AR TARGET SHEET

The following document was too large to scan as one unit, therefore it has been broken down into sections.

DOCUMENT # DOE/RL 88-27 (VOL. 5 of 6)

EDMC # 0008182

SECTION 2 OF 2

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ENGINEERING CHANGE NOTICE

1. ECN ----------------
Proj. ECN B-714-13

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.		4. Date
Supplemental [X]	C KENOYER KEH TCPC 6-9340		6-29-89
Direct Revision [ ]	5. Project Title/No./Work Order No. B-714 GROUT VAULT PAIR 219-E-16-102 & 103 ER8007	6. Bldg./Sys./Fac. No. 218-E-16	7. Impact Level 3
Change ECN [ ]			
Temporary [ ]			
Supersedure [ ]	8. Document Number Affected (include rev. and sheet no.) H-2-77612 SH 1 REV 0	9. Related ECN No(s). N/A	10. Related PO No. N/A
Discovery [ ]			
Cancel/Void [ ]			

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

12. Description of Change

CHANGE FLEX JUMPER IAW PAGE 3 AND 4

9 1 1 7 8 6 0 7 9 9

13a. Justification (mark one)	13b. Justification Details
Criteria Change [ ]	WRONG DRAWING NO AND JUMPER
Design Improvement [ ]	
Environmental [ ]	
As-Found [ ]	
Facilitate Const. [ ]	
Const. Error/Omission [ ]	
Design Error/Omission [X]	

14. Distribution (include name, MSIN, and no. of copies)

KEH DISTRIBUTION

Engrg Doc Cntl	TCPC/5-8-D
Const Doc Cntl	2910E/200E
Station 10	A3-87

WHC DISTRIBUTION

S. R. Briggs	R3-43
J. L. Gilbert	R3-46
O. A. Halverson	R3-09
J. R. McGee	S1-54
D. E. Palmer	R3-43
A. E. Young	S0-05
Project Files	RI-28
DOE	
~~A. G. Lassila~~	~~A5-18~~

RELEASE STAMP

OFFICIAL RELEASE BY WHC 48
DATE JUL 26 1989

A-7900-013 (11/88)

ENGINEERING CHANGE NOTICE

Page 2 of 4

1. ECN (use no. from pg. 1): B714-13

...gn Verification ...uired	16. Cost Impact		17. Schedule Impact (days)
	ENGINEERING	CONSTRUCTION	None
☒ Yes	Additional ☒ $ 0	Additional ☐ $ ϕ	Improvement ☐
☐ No	Savings ☐ $ 0	Savings ☐ $ ϕ	Delay ☐

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

...D/CD	☐	Seismic/Stress Analysis	☐	Tank Calibration Manual	☐
...nctional Design Criteria	☐	Stress/Design Report	☐	Health Physics Procedure	☐
...erating Specification	☐	Interface Control Drawing	☐	Spares Multiple Unit Listing	☐
...iticality Specification	☐	Calibration Procedure	☐	Test Procedures/Specification	☐
...nceptual Design Report	☐	Installation Procedure	☐	Component Index	☐
...uipment Spec.	☐	Maintenance Procedure	☐	ASME Coded Item	☐
...onst. Spec.	☐	Engineering Procedure	☐	Human Factor Consideration	☐
...ocurement Spec.	☐	Operating Instruction	☐	Computer Software	☐
...endor Information	☐	Operating Procedure	☐	Electric Circuit Schedule	☐
...M Manual	☐	Operational Safety Requirement	☐	ICRS Procedure	☐
...AR/SAR	☐	IEFD Drawing	☐	Process Control Manual/Plan	☐
...fety Equipment List	☐	Cell Arrangement Drawing	☐	Process Flow Chart	☐
...adiation Work Permit	☐	Essential Material Specification	☐	Purchase Requisition	☐
...vironmental Impact Statement	☐	Fac. Proc. Samp. Schedule	☐		☐
...vironmental Report	☐	Inspection Plan	☐		☐
...vironmental Permit	☐	Inventory Adjustment Request	☐		☐

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

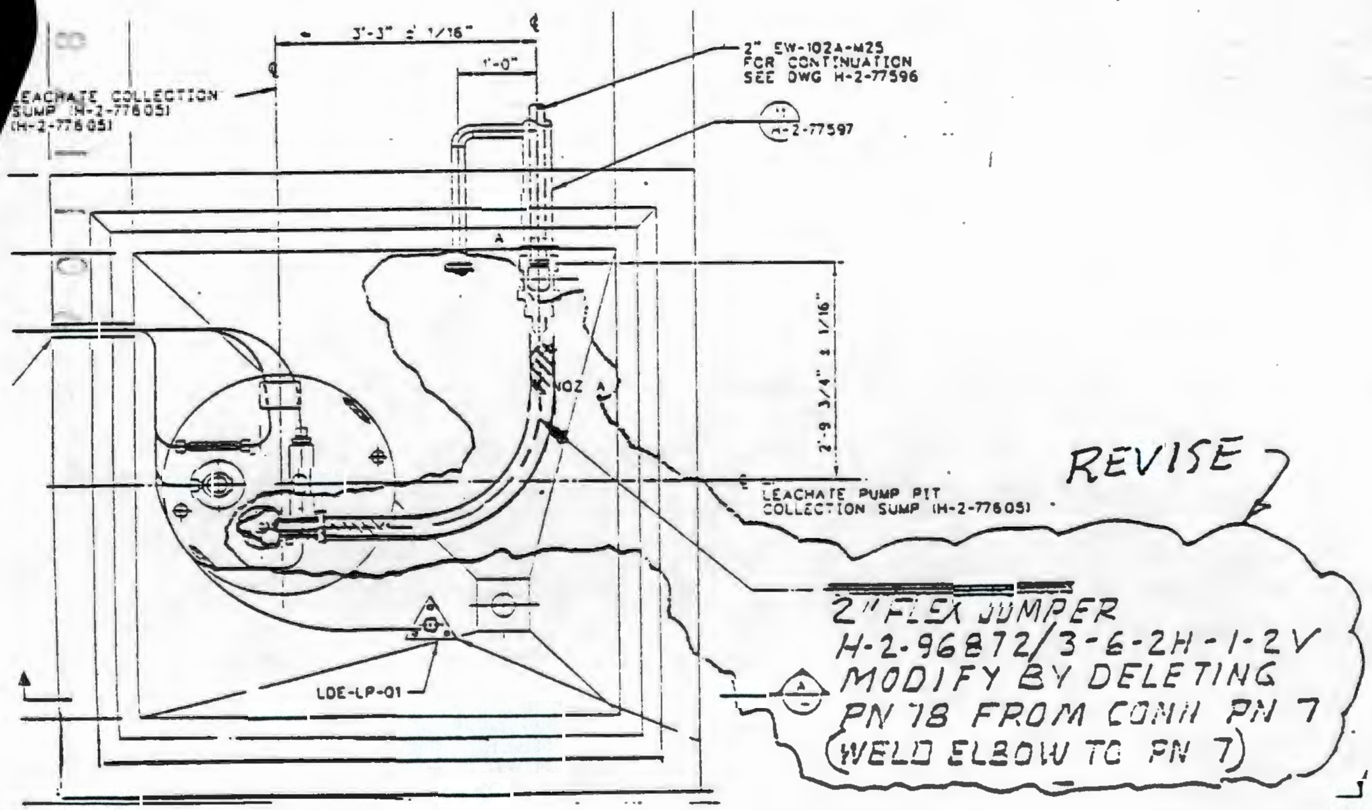
Document Number/Revision	Document Number/Revision	Document Number/Revision

...provals

Signature		Date	Signature		Date
OPERATIONS AND ENGINEERING			ARCHITECT-ENGINEER		
...Project Engineer	LR Bigi	7/10/89	PE	[signature]	7-6-89
...Project Engr. Mgr.	[signature]	7/10/89	QA	[signature]	7/5/89
...A	[signature]	7/10/89	Safety	J. Archibald	6-30-89
...fety	NA		Design	CR Zook	6/29/89
...curity			Other		
...oj.Prog./Dept. Mgr.					
...ef. React. Div.					
...hem. Proc. Div.					
...ef. Wst. Mgmt. Div.			DEPARTMENT OF ENERGY		
...dv. React. Dev. Div.					
...oj. Dept.					
...nviron. Div.			ADDITIONAL		
...M Dept.					
...acility Rep. (Ops)					
...ther					

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH				
Dwg. -2-77612	Sh. 1	Rev. 0	Prepared By C KENOYER	Checked By [signature]	ECN No. B-714-13	Page 3

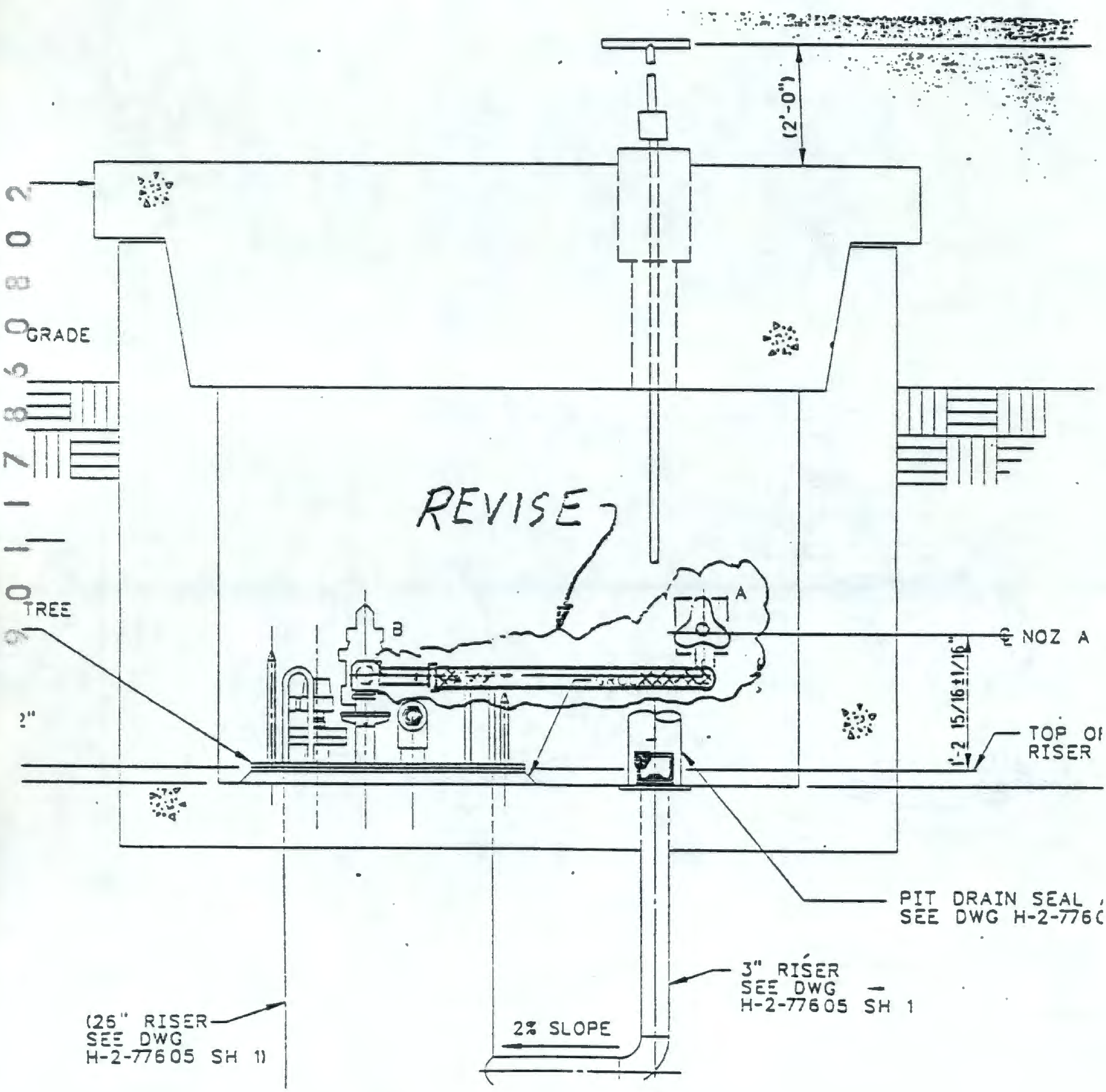
DOE/RL 88-27
Rev. 1, 01/17/90



KEH-0159 00 (1/88)

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77612	1	0	C KENOYER	C R Cook	B-719-13	4

9011785080 2



REISSUE 10/5/89

ENGINEERING CHANGE NOTICE

1. ECN ~~116660~~

Proj. ECN B-714-15

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. Date
Supplemental [X] / Direct Revision [ ] / Change ECN [ ] / Temporary [ ] / Supersedure [ ] / Discovery [ ] / Cancel/Void [ ]	TERESA EHRHARD, KEH 6-2381	9-18-89

DOE/RL 88-27
Rev. 1, 01/17/90

5. Project Title/No./Work Order No.	6. Bldg./Sys./Fac. No.	7. Impact Level
B-714, GROUT VAULT PAIR (218-E-16-102&103)/ER8007	218-E-16 102 & 103	3

8. Document Number Affected (include rev. and sheet no.)	9. Related ECN No(s).	10. Related PO No.
SEE BLOCK 12	B-714-10	N/A

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

12. Description of Change

CHANGES TO DRAWINGS, ECNS AND SPECIFICATIONS SEE:
CIVIL - PAGES 3 THRU 19
ENVIR - PAGE 20
INSTM - PAGE 21
ELEC - PAGES 22 THRU 30

REV 0 [illegible] 10/5/89

AFFECTED DRAWINGS, ECNS AND CONSTRUCTION SPECIFICATION B-714-C2: (W-B714C1-001)

H-2-77580, SH 1, REV 0	H-2-77588, SH 1, REV 0	H-2-77636, SH 1, REV 0
H-2-77580, SH 2, REV 0	H-2-77588, SH 2, REV 0	H-2-77636, SH 2, REV 0
H-2-77580, SH 3, REV 0	H-2-77588, SH 3, REV 0	H-2-77636, SH 3, REV 0
H-2-77580, SH 4, REV 0	H-2-77588, SH 4, REV 0	H-2-77636, SH 4, REV 0
H-2-77582, SH 1, REV 0	H-2-77588, SH 5, REV 0	H-2-77637, SH 1, REV 0
H-2-77583, SH 1, REV 0	H-2-77593, SH 1, REV 0	H-2-77638, SH 1, REV 0
H-2-77587, SH 1, REV 0	H-2-77593, SH 2, REV 0	H-2-77639, SH 2, REV 0
H-2-77587, SH 2, REV 0	H-2-77593, SH 3, REV 0	H-2-77640, SH 1, REV 0
(ECN B-714-10, PG 7)	H-2-77635, SH 1, REV 0	H-2-77641, SH 1, REV 0
		H-2-77639, SH 1, REV 0

13a. Justification (mark one)	13b. Justification Details
Criteria Change [ ] / Design Improvement [X] / Environmental [ ] / As-Found [ ] / Facilitate Const. [X] / Const. Error/Omission [ ] / Design Error/Omission [X]	1) WHC FORMAL DESIGN REVIEW COMMENT INCORPORATION 2) KEH INTERDISCIPLINE REVIEW & DESIGN VERIFICATION

14. Distribution (include name, MSIN, and no. of copies)

KEH DISTRIBUTION
Engrg Doc Cntl TCPC/5-8-D
Const Doc Cntl 2910E/200E

Section 10 A3-37
L. Garza A5-30

WHC DISTRIBUTION
S. R. Briggs R3-43
J. L. Gilbert R3-46
O. A. Halverson R3-09
J. R. McGee S1-54
D. E. Palmer ~~R3-13~~
W. J. Powell R1-48
D. D. Wodrich R1-48
A. E. Young S0-05
Project Files R1-28
DOE
A. G. Lassila A5-18

RELEASE STAMP

OFFICIAL RELEASE 48
BY WHC
DATE OCT 12 1989

A-7900-013 (11/88)

ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1): B-714-15

DOE/RL 88-27
Rev. 1, 01/17/90

15. Design Verification Required	16. Cost Impact		17. Schedule Impact (days)
	ENGINEERING	CONSTRUCTION	
☒ Yes	Additional ☐ $ NONE	Additional ☒ $ 80,000	Improvement ☐ NONE
☐ 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

OPERATIONS AND ENGINEERING	Signature	Date	ARCHITECT-ENGINEER	Signature	Date
Cog. Project Engineer	S R Bigg	9/21/89	PE	[signature]	9-20-89
Cog. Project Engr. Mgr.	[signature]	9/21/89	QA	D. W. Hamilton	9-12-89
QA	Jack Green	9/28/89	Safety	C. D. Eggers	9/18/89
Safety	NA		Design CIVIL	[signature]	9/18/89
Security			Other ENV	R Y Hollenbeck	9/20/89
Proj.Prog. Dept. Mgr.			INST	[signature]	9/18/89
Def. React. Div.			ELEC	A. L. Swindle	9/18/89
Chem. Proc. Div.			SPECS	A. B. Hoffmann	9/19/89
Def. Wst. Mgmt. Div.			DEPARTMENT OF ENERGY		
Adv. React. Dev. Div.			(See Change Request B-714-004)		
Proj. Dept.					
Environ. Div.			ADDITIONAL		
IRM Dept.					
Facility Rep. (Ops)					
Other					

A-7900-013R (11/88)

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH				
SEE BELOW	Sh. ---	Rev. ---	Prepared By TERESA EHRHARD	Checked By [signature]	ECN No. B-714-15	Page 3

DOE/RL 88-27
Rev. 1, 01/17/90

L CHANGES

ECN B-714-10, PAGE 7

VOIDED. SUPERSEDES BY PAGE 10 OF THIS ECN.

H-2-77580, SH 1, REV 0

CHANGE PLAN AS SHOWN ON PAGE 4 OF THIS ECN.

H-2-77580, SH 2, REV 0

a) DELETE SECTION D.
b) CHANGES SECTION A AS SHOWN ON PAGE 5 OF THIS ECN.
c) DELETE DETAIL 1 & REPLACE w/NEW DETAIL 1 AS SHOWN ON PAGE 6 OF THIS ECN.
d) CHANGES SECTION E AS SHOWN ON PAGE 6 OF THIS ECN.
e) NOTE 3: CHANGE DESIGN UNIT STRESSES to read DESIGN MATERIAL AND STRENGTH

H-2-77580, SH 3, REV 0

a) CHANGES SECTION B AS SHOWN ON PAGE 7 OF THIS ECN.
b) CHANGE TYP HORIZ WALL CORNER AS SHOWN ON PAGE 8 OF THIS ECN.
c) ADD SECTION F & G AS SHOWN ON PAGE 8 OF THIS ECN.
d) CHANGE SECTION C & D AND DETAIL 1 AS SHOWN ON PAGE 9 OF THIS ECN.

H-2-77580, SH 4, REV 0

a) CHANGE SECTION C AS SHOWN ON PAGE 10 OF THIS ECN.
b) ADD SECTION H AS SHOWN ON PAGE 11 OF THIS ECN.

) H-2-77587, SH 1, REV 0

CHANGE PLAN & TABLE AS SHOWN ON PAGE 12 OF THIS ECN.

) -77587, SH 2, REV 0

NGE PLAN & TABLE AS SHOWN ON PAGE 13 OF THIS ECN.

) H-2-77588, SH 1, REV 0

CHANGE PLAN AS SHOWN ON PAGE 14 OF THIS ECN

) H-2-77588, SH 2, REV 0

CHANGE RISER TABLE AS SHOWN ON PAGE 14 OF THIS ECN.

) H-2-77588, SH 3, REV 0

CHANGE SECTION A AS SHOWN ON PAGE 15 OF THIS ECN.

) H-2-77588, SH 4, REV 0

CHANGE PLAN AS SHOWN ON PAGE 16 OF THIS ECN.

) H-2-77588, SH 5, REV 0

CHANGE RISER TABLE AS SHOWN ON PAGE 16 OF THIS ECN.

13) H-2-77593, SH 1, REV 0

CHANGE PLAN AS SHOWN ON PAGE 17 OF THIS ECN.

14) H-2-77593, SH 2, REV 0

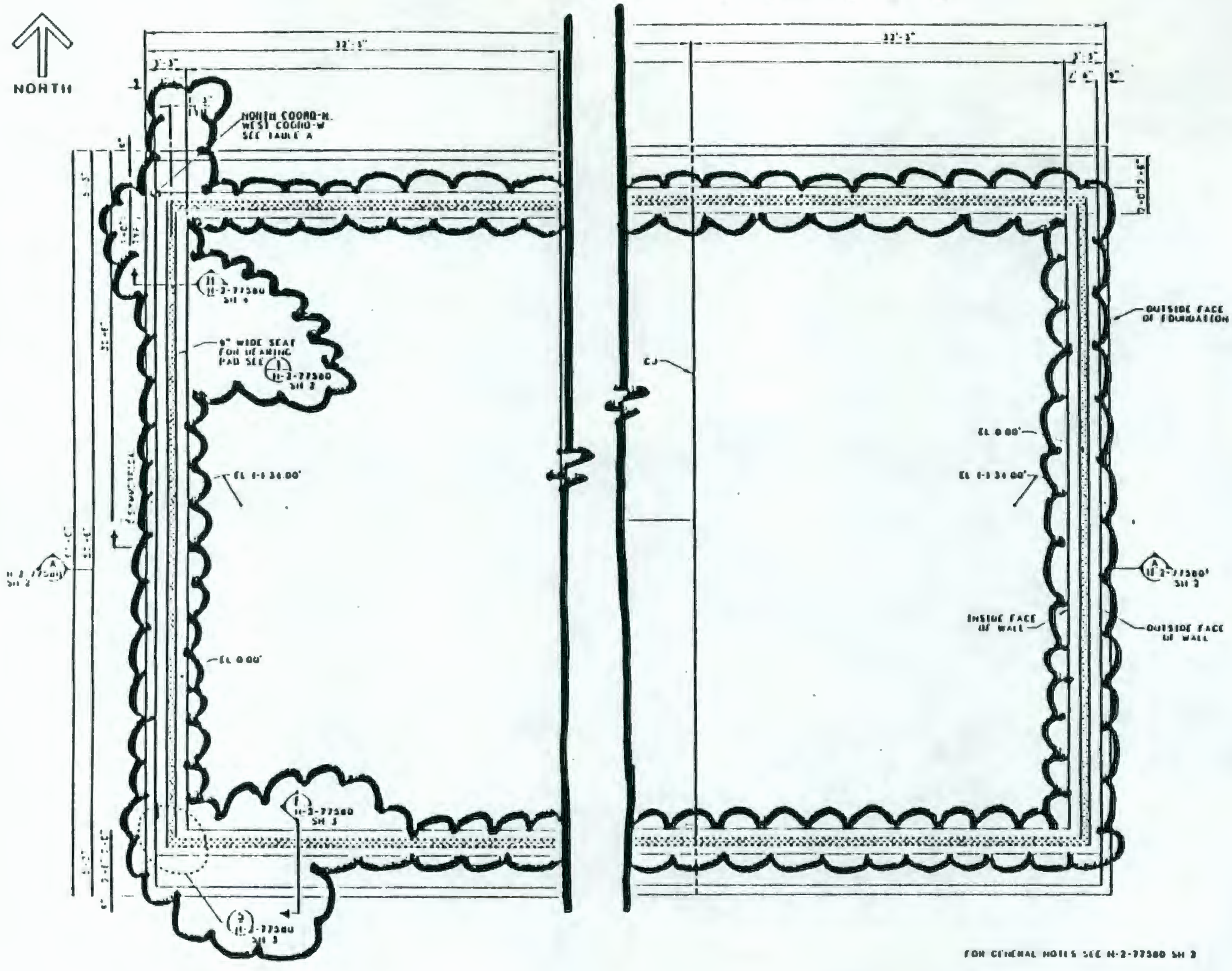
CHANGES SECTION A AS SHOWN ON PAGE 18 OF THIS ECN.

15) H-2-77593, SH 3, REV 0

a) CHANGE SECTION B & C AS SHOWN ON PAGE 19 OF THIS ECN.
b) DELETE VIEW D.

KE-0159.00 (1/88)

9 0 1 1 7 8 6 0 8 0 6



PLAN

KAISER ENGINEERS HANFORD

ENGINEERING CHANGE NOTICE SKETCH

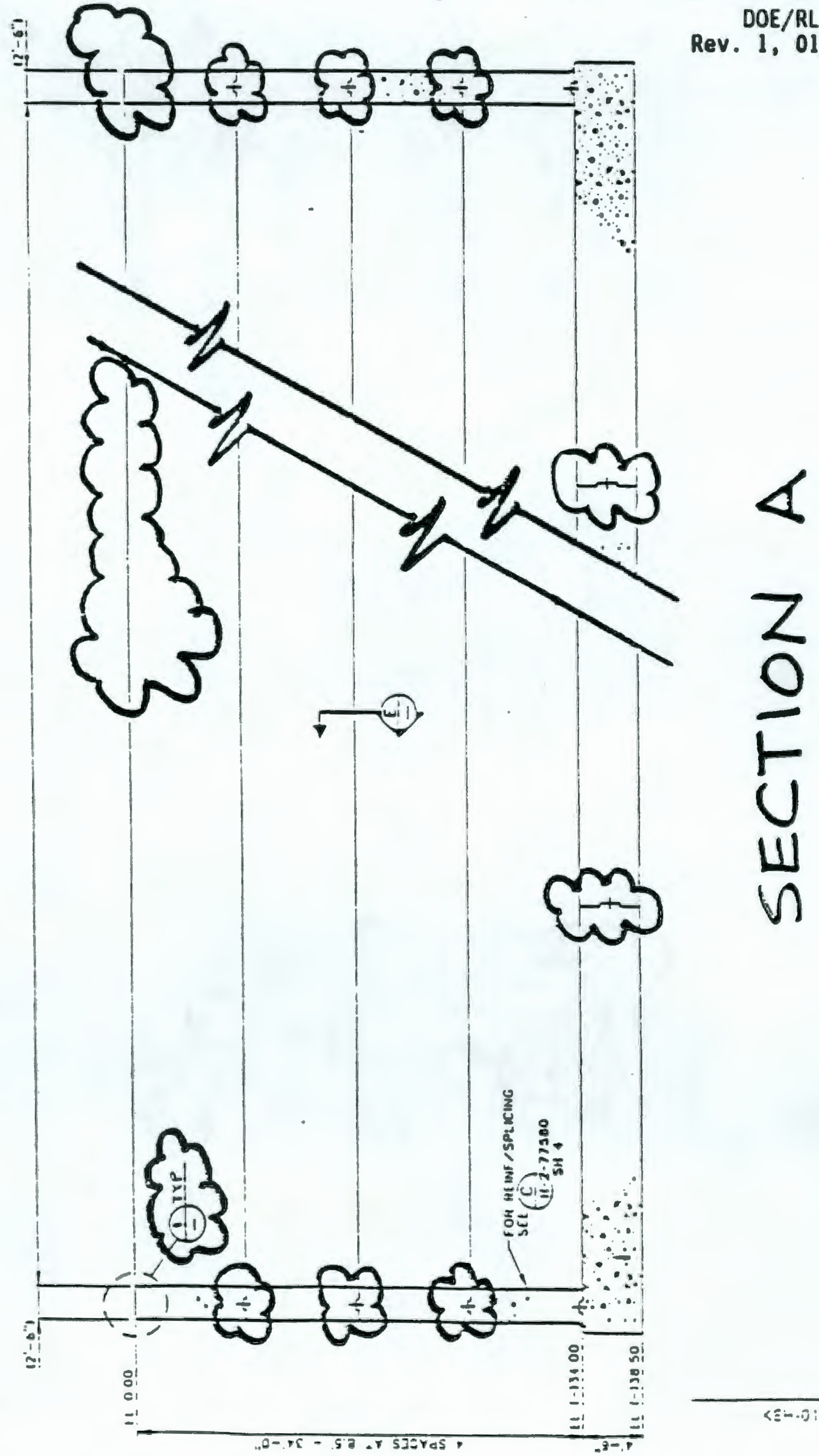
Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77580	1	0	TERESA EHRHARD 6-23-81	S. [illegible]	B-714-15	4

APP 4I-254

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Dwg.	Sh.	Rev.	Prepared By 6-2381	Checked By	ECN No.	Page
7580	2	0	TK EHRHARD	[signature]	B-714-15	5

DOE/RL 88-27
Rev. 1, 01/17/90

9011780807

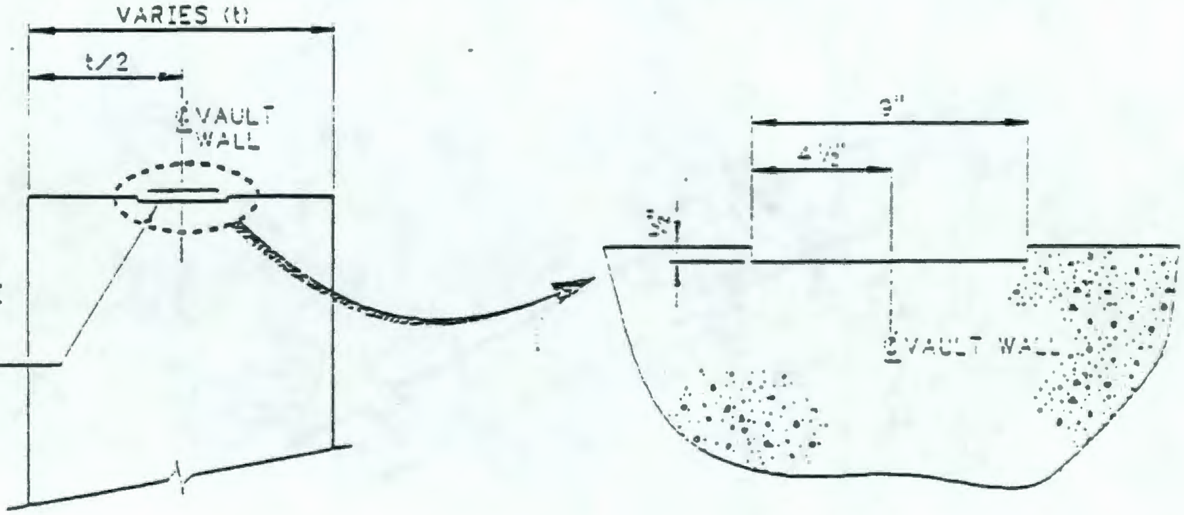


KEH-0159.00 (1/88)

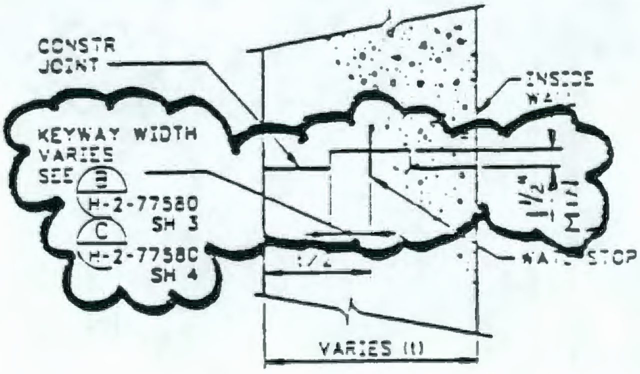
KAISER ENGINEERS
HANFORD

ENGINEERING CHANGE NOTICE SKETCH

Dwg.	Sh.	Rev.	Prepared By 6-2381	Checked By	ECN No.	Page
H-2-77580	2	0	TK EHRHARD	[signature]	B-714-15	6



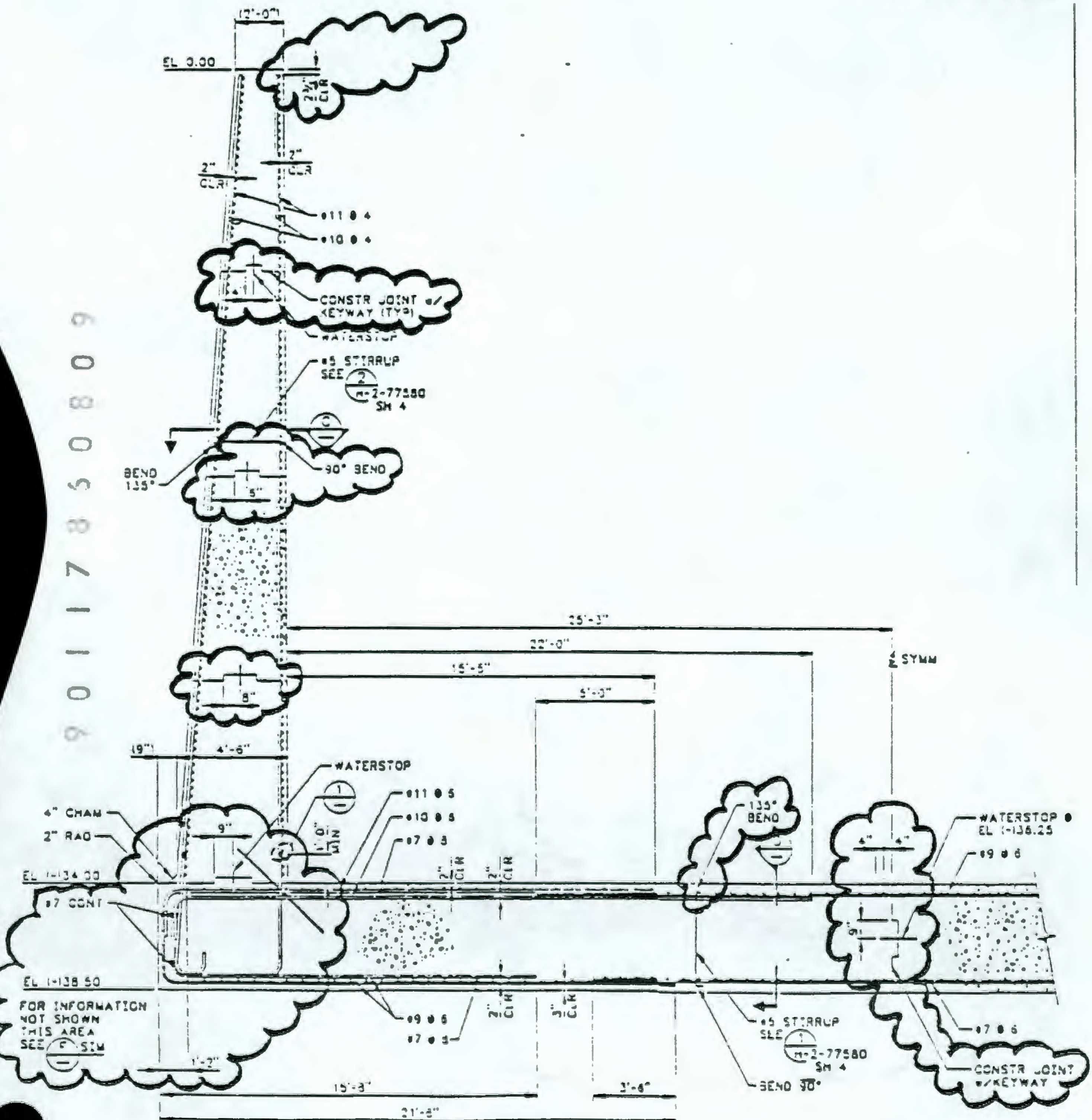
DETAIL 1
SCALE: 1" = 1'-0" H-2-77580 SH 1



SECTION E
SCALE: 1" = 1'-0"

9011178508 0

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH				
77580	Sh. 3	Rev. 0	Prepared By 6-2381 TK EHRHARD	Checked By [signature]	ECN No. B-714-15	Page 7



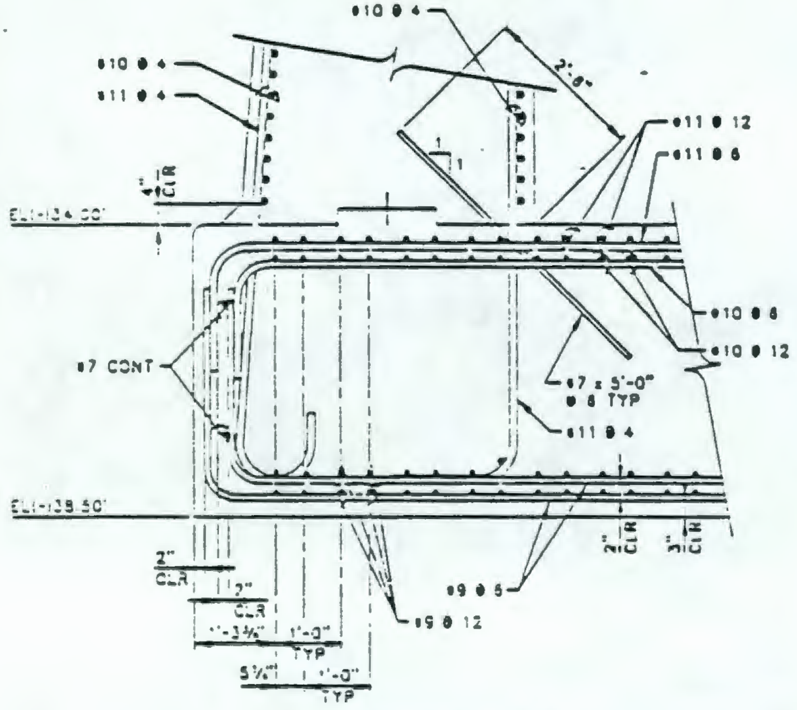
SECTION B
SCALE: ¼" = 1'-0" H-2-77580 SH 1

KE-4059.00 (1/88)

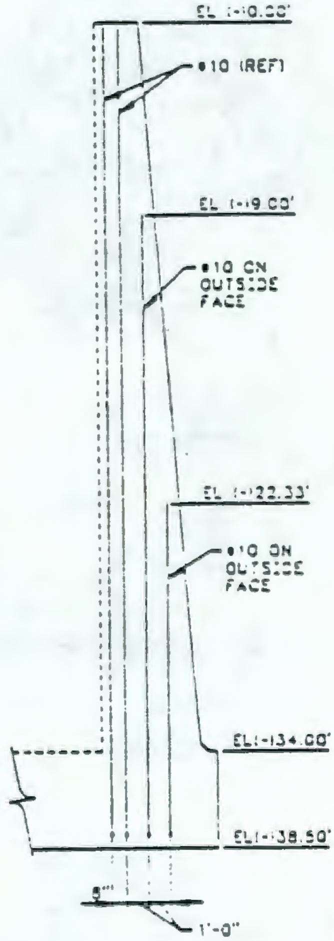
KAISER ENGINEERS
HANFORD

ENGINEERING CHANGE NOTICE SKETCH

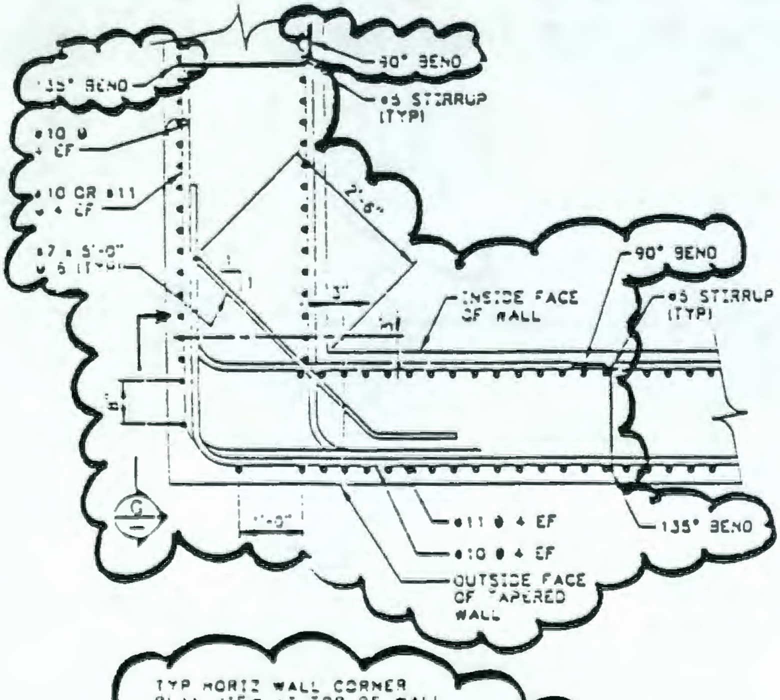
Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77580	3	0	6-2381 TK EHRHARD	[signature]	B-714-15	8



SECTION F
SCALE: 3/4" = 1'-0" H-2-77580 SH 1



SECTION G
SCALE: 1/4" = 1'-0"



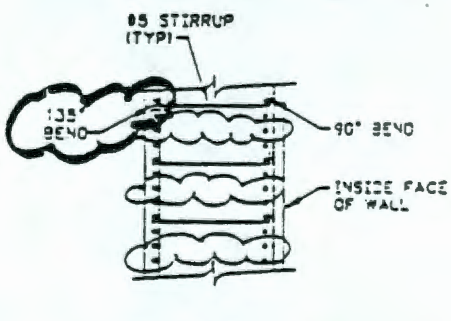
TYP HORIZ WALL CORNER
PLAN VIEW AT TOP OF WALL

ENLARGED PLAN S
H-2-77580 SH 1

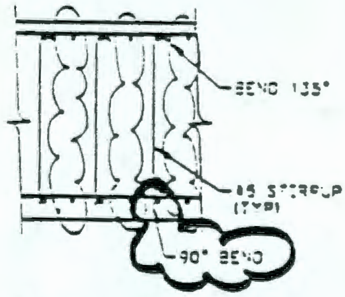
90117350810

ENGINEERING CHANGE NOTICE SKETCH

No.	Sh.	Rev.	Prepared By 6-2381	Checked By	ECN No.	Page
2-[illegible]580	3	0	TK EHRHARD	[signature]	B-714-15	9



SECTION C
SCALE: NONE
H-2-77580 SH 4



SECTION D
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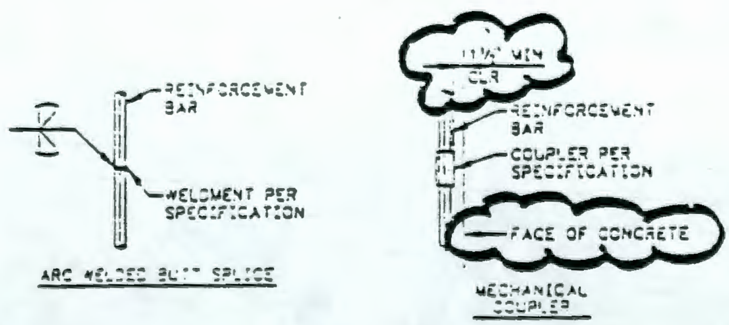


TYPICAL WALL BAR SPLICE 1

SCALE: NONE

SPLICE NOTES

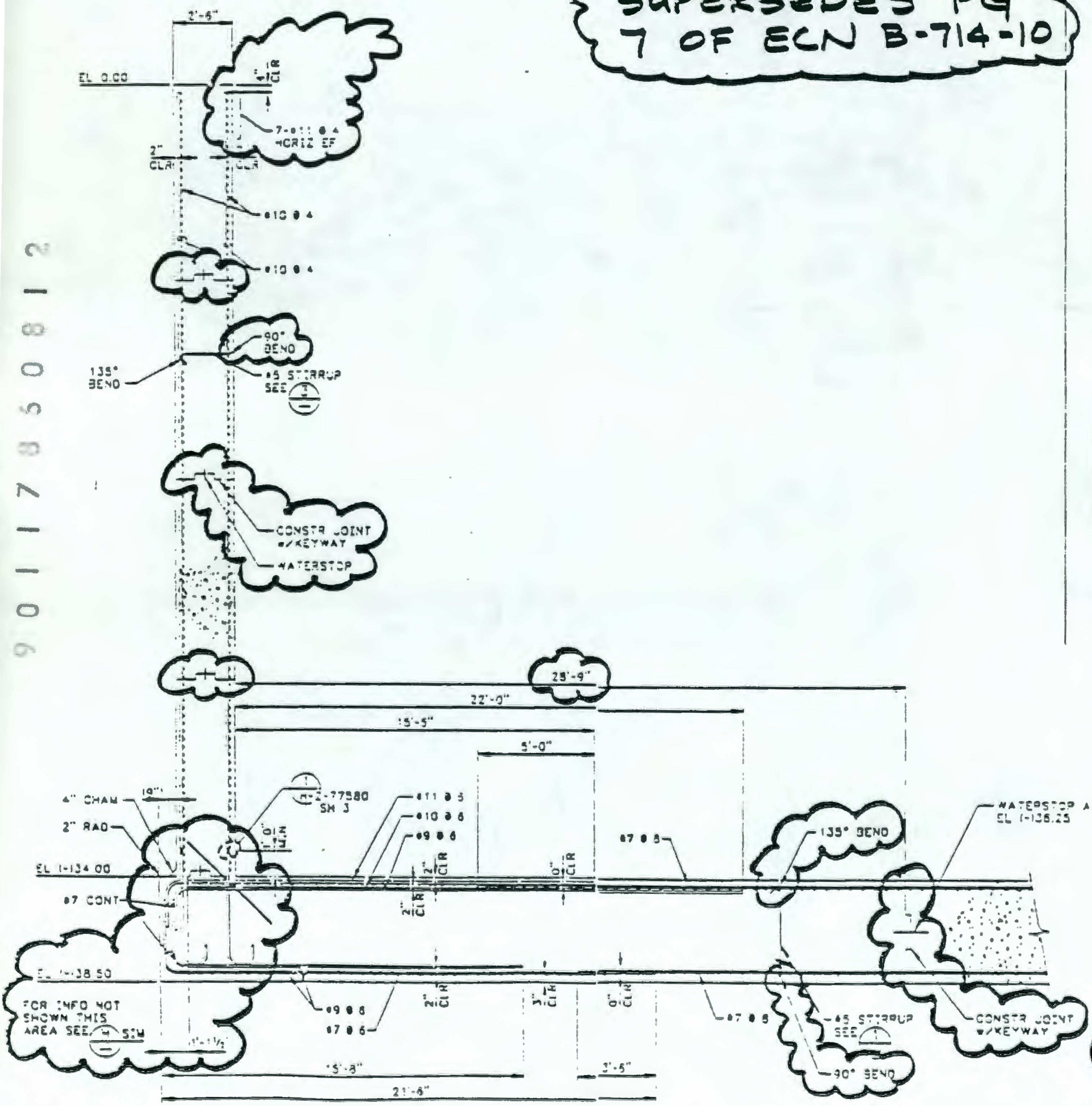
1- CONTRACTOR OPTION ON TYPE OF SPLICE AND SPACING

2- STAGGER CONSECUTIVE SPLICES MINIMUM 2'-6"

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH	DOE/RL 88-27 Rev. 1, 01/17/90

Dwg.	Sh.	Rev.	Prepared By 6-2381	Checked By	ECN No.	Page
H-2-77580	4	0	TK EHRHARD	[signature]	B-714-15	10

*THIS PAGE SUPERSEDES PG 7 OF ECN B-714-10



9001178 5081 2

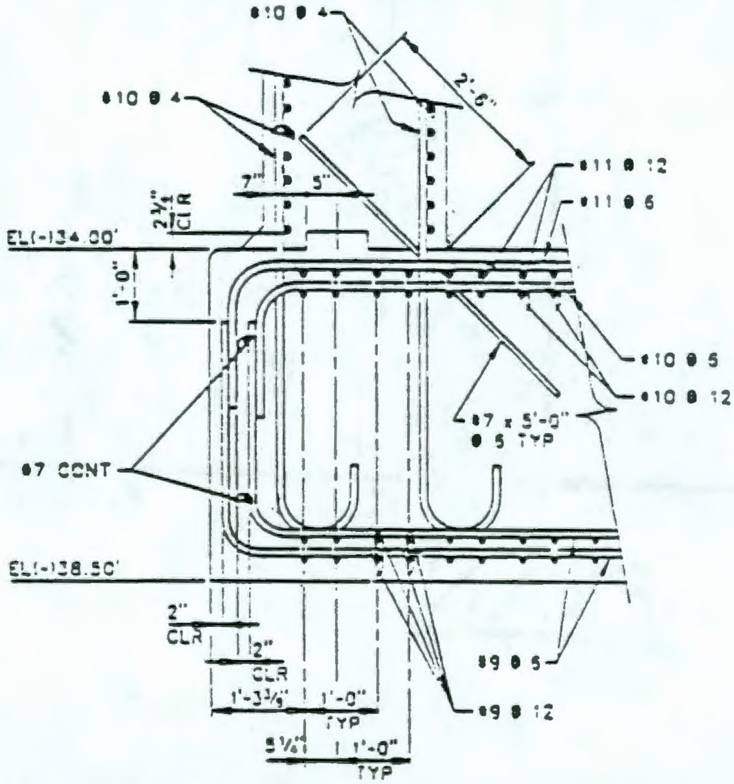
KEH-0159.00 (1/82)

SECTION C

KAISER ENGINEERS
HANFORD

ENGINEERING CHANGE NOTICE SKETCH

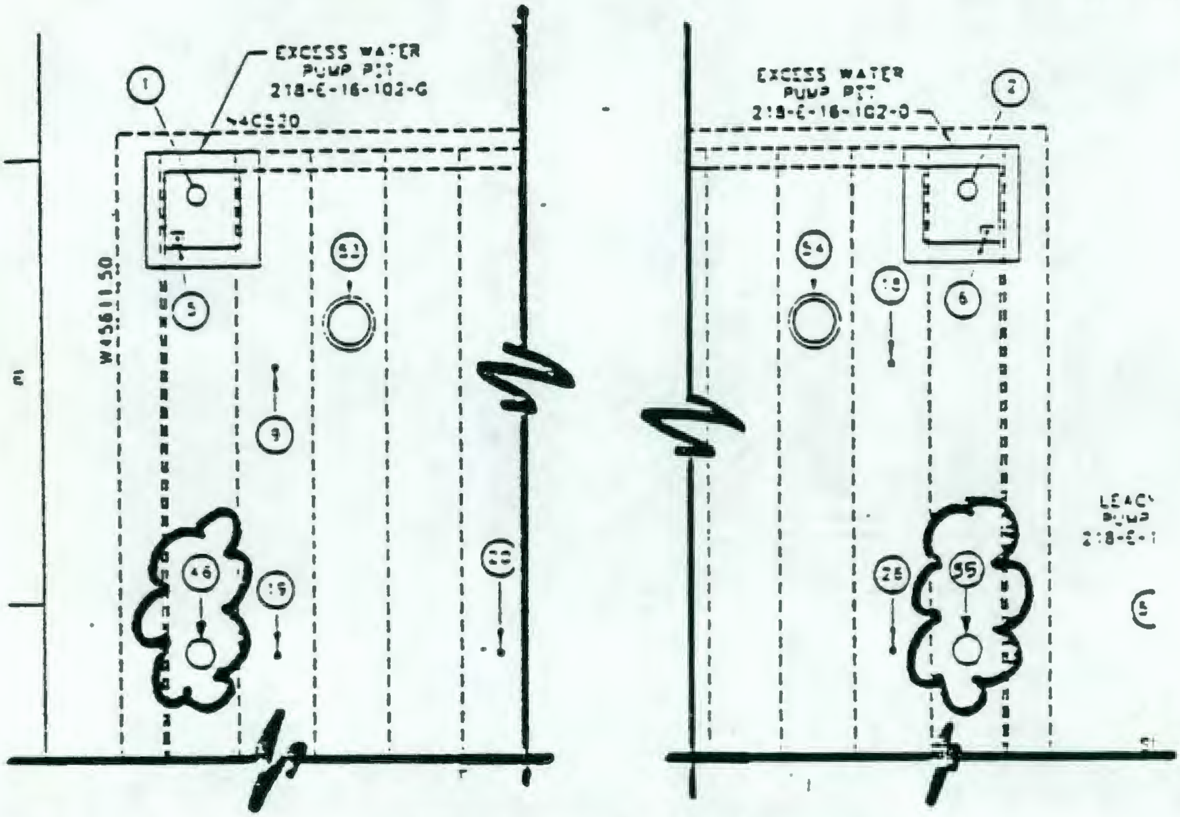
Dwg.	Sh.	Rev.	Prepared By 6-2381	Checked By	ECN No.	Page
H-2-77580	4	0	TK EHRHARD	[signature]	B-714-15	11



SECTION (H / H-2-77580, SH 1)
SCALE: 3/4" = 1'-0"

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH

Dwg.	Sh.	Rev.	Prepared By 6-2381	Checked By	ECN No.	Page
H-2-77587	1	0	TERESA EHRHARD	S. A. Fargo	B-714-15	12



PLAN

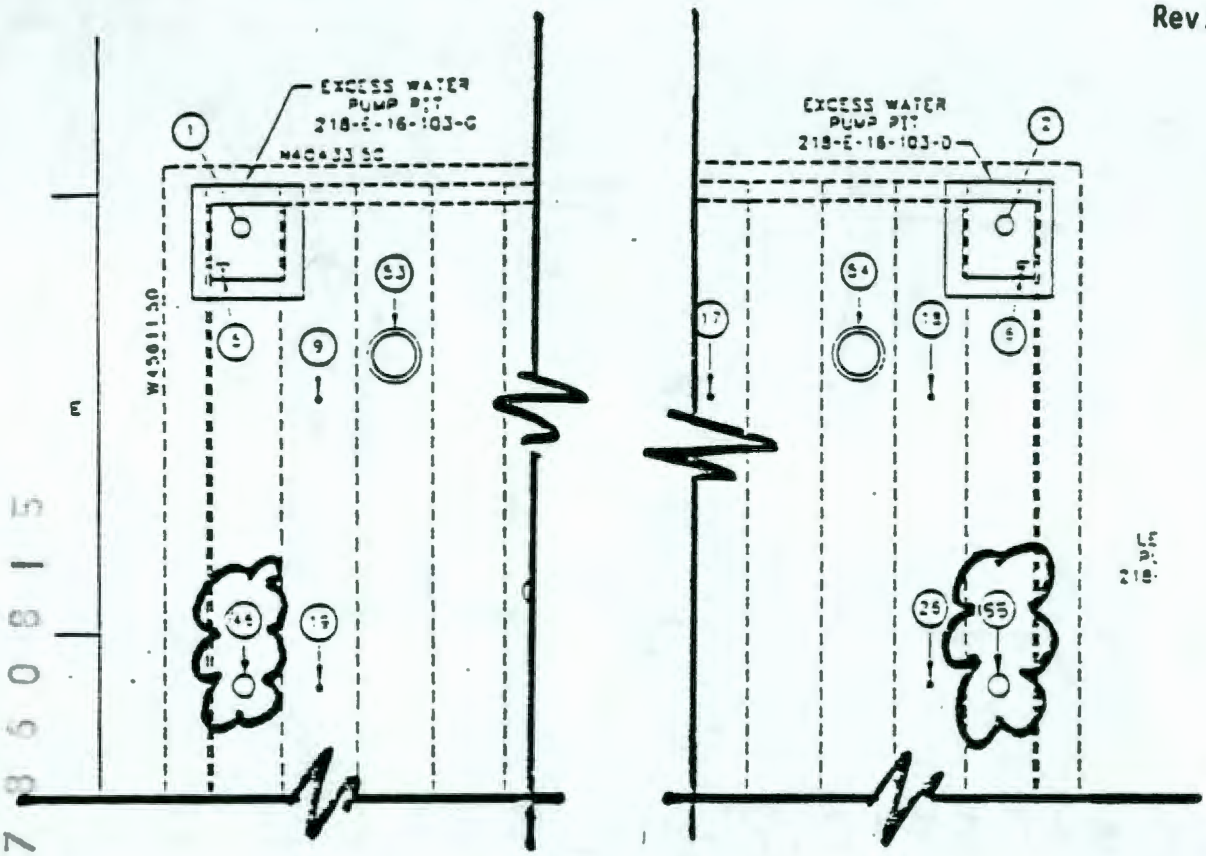
44	1½"SCHED 40	TE-T-102-3	3	H-2-77819	N40492.75	W45535.25
45	[illegible]	TE-T-102-4	3	H-2-77819	N40467.87	W45511.25
46	18" SCHED 40	EXHAUSTER	8	H-2-77581 SH 2	N40492.75	W45607.25
47	[illegible]	CLOSED CIRCUIT CCTV XE-01	4	H-2-77819	N40505.83	W45557.25
48	TS 14X10X¼	CLOSED CIRCUIT CCTV XE-02	4	H-2-77819	N40480.25	W45527.25
49	4"SCHED 40	GROUTED WASTE DISCHARGE	4	H-2-77801	N40492.75	W45547.25
50	3"SCHED 40	PIT DRAIN	A	H-2-77808	N40492.75	W45543.75
51	26" STD WT	PUMP 102-A	A	H-2-77805	N40492.75	W45475.25
52	3"SCHED 40	LEACHATE PIT DRAIN	4	H-2-77808	N40491.17	W45472.87
53	28"SCHED 40	MANWAY ACCESS	C	H-2-77581 SH 2	N40510	W45599.25
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
55	18"SCHED 40	EXHAUSTER	8	H-2-77581 SH 2	N40492.75	W45487.25

