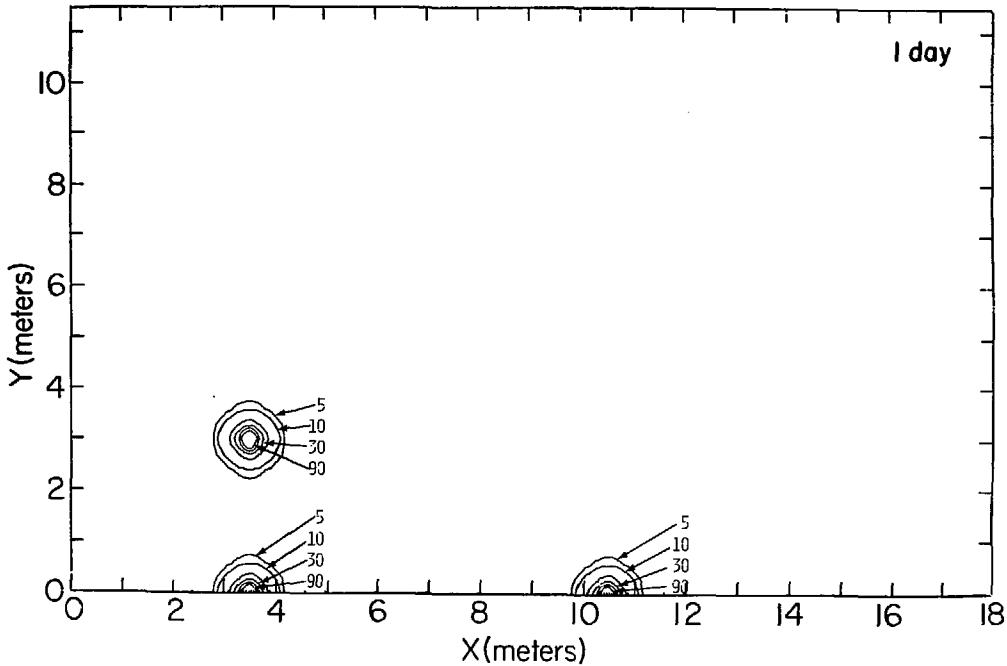
XBL 785-8534

Fig. 39f



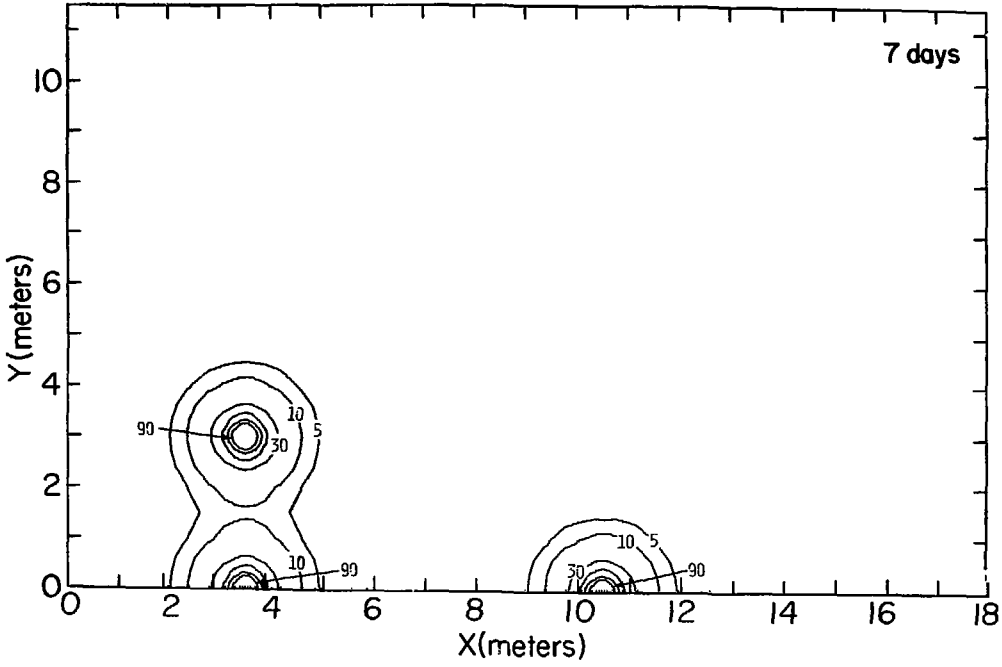
XBL 786-9256

Fig. 40



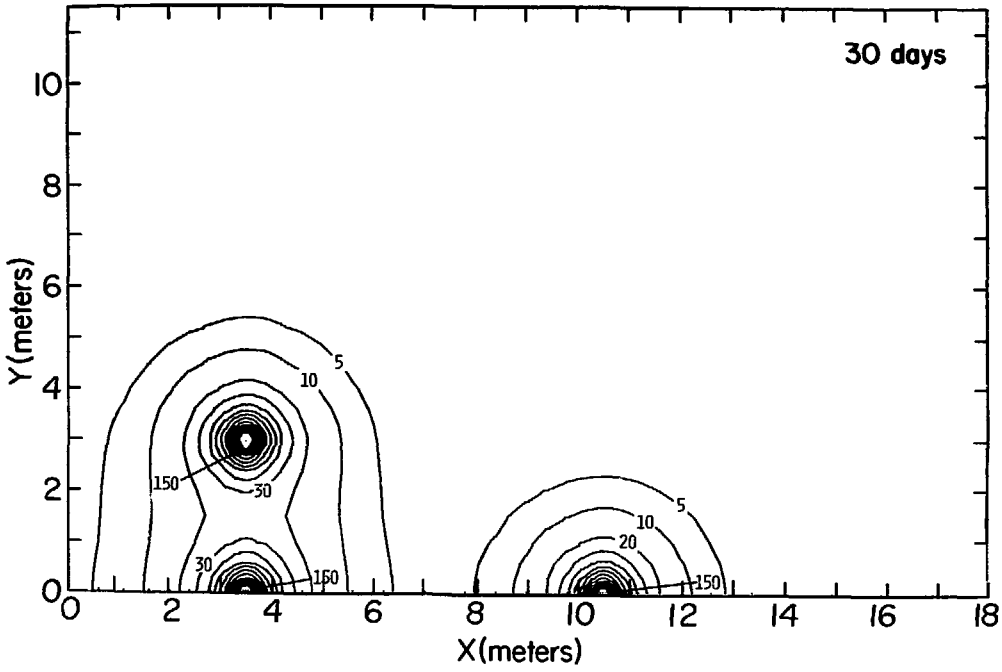
XBL 785-8553

Fig. 41a



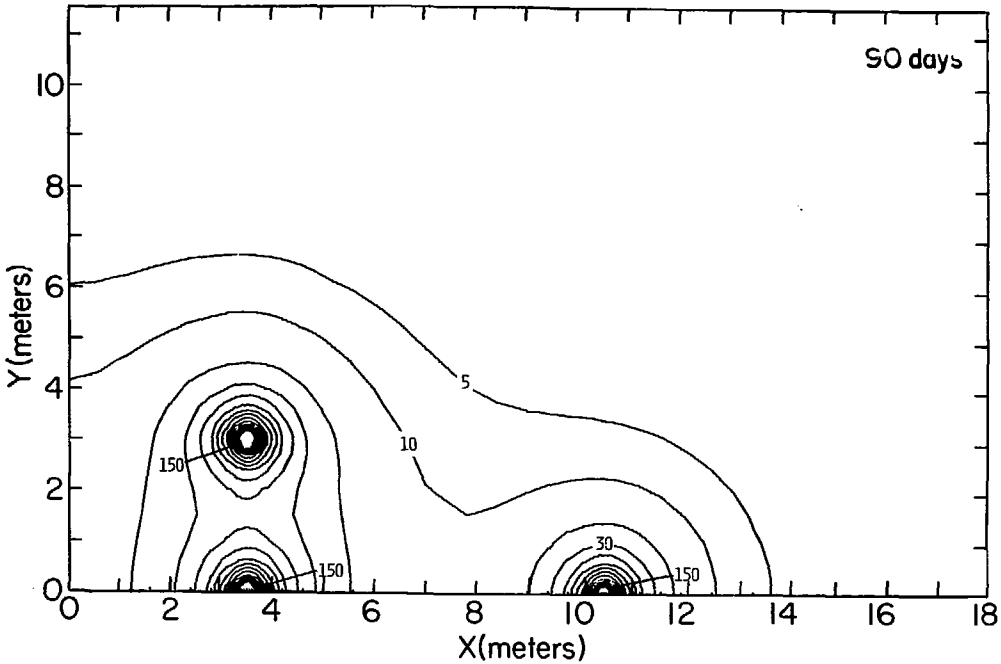
XBL 785-8554

Fig. 41b



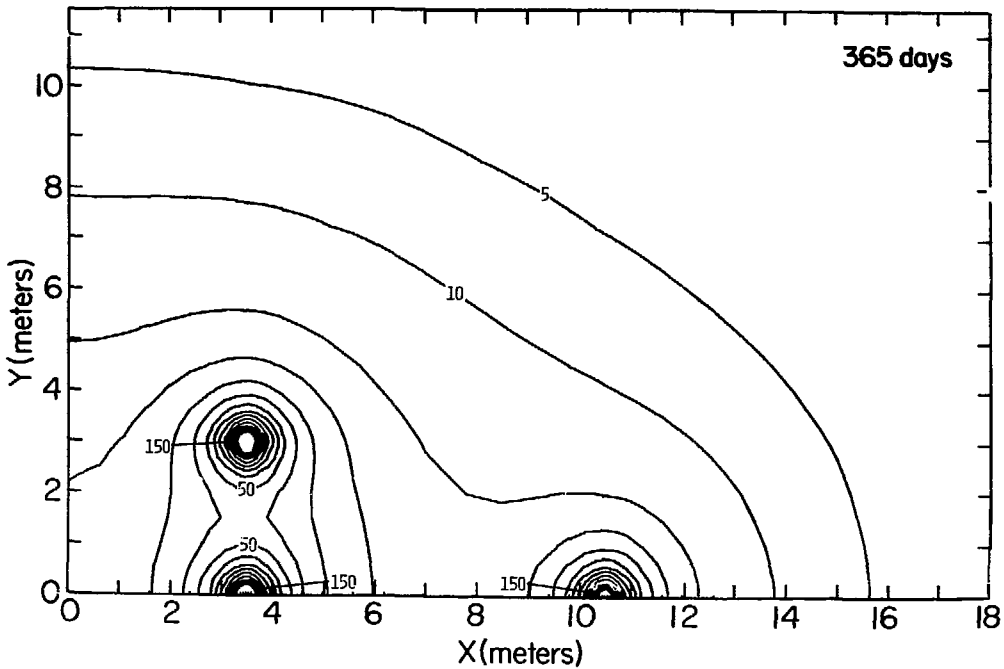
XBL 783-7739

Fig. 41c



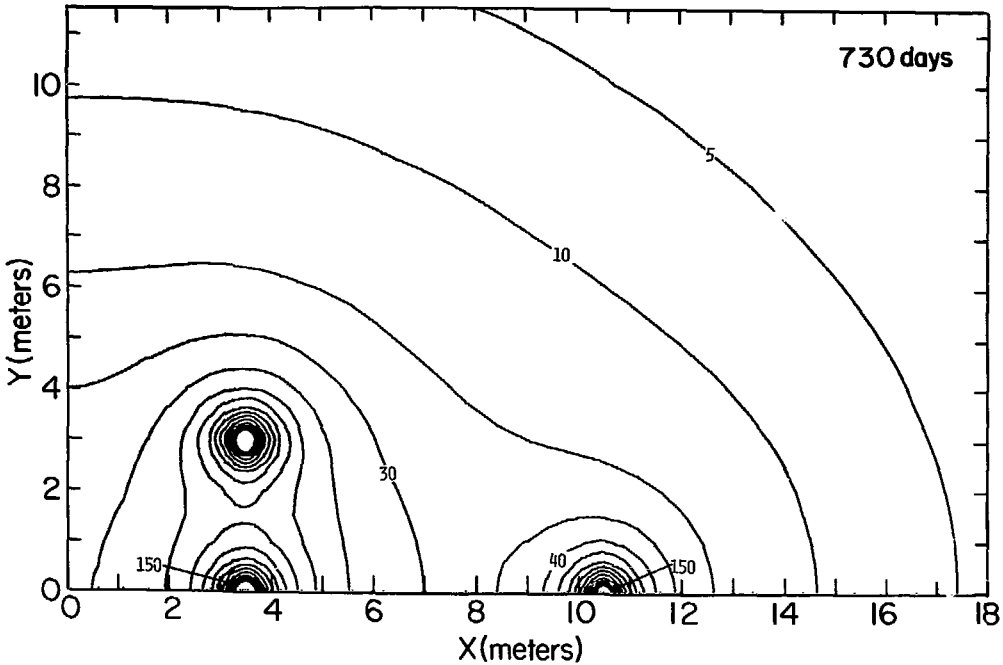
XBL 785-8555

Fig. 41d



XBL 785-8556

Fig. 41e



XBL 783-7740

Fig. 41f

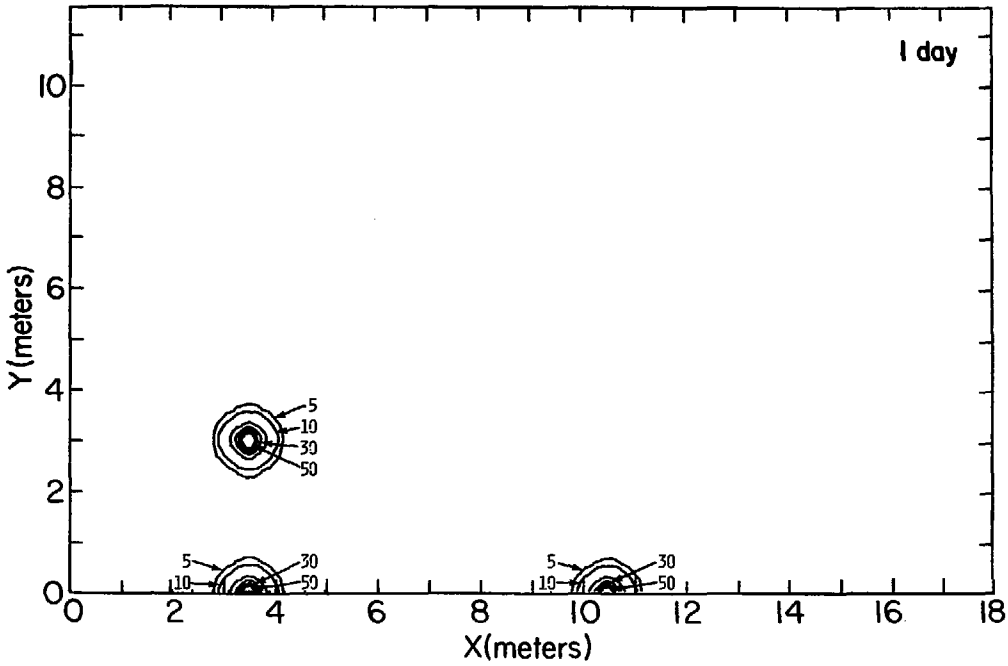


Fig. 42a

XBL 785-8557

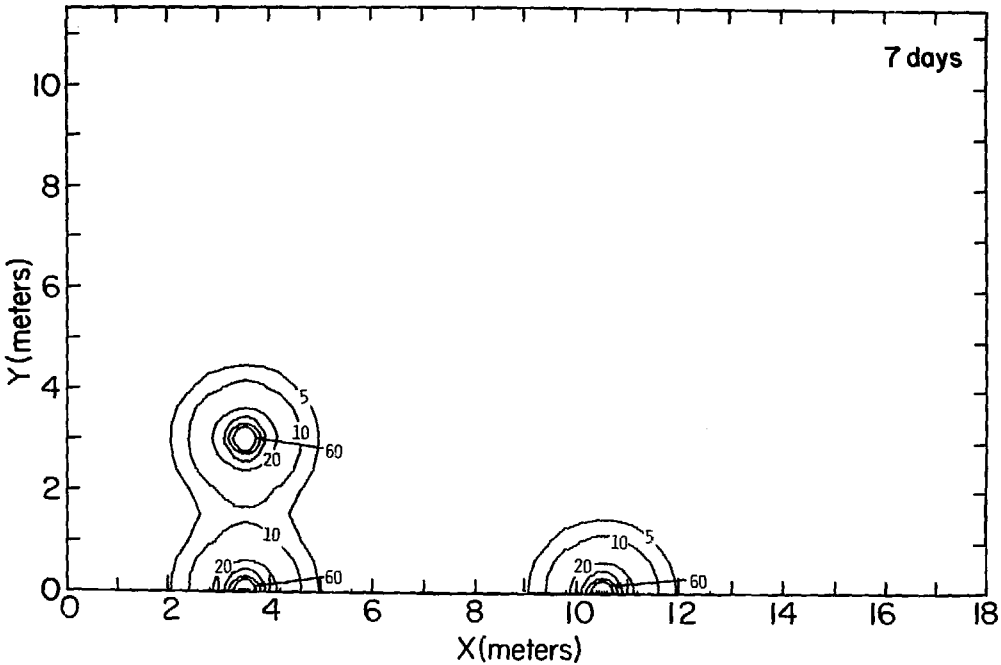


Fig. 42b

XBL 785-8558

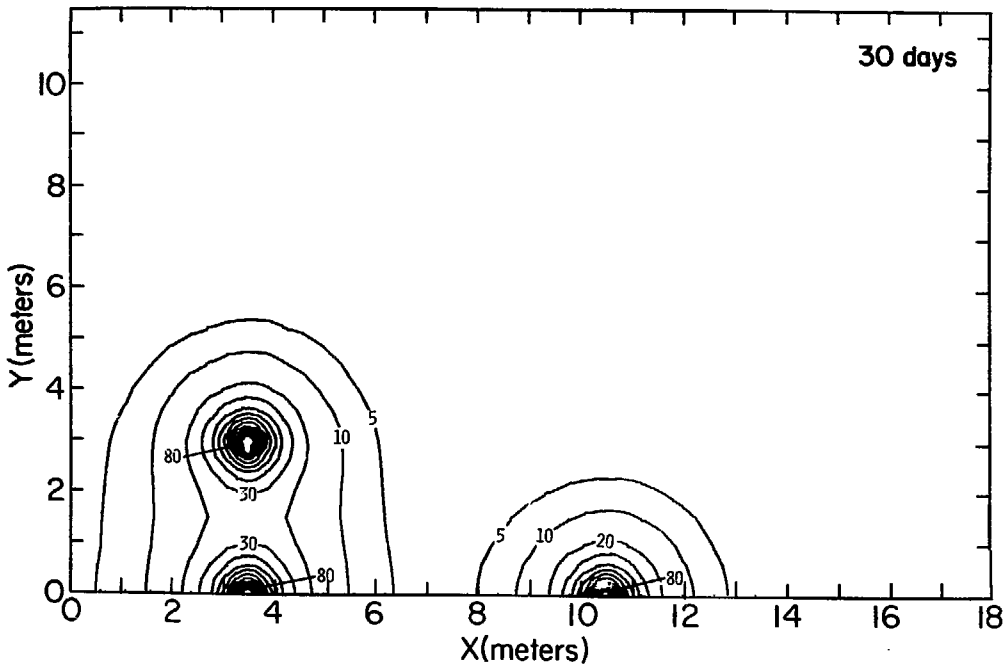
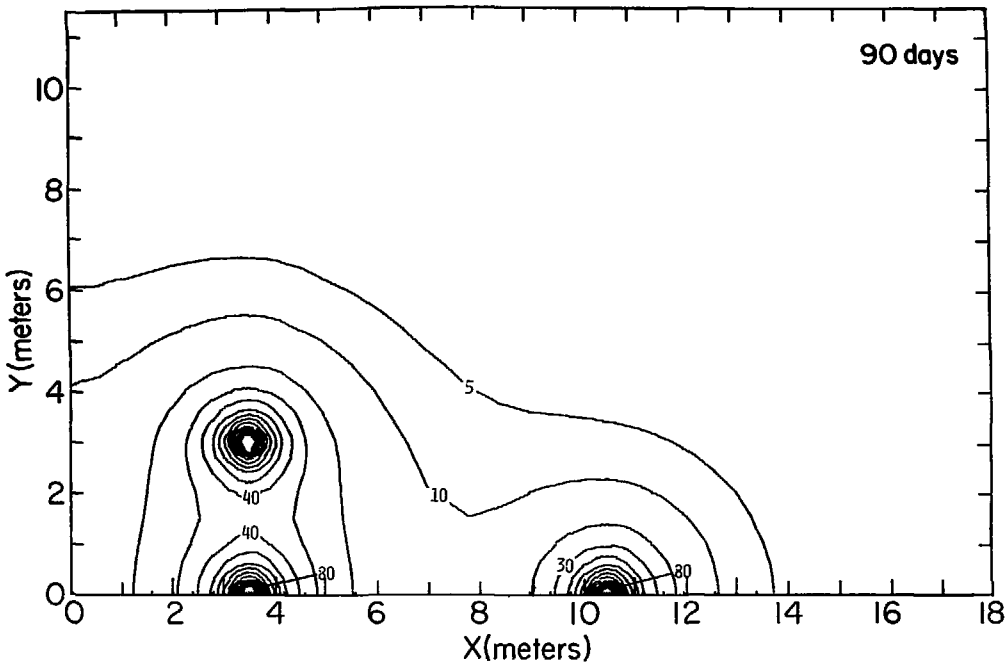


