ENGINEERING CHANGE NOTICE

1. ECN 187403

Proj. ECN

2. ECN Category (mark one)		Supplemental	[]	Change ECN	[]	Supersedure	[]
Cancel/Void	[]	Direct Revision	[X]	Temporary	[]	Discovery	[]

3. Originator's Name, Organization, MSIN, and Telephone No. G. K. Allen/Waste Characterization Analysis/H0-34/6-2263	4. Date 10/28/92

5. Project Title/No./Work Order No. Waste Management/D46B1	6. Bldg./Sys./Fac. No. N/A	7. Impact Level 2SQ
8. Document Number Affected (include rev. and sheet no.) WHC-SD-WM-ER-064, Rev. 0	9. Related ECN No(s). N/A	10. Related PO No. N/A

11a. Modification Work [] Yes (fill out Blk. 11b) [X] No (NA Blks. 11b, 11c, 11d)	11b. Work Package Doc. No. NA	11c. Complete Installation Work NA Cog. Engineer Signature & Date	11d. Complete Restoration (Temp. ECN only) NA Cog. Engineer Signature & Date

12. Description of Change

This thermal analysis updates the results of WHC-SD-WM-ER-064, Rev. 0. Changes to the document include minor dimensional changes to the grout vault as well as updated asphalt thermal properties. The asphalt thermal conductivity increased by a factor of seven which significantly altered the long term grout and structural temperatures.

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13a. Justification (mark one)		Criteria Change	[X]	Environmental	[]	Facilitate Const.	[]
Design Error/Omission	[]	Design Improvement	[]	As-Found	[]	Const. Error/Omission	[]

13b. Justification Details

Changes required to reflect updated asphalt thermal conductivity.

14. Distribution (include name, MSIN, and no. of copies) Per distribution sheet.	RELEASE STAMP OFFICIAL RELEASE BY WHC (23) DATE NOV 04 1992 Sta #21

ENGINEERING CHANGE NOTICE

187403

15. Design Verification Required	16. Cost Impact				17. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[] Yes	Additional	[] $	Additional	[] $	Improvement	[]
[X] No	Savings	[] $	Savings	[] $	Delay	[]

18. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 12. Enter the affected document number in Block 19.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]		[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

19. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision

20. Approvals

Signature	Date	Signature	Date
OPERATIONS AND ENGINEERING		ARCHITECT-ENGINEER	
Cog./Project Engineer G. K. Allen *G K Allen*	28 OCT 92	PE	
Cog./Project Engr. Mgr. W. L. Knecht *W L Knecht*	10/28/92	QA	
QA R. L. Meador } APPROVAL SIGNATURES ON EDT 159257, SEE SHEET 3		Safety	
Safety G. H. Weissberg		Design	
Security		Other	
Proj. Prog./Dept. Mgr.			
Def. React. Div.			
Chem. Proc. Div.			
Def. Wst. Mgmt. Div.		DEPARTMENT OF ENERGY	
Adv. React. Dev. Div.			
Proj. Dept.			
Environ. Div.		ADDITIONAL	
IRM Dept.			
Facility Rep. (Ops.)			
Other			

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PAGE 3 OF 3, ECN 187403

ENGINEERING DATA TRANSMITTAL

1. EDT 159257

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) Waste Characterization Analysis	4. Related EDT No.: 121687
5. Proj./Prog./Dept./Div.: Waste Management 23230	6. Cog. Engr.: G. K. Allen	7. Purchase Order No.: N/A

8. Originator Remarks:
Item #1 is transmitted for approval. Item #2, the Engineering Notebook, provides supporting information and includes documentation of the independent review. It is available for review from Gail Allen, 6-2263, Waste Characterization Analysis.

9. Equip./Component No.: N/A

10. System/Bldg./Facility: N/A

11. Receiver Remarks:

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12. Major Assm. Dwg. No.: N/A

13. Permit/Permit Application No.: N/A

14. Required Response Date: 6/19/92

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Impact Level	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-WM-ER-064		1	Grout Vault Heat Transfer Results for M-106 Grout Formulation	2SQ	1	1	
2	WCA-92-003		N/A	Task Record, Grout Vault Heat Transfer Results for M-106 Grout Formulation	2SQ	N/A	N/A	N/A

16. KEY

Impact Level (F)	Reason for Transmittal (G)	Disposition (H) & (I)
1, 2, 3, or 4 (see MRP 5.43)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Impact Level for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
1		Cog.Eng. G. K. Allen	G K Allen	9JUN92	H0-34
1		Cog. Mgr. W. L. Knecht	W L Knecht	6/9/92	H0-34
1		QA ~~T. K. Cordrey~~ R.L. MEADOR	R L Meador	10-23-92	S1-5K2
1	1	Safety G. H. Weissberg	G H Weissberg	8/21/92	R3-10
		Env.			

18. G. K. Allen — G K Allen 9JUN92 — Signature of EDT Originator, Date

19. Authorized Representative for Receiving Organization, Date

20. W. L. Knecht — Cognizant/Project Engineer's Manager, Date

21. DOE APPROVAL (if required) Ltr. No.
[] Approved
[] Approved w/comments
[] Disapproved w/comments

BD-7400-172-2 (07/91) GEF097

BD-7400-172-1 (02/89)

SUPPORTING DOCUMENT

1. Total Pages 21

2. Title

GROUT VAULT HEAT TRANSFER RESULTS FOR M-106 GROUT FORMULATION

3. Number

WHC-SD-WM-ER-064

4. Rev No.

1

5. Key Words

Grout Vault Heat Transfer
M-106.3 Grout Formulation

6. Author

Name: G. K. Allen

Signature: G. K. Allen 2 Nov 92

Organization/Charge Code 23230/D44C7

7. Abstract

This thermal analysis updates the results of WHC-SD-WM-ER-064, Rev. 0. Changes to the document include minor dimensional changes to the grout vault as well as updated asphalt thermal properties. The asphalt thermal conductivity increased by a factor of seven which significantly altered the long term grout and structural temperatures.

9. Impact Level 2SQ

RECORD OF REVISION	(1) Document Number WHC-SD-WM-ER-064, ~~Rev. 1~~	Page i

(2) Title
Grout Vault Heat Transfer Results for M-106 Grout Formulations

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	Authorized for Release (6) Cog. Mgr. Date
0	(7) Released per EDT 121687, November 15, 1990.	G. K. Allen	W. L. Knecht
1 RS	Minor dimensional changes on grout vault Asphalt thermal conductivity changes per	G K Allen	W L Knecht 6/9/92
	ECN 187403, 10/28/92		

A-7320-005 (08/91) (EF) WEF168

GROUT VAULT HEAT TRANSFER RESULTS FOR M-106 GROUT FORMULATION

G. K. Allen

March 1992

Westinghouse Hanford Company
P. O. Box 1970
Richland, Washington 99352

APPROVALS:

Prepared by: G. K. Allen — 9 June 92
Principal Engineer
Date

Reviewed by: B. A. Crea — 6/9/92
BCSR
Date

Approved by: W. L. Knecht, Manager — 6/9/92
Waste Characterization Analysis
Date

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FIGURES

GROUT VAULT HEAT TRANSFER RESULTS FOR M-106 GROUT FORMULATION

G. K. Allen
March 1992

1.0 INTRODUCTION

Reference 1 documented the results of a heat transfer analysis of a grout vault filled with the M-106.3 grout formulation which provides temperature input for a structural stress analysis of the grout vault. When the structural analysis model was developed, minor dimensional differences between the heat transfer model in Reference 1 and the present design drawings were noted. In addition, the asphalt thermal properties used in Reference 1 were different than the currently accepted values used in Table 1. To maintain dimensional consistency with the stress analysis models, it was decided to update Reference 1 to reflect the current design dimensions and asphalt thermal properties.

The asphalt thermal conductivity was increased by a factor of seven (Reference 2). Revision 0 indicated a second thermal peak after the initial heat of hydration peak. Because this increased asphalt thermal conductivity allowed heat to be conducted out of the vault faster, there is no second thermal peak after the initial temperature due to the heat of hydration.