TABLE

KAISER ENGINEERS HANFORD

ENGINEERING CHANGE NOTICE SKETCH

Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
-77587	2	0	6-2381 TERESA EHRHARD	S. Afargo	B-714-15	13



PLAN

43	1½" SCHED 40	TE-T-103-2	3	H-2-77819	N40408.25	W45559.25
44	1½" SCHED 40	TE-T-103-3	3	H-2-77819	N40406.25	W45535.25
45	[illegible]	TE-T-103-4	3	H-2-77819	N40381.37	W45511.25
46	18" SCHED 40	EXHAUSTER	8	[illegible] SH 2	N40405.25	W45507.25
47	[illegible]	CLOSED CIRCUIT CCTV YE-01	4	H-2-77819	N40419.33	W45557.25
48	TS 14X10X½	CLOSED CIRCUIT CCTV YE-02	4	H-2-77819	N40393.75	W45527.25
49	4" SCHED 40	GROUTED WASTE DISCHARGE	4	H-2-77801	N40405.25	W45547.25
50	3" SCHED 40	PIT DRAIN	A	H-2-77808	N40408.25	W45543.75
51	26" STD WT	PUMP 102-A	A	H-2-77805	N40408.25	W45475.25
52	3" SCHED 40	LEACHATE PIT DRAIN	4	H-2-77808	N40404.57	W45472.97
53	28" SCHED 40	MANWAY ACCESS	C	[illegible] SH 2	N40423.50	W45579.25
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
55	18" SCHED 40	EXHAUSTER	8	H-2-77581 SH 2	N40406.25	W45487.25

TABLE

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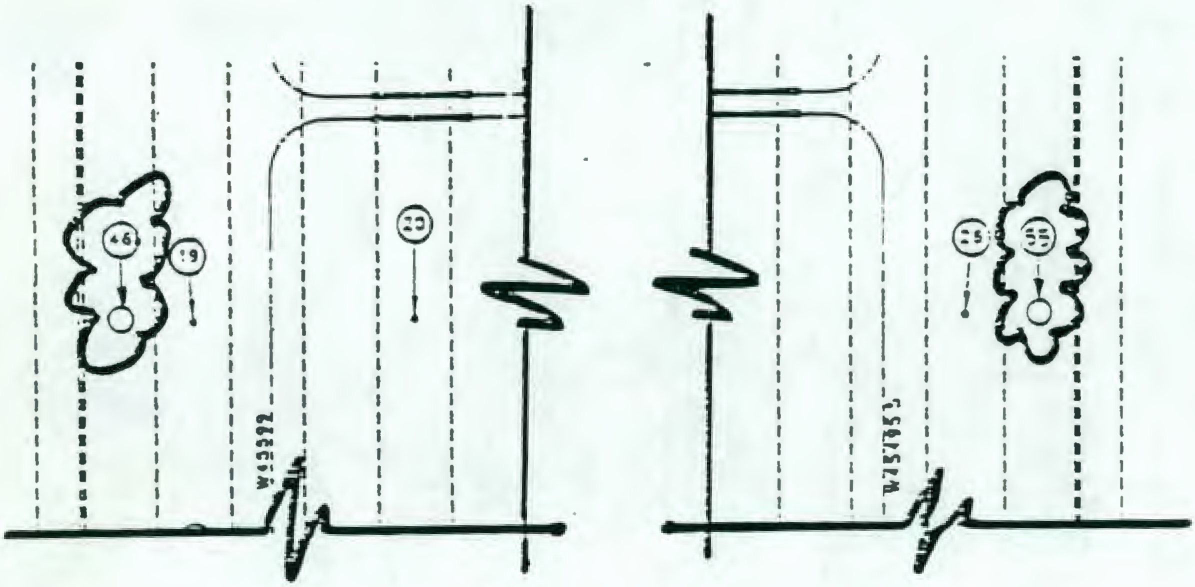
KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH				
Dwg. SEE BELOW	Sh. —	Rev. —	Prepared By 6-2381 TERESA EHRHARD	Checked By S. Afargo	ECN No. B-714-15	Page 14



H-2-77588, SH1, REV 0, PLAN (ZD3 & D7)

41	2" SCHED 40	VAULT PRESS XMTR PT 01 & PT 02	1	H-2-77619	N40505.25	W45511.25	DETAIL 2 DRAWING H-2-77588 SH 3
42	1 1/4" SCHED 40	TE-T-102-1	3	H-2-77619	N40517.52	W45583.25	NO ACTION REQUIRED
43	1 1/4" SCHED 40	TE-T-102-2	3	H-2-77619	N40492.75	W45559.25	NO ACTION REQUIRED
44	1 1/4" SCHED 40	TE-T-102-3	3	H-2-77619	N40492.75	W45535.25	NO ACTION REQUIRED
45	[illegible] SCHED	TE-T-102-4	3	H-2-77619	N40467.87	W45511.25	NO ACTION REQUIRED
46	18" SCHED 40	EXHAUSTER	8	H-2-77581 SH 2	N40492.75	W45607.25	DETAIL 4 DRAWING H-2-77588 SH 3 SIM
47	[illegible]	CLOSED CIRCUIT CCTV XE-01	4	H-2-77619	N40505.33	W45557.25	DETAIL 4 DRAWING H-2-77588 SH 3
48	TS 14x10x1/4	CLOSED CIRCUIT CCTV XE-02	4	H-2-77619	N40480.25	W45527.25	DETAIL 4 DRAWING H-2-77588 SH 3
49	4" SCHED 40	GROUTED WASTE DISCHARGE	4	H-2-77601	N40492.75	W45547.25	FILL WITH GROUT
50	3" SCHED 40	PIT DRAIN	A	H-2-77608	N40492.75	W45543.75	REMOVE DRAIN SEAL & HANDLE
51	26" STD WT	PUMP 102-A	A	H-2-77605	N40492.75	W45475.25	REMOVE PUMP H-2-77616 & REPLACE W/PUMP H-2-77[illegible]
52	3" SCHED 40	LEACHATE PIT DRAIN	A	H-2-77608	N40491.17	W45472.87	NO ACTION REQUIRED
53	25" SCHED 40	MANWAY ACCESS	C	H-2-77581 SH 2	N40510	W45599.25	NO ACTION REQUIRED
54	25" SCHED 40	MANWAY ACCESS	[illegible]	[illegible]	[illegible]	[illegible]	NO ACTION REQUIRED
55	18" SCHED 40	EXHAUSTER	8	H-2-77581 SH2	N40492.75	W45487.25	DETAIL 4 DRAWING H-2-77588 SH 3 SIM

H-2-77588, SH2, REV 0, RISER TABLE (Z83 & A8)

KAISER ENGINEERS
HANFORD

ENGINEERING CHANGE NOTICE SKETCH

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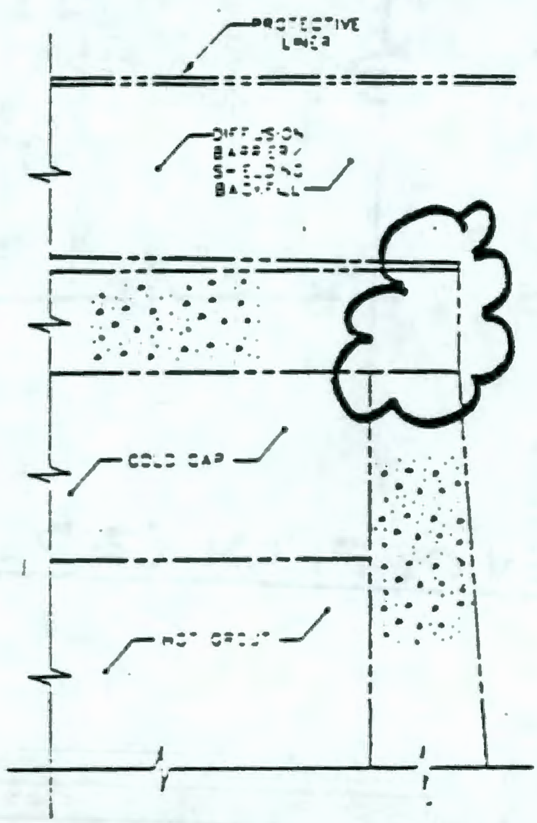
7588	3	0	TERESA EHRHARD	S. Afargo	3-714-15	15

90117850817



SECTION A
SCALE ½"=1'-0"

KAISER ENGINEERS HANFORD | **ENGINEERING CHANGE NOTICE SKETCH**

Dwg.	Sh.	Rev.	Prepared By 6-2381	Checked By	ECN No.	Page
SEE BELOW	—	—	TERESA EHRHARD	S. Afargo	B-714-15	16

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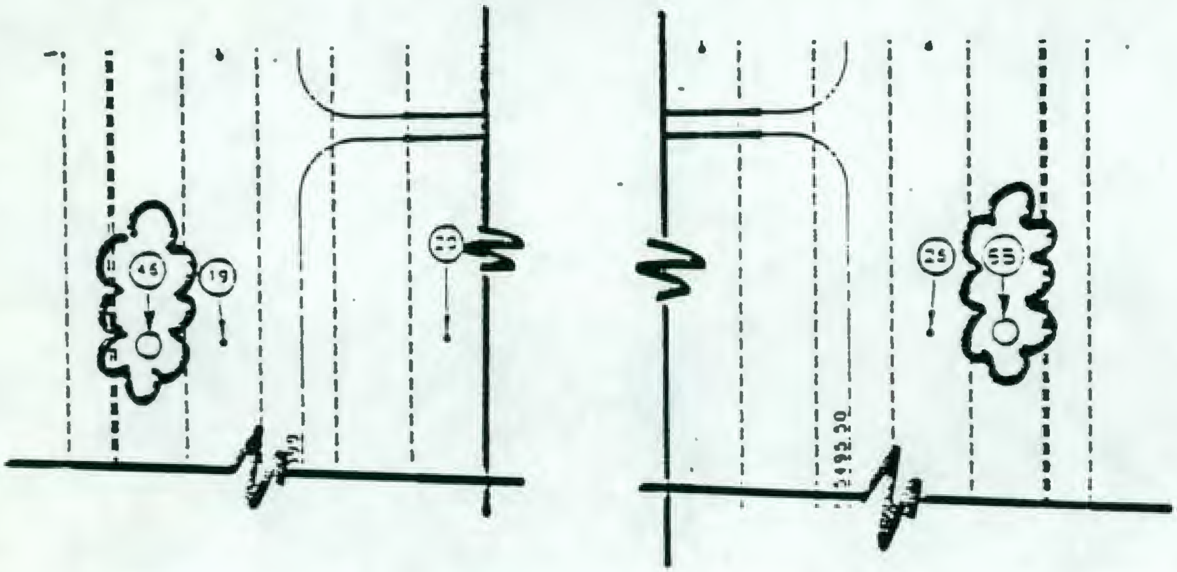

H-2-77583, SH4, REV 0, PLAN (Z D3 & D8)

9 0 1 1 7 8 5 0 8 1 9

44	1½"SCHED 40	TE-T-103-3	3	H-2-77619	N40406.25	W45535.25	NO ACTION REQUIRED
45	[illegible]SCHED [illegible]	TE-T-103-4	3	H-2-77619	N40406.25	W45511.25	NO ACTION REQUIRED
46	18"SCHED 40	EXHAUSTER	8	H-2-77581 SH 2	N40406.25	W45607.25	DETAIL 4 DRAWING H-2-77588 SH 3 SIM
47	[illegible]	CLOSED CIRCUIT CCTV XE-01	4	H-2-77619	N40419.33	W45567.25	DETAIL 4 DRAWING H-2-77588 SH 3
48	TS 14X10X¼	CLOSED CIRCUIT CCTV XE-02	4	H-2-77619	N40393.75	W45527.25	DETAIL 4 DRAWING H-2-77588 SH 3
49	4"SCHED 40	GROUTED WASTE DISCHARGE	4	H-2-77601	N40408.25	W45547.25	FILL WITH GROUT
50	3"SCHED 40	PIT DRAIN	A	H-2-77608	N40408.25	W45543.75	REMOVE DRAIN SEAL & HANDLE
51	2" STD WT	PUMP 103-A	A	H-2-77605	N40406.25	W45475.25	REMOVE PUMP (H-2-77616) & REPLACE W/PUMP (H-2-77514)
52	3"SCHED 40	LEACHATE PIT DRAIN	A	H-2-77608	N40404.67	W45472.87	NO ACTION REQUIRED
53	28"SCHED 40	MANWAY ACCESS	C	H-2-77581 SH 2	N40423.50	W45599.25	NO ACTION REQUIRED
[illegible]	[illegible]	[illegible]		SH [illegible]	[illegible]	[illegible]	[illegible]
55	18"SCHED 40	EXHAUSTER	8	H-2-77581 SH 2	N40406.25	W45487.25	DETAIL 4 DRAWING H-2-77588 SH3 SIM

H-2-77583, SH5, REV 0, RISER TABLE (Z A8 & B8)

KE-4015900 (1/88)

KAISER ENGINEERS
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ENGINEERING CHANGE NOTICE SKETCH

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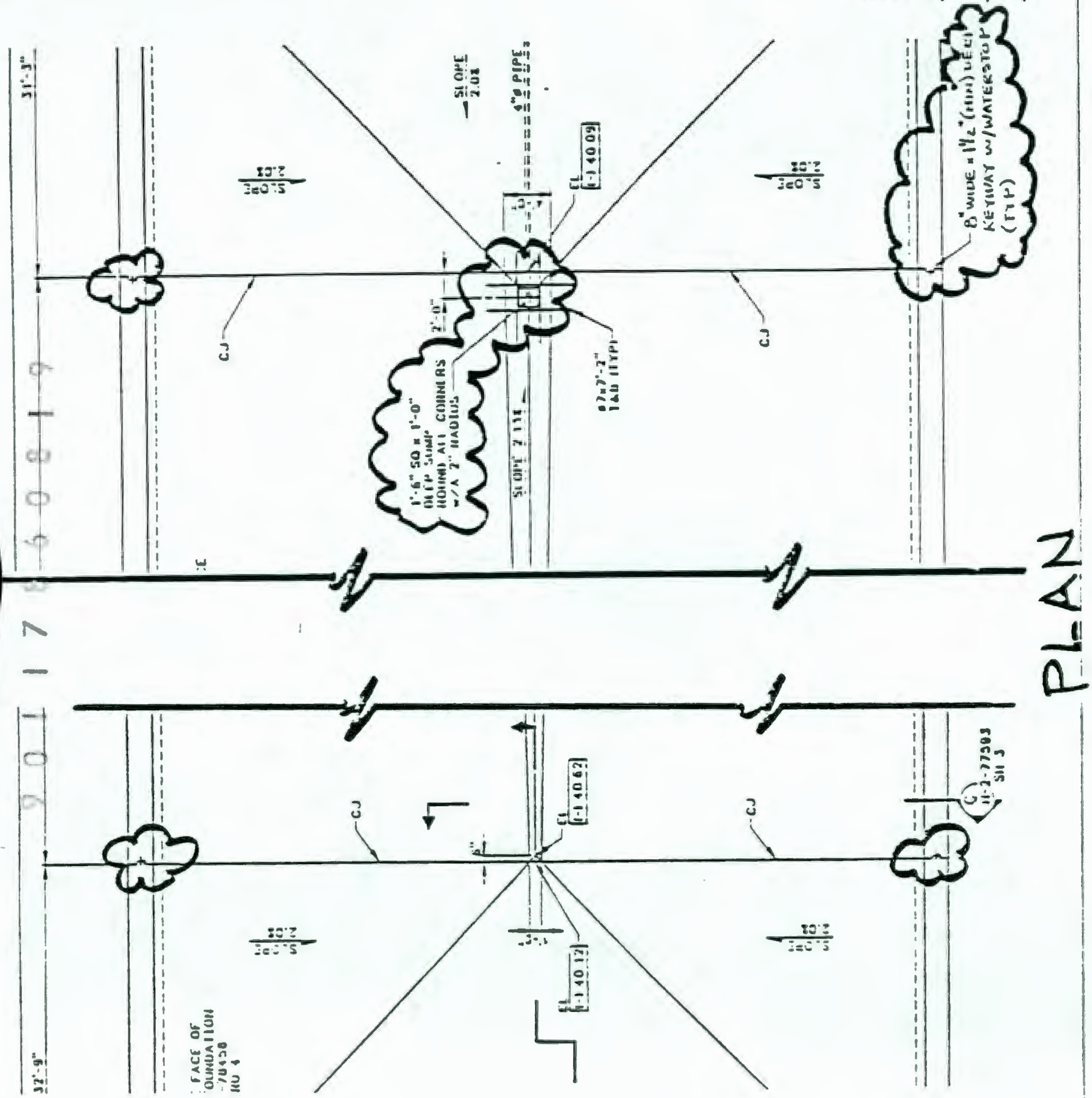

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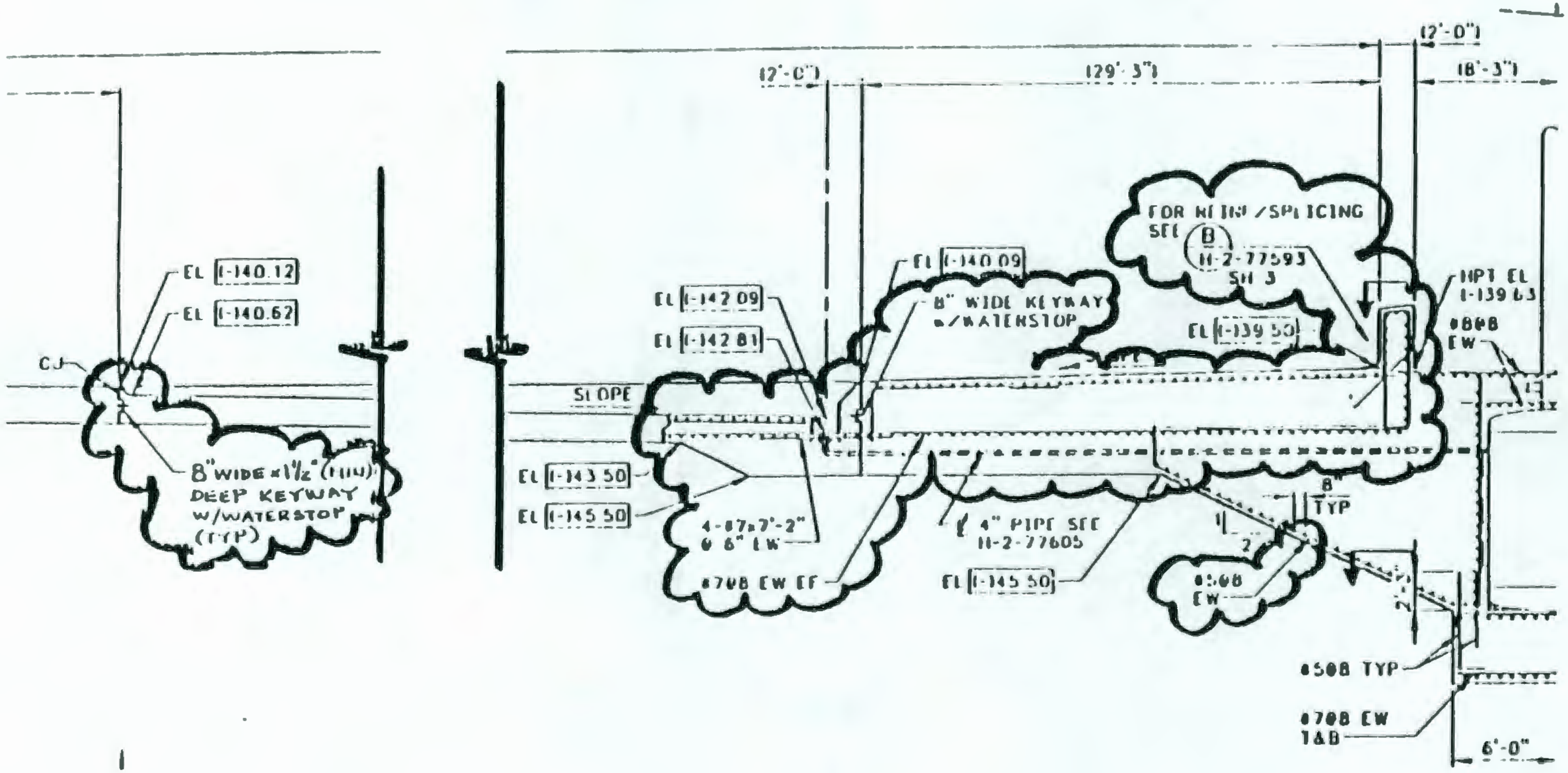

SECTION A

KAISER ENGINEERS HANFORD

ENGINEERING CHANGE NOTICE SKETCH

Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77593	2	0	TK EHRHARD 6-23-81	[signature]	B-714-15	18

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APP 4I-268

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH				
Dwg. 93 -2-7759	Sh. 3	Rev. 0	Prepared By 6-2381 TK EHRHARD	Checked By [signature]	ECN No. B-714-15	Page 19

REF: ECN B-714-10, PG 19 & 20

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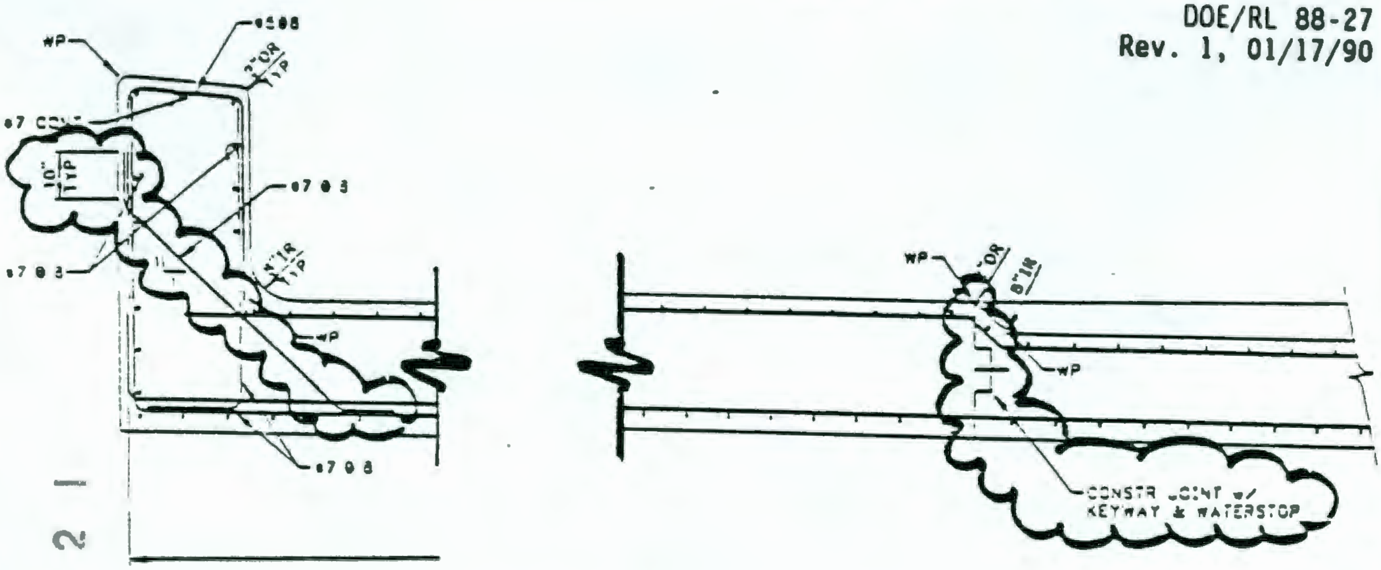
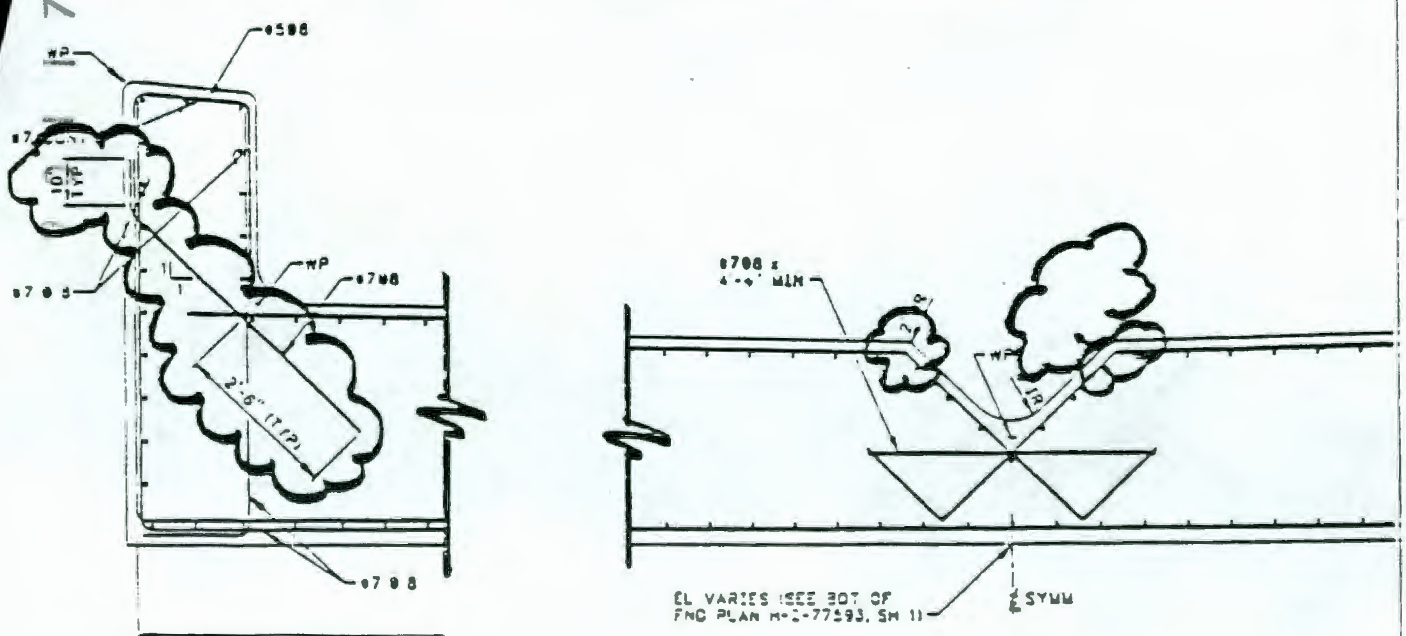


SECTION B



SECTION C

Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
SEE BELOW	--	--	TK EHRHARD/6-2381	[signature]	B-714-15	20

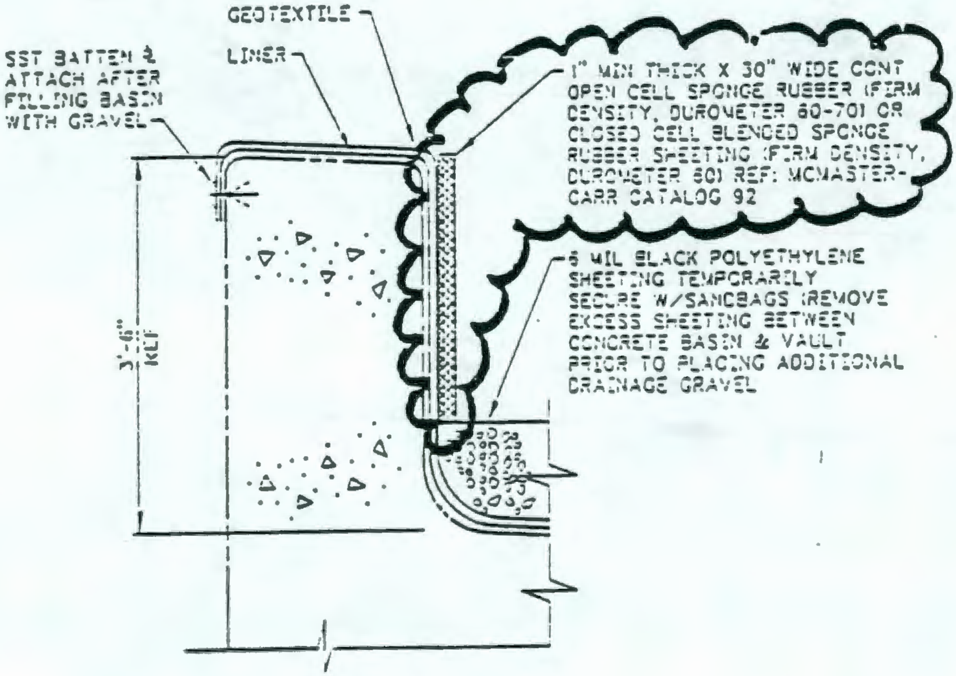
ENVIRONMENTAL CHANGES

1) H-2-77582, SH 1, REV 0

a) DETAIL 1 (ZC7): DELETE WT 6, NOTE, LEADER & ARROW
b) PLAN (ZD4-D7&F4-F7): DELETE WT6, TS4x4 AND ALL RELATED REFERENCES TO THEM.

2) H-2-77583, SH 1, REV 0

a) DETAIL 1 (ZB7): CHANGE AS SHOWN BELOW



DETAIL 1
NTS

3) SPECIFICATION B-714-C2

a) SECTION 02756, para 2.1.3.1:
CHANGE Percent Passing for Sieve Size #8 FROM 0 TO 0-2%
b) SECTION 09885:
DELETE para 3.2.3.2
RENUMBER para 3.2.3.3 TO 3.2.3.2
ADD TO END OF para 3.3.3.2: Apply an additional coating on the upper 4 feet of vertical surfaces. Do not allow the finish coat to cure beyond elastomeric set before applying additional coat.
ADD TO para 3.6.1.a:

ADDITIONAL: Nokorode 705M	2.0 gal/ 100ft^2	30 mils	25 mils

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INSTRUMENTATION CHANGES

SPECIFICATION B-714-C2, SECTION 13440

1) CHANGE PARA. 3.2.1 TO 3.2.1.1

2) ADD: 3.2.1 Test cable and thermocouple assemblies prior to shipment.
3) ADD: 3.2.1.2 Test thermocouples within each assembly by testing each thermocouple against the room ambient temperature. Heat each thermocouple and verify a temperature rise. Deliver test results to KEH upon completion of tests.
4) PAGE 3, ITEM 13: SHOULD READ: Quick-disconnect connector on 25 foot pigtail
5) PAGE 5, NOTES: 1: ADD TO ELEMENT COLUMN: LE-LS-104-1A
LE-LS-104-1B
LE-LS-105-1A
LE-LS-105-1B

ADD TO TRANSMITTER COLUMN: LIT-LS-104-1A
LIT-LS-104-1B
LIT-LS-105-1A
LIT-LS-105-1B

6) PAGE 6, NOTES: 1: ADD

TE-104-1	TE-105-1
TE-104-2	TE-105-2
TE-104-3	TE-105-3
TE-104-4	TE-105-4

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SEE BELOW	—	—	J. L. BRINKLEY	W.C. Atkins 5/4/89	B-714-15	22

ELECTRICAL CHANGES

1) H-2-77635, SH 1, REV 0, ZONE 4F

A) CHANGE "NO. 404610*" TO "NO. AP404610*"

2) H-2-77636, SH 1, REV 0

A) ZONE 4E - MOVE WIRE 14A FROM TERMINAL 13 TO TERMINAL 14A AS SHOWN ON ATTACHED PAGE 24.
B) ZONE 8A - CHANGE "TO PUMP" TO "TO VAULT" AS SHOWN ON ATTACHED PAGE 25.

3) H-2-77636, SH 2, REV 0, ZONE 2E

A) CHANGE "SINGLE PAIR #20" TO "2-SINGLE PAIR #20"

4) H-2-77636, SH 3, REV 0

A) ZONE 4E - MOVE WIRE 14A FROM TERMINAL 13 TO TERMINAL 14A AS SHOWN ON ATTACHED PAGE 26.
B) ZONE 8A - CHANGE "TO PUMP" TO "TO VAULT" AS SHOWN ON ATTACHED PAGE 27.

5) H-2-77636, SH 4, REV 0, ZONE 2D

A) CHANGE "SINGLE PAIR #20" TO "2-SINGLE PAIR #20"

6) H-2-77637, SH 1, REV 0

A) ZONE 7F, DETAIL 1 - CHANGE "W/VAULT NUMBER" TO "W/BASIC VAULT NUMBER"
B) ZONE 1F, DETAIL 7 - CHANGE "MANHOLE NUMBER" TO "BASIC VAULT NUMBER"
C) ZONE 2C, DETAIL 6 - CHANGE "MANHOLE NUMBER" TO "BASIC VAULT NUMBER"

7) H-2-77638, SH 1, REV 0, ZONE 2D

A) DELETE NOTE 9.

8) H-2-77639, SH 1, REV 0, ZONE 6D

A) ADD CONDUIT P64A BETWEEN THE LEACHATE SUMP PUMP CONTROLLER AND C/P-PB-102-1 AS SHOWN ON ATTACHED PAGE 28.

9) H-2-77639, SH 2, REV 0, ZONE 7D

A) ADD CONDUIT P65A BETWEEN THE LEACHATE SUMP PUMP CONTROLLER AND C/P-PB-103-1 AS SHOWN ON ATTACHED PAGE 29.

9011785 0824

10) H-2-77640, SH 1, REV 0, ZONE 2F

A) ADD BACKPLATE AS SHOWN ON ATTACHED PAGE 30.

11) H-2-77641, SH 1, REV 0

A) WIRE RUN NUMBER GWD64 - IN "FROM" COLUMN, CHANGE "I-TB-LSL102" TO I-TB-LS-102"
B) WIRE RUN NUMBER GWD92 - IN "VIA" COLUMN, CHANGE "C/P-PB-102" TO "C/P-PB-102-1"
C) WIRE RUN NUMBER GWD93 - IN "VIA" COLUMN, CHANGE "C/P-PB-103" TO "C/P-PB-103-1"
D) WIRE RUN NUMBER GWD99 - IN "VIA" COLUMN, CHANGE "IP-102-2" TO "I-PB-102-2"
E) WIRE RUN NUMBER GWD100 - IN "TO" COLUMN, CHANGE "LIT-102" TO "LIT-LS-102"
F) WIRE RUN NUMBER GWD102 - IN "TO" COLUMN, CHANGE "LECHATE" TO "LEACHATE"
G) WIRE RUN NUMBER GWD104 - IN "FROM" COLUMN, CHANGE "LKD-LS-103" TO "LDK-LS-103"
H) WIRE RUN NUMBER GWD107 - IN "VIA" COLUMN, CHANGE "IP-103-2" TO "I-PB-103-2" AND "ITB-LS-103"TO "I-TB-LS-103"

KAISER ENGINEERS
HANFORD

ENGINEERING CHANGE NOTICE SKETCH

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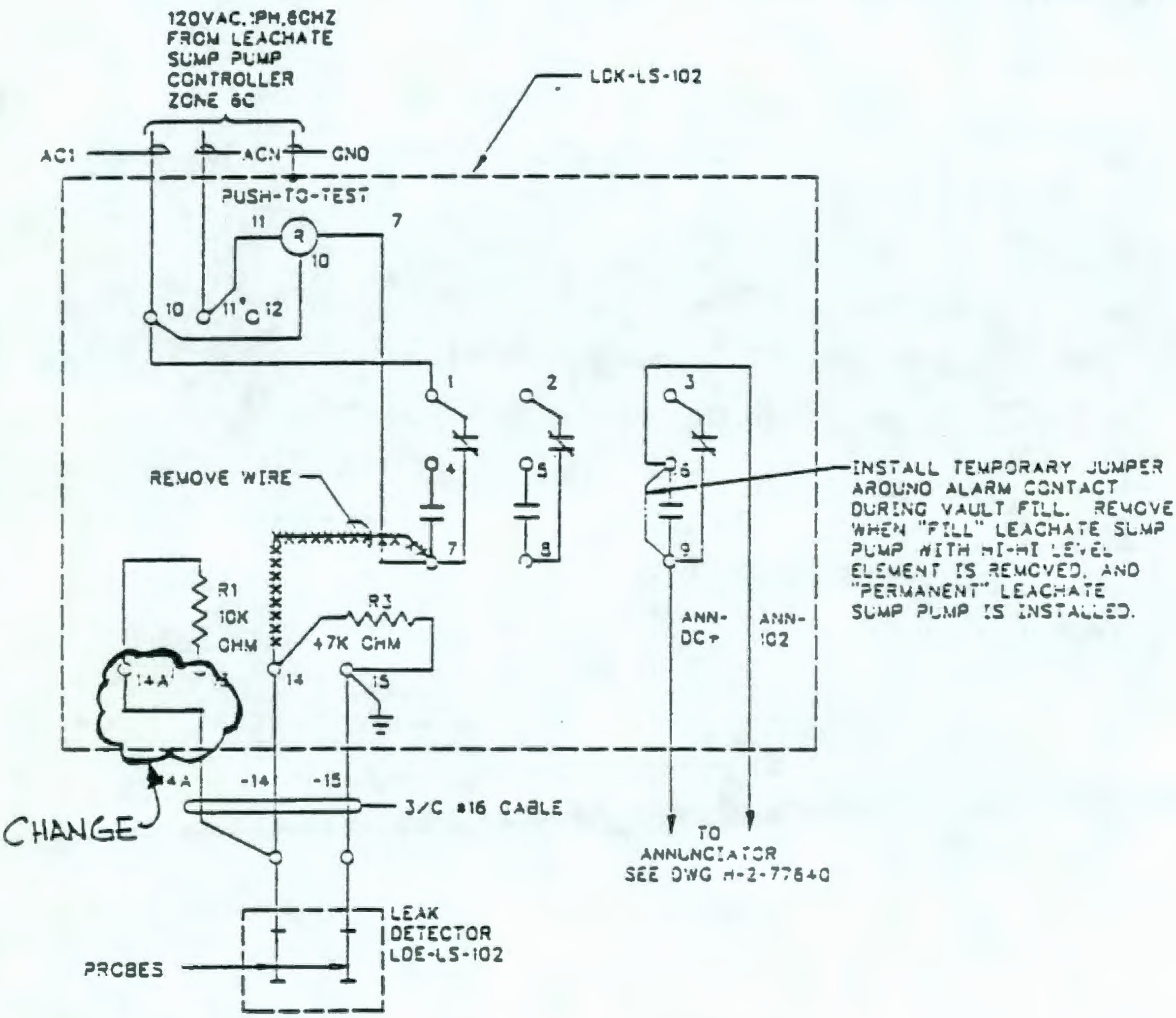
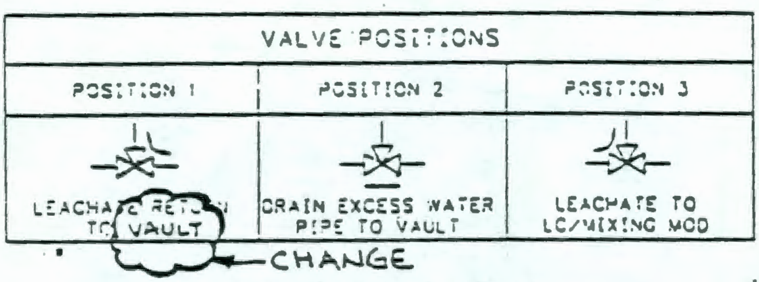
-2-77636	1	0	J.L. BRINKLEY	W.C. Atkins 8/9/89	B-714-15	24



LEACHATE SUMP LEAK DETECTION CONNECTION DIAGRAM
(PREFIX PROBE WIRE NUMBERS WITH LDK-LS-102)

9 0 1 1 7 8 6 0 8 2 6

KEH-0159.00 (89)



EW DIVERTER VALVE MOV-C8
3-WAY 3 POSITION MOTOR OPERATED VALVE
ELEMENTARY DIAGRAM
PREFIX WIRE NUMBERS WITH MOV-C8

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH				
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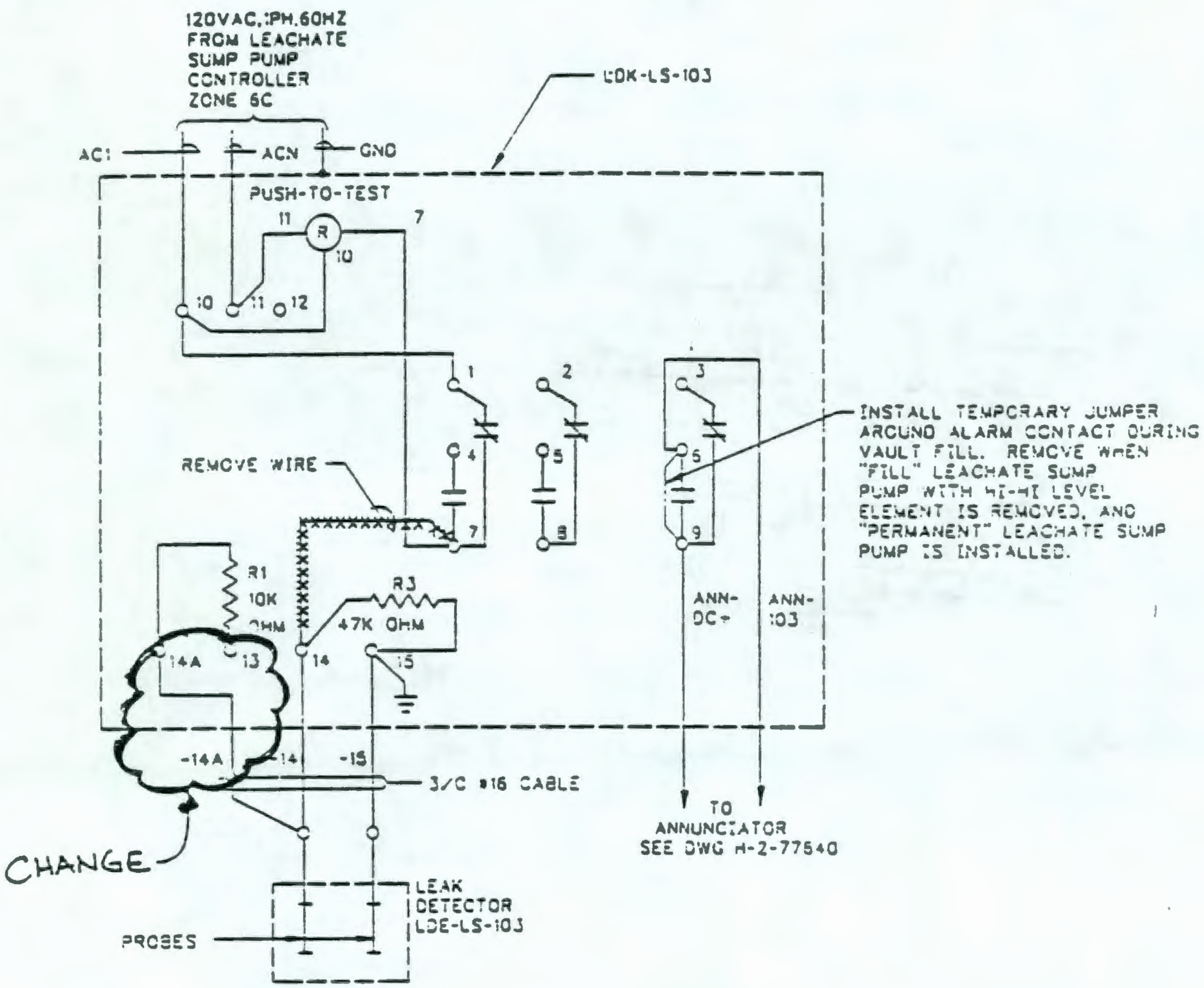

LEACHATE SUMP LEAK DETECTION CONNECTION DIAGRAM
(PREFIX PROBE WIRE NUMBERS WITH LDK-LS-103)

9011785082?

KEH-0159.00 (1/88)

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
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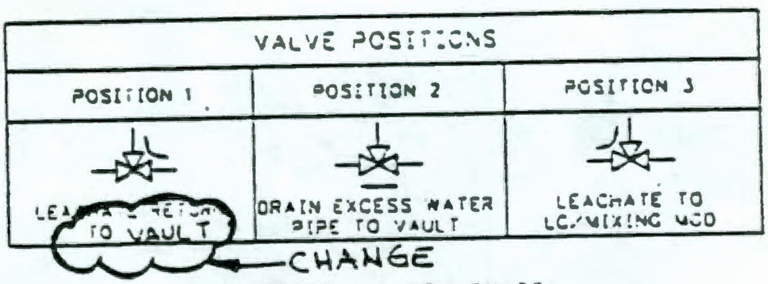
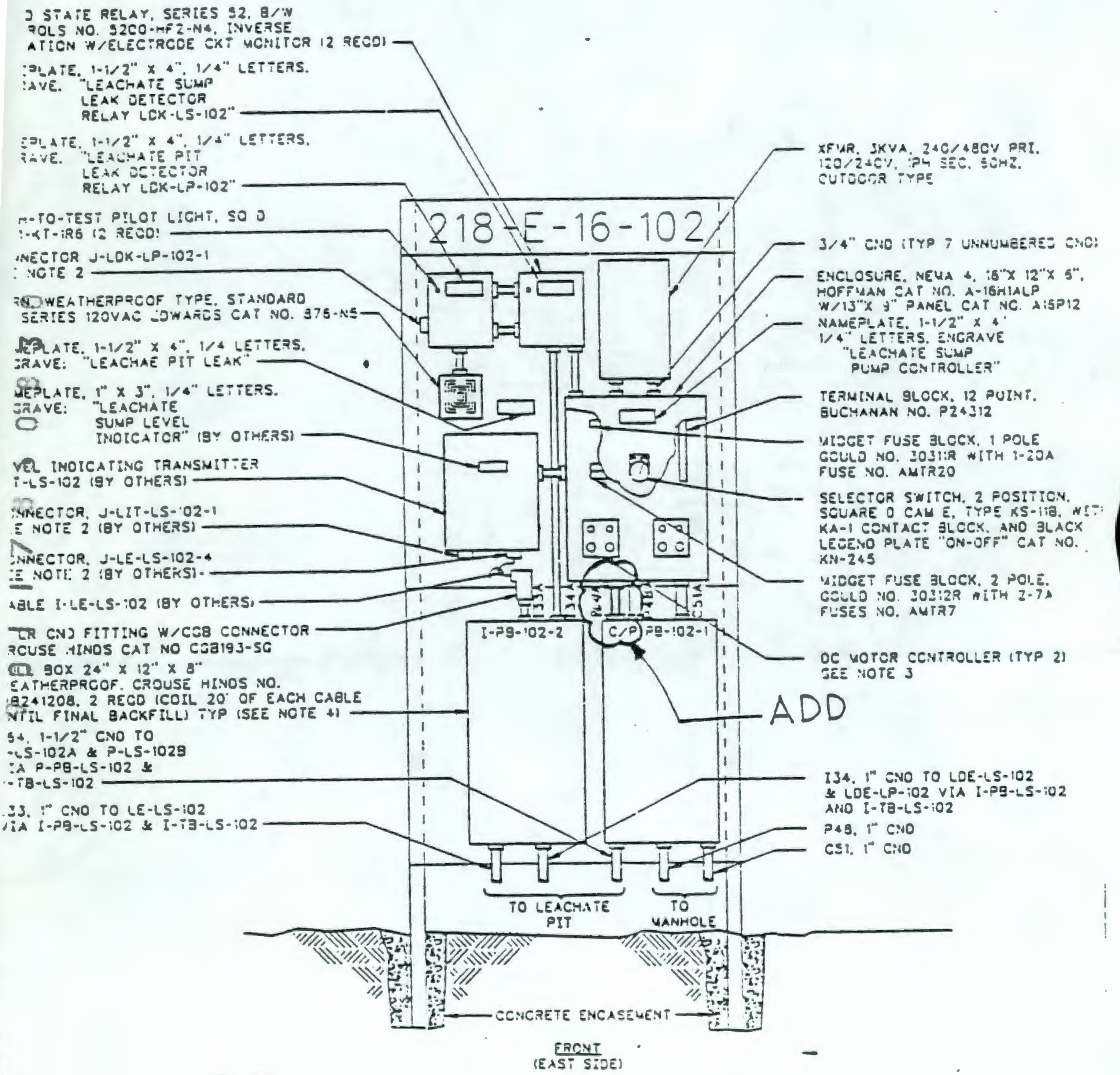


EW DIVERTER VALVE MOV-08
3-WAY 3 POSITION MOTOR OPERATED VALVE
ELEMENTARY DIAGRAM
PREFIX WIRE NUMBERS WITH MOV-08



KEH-0159.00 1.88.

KAISER ENGINEERS HANFORD

ENGINEERING CHANGE NOTICE SKETCH

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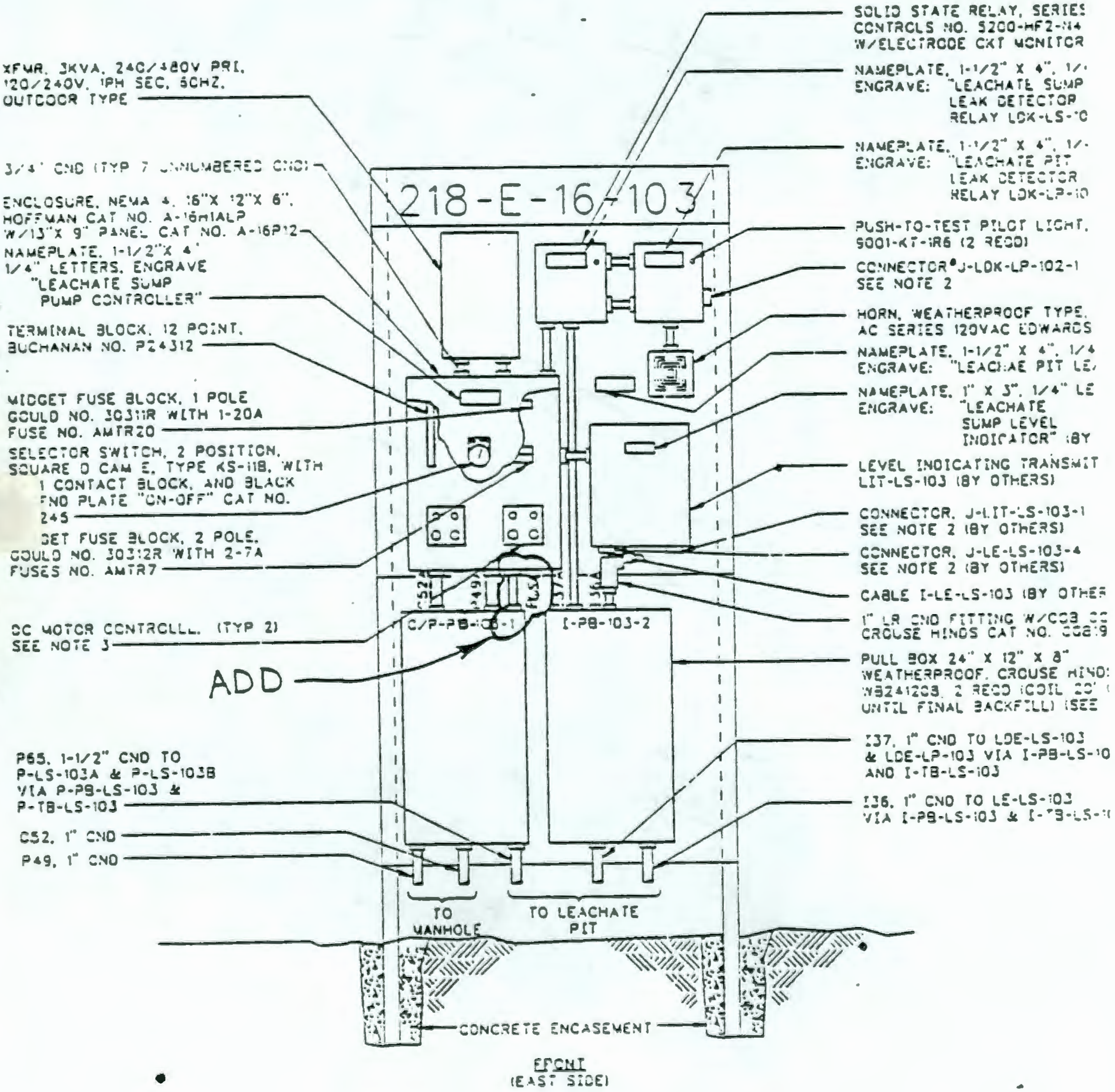
77639	2	0	J. L. BRINKLEY	W. C. Atkins 3/9/89	B-714-15	29



KEH-0159.00 (1.88)

KAISER ENGINEERS HANFORD

ENGINEERING CHANGE NOTICE SKETCH

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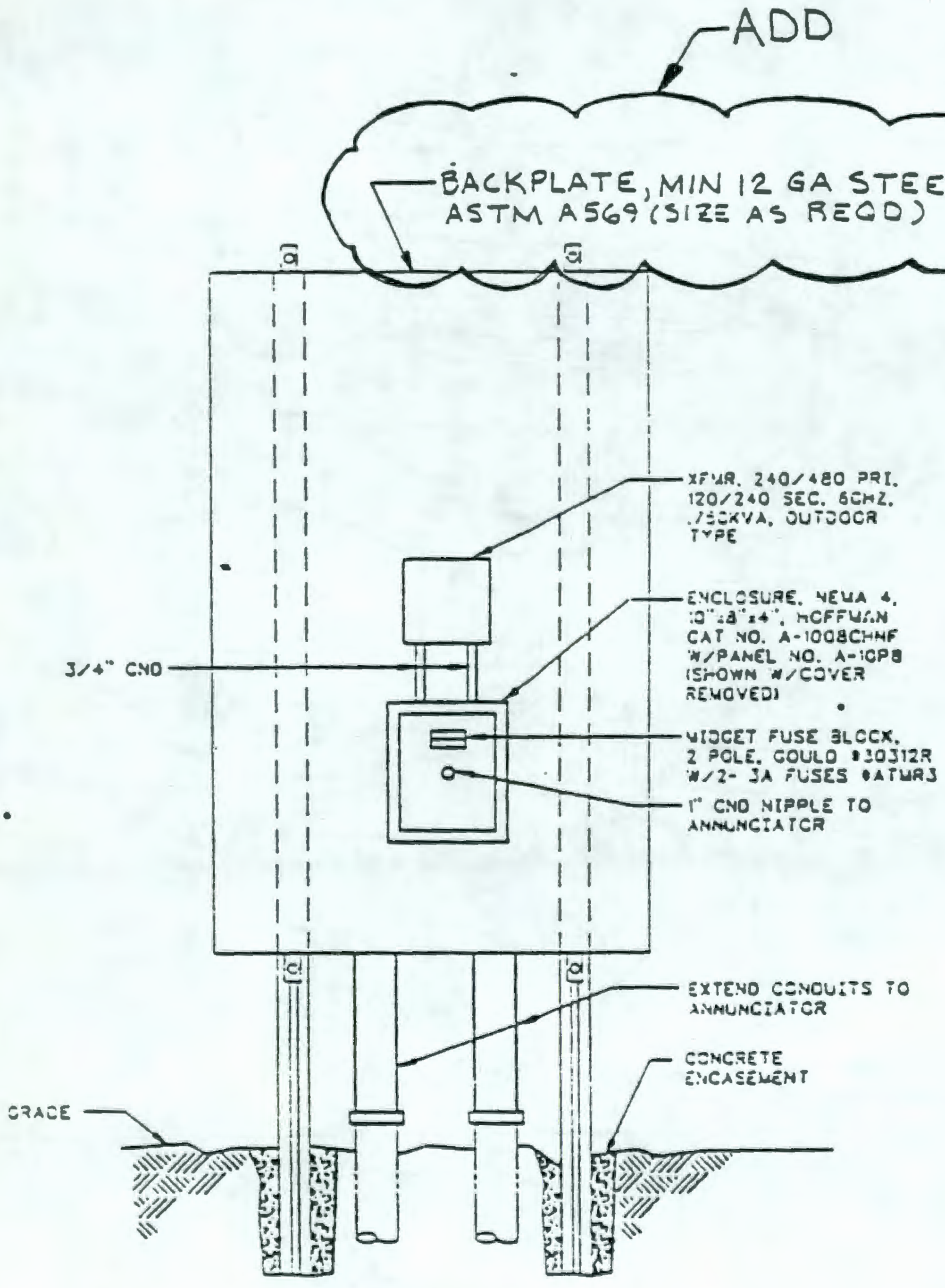
2-77640	1	0	J.L. BRINKLEY	W.C. Atkins 3/10/97	B-714-15	30



ELEVATION (C / H-2-77634)
ANNUNCIATOR PANEL
(LOOKING EAST)
REAR VIEW

ENGINEERING CHANGE NOTICE

1. ECN ~~144127~~
Proj. ECN B-714-17

DOE/RL 88-27
Rev. 1, 01/17/90

2. ECN Category (mark one)	Supplemental [X] Direct Revision [ ] Change ECN [ ] Temporary [ ] Supersedure [ ] Discovery [ ] Cancel/Void [ ]
3. Originator's Name, Organization, MSIN, and Telephone No.	G. J. Kubinski, KEH, 6-2381
4. Date	10-16-89
5. Project Title/No./Work Order No.	B-714/ER8159 Grout Vault Pair 218-E-16-102 & 103
6. Bldg./Sys./Fac. No.	218-E-16
7. Impact Level	3
8. Document Number Affected (include rev. and sheet no.)	See P. 3 & 4
9. Related ECN No(s).	B-714-15
10. Related PO No.	N/A
11a. Modification Work	[ ] Yes (fill out Blk. 11b) [ ] No (NA Blks. 11b, 11c, 11d) UNK
11b. Work Package Doc. No.	UNK
11c. Complete Installation Work	Cog. Engineer Signature & Date
11d. Complete Restoration (Temp. ECN only)	Cog. Engineer Signature & Date

12. Description of Change

See p. 3 & 4

90117850833

13a. Justification (mark one)	Criteria Change [ ] Design Improvement [X] Environmental [ ] As-Found [ ] Facilitate Const. [ ] Const. Error/Omission [ ] Design Error/Omission [ ]
13b. Justification Details	The changes shown by this ECN are due to comments by WHC and improvements in design media presentation as shown by the design media for vaults 104 & 105.