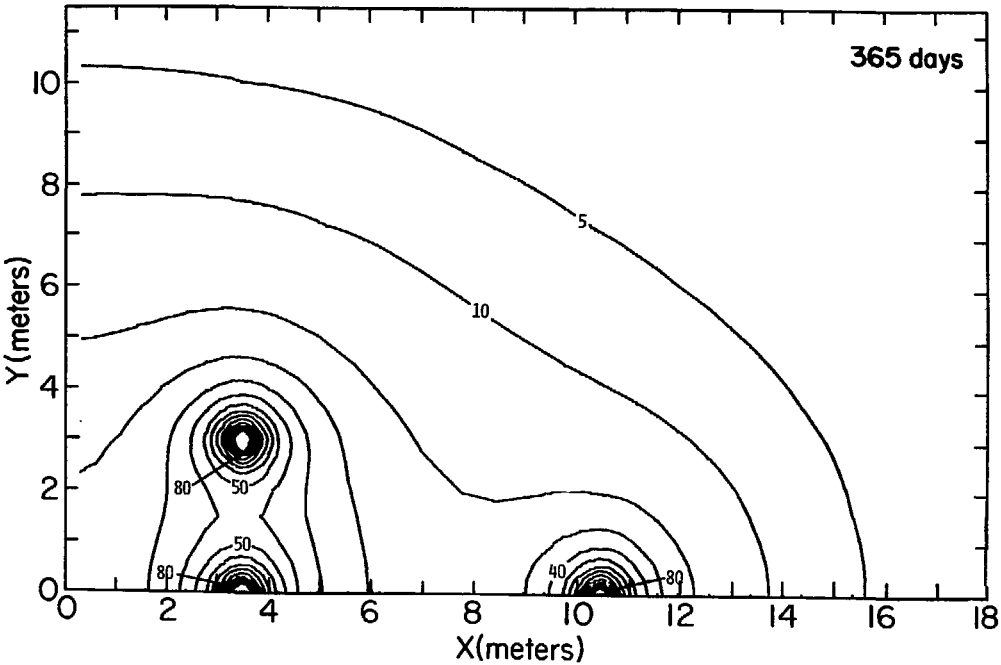
Fig. 42c

XBL 785-8559



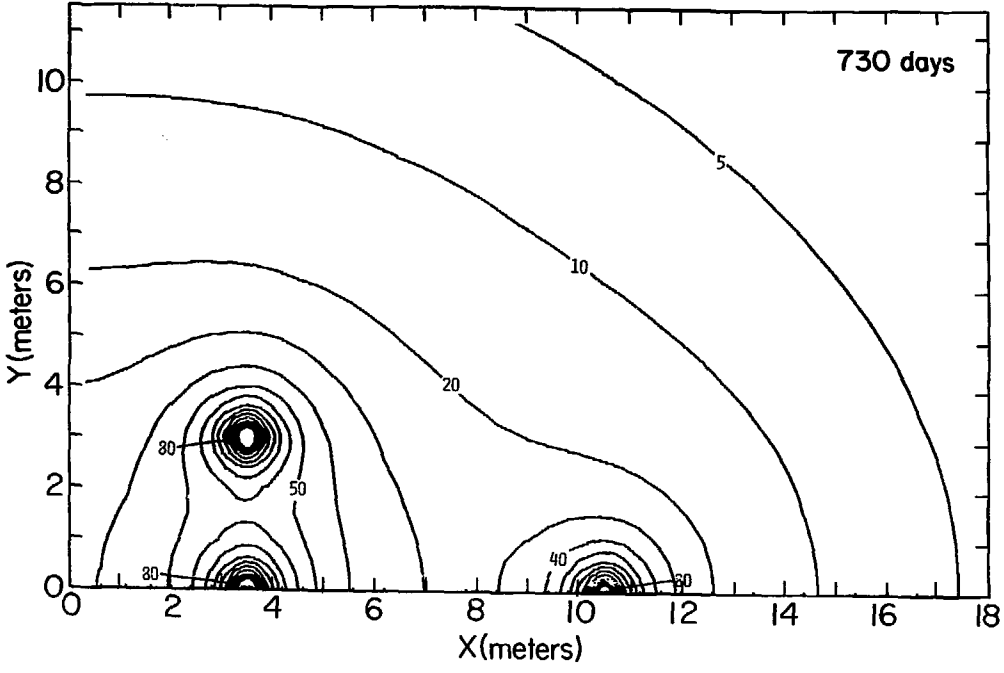
XBL 785-8560

Fig. 42d



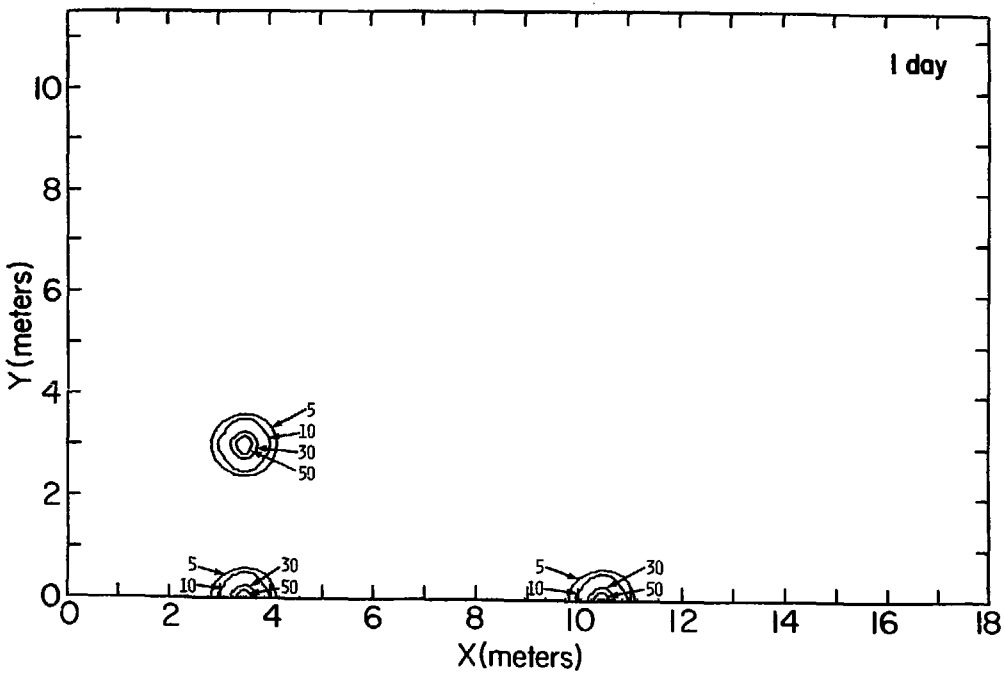
XBL 785-8561

Fig. 42e



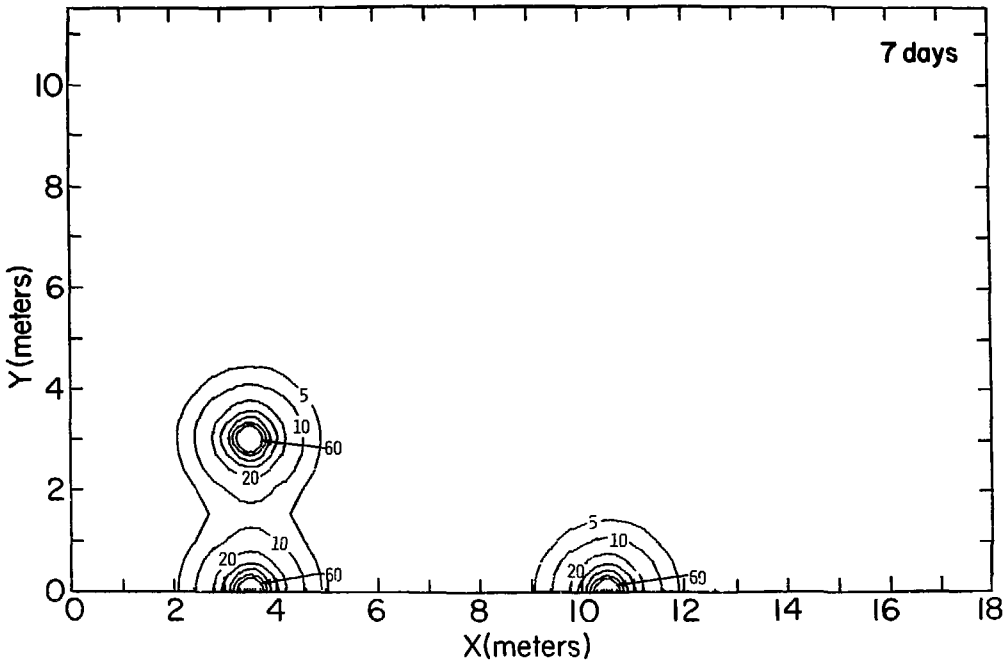
XBL 785-8562

Fig. 42f



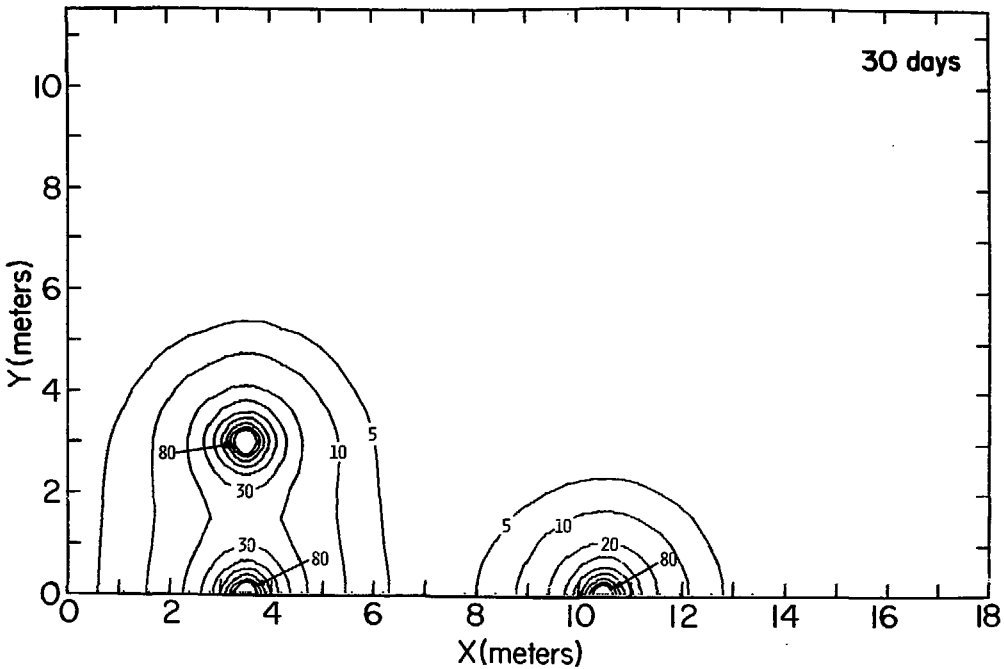
XBL 785-8563

Fig. 43a



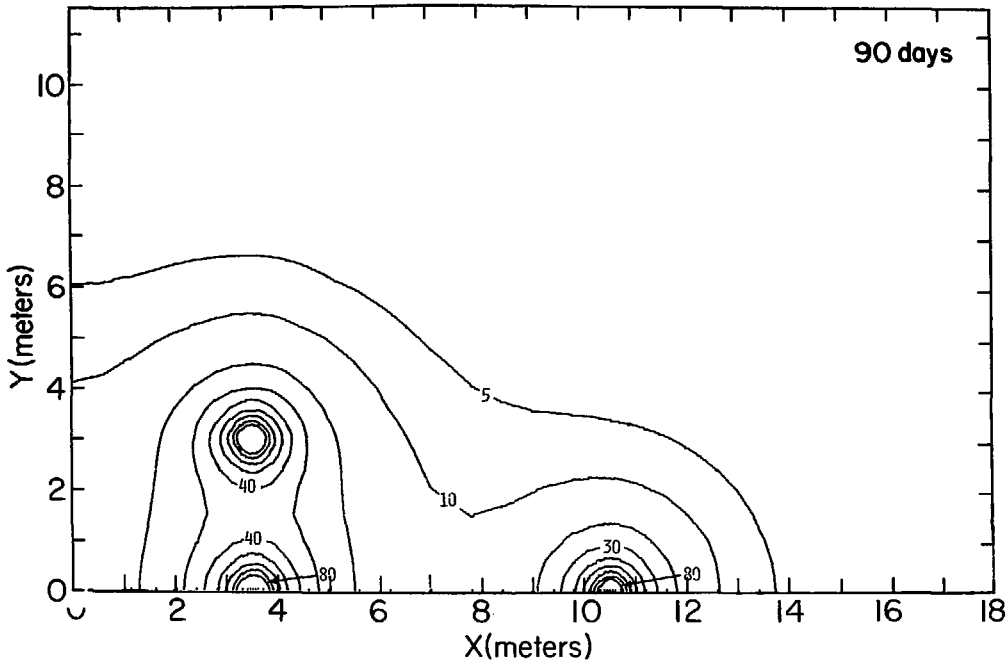
XBL 785-8564

Fig. 43b



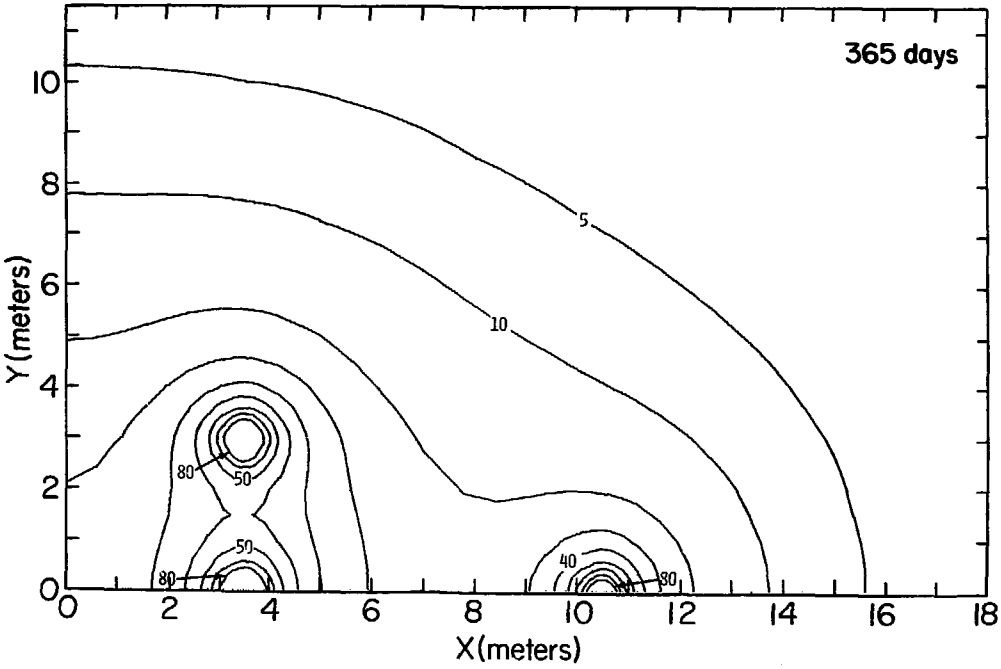
XBL 785-8565

Fig. 43c



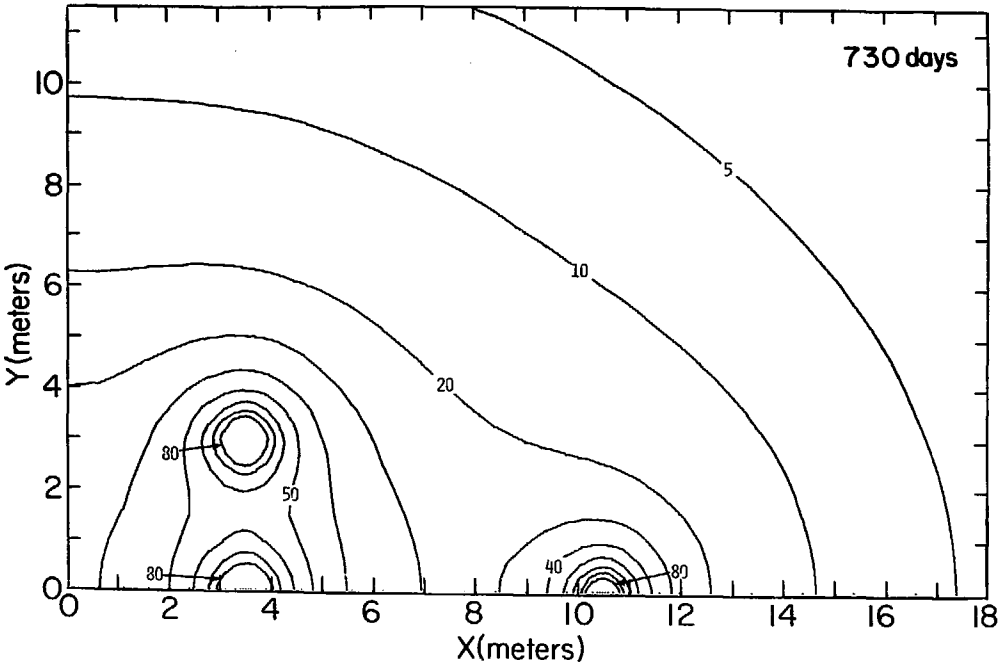
XBL 785-8566

Fig. 43d



XBL 785-8567

Fig. 43e



XBL 785-8568

Fig. 43f

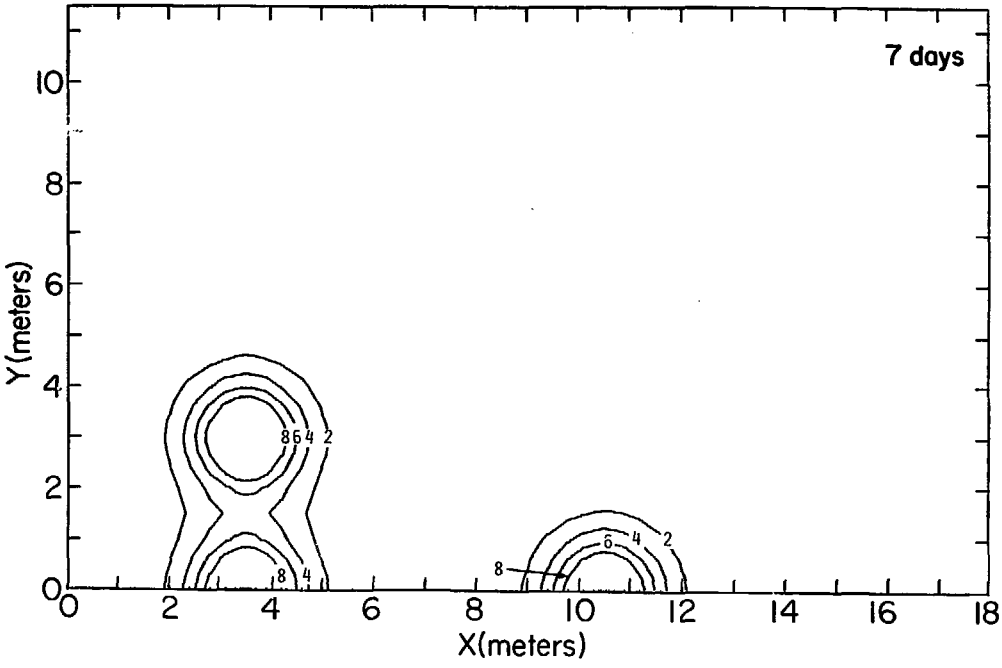
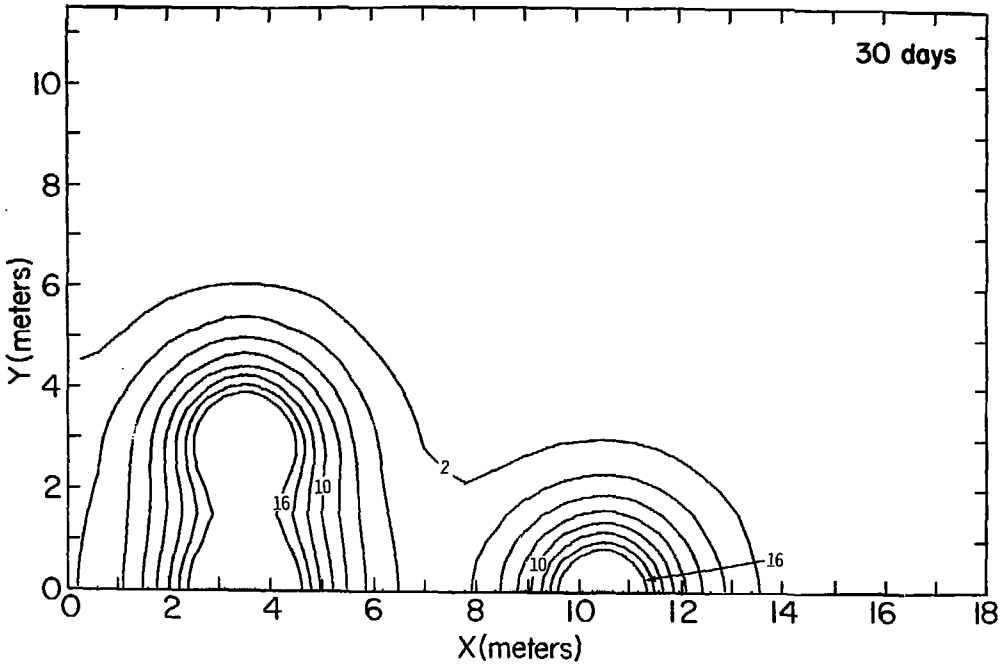


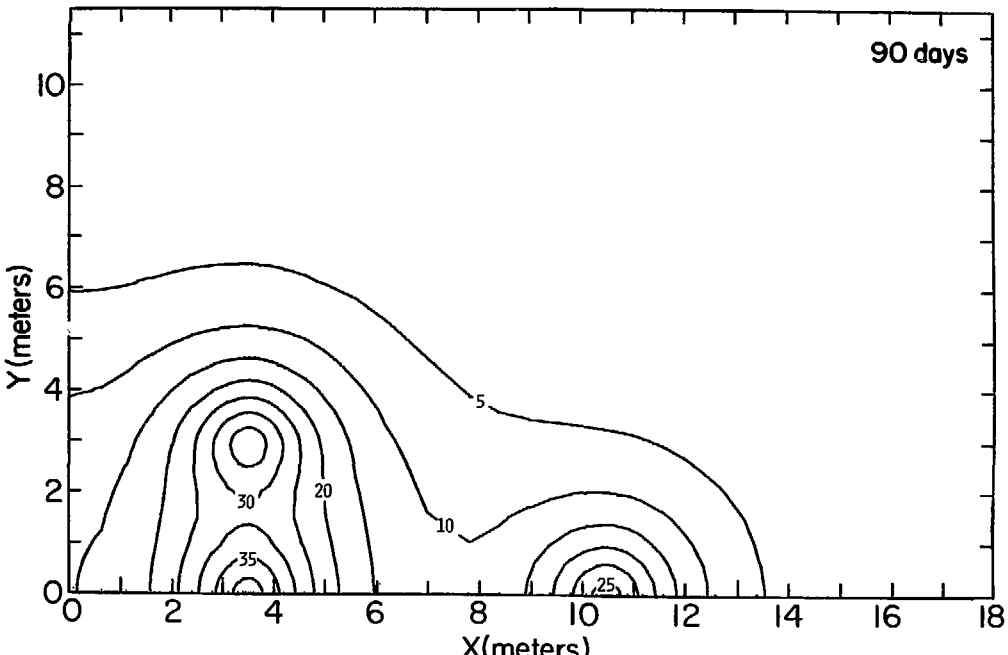
Fig. 44a

XBL 785-8569