2.0 ASSUMPTIONS

The assumptions are broken into three sections. The first section discusses physical model dimensions, the second section discusses material thermal properties, and the third section discusses boundary conditions. All assumptions for this model are identical to the assumptions of the model developed in Reference 1 except in the areas discussed below. The computer code TAPA was used to model the problem (Reference 3).

A three dimensional model with the physical dimensions shown in Figure 1 and Figure 2 was used for this update. Figure 1 shows a two dimensional slice in the xy cartesian coordinate plane. Figure 2 shows the actual three-dimensional solid modeled. The overall vault dimensions including the coated gravel on the bottom and asphalt overburden is 50.4 feet high by 75 feet wide by 129 feet long. In addition, the vaults are assumed to be in an infinite array of grout vaults whose side-to-side center-to-center spacing is 86.5 feet and whose end-to-end center-to-center spacing is 161 feet.

An actual grout vault contains three additional layers between the outside concrete wall and asphalt. A geogrid material is next to the concrete which allows water to drain down the outer wall. The next layer is a plastic liner for leak sealing, and a third layer is an insulating board which protects the plastic liner from the hot asphalt during construction. These layers were not modeled because of the extra model complexity of adding the very narrow regions to the existing model. The thermal conductivity of these layers is lower than the thermal conductivity of concrete, which provides a thermal barrier to the concrete. By disregarding these layers, the heat will flow from the vault easier, causing a higher thermal gradient across the concrete wall. This higher thermal gradient will give conservatively high estimates for stress analysis calculations.

The physical properties used for this study are shown in Table 1. The TAPA input units, based upon inches and seconds, are shown in addition to the more familiar hour and feet units.

The physical properties are identical to those in Reference 1 except for the asphalt properties. As shown, the asphalt density has increased slightly, but the big difference is in the asphalt thermal conductivity, which increased by about a factor of seven. This thermal conductivity will make a significant difference in the temperature results as discussed later.

The boundary conditions for this model are identical to Reference 1 except for the air temperature at the soil-air interface. The air temperature of the original model was set to 80°F to represent a conservatively high ambient air temperature. The current model air temperature was set to 80° F for the first three months. At three months, the air temperature was reduced to the Hanford historical average, 55°F (Reference 9). The 80°F temperature was used to get a conservatively low heat removal rate at the soil-air interface during the initial vault fill period to account for possible summer filling. For long term temperature predictions, the average seasonal air temperature was judged to be appropriate.

The initial temperature profile before filling the vault was calculated by running a steady state model which imposed an isothermal boundary condition of 60°F at the soil-air interface at the top of the model and an isothermal boundary condition of 55°F at the water table. This initial temperature distribution was used as the starting point for the vault filling sequence. All other model assumptions are as indicated in Reference 1.

3.0 RESULTS

Maximum model temperatures are summarized in Figures 3 and 4. Figure 3 shows temperatures to 30 years; Figure 4 expands the time scale to show the details of the first year. The original base case curve on each of the figures shows the maximum temperatures for the model in Reference 1. This is used to give a base case comparison to the present results. The new base case curve shows the maximum temperatures for the current model. As seen, this curve is significantly different from the original results. To check to see if this difference was due to the different thermal properties or the new model dimensions, the original asphalt thermal properties were substituted in the new model. The results of this substitution are shown as the new model, original asphalt properties curve in Figures 3 and 4. Since this curve matches almost identically to the original model temperature curve, the

Table 1. Model Physical Properties

Material	DENSITY		THERMAL CONDUCTIVITY		HEAT CAPACITY
	Lbs/Ft^3	Lbs/In^3	(Btu/(Hr·Ft·°F)	Btu/(Sec·In·°F)	Btu/(lb·°F)
Concrete[4]	144	0.08333	0.7	1.62×10^{-5}	0.21
Grout[5]	104.2	0.0603	0.5314	1.23×10^{-5}	0.49
Asphalt[6]	131.33	0.076	0.0994	2.3×10^{-6}	0.22
Asphalt[2]	149.99	0.0868	0.6996	1.62×10^{-5}	0.22
Gravel[7]	100.22	0.058	0.1382	3.2×10^{-6}	0.2
Soil[8]	126.14	0.073	0.2894	6.7×10^{-6}	0.22
Air[4]	0.0651	0.000035	0.0167	3.3×10^{-7}	0.241

(2) KEH-88-28, Rev 1, ER90B9, "Engineering Report, Vault Design," Appendix N, January 1991. Updated asphalt properties used for this document.
(4) "Fundamentals of Momentum, Heat, and Mass Transfer", Welty, Wicks, Wilson, 1969, John Wiley and Sons, Inc.
(5) WHC-SD-WM-ER-064, Rev. 0, "Grout Vault Heat Transfer Results for M-106 Grout Formulation", G. K. Allen, October 1990.
(6) WHC-SD-WM-ER-082, "Asphalt Diffusion Break and Barrier Material Properties", W. J. Powell, August 31, 1990. Values used in Reference 1.
(7) Marks Standard Handbook for Mechanical Engineers, 8th Edition, McGraw Hill.
(8) J. C. Petrie, et.al., "Radiative and Convective Heat Transfer Within Vertical Annular Spaces Open at the Ends", INEL Report Number IN-1110 (December 1967).

temperature differences between the original and the present model are entirely due to the different asphalt thermal properties used. By raising the asphalt thermal conductivity, the asphalt no longer acts as a thermal barrier against heat removal, so there is no second temperature peak due to the radiolytic heat generation rate. As seen, the increased asphalt thermal conductivity has little affect on the short term temperature, but the temperatures after about five years are approximately 20°F lower.

Figures 5 through 13 show contour plots of temperatures in the xz plane of the model. The temperatures shown are for a slice through the vault centerline and they represent the maximum temperatures the vault structure and grout will be subjected to during the first 30 years of time. As seen from these figures, the maximum temperatures are near the bottom of the vault during the fill stages and as time progresses, the temperatures throughout the vault and surrounding soil equilibrate to a more uniform temperature. At 30 years after the fill, there is very little temperature differences between the inside of the vault and its surroundings.

4.0 REFERENCES

1. WHC-SD-WM-ER-064, "Grout Vault Heat Transfer M-106.3 Grout Formulation", G. K. Allen, October 1990.

2. KEH-88-28, Rev 1, ER90B9, "Engineering Report, Vault Design," Appendix N, January 1991. Updated asphalt properties used for this document.

3. WHC-SD-FF-ER-050, "TAPA-A Code Notebook", J. C. Guzek, March 1990.

4. "Fundamentals of Momentum, Heat, and Mass Transfer", Welty, Wicks, Wilson, 1969, John Wiley and Sons, Inc.

5. WHC-SD-WM-ER-064, Rev. 0, "Grout Vault Heat Transfer Results for M-106 Grout Formulation", G. K. Allen, October 1990.

6. WHC-SD-WM-ER-082, "Asphalt Diffusion Break and Barrier Material Properties", W. J. Powell, August 31, 1990. Values used in Reference 1.

7. Marks Standard Handbook for Mechanical Engineers, 8th Edition, McGraw Hill.

8. J. C. Petrie, et.al., "Radiative and Convective Heat Transfer Within Vertical Annular Spaces Open at the Ends", INEL Report Number IN-1110 (December 1967).

9. WHC-EP-0240-1, "Nusar N Reactor Updated Safety Analysis Report - Amendment 20", 1989.

Figure 1. Asphalt Barrier Grout Vault 2-Dimensional Model.