14. Distribution (include name, MSIN, and no. of copies)

KEH DISTRIBUTION

Engrg Doc Cntl	TCPC/5-8-D
Const Doc Cntl	2910E/200E
Station #10	A3-87
L. Garza	A3-80

WHC DISTRIBUTION

S. R. Briggs(PE)	R3-43
J. L. Gilbert	R3-46
O. A. Halverson	R3-09
J. R. McGee	S1-54
D. E. Palmer	R3-43
W. J. Powell	R1-48
D. D. Wodrich	R1-48
A. E. Young	S0-05
Project Files	R1-28

DOE

A. G. Lassila	A5-18

RELEASE STAMP

OFFICIAL RELEASE 44
BY WHC
DATE NOV 07 1989
Station #4

A-7900-013 (11/88)

ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1): B-714-17

15. Design Verification Required	16. Cost Impact — ENGINEERING	16. Cost Impact — CONSTRUCTION	17. Schedule Impact (days)
[X] Yes	Additional [ ] $ ∅	Additional [X] $ 9,000	Improvement [ ] None
[ ] No	Savings [ ] $	Savings [ ] $	Delay [ ]

18. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) t[o] the change described in Block 12. Enter the affected document number in Block 19.

SDD/DD	[ ]	Seismic/Stress Analysis	[ ]	Tank Calibration Ma[nual]	[ ]
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

OPERATIONS AND ENGINEERING	Signature	Date	ARCHITECT ENGINEER	Signature	Date
Cog./Project Engineer	A R Bu[illegible]	10/31/89	PE	[illegible signature]	10-30-89
Cog./Project Engr. Mgr.	NA		QA	[illegible signature]	10-30-89
QA	Jack [illegible]	11/1/89	Safety	[illegible signature]	10-23-89
Safety	NA		Design	A. R. [illegible]	10-16-89
Security			Other ENVIR	R G Hollenbeck	10/25/89
Proj.Prog./Dept. Mgr.					
Def. React. Div.					
Chem. Proc. Div.					
Def. Wst. Mgmt. Div.			DEPARTMENT OF ENERGY		
Adv. React. Dev. Div.				NA	
Proj. Dept.					
Environ. Div.			ADDITIONAL		
IRM Dept.					
Facility Rep. (Ops)					
Other					

A-7900-013R (11/8[illegible])

9 0 1 1 7 3 5 0 8 3 4

KAISER ENGINEERS HANFORD

ENGINEERING CHANGE NOTICE SKETCH

Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
			G. J. KUBINSKI	A. R. [signature]	B-714-17	3

DOE/RL 88-27
Rev. 1, 01/17/90

H-2-77635, Sh. 1, Rev. 0
Revise Leachate Pit instrument no's as shown on page 5. (Zone 2D, 2E & 3D)
Remove misplaced "LDE-LS-102*" in Zone D1

H-2-77635, Sh. 2, Rev. 0
Revise Leachate Pit instrument no's as shown on page 6. (Zone 2E, 2F, 3D & 3E)
Also show location of future XFMR and supply conduits for vault 104

H-2-77636, Sh. 1, Rev. 0
Revise vault 102 elementary diagrams as shown on page 7, 8 & 9
Also revise note 1 to read "Abbreviations are per ANSI Y1.1 and Dwg H-2-77618, Sh. 1 unless otherwise noted".

H-2-77636, Sh. 2, Rev. 0
Add wire run no's to external & internal wiring and add shields as shown on page 10.
(this modifies ECN B-714-15)
Also revise one line diagram as shown on page 11 & 12.

H-2-77636, Sh. 3, Rev. 0
Revise vault 103 elementary diagrams as shown on page 13, 14 & 15.

H-2-77636, Sh. 4, Rev. 0
Add wire run no's to external & internal wiring and add shields as shown on page 16.
(this modifies ECN B-714-15).

H-2-77637, Sh. 1, Rev. 0
In detail 7 (Zone D1) change beginning of terminal block call-out to read "Terminal block, 12 point, Omega cat no BS12", also at end of call-out add "(4 of each, total of 8) last 4 terminals on right shall be copper, cat no. TLCP-20".
In Detail 1 revise terminal block call-out to read "... TLAL-20 (10 of each, total of 20). Chromel wires shall be...".

H-2-77638, Sh. 1, Rev. 0
Add ductbank ground conductors as shown on page 17 & revise notes as shown on page 18.

H-2-77638, Sh. 2, Rev. 0
Add TB-P-102 to manhole 102 and TB-P-103 to manhold 103 as shown on page 19.
Add ground conductors to Detail 13 and Section A, B & D as shown on page 20 & 21.

H-2-77638, Sh. 3, Rev. 0
Revise instrument no's in Detail 5 & 14 as shown on page 22 & 23. In Elevation 4 (Zone B6) change cutout-arrester call-out to read "...Chance, cat no. C710-112PB, with 40E Fuse (Type of 3)".

H-2-77639, Sh. 1, Rev. 0
In Notes 4 & 5 change "13'-6" in height" to "13'-6" above grade".

H-2-77641, Sh. 1, Rev. 0
Revise wire run list as shown on page 25 & 26.

KEH-0159.00 (1/88)

KAISER ENGINEERS HANFORD

ENGINEERING CHANGE NOTICE SKETCH

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			G. J. KUBINSKI	A. R. [signature]	B-714-17	4

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H-2-77642, Sh. 1, Rev. 0
Add Leachate Sump Temp Connector J-TE-102-5 as shown on page 27.

H-2-77642, Sh. 2, Rev. 0
Add Leachate Sump Temp Connector J-TE-103-5 as shown on page 28.

H-2-77643, Sh. 1, Rev. 0
Add external wiring and wire run no's to terminal boxes and motor controllers as shown on page ~~30~~ 29 & 30.

H-2-77643, Sh. 2, Rev. 0
Add wire run no's as shown on page 31.

H-2-77645, Sh. 1, Rev. 0
Add jumper cables from protected pipe to reinforcing bars in side of vault slab as shown on page 32.

Add Note 14 as follows: Exothermically weld #2AWG jumper cable to two (2) steel reinforcing bars in side of vault slab.

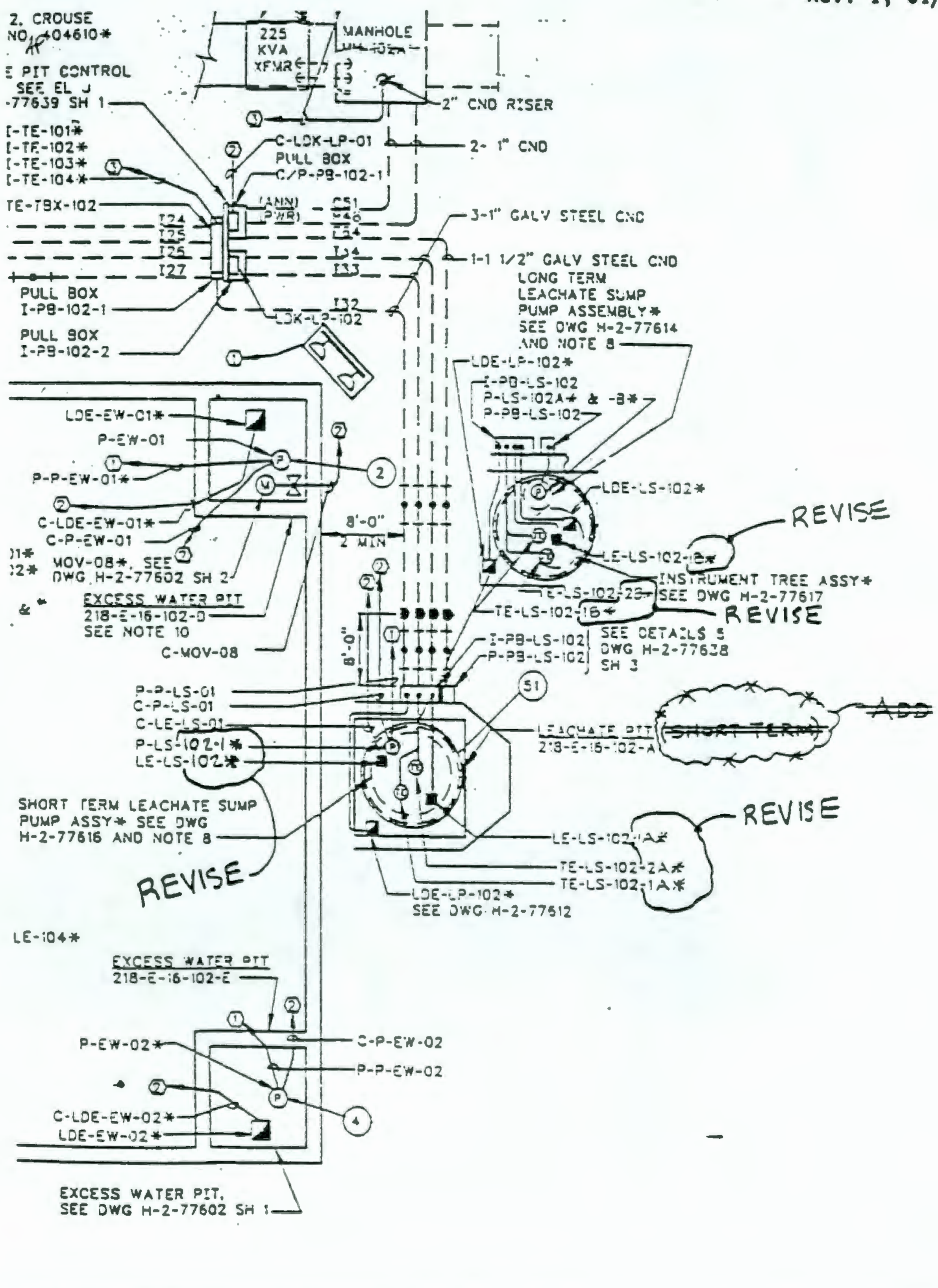
H-2-77638, Sh. 3, Rev. 0
Revise Details 2 & 7 as shown on page 24. GK 10/16/89

Construction Specification B-714-C2 (V-B714C2-003) REV 0
Revise Construction Specification as shown on page 33, 34 & 35. SR 11-1-89

KEH-0159 00 (1/88)

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH				
Dwg. H-2-77635	Sh. 1	Rev. 0	Prepared By G KUBINSKI	Checked By A. R. Snowhite	ECN No. B-714-17	Page 5

DOE/RL 88-27
Rev. 1, 01/17/90



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KEH-0159 00 (1/88)

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH				
Ref. Dwg. H-2-77635	Sh. 2	Rev. 0	Prepared By G KUBINSKI	Checked By A. R. [signature]	ECN No. B-714-17	Page 6

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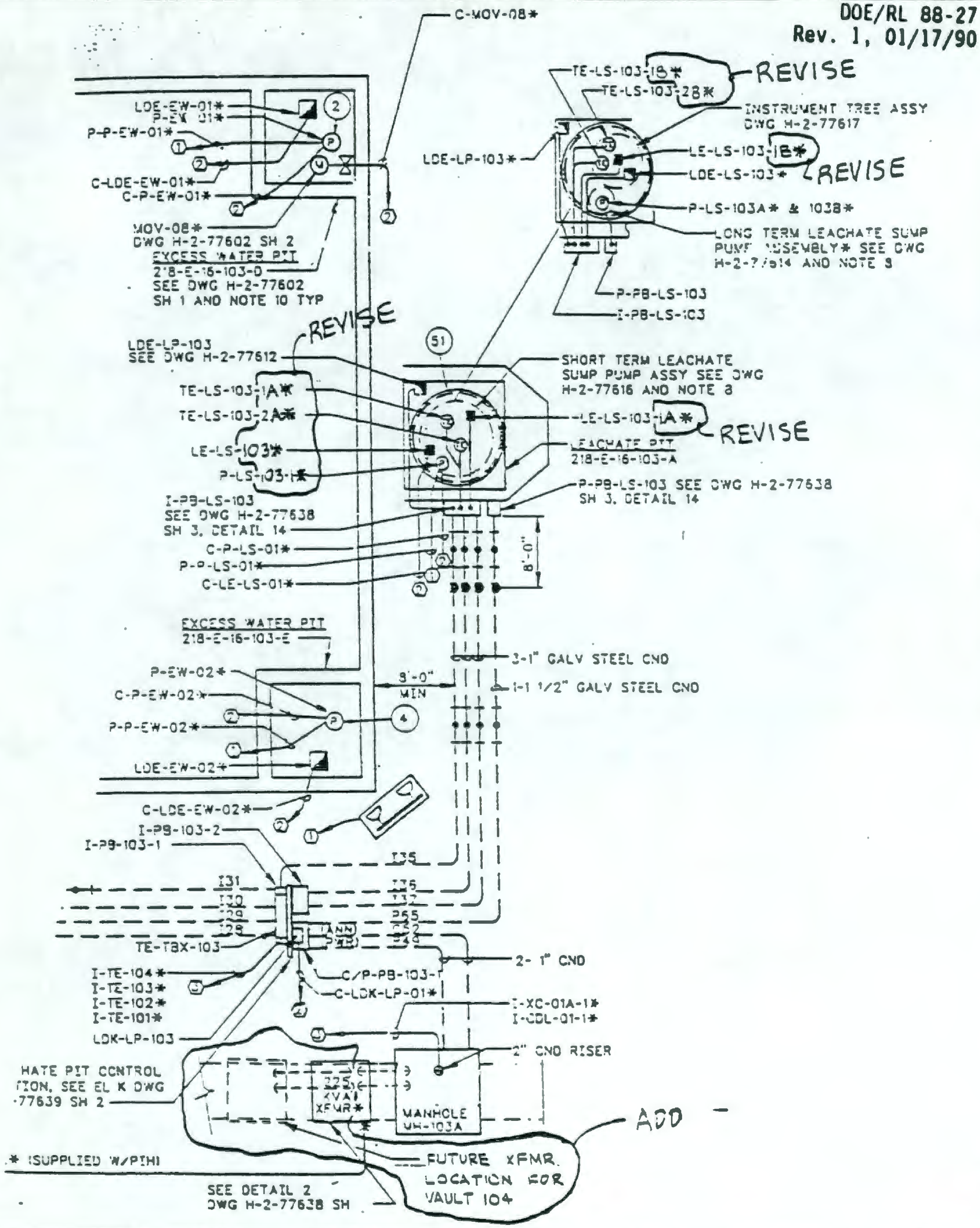

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KEH-0159 00 (1/88)

KAISER ENGINEERS HANFORD

ENGINEERING CHANGE NOTICE SKETCH

Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
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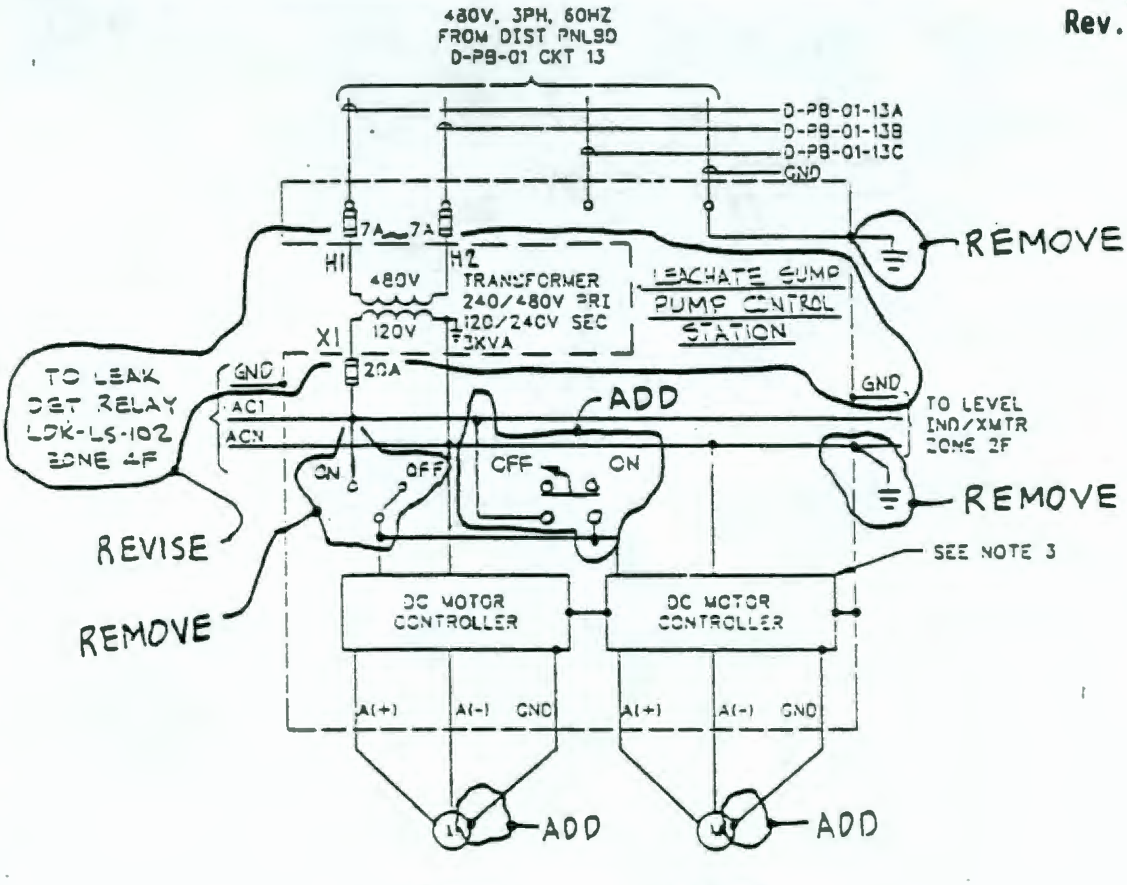
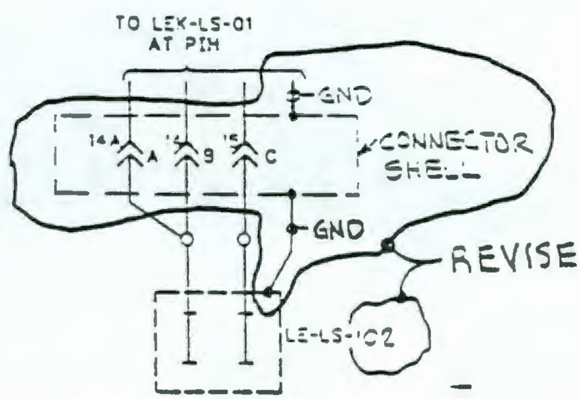


P-LS-102A. P-LS-102B

LONG TERM LEACHATE SUMP PUMPS
P-LS-102A & P-LS-102B
ELEMENTARY DIAGRAM
(PREFIX WIRE NUMBERS WITH PUMP NUMBERS)



LEACHATE SUMP
HIGH-HIGH LEVEL
DETECTION CONN DIAG
(PREFIX WIRE NUMBERS
W/LEK-LS-01)

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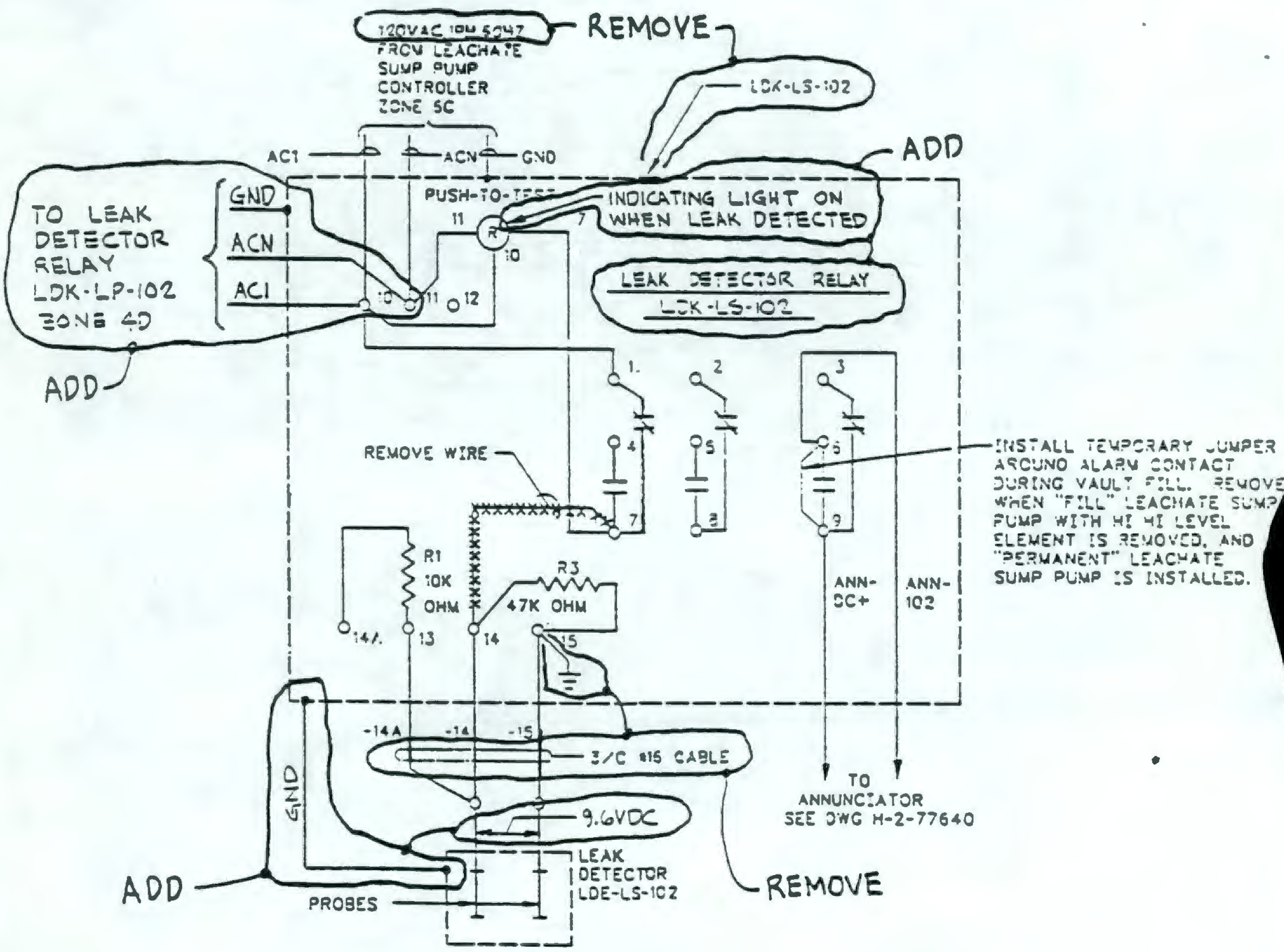
KEH-0159 00 (1/88)

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg. H-2-77636	Sh. 1	Rev. 0	Prepared By G. KUBINSKI	Checked By [signature]	ECN No. B-714-17	Page 8



LEACHATE SUMP LEAK DETECTION CONNECTION DIAGRAM
(PREFIX PROBE WIRE NUMBERS WITH LDK-LS-102)

KEH-0159 00 (1/88)

9011785 0840

KAISER ENGINEERS HANFORD — **ENGINEERING CHANGE NOTICE SKETCH**

Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
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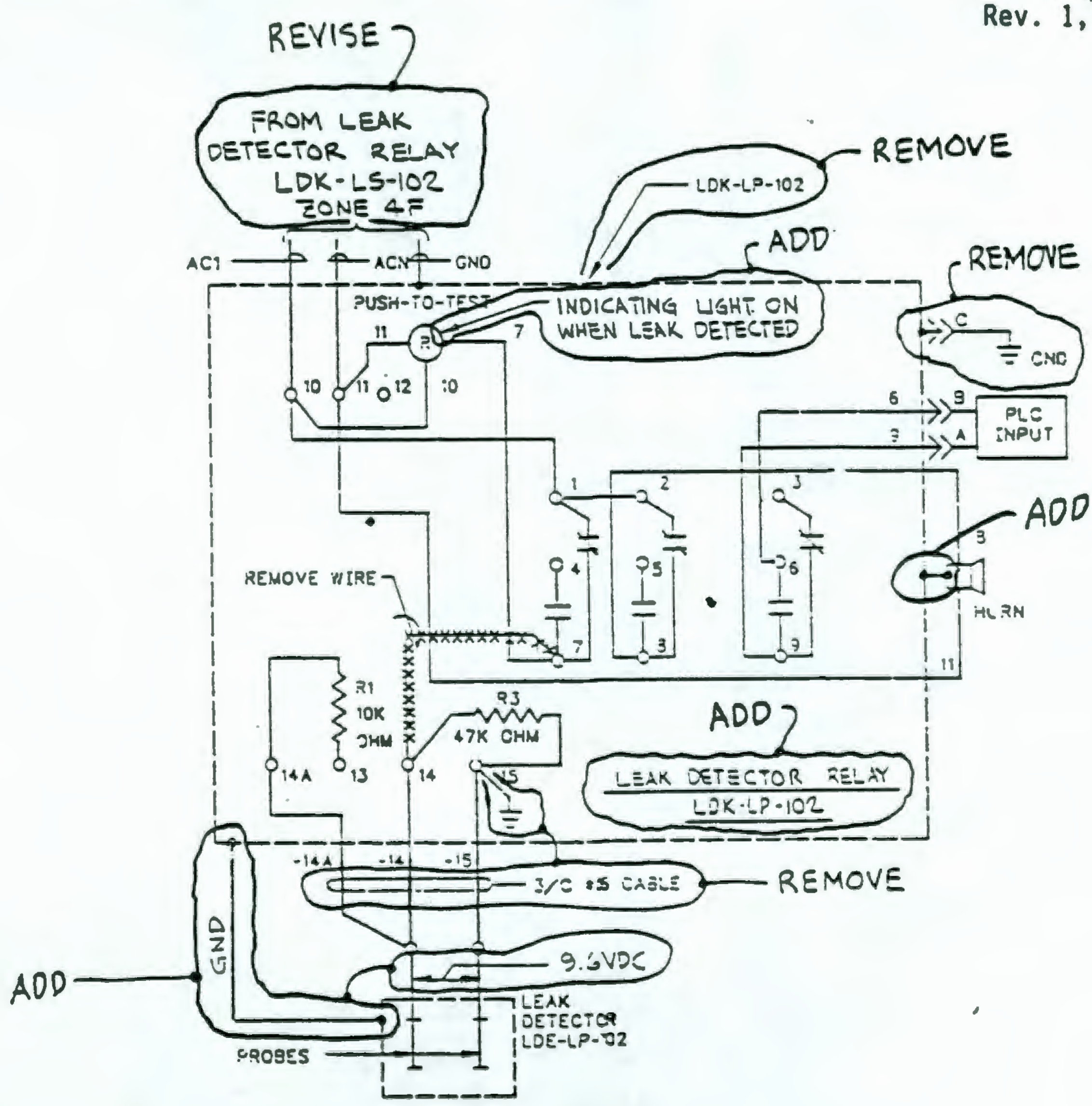
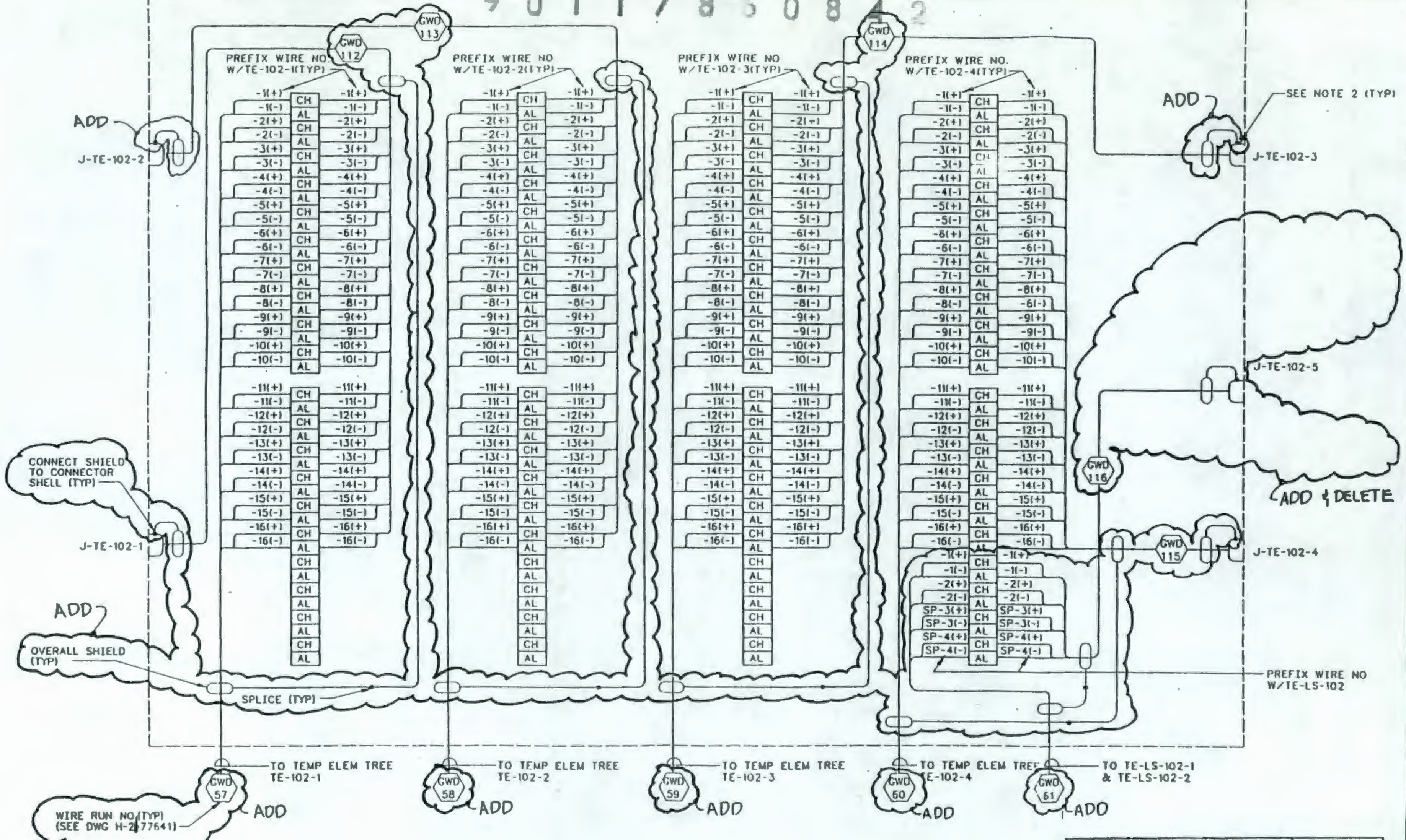


LEACHATE PIT LEAK DETECTION CONNECTION DIAGRAM
(PREFIX WIRE NUMBERS WITH LDK-LP-102)

9011786084 2



ECN No. B-714-17	Page 10	
Ref. Dwg. H-2-77636	Sh. 2	Rev. 0
Prepared by: JL BRINKLEY	Checked by: [signature]	

APP 4I-290

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
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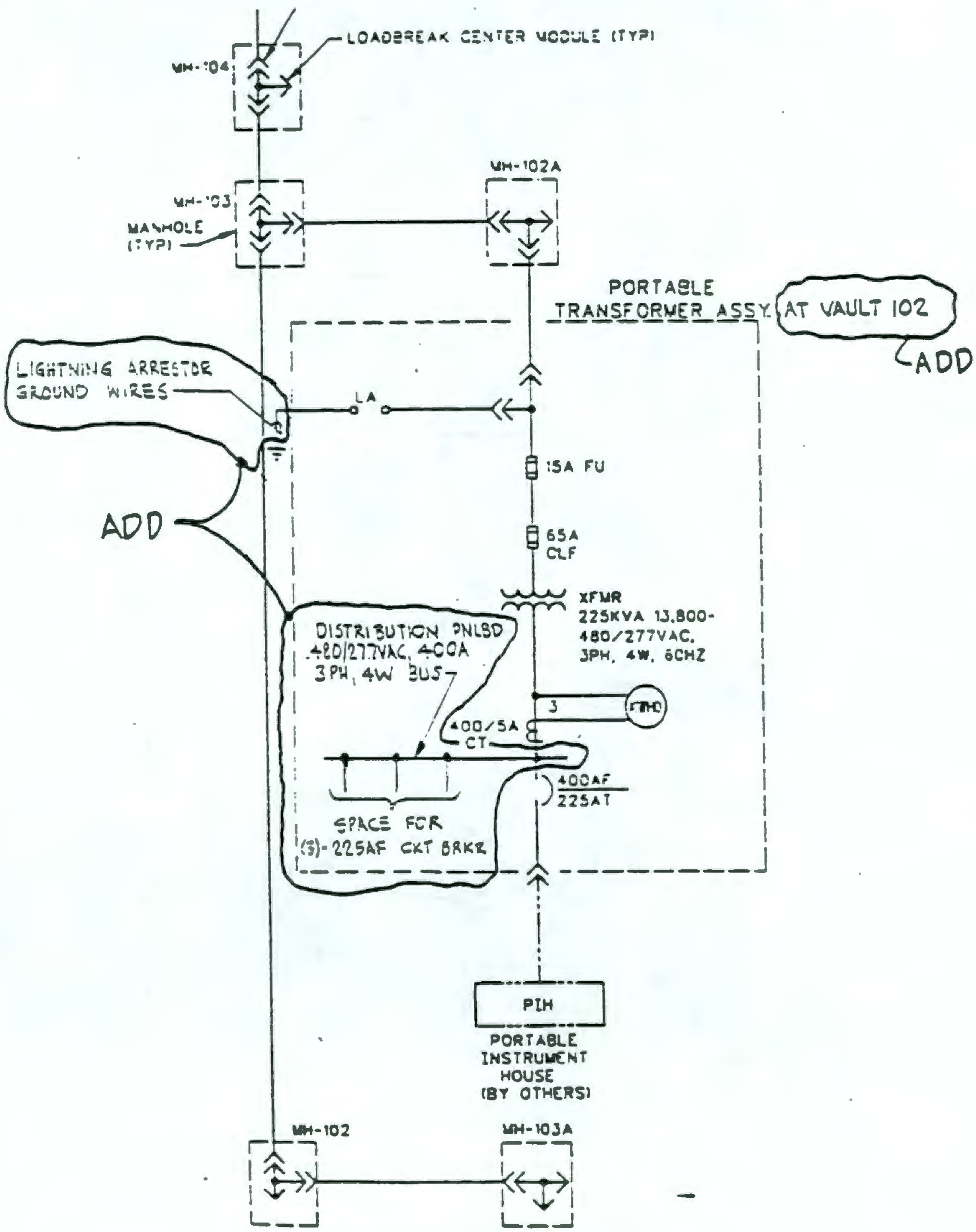

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KAISER ENGINEERS HANFORD — **ENGINEERING CHANGE NOTICE SKETCH**

Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
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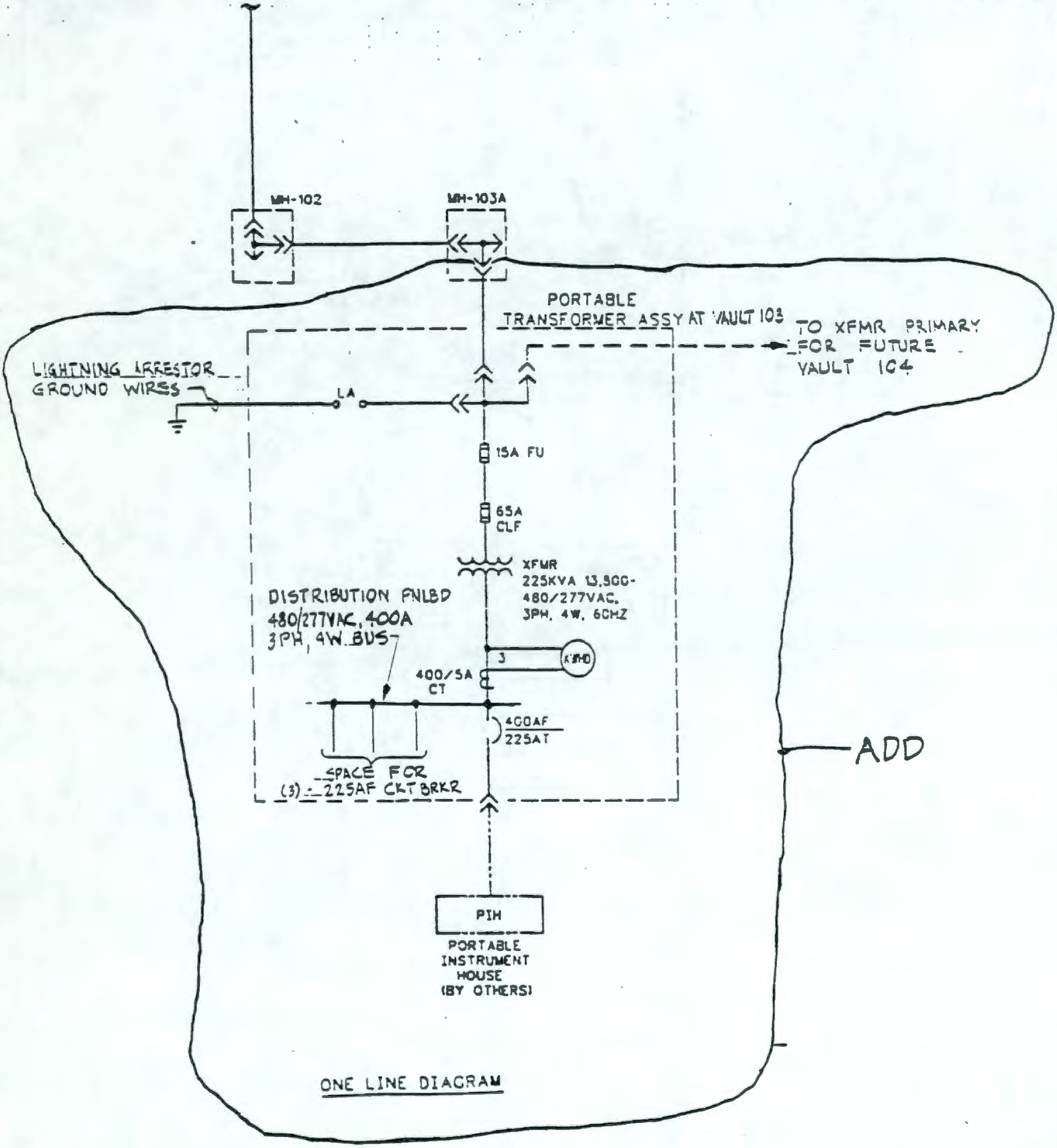

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KEH-0159 00 (1/88)

KAISER ENGINEERS HANFORD

ENGINEERING CHANGE NOTICE SKETCH

Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
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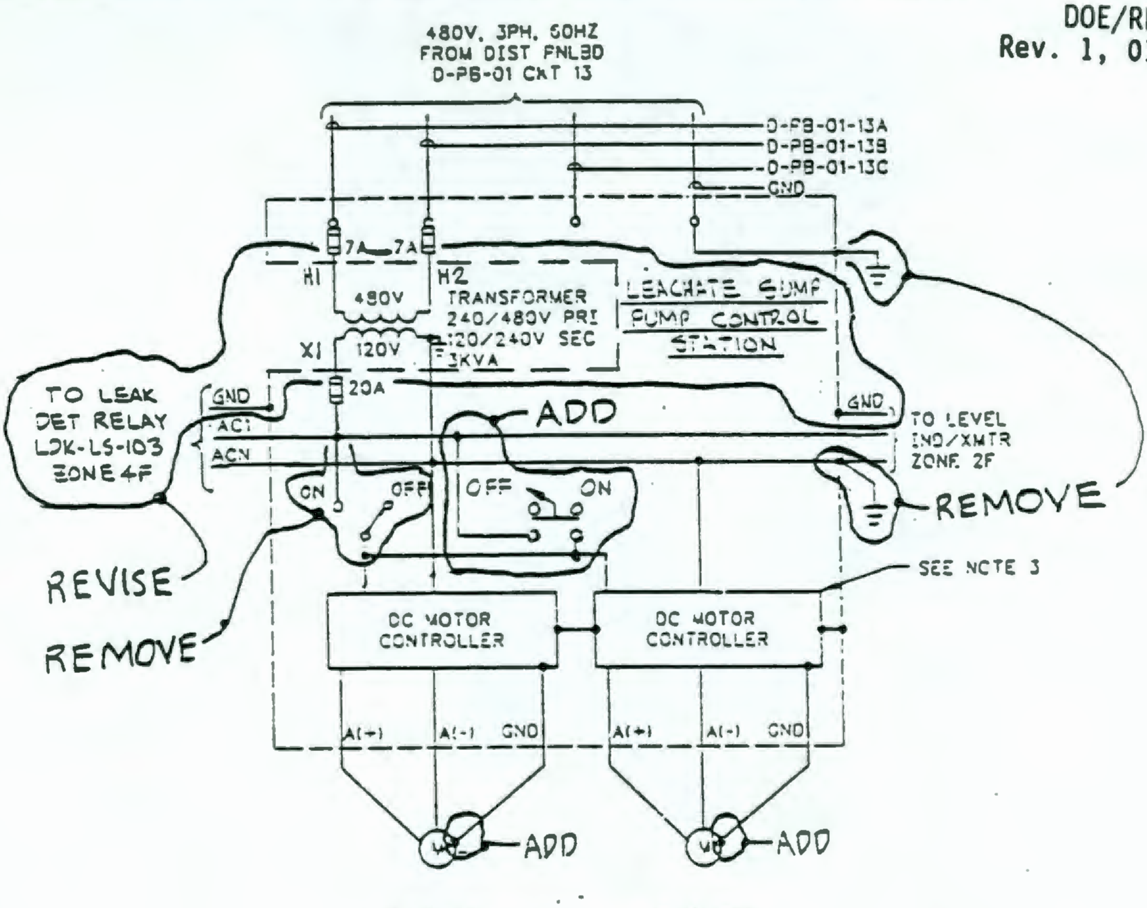
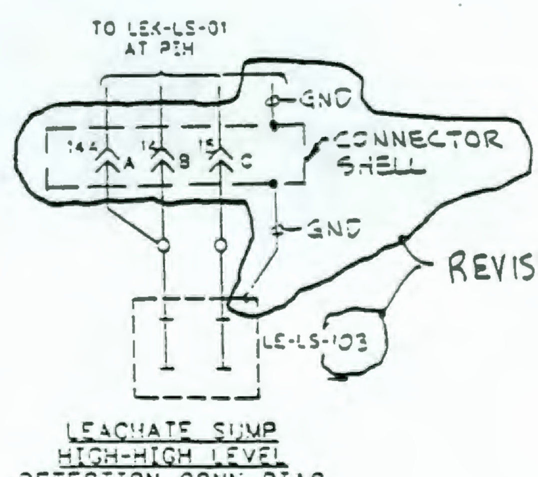


LONG TERM LEACHATE SUMP PUMPS
P-LS-103A & P-LS-103B
ELEMENTARY DIAGRAM
(PREFIX WIRE NUMBERS WITH PUMP NUMBERS)



LEACHATE SUMP
HIGH-HIGH LEVEL
DETECTION CONN DIAG
(PREFIX WIRE NUMBERS
W/LEK-LS-01)

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KEH-0159 00 (1/88)

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
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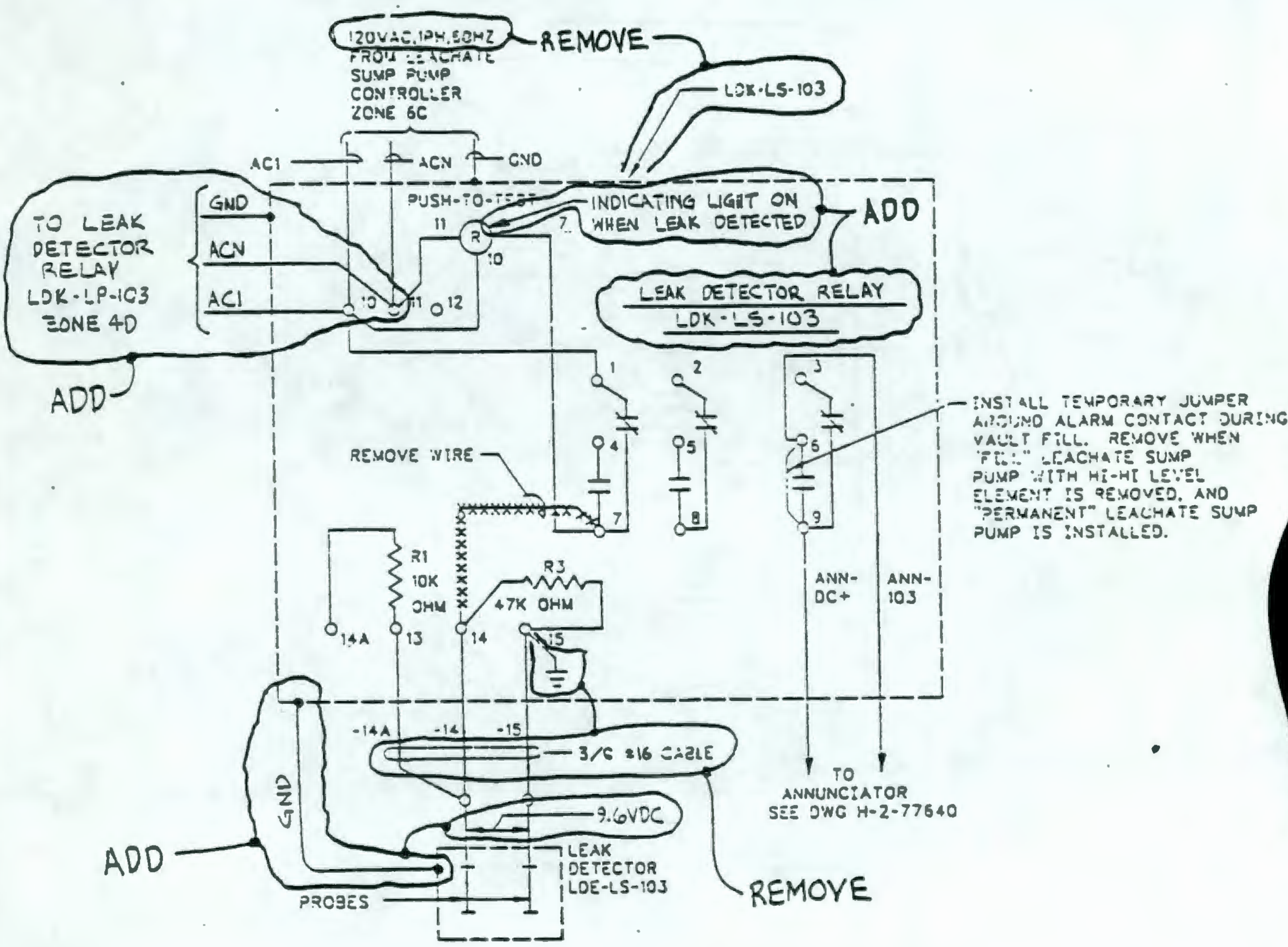

LEACHATE SUMP LEAK DETECTION CONNECTION DIAGRAM
(PREFIX PROBE WIRE NUMBERS WITH LDK-LS-103)

9011783084 6

KEH-0159.00 (1/8

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
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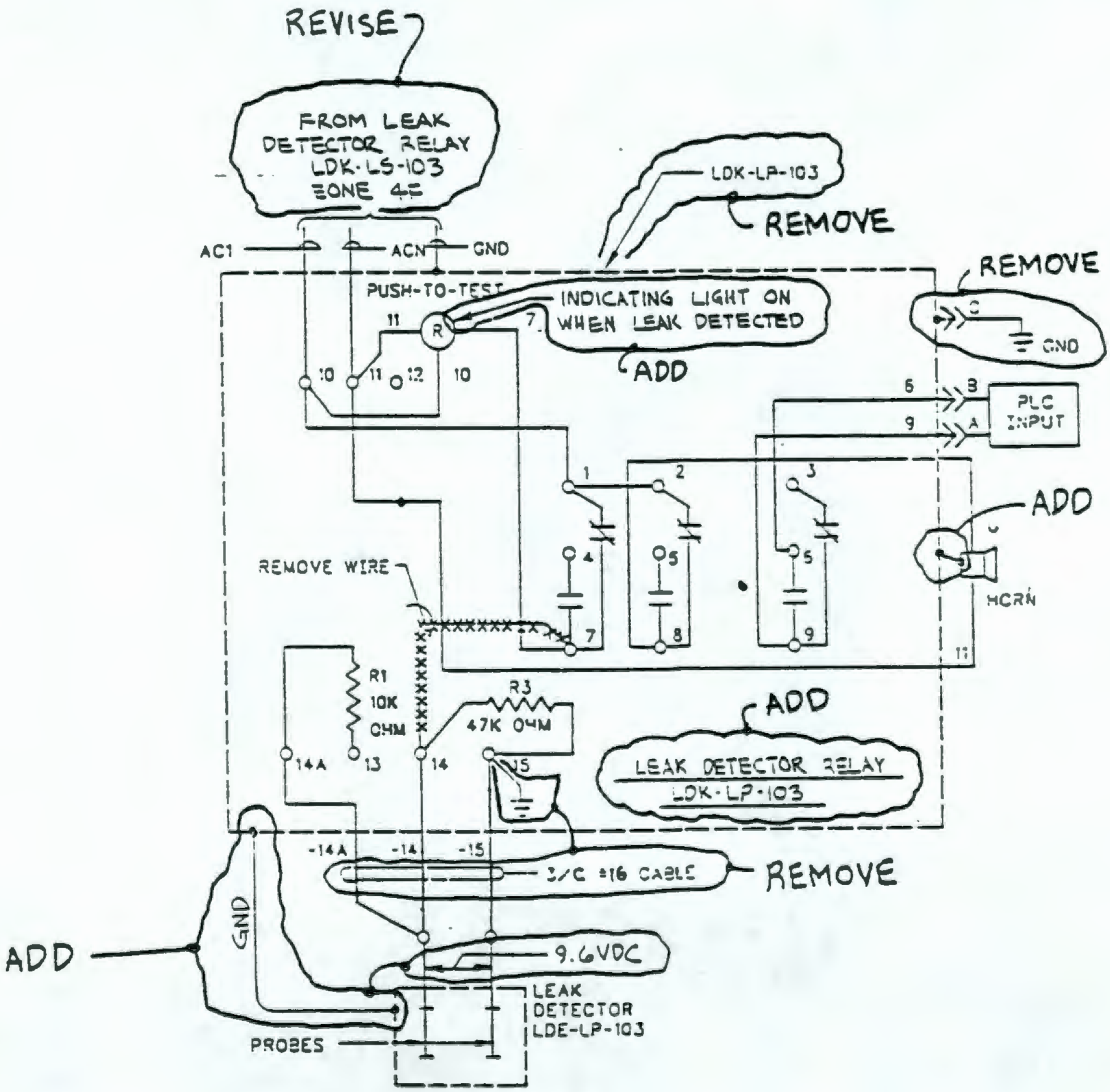

LEACHATE PIT LEAK DETECTION CONNECTION DIAGRAM
(PREFIX WIRE NUMBERS WITH LDK-LP-103)

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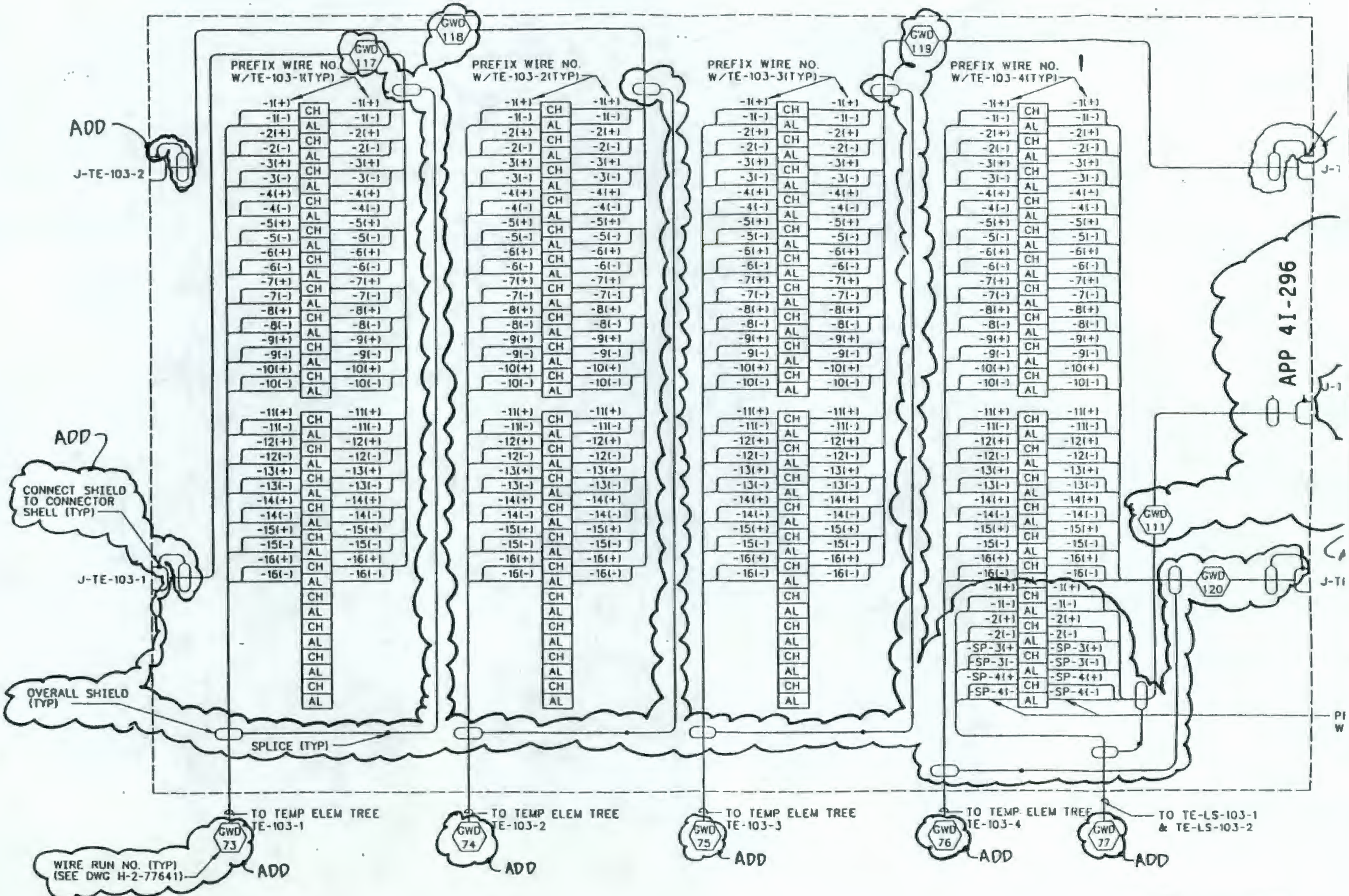

ECN No. B-714-17
Ref. Dwg. H-2-77636
Prepared by:
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KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH				
Dwg. -2-77638	Sh. 1	Rev. 0	Prepared By G. KUBINSKI	Checked By [signature]	ECN No. B-714-17	Page 17

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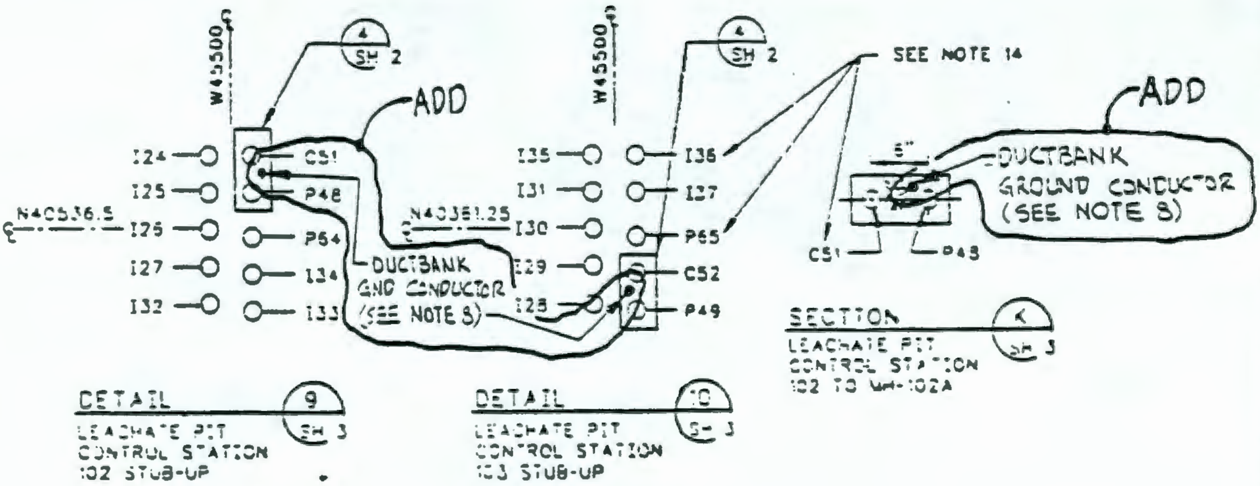

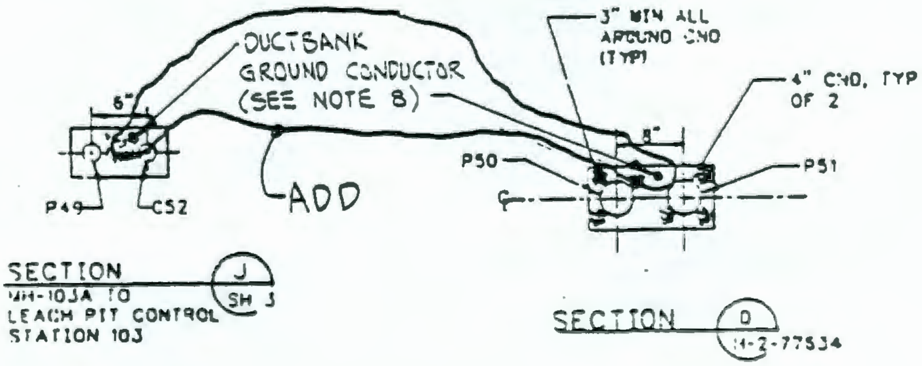

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KEH-0159 00 (1/88)

KAISER ENGINEERS HANFORD | **ENGINEERING CHANGE NOTICE SKETCH**

Ref Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77638	1	0	G. KUBINSKI	[signature]	B-714-17	18

8. A GROUNDING CABLE SHALL BE INSTALLED IN ENCASEMENTS UNLESS SPECIFIED OTHERWISE. THE CONDUCTOR SHALL BE 5/8" DIAMETER, 7 STRAND SPECIAL LOW CARBON GRADE STEEL CABLE. CABLE COATING SHALL BE CLASS B ZINC IN ACCORDANCE WITH ASTM A 475. THIS CONDUCTOR SHALL BE USED FOR INTERCONNECTION OF GROUNDING GRIDS AND FOR GROUNDING OF CONDUIT RISERS, CABLE SHIELDS, ETC. IT SHALL NOT BE USED FOR THE EQUIPMENT

9. ~~CONCRETE ENCASEMENT REQUIREMENT FOR RIGID NON-METALLIC CONDUIT SHALL BE DELETED FOR CONDUITS APPROVED OR SHOWN ON THE CONSTRUCTION DRAWINGS FOR DIRECT BURIAL IN ACCORDANCE WITH NFPA NEC 70, ARTICLES 300-5 AND 347.~~

LINE OUT

10. THE CONCRETE CURE REQUIREMENT - BACKFILL OPERATION MAY BEGIN 72 HOURS AFTER CONCRETE POUR. MINIMUM CONCRETE COMPRESSIVE STRENGTH PRIOR TO BACKFILL IS 1500 PSI.