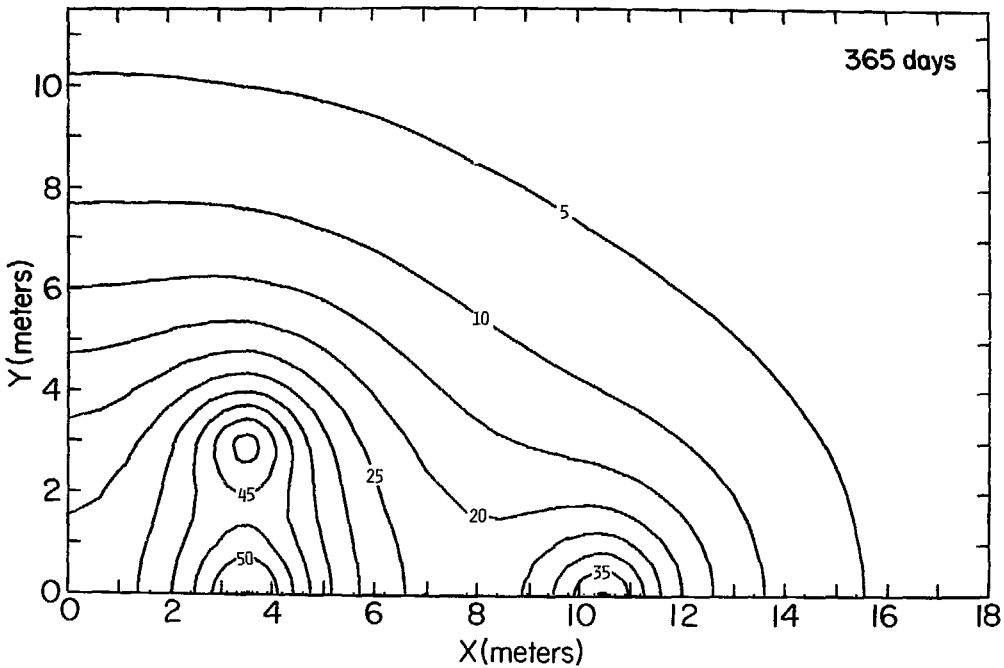
XBL 785-8570

Fig. 44b



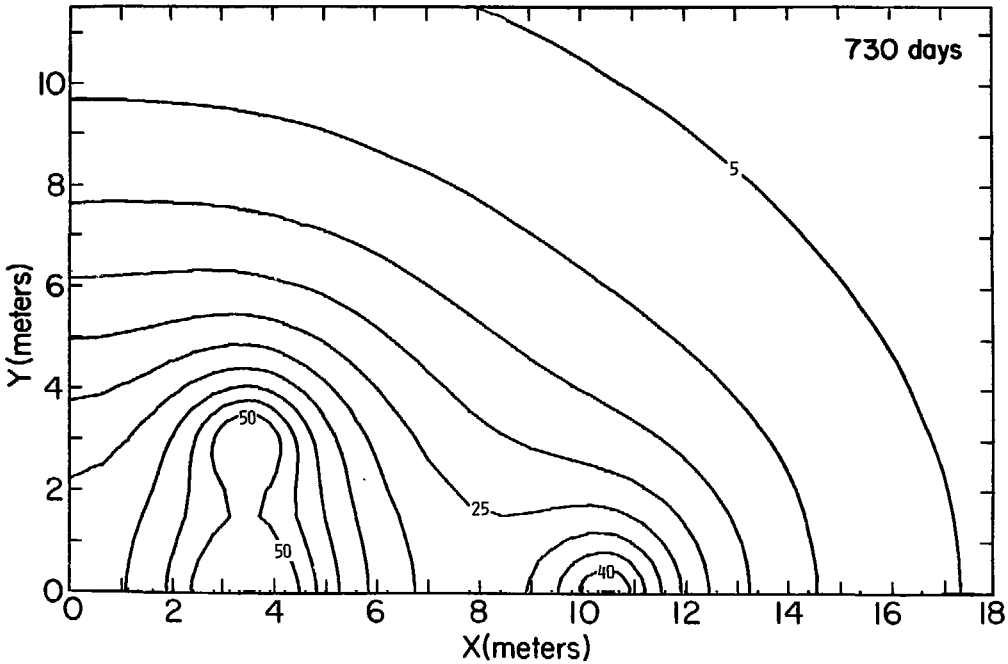
XBL 785-8571

Fig. 44c



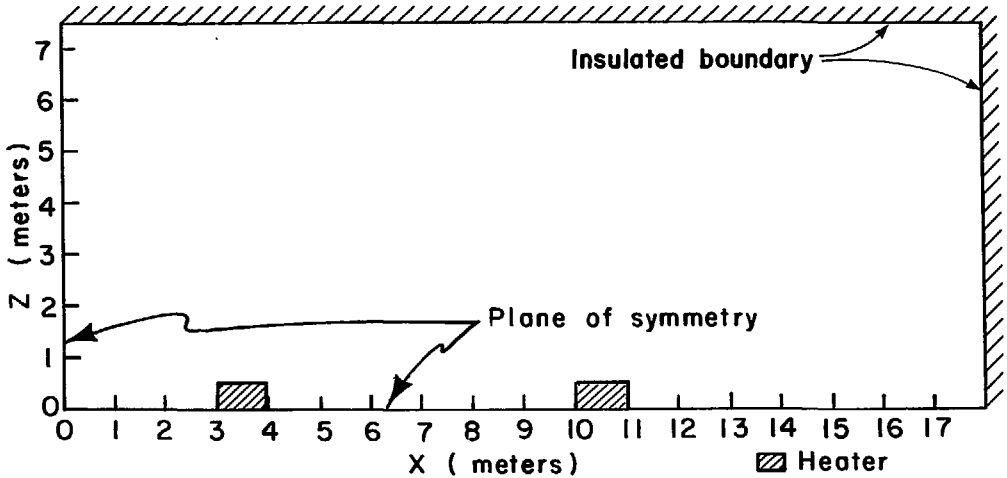
XBL 785-8572

Fig. 44d



X8L 785-8573

Fig. 44e



XBL 782-227

Fig. 45a

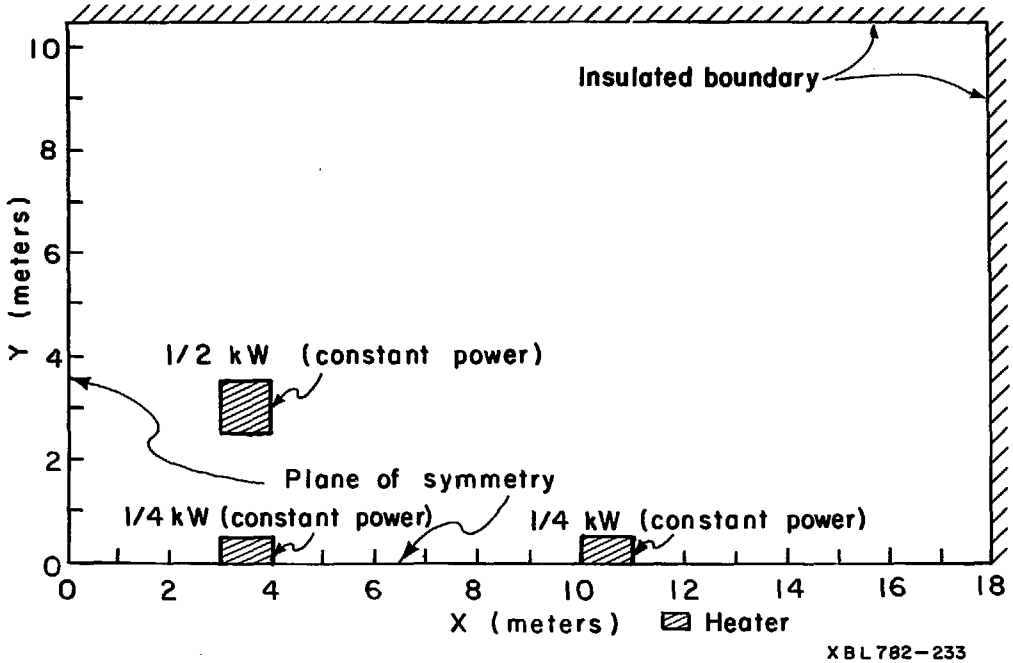

Insulated boundary
1/2 kW (constant power)
Plane of symmetry
1/4 kW (constant power)
1/4 kW (constant power)
Y (meters)
X (meters)
Heater
0
2
4
6
8
10
12
14
16
18
XBL782-233

Fig. 45b

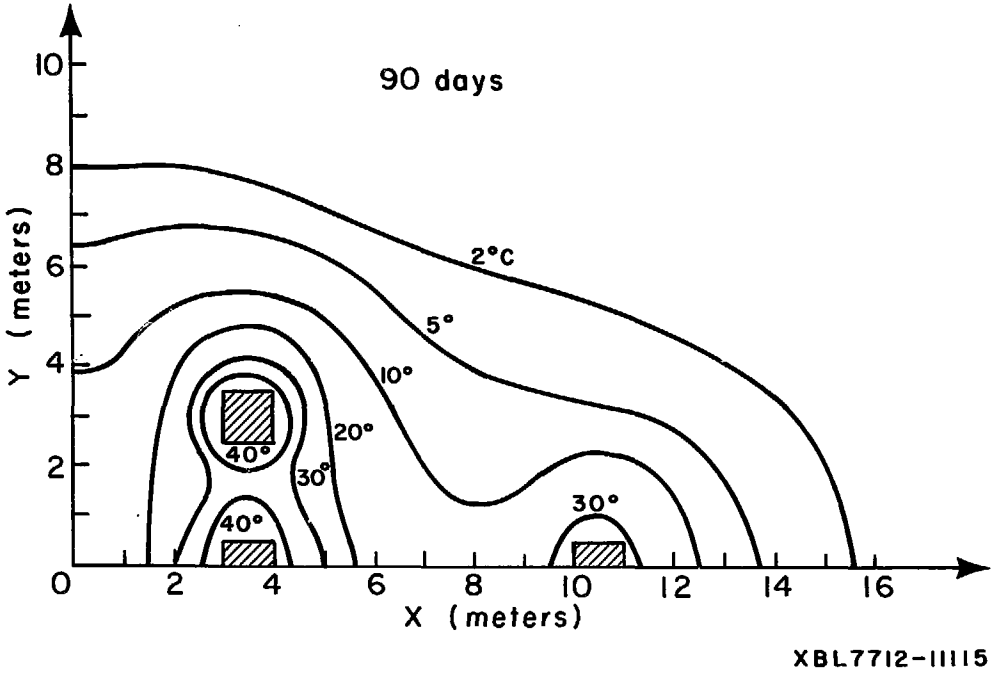

90 days
2°C
5°
10°
20°
30°
40°
40°
30°
Y (meters)
X (meters)
0
2
4
6
8
10
12
14
16
XBL7712-11115

Fig. 46a

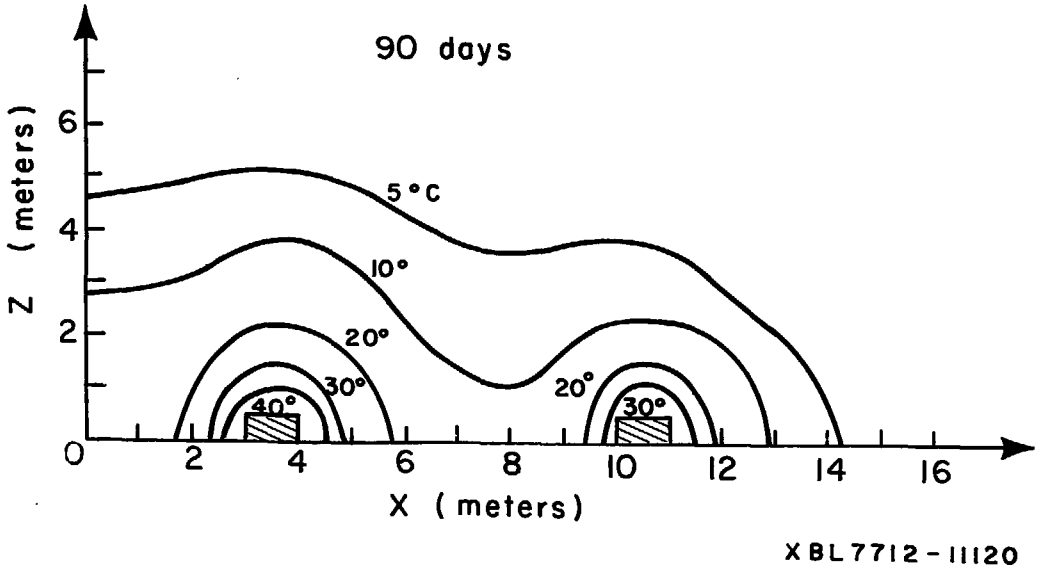

90 days
Z (meters)
X (meters)
0
2
4
6
8
10
12
14
16
5 °C
10°
20°
30°
40°
20°
30°
XBL7712-11120