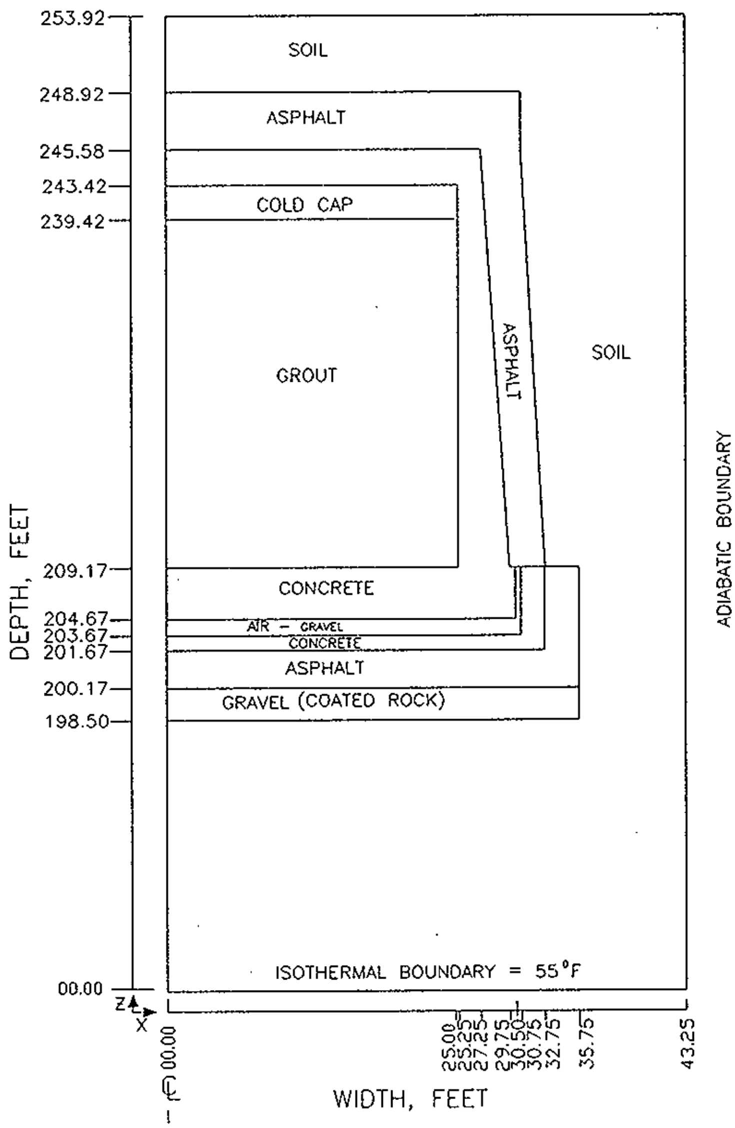
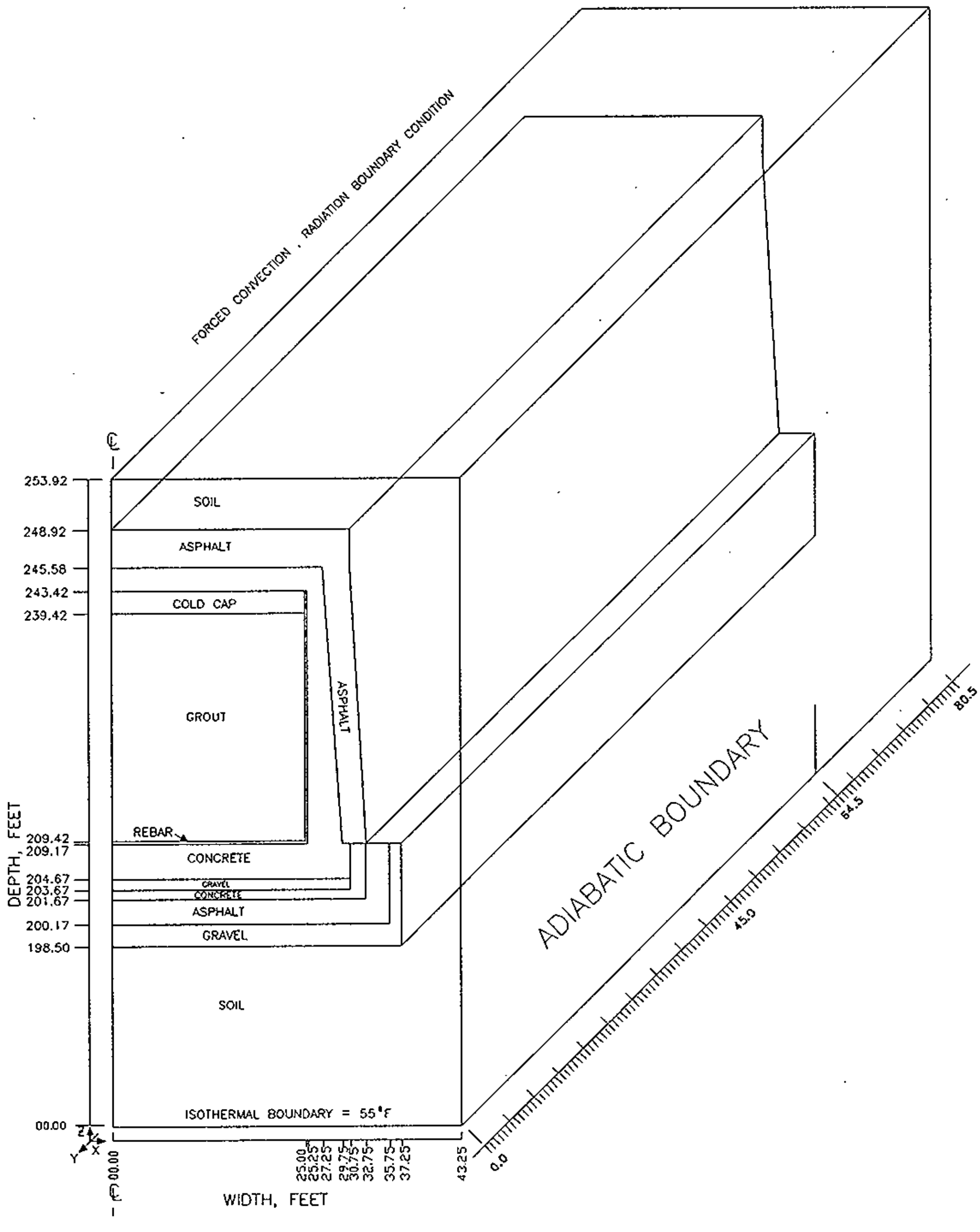


Figure 2. Asphalt Barrier Grout Vault 3-Dimensional.