11. WHEN TRANSFORMER IS TO BE MOVED TO NEXT MANHOLE, ELBOW/CABLE ASSEMBLY SHALL BE DISASSEMBLED AND THE CABLE SHALL BE REMOVED FROM CONDUIT FOR REUSE AT NEXT XFMR LOCATION. WHEN CABLE HAS BEEN REINSTALLED THROUGH CONDUIT AT NEXT MANHOLE AT NEW XFMR LOCATION, CABLE SHALL BE RE-CONNECTED TO ELBOW PER LOAD BREAK ELBOW MANUFACTURER RECOMMENDATIONS (BY OTHERS).

12. GROUND CABLES ROUTED WITH DUCT BANKS SHALL BE CONNECTED TOGETHER TO MAKE ONE CONTINUOUS GROUND CABLE WITH CADWELD CONNECTORS IN EACH MANHOLE. FASTEN GROUND CABLES TO FRAMING CHANNEL SUPPORTS USING UNISTRUT 5/8" O.D. TUBE CLAMP CATALOG NUMBER P2014. CADWELD CONNECTORS SHALL BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS.

13. AT END OF EXTENDED DUCT BANK AT W45430 #6 REBAR IS TO PROTRUDE APPROX 2 FT BEYOND CONCRETE SO THAT WHEN DUCT BANK IS CONTINUED REBAR CAN BE INCORPORATED INTO NEW CONCRETE ENCASEMENT.

14. CONDUIT NUMBERS PREFIXED WITH "P" ARE POWER CONDUITS "C" ARE CONTROL CONDUITS, "I" ARE INSTRUMENT CONDUITS. SEE WIRE RUN LIST DWG H-2-77641.

15. FOR XFMR FEEDER CABLES, CABLE IS TO BE ROUTED THROUGH 4" DIRECT BURIED CONDUIT SHOWN IN DETAILS 1 & 2, SHEET 3 BEFORE ASSEMBLY WITH ELBOW IN MANHOLE.

16. INSULATED PROTECTIVE CAPS AS PROVIDED BY THE LOADBREAK CENTER MODULE MANUFACTURER SHALL BE INSTALLED ON ALL UNUSED BUSHINGS.

17. SHIELDED CABLE SHALL HAVE STRESS CONE TERMINATIONS MADE IN ACCORDANCE WITH THE INSTRUCTIONS OF THE CABLE MANUFACTURER. THE OUTSIDE LAYER OF TAPE SHALL BE APPLIED TO SHED WATER.

18. THE GROUNDING CONDUCTOR FOR THE 13.8KV LINE SHALL BE NO. 6 BIRMINGHAM WIRE GAUGE, GRADE EBB IRON WIRE WITH CLASS B ZINC COATING. CABLE SHIELD GROUNDS AT THE STRESS CONES SHALL BE CONNECTED TO THE LIGHTNING ARRESTER GROUND.

19. IN PREPARATION FOR FINAL BACKFILL DISCONNECT AND UNPLUG CABLES IN I-TB-LS-102, P-TB-LS-102, I-TB-LS-103 AND P-TB-LS-103 AND PULL BACK TO I-PB-LS-102, P-PB-LS-102, I-PB-LS-103, AND P-PB-LS-103. MOVE TOP 24"X30" PLATE TO TOP OF UNISTRUT AFTER EXTENDING UNISTRUT 13'-6" IN HEIGHT. INSTALL NEW CONDUITS I35B, I36B, I37B, AND P65B, I32B, I33B, I34B AND P64B. PULL CABLES BACK INTO CONDUITS AND TERMINAL BOXES AND RECONNECT AS PREVIOUSLY TERMINATED (BY OTHERS).

REVISE

20. AFTER PULLING LEVEL PROBE CABLE THRU CGB FITTING INTO TERMINAL BOX, INSTALL CONNECTOR THAT WAS REMOVED FROM LEVEL PROBE (SEE DRAWING H-2-77617 NOTE 12) WITH CABLE GRIP ON CABLE COMING FROM LEVEL PROBE AND RECONNECT AS PREVIOUSLY TERMINATED. INSTALL AND TERMINATE CONNECTOR BACK ON TO SHORTEND CABLE. RECONNECT AS PREVIOUSLY TERMINATED.

KEH-0159 00 (1/88)

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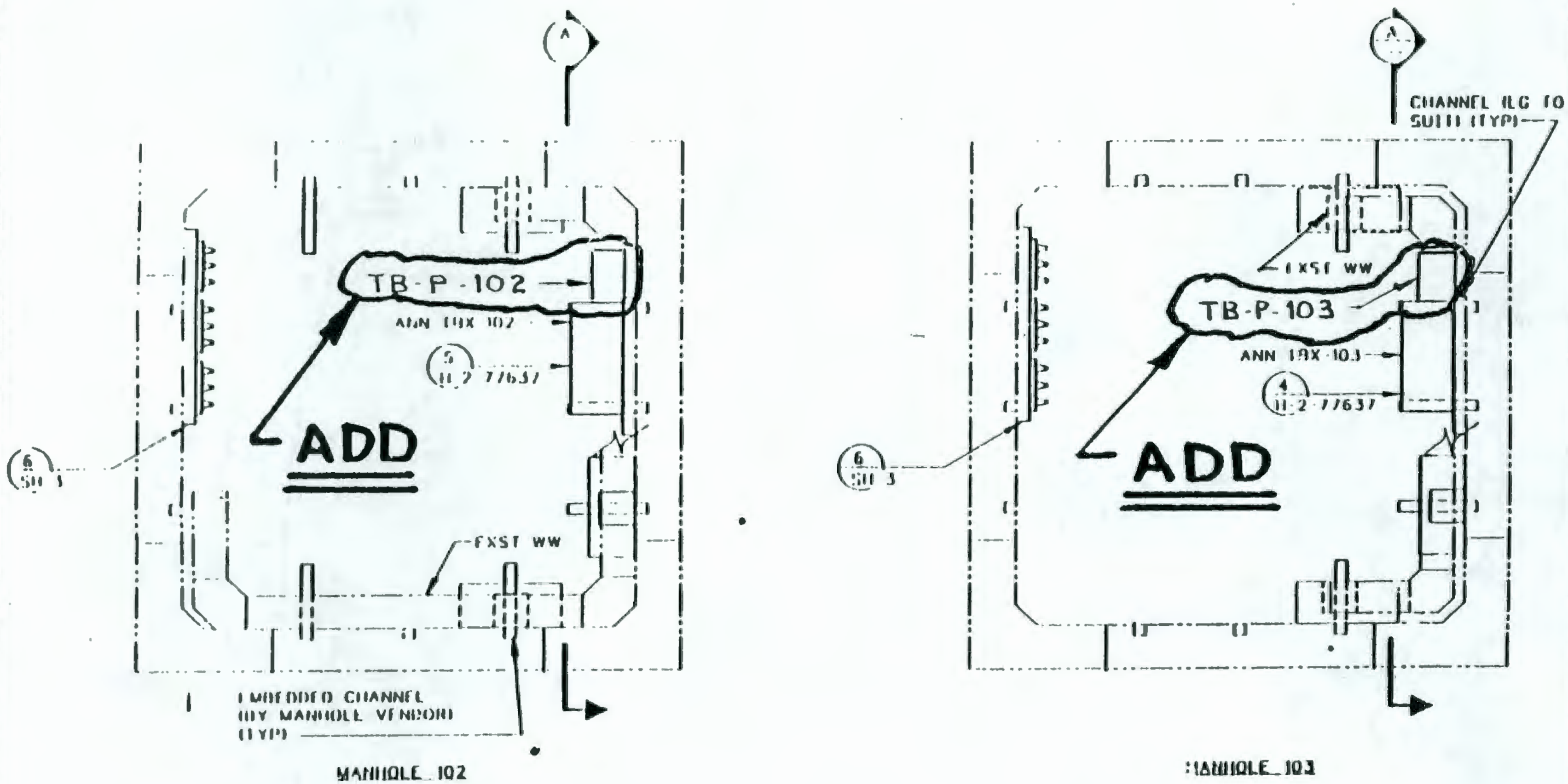

KAISER ENGINEERS HANFORD

ENGINEERING CHANGE NOTICE SKETCH

Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77638	2	0	W. Atkins	[signature]	B-714-17	19

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Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77638	2	0	W. Atkins	A. R. [signature]	B-714-17	20

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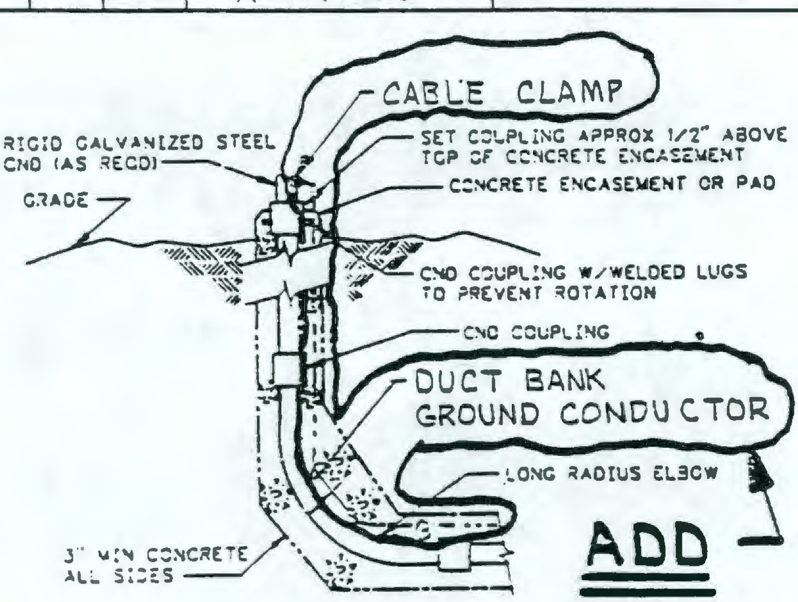
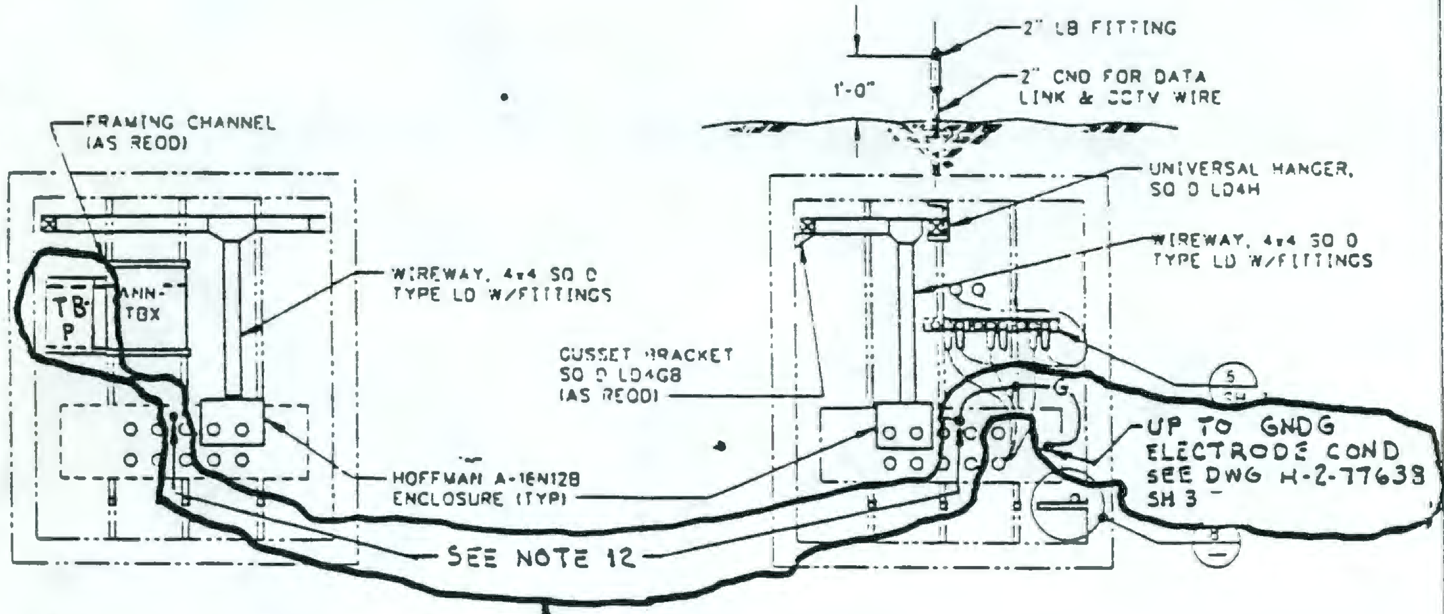


DETAIL 13 SH 1 & 3
CONDUIT STUB-UP
ONE LAYER SHOWN.
SIMILAR FOR 2
LAYERS OF CONDUIT



SECTION A   SECTION B

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KAISER ENGINEERS
HANFORD

ENGINEERING CHANGE NOTICE SKETCH

Dwg. No.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
-77638	2	0	G. KUBINSKI	A. R. [signature]	B-714-17	21

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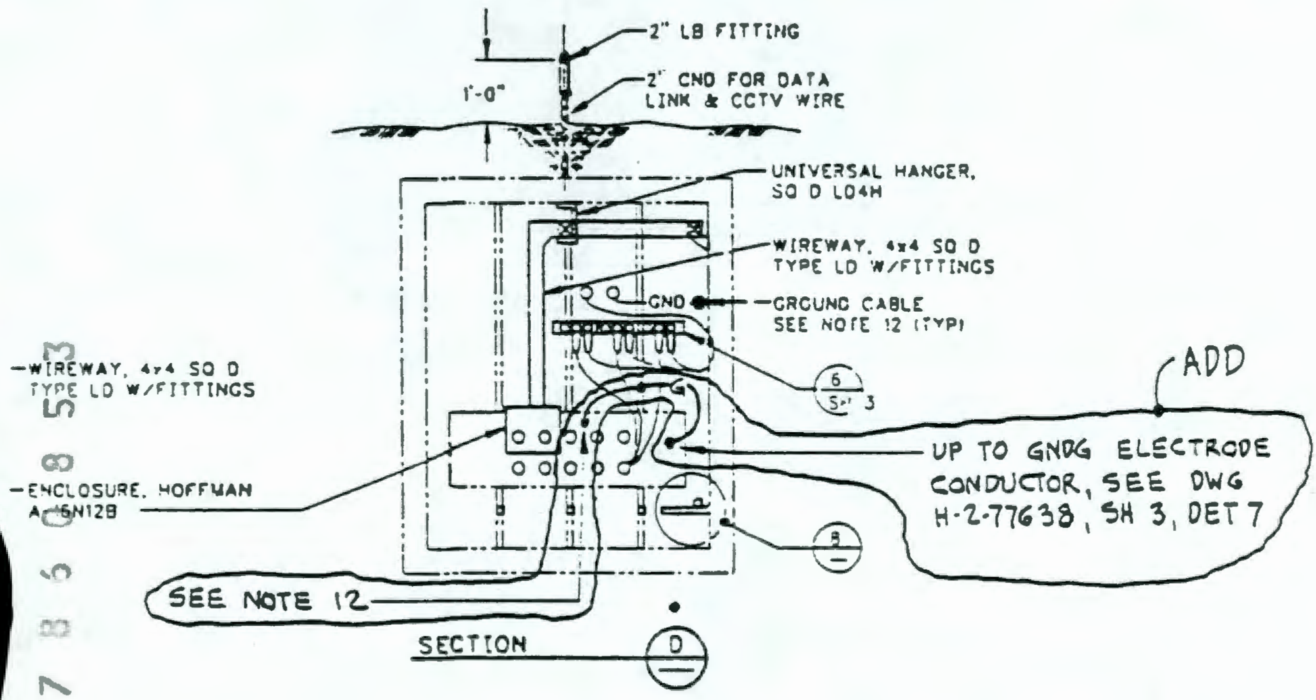

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
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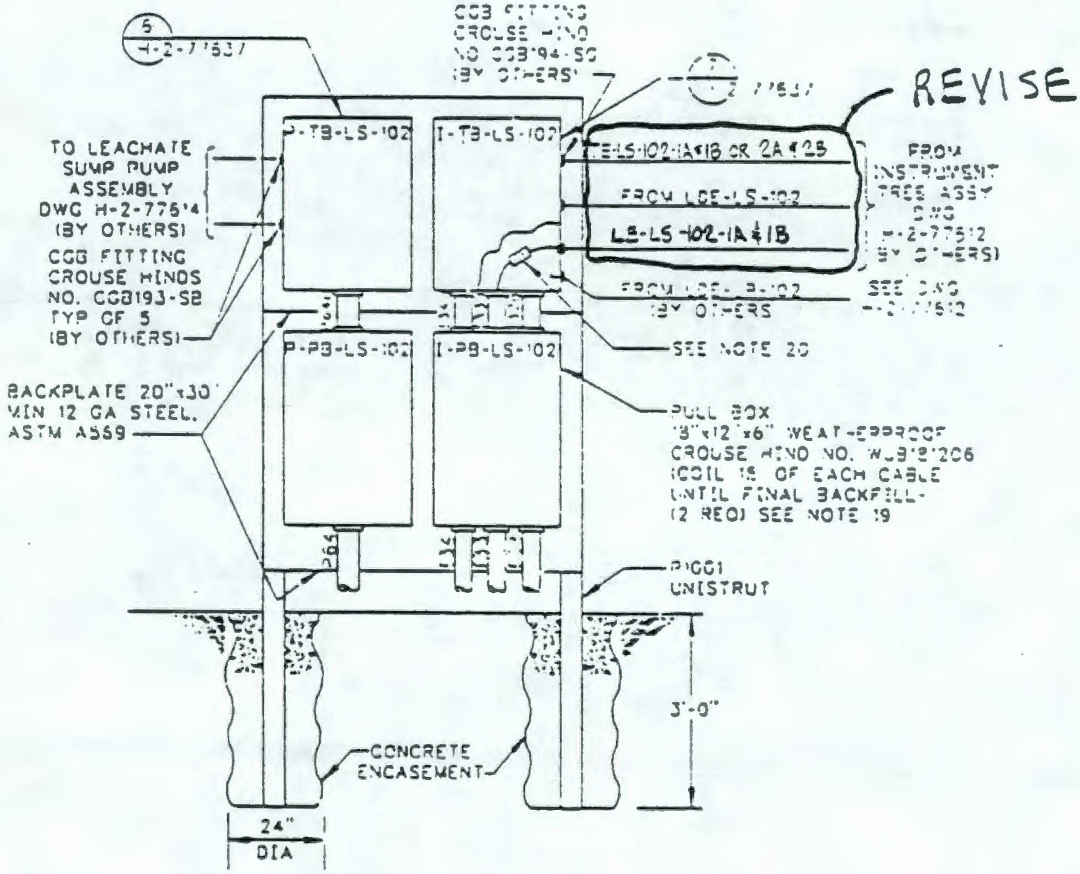

DETAIL
VAULT 102 LEACHATE PIT & SUMP TERMINAL BOXES

THIS DWG & H-2-77635 SH 1

9011178608 54

KEH-0159 00 (1/88)

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Dwg. [redacted]2-77638	Sh. 3	Rev. 0	Prepared By G. KUBINSKI	Checked By A. R. [signature]	ECN No. B-714-17	Page 23

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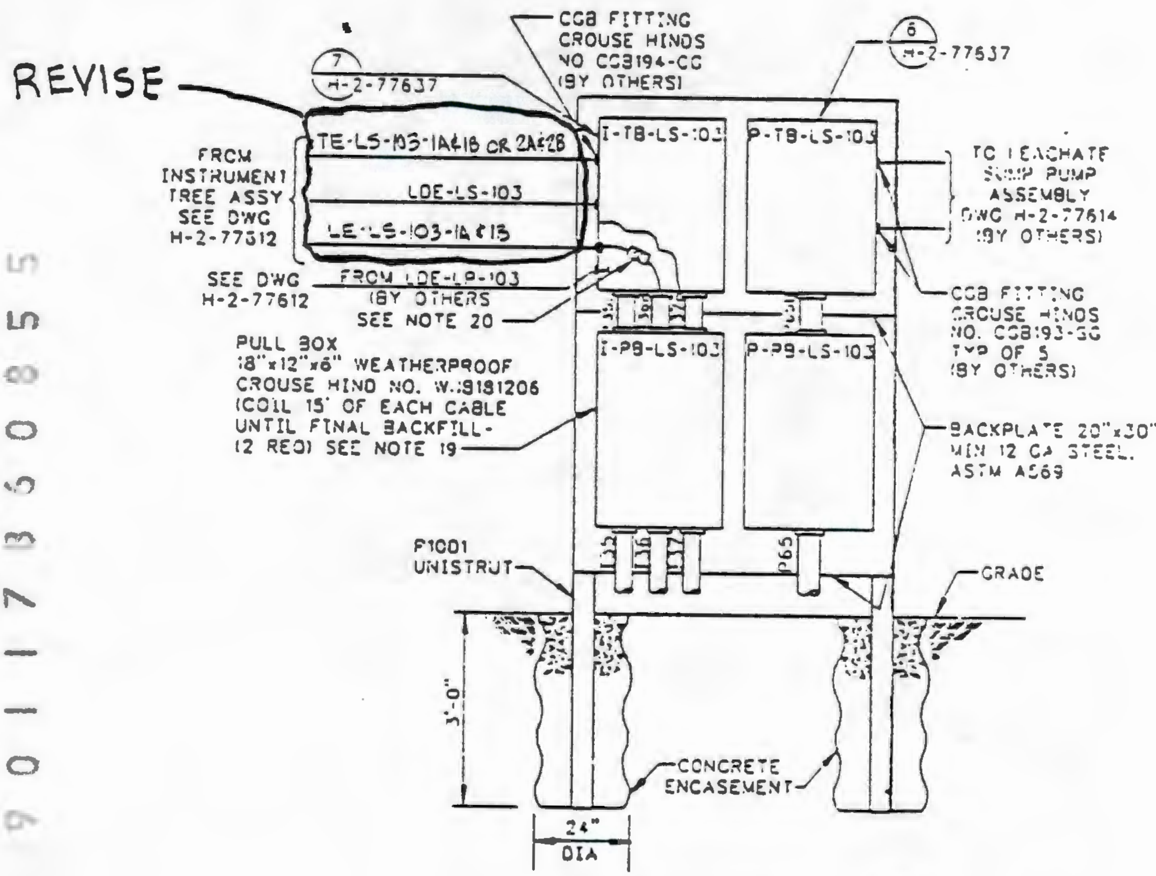

DETAIL 14
VAULT 103 LEACHATE PIT & SUMP TERMINAL BOXES — THIS DWG & H-2-77635 SH 2

KAISER ENGINEERS HANFORD — ENGINEERING CHANGE NOTICE SKETCH

Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77638	3	0	W. ATKINS	[signature]	B-714-17	24

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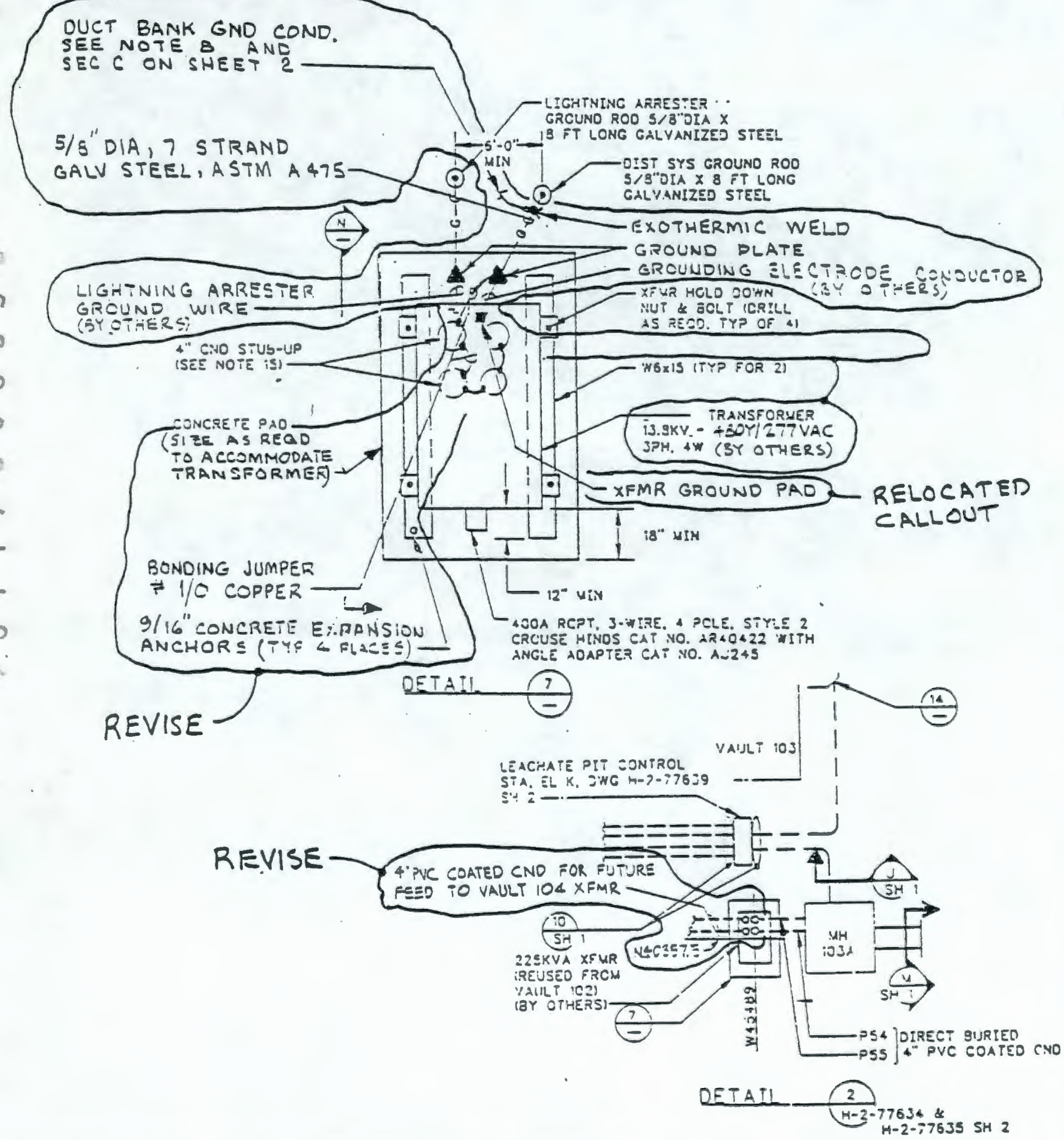

KEH-0159 00 (1/88)

KAISER ENGINEERS HANFORD				ENGINEERING CHANGE NOTICE SKETCH		
Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77641	1	0	JL BRINKLEY	A.R. [signature]	B-714-17	25

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TYPE OF WIRE

1. 1/C XHHW/THHN, 600V INSULATION, #10 AWG AND SMALLER SOLID, #8 AWG AND LARGER STRANDED
2. TYPE TC, 600V ROCKBESTOS FIREWALL III
3. COAXIAL CABLE TYPE RG11, BELDEN NO. 8238
4. 16 PR #20 TYPE K THERMOCOUPLE EXTENSION WIRE, ROCKBESTOS FIREWALL III WITH OVERALL SHIELD
5. 6 SH PR #24 STRANDED COMPUTER CABLE, BELDEN NO. 9731
6. 15KV SHIELDED POWER CABLE/133% INSULATION RATING
7. 4 PR #20 TYPE K THERMOCOUPLE EXTENSION WIRE, ROCKBESTOS FIREWALL III WITH OVERALL SHIELD
8. LEVEL PROBE COMES COMPLETE WITH CONNECTING CABLE AND ASSOCIATED CONNECTORS FOR BOTH ENDS
9. 25/C #14 ALPHA XTRA GUARD 2
10. 5/8"DIA, 7 STRAND, SPECIAL LOW CARBON GRADE STEEL CABLE. CABLE COATING SHALL BE CLASS B ZINC IN ACCORDANCE WITH ASTM A475.

ADD

KEH-0159 00 (1/88)

NO.	WIRES	WIRE	WIRE				
GW050	3-1/C	2	6	POLE P17A	P50	MH 104(LBC)	PH-A, PH-B, PH-C
GW051	3-1/C	2	6	MH 104(LBC)	EXST P14	MH 103(LBC)	PH-A, PH-B, PH-C
GW052	3-1/C	2	6	MH 103(LBC)	P40	MH 102A(LBC)	PH-A, PH-B, PH-C
GW053	3-1/C	2	6	MH 102A(LBC)	P53	225KVA TRANSFORMER	PH-A, PH-B, PH-C
GW054	3-1/C	2	6	MH 103(LBC)	EXST P8	MH 102(LBC)	PH-A, PH-B, PH-C
GW055	3-1/C	2	6	MH 102(LBC)	P44	MH 103A(LBC)	PH-A, PH-B, PH-C
GW056	2-25/C	14	9	ANN-TBX-103 (MH 103)	MH 103, EXST C12, MH 102	ANN-TBX-102 (MH 102)	ANN-103 THRU -119,-121,-123,-125,-127,-129,-131,-133,-153 THRU -156,(4)-DC+,GND,(17) SPARE
GW057	16PR	20	4	TE-102-1 JB	I24, I-PB-102-1, I24A	TE-TBX-102	TE-102-1-1(+) & (-) THRU TE-102-1-16(+) & (-),SHLD
GW058	16PR	20	4	TE-102-2 JB	I25, I-PB-102-1, I25A	TE-TBX-102	TE-102-2-1(+) & (-) THRU TE-102-2-16(+) & (-), SHLD
GW059	16PR	20	4	TE-102-3 JB	I26, I-PB-102-1, I26A	TE-TBX-102	TE-102-3-1(+) & (-) THRU TE-102-3-16(+) & (-), SHLD
GW060	16PR	20	4	TE-102-4 JB	I27, I-PB-102-1, I27	TE-TBX-102	TE-102-4-1(+) & (-) THRU TE-102-4-15(+) & (-), SHLD
GW061	4PR	20	7	I-TB-LS-102	I32B, I-PB-LS-102, I32, I-PB-102-1, I32A	TE-TBX-102	TE-LS-102-1(+),-1(-),-2(+),-2(-),-SP-3(+),-SP-3(-),-SP-4(+),-SP-4(-),SHLD
GW062	25/C	14	9	ANN-TBX-103 (MH 103)	MH 103, C43, MH 102A	ANN-TBX-102A (MH 102A)	ANN-102,-120,-122,-124,-126,-128,-130,-132,-135,-137,-139,-141,-143,-144,-151,-152,(2)DC GND,(6)SPARE
GW063	-	-	8	I-TB-LS-102	I33B, I-PB-LS-102, I33, I-PB-102-2, I33A, CABLE CONNECTOR	LIT-LS-102	LIT-LS-102-10,-11 (CABLE INSTALLATION BY OTHERS)
GW064	4/C	16	2	I-TB-LSL'02	I34B, I-PB-LS-102, I34, I-PB-102-2, I34A	LDK-LS-102	LDK-LS-102-14,-14A,-15,GND
GW065	1	COAX	3	MH 102A WW(CCTV XMTR)	MH 102A WW, I20, MH 103 WW (SEE NOTE 1)	MH 103 WW	I-XC-01A-3 (SEE NOTE 1)
GW066	2	COAX	3	MH 102A(CCTV XMTR)	MH 102A WW, I20, MH 103 WW, EXST I5, MH 102 WW, EXST I3,	TGE CONTROL ROOM	I-XC-01A-4,-5 (SEE NOTE 1)
					MH 101 WW, EXST I1, SPARE TBX, EXST CND (SEE NOTE 1)		
GW067	3	COAX	3	MH 103A(CCTV XMTR)	MH 103A WW, I22, MH 102 WW (SEE NOTE 1)	MH 102 WW	I-XC-01A-6,-7,-8 (SEE NOTE 1)
GW068	6 PR	24	5	MH 102A(DATA LINK)	MH 102A WW, I20, MH 103 WW (SEE NOTE 1)	MH 103 WW	CDL-01-1(+),-1(-),-1(SH) THRU -6(+),-6(-),-6(SH) (SEE NOTE 1)
GW069	2-6 PR	24	5	MH 102A(DATA LINK)	MH 102A WW, I20, MH 103 WW, EXST I5, MH 102 WW, EXST I3,	TGE CONTROL ROOM	CDL-01-1(+),-1(-),-1(SH) THRU -6(+),-6(-),-6(SH) (SEE NOTE 1)
					MH 101 WW, EXST I1, SPARE TBX, EXST CND (SEE NOTE 1)		
GW070	3-6 PR	24	5	MH 103A(DATA LINK)	MH 103A WW, I22, MH 102 WW (SEE NOTE 1)	MH 102 WW	CDL-01-1(+),-1(-),-1(SH) THRU -6(+),-6(-),-6(SH) (SEE NOTE 1)
GW071	[illegible]	12	2	TB-P-102A (MH 102A)	MH 102A, P48, C/P-PB-102-1, P48A	(102) LEACHATE SUMP PUMP CONTROLLER	D-PB-01-13A,-13B,-13C,GND
GW072	3/C	12	2	LDK-LS-102	C51A, C/P-PB-102-1, C51, MH 102A	ANN-TBX-102A (MH 102A)	ANN-DC+,ANN-103,GND
GW073	[illegible]	20	4	TE-103-1 JB	I28, I-PB-103-1, I28A	TE-TBX-103	TE-103-1-1(+) & (-) THRU TE-103-1-16(+) & (-),SHLD
GW074	16PR	20	4	TE-103-2 JB	I29, I-PB-103-1, I29A	TE-TBX-103	TE-103-2-1(+) & (-) THRU TE-103-2-16(+) & (-) SHLD
GW075	16PR	20	4	TE-103-3 JB	I30, I-PB-103-1, I30A	TE-TBX-103	TE-103-3-1(+) & (-) THRU TE-103-3-16(+) & (-) SHLD
GW076	16PR	20	4	TE-103-4 JB	I31, I-PB-103-1, I31A	TE-TBX-103	TE-103-4-1(+) & (-) THRU TE-103-4-16(+) & (-) SHLD
GW077	4PR	20	7	I-TB-LS-103	I35B, I-PB-LS-103, I35, I-PB-103-1,I35A	TE-TBX-103	TE-LS-103-1(+),-1(-),-2(+),-2(-),-SP-3(+),-SP-3(-),-SP-4(+),-SP-4(-),SHLD
GW078	25/C	14	9	ANN-TBX-102 (MH 102)	MH 102, C47, MH 103A	ANN-TBX-103A (MH 103A)	ANN-103,-104,-106,-108,-110,-112,-114,-116,-118,-121,-123,-125,-127,-129,-131,-133,-153,-154, (2)-DC (14) SPARE,GND
GW079	-	-	8	I-TB-LS-103	I36B, I-PB-LS-103, I36, I-PB-103-2, I36A, CABLE CONNECTOR	LIT-LS-103	LIT-LS-103-10,-11 (CABLE INSTALLATION BY OTHERS)
GW080	3/C	16	2	I-TB-LS-103	I37B, I-PB-LS-103, I37, I-PB-103-2, I37A	LDK-LS-103	LDK-LS-103-14,-14A,-15,GND
GW081	2/C	16	2	ANNUNCIATOR	EXST C33, MH 103, EXST C12, MH 102, EXST C8, MH 101, EXST C5	CASS TBX	A-A-247-16, -C3
GW082	3	12	1	P-TBX-103 (MH 103)	EXST C33, GROUT FACILITY ANNUN, CND NIPPLE	FUSE ENCLOSURE	D-PB-01-13B,-13C,GND
GW083	5-25/C	14	9	ANN-TBX-103 (MH 103)	EXST C32	GROUT FACILITY ANNUNCIATOR	ANN-102 THRU -156, (6)-DC+,GND (13) SPARE
GW084	3	12	1	FUSE ENCLOSURE	NIPPLE	ANNUNN TRANSFORMER	B.C.GND
GW085	3	12	1	ANNUN TRANSFORMER	NIPPLE, FUSE ENCLOSURE, NIPPLE	GROUT FACILITY ANNUNCIATOR	AC1,ACN,GND
GW086	2	12	1	ANNUN HORN RELAY TB	ANNUNCIATOR	ANNUN WINDOW 1A	HORN 1, HORN 3
GW087	[illegible]	12	2	TB-P-103A (MH 103A)	MH 103A, P49, C/P-PB-103-1, P49A	(103) LEACHATE SUMP PUMP CONTROLLER	D-PB-01-13A,-13B,-13C,GND
GW088	3/C	12	2	LDK-LS-103	C52A, C/P-PB-103-1, C52, MH 103A	ANN-TBX-103A (MH 103A)	ANN-DC+,ANN-10.,GND
GW089	[illegible]	12	2	P-TBX-103(MH 103)	MH 103, P41, MH 102A	TB-P-102A(MH 102A)	D-PB-01-13A,-13B,-13C,GND
GW090	4/C	12	2	P-TBX-103(MH 103)	MH 103, EXST P6, MH 102	TB-P-102(MH 102)	D-PB-01-13A,-13B,-13C,GND
GW091	4/C	12	2	P-TBX-102(MH 102)	MH 102, P45, MH 103A	TB-P-103A(MH 103A)	D-PB-01-13A,-13B,-13C,GND
GW092	2-3/C	12	2	P-TB-LS-102	P64B, P-PB-LS-102, P64, C/P-PB-102, P64A	(102) LEACHATE SUMP PUMP CONTROLLER	P-LS-102A-A(+)-A(-)-GND; P-LS-102B-A(+)-A(-)-GND
GW093	2-3/C	12	2	P-TB-LS-103	P65B, P-PB-LS-103, P65, C/P-PB-103, P65A	(103) LEACHATE SUMP PUMP CONTROLLER	P-LS-103A-A(+)-A(-)-GND; P-LS-103B-A(+), A(-)-GND
GW094	3	12	1	(102) LEACHATE SUMP PUMP CONT	3/4" NIPPLE	(102) 3KVA XFMR PRIMARY	H1,H2,GND
GW095	3	12	1	(102) 3KVA XFMR SECONDARY	3/4" NIPPLE	(102) LEACHATE SUMP PUMP CONTROLLER	X1, XCN, GND
GW096	3	12	1	(102) LEACHATE SUMP PUMP CONT	3/4" NIPPLE	LDK-LS-102	AC1, ACN, GND
GW097	3	12	1	LDK-LS-102	3/4" NIPPLE	LDK-LP-102	AC1, ACN, GND
GW098	[illegible]	12	1	LDK-LP-102	3/4" NIPPLE	(102) HORN	LDK-LP-102-8,-11,GND
GW099	4/C	16	2	LDK-LP-102	3/4" NIPPLE, LDK-LS-102, I34A, IP-102-2, I34, I-PB-LS-102, I34B	I-TB-LS-102	LDK-LP-102-14,-14A,-15,GND
GW0100	[illegible]	12	1	(102) LEACHATE SUMP PUMP CONT	3/4" NIPPLE	LIT-LS-102	AC1, ACN, GND (CONDUIT & CABLE INSTALLATION BY OTHERS)
GW0101	3	12	1	(103) LEACHATE SUMP PUMP CONT	3/4" NIPPLE	(103) 3KVA TRANSFORMER PRIMARY	H1,H2,GND
GW0102	3	12	1	(103) 3KVA XFMR SECONDARY	3/4" NIPPLE	(103) LECHATE SUMP PUMP CONTROLLER	X1, XCN, GND
GW0103	3	12	1	(103) LEACHATE SUMP PUMP CONT	3/4" NIPPLE	LDK-LS-103	AC1, ACN, GND
GW0104	3	12	1	LKD-LS-103	3/4" NIPPLE	LDK-LP-103	AC1, ACN, GND
GW0105	3	12	1	(103) LEACHATE SUMP PUMP CONT	3/4" NIPPLE	LIT-LS-103	AC1, ACN, GND (CONDUIT & CABLE INSTALLATION BY OTHERS)
GW0106	[illegible]	12	1	LDK-LP-103	3/4" NIPPLE	(103) HORN	LDK-LP-103-8,-11,GND
GW0107	4/C	16	2	LDK-LP-103	3/4" NIPPLE, LDK-LS-103, I37A, IP-103-2, I37, ITB-LS-103, I37B	I-TB-LS-103	LDK-LP-103-14,-14A,-15,GND
GW0108	1	5/8"DIA	10	225KVA XFMR GND PAD	P52	MH-102A GROUND GRID	GND
GW0109	1	5/8"DIA	10	225KVA XFMR GND PAD	P54	MH-103A GROUND GRID	GND (CABLE INSTALLATION BY OTHERS)
GW0110	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	225KVA TRANSFORMER	PH-A, PH-B, PH-C (CABLE INSTALLATION BY OTHERS)
GW0111	4PR	20	7	TE-TBX-103 TERM BLK	INTERNAL	J-TE-103-5	TE-LS-103-1(+),-1(-),-2(+),-2(-),-SP-3(+),-SP-3(-),-SP-4(+),-SP-4(-),SHLD
GW0112	16PR	20	4	TE-TBX-102 TERM BLK	INTERNAL	J-TE-102-1	TE-102-1-1(+) & (-) THRU TE-102-1-16(+) & (-),SHLD
GW0113	16PR	20	4	TE-TBX-102 TERM BLK	INTERNAL	J-TE-102-2	TE-102-2-1(+) & (-) THRU TE-102-2-16(+) & (-),SHLD
GW0114	16PR	20	4	TE-TBX-102 TERM BLK	INTERNAL	J-TE-102-3	TE-102-3-1(+) & (-) THRU TE-102-3-16(+) & (-),SHLD
GW0115	16PR	20	4	TE-TBX-102 TERM BLK	INTERNAL	J-TE-102-4	TE-102-4-1(+) & (-) THRU TE-102-4-16(+) & (-),SHLD
GW0116	4PR	20	7	TE-TBX-102 TERM BLK	INTERNAL	J-TE-102-5	TE-LS-102-1(+),-1(-),-2(+),-2(-),-SP-3(+),-SP-3(-),-SP-4(+),-SP-4(-),SHLD
GW0117	16PR	20	4	TE-TBX-103 TERM BLK	INTERNAL	J-TE-103-1	TE-103-1-1(+) & (-) THRU TE-103-1-16(+) & (-),SHLD
GW0118	16PR	20	4	TE-TBX-103 TERM BLK	INTERNAL	J-TE-103-2	TE-103-2-1(+) & (-) THRU TE-103-2-16(+) & (-),SHLD
GW0119	16PR	20	4	TE-TBX-103 TERM BLK	INTERNAL	J-TE-103-3	TE-103-3-1(+) & (-) THRU TE-103-3-16(+) & (-),SHLD
GW0120	16PR	20	4	TE-TBX-103 TERM BLK	INTERNAL	J-TE-103-4	TE-103-4-1(+) & (-) THRU TE-103-4-16(+) & (-),SHLD

Handwritten revision annotations: CHANGE (GW065–GW072); CHANGE (GW087–GW098); CHANGE (GW106–GW107); ADD (GW111–GW120); CHANGE & ADD (GW056–GW062); ADD (GW064–GW067); ADD (GW071–GW072); CHANGE & ADD (GW073–GW078); ADD (GW082–GW083); CHANGE (GW086); ADD (GW087–GW088); CHANGE (GW094–GW095); CHANGE & ADD (GW096–GW107).