Fig. 46b

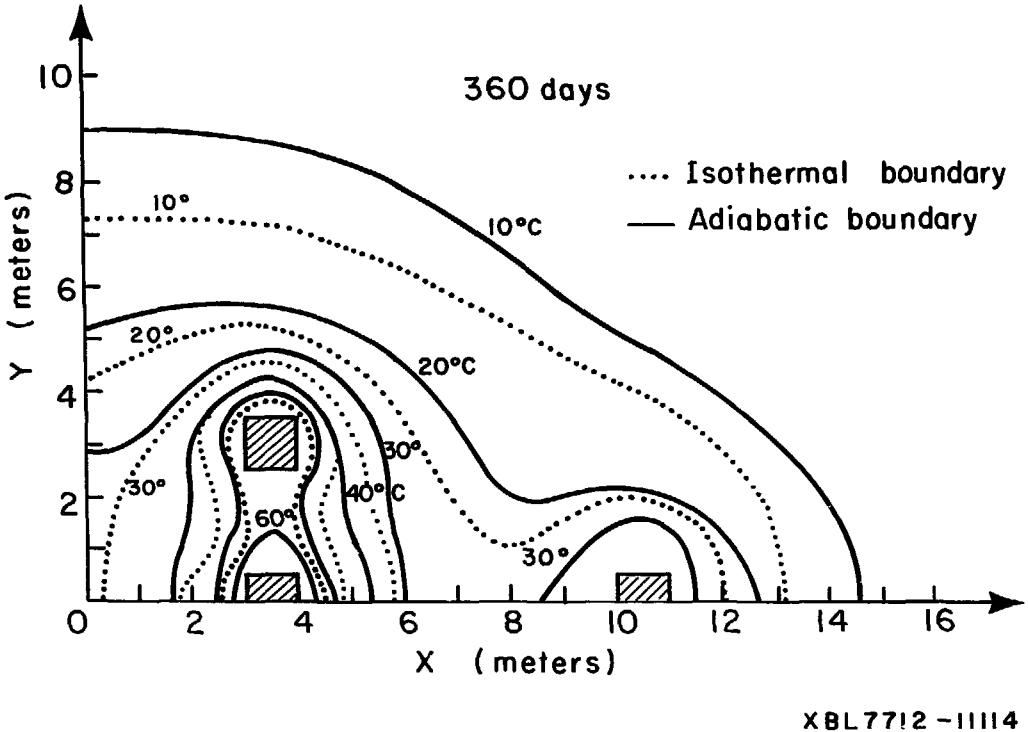

360 days
.... Isothermal boundary
— Adiabatic boundary
10°C
20°C
30°
40°C
60°
10°
20°
30°
30°
Y (meters)
X (meters)
0
2
4
6
8
10
12
14
16
XBL7712-11114

Fig. 47a

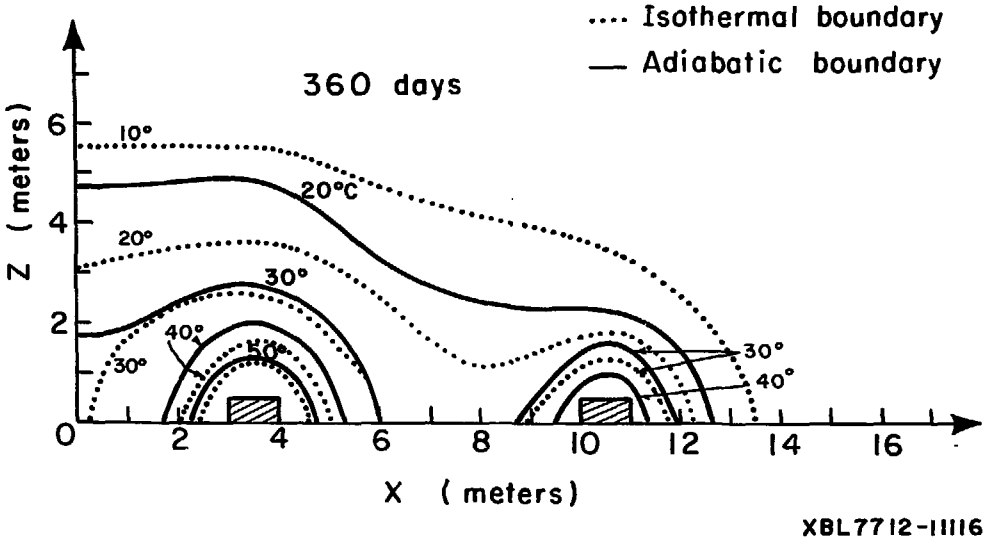

.... Isothermal boundary
— Adiabatic boundary
360 days
10°
20°C
20°
30°
40°
50°
30°
30°
40°
Z (meters)
X (meters)
0
2
4
6
8
10
12
14
16
XBL7712-11116

Fig. 47b

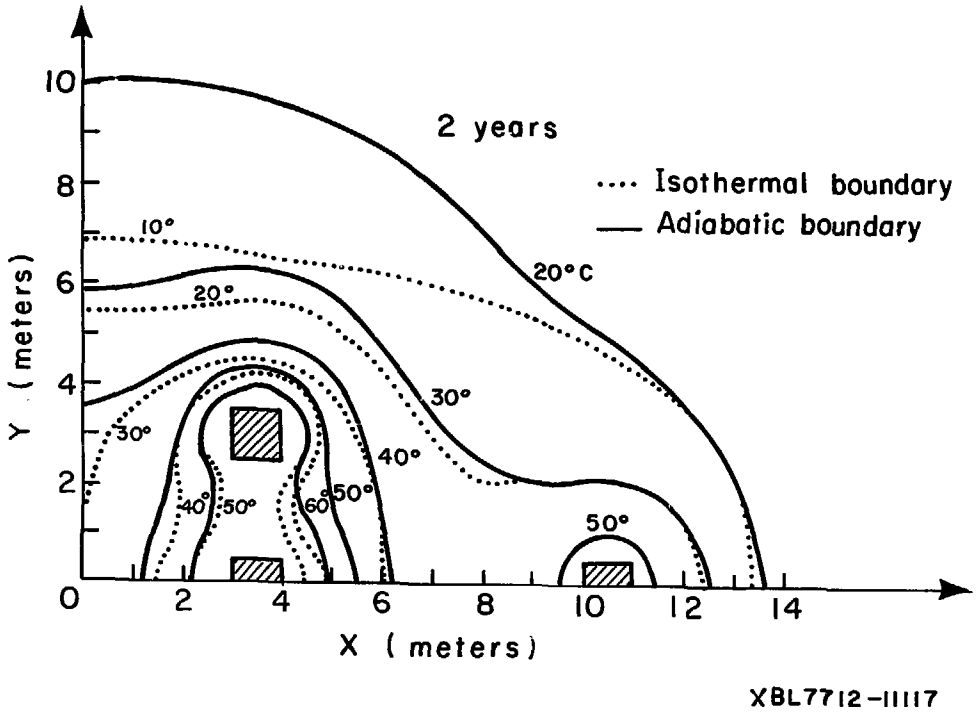
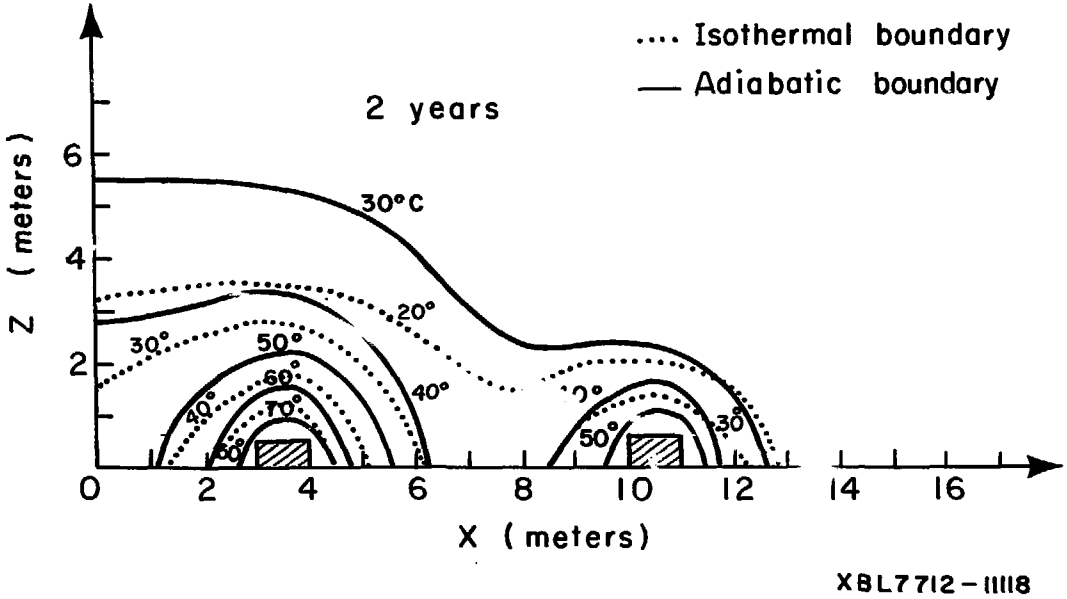

2 years
Isothermal boundary
Adiabatic boundary
10°
20°
30°
40°
50°
60°
20°c
Y (meters)
X (meters)
0
2
4
6
8
10
12
14
XBL7712-11117

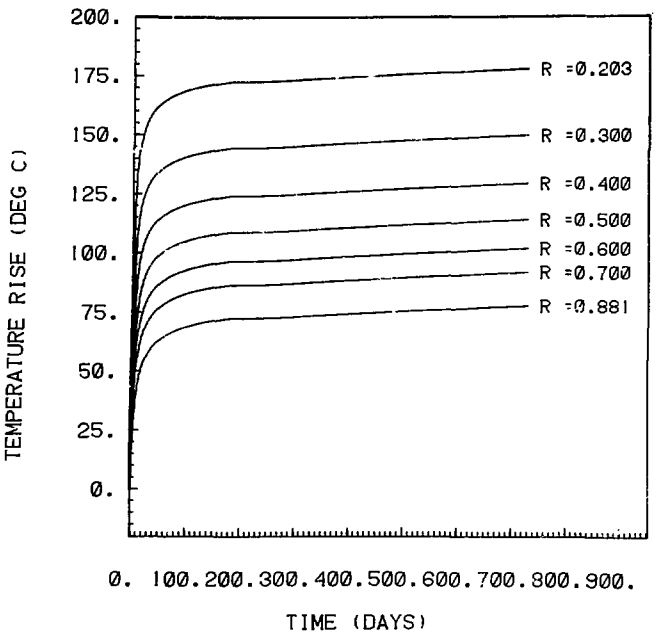
Fig. 48a



.... Isothermal boundary
— Adiabatic boundary
2 years
30°C
20°
30°
50°
60°
70°
40°
40°
50°
30°
Z (meters)
X (meters)
0
2
4
6
8
10
12
14
16
XBL7712-11118

Fig. 48b

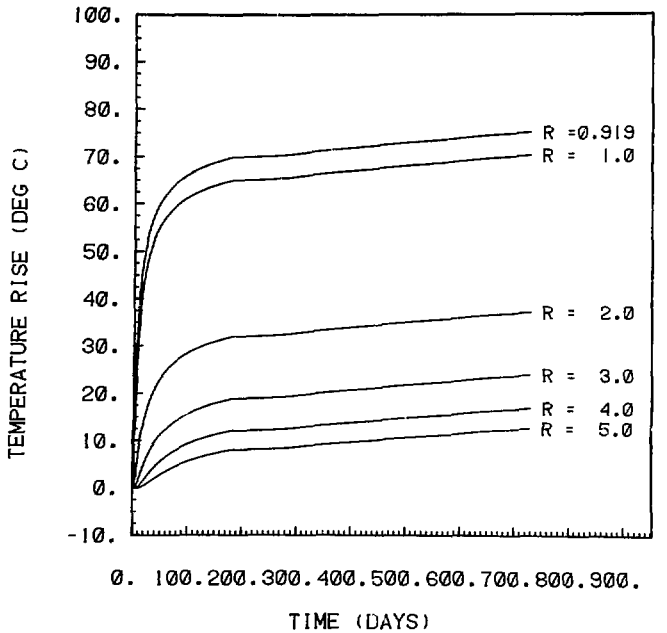
TEMPERATURE PROFILES FOR
STRIPA FULL-SCALE EXPERIMENT 1
Z = 0 M, THETA = 0 DEG., R = 0.203 TO 0.881
INFINITE MEDIUM MODEL



XBL 788-10521

Fig. 49a

TEMPERATURE PROFILES FOR
STRIPA FULL-SCALE EXPERIMENT 1
Z = 0 M, THETA = 0 DEG., R = 0.919 TO 5.0 M
INFINITE MEDIUM MODEL



XBL 788-10520

Fig. 49b

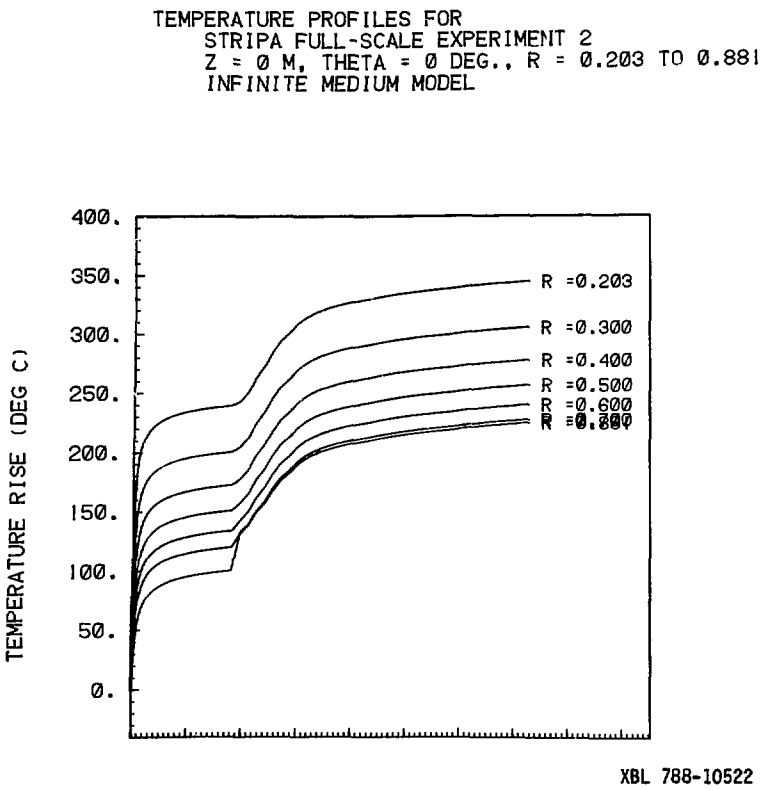
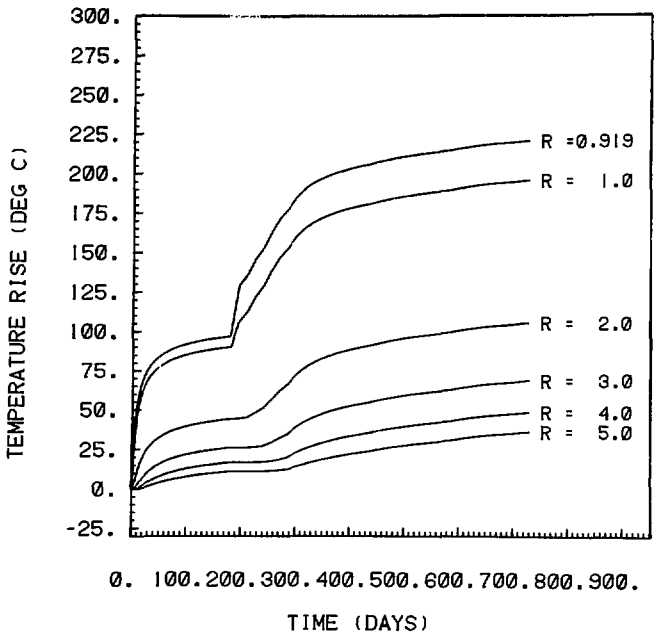

TEMPERATURE PROFILES FOR
STRIPA FULL-SCALE EXPERIMENT 2
Z = 0 M, THETA = 0 DEG., R = 0.203 TO 0.881
INFINITE MEDIUM MODEL
TEMPERATURE RISE (DEG C)
400.
350.
300.
250.
200.
150.
100.
50.
0.
R =0.203
R =0.300
R =0.400
R =0.500
R =0.600
R =0.700
R =0.800
XBL 788-10522

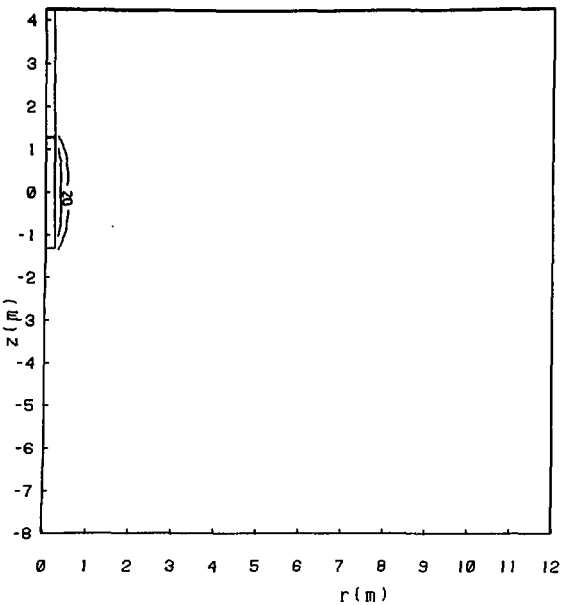
Fig. 50a

TEMPERATURE PROFILES FOR
STRIPA FULL-SCALE EXPERIMENT 2
Z = 0 M, THETA = 0 DEG., R = 0.919 TO 5.0 M
INFINITE MEDIUM MODEL



XBL 788-10519

Fig. 50b



temperature rise (°C)

STRIPA FULL SCALE 1 - ONE HEATER 3.6KW

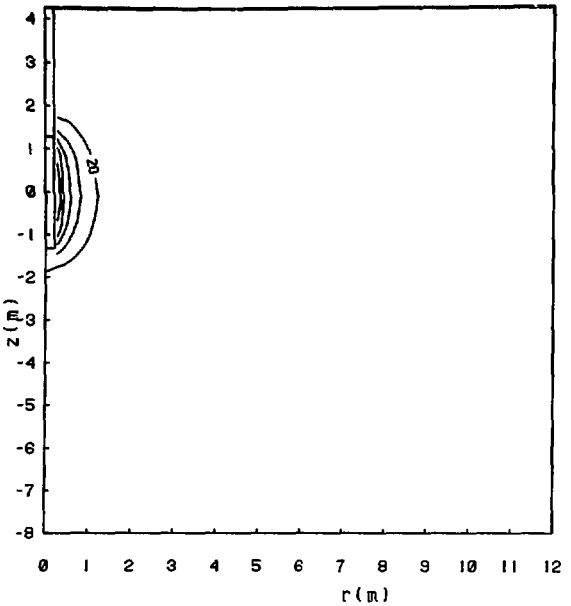
time = 1.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	40.00

model: INFI SSET3 calculated 08/18/78

XBL 788-10571

Fig. 51a



temperature rise (°C)

STRIPA FULL SCALE I - ONE HEATER 3.6KW

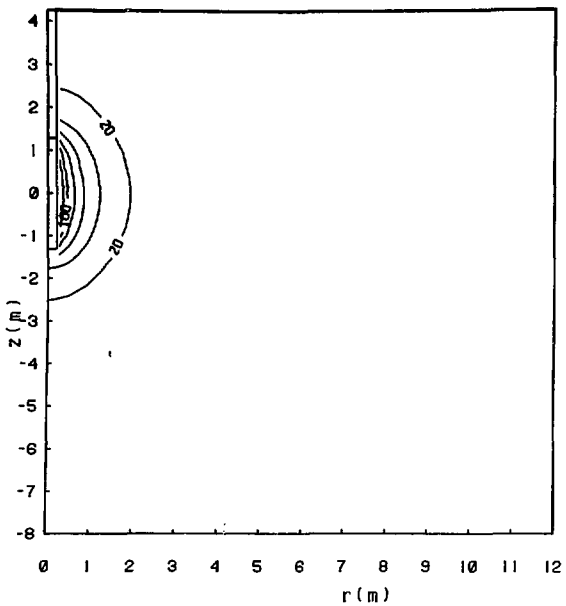
time = 7.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	100.0

model: INFI SSET3 calculated 08/18/78

XBL 788-10570

Fig. 51b



temperature rise (°C)