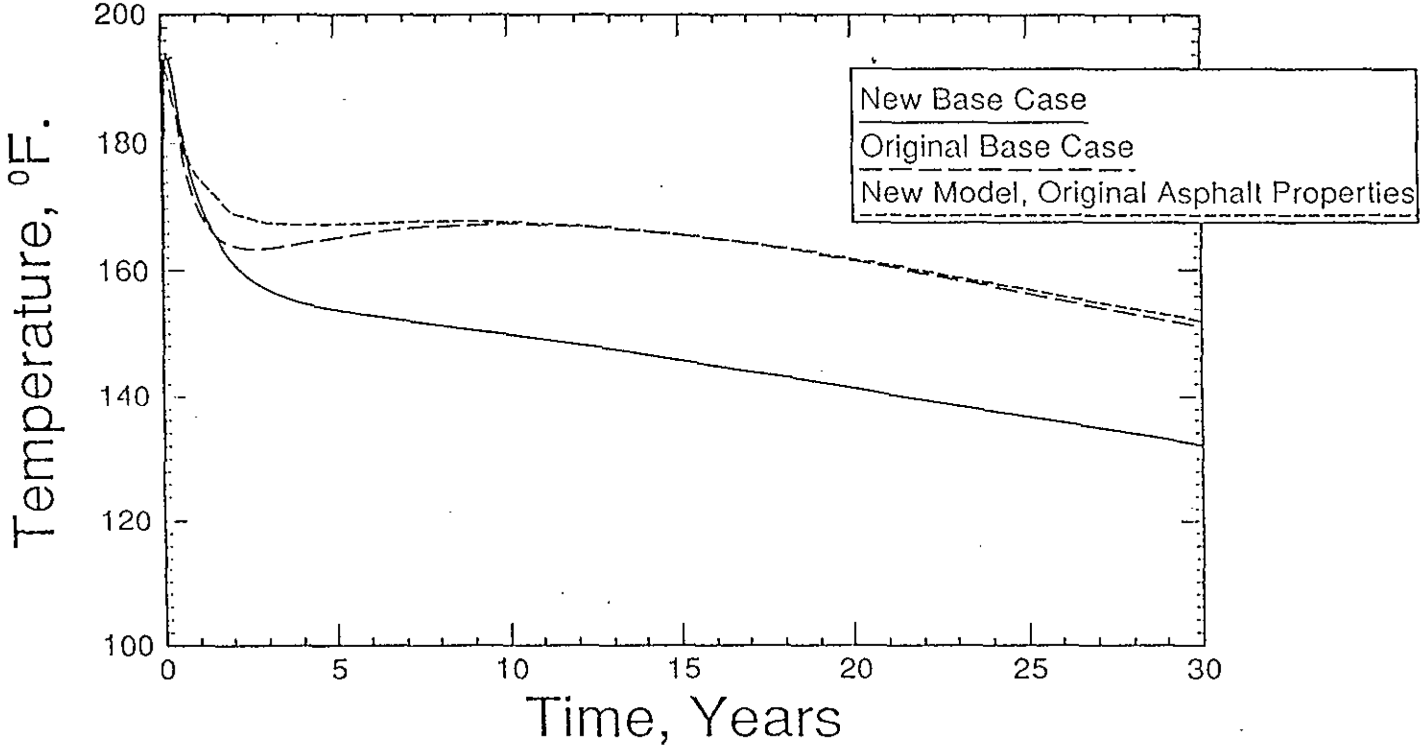


Figure 3. Maximum TAPA Model Temperatures.

Figure 4. Maximum TAPA Model Temperatures.

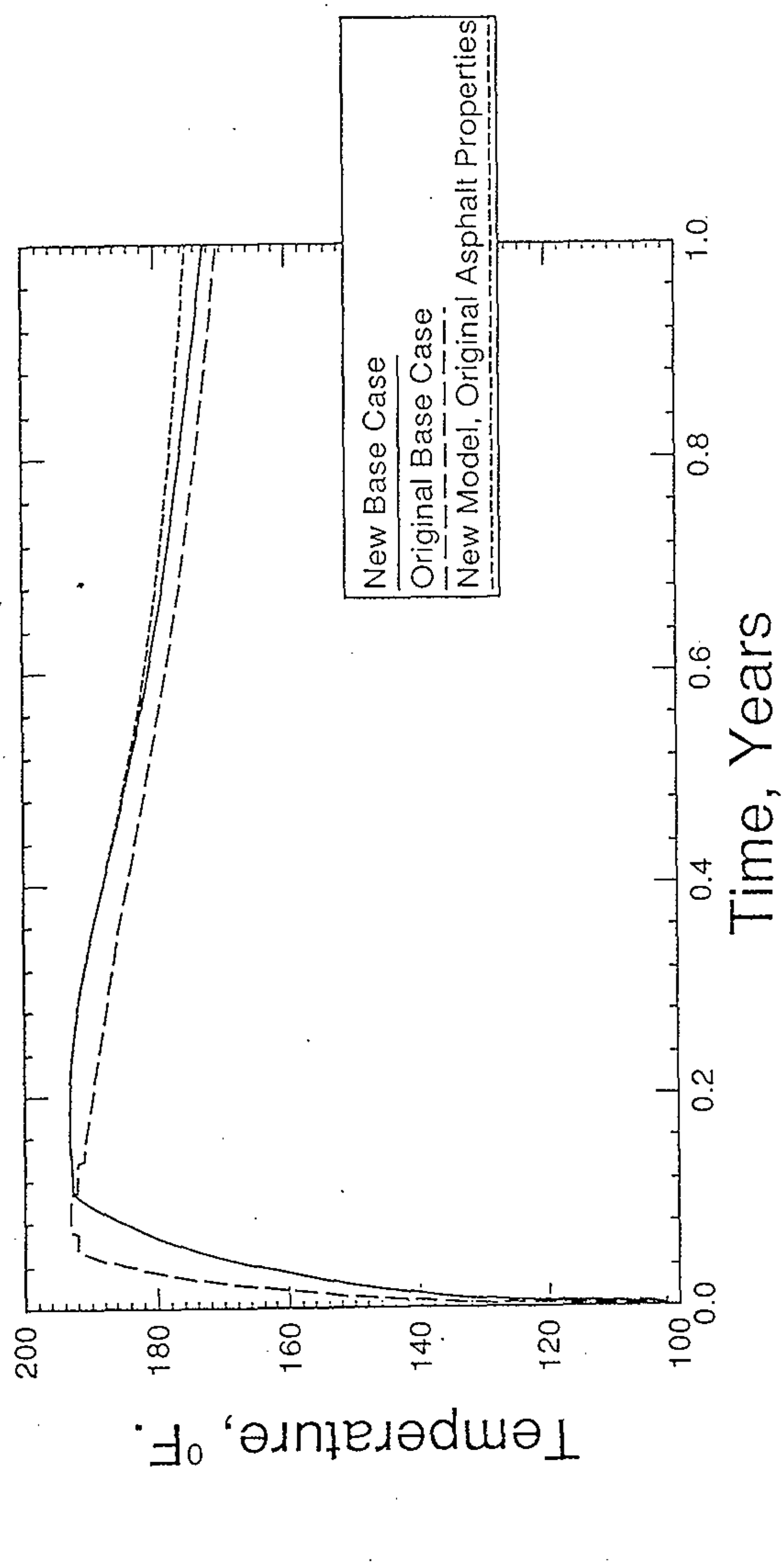


Figure 5. Half Full Grout Vault.

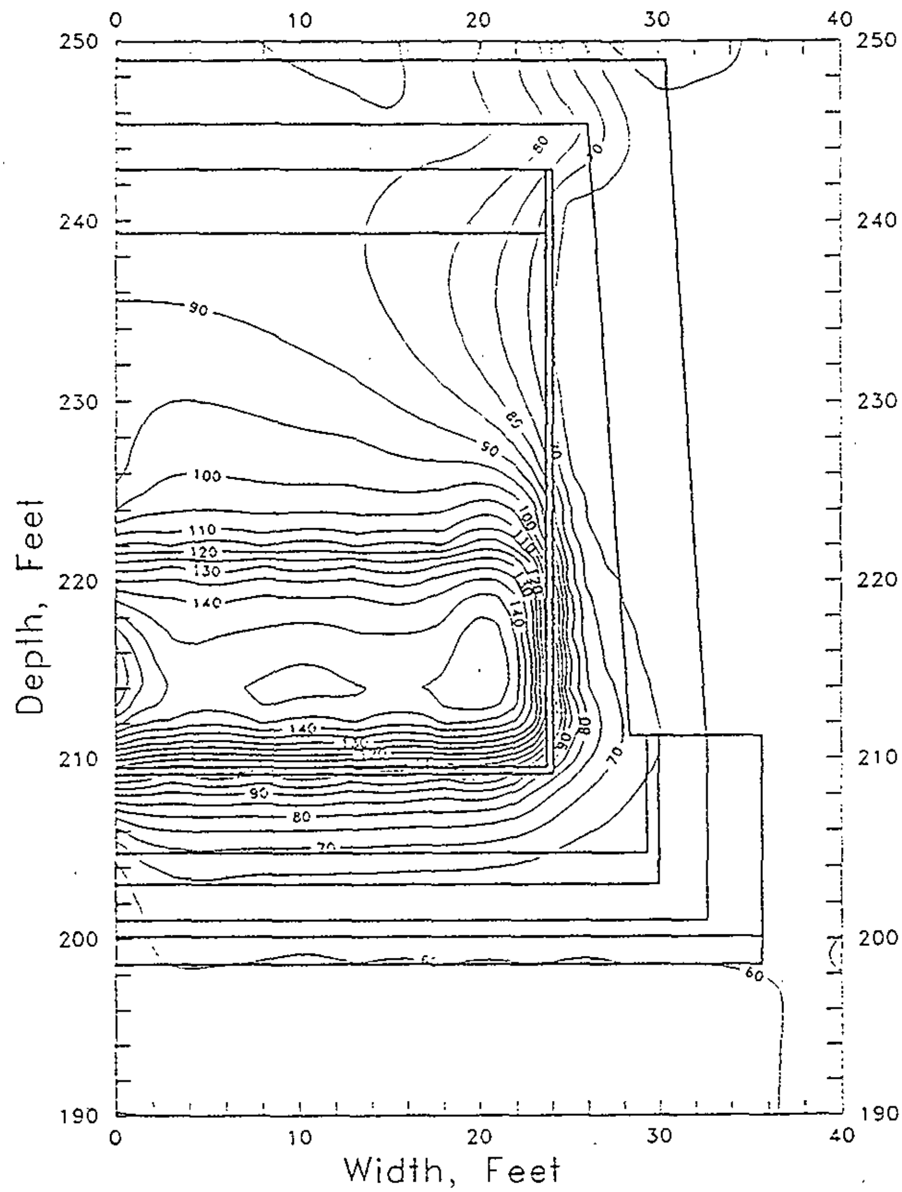


Figure 6. Full Grout Vault, 400 Hours.