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Prepared by: JL BRINKLEY	Checked by: A. R. [illegible]	

CONNECTOR SCHEDULE (SEE NOTE 9)

EQUIPMENT					
DEVICE	NAME	CONN NO	CONN TYPE	CABLE NO	CONN
VAULT TEMPERATURE ELEMENT TREES TE TERMINAL BOX DWG H-2-77637 DETAIL 1	TE-102-1 (TE-102-1-1 THRU -16)	J-TE-102-1 TE TERM BOX	PV-72L18-32SL W/CAP & CHAIN SEE NOTE 3	1-TE-101	EXI SEE TO
	TE-102-2 (TE-102-2(1 THRU 16)	J-TE-102-2 TE TERM BOX	PV-72L18-32SL W/CAP & CHAIN SEE NOTE 3	1-TE-102	
	TE-102-3 (TE-102-3(1 THRU 16)	J-TE-102-3 TE TERM BOX	PV-72L18-32SL W/CAP & CHAIN SEE NOTE 3	1-TE-103	
	TE 102-4 (TE-102-4(1 THRU 16)	J-TE-102-4 TE TERM BOX	PV-72L18-32SL W/CAP & CHAIN SEE NOTE 3	1-TE-104	
LEACHATE SUMP TEMPERATURE	TE-LS-102-1A & -2A OR TE-LS-102-1B & -2B	J-TE-102-5 TE TERM BOX	PV-72L18-32SL W/CAP & CHAIN SEE NOTE 3	———	

Add

CONNECTOR TERMINATION CHART

DEVICE	CONNECTOR NO	WIRE PREFIX NO.	A	B	C	D	E	F	G	H	J	h	J	CONN SHELL
VAULT TEMPERATURE ELEMENTS	J-TE-102-1 J-TE-102-2 J-TE-102-3 J-TE-102-4	TE-102-1 TE-102-2 TE-102-3 TE-102-4	1(+) 1(+) 1(+) 1(+)	1(-) 1(-) 1(-) 1(-)	2(+) 2(+) 2(+) 2(+)	2(-) 2(-) 2(-) 2(-)	3(+) 3(+) 3(+) 3(+)	3(-) 3(-) 3(-) 3(-)	4(+) 4(+) 4(+) 4(+)	4(-) 4(-) 4(-) 4(-)	5(+ 5(5(5	16(+) 16(+) 16(+) 16(+)	16(-) 16(-) 16(-) 16(-)	SHLD SHLD SHLD SHLD
LEACHATE SUMP TEMPERATURE	J-TE-102-5	TE-102-5	1(+)	1(-)	2(+)	2(-)	SP-3(+)	SP-3(-)	SP-4(+)	SP-4(-)			———	SHLD
LEACHATE SUMP HIGH HIGH LEVEL	J-LE-LS-01-1 THRU -4	LE-LS-01	14A	14	15									GND

Add

APP 4I-307

KEH-0159.00 (1/88)

KAISER ENGINEERS HANFORD

ENGINEERING CHANGE NOTICE SKETCH

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2-77642	1	0	G. KUBINSKI	[signature]	B-714-17	27

KAISER ENGINEERS HANFORD

Ref. Dwg. H-2-77642 | Sh. 2 | Rev. 0 | Prepared By G. KUBINSKI | Checked By [signature]

ENGINEERING CHANGE NOTICE SKETCH

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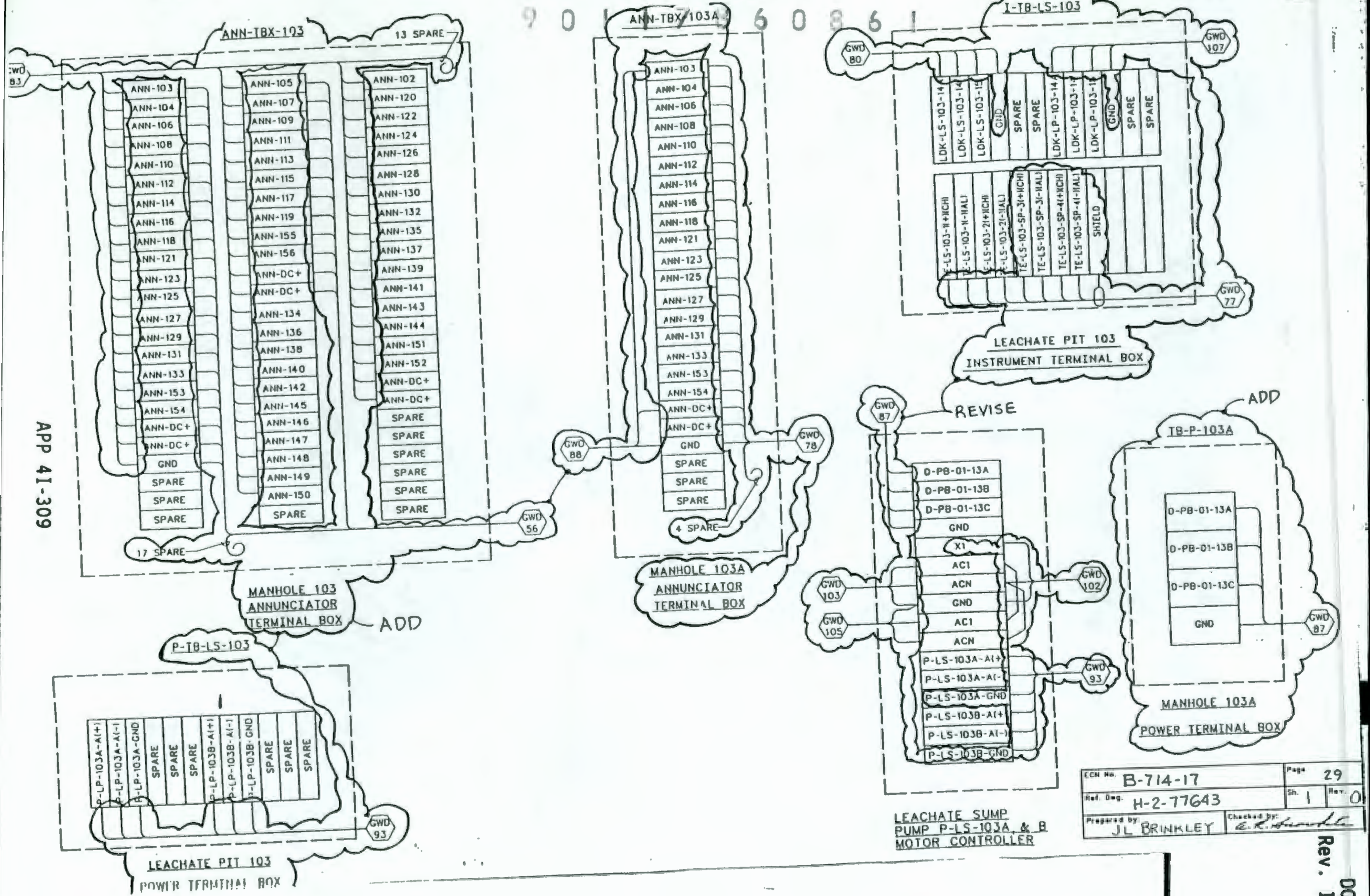
CONNECTOR SCHEDULE (SEE NOTE 9)

EQUIPMENT						
DEVICE	NAME	CONN NO	CONN TYPE	CABLE NO	CONN NO	CC
VAULT TEMPERATURE ELEMENT TREES TE TERMINAL BOX DWG H-2-77637 DETAIL 1	TE-103-1 (1 THRU 16)	J-TE-103-1 TE TERM BOX	PV-72L18-32SL W/CAP & CHAIN SEE NOTE 3	1-TE-101	EXISTING CABLES SEE DWG H-2-98 AND CONNECTIO'	
	TE-103-2 (TE-103-2-1 THRU 16)	J-TE-103-2 TE TERM BOX	PV-72L18-32SL W/CAP & CHAIN SEE NOTE 3	1-TE-102		
	TE-103-3 (TE-103-3-1 THRU 16)	J-TE-103-3 TE TERM BOX	PV-72L18-32SL W/CAP & CHAIN SEE NOTE 3	1-TE-103		
	TE-103-4 (TE-103-4-1 THRU 16)	J-TE-103-4 TE TERM BOX	PV-72L18-32SL W/CAP & CHAIN SEE NOTE 3	1-TE-104		
LEACHATE SUMP TEMPERATURE	TE-LS-103-1A & -2A OR TE-LS-103-1B & -2B	J-TE-103-5 TE TERM BOX	PV-72L18-32SL W/CAP & CHAIN SEE NOTE 3	——		

Add

DEVICE	CONNECTOR NO	WIRE PREFIX NO.	A	B	C	D	E	F	G	H	J	h	j	CONN SHELL
VAULT TEMPERATURE ELEMENTS	J-TE-103-1	TE-103-1	1(+)	1(-)	2(+)	2(-)	3(+)	3(-)	4(+)	4(-)	5(+	16(+)	16(-)	SHLD
	J-TE-103-2	TE-103-2	1(+)	1(-)	2(+)	2(-)	3(+)	3(-)	4(+)	4(-)	5(	16(+)	16(-)	SHLD
	J-TE-103-3	TE-103-3	1(+)	1(-)	2(+)	2(-)	3(+)	3(-)	4(+)	4(-)	5(	16(+)	16(-)	SHLD
	J-TE-103-4	TE-103-4	1(+)	1(-)	2(+)	2(-)	3(+)	3(-)	4(+)	4(-)	5(	16(+)	16(-)	SHLD
LEACHATE SUMP TEMPERATURE	J-TE-103-5	TE-103-5	1(+)	1(-)	2(+)	2(-)	SP-3(+)	SP-3(-)	SP-4(+)	SP-4(-)			-	SHLD
LEACHATE SUMP HIGH HIGH LEVEL	J-LE-LS-01-1	LE-LS-01	14A	14	15									GND

Add



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Prepared by: JL BRINKLEY	Checked by: [signature]

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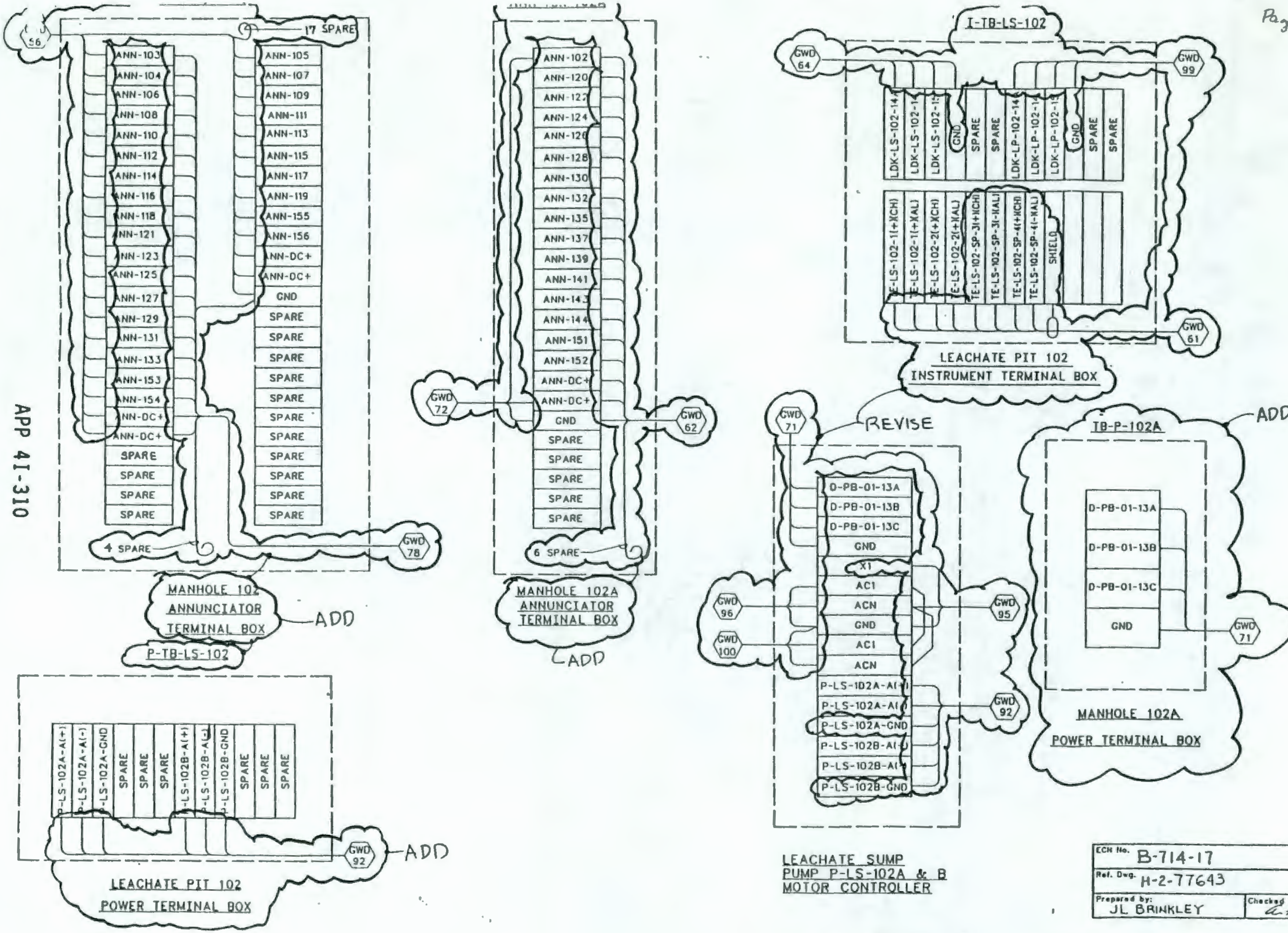
APP 4I-310



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KAISER ENGINEERS HANFORD

ENGINEERING CHANGE NOTICE SKETCH

Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77643	2	0	G. KUBINSKI	[signature]	B-714-17	31

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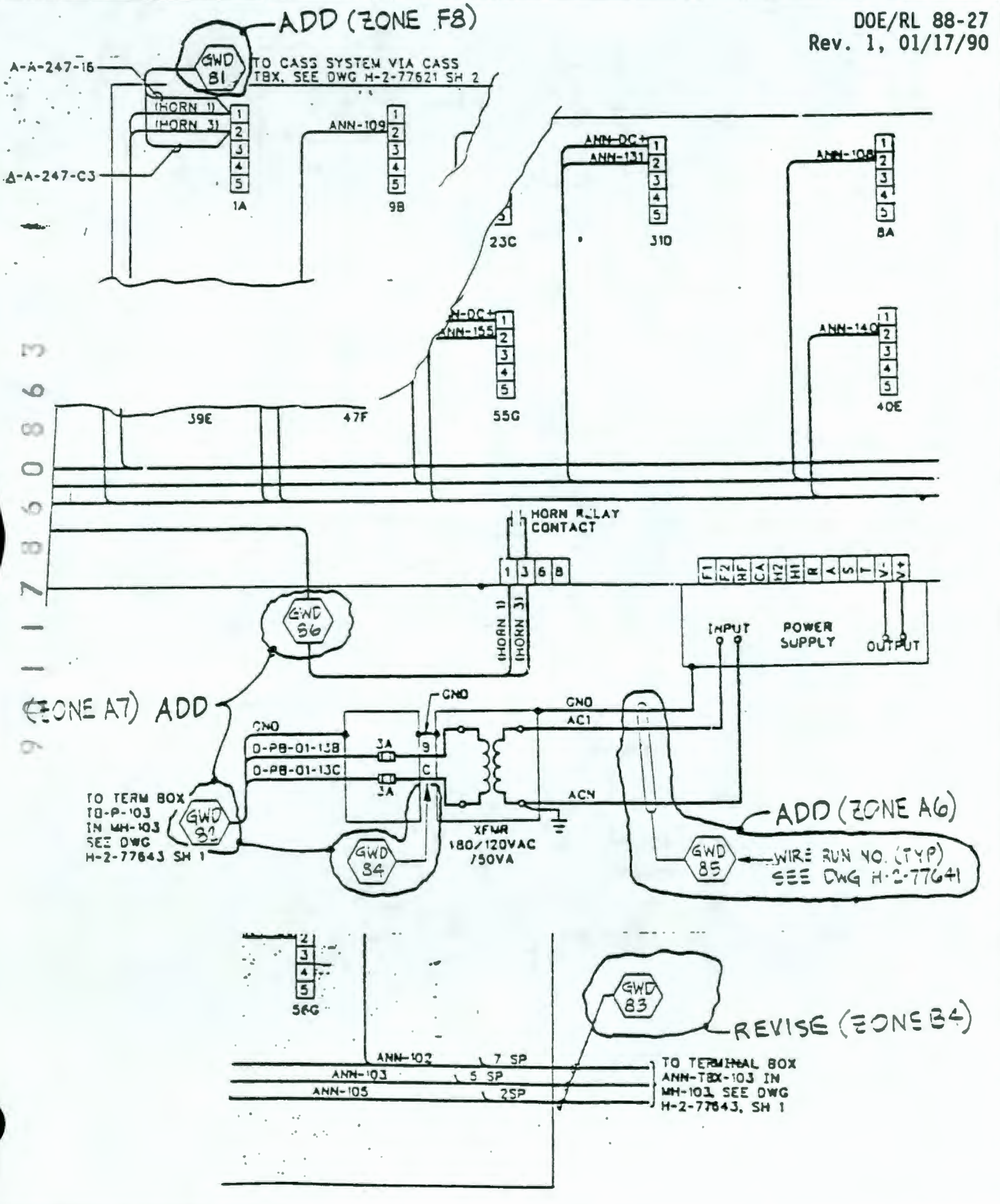

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KAISER ENGINEERS HANFORD | **ENGINEERING CHANGE NOTICE SKETCH**

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H-2-77645	1	0	A.R. SNOWHITE	[signature]	B-714-17	32

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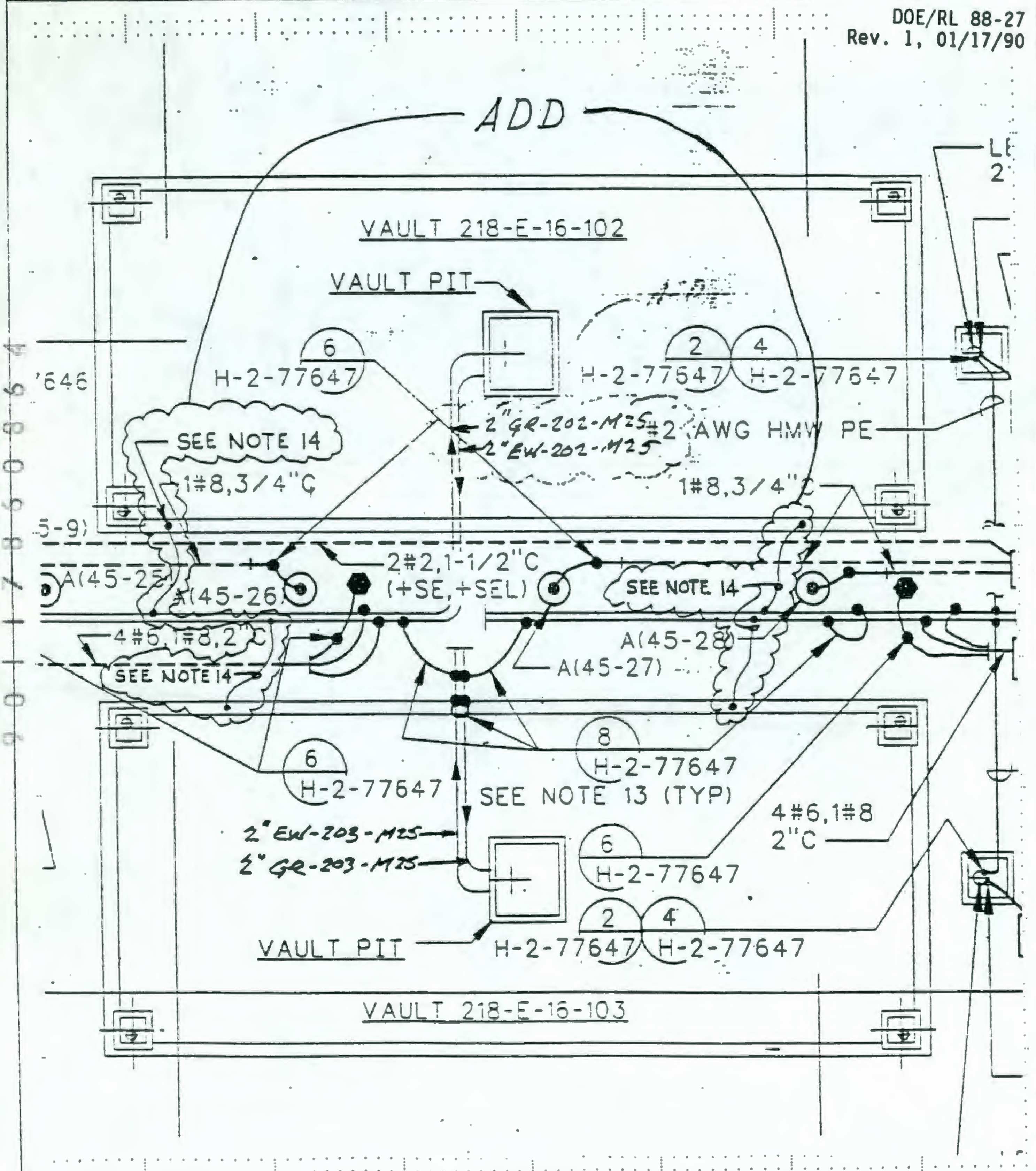

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KAISER ENGINEERS HANFORD

ENGINEERING CHANGE NOTICE SKETCH

Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
—	—	—	A. R. SNOWHITE	G. J. Kubinski	B-714-17	33

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CONSTRUCTION SPECIFICATION B-714-C2, REV. 0

SECTION 16300

P.6, paragraph 2.2.2	Delete words: 1-piece integral bushings and add in place of these words: bushing wells.
P.6, paragraph 2.2.2.1	Delete last (7) words: and secondary breaker shown on the Drawings, and put period after Cat. No. 150615-65.
P.6, paragraph 2.2.2.2 c, d and e	Change to d., e. and f. Add - paragraph 2.2.2.2c as follows; Transformer secondary distribution panelboard rated 480/277 VAC, 400 amperes, with (1) 400 AF, 300 AT, 3P molded case circuit breaker and space for (3) 225 AF, 3P molded case circuit breakers.
P.9, Add paragraph 3.2.5.4	Maximum pulling tension on conductors as recommended by the conductor manufacture.
P.12, Vendor Data List	Add "X" in column 6 for Dimensional Drawings, Equipment Weights and Specifications for item: Transformers.

SECTION 16400

P.3, paragraph 2.1.3.1	Delete type THWN/THNN or XHHW and add: as specified on the drawings.
Add P.12	Approval Data List as shown on page 34.
Add P.13	Vendor Information List as shown on page 35.

CONSTRUCTION SPECIFICATION B-714-C2
SECTION 16640

P.5, paragraph 2.2.6.1b	Change 10 years to 20 years.
P.12, paragraph 3.3.9.1j	Change as follows: Identify each cable end, with nomenclature as shown on the drawings, typewritten on specified wiremarker. Delete 1), 2) and 3) and associated work.

KEH-0159 00 (1/88)

Project No B-714
Project Title GROUTED WASTE DISPOSAL FACILITIES GROUT VAULT PAIR (218-E-102 & 103)
Specification Section 16400

APPROVAL DATA LIST

("X" Indicates Required Data)

1 EPN IDENTIFICATION	2 DESCRIPTION	3 REFERENCE DRAWING	4 SPECIFICATION PARAGRAPH	5 DATA: Dimensional Drawings	Equipment Weights	Specifications	Material Description	Performance Data	Circuit or Control Diagrams	Data Sheets	Illustrative Cuts	Installation Instructions	6 REMARKS
	ANNUNCIATOR	H-2-77640	2.2.3	X	X	X					X		

APP 4I-314

16400-12

ECN No. B-714-17	Page 34
Ref. Dwg. B-714-C2	Sh.	Rev.
Prep. By R. Snowhite	Ckd. By J. Kuhlman

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Project B-714
Project Title GROUTED WASTE DISPOSAL FACILITIES GROUT VAULT PAIR (218-E-102 & -103)
Specification Section 16400

9 0 1 1 7 8 5 0 8 6 7

VENDOR INFORMATION LIST

("X" Indicates Required Data)

1 EPN IDENTIFICATION	2 DESCRIPTION	3 REFERENCE DRAWING	4 SPECIFICATION PARAGRAPH	5 VENDOR INFORMATION (VI): Dimensional Drawings	Equipment Weights	Specifications	Certified Test Data	Circuit or Control Diagram	Instructions: Installation	Instructions: Operation	Instructions: Maintenance	Spare Parts List	Data Sheets	Illustrative Cuts	
	LEAK SENSING CABLE	H-2-77635-1/2	2.1.4			X									

END OF SECTION
16400 - 12
APP 4I-315

ECN No. B-714-17		
Rel. Dwg. B-714-C2		Page 35
Prep. By R. Snowhite	Ckd. By [signature]	Sh — Rev. —

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ENGINEERING CHANGE NOTICE

Page 1 of 43

1. ECN ~~116332~~
Proj. ECN B-714-18

CN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. Date
upplemental [X] / Direct Revision [ ] / Change ECN [ ] / emporary [ ] / upersedure [ ] / iscovery [ ] / ancel/Void [ ]	TERESA EHRHARD, KEH, TC3C, 6-2381	11-8-89
	5. Project Title/No./Work Order No. B-714, GROUT VAULT PAIR (218-E-16-102&103)/ER8007 ; 6. Bldg./Sys./Fac. No. 218-E-16-102 & 103	7. Impact Level 3
	8. Document Number Affected (include rev. and sheet no.) SEE BLOCK 12 ; 9. Related ECN No(s). SEE BLOCK 12	10. Related PO No. N/A

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

Description of Change

) CHANGES TO DRAWINGS

IL - PAGES 3 & 4 & 7 THRU 22

PIPING - PAGES 4 & 5 & 23 THRU 28

INSTM - PAGE 5 & 29 THRU 34

ELEC - PAGE 6 & 35 THRU 36

) AFFECTED ECN's & DRAWINGS

(ECN B-714-8, ECN B-714-9, ECN B-714-10)

H-2-77573, SH 1, REV 0	H-2-77587, SH 1, REV 0	H-2-77605, SH 3, REV 0
H-2-77575, SH 1, REV 1	H-2-77587, SH 2, REV 0	H-2-77618, SH 1, REV 0
H-2-77576, SH 1, REV 0	H-2-77588, SH 2, REV 0	H-2-77618, SH 4, REV 0
H-2-77578, SH 1, REV 0	H-2-77588, SH 3, REV 0	H-2-77618, SH 8, REV 0
H-2-77582, SH 1, REV 0	H-2-77588, SH 5, REV 0	H-2-77618, SH 12, REV 0
H-2-77584, SH 1, REV 0	H-2-77590, SH 1, REV 0	H-2-77619, SH 1, REV 0
H-2-77585, SH 1, REV 0	H-2-77591, SH 1, REV 0	H-2-77619, SH ~~1~~ 2, REV 0 GLK/SRT 11-16-89
H-2-77586, SH 1, REV 0	H-2-77605, SH 1, REV 0	H-2-77635, SH 1, REV 0
H-2-77586, SH ~~1~~ 2, REV 0 GLK/SRT 11-16-89	H-2-77605, SH 2, REV 0	H-2-77635, SH 2, REV 0

AFFECTED SPECIFICATION B-714-C2 (V-B714C2-003, REV. 0) GLK/SRT 11-15-89

SEE PAGES 37 THRU 43

Justification (mark one)	13b. Justification Details
ia ...ge [X] / n...ement [X] / onm...tal [ ] / und [ ] / ate Const. [ ] / . Error/Omission [X] / n Error/Omission [ ]	1) LEVEL ELEMENTS REMOVED FROM CRITERIA 2) INCORPORATION OF WHC DESIGN REVIEW & KEH DESIGN VERIFICATION COMMENTS

APP 4I-317

ribution (include name, MSIN, and no. of copies)

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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	☐		☐

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

Approvals

Signature	Date	Signature	Date
OPERATIONS AND ENGINEERING		ARCHITECT-ENGINEER	
Cog./Project Engineer LR Boggs	11/15/89	PE [signature]	11/13/89
Cog./Project Engr. Mgr. NA		QA [signature] / T.D. Haup	11/13/89
QA [signature]	11/15/89	Safety [signature]	11-13-89
Safety NA		Design C/S [signature]	11/10/89
Security		Other ENVIR R H Hollenbeck	11/10/89
Proj.Prog./Dept. Mgr.		PIPING [signature]	11/10/89
Def. React. Div.		INSTM [signature]	11/10/89
Chem. Proc. Div.		ELEC [signature]	11/10/89
Def. Wst. Mgmt. Div.		SPECS GLK for WHL /srt 11-15-89	11-15-89
Adv. React. Dev. Div.		DEPARTMENT OF ENERGY	
Proj. Dept.		NA (APPROVAL TO BE OBTAINED VIA CHANGE REQUEST)	
Environ. Div.		ADDITIONAL	
IM Dept.			
Facility Rep. (Ops)			
Other			

A-7900-013R (11/88)

ENGINEERING CHANGE NOTICE CONTINUATION SHEET Page 3 of __ | 1. ECN B-714-18

CIVIL CHANGES TO DRAWINGS

1) H-2-77573, SH 1, REV 0, DRAWING LIST (ZA4-6)
   a) DELETE, SH 1 from Drawing Number H-2-77619
   b) DELETE H-2-77619, SH 2   5901   INSTM VAULT MTD LEVEL ASSY

2) H-2-77575, SH 1, REV 1, GENERAL NOTES (ZC1-2)
   CHANGE NOTE 3 TO READ AS FOLLOWS:
   EARTH HAULING EQUIPMENT AND CONCRETE TRANSPORT VEHICLES SHALL NOT BE OPERATED WITHIN 5 FEET HORIZONTALLY OF THE VERTICAL PLANE OF THE EXTERIOR FACES OF CONCRETE BASIN WALLS.
   CONSTRUCTION EQUIPMENT, INCLUDING CRANES, SHALL NOT BE OPERATED OR PLACED IN A LOCATION THAT COULD EXCEED THE DESIGN STRESSES OF THE VAULT OR CONCRETE BASIN.
   DESIGN LOAD ON VAULT WALLS IS BASED ON BACKFILL TO TOP OF WALLS PLUS A VERTICAL SURCHARGE LOAD OF 300 PSF APPLIED AT THE TOP OF THE BACKFILL.

3) H-2-77576, SH 1, REV 0, GENERAL NOTES (ZB1-2)
   CHANGE NOTE 3 TO READ AS FOLLOWS:
   EARTH HAULING EQUIPMENT AND CONCRETE TRANSPORT VEHICLES SHALL NOT BE OPERATED WITHIN 5 FEET HORIZONTALLY OF THE VERTICAL PLANE OF THE EXTERIOR FACES OF CONCRETE BASIN WALLS.
   CONSTRUCTION EQUIPMENT, INCLUDING CRANES, SHALL NOT BE OPERATED OR PLACED IN A LOCATION THAT COULD EXCEED THE DESIGN STRESSES OF THE VAULT OR CONCRETE BASIN.
   DESIGN LOAD ON VAULT WALLS IS BASED ON BACKFILL TO TOP OF WALLS PLUS A VERTICAL SURCHARGE LOAD OF 300 PSF APPLIED AT THE TOP OF THE BACKFILL.

4) H-2-77578, SH 1, REV 0, DETAIL 1 (ZE1)
   MODIFY DETAIL 1 as shown on page 7 of this ECN.

5) H-2-77582, SH 1, REV 0
   a) PLAN (ZE7): Change HDPE GEOMEMBRANE to read 60 MIL HDPE GEOMEMBRANE
   b) SECTION B (ZC3-D3): MODIFY as shown on page 8 of this ECN.
   c) DETAIL (ZC2-D2): MODIFY as shown on page 9 of this ECN.
   d) DETAIL 1 (ZC7-D8): MODIFY as shown on page 10 of this ECN.

6) H-2-77584, SH 1, REV 0
   a) PLAN (ZD6): MODIFY as shown on page 11 of this ECN.
   b) SECTION A (ZE2-4): MODIFY as shown on page 12 of this ECN.
   c) COVER BLOCK PLAN (ZC2-3): MODIFY as shown on page 13 of this ECN.

7) H-2-77585, SH 1, REV 0
   a) DETAIL 5 (ZF5): ADD FIELD WELD SYMBOL TO WELDMENT
   b) ADD NEW DETAIL 8 as shown on page 14 of this ECN.

8) H-2-77586, SH 1, REV 0
   a) PLAN (ZD6): MODIFY as shown on page 15 of this ECN.
   b) SECTION A (ZE3-4): MODIFY as shown on page 16 of this ECN.
   c) COVER BLOCK PLAN (ZD1):   Change 9" OD SLV to read SLEEVE w/PLUG SEE H-2-77586, SH 2

A-7320-036 2 (11-88)

ENGINEERING CHANGE NOTICE CONTINUATION SHEET   Page 4 of ___   1. ECN B-714-18

CIVIL CHANGES TO DRAWINGS CONTINUED

9) H-2-77586, SH 2, REV 0
   a) DETAIL 5 (ZF5): ADD FIELD WELD SYMBOL TO WELDMENT
   b) ADD SLEEVE w/PLUG DETAIL as shown on page 17 of this ECN.

10) H-2-77587, SH 1, REV 0, TABLE, RISERS 37, 38, 39, 40 (ZC2)

DELETE:	LEVEL ELEMENT LE 102-1	2	H-2-77619
	LEVEL ELEMENT LE 102-3	2	H-2-77619
	LEVEL ELEMENT LE 102-2	2	H-2-77619
	LEVEL ELEMENT LE 102-4	2	H-2-77619

11) H-2-77587, SH 2, REV 0, TABLE, RISERS 37, 38, 39, 40 (ZC2)

DELETE:	LEVEL ELEMENT LE 103-1	2	H-2-77619
	LEVEL ELEMENT LE 103-3	2	H-2-77619
	LEVEL ELEMENT LE 103-2	2	H-2-77619
	LEVEL ELEMENT LE 103-4	2	H-2-77619

12) H-2-77588, SH 2, REV 0, RISER TABLE, RISERS 37, 38, 39, 40 (ZC7)

DELETE:	LEVEL ELEMENT LE 102-1	2	H-2-77619
	LEVEL ELEMENT LE 102-3	2	H-2-77619
	LEVEL ELEMENT LE 102-2	2	H-2-77619
	LEVEL ELEMENT LE 102-4	2	H-2-77619

13) H-2-77588, SH 3, REV 0
   a) SECTION B (ZE6): MODIFY as shown on page 18 of this ECN.
   b) SECTION C (ZE4): MODIFY as shown on page 19 of this ECN.

14) H-2-77588, SH 5, REV 0, RISER TABLE, RISERS 37, 38, 39, 40 (ZC7)

DELETE:	LEVEL ELEMENT LE 103-1	2	H-2-77619
	LEVEL ELEMENT LE 103-3	2	H-2-77619
	LEVEL ELEMENT LE 103-2	2	H-2-77619
	LEVEL ELEMENT LE 103-4	2	H-2-77619

15) H-2-77590, SH 1, REV 0
   a) SECTION A (ZD4-E5): MODIFY as shown on page 20 of this ECN.
   b) COVER BLOCK PLAN (ZE1): MODIFY as shown on page 21 of this ECN.

16) H-2-77591, SH 1, REV 0
   a) DETAIL 5 (ZF5): ADD FIELD WELD SYMBOL TO WELDMENT
   b) ADD SLEEVE w/PLUG DETAIL as shown on page 22 of this ECN.

PIPING CHANGES TO DRAWINGS

1) H-2-77605, SH 1, REV 0
   a) PARTIAL PLAN (ZE6-8): MODIFY as shown on page 23 of this ECN.
   b) DETAIL 2 (ZE1): MODIFY as shown on page 24 of this ECN.
   c) SECTION A (ZA5-D8): MODIFY as shown on page 25 of this ECN.

2) H-2-77605, SH 2, REV 0
   a) TOP VIEW (ZD6-E7): MODIFY as shown on page 26 of this ECN.
   b) SECTION C (ZC2-3,D4,E2-4): MODIFY as shown on page 27 of this ECN.

A-7320-036.2 (11-88)

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ENGINEERING CHANGE NOTICE CONTINUATION SHEET Page 5 of __	1. ECN B-714-1B

PIPING CHANGES TO DRAWINGS CONTINUED

3) H-2-77605, SH 3, REV 0
   a) DETAIL 4 (ZC4-E5): MODIFY as shown on page 28 of this ECN.
   b) NOTE 2 (ZB1): CHANGE as shown on page 28 of this ECN.

INSTRUMENTATION CHANGES TO DRAWINGS

1) H-2-77618, SH 1, REV 0
   a) LEGEND (ZC7-8): ADD ∿∿ ULTRASONIC LEVEL SIGNAL
   b) NOTES (ZD1-3):
      CHANGES NOTES 9 AND 10 AS FOLLOWS:

   9. THIS IS THE LEACHATE SUMP ARRANGEMENT FOR VAULT 218-E-16-1XX DURING THE VAULT FILLING SEQUENCE. THIS ARRANGEMENT CONSISTS OF A SHORT TERM LEACHATE PUMP ASSEMBLY WITH A HIGH-HIGH LEVEL ELEMENT LE-LS-1XX, PUMP P-LS-1XX-1, LEVEL ELEMENT LE-LS-1XX-1A AND THERMOCOUPLES TE-LS-1XX-1A AND TE-LS-1XX-2A.

   10. THIS IS THE LEACHATE SUMP ARRANGEMENT FOR VAULT 218-E-16-1XX DURING THE VAULT LONG TERM STORAGE. THIS ARRANGEMENT CONSISTS OF 2 ASSEMBLIES:
      (1) THE LEACHATE PUMP ASSEMBLY WITH PUMPS P-LS-1XXA AND P-LS-1XXB.
      (2) THE LEACHATE INSTRUMENT TREE ASSEMBLY WITH LEAK DETECTOR ELEMENT LDE-LS-1XX, LEVEL ELEMENT LE-LS-1XX-1B, AND THERMOCOUPLES TE-LS-1XX-1B AND TE-LS-1XX-2B.

2) H-2-77618, SH 4, REV 0
   a) PLAN (ZB4,B7,E4-F6): MODIFY as shown on page 29 of this ECN.
   b) PLAN (ZA3): CHANGE LEACHATE PUMP from P-LS-01-1 to P-LS-102-1
   c) PLAN (ZA8): ADD PUMP PIECE NUMBER P-EW-01 to EXCESS WATER PIT 218-E-16-1020
   d) PLAN (ZC2): CHANGE HIGH-HIGH LEVEL PROBE LE-LS-01 to LE-LS-102

3) H-2-77618, SH 8, REV 0 (ZD3-C4,B7-C8)
   MODIFY as shown on page 30 & 31 of this ECN.

4) H-2-77618, SH 12, REV 0
   a) PLAN (ZB4,B7,E4-F7): MODIFY as shown on page 32 of this ECN.
   b) PLAN (ZA3): CHANGE LEACHATE PUMP FROM P-LS-01-1 to P-LS-103-1
   c) PLAN (ZA8): ADD PUMP PIECE NUMBER P-EW-01 to EXCESS WATER PIT 218-E-16-1030
   d) PLAN (ZC2): CHANGE HIGH-HIGH LEVEL PROBE LE-LS-01 to LE-LS-103

5) H-2-77619, SH 1, REV 0
   a) SECTION A (ZC5,B6-D7): MODIFY as shown on page 33 of this ECN.
   b) DETAIL 2 (ZE6,F6): MODIFY as shown on page 34 of this ECN.
   c) NOTES (ZC1-D2): DELETE NOTES 8, 10, 11, 12 & 13
      RENUMBER NOTE 9 to 8
   d) TITLE BLOCK (ZA1): CHANGE Sheet 1 of 2 to read 1 of 1

6) H-2-77619, SH 2, REV 0
   VOID IN ITS ENTIRETY

ENGINEERING CHANGE NOTICE CONTINUATION SHEET Page 6 of ___ | ECN B-714-18

ELECTRICAL CHANGES TO DRAWINGS

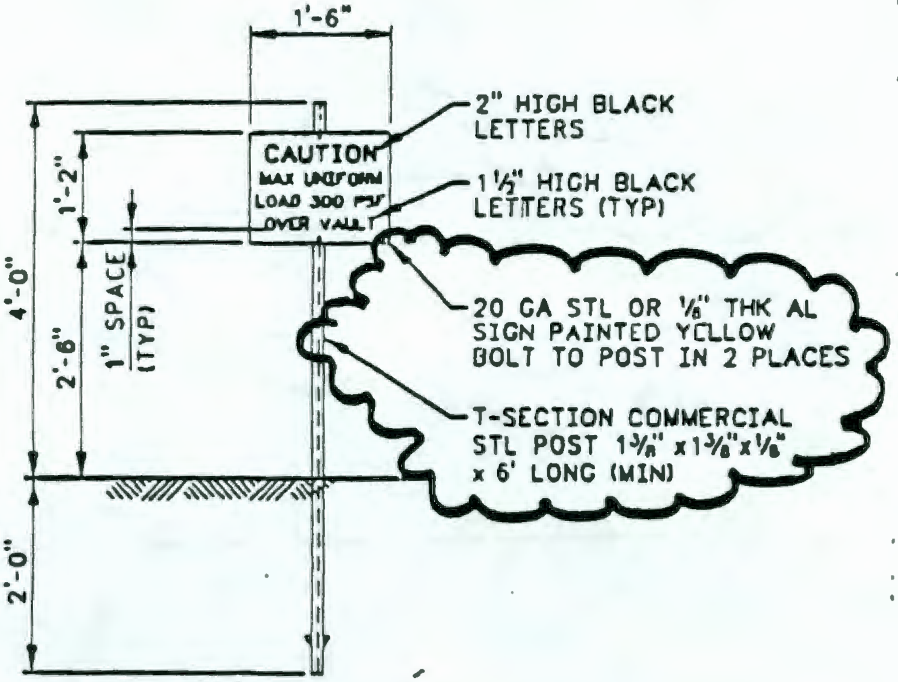
1) H-2-77635, SH 1, REV 0
   a) PLAN (ZD7-8): PLACE CLOUD & HOLD #4 around EXHAUSTER
   b) PLAN (ZC4,C6,E5,E7): DELETE LEVEL ELEMENTS as shown on page 35 of this ECN.
   c) NEAR TITLE BLOCK (ZB3): ADD Hold Description, in a cloud, as follows:

   HOLD # 4 FUTURE EXHAUSTER DESIGN

2) H-2-77635, SH 2, REV 0
   a) PLAN (ZD7-E8): PLACE CLOUD AND HOLD #4 around EXAUSTER
   b) PLAN (D4,D6,E5,E7): DELETE LEVEL ELEMENTS as shown on page 36 of this ECN.
   c) NEAR TITLE BLOCK (ZB3): ADD Hold Description, in a cloud, as follows:

   HOLD # 4 FUTURE EXHAUSTER DESIGN

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH				
Ref. Dwg. H-2-77578	**Sh.** 1	**Rev.** 0	**Prepared By** TERESA EHRHARD	**Checked By** [signature]	**ECN No.** B-714-18	**Page** 7/



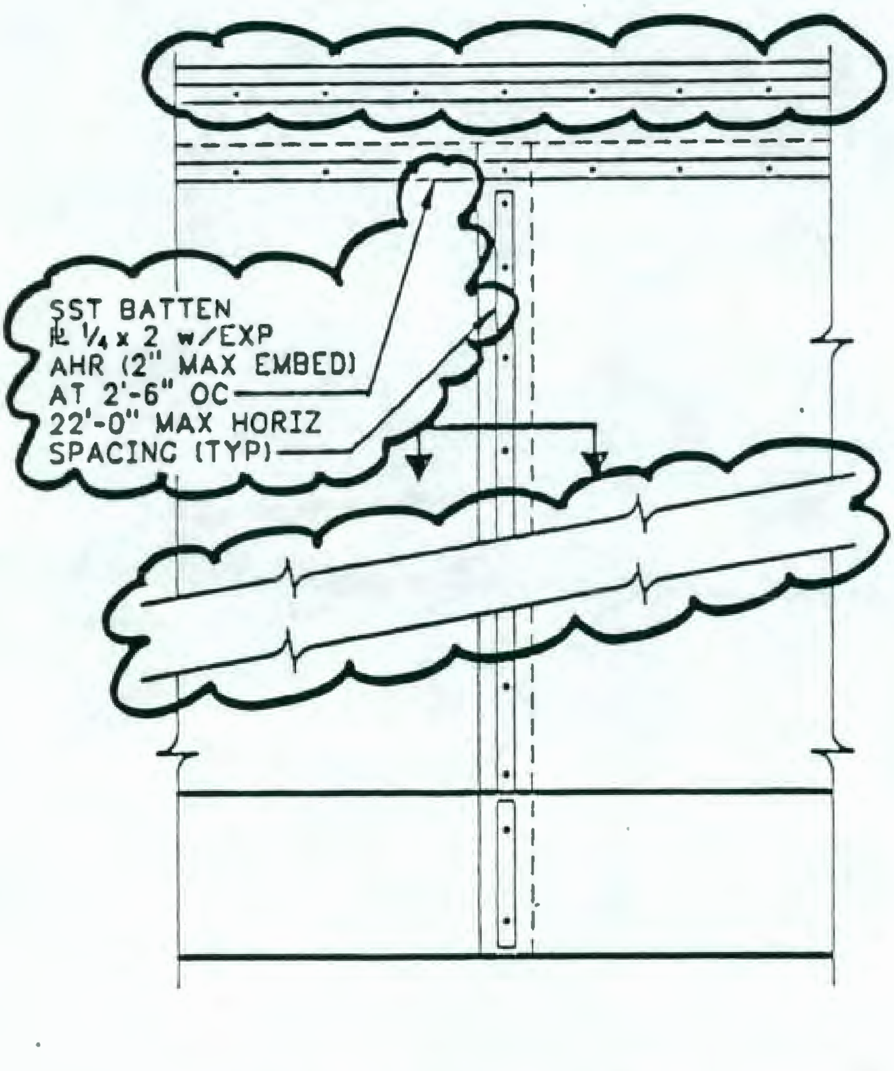
DETAIL 1
SCALE: ¾" = 1'-0"

9 0 1 1 7 8 5 0 8 7 5

KEH-0159.00 (1.88)

Contract KEH-3166
Change Order 6

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77582	1	0	TERESA EHRHARD	RG HOLLENBECK	B-714-18	8/



SECTION B
SCALE: 1/4" = 1'-0"

KEH-0159.00 (1/88)

9 0 1 1 7 3 5 0 8 7 6

Contract KEH-5162
Change Order 6

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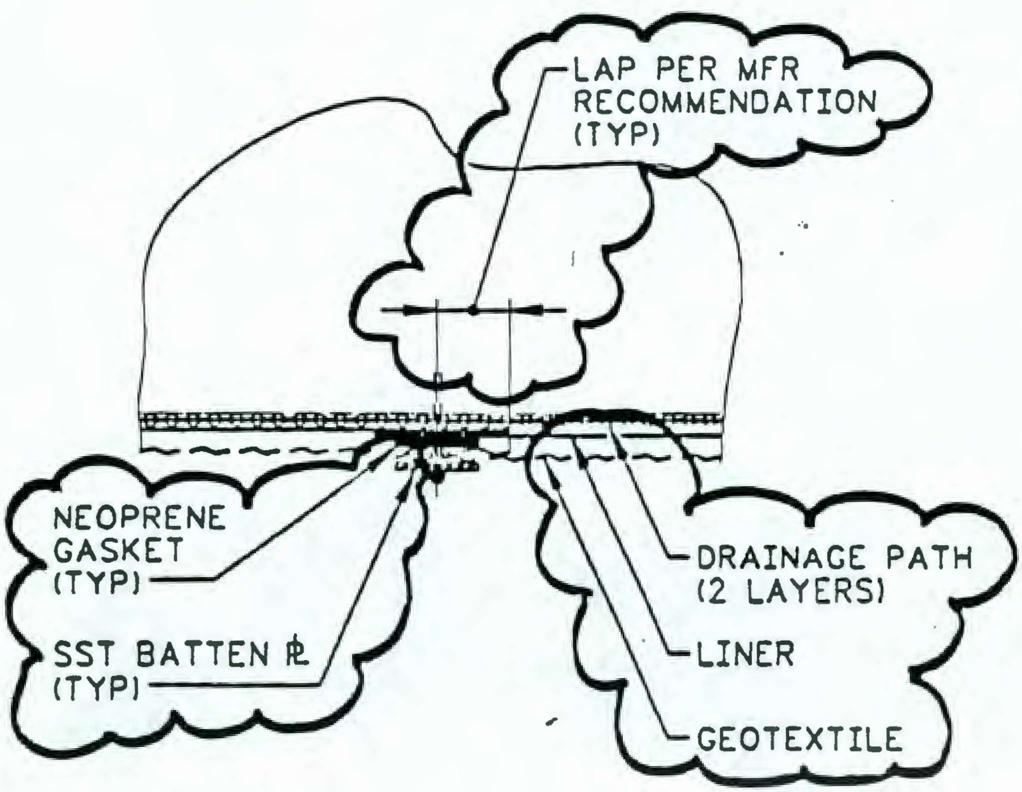
KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77582	1	0	TERESA EHRHARD	RG HOLLENBECK	B-714-18	9/



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KEH-0159.00 (1-88)

Contract KEH-5162 Change Order 6

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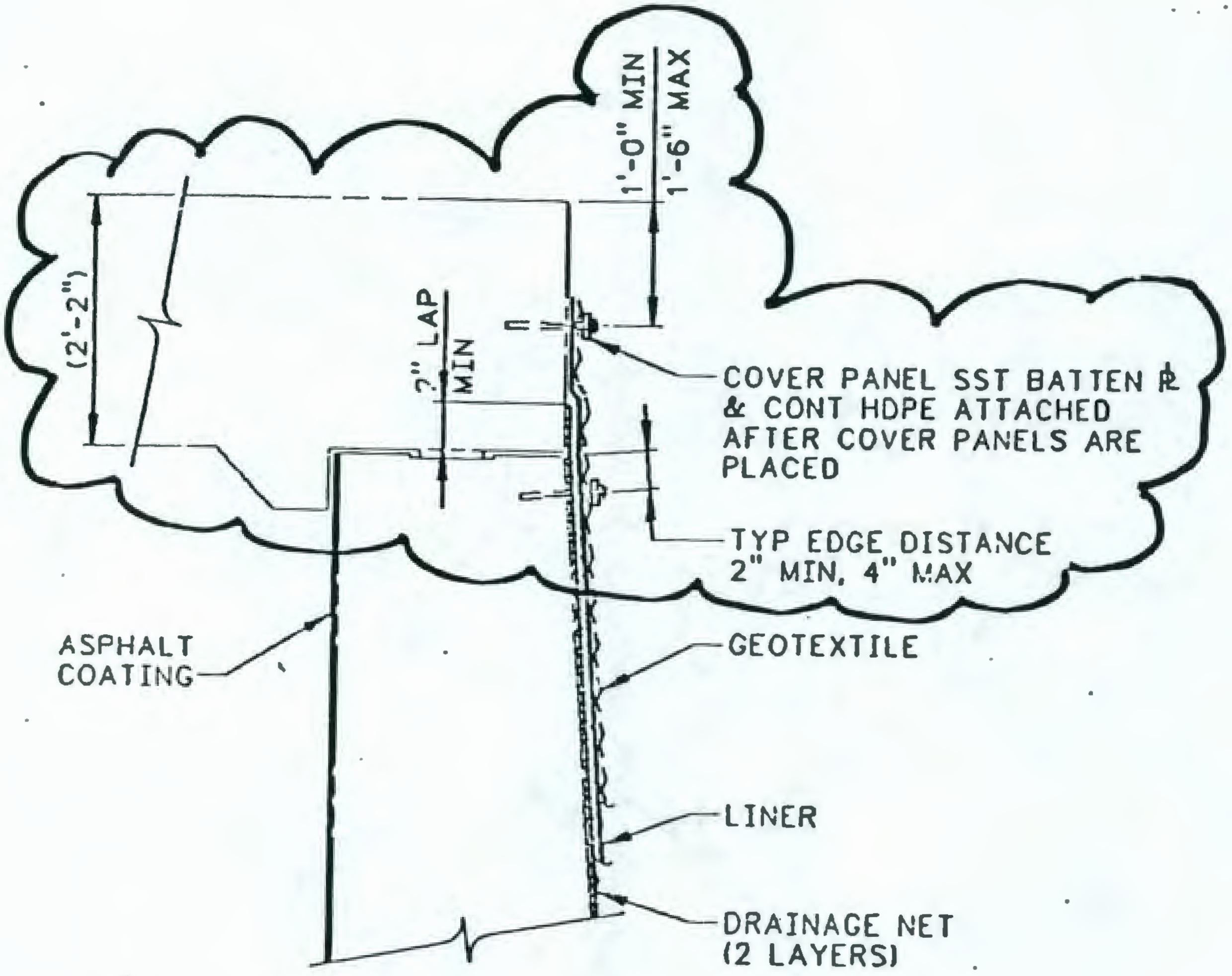
Rev. 1, 01/17/90



DETAIL 1

SCALE: NONE

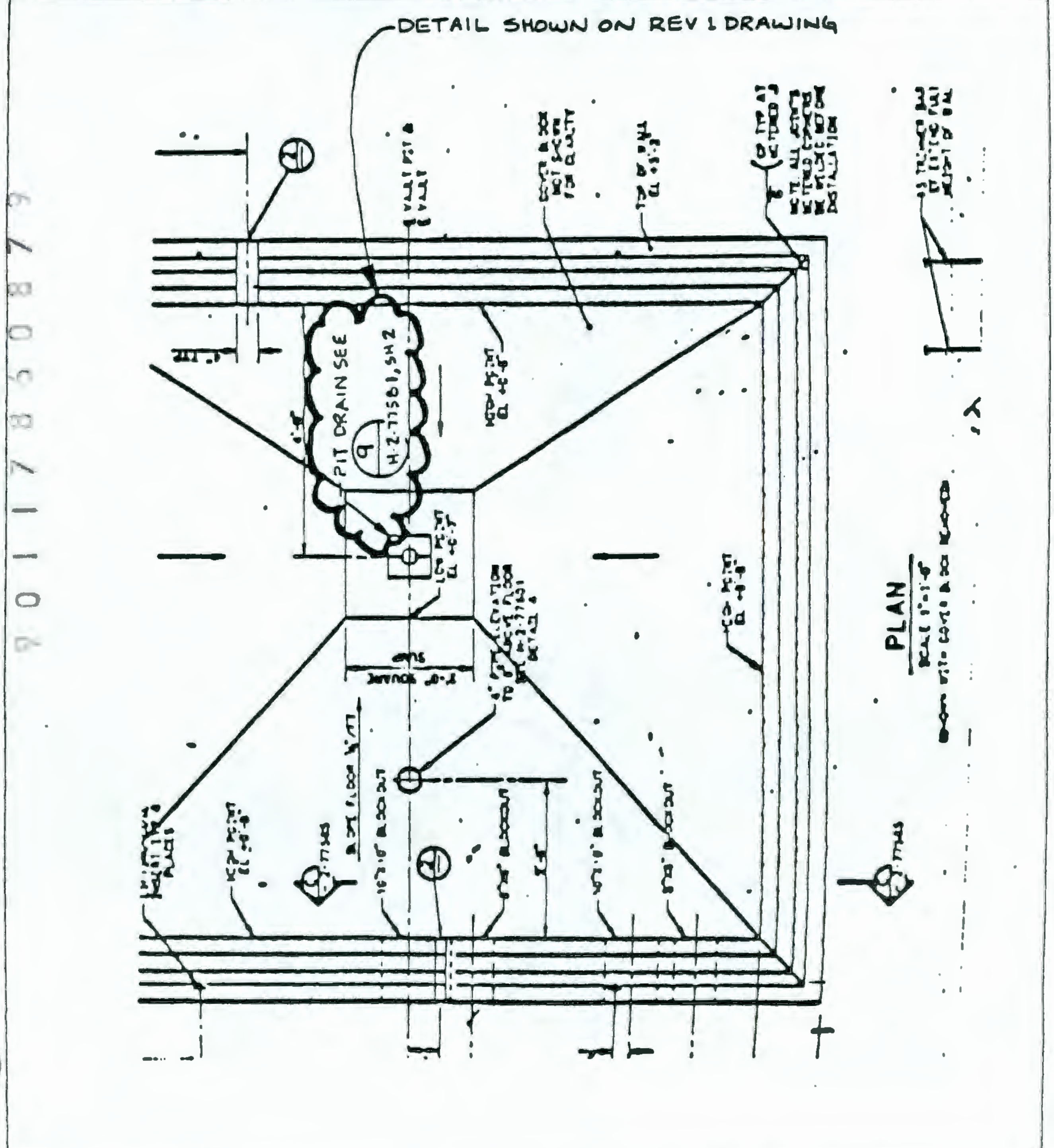
KAISER ENGINEERS HANFORD

ENGINEERING CHANGE NOTICE SKETCH

Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77582	1	0	TERESA EHRHARD	RG Hollenbeck	B-714-18	10/

KEH-0159 00 (1/88)

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77584	1	0	TERESA EHRHARD	[signature]	B-714-18	11



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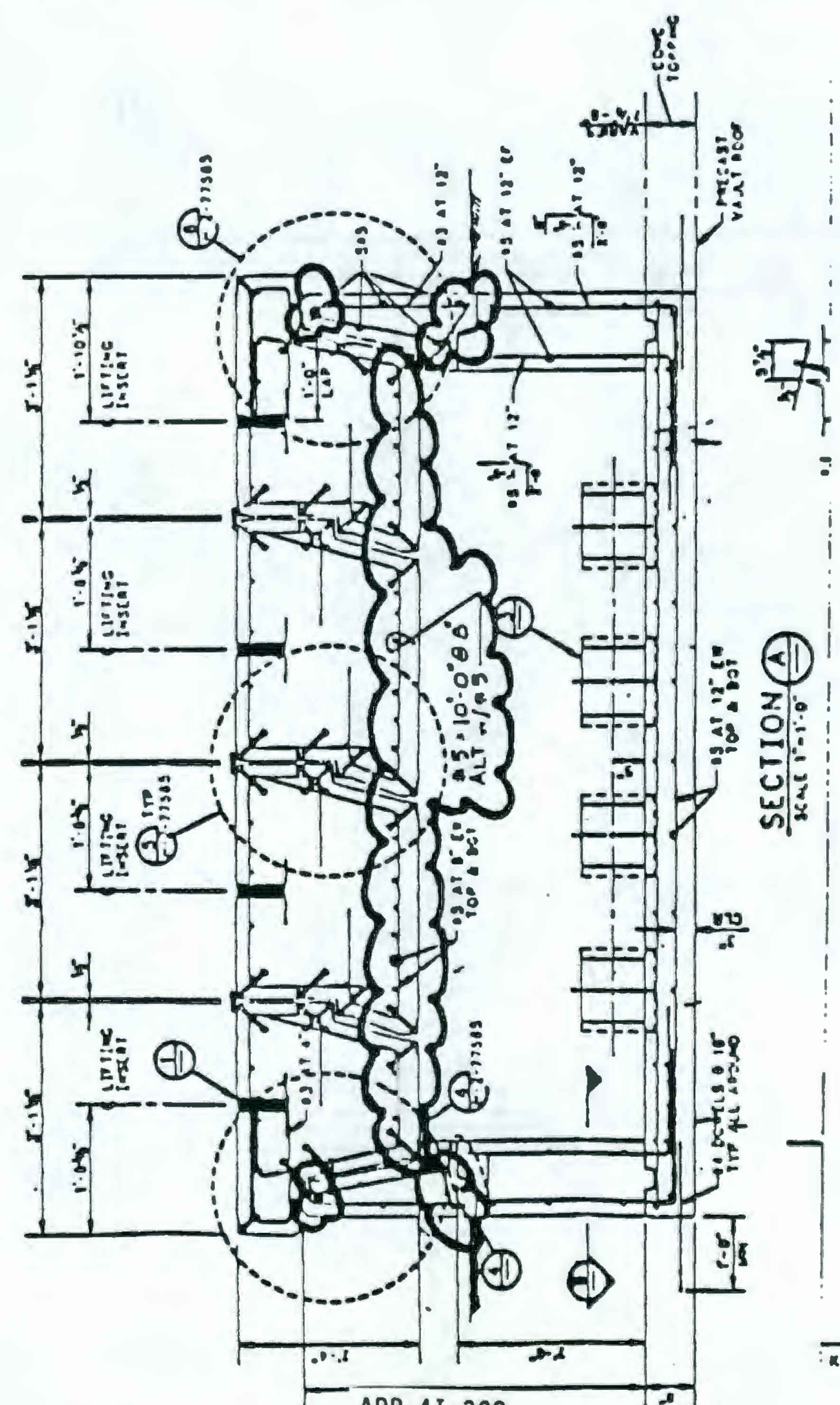
KEH-0159 00 (1/88)

Contract KEH-5162
Change Order 6

DOE/RL 88-27
Rev. 1, 01/17/90

KAISER ENGINEERS HANFORD			ENGINEERING CHANGE NOTICE SKETCH			
Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77584	1	0	TERESA EHRHARD	[signature]	B-714-18	12/



SECTION A
SCALE 1"=1'-0"