STRIPA FULL SCALE I - ONE HEATER 3.6KW

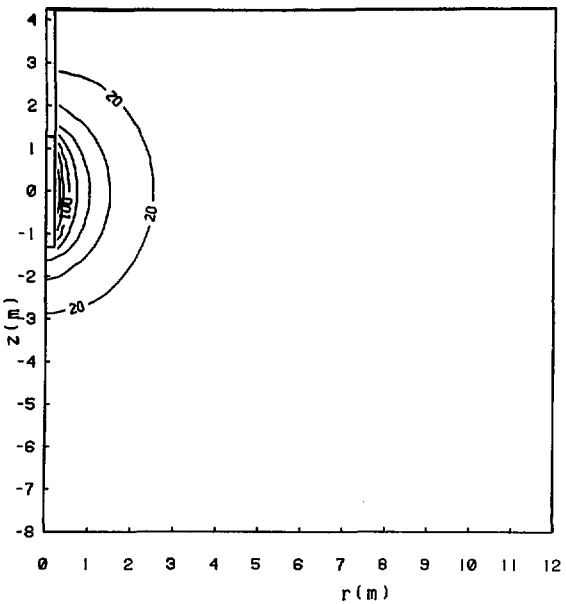
time = 30.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	120.0

model: INFI SSET3 calculated 06/18/78

XBL 788-10572

Fig. 51c



temperature rise (°C)

STRIPA FULL SCALE 1 - ONE HEATER 3.6KW

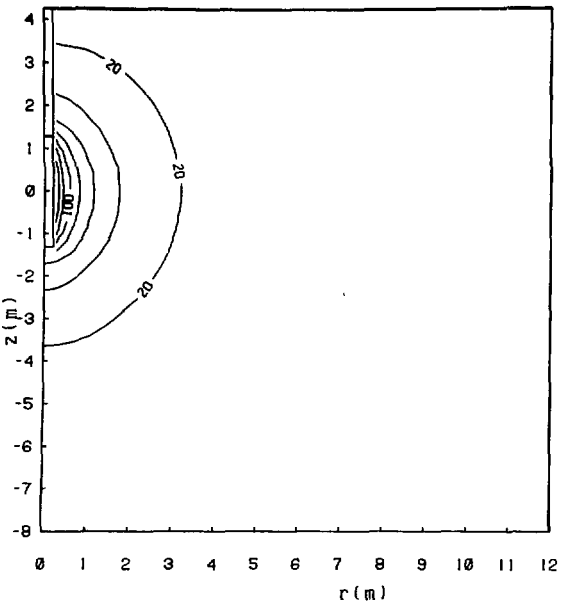
time = 90.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	140.0

model: INFI SSET3 calculated 08/18/78

XBL 788-10569

Fig. 51d



temperature rise (°C)

STRIPA FULL SCALE 1 - ONE HEATER 3.6KW

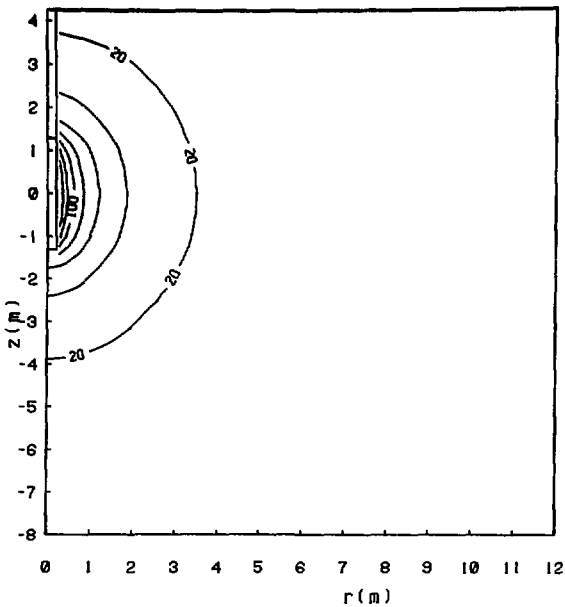
time = 360.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	140.0

model: INFI SSET3 calculated 08/18/78

XBL 788-10564

Fig. 51e



temperature rise (°C)

STRIPA FULL SCALE 1 - ONE HEATER 3.6KW

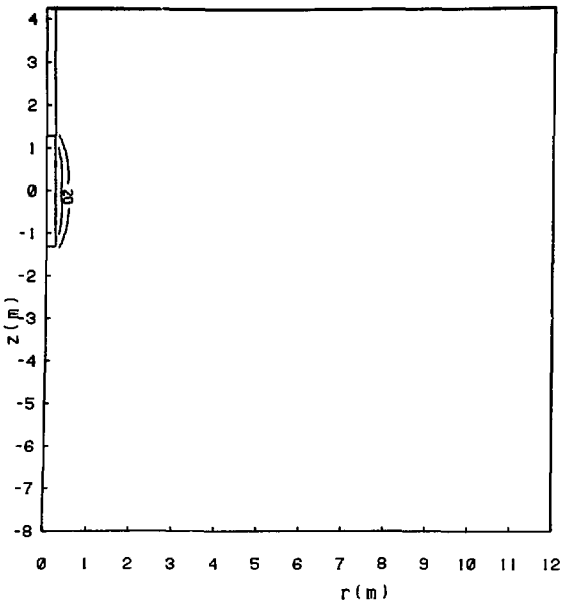
time = 730.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	140.0

model: INFI SSET3 calculated 08/19/79

XBL 788-10561

Fig. 51f



temperature rise (°C)

STRIPA FULL SCALE I - ONE HEATER 3.6KW

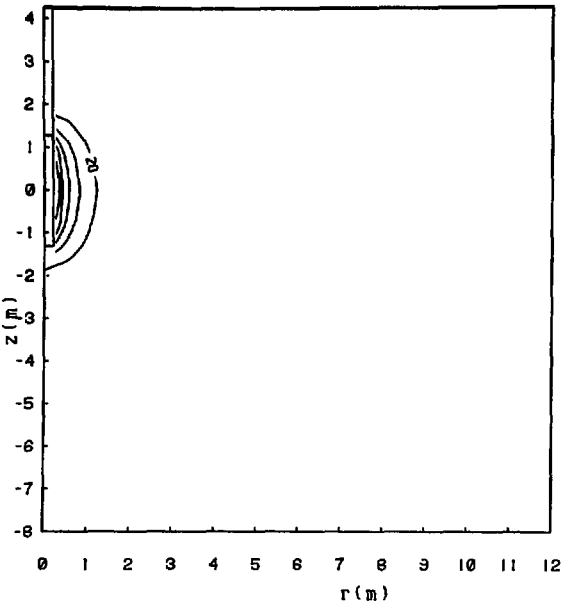
time = 1.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	40.00

model: ISOT SSET3 calculated 08/18/78

XBL 788-10562

Fig. 52a



temperature rise (°C)

STRIPA FULL SCALE I - ONE HEATER 3.6KW

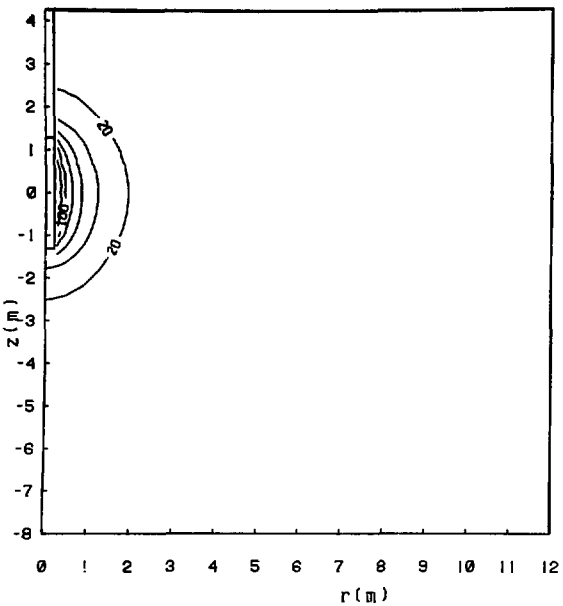
time = 7.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	100.0

model: ISOT SSET3 calculated 08/18/78

XBL 788-10557

Fig. 52b



temperature rise (°C)

STRIPA FULL SCALE I - ONE HEATER 3.6KW

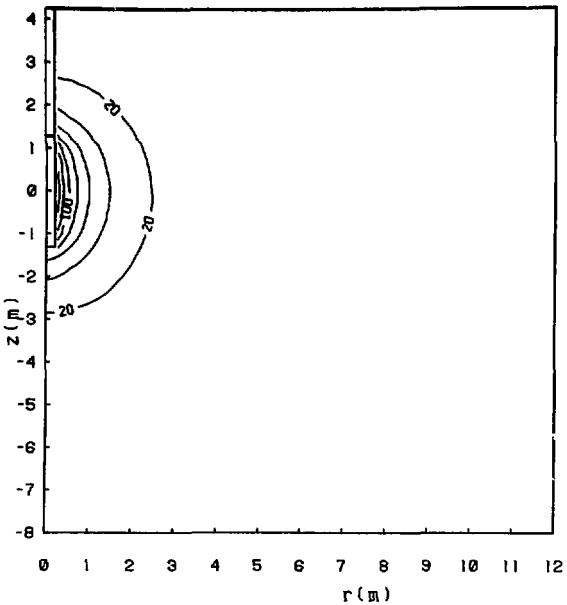
time = 30.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	120.0

model: ISOT SSET3 calculated 08/18/78

XBL 788-10560

Fig. 52c



temperature rise (°C)

STRIPA FULL SCALE I - ONE HEATER 3.6KW

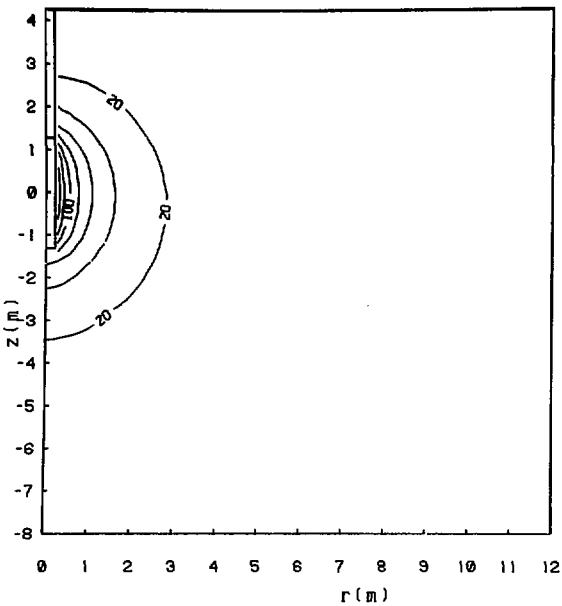
time = 90.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	140.0

model: ISOT SSET3 calculated 08/18/78

XBL 788-10558

Fig. 52d



temperature rise (°C)

STRIPA FULL SCALE 1 - ONE HEATER 3.6KW

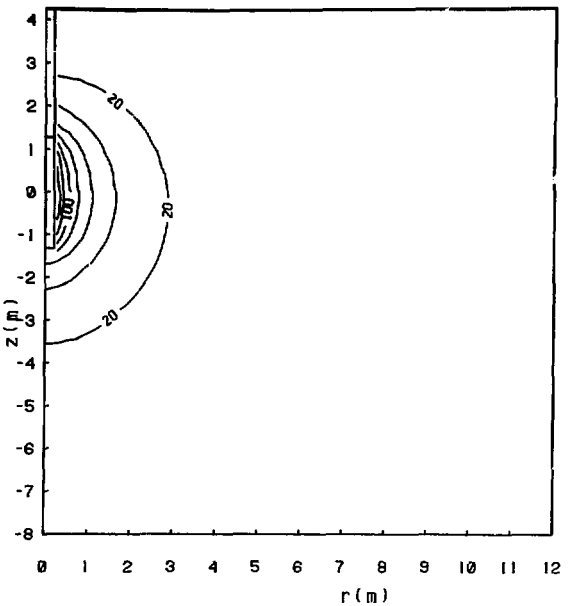
time = 360.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	140.0

model: ISOT SSET3 calculated 08/18/78

XBL 788-10590

Fig. 52e



temperature rise (°C)

STRIPA FULL SCALE I - ONE HEATER 3.6KW

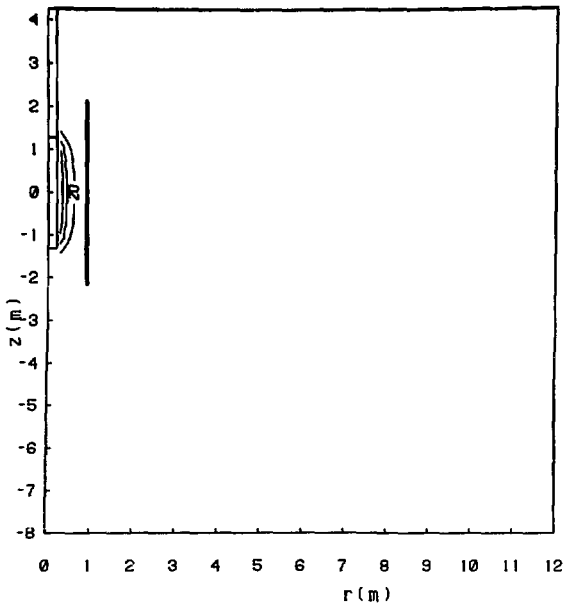
time = 730.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	140.0

model: ISOT SSET3 calculated 08/18/78

XBL 788-10592

Fig. 52f



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

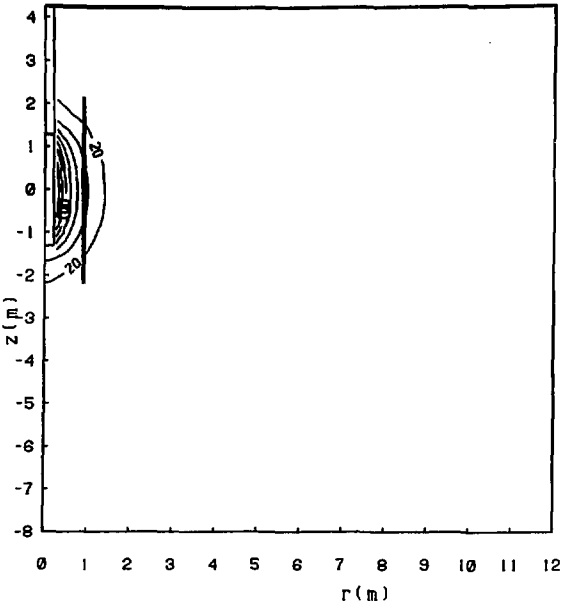
time = 1.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	60.00

model: INFI SSET3 calculated 08/18/78

XBL 788-10580

Fig. 53a



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

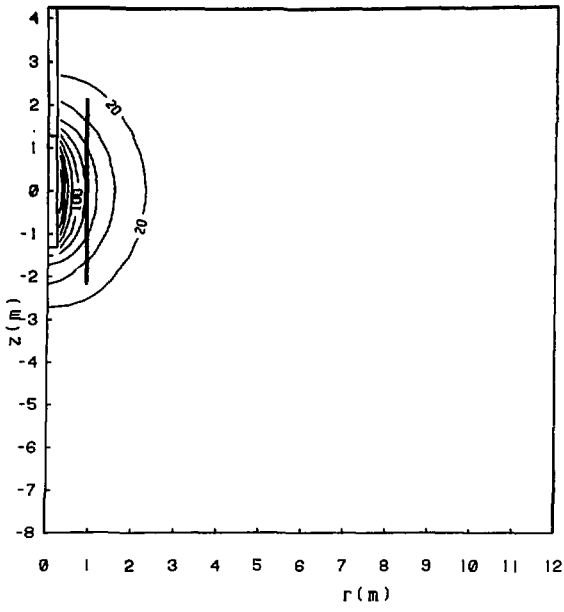
time = 7.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	140.0

model: INFI SSET3 calculated 08/18/78

XBL 788-10579

Fig. 53b



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

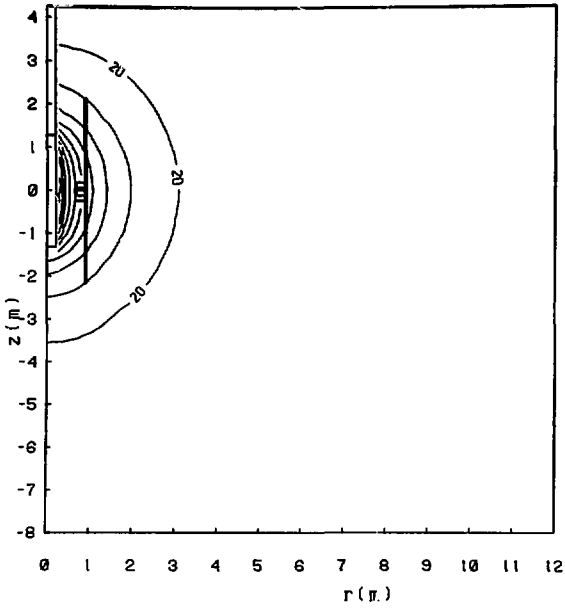
time = 30.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	180.0

model: INFI SSET3 calculated 08/18/78

XBL 788-10577

Fig. 53c



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

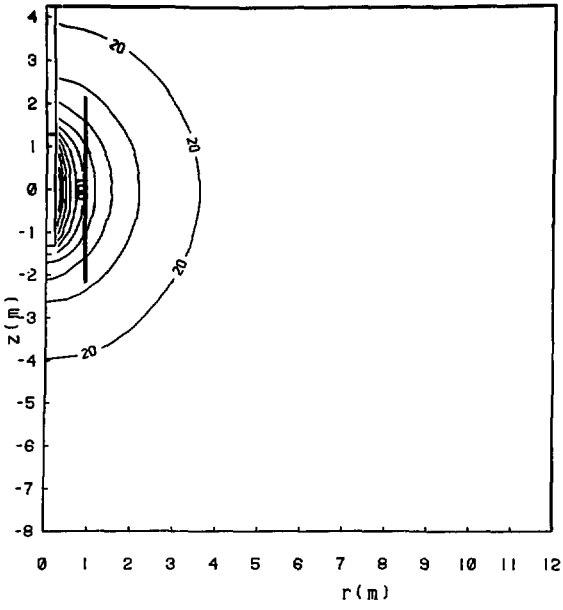
time = 90.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	200.0

model: INFI SSET3 calculated 08/18/78

XBL 788-10575

Fig. 53d



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

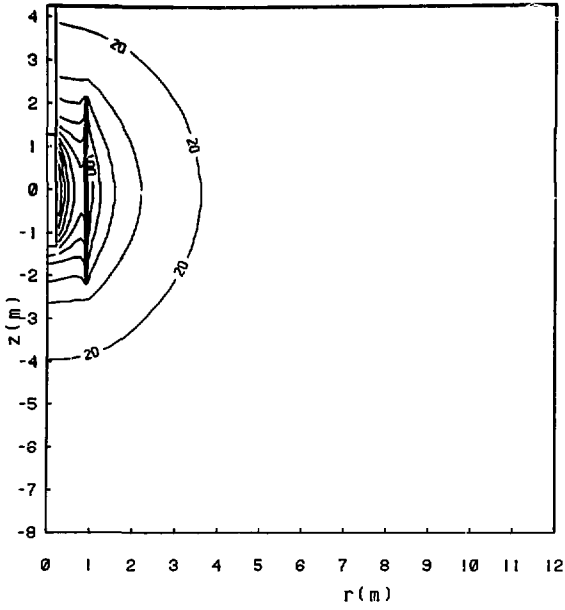
time = 180.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	200.0