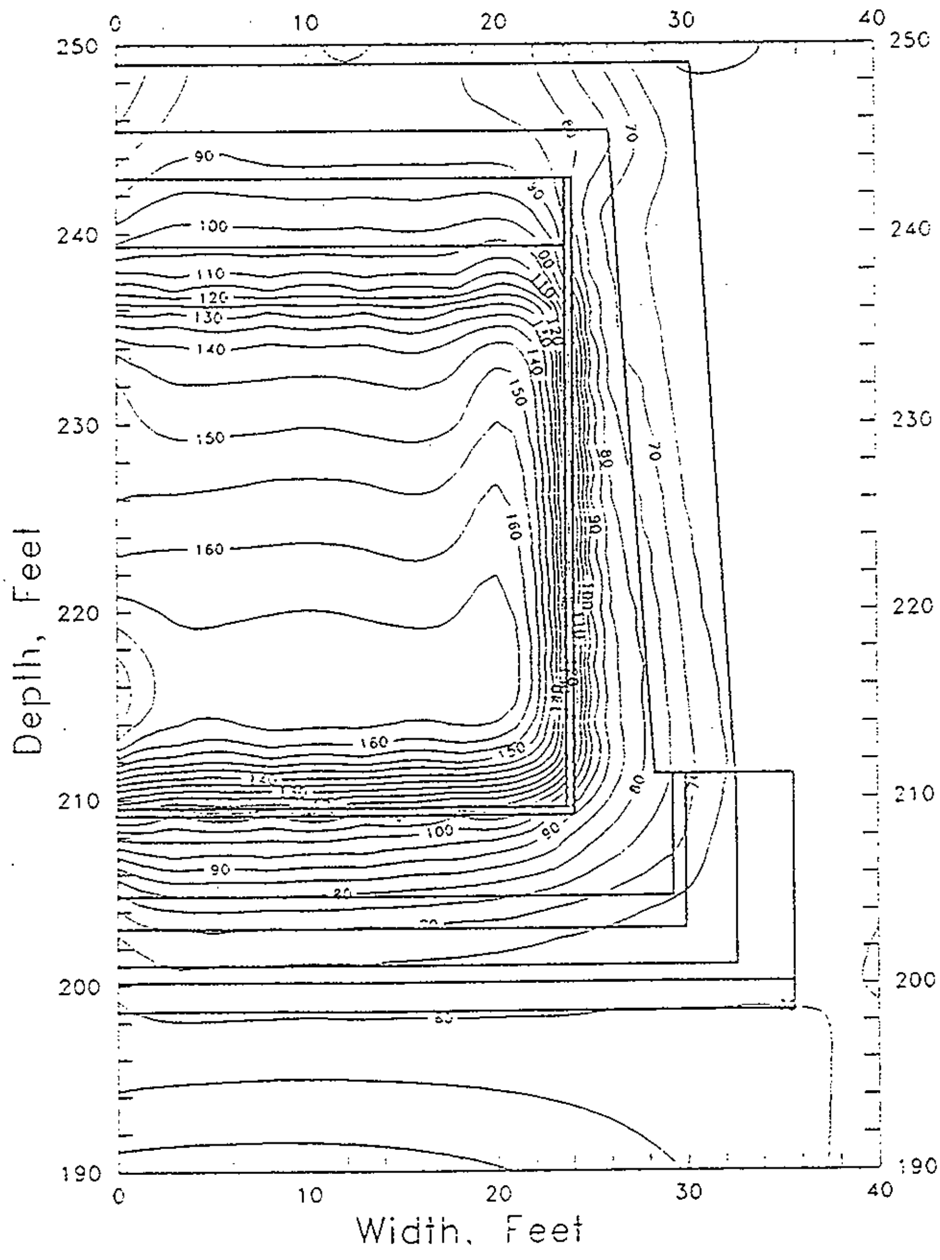


Figure 7. 3 Months After Start.

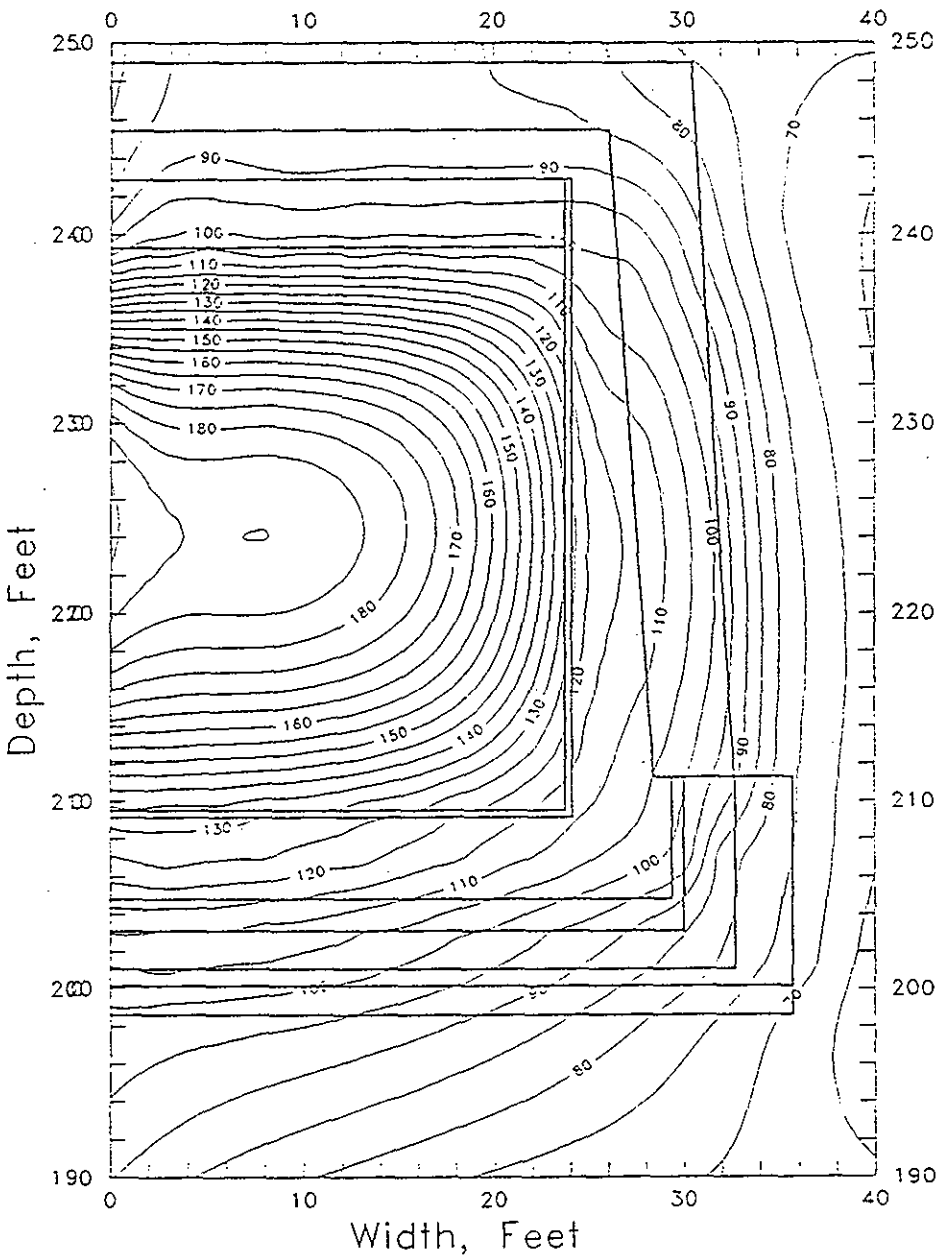


Figure 8. 1 Year After Start.