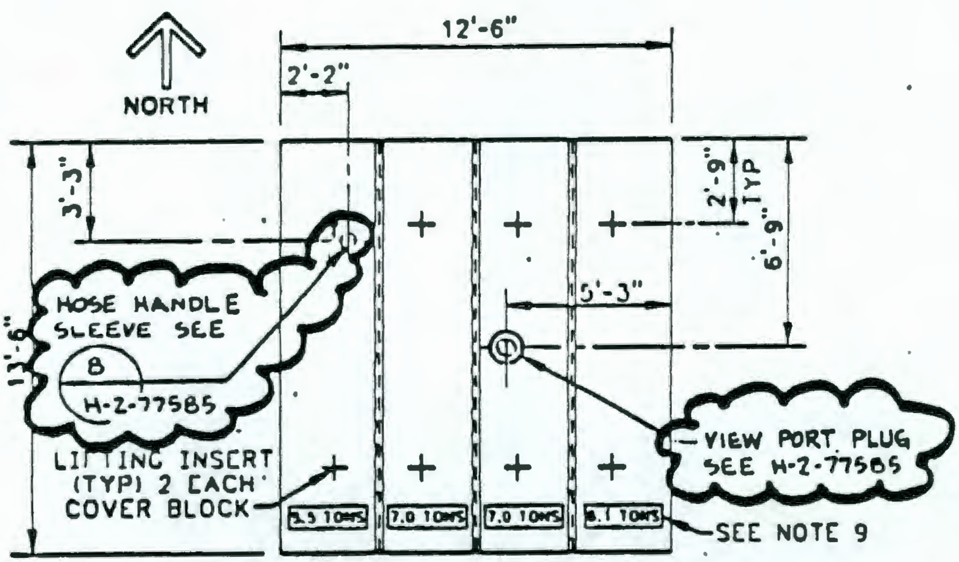
KEH-0159.00 (1/88)

9 0 1 1 7 8 5 0 8 8 0

Contract KEH-5162
Change Order 6

DOE/RL 88-27
Rev. 1, 01/17/90

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH				
Ref. Dwg. H-2-77584	Sh 1	Rev. 0	Prepared By TERESA EHRHARD	Checked By S. Koci	ECN No. B-714-18	Page 13/



PLAN OF COVER BLOCKS

SCALE 1/4"=1'-0"

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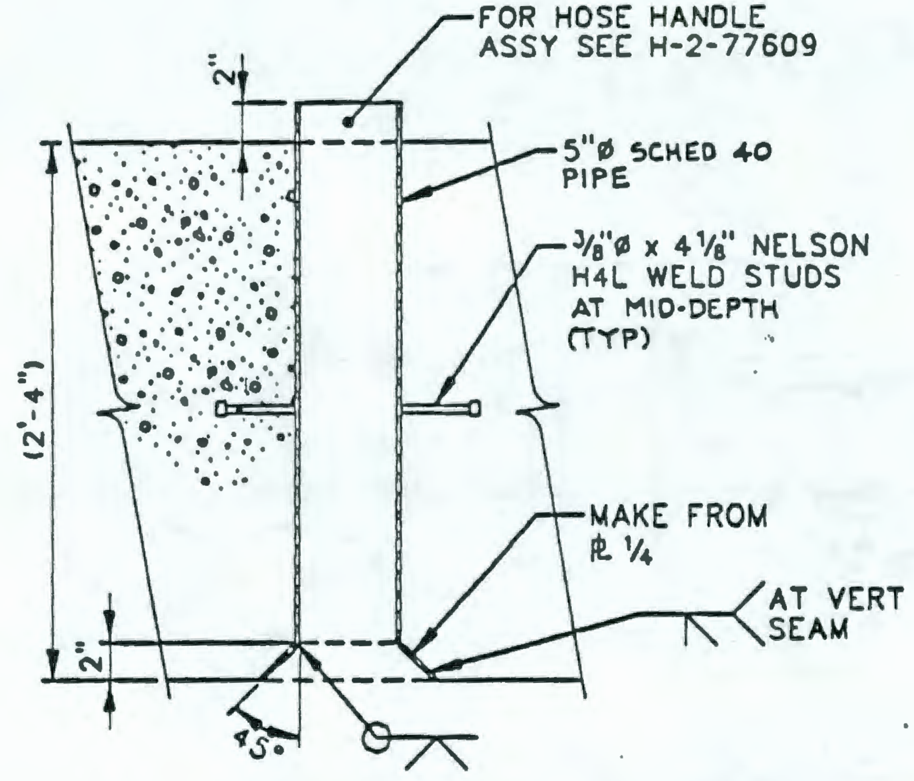
KEH-0159.00 (1/88)

KAISER ENGINEERS HANFORD — ENGINEERING CHANGE NOTICE SKETCH

Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77585	1	0	TERESA EHRHARD	[signature]	B-714-18	14/



DETAIL 8 H-2-77584
SCALE: 1½" = 1'-0"

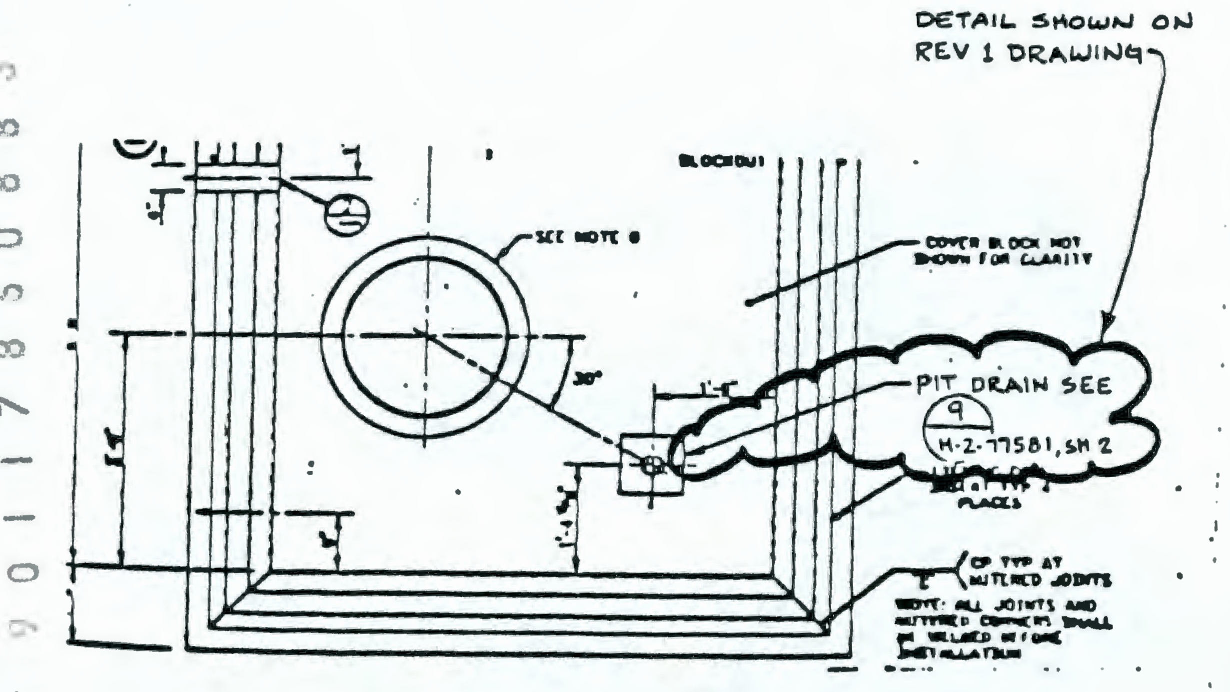
90117850882

KEH-0159 00 (1/88)

Contract KEH-5162
Change Order 6

90117850883

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77586	1	0	TERESA EHRHARD	[signature]	B-714-18	15/



PLAN

SCALE 1"=1'-0"
SHOWN WITH COVER BLOCK REMOVED

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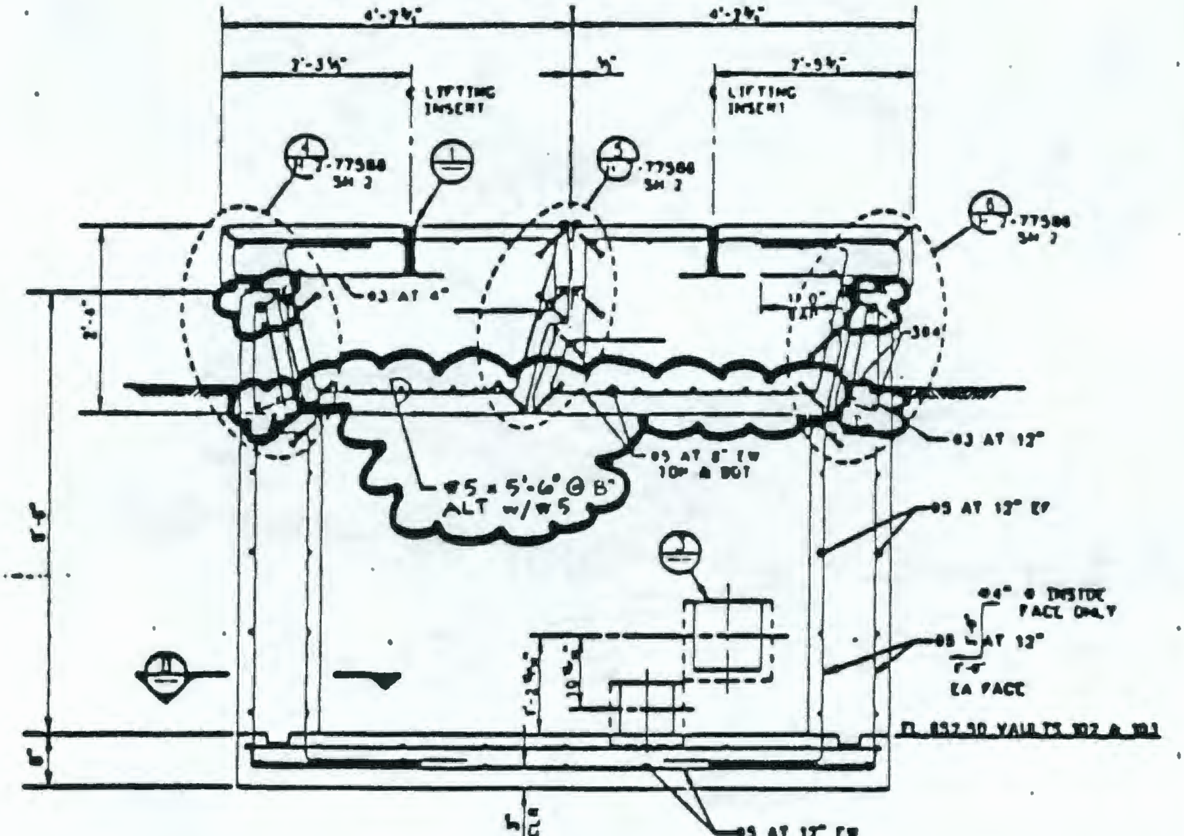
KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77586	1	0	TERESA EHRHARD	[signature]	B-714-18	16/

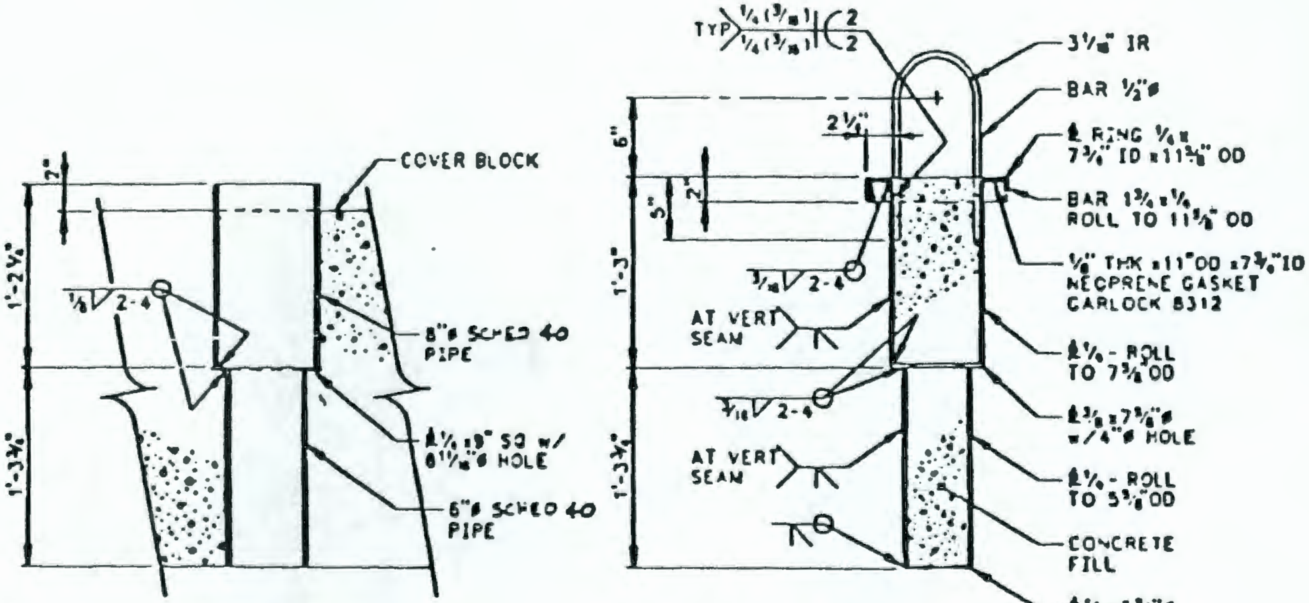


SECTION A
SCALE 1"=1'-0"

KEH-0159.00 (1-88)

9 0 1 1 7 3 5 0 5 8 4

9011786088 5



SLEEVE

PLUG

SLEEVE w/PLUG DETAIL

SCALE: 1½" = 1'-0"

APP 4I-333

KEH 0159.00 (1-88)

KAISER ENGINEERS HANFORD

ENGINEERING CHANGE NOTICE SKETCH

Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77586	2	0	TERESA EHRHARD	[signature]	B-714-18	17

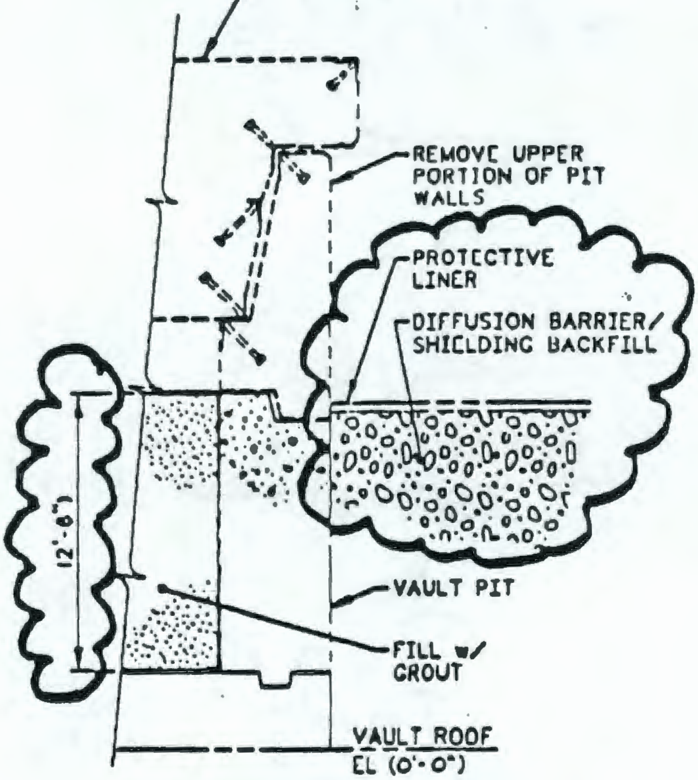
Contract KEH-5162
Change Order 6

Pg 17 of 43

DOE/RL 88-27
Rev. 1, 01/17/90

Contract KEH-5162
Change Order 6

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg.	Sh	Rev.	Prepared By	Checked By	ECN No	Page
H-2-77588	3	0	TERESA EHRHARD	[signature]	B-714-18	19/



REMOVE PRIOR TO GROUTING:

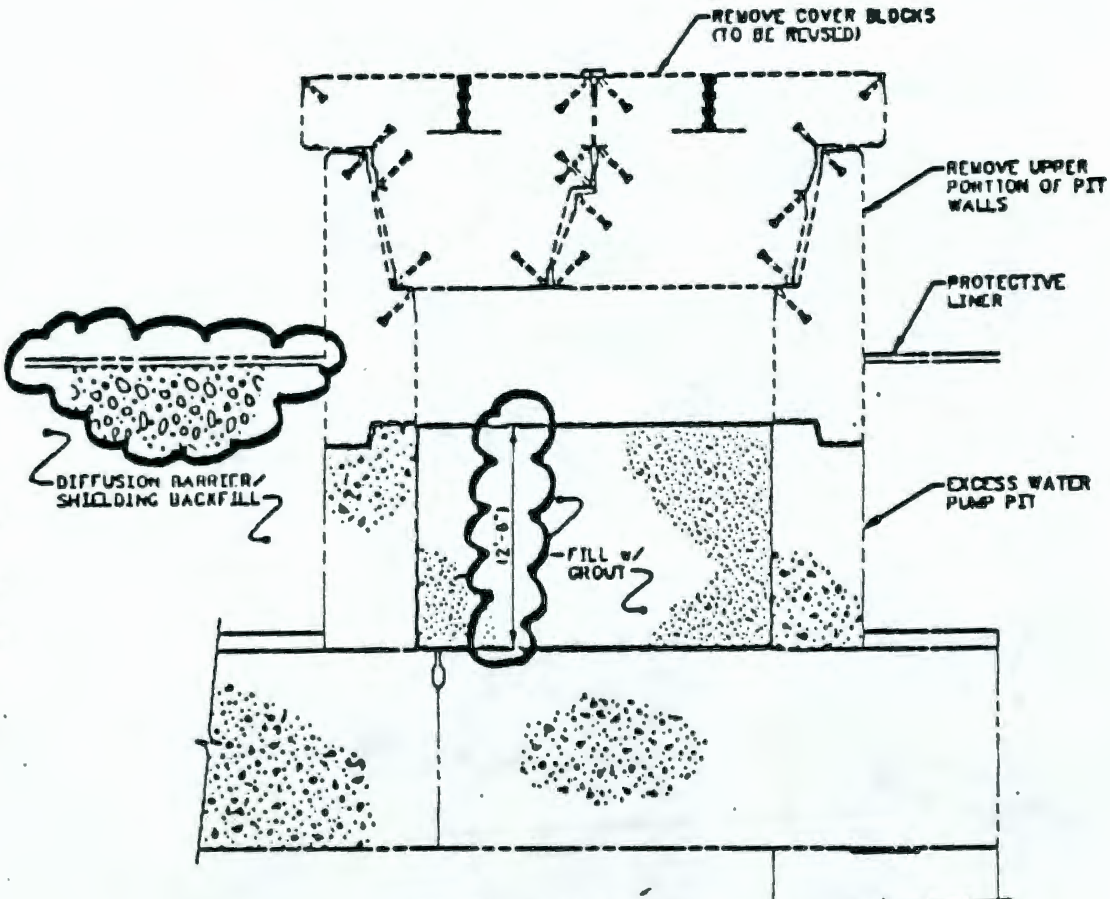
1- JUMPER ASSEMBLY
2- DRAIN SEAL AND HANDLE
3- LEAK DETECTION ASSEMBLY

SECTION (B) H-2-77588, SH 1 & SH 4
SCALE: 1" = 1'-0"

KEH-0159 00 (1/88)

9011785088 6

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg. H-2-77588	Sh 3	Rev. 0	Prepared By TERESA EHRHARD	Checked By [signature]	ECN No B-714-18	Page 19



REMOVE PRIOR TO GROUTING:

1- EXCESS WATER PUMP PIT ASSEMBLY
2- DRAIN SEAL AND HANDLE
3- LEAK DETECTION ASSEMBLY

SECTION (C) H-2-77588, SH 1 & SH 4

SCALE: 1" = 1'-0"

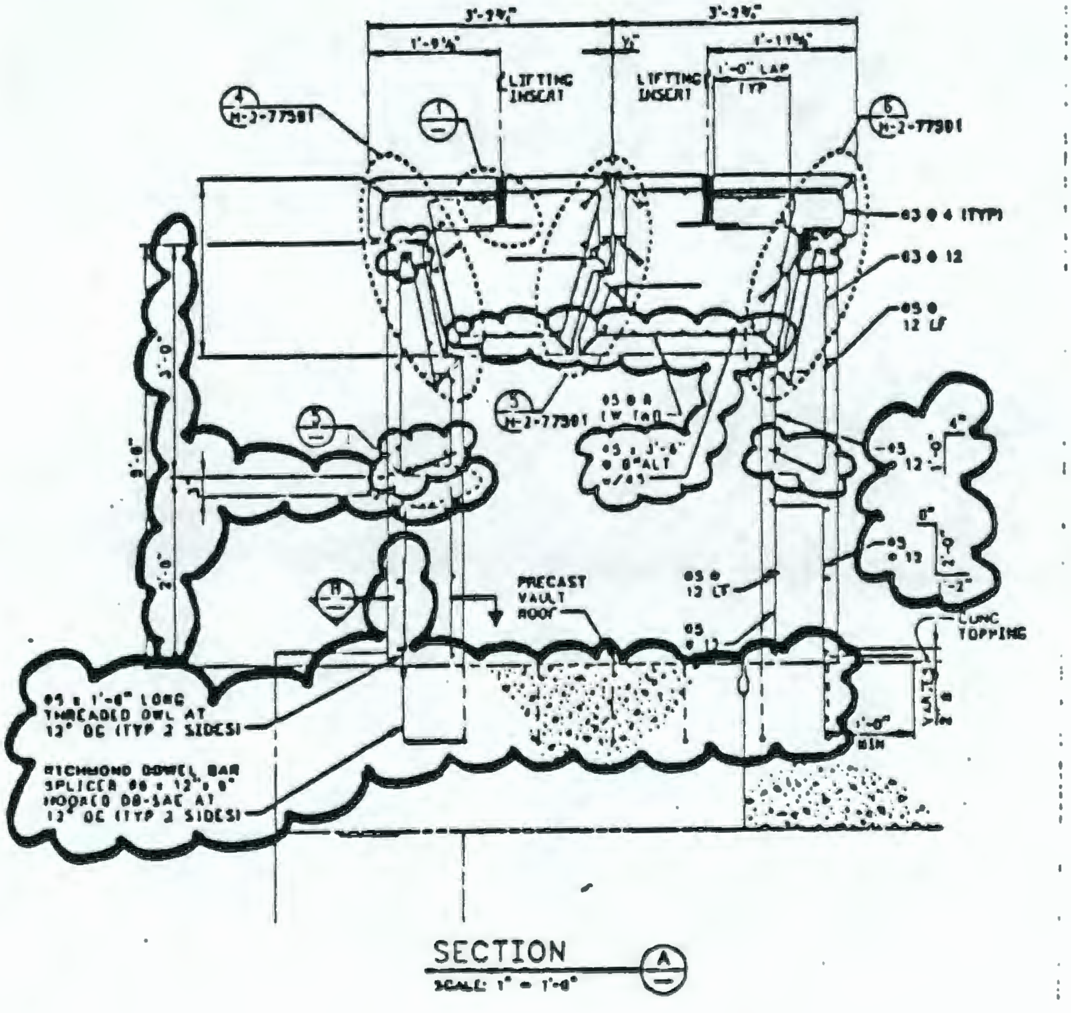
KEH-0159.00 (1/88)

Contract KEH-5162
Change Order 6

90117850833

KAISER ENGINEERS HANFORD — ENGINEERING CHANGE NOTICE SKETCH

Ref. Dwg.	Sh	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77590	1	0	TERESA EHRHARD	[signature]	B-714-18	20/

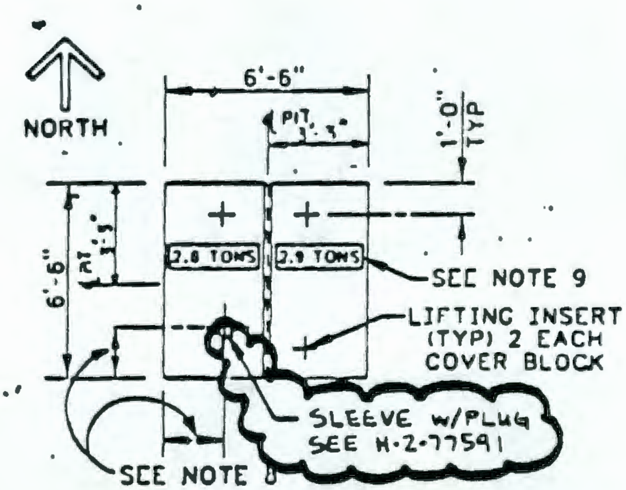


SECTION A
SCALE: 1" = 1'-0"

KEH-0159.00 (1/88)

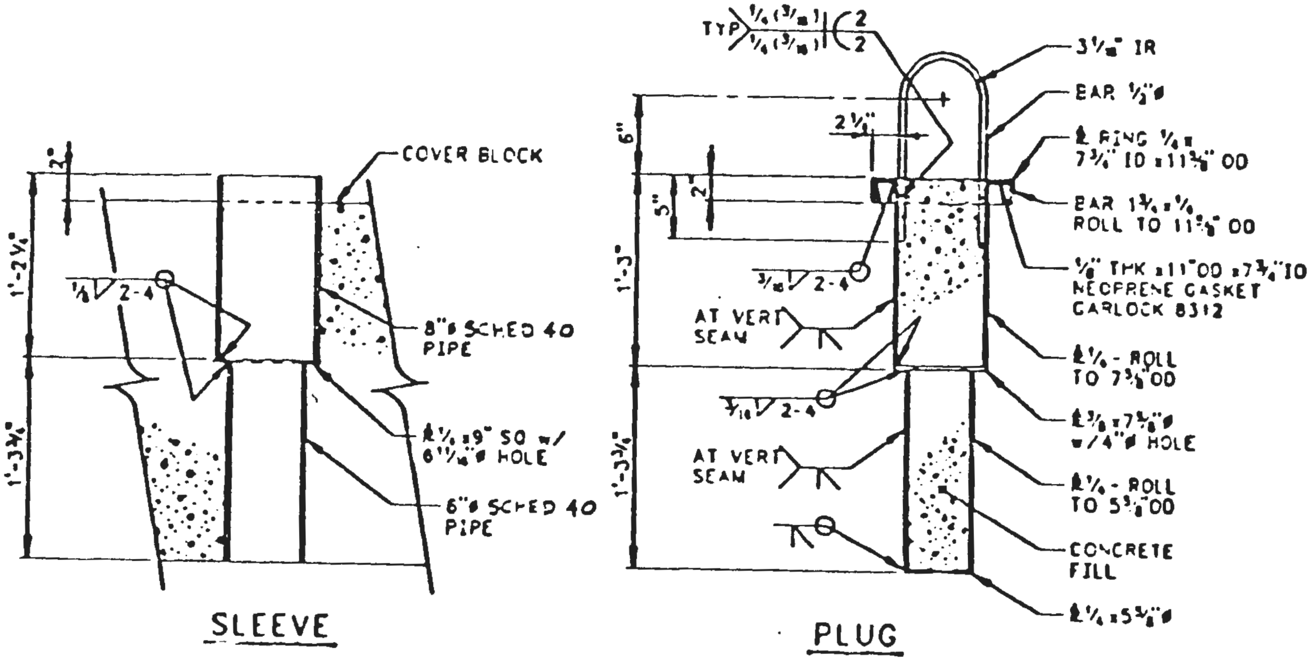
Contract KEH-5162
Change Order 6

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg. H-2-77590	Sh. 1	Rev. 0	Prepared By TERESA EHRHARD	Checked By [signature]	ECN No. B-714-18	Page 21



PLAN OF COVER BLOCKS

SCALE 1/4"=1'-0"



SLEEVE w/PLUG DETAIL

SCALE: 1 1/2" = 1'-0"

KAISER ENGINEERS HANFORD

ENGINEERING CHANGE NOTICE SKETCH

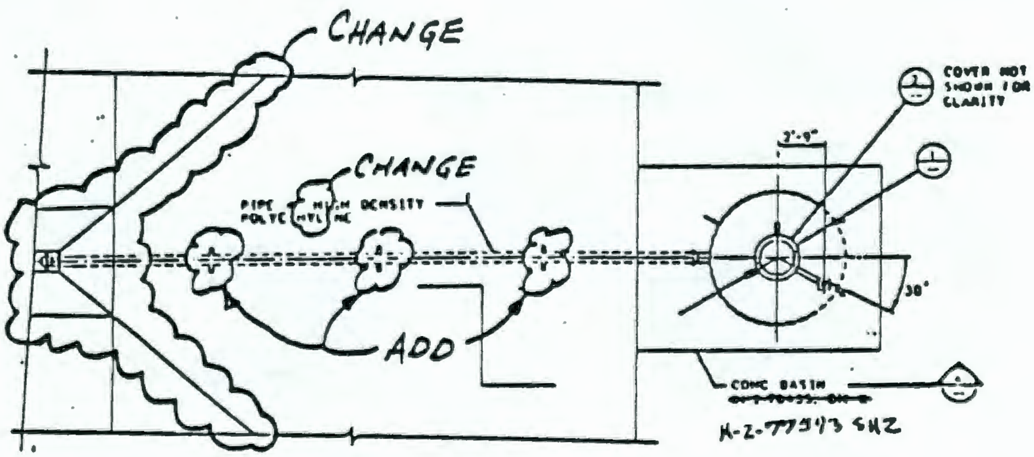
Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77591	1	0	TERESA EHRHARD	[signature]	B-714-18	22/

APP 41-338

KEH-0159 (01/88)

Contract KEH-5162 Change Order 6

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77605	1	0	DK MILTON	[signature]	B-714-18	23/



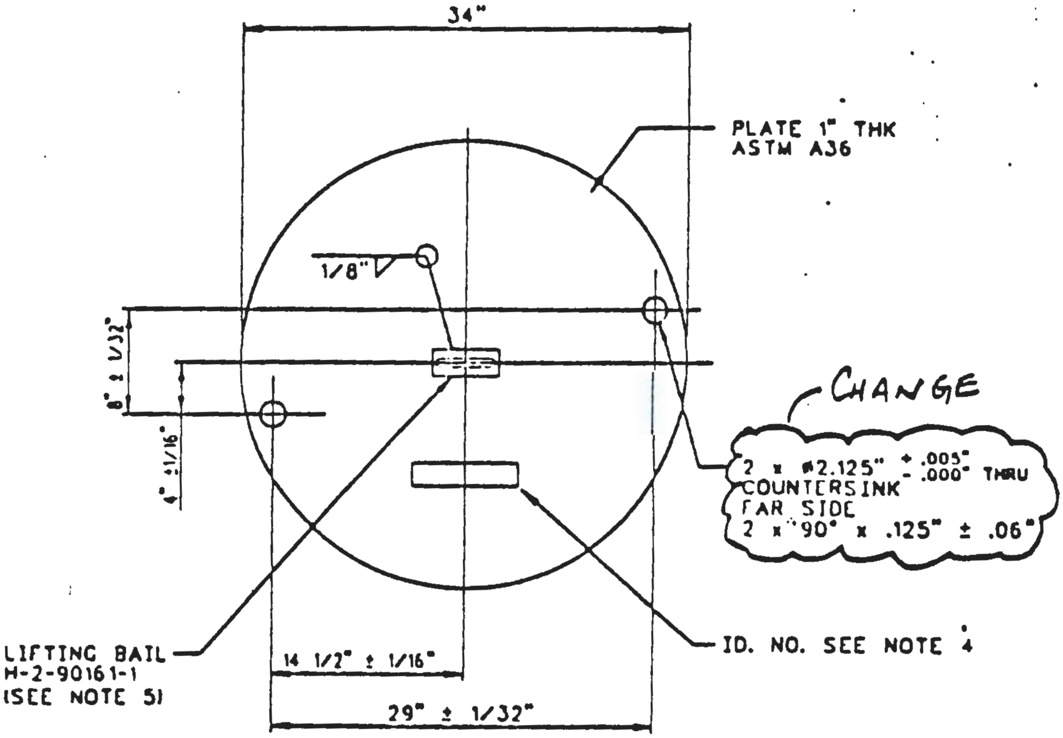
PARTIAL PLAN
SCALE: 1/4"=1'-0" (VAULT NOT SHOWN)

KEH-0159 00 (1/88)

KAISER ENGINEERS HANFORD

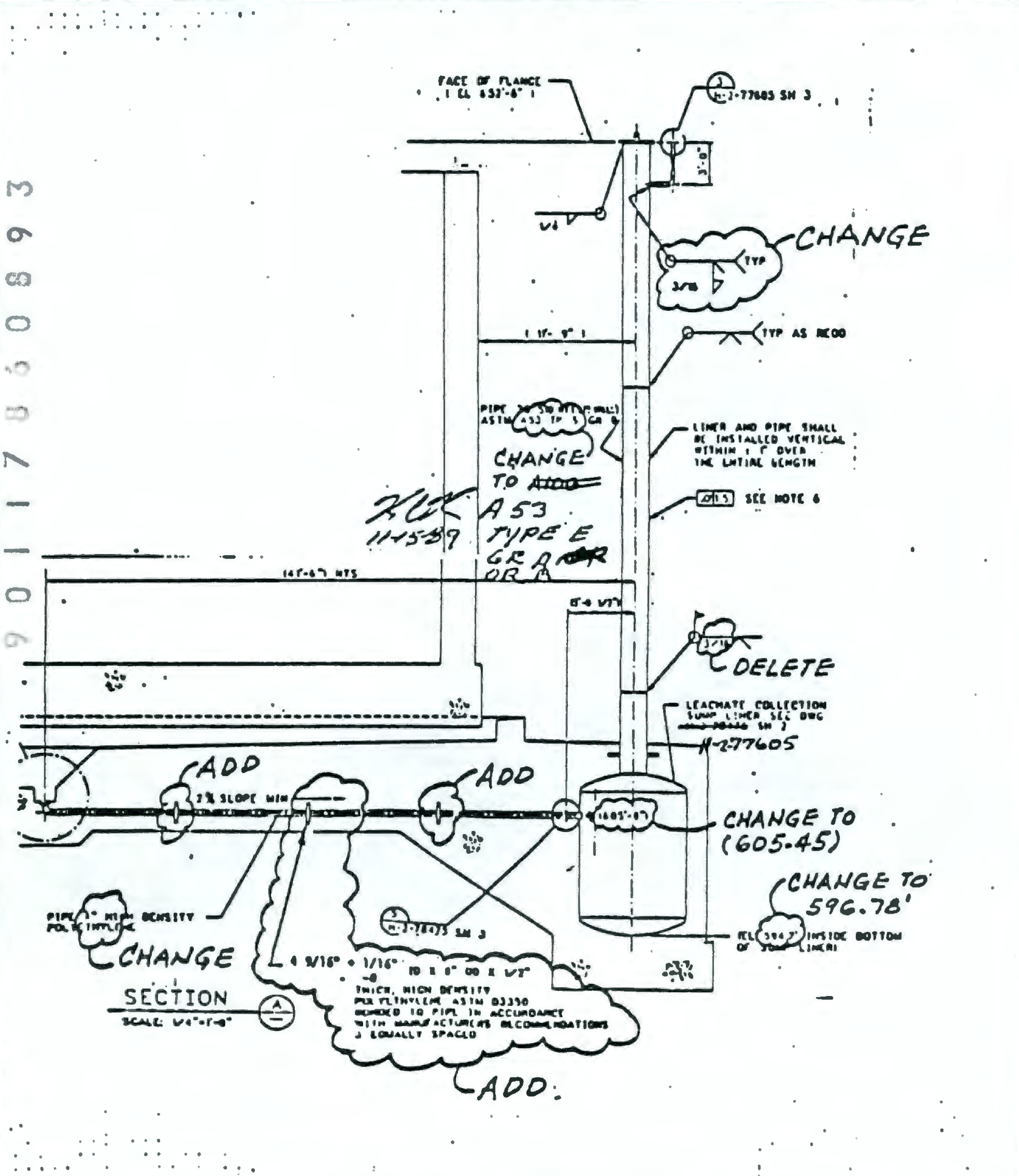
ENGINEERING CHANGE NOTICE SKETCH

Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77605	1	0	DK MILTON	[signature]	B-714-18	24



DETAIL 2
SCALE: 1 1/2"=1'-0"

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77605	1	0	DK MILTON	[signature]	B-714-18	25/



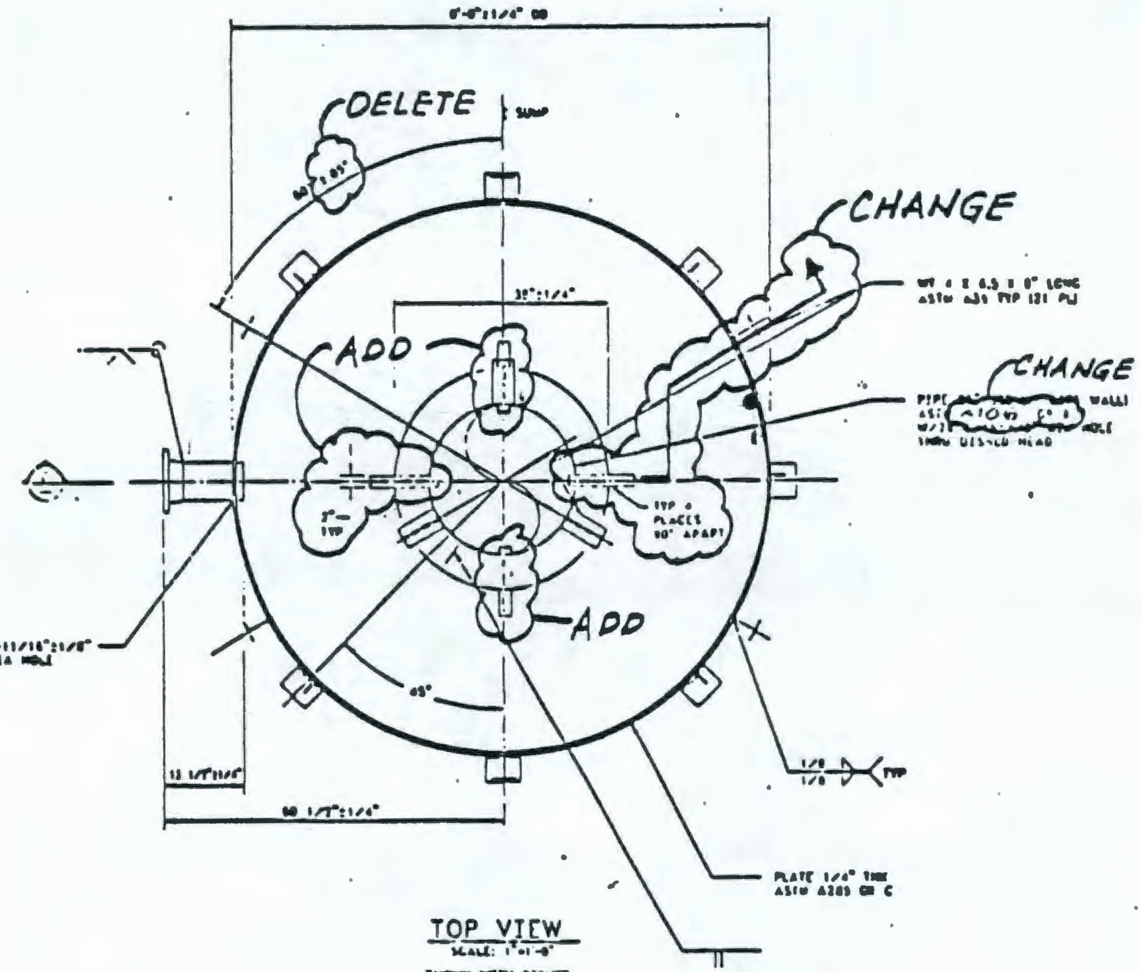
9 3 1 1 7 8 5 0 8 9 3

KEH-0159 00 (1/88)

Contract KEH-5162
Change Order 6

DOE/RL 88-27
Rev. 1, 01/17/90

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH				
Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77605	2	0	DK MILTON	[signature]	B-714-18	26

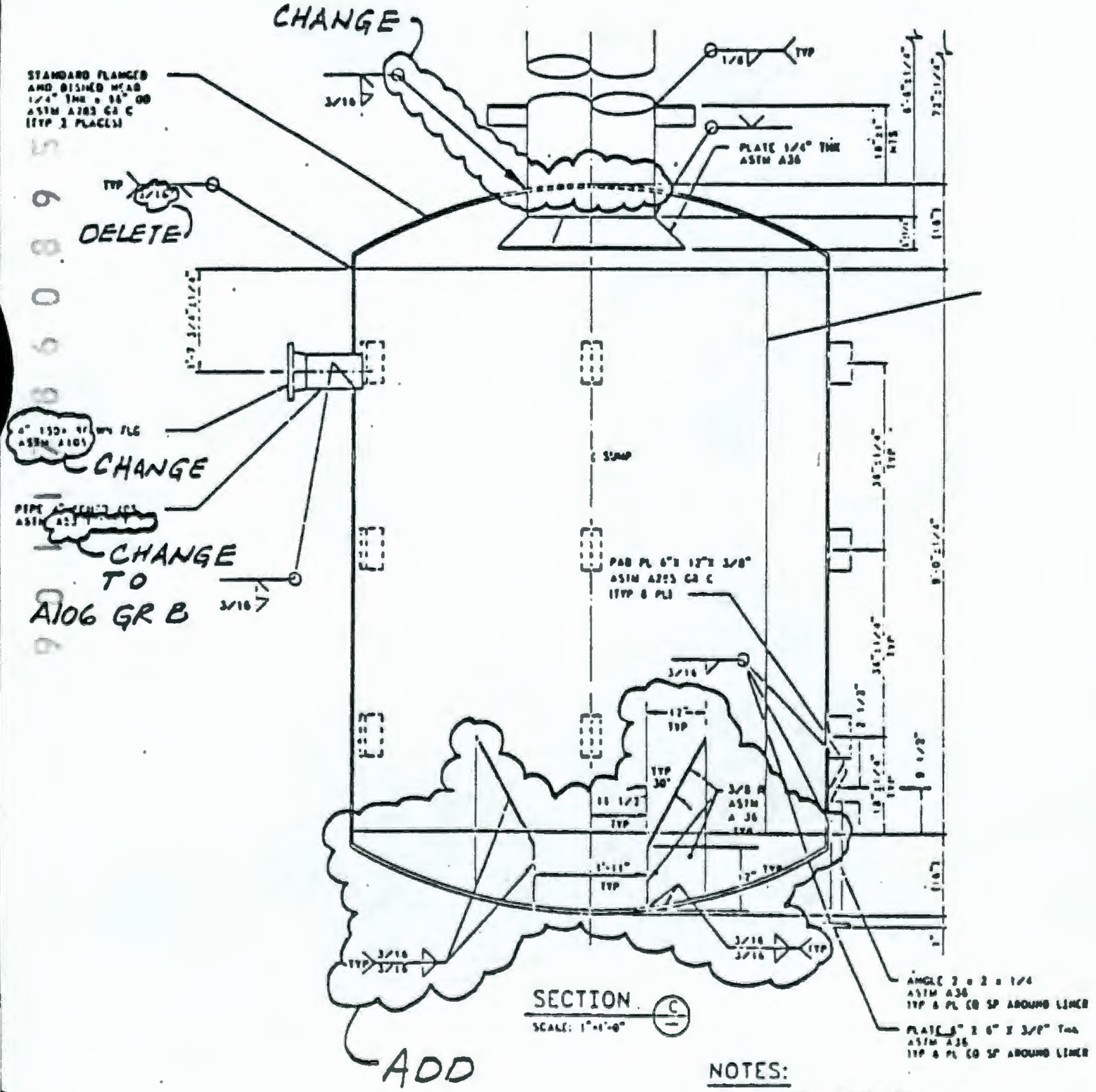


TOP VIEW

KEH-0159.00 (1/88)

901178508 94

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg. H-2-77605	**Sh.** 2	**Rev.** 0	**Prepared By** DK MILTON	**Checked By** [signature]	**ECN No.** B-714-18	**Page** 27/



SECTION (C)
SCALE: 1"=1'-0"

NOTES:

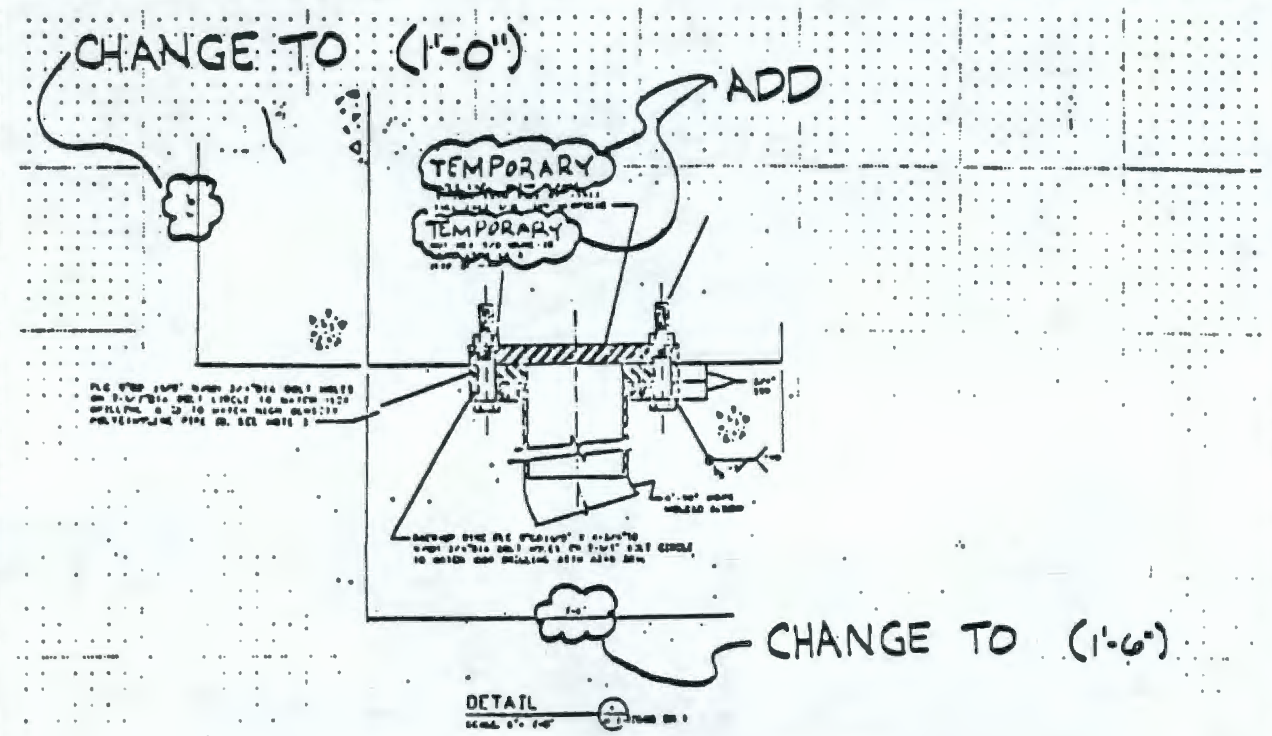
1. FOR GENERAL NOTES SEE SH 1.
2. APPROXIMATE DRY WEIGHT = 4300 LB

KEH-0159.00 (1/88)

Contract KEH-0102
Change Order 6

DOE/RL 88-27
Rev. 1, 01/17/90

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77605	3	0	DJKOLAR	DK MILTON	B-714-18	28



NOTES:

1. FOR GENERAL NOTES, SEE SH 1
2. INSTALL HIGH DENSITY POLYETHYLENE PIPE ASTM D3350 TO PIPE IN ACCORDANCE WITH MANUFACTURE RECOMMENDATIONS.
3. INSTALL BLIND FLANGE DUST COVER DURING CONCRETE POUR. REMOVE AND REPLACE WITH DRAINAGE PIPE.

KEH-0159.00 (1/88)

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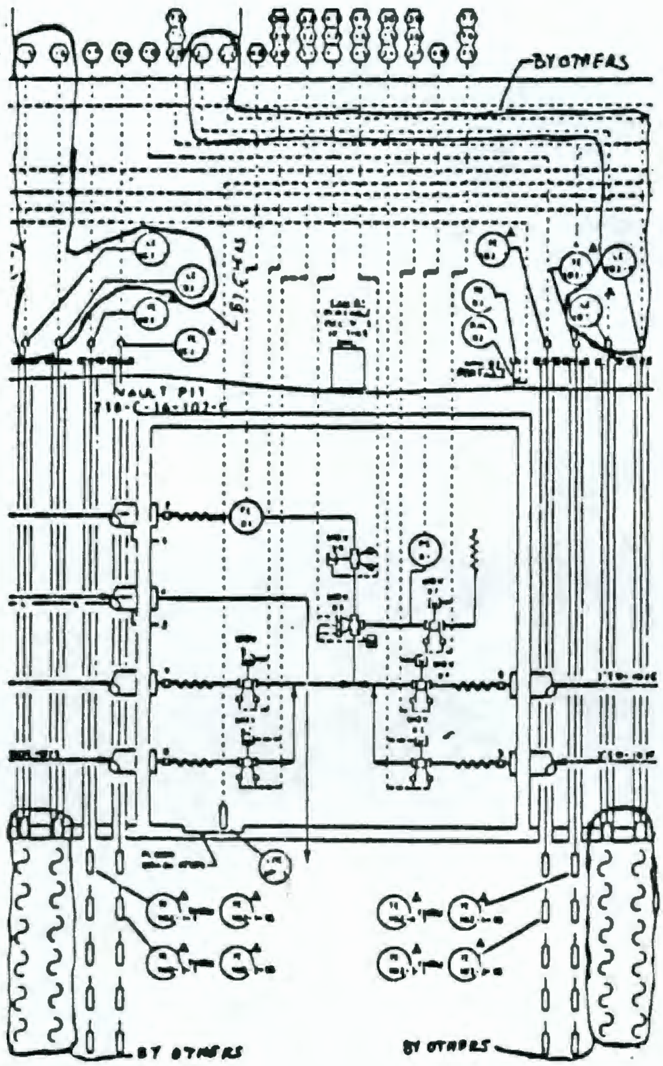
Contract KEH-5162
Change Order 6

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH				
Ref. Dwg. H-2-77618	Sh. 4	Rev. 0	Prepared By HJ STEFFENS	Checked By [signature] 11/2/89	ECN No. B-714-18	Page 24/

1. REPLACE CAPACITANCE LEVEL SYSTEM WITH ULTRASONIC SYSTEM AND LABEL THAT IT IS "BY OTHERS" AS SHOWN BELOW.

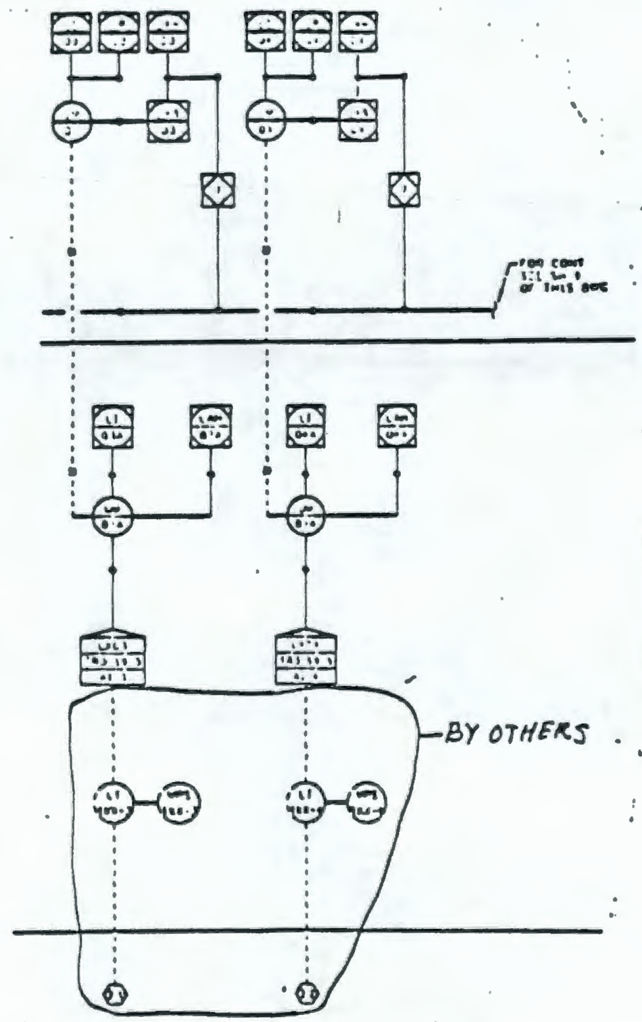
9 0 1 1 7 8 5 0 8 9 7



KEH-0159.00 (1/88)

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH				
Ref. Dwg. H-2-77618	Sh. 8	Rev. 0	Prepared By HJ STEFFENS	Checked By 11/2/89	ECN No 8-714-18	Page 30/

1. CIRCLE THE LEVEL TRANSMITTERS LT-1XX-3 AND LT-1XX-4 AND CONNECTION TO THE PIH AS BEING "BY OTHERS."



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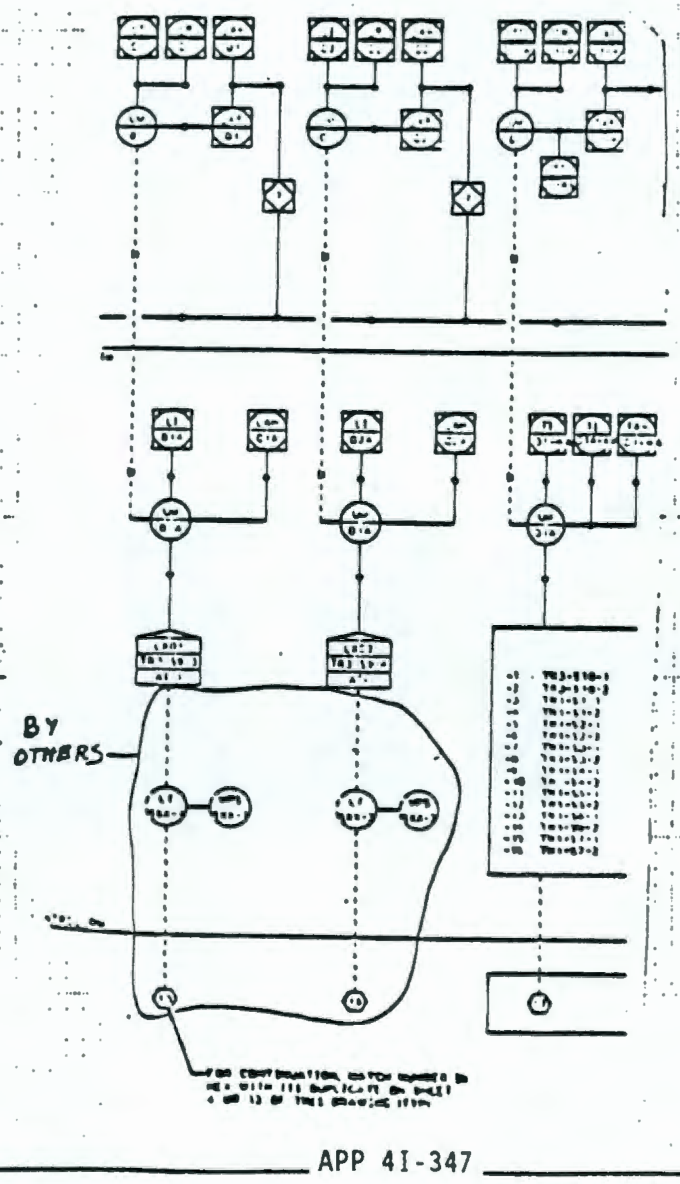
KEH-0159.00 (1/88)

Contract KEH-5162
Change Order 6

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77618	8	0	HJ STEFFENS	11/2/89 [signature]	B-714-18	31

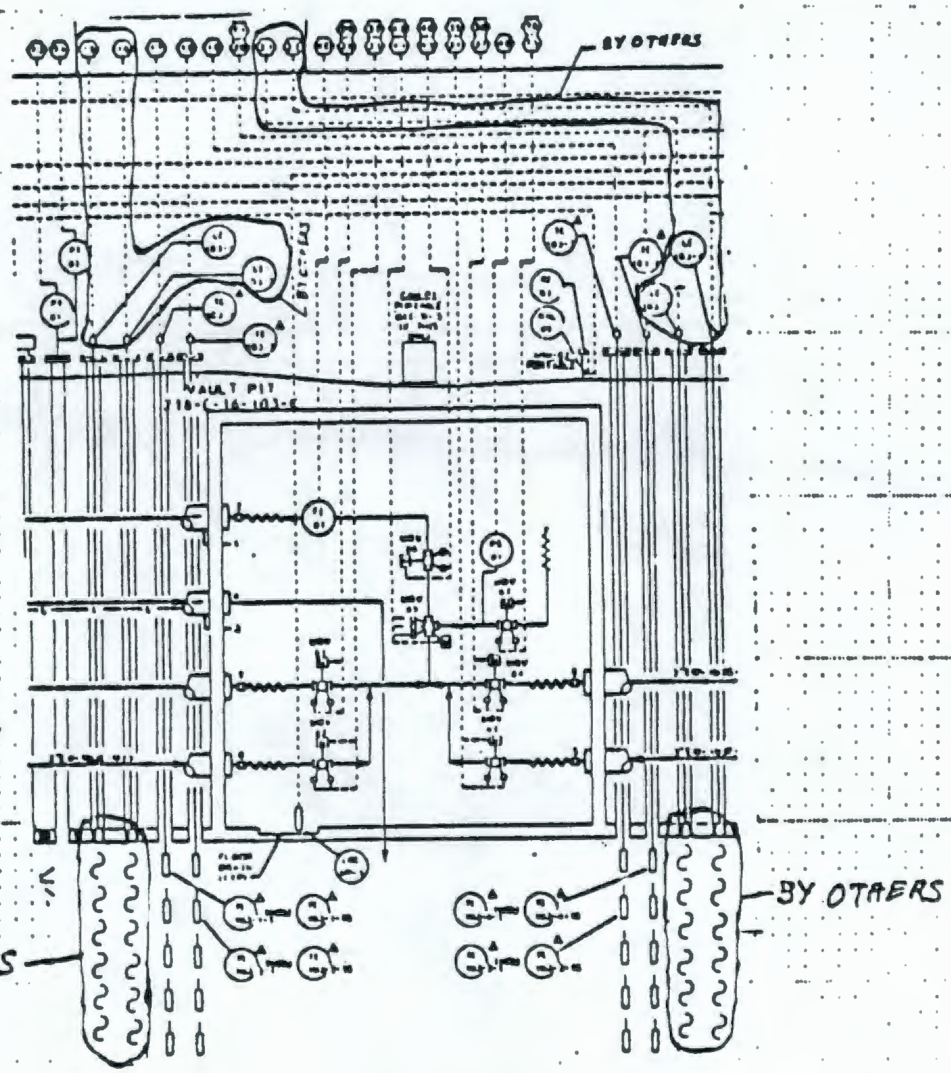
1. CIRCLE THE LEVEL TRANSMITTERS LT-1XX-1 AND LT-1XX-2 AND CONNECTIONS TO THE PIH AS BEING "BY OTHERS".