model: INFI SSET3 calculated 08/18/78

XBL 788-10573

Fig. 53e



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

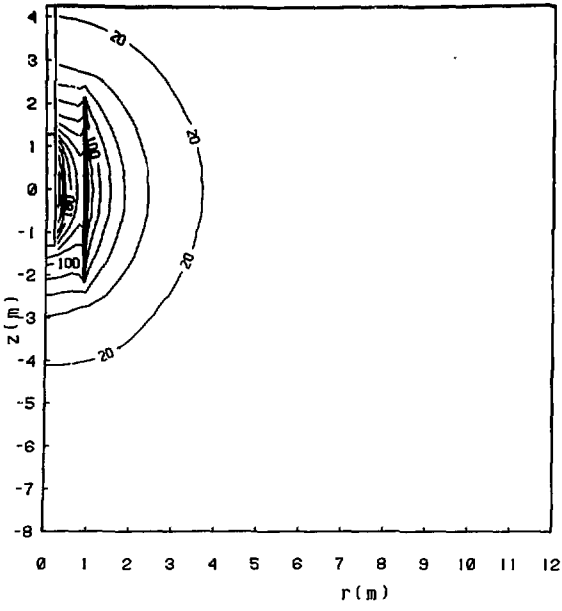
time = 181.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	200.0

model: INFI SSET3 calculated 08/18/78

XBL 788-10574

Fig. 53f



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

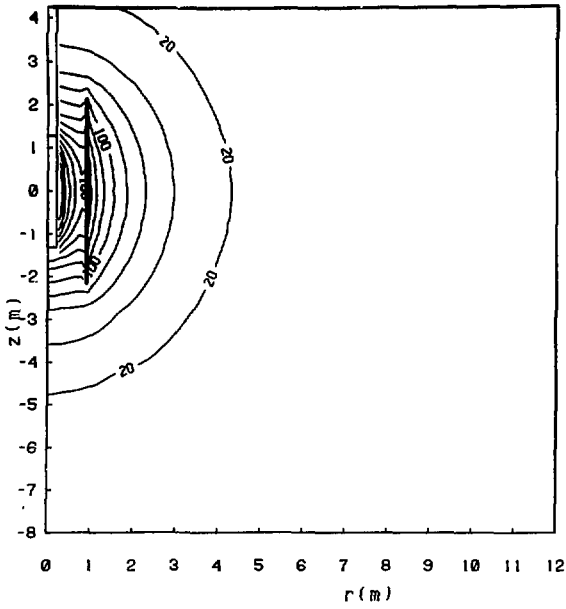
time = 187.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	240.0

model: INFI SSET3 calculated 08/18/78

XBL 788-10576

Fig. 53g



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

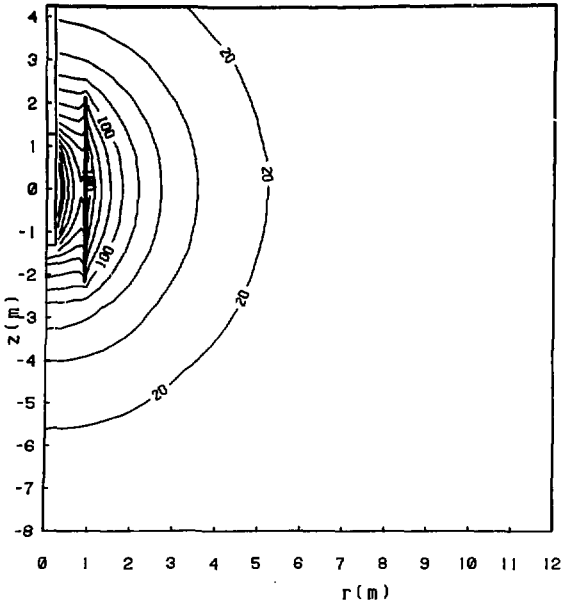
time = 210.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	260.0

model: INFI SSET3 calculated 08/18/78

XBL 788-10595

Fig. 53h



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

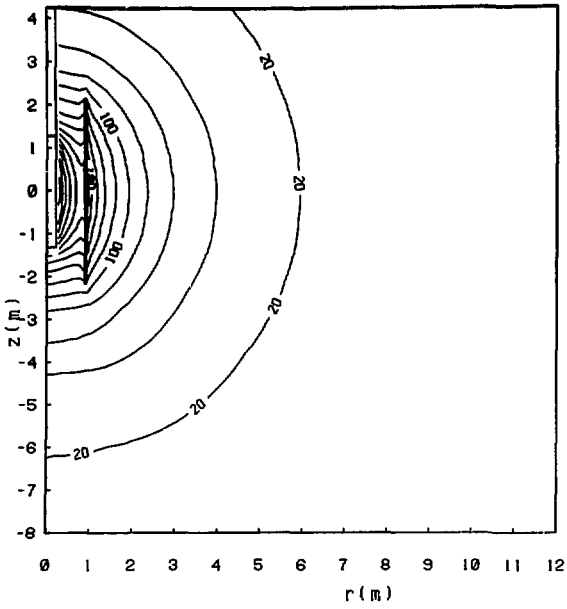
time = 270.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	280.0

model: INFI SSET3 calculated 08/18/78

XBL 788-10594

Fig. 53i



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

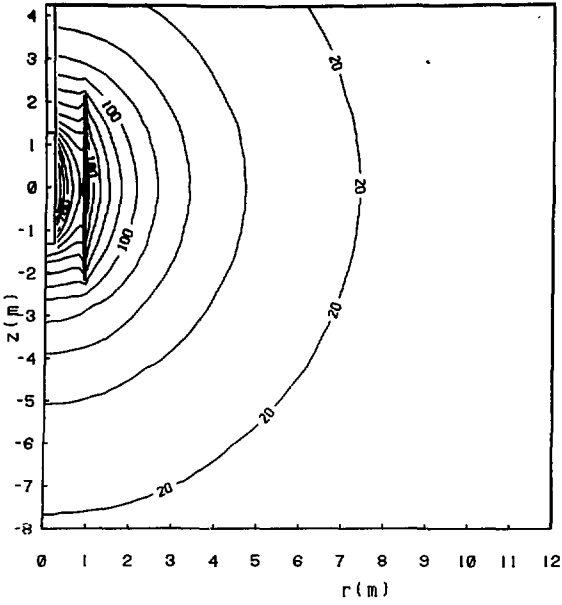
time = 360.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	300.0

model: INFI SSET3 calculated 08/18/78

XBL 788-10593

Fig. 53j



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

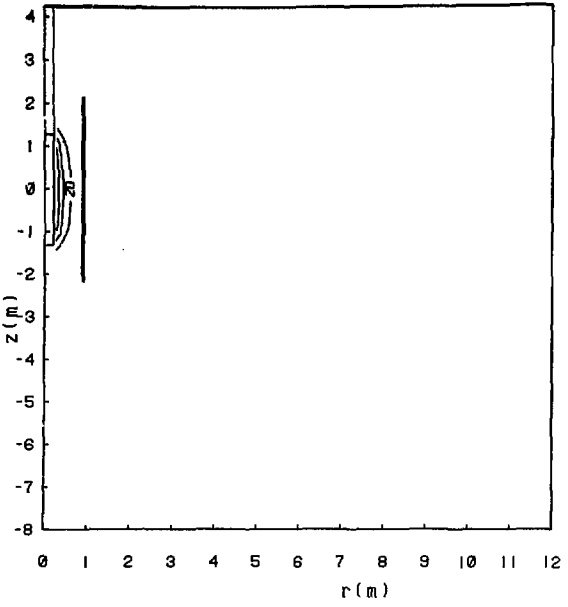
time = 730.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	300.0

model: INFI SSET3 calculated 08/18/78

XBL 788-10596

Fig. 53k



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

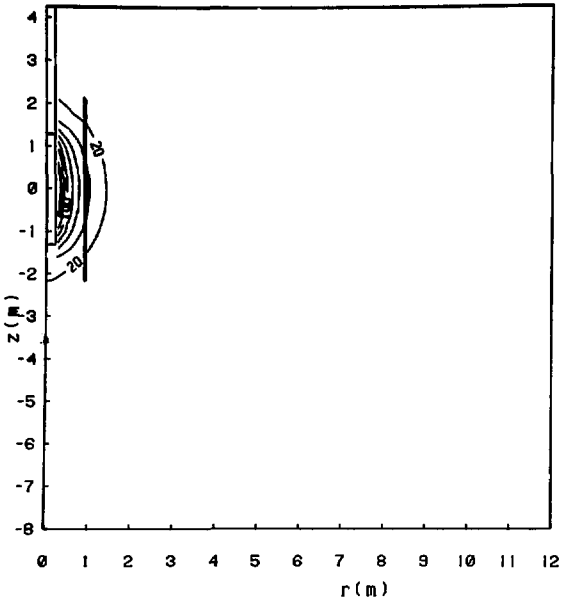
time = 1.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	60.00

model: ISOT SSET3 calculated 08/18/78

XBL 788-10591

Fig. 54a



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

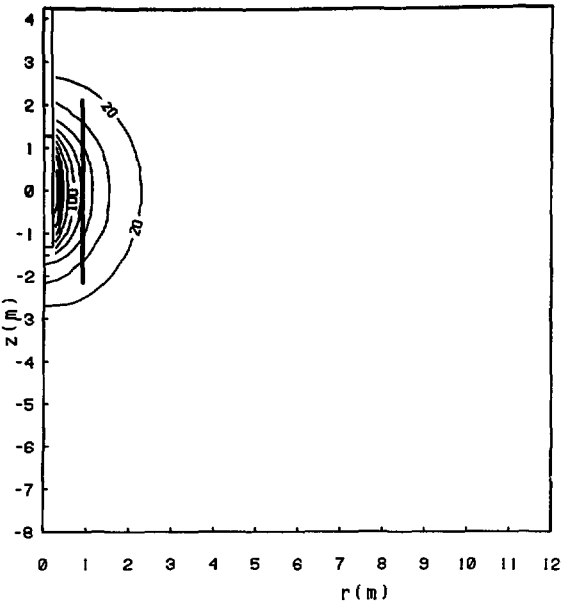
time = 7.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	140.0

model: ISOT SSET3 calculated 08/18/78

XBL 788-10589

Fig. 54b



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

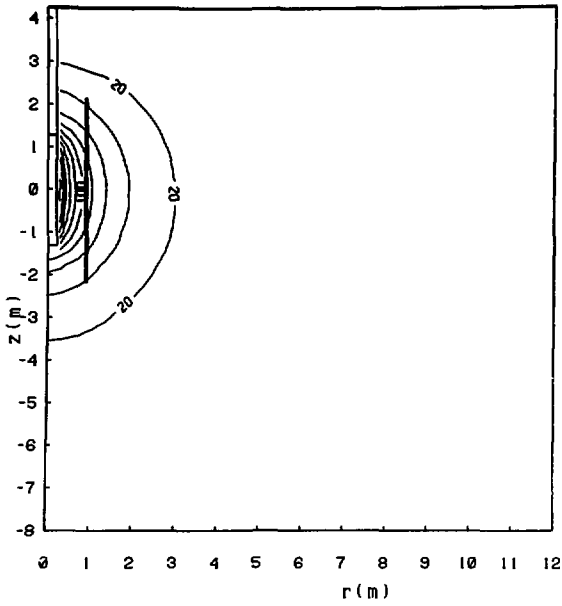
time = 30.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	180.0

model: ISOT SSET3 calculated 08/18/78

XBL 788-10586

Fig. 54c



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

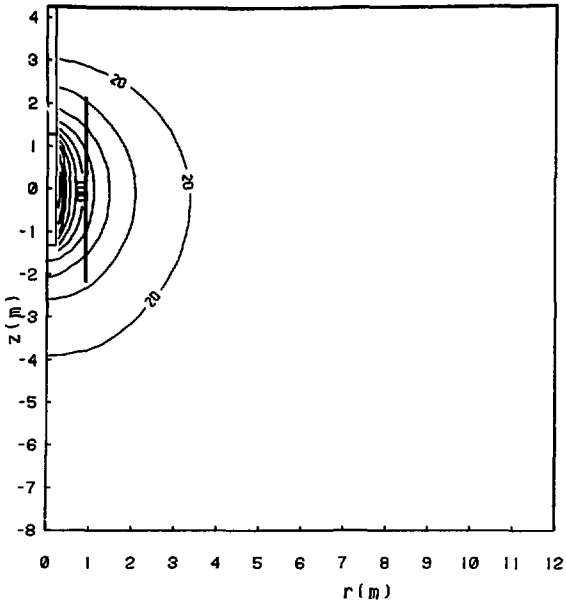
time = 90.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	200.0

model: ISOT SSET3 . calculated 08/18/78

XBL 788-10588

Fig. 54d



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

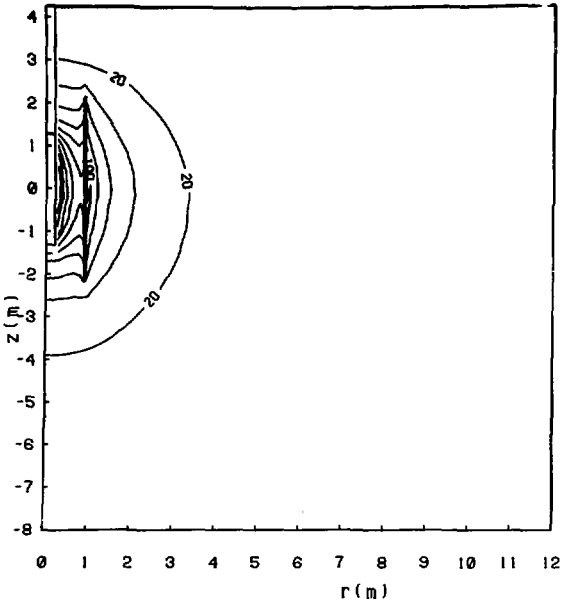
time = 180.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	200.0

model: ISOT SSET3 calculated 08/18/78

XBL 788-10585

Fig. 54e



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

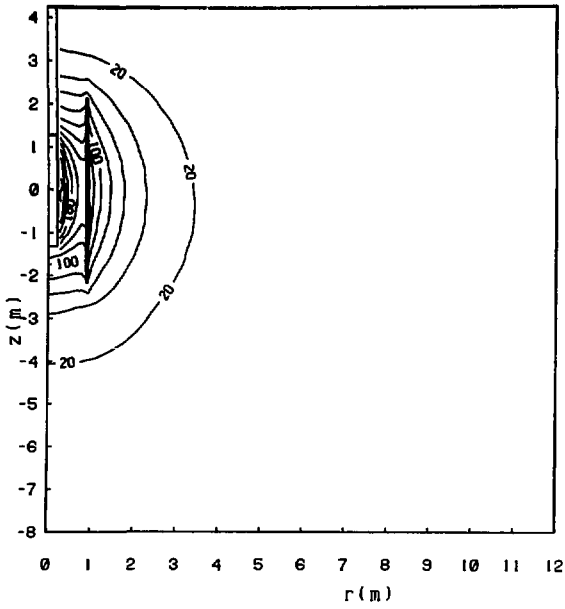
time = 181.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	200.0

model: ISOT SSET3 calculated 08/18/78

XBL 788-10587

Fig. 54f



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

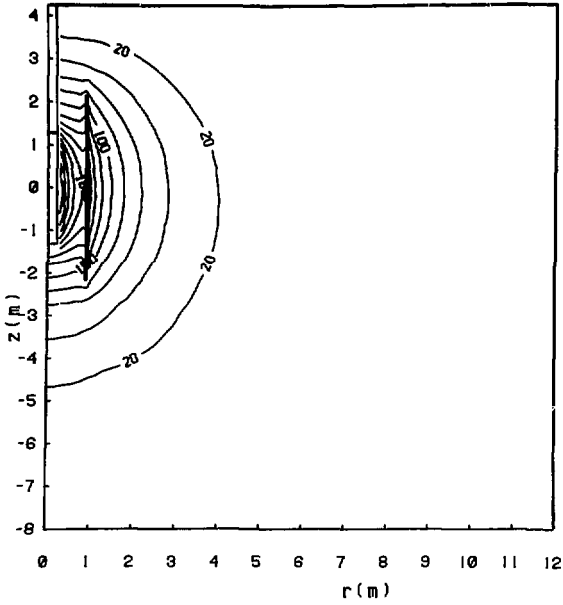
time = 187.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	240.0

model: ISOT SSET3 calculated 08/18/78

XBL 788-10581

Fig. 54g



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

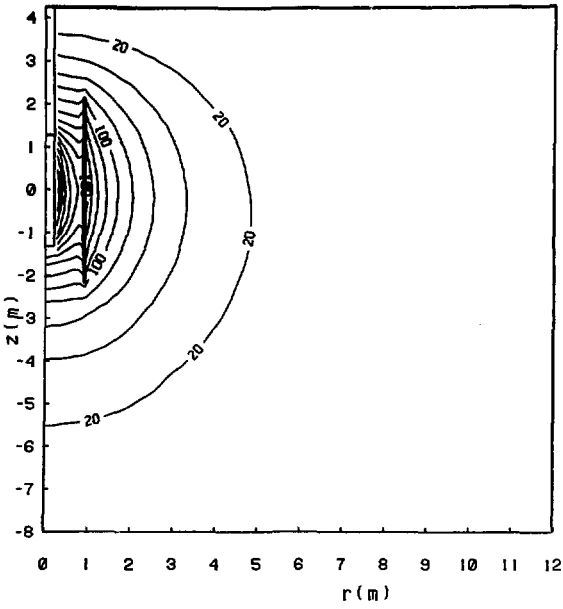
time = 210.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	260.0

model: ISOT SSET3 calculated 08/18/78

XBL 788-10583

Fig. 54h



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

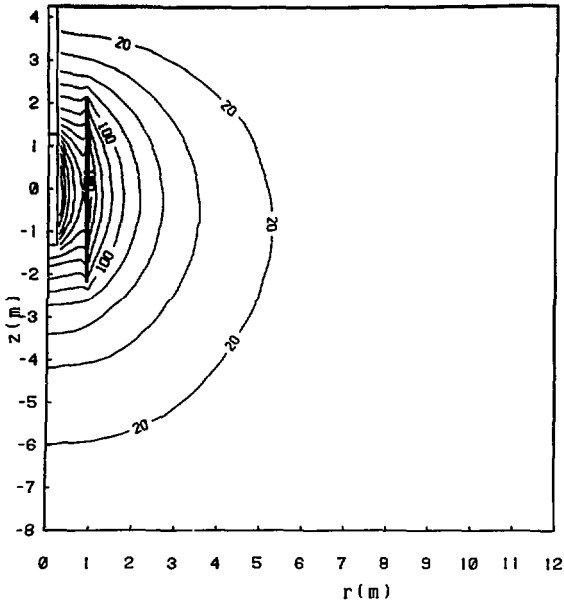
time = 270.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	280.0

model: ISOT SSET3 calculated 08/18/78

XCL 788-10584

Fig. 54i



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

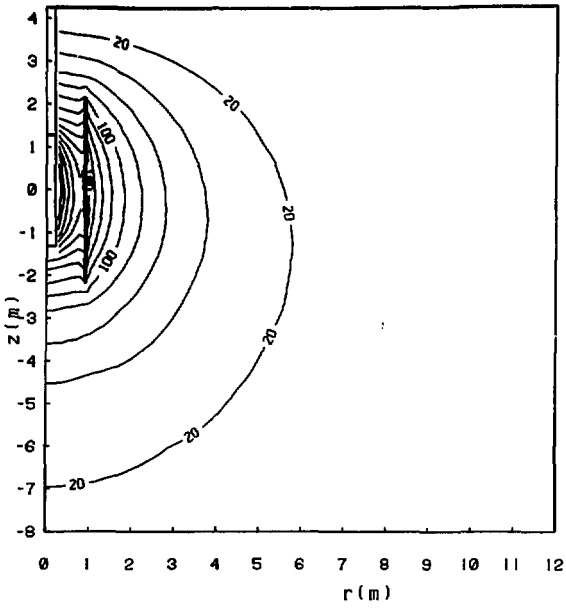
time = 360.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	280.0

model: ISDT SSET3 calculated 08/18/78

XBL 788-10582

Fig. 54j



temperature rise (°C)