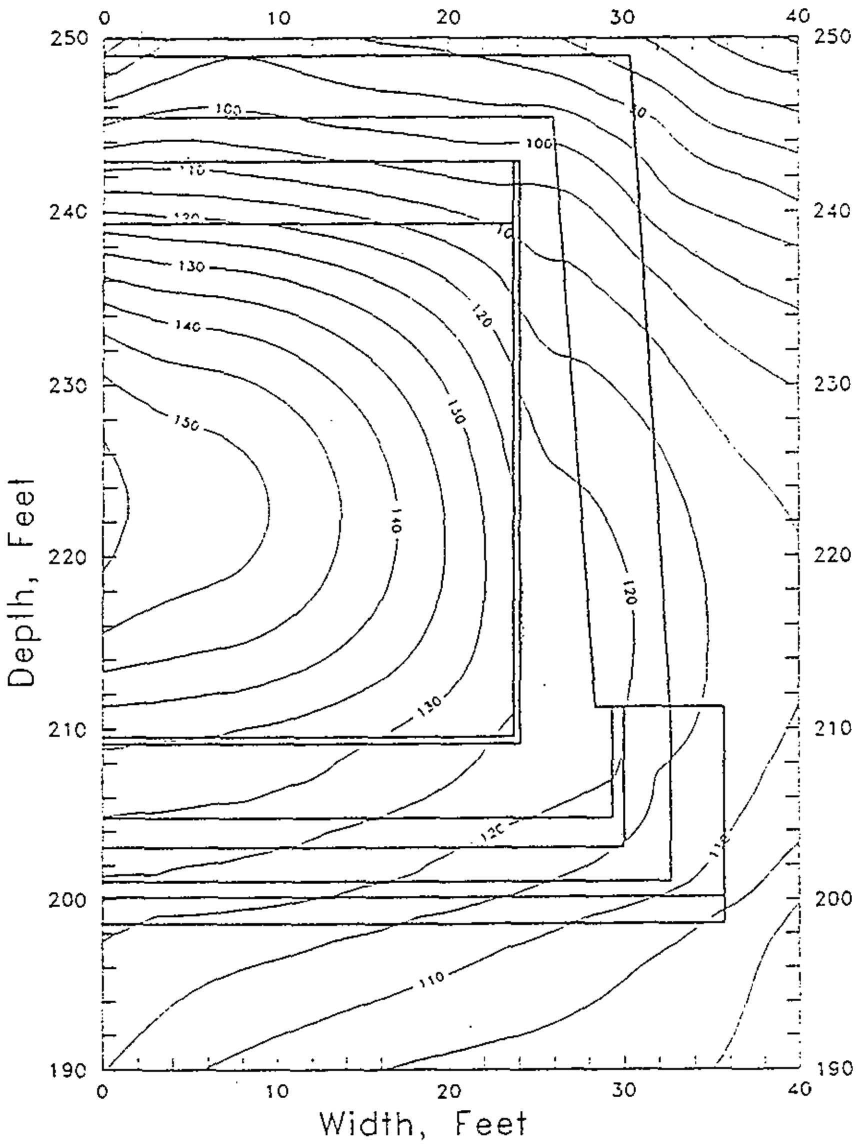


Figure 9. 5 Years After Start.

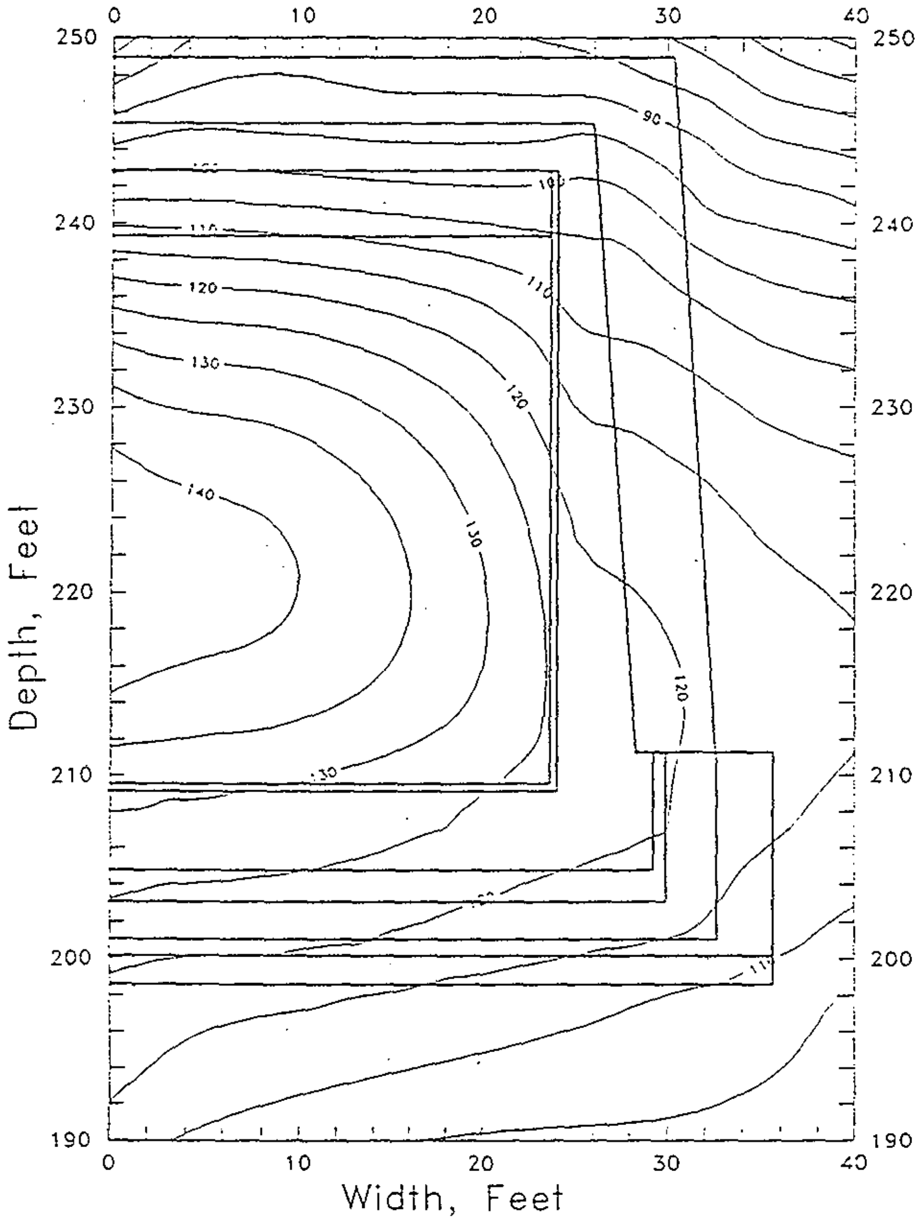


Figure 10. 10 Years After Start.