KEH-0159.00 (1/88)

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg. H-2-77618	Sh. 12	Rev. 0	Prepared By HJSTEFFENS	Checked By [signature] 11/4/87	ECN No. B-714-18	Page 32

1. REPLACE CAPACITANCE LEVEL SYSTEM WITH ULTRASONIC SYSTEM AND LABEL THAT IT IS "BY OTHERS" AS SHOWN BELOW



KEH-0159.00 (1/88)

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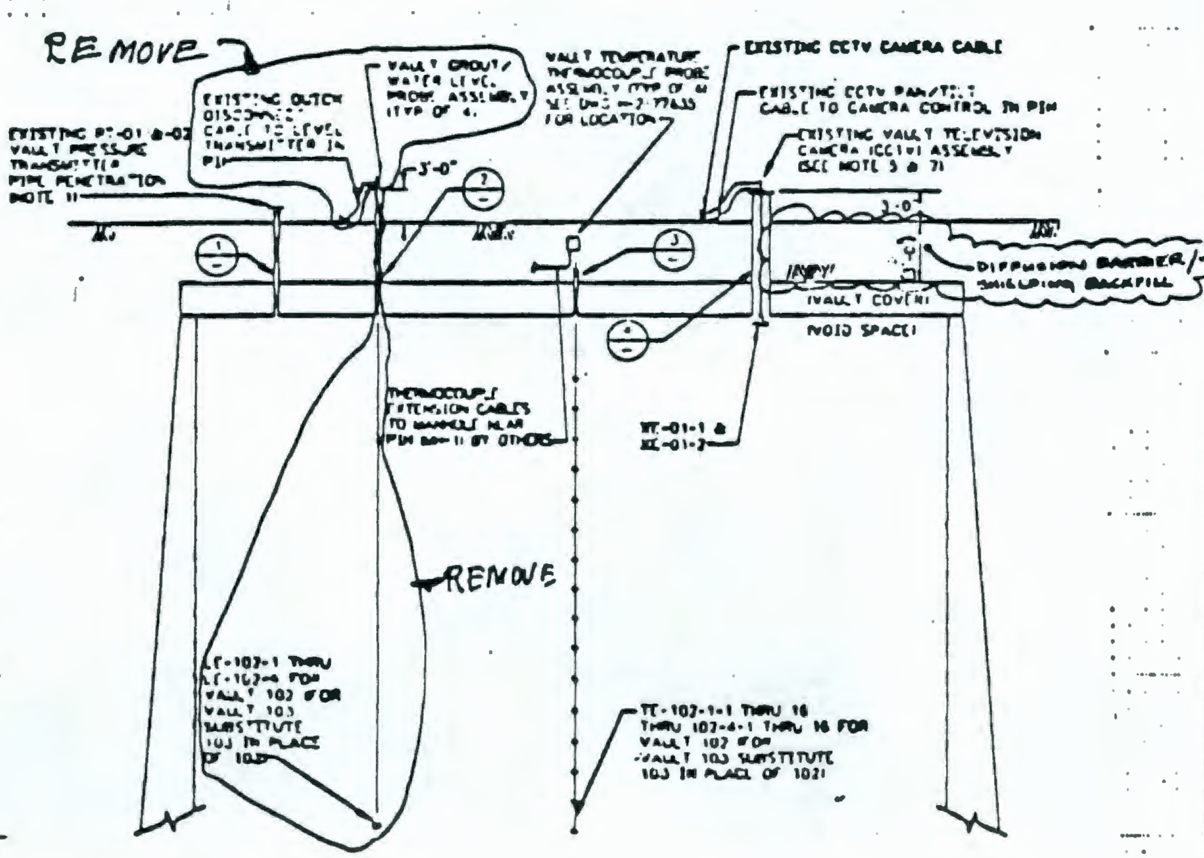
Contract KEH-5162
Change Order 6

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH				
Ref. Dwg. H-2-77619	**Sh.** 1	**Rev.** 0	**Prepared By** HJ STEFFENS	**Checked By** R. [signature] 11/2/89	**ECN No.** B-714-18

Page 33/

1. REMOVE THE 4 LEVEL PROBE ASSEMBLIES AND ASSOCIATED CABLES AND CONNECTORS AS OUTLINED BELOW.



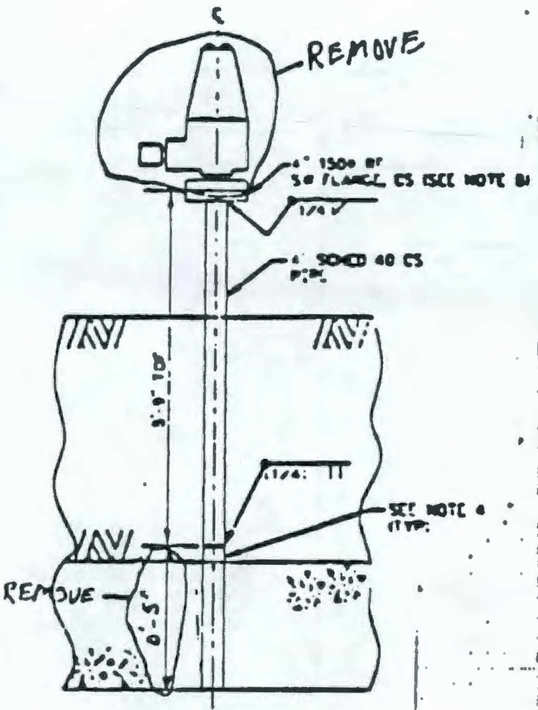
VAULT SECTION (A)
SCALE 3/16 = 1-0
SEE NOTE 2

KEH-0159 00 (1/88)

KAISER ENGINEERS HANFORD | **ENGINEERING CHANGE NOTICE SKETCH**

Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77619	1	0	AJSTEFFENS	[signature] 11/2/89	B-714-18	34/

1. REMOVE THE DIMENSION OF THE RISER STUB IN THE ROOF. ZD6.
2. REMOVE THE LEVEL PROBE HEAD AND FLANGE ASSEMBLY.
3. CHANGE THE SHEET NUMBERING FROM 1 OF 2 TO 1 OF 1.
4. VOID SHEET 2 OF 2 OF H-2-77619.



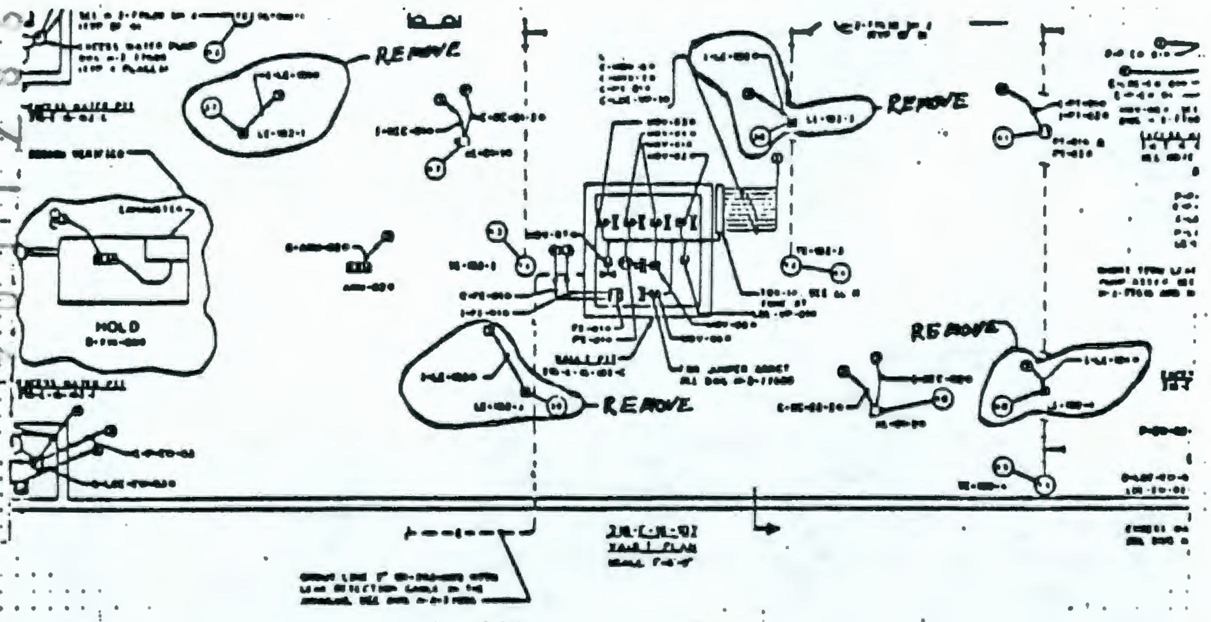
DETAIL 2
SCALE 3/4"=1'-0
LEVEL PROBE PENETRATION RISER

KEH-0159 00 (1/88)

Contract KEH-5162
Change Order 6

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg. H-2-77635	Sh. 1	Rev. 0	Prepared By HJ STEFFENS	Checked By [signature] 11/2/92	ECN No. B-714-18	Page 35/

1. REMOVE FROM THE 218-E-102 VAULT PLAN THE 4 LEVEL ELEMENTS SHOWN CIRCLED



KEH-0159 00 (1/88)

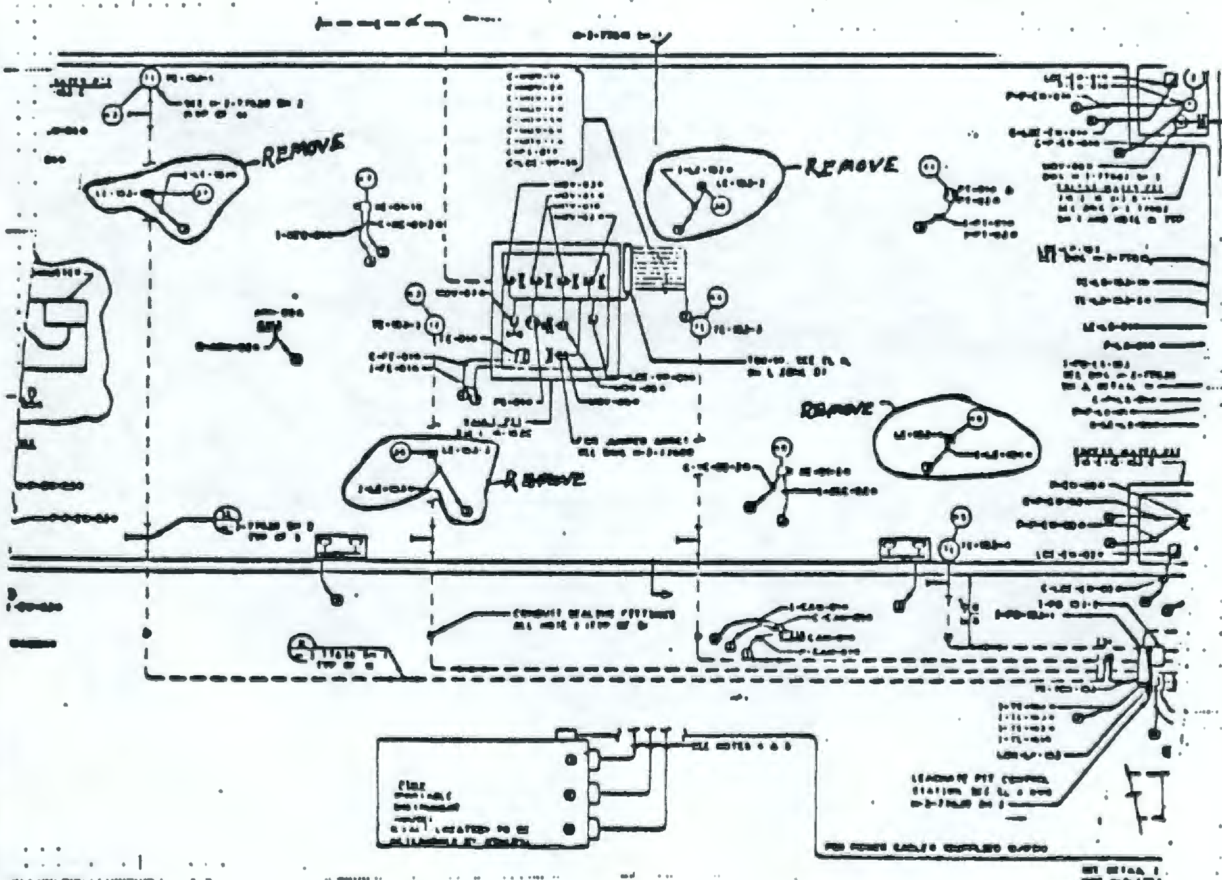
Contract KEH-5162
Change Order 6

KAISER ENGINEERS
HANFORD

ENGINEERING CHANGE NOTICE SKETCH

Ref. Dwg.	Sh	Rev.	Prepared By	Checked By	ECN No	Page
H-2-77635	2	0	HJ STEFFENS	R [signature] 11/4/87	8-714-18	34/

1. REMOVE FROM THE 218-E-103 VAULT PLAN THE 4 LEVEL ELEMENTS SHOWN CIRCLED.



ENGINEERING CHANGE NOTICE CONTINUATION SHEET — Page 37 of ___ — 1. ECN B-714-18

CHANGES TO SPECIFICATION B-714-C2

1) TABLE OF CONTENTS, DIVISION 2-SITEWORK

Change Waste Disposal Basin Liners to read Catch Basin Liners

2) SECTION 01010

Para 1.2.2.9: Change to read Leachate Detection Collection and Removal System (LDCRS)

3) SECTION 01050

Para 1.3.2: Change 3 month to read 3 week

4) SECTION 01300, Para 1.3: SUBMITTALS SECTION 02755

page 5 & 6: Change WASTE DISPOSAL BASIN LINER to read CATCH BASIN LINERS

5) SECTION 01400, Para 1.7 (Reference ECN B-714-9, pg 7)

Change Waste Disposal Basin Liners to read Catch Basin Liners

6) SECTION 02145 (Reference ECN B-714-8)

A) Para 1.1.1.1: Remove E 11-87 Standard Specification for Wire-Cloth Sieves for Testing Purposes

B) Para 1.1.1.1: Add C 136-84a Standard Method for Sieve Analysis of Fine and Coarse Aggregates

D 4751-87 Standard Test Method for Determining the Apparent Opening Size of a Geotextile

C) Para 1.2.2: Change "Paragraph 2.1.3" to read "Paragraph 2.1.4" in last sentence

D) Replace/Add the following paragraphs:

1.3.2 Geotextile

1.3.2.1 During shipment and storage, wrap geotextile in heavy-duty protective covering to prevent damage and exposure to ultraviolet light. Examine geotextile delivered to Site for damage. Damaged geotextile shall be set aside and not used. Removal of material identification labels from rolls will be accomplished by KEH only.

1.3.2.2 Store geotextile materials in original unopened packaging. Storage area shall protect geotextile from mud, soil, dust, debris, ultraviolet light, heavy winds, temperature extremes, and precipitation.

A-7320-036.2 (11-88)

9 0 1 1 7 8 5 0 9 9 5

ENGINEERING CHANGE NOTICE CONTINUATION SHEET Page 38 of ___	1. ECN B-714-18

CHANGES TO SPECIFICATION B-714-C2, SECTION 02145 CONTINUED

1.3.2.3 If geotextile is temporarily stored outdoors, place on pallet and protect from direct rays of sun under light colored heat-reflective opaque cover to provide free air flowing space between materials and cover.

1.3.2.4 Handle geotextile to ensure sound, undamaged condition.

E) Para 2.1.1.2: Add "in accordance with ASTM C 136" after Grading and quality

F) Para 2.1.4: Change Equivalent Opening Size ----- ASTM E 11 (EOS), US Sieve
to read Apparent Opening Size ----- ASTM D 4751 (AOS), US Sieve

G) Add new Para 3.5.4:

3.5.4 Samples: KEH will collect minimum 2 geotextile samples from different rolls, full roll width at least 5 foot long, from each lot.

7) SECTION 02753

A) Para 1.1.1.1: Delete D 1593, D 638, D 792, D 746, D 1004 in their entirety

Add D 4716-87 Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products

B) Para 1.2.3: Delete "and membrane"

C) Para 1.2.5, 1.3.3.2, and 1.4.1: Delete in their entirety

D) Replace Article 1.3 with the following paragraphs:

1.3 DELIVERY, STORAGE AND HANDLING

1.3.1 Pack rolls wrapped with sheet of same material in containers supported and padded to prevent damage during shipment. Pack containers for minimum handling at site. Provide label for each roll showing results of tests in subparagraph 2.1.1.2 and stating name of manufacturer, product type, thickness, manufacturers batch code, date of manufacture, and physical dimensions. Roll labels will be removed by KEH only.

1.3.2 Examine materials delivered to Site for:

1.3.2.1 Tears from operation of equipment or inadequate packaging.

9 0 1 1 7 8 5 0 9 0 7

ENGINEERING CHANGE NOTICE CONTINUATION SHEET Page 39 of __	1. ECN B-714-18

CHANGES TO SPECIFICATION B-714-C2, SECTION 02753 CONTINUED

1.3.2.2 Exposure to temperature extremes resulting in unusable materials.

1.3.2.3 Bonding together of adjacent layers caused by excessive heat.

1.3.2.4 Crumpling or tearing from inadequate packaging support.

1.3.3 Unload and store with minimum handling.

1.3.4 Store materials off ground on padded dunnage in secure area sheltered from mud, soil, dirt, debris, adverse weather, precipitation, ultraviolet light, heavy winds, and temperature extremes.

E) Delete para 2.1.1.1, 2.1.1.2 and 2.1.1.3

F) Para 2.1.1: Change HDPE Membrane to read High Density Polyethylene (HDPE) Membrane: See Section 02755, except execution shall be in accordance with this Section.

G) Para 2.1.2.1: Add to end of table

Transmissivity (m^2/sec)	ASTM D 4716	0.002*

*Normal stresses of 2000 PSF, Hydraulic gradient of 0.25.

H) Para 3.1.1: Change "sheet" to read "material"

J) Para 3.2.1: Change "handling" to read "handling or repairing"

K) Para 3.2.4.1: Add to the beginning of paragraph:

Make repair welds using extrudate with composition identical to sheeting material.

L) Replace Article 3.3 with the following:

3.3 FIELD QUALITY CONTROL

3.3.1 Nondestructive Seam Testing

3.3.1.1 Test welds in their entirety using vacumm box.

3.3.1.2 Vacuum test for welded repairs

a. Equipment: Aluminum frame box with calibrated vacuum gage on frame, fitted with sponge gasket on bottom, sealed with transparent Plexiglass top, and connected to vacuum pump.

A-7320-036.2 (11-88)

9 0 1 1 7 3 6 0 9 0 8

ENGINEERING CHANGE NOTICE CONTINUATION SHEET	Page 40 of ___	1. ECN B-714-18

CHANGES TO SPECIFICATION B-714-C2, SECTION 02753 CONTINUED

b. Test: Spread soap solution over seam, press box down over seam, and apply 10 inches Hg vacuum, plus or minus 2 inches, for minimum 15 seconds to each portion of seam. If defect is present, bubble will form and indicate area of repair. Test seams and repairs in their entirety.

3.3.1.3 KEH will observe testing and review results.

3.3.2 Destructive Seam Testing

3.3.2.1 Preparation: Obtain samples of field seams at beginning and end of each work day, and at 1 or more intervals during day if seaming conditions have been altered.

a. Use 10 foot long test weld from each welding machine, and mark with date, ambient temperature, and machine number.

b. Cut test weld in 2 parts, keeping 1/2 for testing and deliver remaining half to KEH.

3.3.2.2 Tests: Test samples for bonded seam strength in accordance with ASTM D 3083, and for peel adhesion in accordance with ASTM D 413.

3.3.3 Documentation

3.3.3.1 Certify test results.

3.3.3.2 Deliver documentation to KEH within 7 working days.

3.3.4 Final Examination and Acceptance

3.3.4.1 Measure overlap of seams and verify no damage has occurred to membrane.

3.3.4.2 Prepare record drawings showing field changes and repairs.

3.3.4.3 Deliver record drawings to KEH within 10 working days after completion of membrane installation.

3.3.5 Sampling: KEH will take 2 randomly selected samples for each type of drainage net supplied. Samples will be 3 feet long by full roll width.

8) SECTION 02755

A) Change title to read CATCH BASIN LINERS

B) Add to end of Para 1.3.2:

Provide qualifications of key personnel including superintendent and foreman.

A-7320-036.2 (11-88)

ENGINEERING CHANGE NOTICE CONTINUATION SHEET	Page 41 of ___	1. ECN B-714-18

CHANGES TO SPECIFICATION B-714-C2, SECTION 02755 CONTINUED

C) Para 3.2.3: Add to end of paragraph

Seams in the collection trench shall be kept to a minimum.

D) Renumber para 3.2.4.1 and 3.2.5 to 3.2.5 and 3.2.6

E) Add new para as follows:

3.2.5.1 Repair seam defects revealed by nondestructive testing. Retest until seam passes.

F) Para 3.3.2.1.b: Change to read as follows:

Take 4 lineal feet of welded seam samples by 1'-6" wide from installed welded sheeting at rate of 1 sample for each seaming crew for each day.

G) Para 3.3.2.2: Change to read as follows:

Have equipment to perform bonded seam strength and peel adhesion in field.

H) Add new para as follows:

3.3.2.3 Tests: Test samples for bonded seam strength in accordance with ASTM D 3083. Minimum elongation at break shall be 30 percent. Test samples for peel adhesion is accordance with ASTM D 413. Peel strength shall be greater than 60 percent of manufacturer specified mimimum yield strength of parent material.

9) SECTION 02756

A) Para 1.1.1.2: Delete E 11-87 Standard Specification for Wire-Cloth Sieves for Testing Purposes

D 4491 Standard Test Methods for Water Permeability of Geotextiles by Perittivity

B) Para 1.1.1.2: Add D 4751-87 Standard Test Method for Determining Apparent Opening Size of a Geotextile

C) Para 1.4.1.2: Add to end of para

Identification labels will be removed only by KEH.

D) Para 2.1.1: Remove Coefficient of Water Permeability (cm/sec) ASTM D 4491 0.2

ENGINEERING CHANGE NOTICE CONTINUATION SHEET	Page 42 of __	1. ECN B-714-18

CHANGES TO SPECIFICATION B-714-C2, SECTION 02756 CONTINUED

E) Para 2.1.1: Change	Equivalent Opening Size (EOS), US Sieve	ASTM E 11
to read	Apparent Opening Size (AOS), US Sieve	ASTM D 4751

F) Add new Para 3.3.2

3.3.2 Samples: KEH will collect minimum 2 geotextile samples from different rolls, full roll width at least 5 foot long, from each lot.

10) SECTION 03301

A) Para 1.1.1.2: Add the following references

C 311-87 Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete

C 920-86 Standard Specification for Elastometric Joint Sealants

B) Renumber para 1.1.1.4 and 1.1.1.5 to 1.1.1.5 and 1.1.1.6, respectively

C) Add new para as follows:

1.1.1.4	Federal Specification (FS) TT-S-00230C, Including AMD 2	Sealing Compound: Elastometric Type, Single Component (For Calking, Sealing And Glazing In Buildings And Other Structures)

D) Add new subparagraph to subpara 1.2.4.3 as follows:

d. Pozzolan: Tested in accordance with ASTM C 311.

E) Para 2.1.2.5.a: Change 4000 psi to 4500 psi

F) Para 2.1.2.5.b: Change 2-4 inches to 3-5 inches

G) Para 2.1.2.5.d: Change 0.42 maximum to 0.41 maximum

H) Replace/Add 2.1.5 as follows:

2.1.5 Bonding Agents

2.1.5.1 Concrete: Meeting the requirements of ASTM C 392.

2.1.5.2 Neoprene: Urethane meeting TT-S-00230C, Type II, Class A, ASTM C 920-86, Type S, Grade NS, Class 25.

A-7320-036.2 (11-88)

9011785 0910

ENGINEERING CHANGE NOTICE CONTINUATION SHEET	Page 43 of ___	1. ECN B-714-18

CHANGES TO SPECIFICATION B-714-C2, SECTION 03301 CONTINUED

J) Add new paragraph as follows:

2.1.9 Neoprene Bearing Pad: Solid neoprene sheeting meeting the requirements of ASTM D 2000, Durometer Hardness 50, Type BC.

K) Para 2.2.4.2: Change 15 percent to read 20 percent

L) Para 2.3.1.1: Change to read as follows:

Take two 50 pound samples for each 200 tons for sieve analysis of fine aggregate sand and specific gravity tests. Sampling may be reduced to 1 when test results show fine aggregates consistently meet specified requirements. Additional samples shall be taken when analyses show deficiencies, unacceptable variances, or deviations. Take samples of sand when sand is moist.

11) SECTION 09885

Para 1.3.2: Add to end the following

Provide qualifications of key personnel including superintendent and forman.

12) SECTION 13440

Data Sheet Y-102, Note 3: Change 10 years to read 30 years

A-7320-036 2 (11-88)

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ENGINEERING CHANGE NOTICE

Page 1 of 24

1. ECN 116336
Proj. ECN B-714-19

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

3. Originator's Name, Organization, MSIN, and Telephone No.: TERESA EHRHARD, KEH, TC3C, 6-2381

4. Date: 11-27-89

5. Project Title/No./Work Order No.: SEE BLOCK 12

6. Bldg./Sys./Fac. No.: SEE BLOCK 12

7. Impact Level: 2

8. Document Number Affected (include rev. and sheet no.): SEE BLOCK 12

9. Related ECN No(s).: SEE BLOCK 12

10. Related PO No.: N/A

11a. Modification Work: [ ] Yes (fill out Blk. 11b) [ ] No (NA Blks. 11b, 11c, 11d) UNK

11b. Work Package Doc. No.: UNK

11c. Complete Installation Work: Cog. Engineer Signature & Date

11d. Complete Restoration (Temp. ECN only): Cog. Engineer Signature & Date

12. Description of Change

BLOCK 5: B-714, GROUT VAULT PAIR (218-E-16-102 & 103) (218-E-16-104 & 105) /ER8007
BLOCK 6: 218-E-16-102 & 103 and 218-E-16-104 & 105

BLOCK 8: AFFECTED DRAWINGS

VAULT -102 & -103: H-2-77575, SH 2, REV 1
H-2-77576, SH 1, REV 0
H-2-77578, SH 1, REV 0

VAULT -104 & -105: H-2-78446, SH 2, REV 0
H-2-78447, SH 1, REV 0
H-2-78448, SH 1, REV 0

AFFECTED SPECIFICATION B-714-C2, REV 0 (V-B714C2-003, REV 0)

See page 4 and 15 thru 24

BLOCK 9: RELATED ECNs

B-714-8
B-714-9
B-714-10
B-714-18

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

13b. Justification Details

DIFFUSION BARRIER MODIFICATIONS
(REF:
a-WHC Ltr 8955536, SR BRIGGS to NM HUTCHINS, Sept 19, 1989
b-WHC Ltr 8956689, SR BRIGGS to NM HUTCHINS, undated)

Contract KEH-5162
Change Order 7

Signature	Date	Signature	Date
OPERATIONS AND ENGINEERING		ARCHITECT-ENGINEER	
Cog./Project Engineer [signature]	12/1/89	PE [signature] L.A. Gaddis	11/30/89
Cog./Project Engr. Mgr [signature]	12/1/89	QA T.D. [signature]	12/1/89
QA [signature]	12-1-89	Safety [signature]	11-30-89
Safety [signature]	12-1-89	Design [signature]	11/30/89
Security		Other	
Proj.Prog./Dept. Mgr.		ENVIR- [signature]	12-1-89
Def. React. Div.		SPECS- [signature]	12-1-89
Chem. Proc. Div.			
Def. Wst. Mgmt. Div. for W J Powell	12/4/89 (TSD am)	DEPARTMENT OF ENERGY for Implementation	
Adv. React. Dev. Div		[signature] (Approved via C.R. B-714-006) 12/4/89	10/26/89
Proj. Dept.			
Environ. Div.		ADDITIONAL	
IRM Dept.			
Facility Rep. (Ops)			
Other [signature] - PNL	12/4/89		

A-7900-613R (11/88)

ENGINEERING CHANGE NOTICE CONTINUATION SHEET Page 3 of 24	1. ECN B-714-19

CHANGES TO CIVIL DRAWINGS

VAULTS -102 & 103

1) ECN B-714-10, PG 6
VOID page 6 in its entirety.

2) H-2-77575, SH 2, REV 1
a) EXCAVATION PLAN (ZE7): Modify - see page 5 of this ECN.
b) SECTION A (ZE3-5): Modify - see page 7 of this ECN.
c) SECTION B (ZD3-4): Modify - see page 8 of this ECN.
d) SECTION C (ZB3-C6): Modify - see page 9 of this ECN.
e) SECTION D: Add - see page 10 of this ECN.
f) DETAIL 1 (ZD1-2): Modify - see page 10 of this ECN.

3) H-2-77576, SH 1, REV 0
a) PLAN (ZD6): Modify - see page 11 of this ECN.
b) SECTION A (ZE3-4): Modify - see page 12 of this ECN.
c) SECTION B (ZF1-2): Modify - see page 12 of this ECN.
d) SECTION D (ZD1-2): Modify - see page 13 of this ECN.
e) SECTION E (ZB3-4): Modify - see page 13 of this ECN.

4) H-2-77578, SH 1, REV 0
SECTION A (ZB5-7): Modify - see page 14 of this ECN.

VAULTS -104 & 105

5) H-2-78446, SH 2, REV 0
a) EXCAVATION PLAN (ZD7): Modify - see page 6 of this ECN.
b) SECTION A (ZE3-5): Modify - see page 7 of this ECN.
c) SECTION B (ZD3-4): Modify - see page 8 of this ECN.
d) SECTION C (ZB3-C5): Modify - see page 9 of this ECN.
e) SECTION D: Add - see page 10 of this ECN.
f) DETAIL 1 (ZD1-2): Modify - see page 10 of this ECN.

6) H-2-78447, SH 1, REV 0
a) PLAN (D6-7, C7): Modify - see page 11 of this ECN.
b) SECTION A (ZE4): Modify - see page 12 of this ECN.
c) SECTION B (ZE2-3): Modify - see page 12 of this ECN.
d) SECTION D (D1-2): Modify - see page 13 of this ECN.
e) SECTION E (ZB3-4): Modify - see page 13 of this ECN.

7) H-2-78448, SH 1, REV 0
a) SECTION A (ZB2-5): Modify - see page 14 of this ECN.
b) SECTION B (ZE2, E4): Delete reference Types 1 thru 3 and Diffusion Barrier Types in both zones

ENGINEERING CHANGE NOTICE CONTINUATION SHEET Page 4 of 24 | 1. ECN B-714-19

CHANGES TO SPECIFICATION B-714-C2, REV 0

1) SECTION 01300, para 1.3, SCHEDULE OF SUBMITTALS (page 4)

ADD: 02145/1.2.7	Log of Barrier Placement	10	--	7 days after placement

2) ECN B-714-9, pg 6 (Ref SECTION 01400, para 1.7, SITEWORK, Diffusion Barrier)

ADD the following line below Off-Site* :

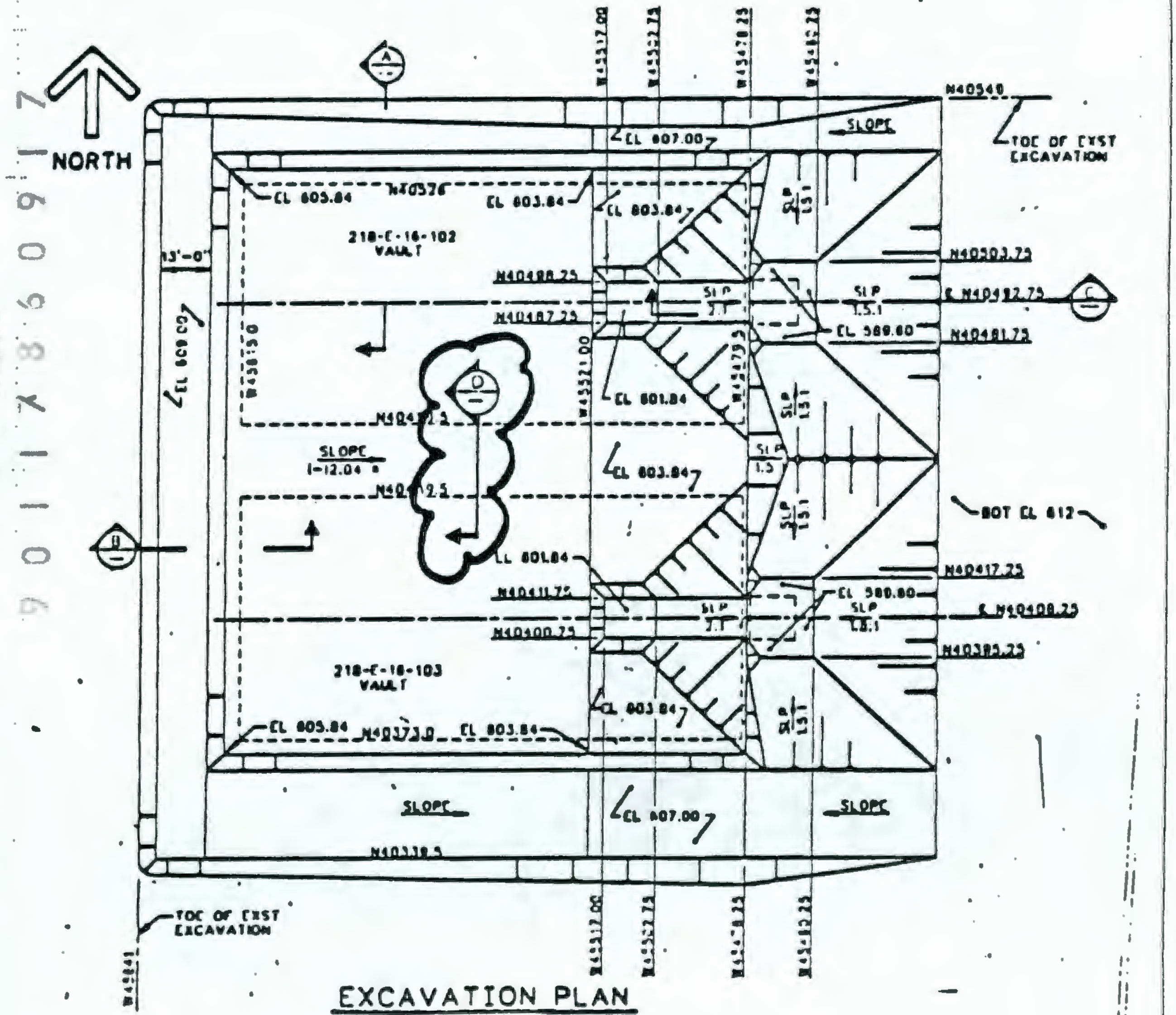
H - Initial mixing of aggregate with hydrated lime

3) ECN B-714-8 (Ref SECTION 02145)

VOID in its entirety. REPLACE with modified SECTION 02145 attached pages 15 thru 24 of this ECN. (ECN B-714-18, SECTION 02145, incorporated in this modification)

A-7320-036.2 (11-88)

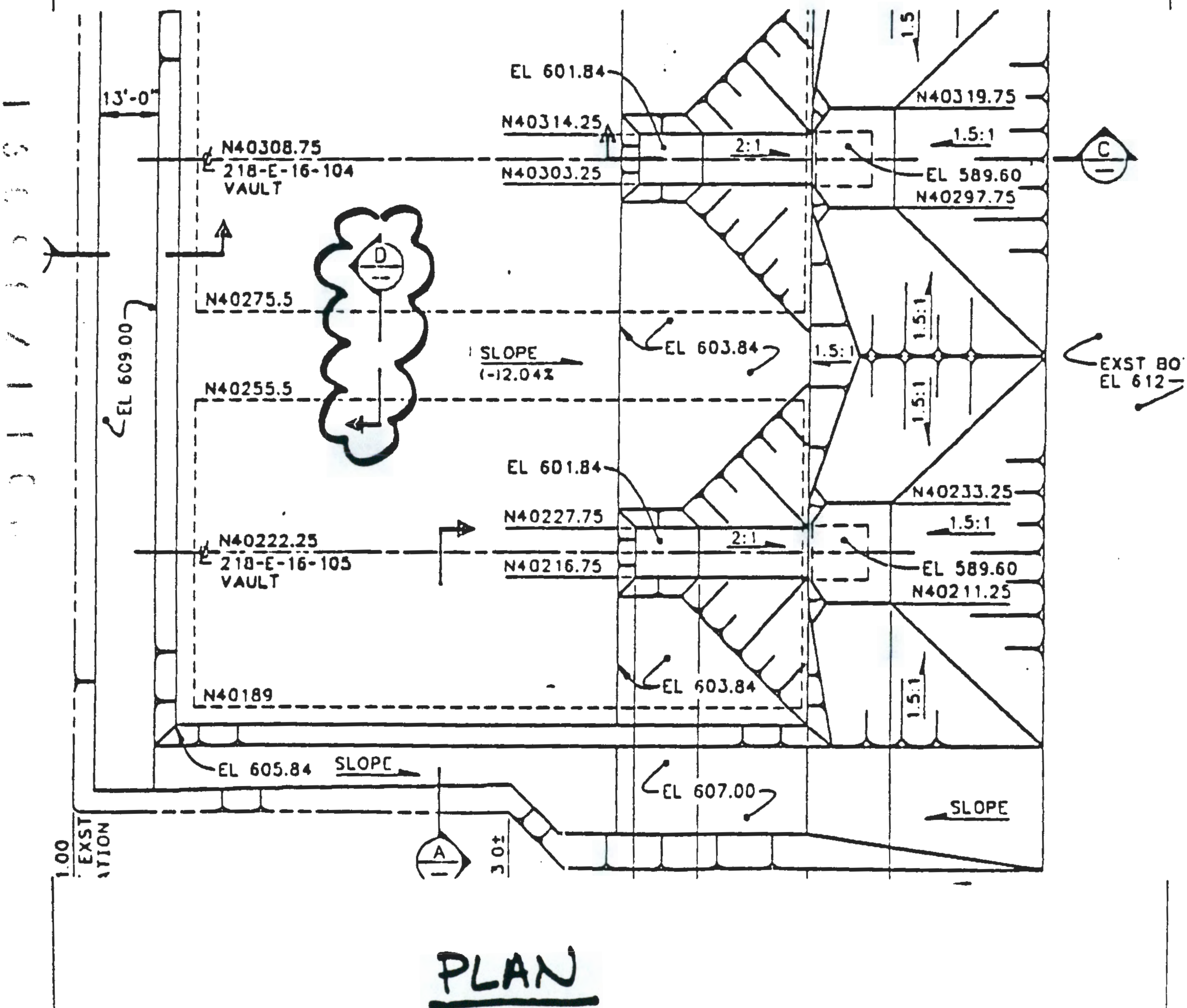
KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg. H-2-77575	Sh. 2	Rev. 1	Prepared By TERESA EHRHARD	Checked By MD STINE	ECN No. B-714-19	Page 5/24



EXCAVATION PLAN
SCALE 1"=20'

KEH-0159.00 (1/88)

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH				
Ref. Dwg. H-2-78446	Sh. 2	Rev. 0	Prepared By TERESA EHRHARD	Checked By MD STINE	ECN No. B-714-19	Page 6/24

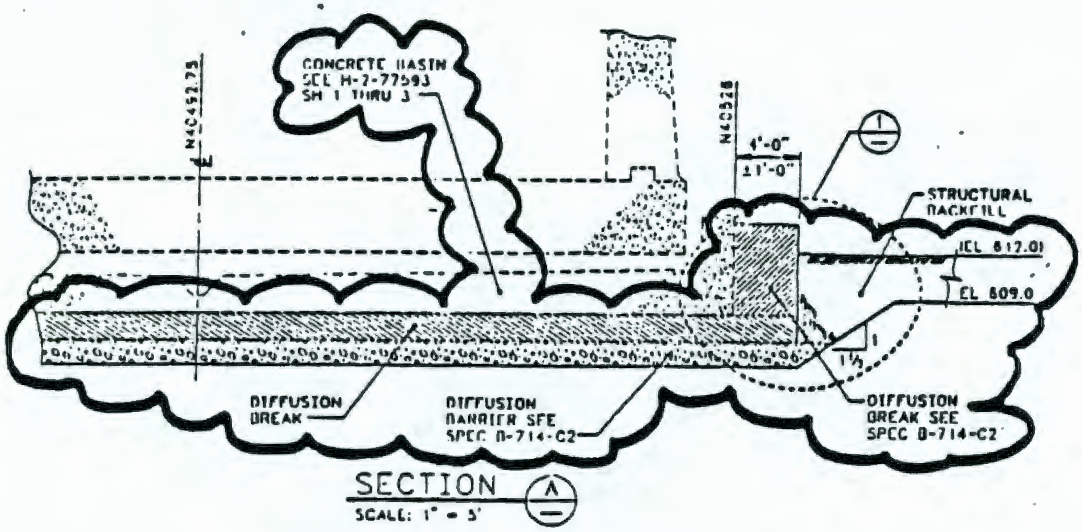


KEH-0159.00 (1/88)

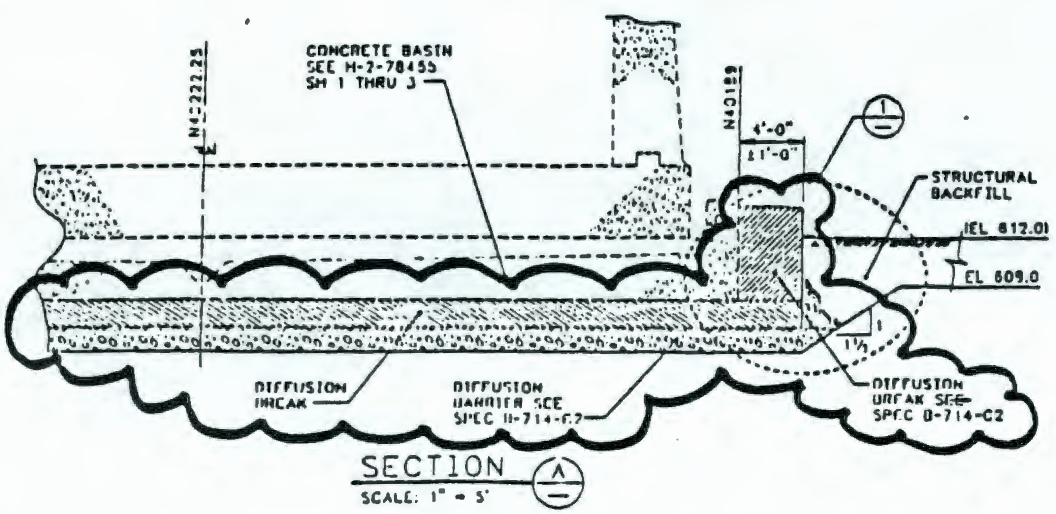
Contract KEH-0160
Change Order 7

DOE/RL 88-27
Rev. 1, 01/17/90

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH				
Ref Dwg. / Sh / Rev.	Prepared By	Checked By	ECN No.	Page	
H-2-77575 / 2 / 1; H-2-78446 / 2 / 0	TERESA EHRHARD	MD STINE	B-714-19	7/24	



H-2-77575, SH 2

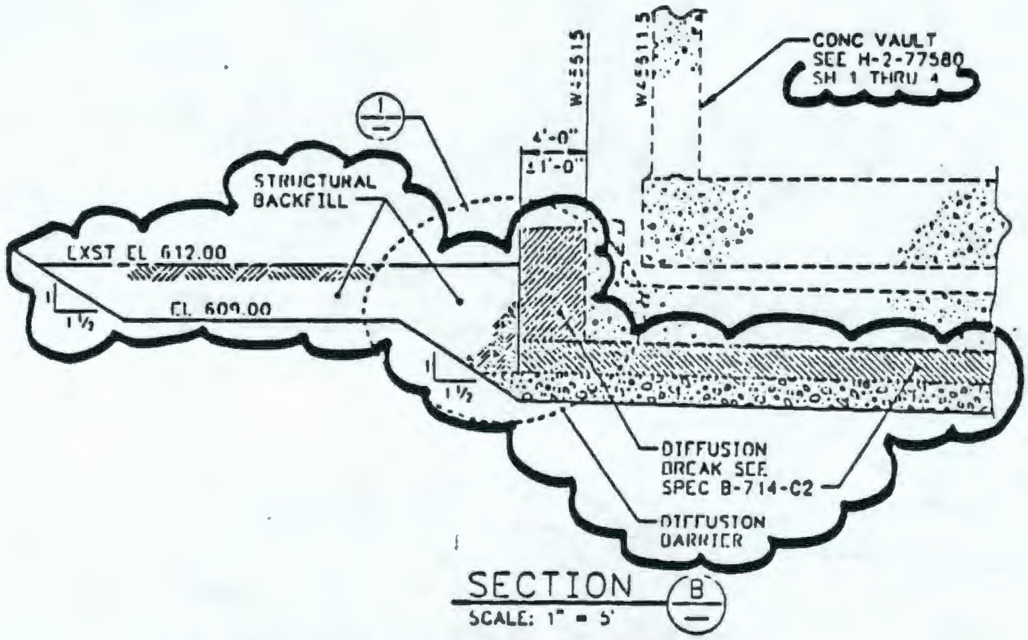


H-2-78446, SH 2

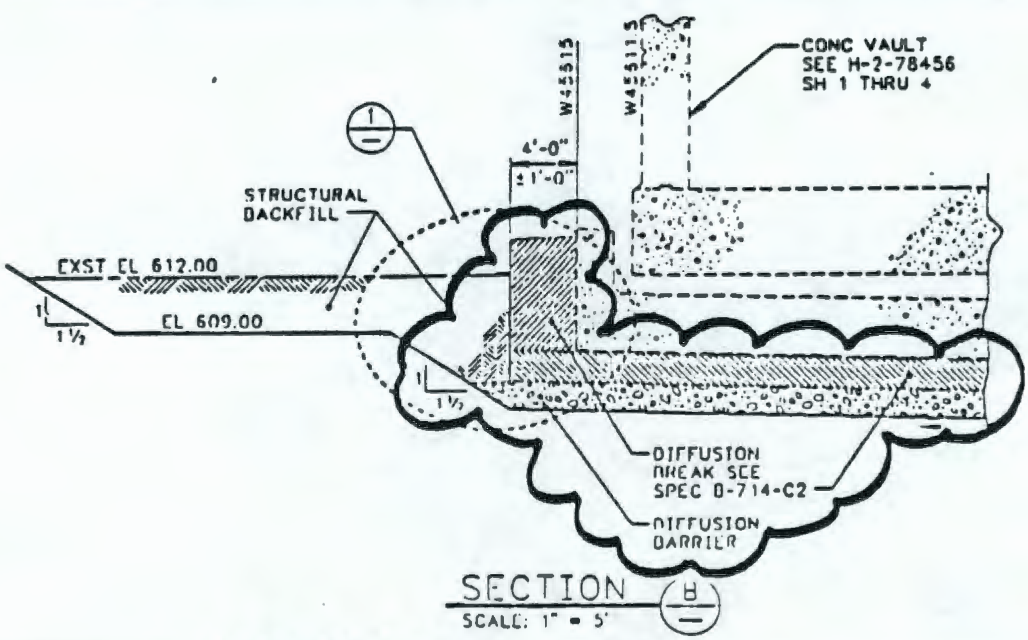
KEH-0159.00 (1/88)

90117850920

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH			
Ref. Dwg. / Sh / Rev.: H-2-77575, 2, 1; H-2-78446, 2, 0	Prepared By: TERESA EHRHARD	Checked By: MD STINES	ECN No.: B-714-19	Page: 8/24



H-2-77575, SH 2

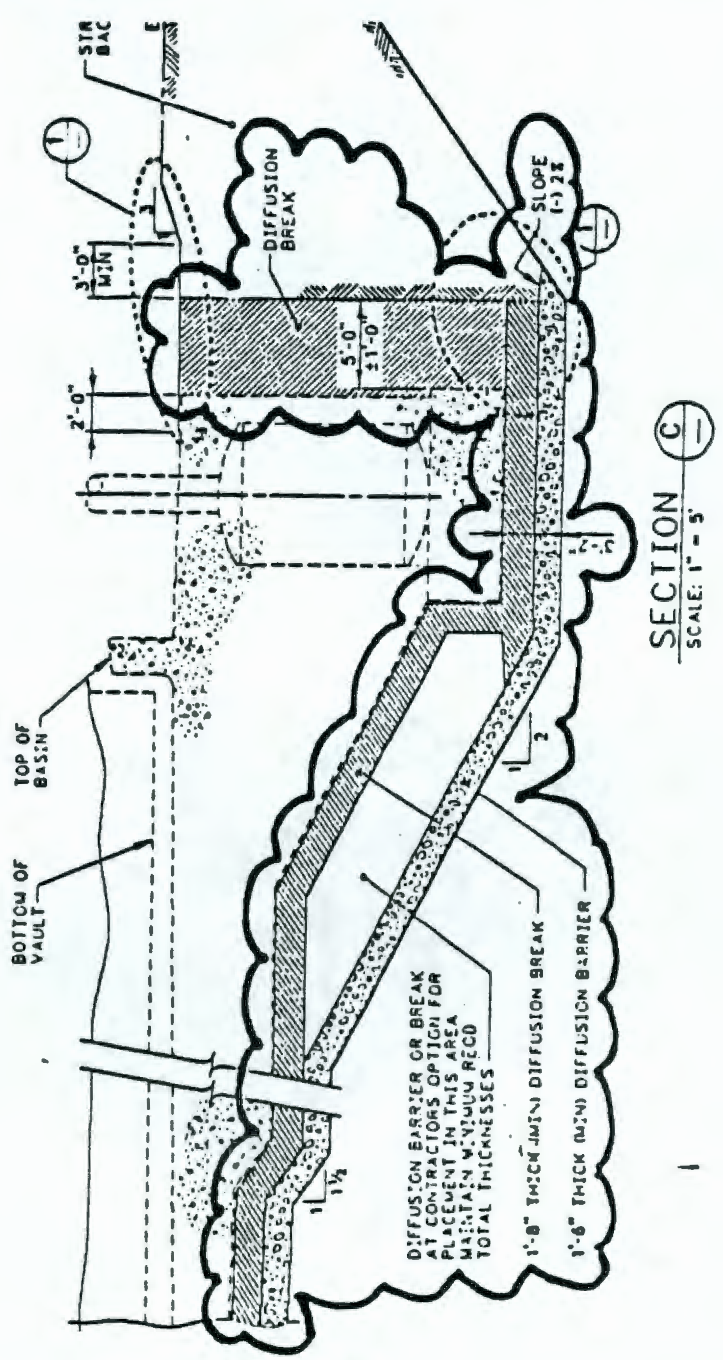


H-2-78446, SH 2

KEH-0159.00 (1/88)

KAISER ENGINEERS HANFORD			ENGINEERING CHANGE NOTICE SKETCH			
Ref. Dwg.	Sh	Rev	Prepared By	Checked By	ECN No.	Page
H-2-77575	2	1	TERESA EHRHARD	MD STING	B-714-19	9/24
H-2-78446	2	0				

90117850921

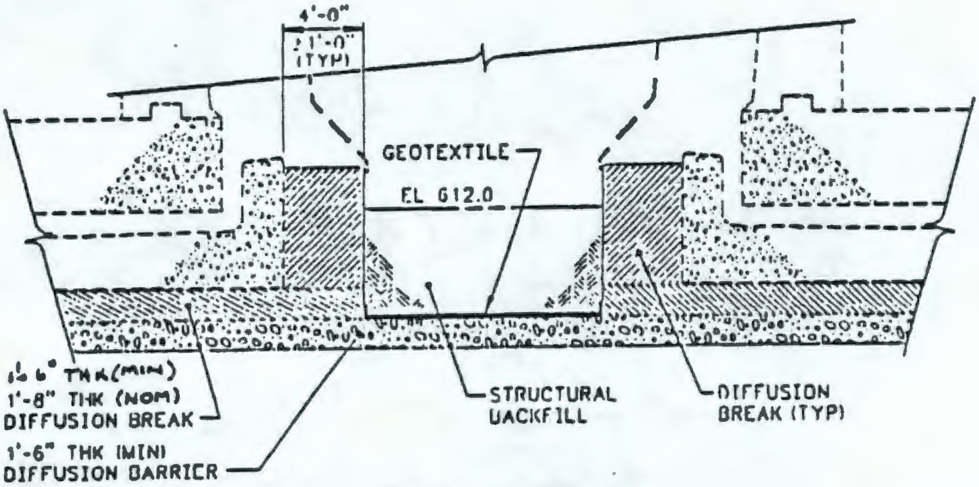


SECTION C
SCALE: 1" = 5'

APP 4I-369

KEH 0159.00 (1/88)

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH				
Ref. Dwg. / Sh / Rev.	Prepared By	Checked By	ECN No.	Page	
H-2-77575 / 2 / 1; H-2-78446 / 2 / 0	TERESA EHRHARD	MD STINE	B-714-19	10/24	