STRIPA FULL SCALE 2 - 5KW CENTRAL HEATER + PERIPHERALS

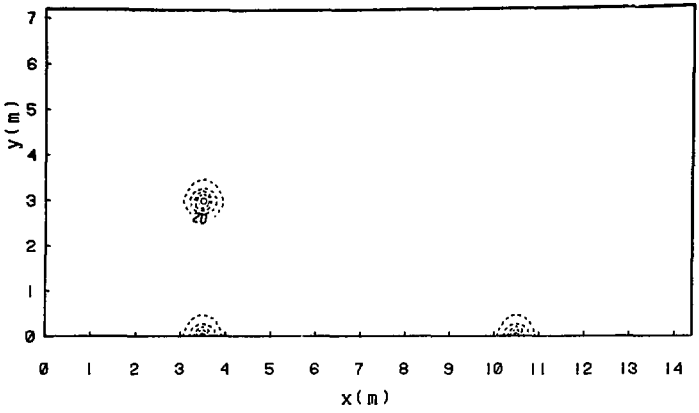
time = 730.000 θ = 0.000 °

contour interval	lowest level	highest level
20.00	20.00	280.0

model: ISOT SSET3 calculated 08/18/78

XBL 788-10578

Fig. 54k



temperature rise (°C)

Horizontal section
STRIPA TIME SCALE

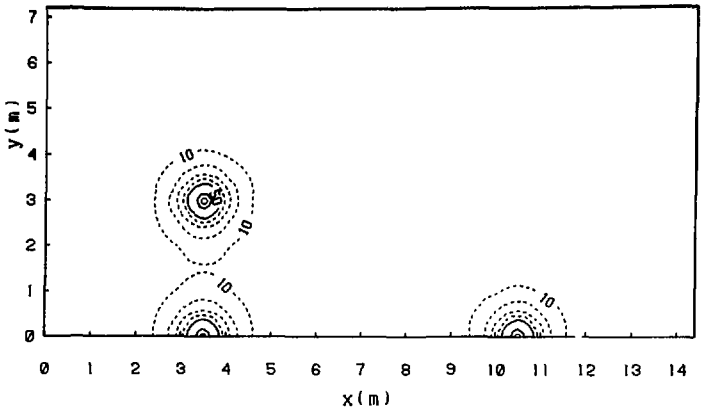
time = .980 z = 0.000 m

	contour interval	lowest level	highest level
Solid lines:	100.0	100.0	100.0
Dashed lines:	20.00	20.00	80.00

calculated 04/19/78

XBL 788-10552

Fig. 55a



temperature rise (°C)

Horizontal section

STRIPA TIME SCALE

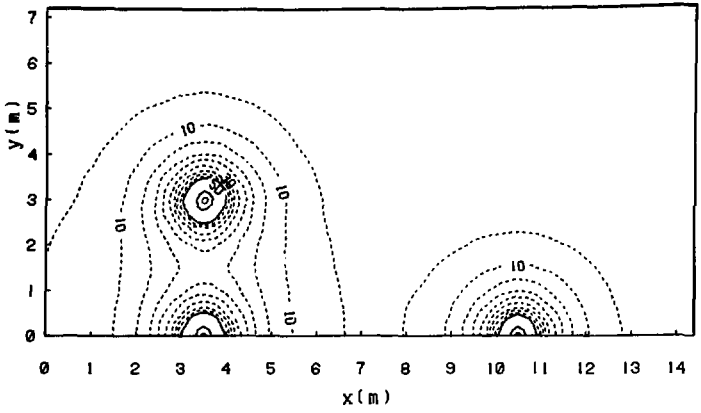
time = 6.850 z = 0.000 m

	contour interval	lowest level	highest level
Solid lines:	50.00	50.00	100.0
Dashed lines:	10.00	10.00	40.00

calculated 04/19/78

XBL 788-10546

Fig. 55b



temperature rise (°C)

Horizontal section

STRIPA TIME SCALE

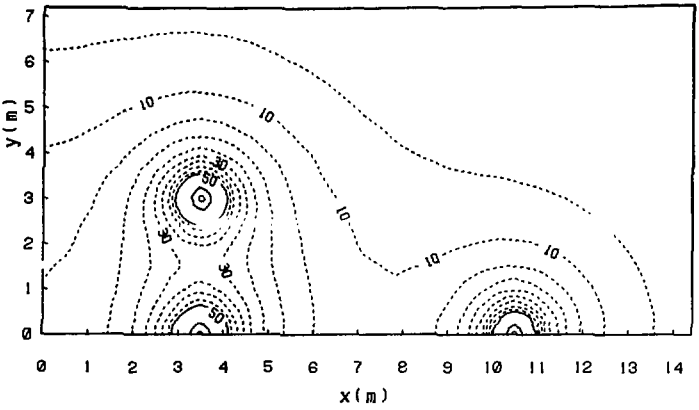
time = 29.350 z = 0.000 m

	contour interval	lowest level	highest level
Solid lines:	50.00	50.00	100.0
Dashed lines:	5.000	5.000	45.00

calculated 04/19/78

XBL 788-10543

Fig. 55c



temperature rise (°C)

Horizontal section

STRIPA TIME SCALE

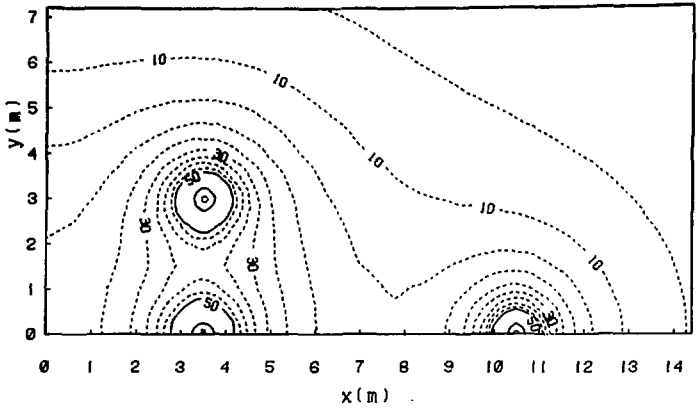
time = 90.000 z = 0.000 m

	contour interval	lowest level	highest level
Solid lines:	50.00	50.00	150.0
Dashed lines:	5.000	5.000	45.00

calculated 04/19/78

XBL 788-10541

Fig. 55d



temperature rise (°C)

Horizontal section
STRIPA TIME SCALE

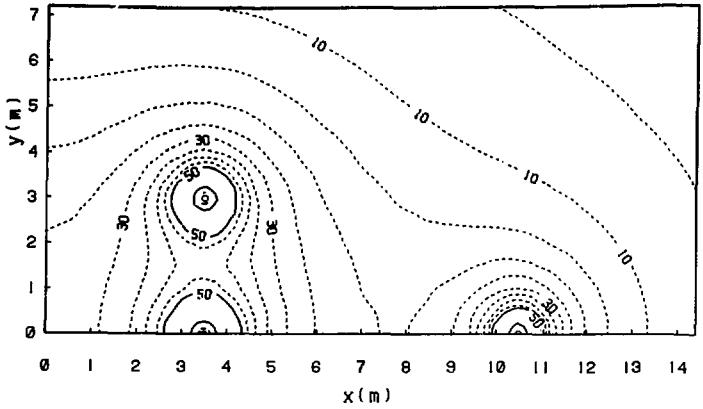
time = 180.000 z = 0.000 m

	contour interval	lowest level	highest level
Solid lines:	50.00	50.00	150.0
Dashed lines:	5.000	5.000	45.00

calculated 04/19/78

XBL 788-10535

Fig. 55e



temperature rise (°C)

Horizontal section
STRIPA TIME SCALE

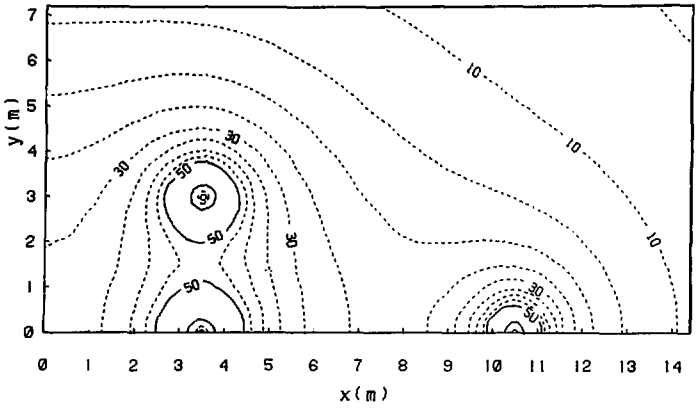
time = 360.000 z = 0.000 m

	contour interval	lowest level	highest level
Solid lines:	50.00	50.00	150.0
Dashed lines:	5.000	5.000	45.00

calculated 04/19/78

XBL 788-10538

Fig. 55f



temperature rise (°C)

Horizontal section
STRIPA TIME SCALE

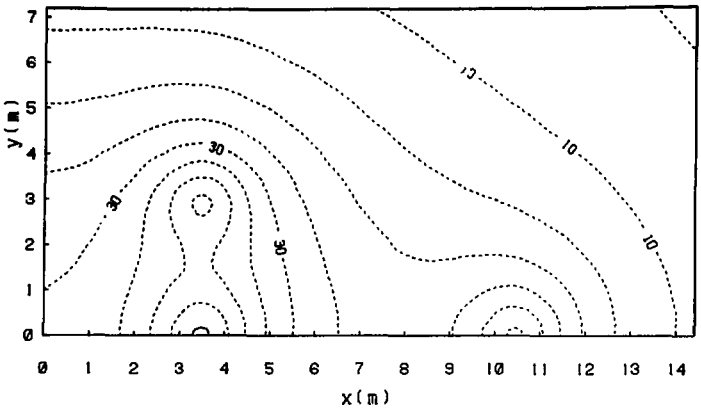
time = 730.000 z = 0.000 m

	contour interval	lowest level	highest level
Solid lines:	50.00	50.00	150.0
Dashed lines:	5.000	5.000	45.00

calculated 04/19/78

XBL 788-10530

Fig. 55g



temperature rise (°C)

Horizontal section
STRIPA TIME SCALE

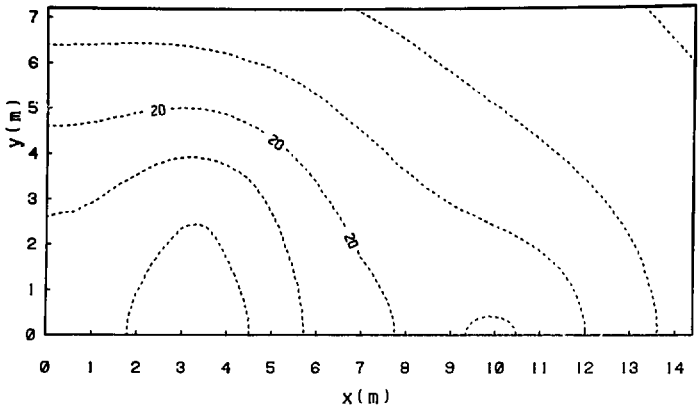
time = 730.000 z = 1.000 m

	contour interval	lowest level	highest level
Solid lines:	50.00	50.00	50.00
Dashed lines:	5.000	5.000	45.00

calculated 04/19/78

XBL 788-10529

Fig. 56a



temperature rise (°C)

Horizontal section
STRIPA TIME SCALE

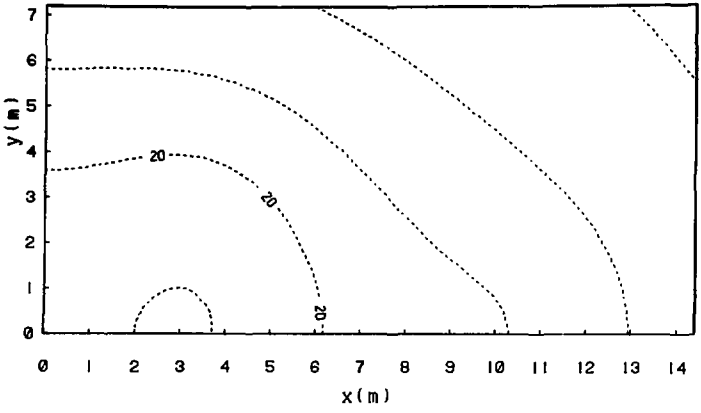
time = 730.000 z = 2.000 m

contour interval	lowest level	highest level
5.000	5.000	30.00

calculated 04/19/78

XBL 788-10525

Fig. 56b



temperature rise (°C)

Horizontal section
STRIPA TIME SCALE

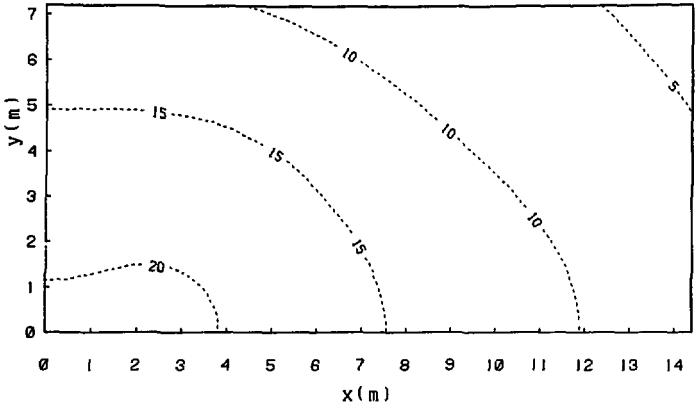
time = 730.000 z = 3.000 m

contour interval	lowest level	highest level
5.000	5.000	25.00

calculated 04/19/78

XBL 788-10528

Fig. 56c



temperature rise (°C)

Horizontal section
STRIPA TIME SCALE

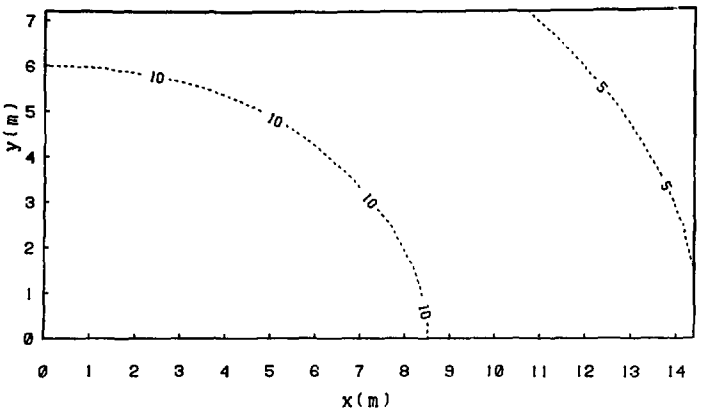
time = 730.000 z = 4.000 m

contour interval	lowest level	highest level
5.000	5.000	20.00

calculated 04/19/78

XBL 788-10523

Fig. 56d



temperature rise (°C)

Horizontal section
STRIPA TIME SCALE

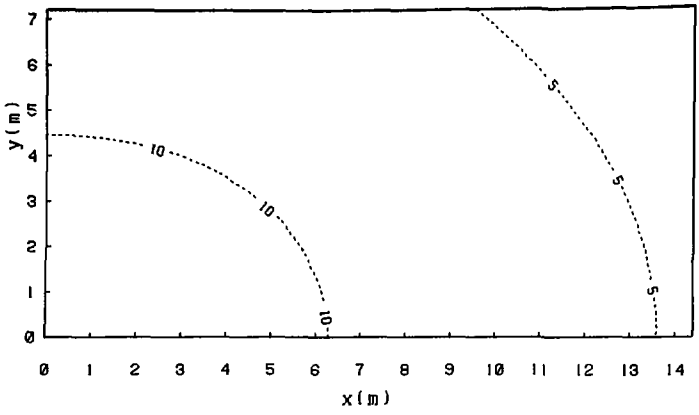
time = 730.000 z = 6.000 m

contour interval	lowest level	highest level
5.000	5.000	10.00

calculated 04/19/78

XBL 788-10527

Fig. 56e



temperature rise (°C)

Horizontal section

STRIPA TIME SCALE

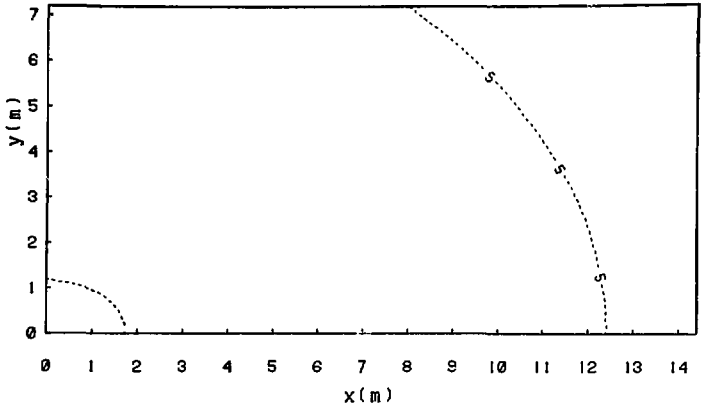
time = 730.000 z = 7.000 m

contour interval	lowest level	highest level
5.000	5.000	10.00

calculated 04/19/78

XBL 788-10526

Fig. 56f



temperature rise (°C)

Horizontal section

STRIPA TIME SCALE

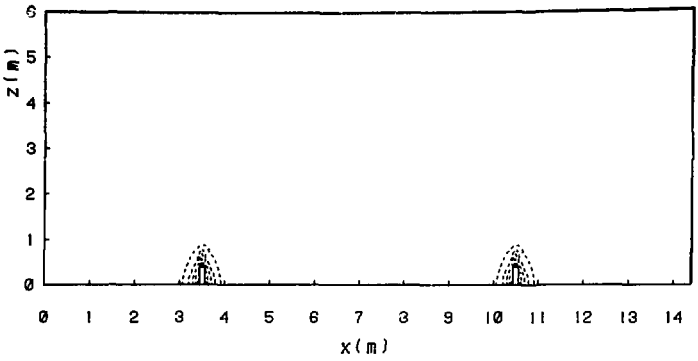
time = 730.000 z = 8.000 m

contour interval	lowest level	highest level
5.000	5.000	10.00

calculated 04/19/78

XBL 788-10524

Fig. 56g



temperature rise (°C)

Vertical section through H1, H2, H3, and H4
STRIPA TIME SCALE

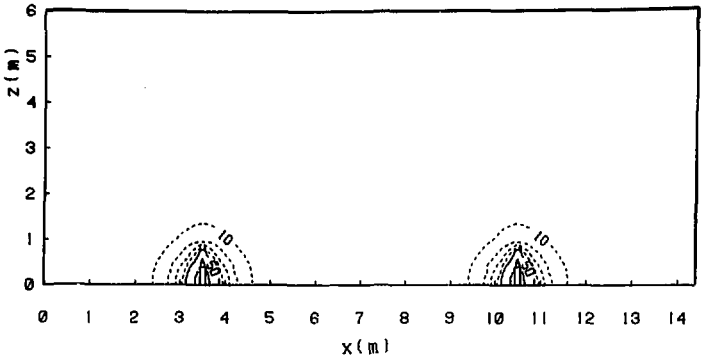
time = .980 y = 0.000 m

	contour interval	lowest level	highest level
Solid lines:	100.0	100.0	100.0
Dashed lines:	20.00	20.00	80.00

calculated 04/19/78

XBL 788-10548

Fig. 57a



temperature rise (°C)

Vertical section through H1, H2, H3, and H4
STRIPA TIME SCALE

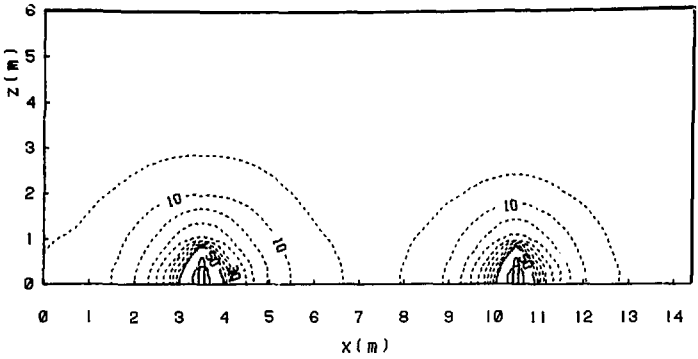
time = 6.850 y = 0.000 m

	contour interval	lowest level	highest level
Solid lines:	50.00	50.00	100.0
Dashed lines:	10.00	10.00	40.00

calculated 04/19/78

XBL 788-10550

Fig. 57b



temperature rise (°C)