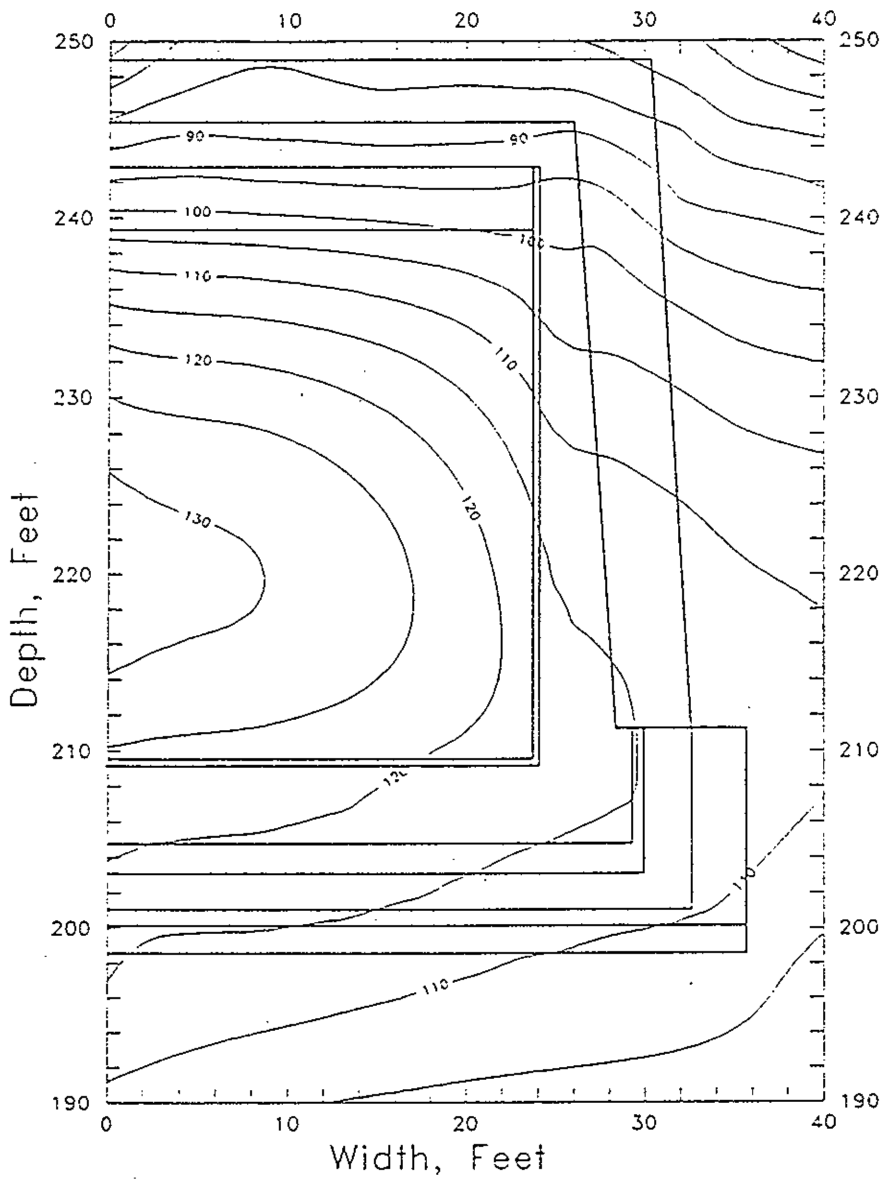


Figure 11. 15 Years After Start.

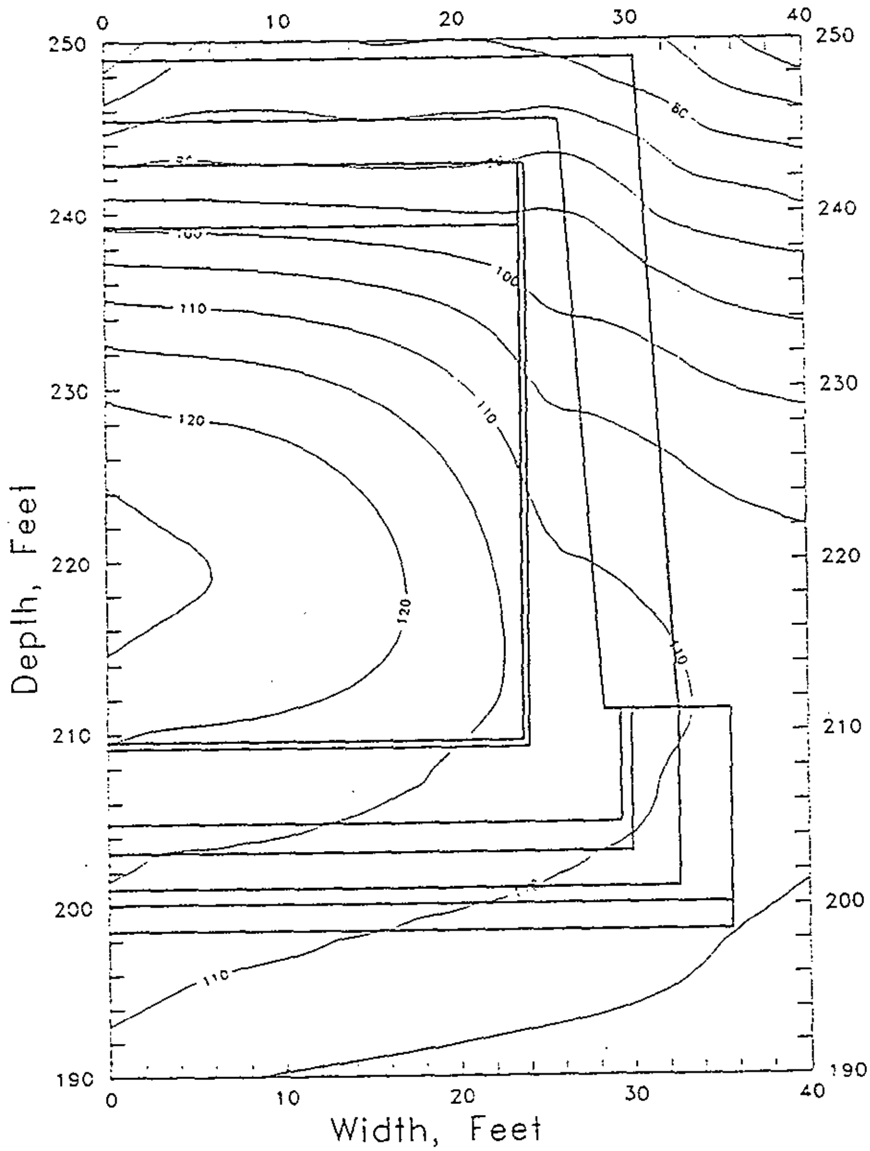


Figure 12. 20 Years After Start.