Vertical section through H1, H2, H3, and H4
STRIPA TIME SCALE

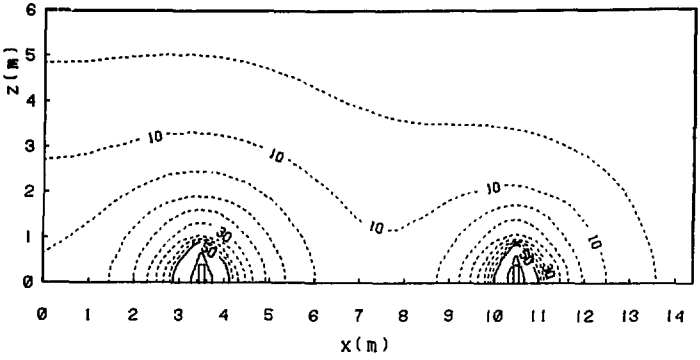
time = 29.350 y = 0.000 m

	contour interval	lowest level	highest level
Solid lines:	50.00	50.00	150.0
Dashed lines:	5.000	5.000	45.00

calculated 04/19/78

XBL 788-10545

Fig. 57c



temperature rise (°C)

Vertical section through H1, H2, H3, and H4
STRIPA TIME SCALE

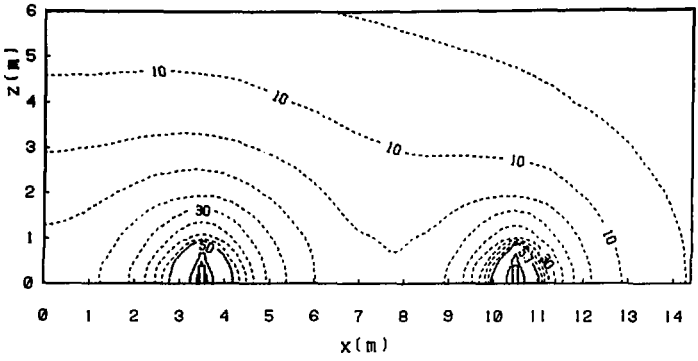
time = 90.000 y = 0.000 m

	contour interval	lowest level	highest level
Solid lines:	50.00	50.00	150.0
Dashed lines:	5.000	5.000	45.00

calculated 04/19/78

XBL 788-10542

Fig. 57d



temperature rise (°C)

Vertical section through H1, H2, H3, and H4
STRIPA TIME SCALE

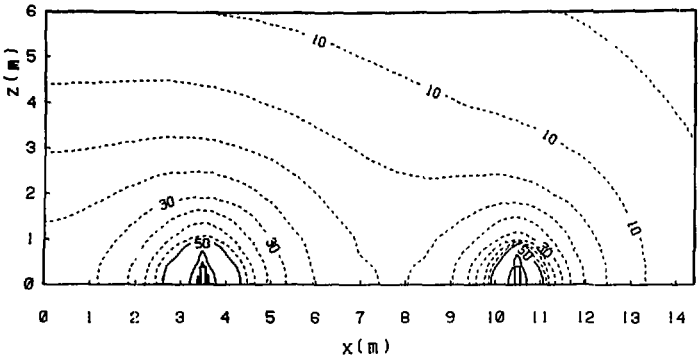
time = 180.000 y = 0.000 m

	contour interval	lowest level	highest level
Solid lines:	50.00	50.00	150.0
Dashed lines:	5.000	5.000	45.00

calculated 04/19/78

XBL 788-10539

Fig. 57e



temperature rise (°C)

Vertical section through H1, H2, H3, and H4
STRIPA TIME SCALE

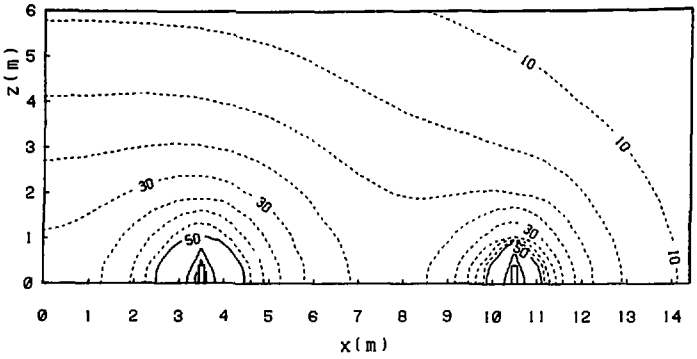
time = 360.000 y = 0.000 m

	contour interval	lowest level	highest level
Solid lines:	50.00	50.00	150.0
Dashed lines:	5.000	5.000	45.00

calculated 04/19/78

XBL 788-10537

Fig. 57f



temperature rise (°C)

Vertical section through H1, H2, H3, and H4
STRIPA TIME SCALE

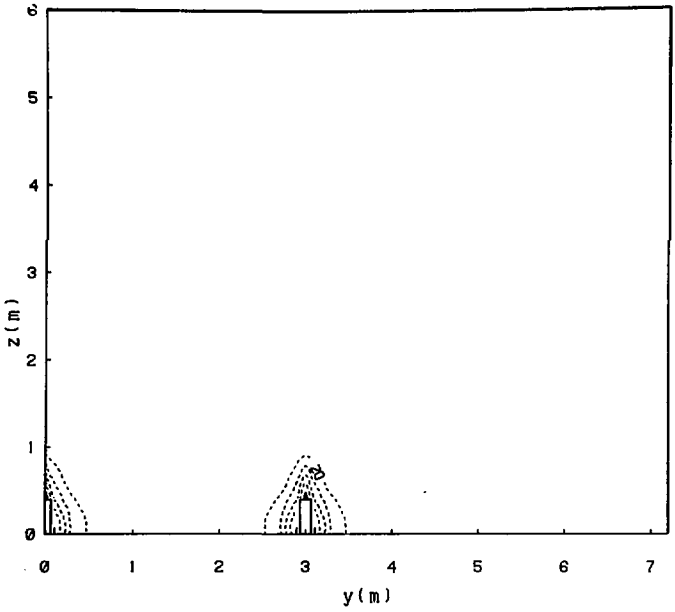
time = 730.000 y = 0.000 m

	contour interval	lowest level	highest level
Solid lines:	50.00	50.00	150.0
Dashed lines:	5.000	10.00	45.00

calculated 04/19/78

XBL 788-10532

Fig. 57g



temperature rise (°C)

Vertical section through H3, H6, and H8

STRIPA TIME SCALE

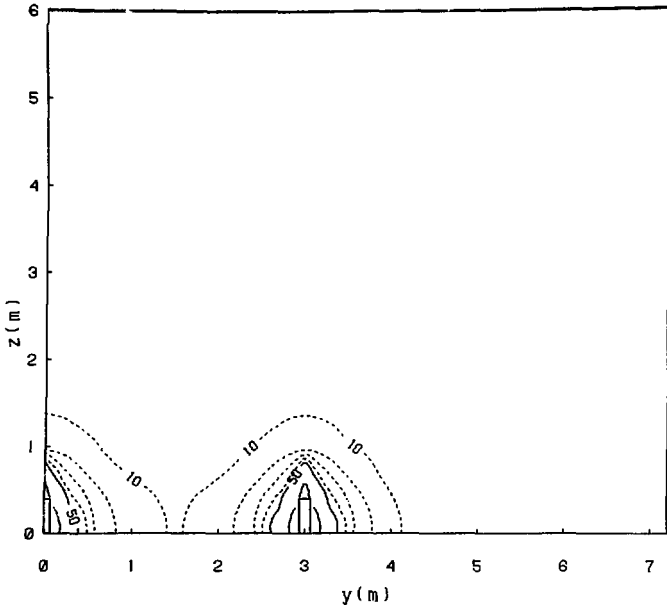
time = .980 x = 3.500 m

	contour interval	lowest level	highest level
Solid lines:	100.0	100.0	100.0
Dashed lines:	20.00	20.00	80.00

calculated 04/19/78

XBL 788-10549

Fig. 58a



temperature rise (°C)

Vertical section through H3, H6, and H8
STRIPA TIME SCALE

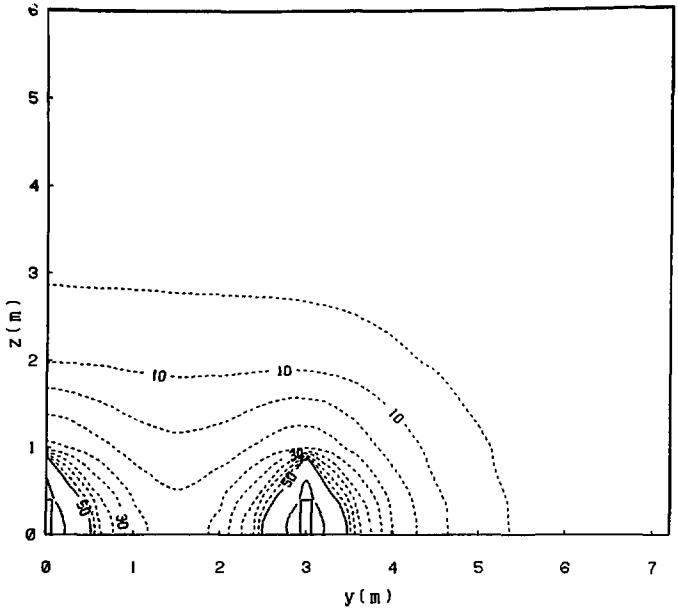
time = 6.850 x = 3.500 m

	contour interval	lowest level	highest level
Solid lines:	50.00	50.00	100.0
Dashed lines:	10.00	10.00	40.00

calculated 04/19/78

XBL 788-10551

Fig. 58b



temperature rise (°C)

Vertical section through H3, H6, and H8
STRIPA TIME SCALE

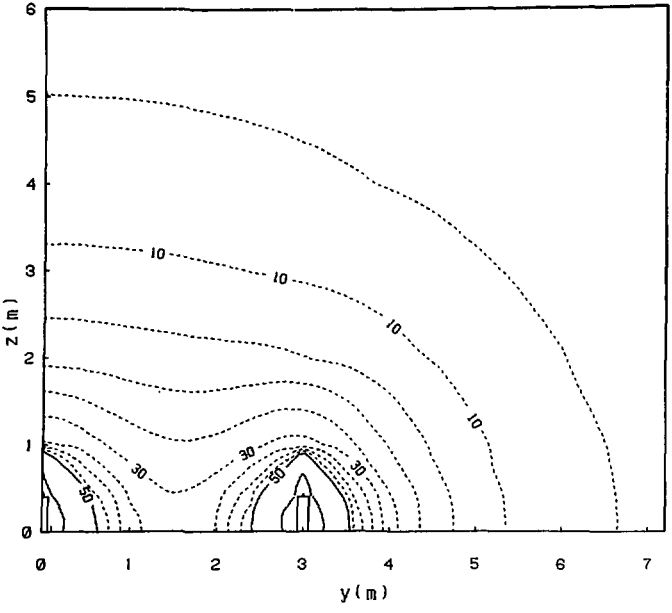
time = 29.350 x = 3.500 m

	contour interval	lowest level	highest level
Solid lines:	50.00	50.00	150.0
Dashed lines:	5.000	5.000	45.00

calculated 04/19/78

XBL 788-10544

Fig. 58c



temperature rise (°C)

Vertical section through H3, H6, and H8
STRIPA TIME SCALE

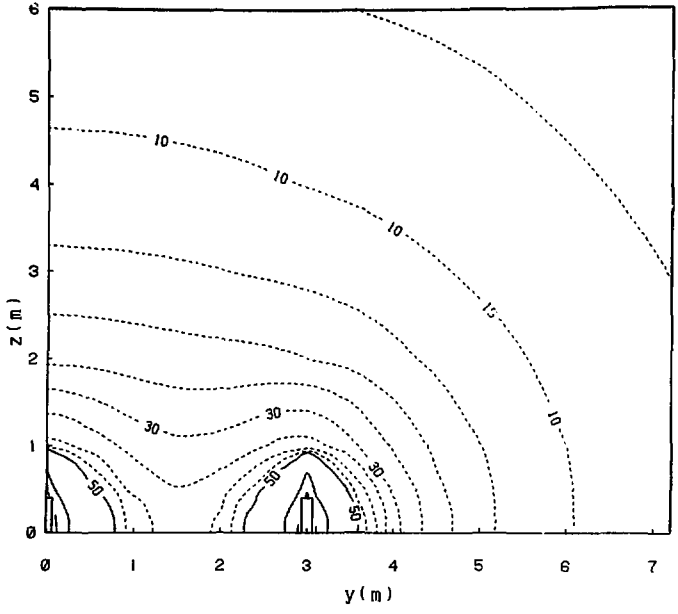
time = 90.000 x = 3.500 m

	contour interval	lowest level	highest level
Solid lines:	50.00	50.00	150.0
Dashed lines:	5.000	5.000	45.00

calculated 04/19/78

XBL 788-10547

Fig. 58d



temperature rise (°C)

Vertical section through H3, H6, and H8
STRIPA TIME SCALE

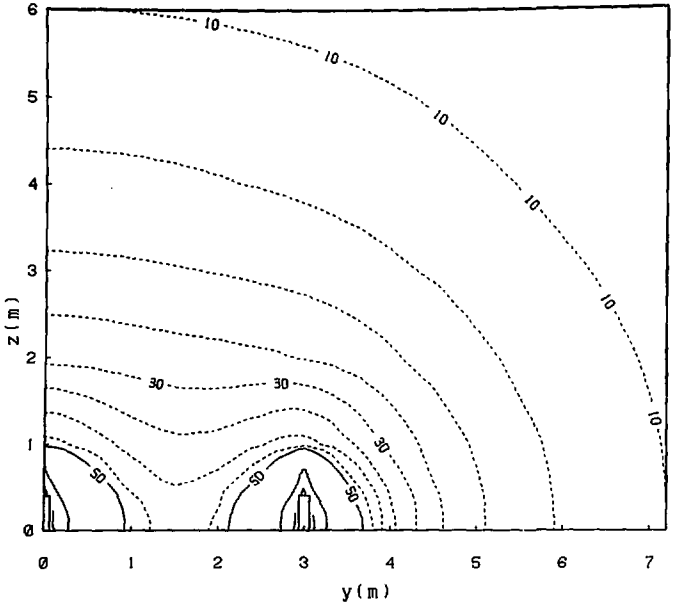
time = 180.000 x = 3.500 m

	contour interval	lowest level	highest level
Solid lines:	50.00	50.00	150.0
Dashed lines:	5.000	5.000	45.00

calculated 04/19/78

XBL 788-10540

Fig. 58e



temperature rise (°C)

Vertical section through H3, H6, and H8
STRIPA TIME SCALE

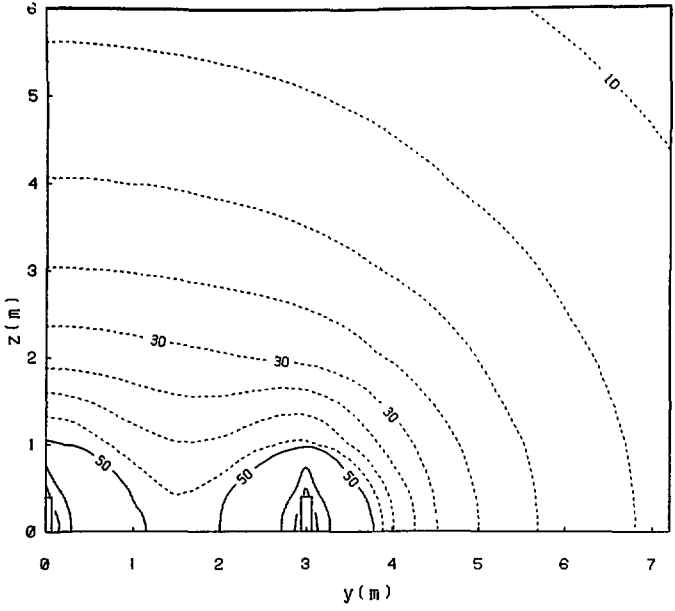
time = 360.000 x = 3.500 m

	contour interval	lowest level	highest level
Solid lines:	50.00	50.00	150.0
Dashed lines:	5.000	10.00	45.00

calculated 04/19/78

XBL 788-10536

Fig. 58f



temperature rise (°C)

Vertical section through H3, H6, and H8
STRIPA TIME SCALE

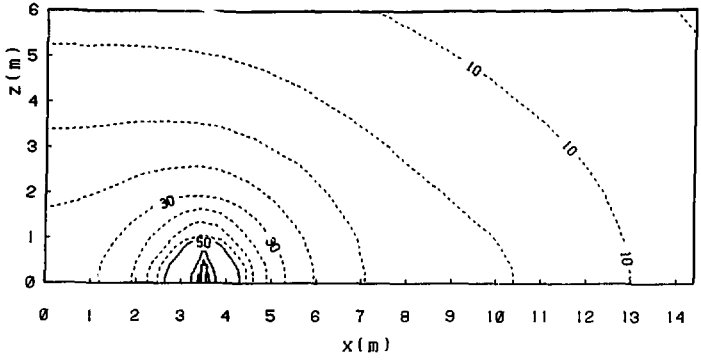
time = 730.000 x = 3.500 m

	contour interval	lowest level	highest level
Solid lines:	50.00	50.00	150.0
Dashed lines:	5.000	10.00	45.00

calculated 04/19/78

XBL 788-10534

Fig. 58g



temperature rise (°C)

Vertical section through H5 and H6

STRIPA TIME SCALE

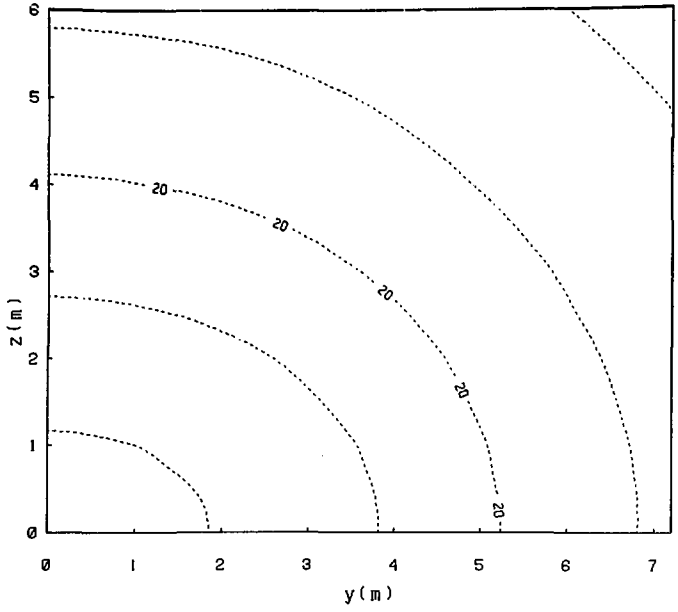
time = 730.000 y = 3.000 m

	contour interval	lowest level	highest level
Solid lines:	50.00	50.00	150.0
Dashed lines:	5.000	5.000	45.00

calculated 04/19/78

XBL 788-10531

Fig. 59a



temperature rise (°C)

Vertical section through E1 and E4
STRIPA TIME SCALE

time = 730.000 x = 0.000 m

contour interval	lowest level	highest level
5.000	10.00	30.00

calculated 04/19/78

XBL 788-10533

Fig. 59b