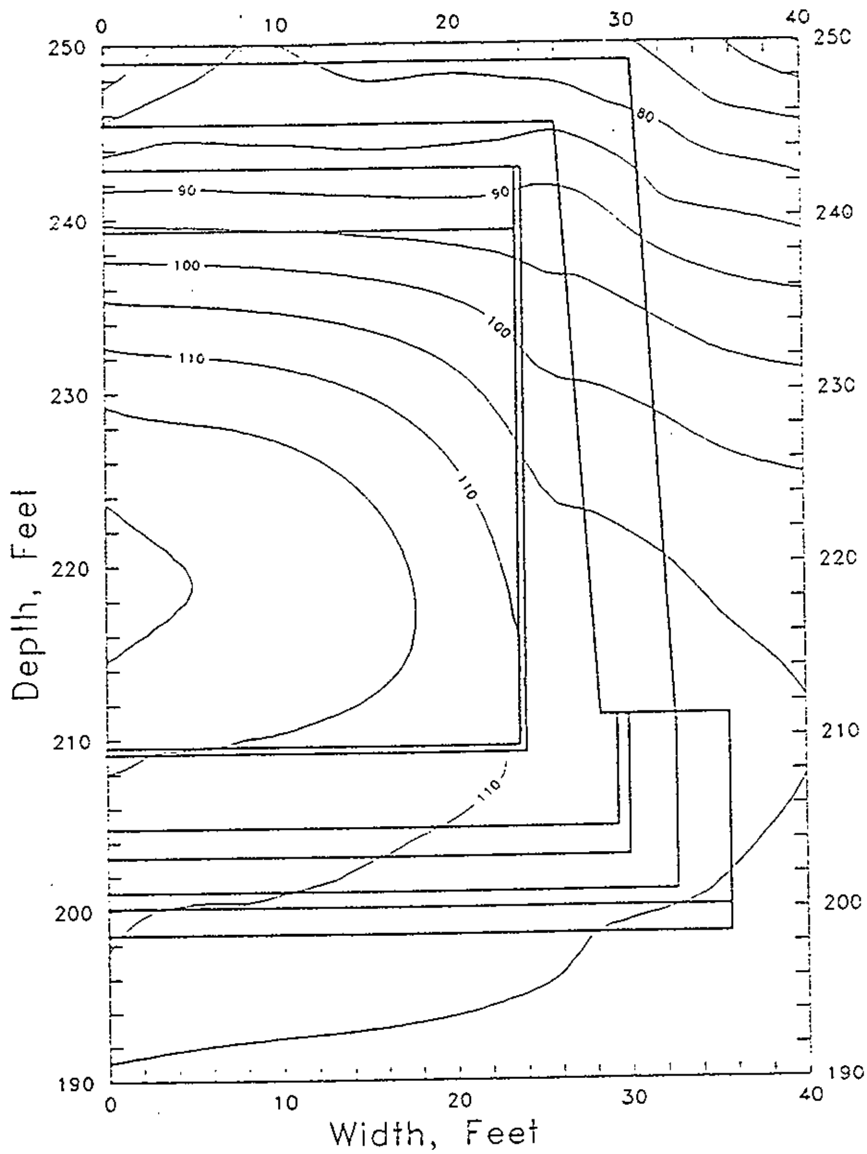
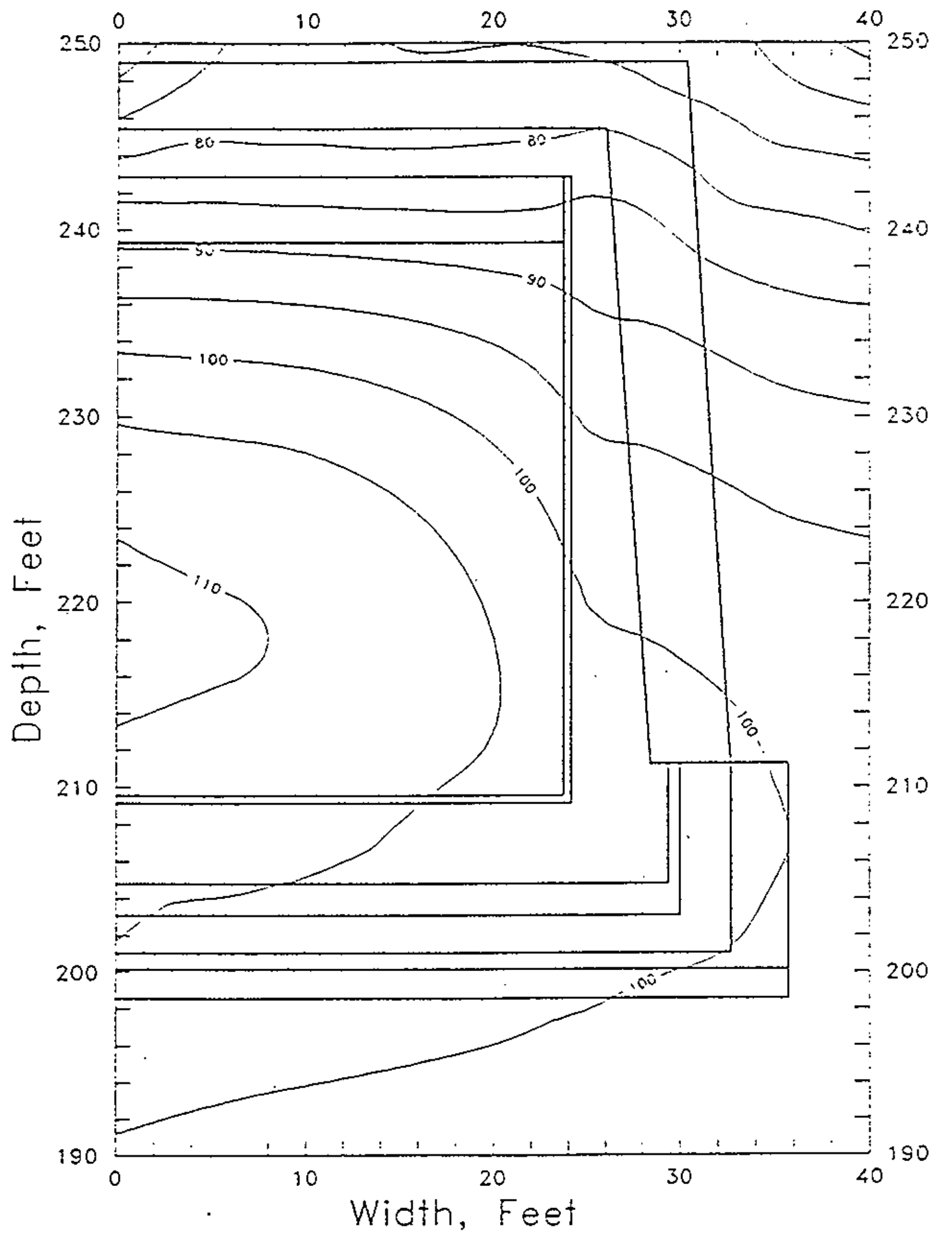


Figure 13. 30 Years After Start.



NOV 04 1992

INFORMATION RELEASE REQUEST

References: WHC-CM-3-4

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[X] Technical Report
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Existing ID Number (include revision, volume, etc.): WHC-SD-WM-ER-064, Rev. 1

If previously cleared, list ID number: WHC-SD-WM-ER-064, Rev. 0

Date Release Required:

Title: GROUT VAULT HEAT TRANSFER RESULTS FOR M-106 GROUT FORMULATION

Unclassified Category: UC-

Impact Level: 2SQ

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Title of Journal:

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Date(s) of Conference or Meeting:

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Legal - General Counsel	[]	[X]			
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DOE-RL Program	[]	[X]			
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Other Program	[]	[X]			
References Available to Intended Audience	[]	[X]			
Transmit to DOE-HQ/Office of Scientific and Technical Information	[]	[X]			

Information conforms to all applicable requirements. The above information is certified to be correct.

Author/Requestor (Printed/Signature): G. K. Allen — *G K Allen* — Date: 31 MAR 92

Responsible Manager (Printed/Signature): *W L Knecht* — W. L. KNECHT — Date: 4/1/92

Intended Audience: [] Internal [X] Sponsor [] External

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Stamp is required before release. Release is contingent upon resolution of mandatory comments.

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Distribution	G. K. Allen HO-34	March 31, 1992

Project Title/Work Order:

GROUT VAULT HEAT TRANSFER RESULTS FOR M-106 GROUT FORMULATION/WHC-SD-WM-ER-064, Rev. 1

EDT No.: 159257

ECN No.:

Name	MSIN	With Attachment	EDT/ECN & Comment	EDT/ECN Only
G. K. Allen	HO-34	X		
T. J. Bander	HO-33	X		
S. C. Chang	HO-34	X		
B. A. Crea	HO-33	X		
J. C. Guzek	HO-33	X		
R. J. Hirano	B5-25	X		
R. F. Jimenez	R4-05	X		
W. L. Knecht	HO-34	X		
T. B. McCall	HO-33	X		
R. L. Miller	HO-34	X		
D. M. Ogden	HO-33	X		
D. B. Powell	T3-21	X		
W. J. Powell	R4-03	X		
R. K. Sanan	R4-05	X		
J. D. Schaffer	N1-71	X		
M. A. Scott	R4-05	X		
D. D. Stepnewski	H5-32	X		
P. F. Stevens	HO-33	X		
J. A. Voogd	R4-03	X		
G. F. Williamson	R4-01	X		
R. R. Wyer	G6-46	X		
Central Files (Original + 3)	L8-04	X		
WCA File (2)	HO-34	X		