SECTION D
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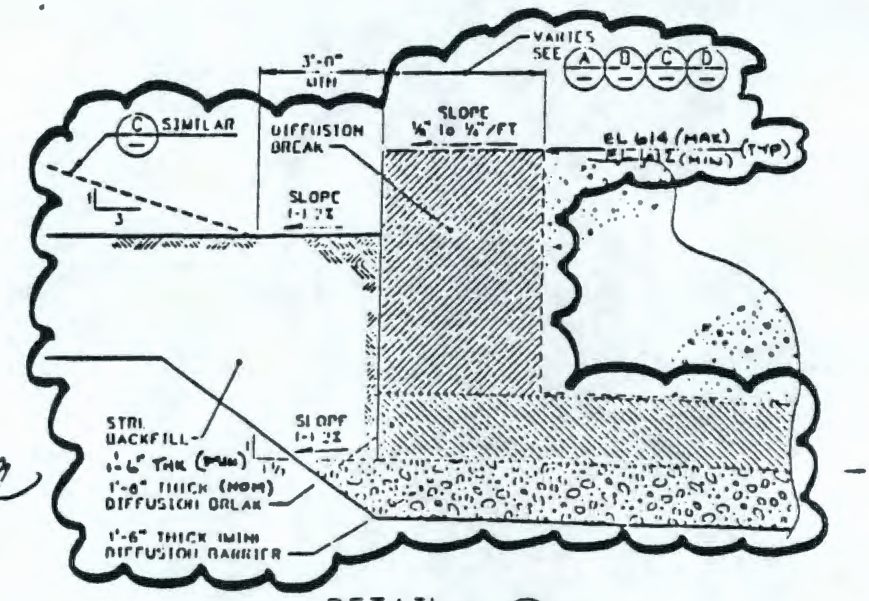
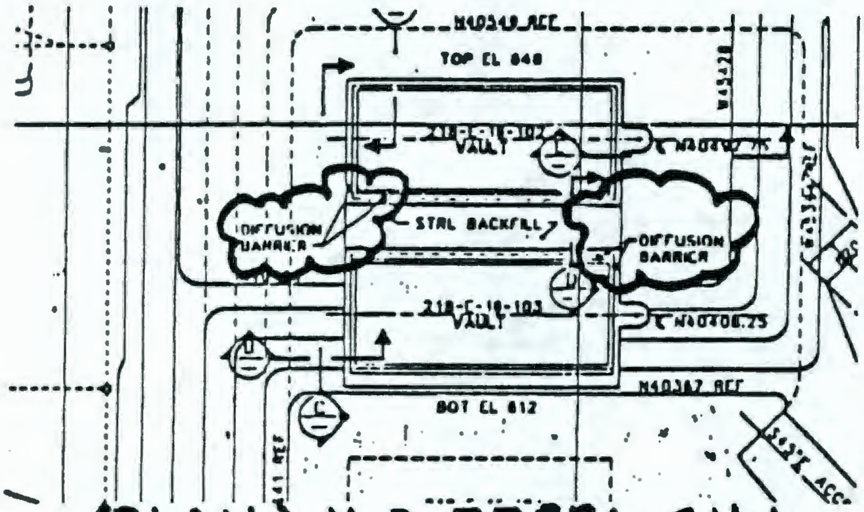


DETAIL 1

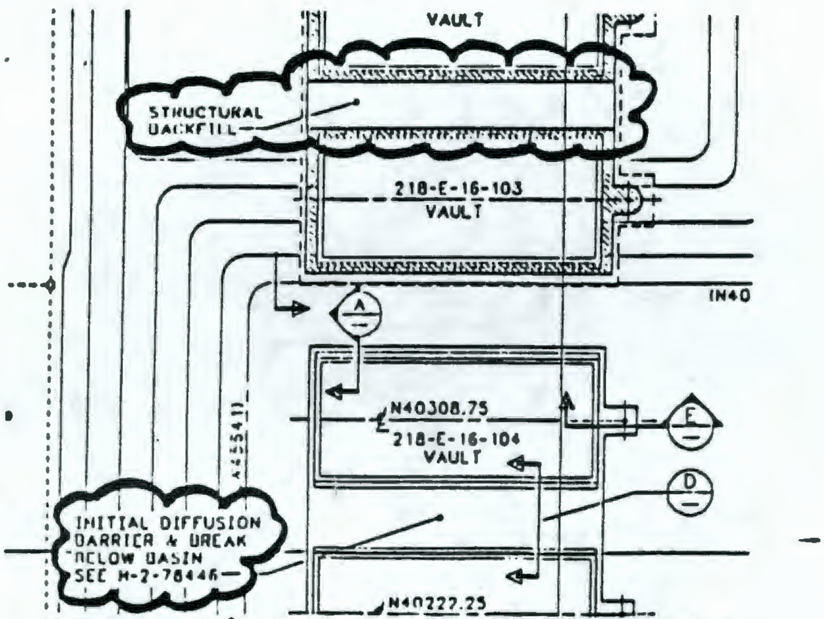
KEH-0157 00 (1/88)

9 0 1 1 7 8 5 0 9 2 2

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77576	1	0	TERESA EHRHARD	MD STINE	8-714-19	11/24
H-2-78447	1	0				



(PLAN) H-2-77576, SH 1

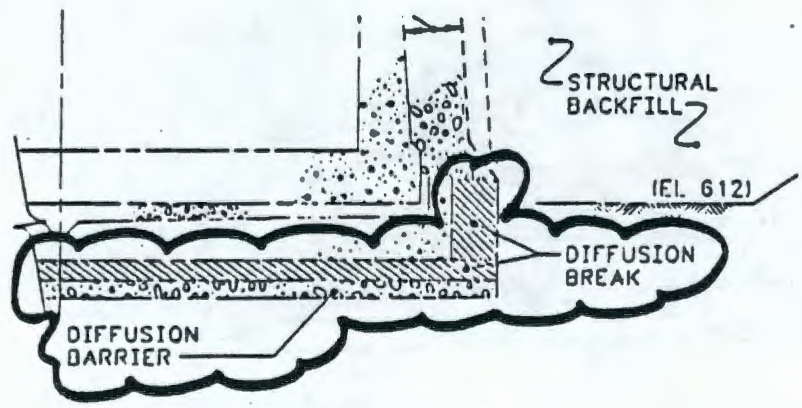


(PLAN) H-2-78447, SH 1

KEH-0159 00 (1/88)

9011785092 3

KAISER ENGINEERS HANFORD	ENGINEERING CHANGE NOTICE SKETCH					
Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77576 H-2-78447	1 1	0 0	TERESA EHRHARD	MD STINE	B-714-19	12/24



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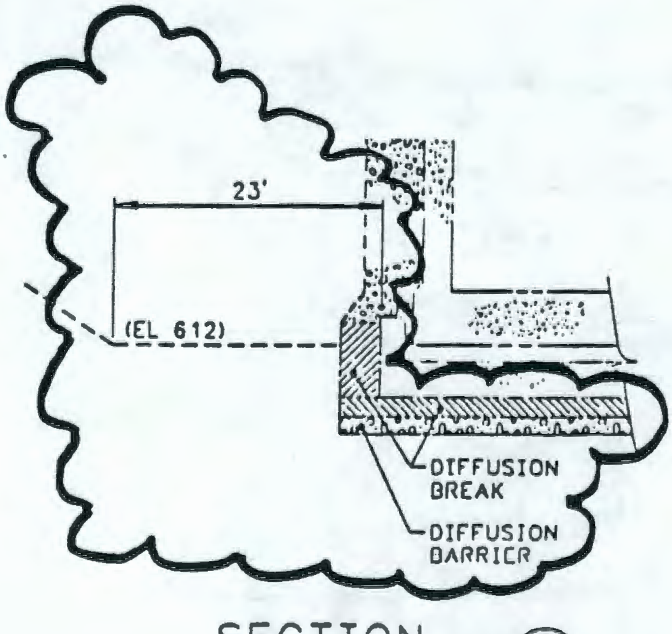

SECTION B
SCALE: 1" = 10'

9011785092 4

KEH-0150.00 (1/88)

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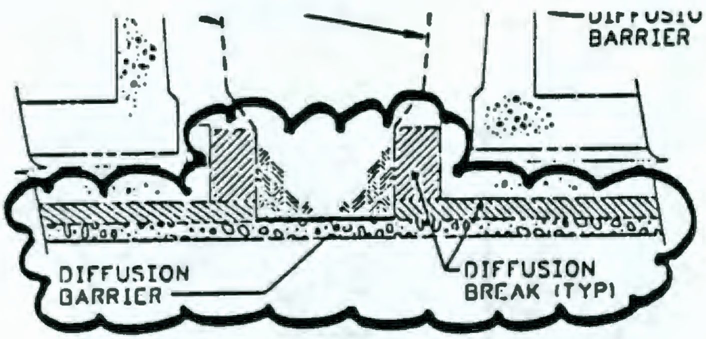
Change Order 7

KAISER ENGINEERS HANFORD			ENGINEERING CHANGE NOTICE SKETCH			
Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77576	1	0	TERESA EHRHARD	MD Stine	B-714-19	13/24
H-2-78447	1	0				



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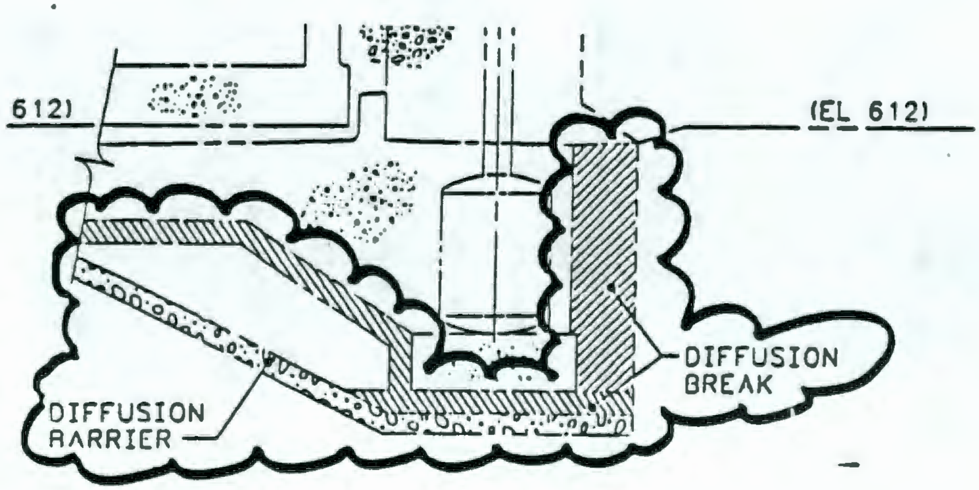

SECTION E
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KEH-0139 00 (1/88)

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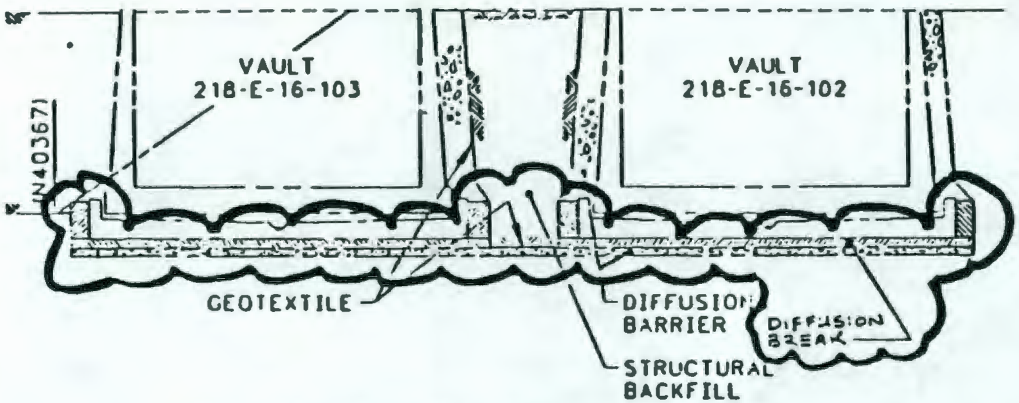
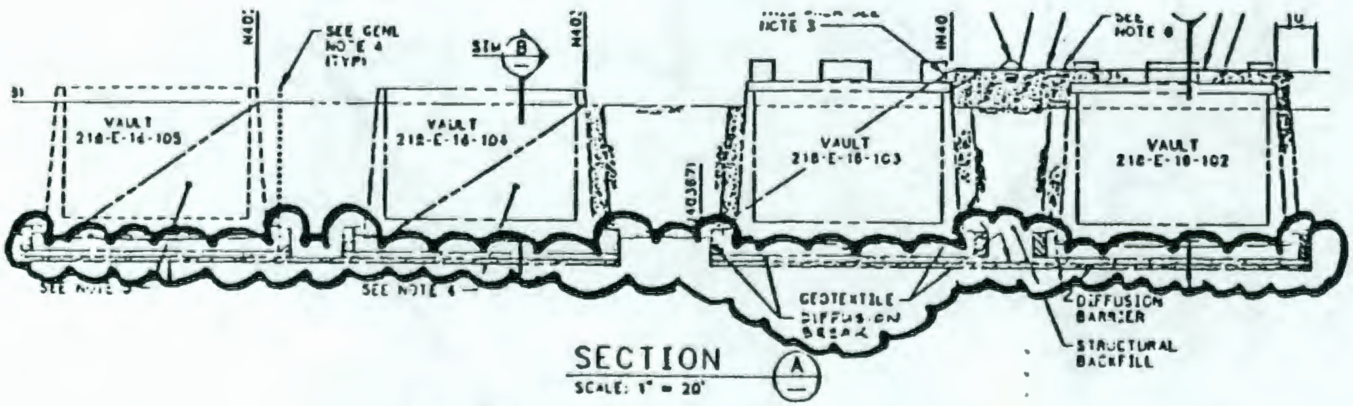


H-2-77578, SH 1



H-2-78448, SH 1

APP 41-374

KAISER ENGINEERS HANFORD

ENGINEERING CHANGE NOTICE SKETCH

Ref. Dwg.	Sh.	Rev.	Prepared By	Checked By	ECN No.	Page
H-2-77578	1	0	TERESA EHRHARD	MD Gome	B-714-19	14/24
H-2-78448	1	0				

Contract Modification
Change Order 7

Page 14 of 24

DOE/RL 88-27
Rev. 1, 01/17/90

KEH-0159 00 (1/88)

SECTION 02145

DIFFUSION BARRIER

PART 1 - GENERAL

1.1 REFERENCES

1.1.1 Reference Standards and Specifications: The following standards and specifications, including documents referenced therein, form part of this Section to extent designated herein.

1.1.1.1 American Society for Testing and Materials (ASTM)

C 136-84a	Standard Method for Sieve Analysis of Fine and Coarse Aggregates
C 207-79	Standard Specification for Hydrated Lime for Masonry Purposes
C 294-86	Standard Descriptive Nomenclature for Constituents of Natural Mineral Aggregates
C 295-85	Standard Practice for Petrographic Examination of Aggregates for Concrete
D8-88	Standard Definitions of Terms Relating to Materials for Roads and Pavements
D 242-85	Standard Specification for Mineral Filler for Bituminous Paving Mixtures
D 1117-80	Standard Methods of Testing Nonwoven Fabrics
D 1664-80 (1985)	Standard Test Method for Coating and Stripping of Bitumen-Aggregate Mixtures
D 1682-64 (1975)	Standard Test Methods for Breaking Load and Elongation of Textile Fabrics
D 1777-64 (1975)	Standard Method for Measuring Thickness for Textile Materials

D 3776-85	Standard Test Methods for Mass Per Unit Area (Weight) of Woven Fabric
D 3787-80a	Standard Test Method for Bursting Strength of Knitted Goods--Constant-Rate-of-Traverse (CRT) Ball Burst Test
D 4491-85	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
D 4751-87	Standard Test Method for Determining Apparent Opening Size of a Geotextile

1.1.1.2 Washington State Department of Transportation (WSDOT)

M41-10-88	Standard Specifications for Road, Bridge, and Municipal Construction

1.2 SUBMITTALS: Refer to Section 01300 for submittal procedures.

1.2.1 Laboratory Reports: Submit reports from independent laboratory showing following.

1.2.1.1 Proposed aggregate source will produce gravel classified as igneous or metamorphic rock in accordance with ASTM C 294. Examine aggregate in accordance with ASTM C 295.

1.2.1.2 Aggregate meets the requirements of Paragraph 2.1.1.

1.2.1.3 Liquid asphalt meeting the requirements of Paragraph 2.1.2.

1.2.1.4 Anti-stripping additive meeting the requirements of Paragraph 2.1.3.

1.2.2 Manufacturer's Data: Provide data defining physical properties of geotextile filtration and reinforcing fabrics to be supplied. As minimum, properties shall meet requirements of specified ASTM standards listed in Paragraph 2.1.4.

1.2.3 Handling Procedure: Submit proposed procedure defining methods used for delivering, storing, and handling to ensure requirements of Paragraphs 1.3.1 and 3.3.1 are met. Include method for keeping coated gravel free of dirt or foreign material.

1.2.4 Placing Procedure: Submit proposed procedure defining methods used during placing and spreading to ensure requirements of Paragraph 3.3.1 are met. Include method for keeping coated gravel free of dirt or foreign material, and type and size of equipment used.

1.2.5 Compacting Procedures: Submit proposed procedures for compacting, including type and size of equipment. Include 3 separate procedures for placement under concrete basin, adjacent to vault walls, and over vault roof.

1.2.6 Geotextile Installation Procedure: Submit proposed procedure for installing geotextile as shown on the Drawings. Include placement and removal techniques of temporary protective geotextile to minimize contamination of coated gravel.

1.2.7 Log for Diffusion Barrier Placement: Submit log delineating approximate placed location and limits of each load including lift thickness. Traceability shall be tied to each batched or trucked unit of mix as delivered to Site and noted on log.

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Diffusion Barrier Aggregate

1.3.1.1 Construct stockpiles in accordance with WSDOT M41-10, Section 3-02.2(6).

1.3.1.2 Remove aggregate from stockpiles in accordance with WSDOT M41-10, Section 3-02.2(7).

1.3.1.3 Mix and age aggregate, 48 hours minimum, in stockpile after treatment with anit-stripping additive in accordance with Article 2.2. Aggregate mixtures stored over 6 months after treatment shall be retreated with dry lime before use in diffusion barrier.

1.3.1.4 Hauling equipment shall meet the requirements of WSDOT M41-10, Section 5-04.3(2) with additional requirement that asphalt coated gravel be covered during transportation.

1.3.2 Geotextile

1.3.2.1 During shipment and storage, wrap geotextile in heavy-duty protective covering to prevent damage and exposure to ultraviolet light. Examine geotextile delivered to Site for damage. Set damaged geotextile aside and do not use. Removal of material identification labels from rolls will be by KEH only.

1.3.2.2 Store geotextile materials in original unopened packaging. Storage area shall protect geotextile from mud, soil, dust, debris, ultraviolet light, heavy winds, temperature extremes, and precipitation.

1.3.2.3 If geotextile is temporarily stored outdoors, place on pallet and protect from direct rays of sun under light colored heat-reflective opaque cover to provide free air flowing space between materials and cover.

1.3.2.4 Handle geotextile to ensure sound, undamaged condition.

PART 2 - PRODUCTS

2.1 MATERIALS

2.1.1 Aggregate: Composed of crushed stone or gravel aggregates classified in ASTM C 294 as either igneous or metamorphic rocks, and meeting following requirements.

2.1.1.1 Aggregate production: In accordance with WSDOT M41-10, Section 3-01.

2.1.1.2 Grading and quality: In accordance with ASTM C 136.

a. Amounts finer than each laboratory sieve (square-openings), weight percent.

Nominal Square Opening Sieve Size	Percent
1 in.	100
3/4 in.	50 to 90
1/2 in.	20 to 55
3/8 in.	5 to 15
No. 4	0 to 5
No. 200	0 to 1

b. Deleterious materials: Particles of specific gravity less than 1.95, maximum 1 percent by weight.

c. Limits for fractured faces by percent weight: Minimum of 2 fractured faces on 75 percent and least 1 fractured face of 90 percent of material retained on 3/8 inch and above sieves, as determined by WSDOT Test Method No. 103.

2.1.2 Asphalt: Meeting requirements of WSDOT M41-10, Section 9-02.1(4) for AR-4000W liquid asphalt.

2.1.3 Anti-Stripping Additive

2.1.3.1 Meet the requirements of WSDOT M41-10, Section 9-02.4 except percent of additive and requirement for use shall be determined by KEH, based on temperature and pH modified ASTM D 1664 for each aggregate source.

2.1.3.2 Meet the requirements of ASTM D 242 for physical requirements, sampling, and testing.

2.1.3.3 Shall be hydrated lime meeting chemical composition of ASTM C 207.

2.1.4 Nonwoven Geotextile: Long-chain synthetic polymer with stabilizers and inhibitors added to base plastic to make filaments resistant to deterioration due to ultraviolet and heat exposure. Geotextile shall meet following requirements.

Property	Test Method	Values
Fabric Weight (oz/sq yd)	ASTM D 3776	10
Thickness (mil)	ASTM D 1777	100
Grab Tensile Strength (lbs, min)	ASTM D 1682	300
Grab Elongation (%, min)	ASTM D 1682	30 in any principal direction
Coefficient of Water Permeability (cm/sec)	ASTM D 4491	0.5
Puncture Strength (lbs, min)	ASTM D 3787	100
Tear Strength (lbs, min trapezoidal)	ASTM D 1117	100 in any principal direction
Apparent Opening Size (AOS), US Sieve	ASTM D 4751	70-100
Minimum Width (ft)	----	12

2.2 MIXES

2.2.1 Proportions

2.2.1.1 Size, grade, and quantity of materials, when proportioned and mixed shall produce mixture meeting following requirements.

a. Asphalt: Range from 2.5 to 3.0 percent by weight of total asphalt mixture.

b. Anti-stripping additive: 2.5 to 3 percent by weight of total dry aggregate mixture with 2 percent minimum residual after mixing and aging in stockpile and before coating of aggregate with asphalt.

c. Amount passing No. 200 sieve: 1 to 3 percent.

2.2.2 Mixing

2.2.2.1 Asphalt mixing plants: Meet the requirements of WSDOT M41-10, Section 5-04.3(1). Collect and reintroduce lime driven from aggregate during drying and heating in batch plant into product at mixing unit.

2.2.2.2 Remove aggregates from stockpiles to ensure minimum segregation when being moved to plant for processing into final mixture. Treat aggregates with anti-stripping additive in accordance with subparagraph 2.2.2.3, and store in accordance with subparagraph 1.3.1.3 before introduction to mixing process.

2.2.2.3 Anti-stripping additive: Lime treatment to meet 95 percent minimum coverage determined by modified ASTM D 1664. Mix lime, water, and aggregate thoroughly in pugmill or other approved mechanical mixer with the lime as specified in subparagraph 2.2.1.1(b) and water as 5 percent plus or minus 0.5 percent moisture by aggregate weight.

2.2.2.4 Heat aggregates to minimum of 260 and maximum 285 F for AR 4000.

2.2.2.5 Heat AR4000 asphalt to minimum 225 and maximum 290 F. Heat to avoid local overheating and provide continuous supply of material to mixer.

2.2.2.6 Wet mixing time: Sufficient to produce 95 percent coated particles as determined by WSDOT Test Method No. 714.

2.2.2.7 Mix temperature not to exceed 290 F and controlled to limit drain down of asphalt.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Geotextile

3.1.1.1 Before work is started examine sheet rolls for damage from transit and storage. If damaged set aside and do not use.

3.1.1.2 During unrolling of material, visually examine surfaces. Do not use material showing defects or damage. Cut out and replace or patch defective or damaged areas.

3.2 PREPARATION

3.2.1 Subgrade: Prepare subgrade in accordance with Section 02200, Paragraph 3.2.6, within 3 weeks before placing diffusion barrier.

3.3 INSTALLATION

3.3.1 Diffusion Barrier

3.3.1.1 Before placement, demonstrate to KEH by trial placement at Site, the procedure proposed for placing and compacting diffusion barrier. Prepare "Soil Compaction Procedure" Form KEH-382, sample appended, in accordance with printed instructions, for following areas. Forms will be furnished by KEH.

a. Under concrete.

b. Adjacent to vault/basin walls.

c. On top of vault roof.

d. Other areas requiring hand tampers or small compaction equipment.

3.3.1.2 Keep surrounding area free of dust by watering during placing.

3.3.1.3 Stop placing and cover diffusion barrier gravel when average wind speed at Hanford weather station exceeds 25 mph or peak gusts exceed 40 mph.

3.3.1.4 Cover diffusion barrier at end of each shift, or when placement or compaction is not in progress.

3.3.1.5 Clean equipment used for hauling, placing, spreading, and compacting of dirt or gravel before handling diffusion barrier material.

3.3.1.6 Conveyers or other equipment used for placement shall not produce segregation or damage to coated gravel.

3.3.1.7 Hauling equipment shall not be allowed to be driven on diffusion barrier unless thoroughly cleaned.

3.3.1.8 Place coated gravel in layers not to exceed 6 inches nominal compacted measurement. Compact areas inaccessible to large compacting equipment by small vibratory mechanical compactors. Roll or compact until acceptable consolidation is achieved. KEH will determine type and number of passes required for particular compacting equipment used based on trial placement in subparagraph 3.3.1.1.

a. It is anticipated that desired compaction can be obtained with 6 passes of double-drum vibratory steel roller weighing at least 8 to 10 tons.

b. Acceptable level of compaction shall be minimum of 65 percent of maximum density as determined by WSDOT Test Method 705.

c. Allow minimum of 4 to 12 hours interim or maximum material temperature of 140 F before placement of subsequent lifts of AR4000 mix.

d. Dual drive tandem wheel vibratory steel rollers are recommended.

3.3.1.9 Weather limitations for placing shall be in accordance with WSDOT M41-10, Section 5-04.3(16) except surface course shall be same as subsurface course for thickness more than 0.35 feet.

3.3.2 Geotextile

3.3.2.1 Lay to minimize tension, stress, folds, wrinkles, or creases, and to provide minimum 18 inch overlap for each joint.

3.3.2.2 Use bags of clean, washed gravel to secure material during installation. Do not use securing pins.

3.4 CONTAMINATED MATERIAL

3.4.1 Remove placed or stored material that has excess dirt or dust contamination, as determined by KEH.

3.5 FIELD QUALITY CONTROL

3.5.1 Verify placement and compaction of diffusion barrier and geotextile in accordance with Paragraph 1.2.7, and subparagraphs 3.3.1.1 and 3.3.1.8.

3.5.2 Sampling and testing of aggregate and coated gravel will be performed by KEH. Rolling and compaction requirements will be controlled based on subparagraph 3.3.1.8.

3.5.3 KEH will examine equipment referenced in subparagraph 3.3.1.5 for cleanliness.

3.5.4 Samples

3.5.4.1 KEH will collect minimum 2 geotextile samples from different rolls, full roll width at least 5 foot long, from each lot.

3.5.4.2 KEH will collect minimum 1 representative aggregate sample from stockpiled material before each day or partial days production of diffusion barrier material to determine residual lime content.

SOIL COMPACTION PROCEDURE

A

Project Number	Project Title	Date

Contract Number	Procedure Number	Location of Demonstration

REQUIREMENTS		EQUIPMENT DEMONSTRATED	
Applicable Spec./Dwg.		Type	
Compaction Required	%	Manufacturer	
Maximum Lift Size		Model	

B

LABORATORY SOIL TEST RESULTS

☐ Non-granular Materials (WSDOT Test Method No. 609) Maximum Density ________ Moisture % ________

☐ Granular Materials (WSDOT Test Method No. 606-A)
☐ Density Chart Attached

☐ In-Situ Density ________

C

COMPACTION DEMONSTRATION TEST RESULTS

Formula for Percent Compaction: $\frac{\text{dry density}}{\text{max density}} \times 100$ = Percent Compaction

No. of Passes	Depth of Lift	Percent Moisture	Lbs/ft³ Dry	Maximum Density	Percent Compaction	Accept	Reject

Observations or Comments

TEST METHOD USED FOR DEMONSTRATION

☐ Nuclear Gage (ASTM D2922 & D3017)

☐ Other ____________________
____

D

Contractor Representative		Date
Engineer/Constructer Inspector	APP 4I-383	Date

INSTRUCTIONS

This Soil Compaction Procedure form, when approved by the Engineer/Constructor Inspector, documents witnessing and verifying the compaction procedure.

Section A is the responsibility of the Construction Contractor. It is to be completed at the time of backfill compaction demonstration and presented to the Engineer/Constructor Inspector.

Section B is completed by the Engineer/Constructor Inspector. Data entered is obtained from the agency or individual that performed testing.

Section C is completed by the Engineer/Constructor Inspector as the demonstration is performed. Using the applicable formula, the percent compaction achieved is determined and entered. Acceptance is based on the results as compared with the compaction percent required in Section A.

Section D is signed and dated by the Construction Contractor Representative acknowledging responsibility for this procedure and compliance thereto for applicable backfill operations. Section D is signed and dated by the Engineer/Constructor Inspector to signify witnessing and verification.

KEH-0382.00R (03/89)

END OF SECTION

DOE/RL 88-27
Rev. 1, 01/17/90

B-714-C2

CONSTRUCTION SPECIFICATION FOR

VAULT CONCRETE BASIN, SHELL, AND LEACHATE SUMP

FOR
GROUTED WASTE DISPOSAL FACILITIES
GROUTED VAULT PAIR (218-E-16)

CAUTION
NOT COMPLETE WITHOUT
CURRENT STATUS OF OUTSTANDING
ECNS FROM DATA BASE

SEP 13 1989

SECTION 01300

SUBMITTALS

PART 1 - GENERAL

1.1 DESCRIPTION

1.1.1 This Section summarizes submittals required in Part 1 of each section of this Specification. It explains type of submittals required, and describes procedures for submittals and review.

1.1.2 Submittals required in Part 1 of each section are summarized in Schedule of Submittals. Each submittal is identified by Submittal Number, Reference Section, and Title. Submittals are required for either Review and Approval or Review for Record.

1.1.2.1 Submittals requiring Review and Approval are those which shall receive approval before procurement, fabrication, or construction is started.

1.1.2.2 Submittals requiring Review for Record are those which Contractor may proceed with procurement, fabrication, construction, or acceptance testing, but acceptance is contingent upon compliance with Drawings and Specifications.

1.1.3 Supplemental Submittals are initiated by Contractor in accordance with Section 01630 for consideration of substitute products or corrective procedures and require Review and Approval.

1.2 SUBMITTAL PROCEDURES

1.2.1 Transmit submittals for each vault to KEH by Data Transmittal form. Identify submittals by vault numbers.

1.2.2 Identify each submittal by Submittal Number, Reference Section, and Title noted in the Schedule of Submittals. Number of copies required for retention by KEH are shown in Schedule and include 2 copies to be returned to Contractor. Additional copies required for Contractor uses shall be added.

1.2.3 Review each submittal for completeness, compliance with Contract Documents, and proper identification before sending to KEH. Submittal data shall either be stamped showing review process has taken place or Data Transmittal form may be signed with statement of "Reviewed for Compliance." Submittals not stamped or signed to show review will be returned without consideration.

1.2.4 Submittals requiring Review and Approval will be stamped by KEH and marked "Approved", "Approved with Exception," or "Not Approved, Revise and Resubmit." Approval of submittals does not relieve Contractor of responsibility for errors which may be contained therein.

1.2.4.1 Approved submittals are identified by submittal stamp with "Approved" or "Approved with Exception" box checked. "Approved" signifies general concurrence to achieve conformance with design concept of Project and compliance with requirements of Contract Documents. "Approved with Exception" signifies general concurrence with noteworthy comments or clarifications. Approval of submittals does not relieve Contractor of responsibility for errors contained therein. Approval of specific item shall not be construed as approval of system or assembly of which item is a component.

1.2.4.2 A submittal which is not approved is identified as "Not Approved, Revise and Resubmit." Submittal is considered by KEH to be technically deficient or incomplete and therefore, unacceptable. Resubmittal is required, hence fabrication, procurement, or performance of procedures shall not proceed.

1.2.4.3 Upon receipt of deficient submittal data, Contractor shall make corrections noted on transmittal and resubmit data to KEH within 10 calendar days.

1.2.5 Materials and equipment fabricated or installed without required approved submittals, or which differ from approved Drawings or vendor data are subject to rejection and replacement at Contractor's expense.

1.2.6 Delays arising out of Contractor's failure to submit in timely manner required Drawings and other related data described in Contract Documents shall not constitute excusable delays for extensions, unless excusable under other provisions of Contract. Contractor shall allow 15 calendar days for KEH review and disposition of submittals, including shop drawings and vendor information, required to be furnished by Contractor. Time period will be measured from date of receipt of submittal in KEH's office to date of return mailing to Contractor.

1.2.7 Contractor is responsible for dimensions to be confirmed and correlated at worksite.

1.2.8 Submittals for Review and Record will be reviewed and filed. Incomplete or inaccurate data will be returned to Contractor marked "Resubmit" with appropriate comments, and items procured or work performed shall be corrected. Payment for equipment will not be made unless required Certified Vendor Information (CVI) has been furnished.

1.2.9 Supplemental Submittals shall contain sufficient data required in Section 01630 to show substantial compliance with Drawings and Specifications. Substitute product submittals shall contain as minimum, outline dimensions, operating clearances, and engineering data. Identify each submittal by Specification Section number and Paragraph number or referenced Drawing number and detail. Improperly identified or incomplete submittals will be returned without consideration.

1.2.10 Procedures for performing certain items of work are required to be submitted for Review and Approval before work is commenced. Those work procedures which have been approved by KEH for work similar to that to be accomplished on Project may not need to be reapproved. Forward 1 copy of previously approved procedure to KEH by Data Transmittal form and identify by Submittal Number, Reference Section, Title, and either Contractor's procedure number or project number for which procedure was approved. Submittal will be reviewed by KEH and if acceptable retained for record. If previously approved procedure is not acceptable submittal will be returned with requirements for resubmittal.

1.3 SCHEDULE OF SUBMITTALS

Submittal Number	Submittal Title	Quantity	Review and Approval	Review For Record
CONTRACT GENERAL CONDITIONS				
55.2	Safety Program and Job Safety Analysis	5	5 days before start of work	
55.3	Industrial Injury/ Illness Experience	5		5 days before start of work and each month
55.5.1	OSHA Form No. 200 Report	5		5th working day, each month
55.6	Equipment Certification	5		2 days before bringing equipment onsite
SPECIAL PROJECT PROCEDURES				
01100/1.2.1	Air Quality Test Reports	5	Before equipment use	
PROGRESS SCHEDULES				
01310/1.2.1	Progress Schedules	5	30 days after notice of award	
01310/1.2.2	CPM Project Schedule	5	30 days after notice of award	
01310/1.2.3	Initial Weekly Work Schedule	2	10 days after notice to proceed	

Submittal Number	Submittal Title	Quantity	Review and Approval	Review For Record
PROGRESS SCHEDULES (Continued)				
01310/1.2.4	Subsequent Weekly Work Schedules	2	By noon each Friday	
01310/1.2.5	Start-up Schedule	5	5 days after notice to proceed	
CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS				
01500/1.2.1	Anchoring and Enclosure Methods	10	Before placing field office	
SUBMIT FOLLOWING FOR EACH VAULT				
DIFFUSION BARRIER				
02145/1.2.1	Laboratory Reports	10	Before delivery	
02145/1.2.2	Manufacturer's Data	10	Before mixing	
02145/1.2.3	Handling Procedure	10	Before delivery	
02145/1.2.4	Placing Procedure	10	Before delivery	
02145/1.2.5	Compacting Procedure	10	Before delivery	
02145/1.2.6	Geotextile Installation Procedure	10	Before installation	
EARTHWORK				
02200/1.2.1	Method to Prevent Damage During Excavation	10	Before excavation	
HOT-LAID ASPHALTIC CONCRETE PAVEMENT				
02512/1.2.1	Laboratory Reports	10	Before delivery	
02512/1.2.2	Handling and Placing Procedure	10	Before delivery	

Submittal Number	Submittal Title	Quantity	Review and Approval	Review For Record
LEACHATE COLLECTION SUMP LINER				
02752/1.2.1	Fabricator Drawings and Procedures	10	Before fabrication	
02752/1.2.2	Certified Material Test Reports (CMTR)	10	Before delivery	
02752/1.2.3	Filler Material Control Procedure	10	Before fabrication	
EXTERIOR DRAINAGE PATH				
02753/1.2.1	Fabricator Drawings	10	Before delivery	
02753/1.2.2	Installation Plan	10	Before installation	
02753/1.2.3	Manufacturer's Data	10	Before fabrication	
02753/1.2.4	Surface Acceptance	10	Before installation	
02753/1.2.5	Care and Repair Instructions	10		Before acceptance
WASTE DISPOSAL BASIN LINER				
02755/1.2.1	Installation Drawings	10	Before delivery	
02755/1.2.2	Installation Procedures	10	Before installation	
02755/1.2.3	Manufacturer's Data	10	Before fabrication	
02755/1.2.4	Samples	10		Upon completion of fabrication
02755/1.2.5	Certified Material Test Reports (CMTR)	10	Before delivery	
02755/1.2.6	Care and Repair Instructions	10	—	Before acceptance

Submittal Number	Submittal Title	Quantity	Review and Approval	Review For Record
WASTE DISPOSAL BASIN LINER (Continued)				
02755/1.2.7	Certificates of Experience	10	Before notice to proceed	
02755/1.2.8	Manufacturer's Quality Control Plan	10	5 days after notice of award	
02755/1.2.9	Certification	10		Before acceptance
02755/1.2.10	Surface Acceptance	10	Before installation	
LEACHATE COLLECTION SYSTEM				
02756/1.2.1	Fabricator Drawings	10	Before delivery	
02756/1.2.2	Installation Plan	10	Before installation	
02756/1.2.3	Manufacturer's Data	10	Before fabrication	
02756/1.2.4	Care and Repair Instructions	10		Before acceptance
02756/1.2.5	Certified Material Test Reports (CMTR)	10	Before delivery	
02756/1.2.6	Certificate of Conformance	10		At time of delivery
02756/1.2.7	Certificates of Experience	10	5 days after notice of award	
02756/1.2.8	Manufacturer's Quality Control Plan	10	5 days after notice of award	
CAST-IN-PLACE CONCRETE				
03300/1.2.1	Form Coating Materials	10	Before use	
03300/1.2.2	Certification of Ready Mixed Concrete Production Facilities	10	Before mixing	

Submittal Number	Submittal Title	Quantity	Review and Approval	Review For Record
CAST-IN-PLACE CONCRETE (Continued)				
03300/1.2.3	Certified Test Reports for Reinforcing Steel	10	Before delivery	
03300/1.2.4	Reinforcing Steel Fabricator Drawings	10	Before delivery	
03300/1.2.5	Block Diagram	10	Before installation of forms	
03300/1.2.6	Concrete Materials, Mix Design and Mix proportions	10	Before mixing	
03300/1.2.7	Cold Weather Concreting	10	Before placement	
03300/1.2.8	Curing Procedure	10	Before mixing	
03300/1.2.9	Certificate of Conformance	10		At time of delivery
VAULT AND BASIN CAST-IN-PLACE CONCRETE				
03301/1.2.1	Formwork	10	Before installation	
03301/1.2.2	Form Coating Materials	10	Before use	
03301/1.2.3	Certification of Ready Mixed Concrete Production Facilities	10	Before mixing	
03301/1.2.4	Laboratory Test Reports	10	Before delivery	
03301/1.2.5	Reinforcing Steel Fabricator Drawings	10	Before delivery	
03301/1.2.6	Manufacturer's Data	10	Before delivery	
03301/1.2.7	Certified Test Reports	10	Before delivery	

Submittal Number	Submittal Title	Quantity	Review and Approval	Review For Record
VAULT AND BASIN CAST-IN-PLACE CONCRETE (Continued)				
03301/1.2.8	Schedule for Concrete Placement	10	Before installation of forms	
03301/1.2.9	Mix Design	10	Before mixing	
03301/1.2.10	Mix Certification	10	Before mixing	
03301/1.2.11	Control Procedures for Batching	10	Before mixing	
03301/1.2.12	Certificate of Conformance	10		At time of delivery
03301/1.2.13	Construction Joints	10	Before installation of forms	
03301/1.2.14	Weather Protection During Placement	10	Before placement	
03301/1.2.15	Curing and Protection	10	Before placement	
03301/1.2.16	Pump Concrete	10	10 days before placing concrete	
03301/1.2:17	Methods for Controlling Heat of Hydration and Thermal Gradients	10	Before placement	
03301/1.2.18	Air Leakage Test	10	Before test	
PRECAST PRESTRESSED CONCRETE SECTIONS				
03419/1.2.1	Fabricator Drawings	10	Before delivery	
03419/1.2.2	Records of Tests	10	Before mixing	
03419/1.2.3	Concrete Materials and Mix Design	10	Before mixing	

Submittal Number	Submittal Title	Quantity	Review and Approval	Review For Record
PRECAST PRESTRESSED CONCRETE SECTIONS (Continued)				
03419/1.2.4	Certification	10		At time of delivery
03419/1.2.5	Certification of Prestressed Concrete Production Facilities	10	Before fabrication	
03419/1.2.6	Manufacturer's Quality Assurance Plan	10	5 days after notice of award	
METAL FABRICATIONS				
05500/1.2.1	Fabricator Drawings	10	Before fabrication	
05500/1.2.2	Certified Material Test Reports (CMTR)	10	Before delivery	
SPECIAL PROTECTIVE COATING				
09805/1.2.1	List of Materials	10	Before delivery	
PROTECTIVE COATING FOR CONCRETE VAULT INTERIOR				
09885/1.2.1	List of Materials	10	Before delivery	
09885/1.2.2	Certified Material Test Reports (CMTR)	10	Before delivery	
09885/1.2.3	Samples	10	Concurrent with CMTR	
INSTRUMENTATION				
13440/1.2.1	Approval Data	10	Before delivery	
13440/1.2.2	Certified Vendor Information (CVI)	10		Before acceptance
CHEMICAL PROCESS PIPING SYSTEMS				
15493/1.2.1	Certified Material Test Reports (CMTR)	10	Before delivery	
15493/1.2.2	Certificate of Conformance	10		At time of delivery

Submittal Number	Submittal Title	Quantity	Review and Approval	Review For Record
CHEMICAL PROCESS PIPING SYSTEMS (Continued)				
15493/1.2.3	Weld Identification Drawings	10	Before welding	
15493/1.2.4	Filler Material Control Procedure	10	Before fabrication	
15493/1.2.5	Welding Filler Metal	10	Before welding	
15493/1.2.6	Welding Procedures and Personnel	10	Before welding	
15493/1.2.7	NDE Personnel and Procedures	10	Before welding	
HIGH VOLTAGE DISTRIBUTION (ABOVE 600-VOLT)				
16300/1.2.1	Approval Data	10	Before delivery	
16300/1.2.2	Certification Vendor Information (CVI)	10		Before acceptance
CATHODIC PROTECTION				
16640/1.2.1	Approval Data	10	Before delivery	
16640/1.2.2	Certified Vendor Information (CVI)	10		Before acceptance
16640/1.2.3	Visual Examination Procedure	10	Before examination	
16640/1.2.4	Manufacturer's Instructions	10	Before installation	

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

SECTION 02145

DIFFUSION BARRIER

PART 1 - GENERAL

1.1 REFERENCES

1.1.1 Reference Standards and Specifications: The following standards and specifications, including documents referenced therein, form part of this Section to extent designated herein.

1.1.1.1 American Society for Testing and Materials (ASTM)

C 294-86	Standard Descriptive Nomenclature for Constituents of Natural Mineral Aggregates
C 295-85	Standard Practice for Petrographic Examination of Aggregates for Concrete
D 1117-80	Standard Methods of Testing Nonwoven Fabrics
D 1682-64 (1975)	Standard Test Methods for Breaking Load and Elongation of Textile Fabrics
D 1777-64 (1975)	Standard Method for Measuring Thickness for Textile Materials
D 3776-85	Standard Test Methods for Mass Per Unit Area (Weight) of Woven Fabric
D 3787-80a	Standard Test Method for Bursting Strength of Knitted Goods--Constant-Rate-of-Traverse (CRT) Ball Burst Test
D 4491-85	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
E 11-87	Standard Specification for Wire-Cloth Sieves for Testing Purposes

1.1.1.2 Washington State Department of Transportation (WSDOT)

M41-10-88	Standard Specification for Road, Bridge, and Municipal Construction

1.2 SUBMITTALS: Refer to Section 01300 for submittal procedures.

1.2.1 Laboratory Reports: Submit reports from independent laboratory showing following.

1.2.1.1 Proposed aggregate source will produce gravel classified as igneous or metamorphic rock in accordance with ASTM C 294. Examine aggregate in accordance with ASTM C 295.

1.2.1.2 Aggregate meets the requirements of Paragraph 2.1.1.

1.2.1.3 Liquid asphalt meets the requirements of MC-250 in accordance with WSDOT M41-10, Section 9-02.1(2).

1.2.2 Manufacturer's Data: Provide data defining physical properties of geotextile filtration and reinforcing fabrics to be supplied. As minimum, properties shall meet requirements of specified ASTM standards listed in Paragraph 2.1.3.

1.2.3 Handling Procedure: Submit proposed procedure that defines methods used for delivery, storage, and handling to ensure requirements of Paragraphs 1.3.1 and 3.3.1 are met. Include method for keeping coated gravel free of dirt or foreign material.

1.2.4 Placing Procedure: Submit proposed procedure that defines methods used during placing and spreading to ensure requirements of Paragraph 3.3.1 are met. Include method for keeping coated gravel free of dirt or foreign material, and type and size of equipment used.

1.2.5 Compacting Procedures: Submit proposed procedures for compacting, including type and size of equipment. Include 3 separate procedures for placement under concrete basin, adjacent to vault walls, and over vault roof.

1.2.6 Geotextile Installation Procedure: Submit proposed procedure for installation of geotextile as shown on the Drawings. Include placement and removal techniques of temporary protective geotextile to minimize contamination of coated gravel.

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Diffusion Barrier

1.3.1.1 Construct stockpiles in accordance with WSDOT M41-10, Section 3-02.2(6).

1.3.1.2 Place stockpiles of coated gravel on asphalt or concrete surface, free of dirt and debris.

1.3.1.3 Cover stockpiles with suitable covers or tarps approved by KEH when not in use, at end of each shift, or when average wind speed at Hanford weather station exceeds 25 mph or peak gusts exceed 40 mph.

1.3.1.4 Remove coated gravel from stockpiles in accordance with WSDOT M41-10, Section 3-02.2(7).

1.3.1.5 Hauling equipment shall meet the requirements of WSDOT M41-10, Section 5-04.3(2) with additional requirement that coated gravel shall be covered during transportation.

1.3.2 Geotextile: Handle and store in accordance with manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MATERIALS

2.1.1 Aggregate: Composed of crushed stone or gravel aggregates classified in ASTM C 294 as either igneous or metamorphic rocks, and meeting following requirements.

2.1.1.1 Aggregate production: In accordance with WSDOT M41-10, Section 3-01.

2.1.1.2 Grading and quality

a. Amounts finer than each laboratory sieve (square-openings), weight percent.

Nominal Square Opening Sieve Size	Percent
1 in.	100
3/4 in.	50 to 100
1/2 in.	10 to 55
3/8 in.	0 to 15
No. 4	0 to 5
No. 200	0 to 1

b. Deleterious materials: Particles of specific gravity less than 1.95, maximum 1 percent by weight.

c. Limits for fractured faces by percent weight: Minimum of 2 fractured faces on 75 percent and least 1 fractured face of 90 percent of material retained on 3/8 inch and above sieves, as determined by WSDOT Test Method No. 103.

2.1.2 Asphalt: Meeting the requirements of WSDOT M41-10, Section 9-02.1(2) for MC-250 liquid asphalt.

2.1.3 Nonwoven Geotextile: Long-chain synthetic polymer with stabilizers and inhibitors added to base plastic to make filaments resistant to deterioration due to ultraviolet and heat exposure. Geotextile shall meet following requirements.

Property	Test Method	Values
Fabric Weight (oz/sq yd)	ASTM D 3776	10
Thickness (mil)	ASTM D 1777	100
Grab Tensile Strength (lbs, min)	ASTM D 1682	300
Grab Elongation (%, min)	ASTM D 1682	30 in any principal direction
Coefficient of Water Permeability (cm/sec)	ASTM D 4491	0.5
Puncture Strength (lbs, min)	ASTM D 3787	100
Tear Strength (lbs, min trapezoidal)	ASTM D 1117	100 in any principal direction
Equivalent Opening Size (EOS), US Sieve	----	70-100 in accordance with ASTM E 11
Minimum Width (ft)	----	12

2.2 MIXES

2.2.1 Proportions

2.2.1.1 Size, grade, and quantity of materials, when proportioned and mixed shall produce mixture meeting following requirements.

a. Percentage of asphalt: Range from 1.5 to 2.5 percent by weight of total asphalt mixture.

2.2.2 Mixing

a. Asphalt mixing plants: Meet the requirements of WSDOT M41-10, Section 5-04.3(1).

b. Remove aggregates from stockpiles in manner to ensure minimum segregation when being moved to plant for processing into final mixture.

c. Heat aggregates to minimum 150 and maximum 200 F.

d. Heat asphalt to minimum 175 and maximum 225 F. Heat in manner to avoid local overheating and provide continuous supply of material to mixer.

e. Wet mixing time: Sufficient to produce 95 percent coated particles as determined by WSDOT Test Method No. 714.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Geotextile

3.1.1.1 Before work is started inspect sheet rolls for damage from transit and storage. If damaged set aside and do not use.

3.1.1.2 During unrolling of material, visually examine surfaces. Do not use material showing defects or damage. Cut out and replace or patch defective or damaged areas.

3.2 PREPARATION

3.2.1 Subgrade: Prepare subgrade in accordance with Section 02200, Paragraph 3.2.6, within 3 weeks before placing diffusion barrier.

3.3 INSTALLATION

3.3.1 Diffusion Barrier

3.3.1.1 Before placement demonstrate to KEH, by trial placement at site, procedure proposed for placing and compacting diffusion barrier. Prepare "Soil Compaction Procedure" Form KEH-382, sample appended, in accordance with printed instructions, for following areas. Forms will be furnished by KEH.

a. Under concrete.

b. Adjacent to vault/basin walls.

c. On top of vault roof.

d. Other areas requiring hand tampers or small compaction equipment.

3.3.1.2 Keep surrounding area free of dust by watering during placing operation.

3.3.1.3 Stop placing and cover diffusion barrier gravel when average wind speed at Hanford weather station exceeds 25 MPH or peak gusts exceed 40 MPH.

3.3.1.4 Cover diffusion barrier at end of each shift, or when placement or compaction is not in progress.

3.3.1.5 Clean equipment used for hauling, placing, spreading, or compacting of dirt or gravel before handling diffusion barrier material.

3.3.1.6 Conveyers or other equipment used for placement shall not produce segregation.

3.3.1.7 Maximum placement temperature of coated gravel: 150 F when placing against exterior drainage path.

3.3.1.8 Hauling equipment will not be allowed to be driven on diffusion barrier unless thoroughly cleaned.

3.3.1.9 Place coated gravel in layers not to exceed 6 inches loose measurement. Compact areas inaccessible to large compacting equipment by small mechanical compactors. Continue rolling or compacting until particle orientation and consolidation has stopped. KEH will determine type and number of passes required for particular compacting equipment used based on trial placement in subparagraph 3.3.1.1.

a. It is anticipated that desired compaction can be obtained with 6 passes of tandem wheel steel roller weighing at least 10 tons.

3.3.2 Geotextile

3.3.2.1 Lay to minimize tension, stress, folds, wrinkles, or creases, and to provide minimum 12 inch overlap for each joint.

3.3.2.2 Use bags of clean, washed gravel to secure material during installation. Do not use securing pins.

3.4 CONTAMINATED MATERIAL

3.4.1 Remove placed or stored material that has excess dirt or dust contamination, as determined by KEH.

3.5 FIELD QUALITY CONTROL

3.5.1 Verify placement and compaction of diffusion barrier and geotextile as specified in subparagraphs 3.3.1.1 and 3.3.1.9.

3.5.2 Sampling and testing of aggregate and coated gravel will be performed by KEH.

SOIL COMPACTION PROCEDURE

Project No.	Project Title	Date

Contract No.	Procedure No.	Location of Demonstration

A

REQUIREMENTS		EQUIPMENT DEMONSTRATED	
Applicable Spec./Dwg.		Type	
Compaction Required	%	Manufacturer	
Maximum Lift Size		Model	

B

LABORATORY SOIL TEST RESULTS

☐ Non-granular Materials (WSDOT Test Method No. 609)

☐ Granular Materials (WSDOT Test Method No. 606-A)

C

COMPACTION DEMONSTRATION TEST RESULTS

Formula for Percent Compaction:

$$\frac{\text{dry density}}{\text{max density}} \times 100 = \text{Percent Compaction}$$

No. of Passes	Depth of Lift	Percent Moisture	Lbs/ft^3 Dry	Maximum Density	Percent Compaction	Accept	R

Observations or Comments

TEST METHOD USED FOR DEMONSTRATION

☐ Nuclear Gage (ASTM D2922 & D3017)

☐ Sand Cone (ASTM D1556)

Apparatus No. ____________

☐ Other ____________

D

Contractor Representative		Date
Government Representative		Date

INSTRUCTIONS

This Soil Compaction Procedure form, when approved by the Government Representative, constitutes an approved compaction procedure.

Section A is the responsibility of the Construction Contractor. It is to be completed at the time of backfill compaction demonstration and presented to the Government Representative.

Section B is completed by the Government Representative. Data entered is obtained from the agency that performs the laboratory testing.

Section C is completed by the Government Representative as the demonstration is performed. Using the applicable formula, the percent compaction achieved is determined and entered. Acceptance is based on the results as compared with the compaction percent required in Section A.

Section D is signed and dated by the Construction Contractor Representative acknowledging responsibility for this procedure and compliance thereto for applicable backfill operations. Section D is signed and dated by the Government Representative to signify approval.

END OF SECTION

SECTION 02200

EARTHWORK

PART 1 - GENERAL

1.1 REFERENCES

1.1.1 Reference Standards and Specifications: The following standards and specifications, including documents referenced therein, form part of this Section to extent designated herein.

1.1.1.1 Washington State Department of Transportation (WSDOT)

M41-10-88	Standard Specifications for Road, Bridge, and Municipal Construction

1.2 SUBMITTALS: Refer to Section 01300 for submittal procedures.

1.2.1 Method to Prevent Damage During Excavation: Submit procedure proposed to prevent overstressing existing structures or interrupting service to existing facilities.

PART 2 - PRODUCTS

2.1 MATERIALS

2.1.1 General: Obtain select soils from excavation or other designated locations. Obtain on-site approval for soils.

2.1.2 Structural Fill or Backfill: Well graded soil mixtures which may contain cobbles up to 3 inches in greatest dimension if uniformly distributed and not constituting more than 20 percent of volume of fill.

2.1.3 Plastic Sheet Marker: 6 inch wide nondetectable tape similar to "Terra Tape" manufactured by Griffolyn Co, Inc. Tape shall be imprinted with warning such as "Caution Buried Installation Below" at intervals of not more than 4 feet. Color code in accordance with the American Public Works Association uniform color code.

PART 3 - EXECUTION

3.1 PREPARATION

3.1.1 Clearing and Grubbing: Clear debris and organic material from areas to be excavated and to be used for stockpile, and move to location designated by Operating Contractor.

3.2 EXCAVATION

3.2.1 Before performing excavation, obtain excavation permit. Excavation permits will be furnished as set forth in Section 01065.

3.2.2 Locate and expose underground utilities by hand tools. Use of heavy equipment and machinery is subject to approval of KEH.

3.2.3 Shore excavations more than 4 feet deep and with sides sloped steeper than 1-1/2 horizontal to 1 vertical. Install shoring as excavation progresses and remove as backfilling is accomplished.

3.2.4 Store excavated material at stockpile area shown on the Drawings. Water stockpile to ensure dust control.

3.2.5 Wherever slopes of excavations will intersect existing underground lines or structures such as building foundations, underground piping, electrical ducts or direct buried electrical lines, install shoring or other means of support to prevent overstressing existing structure or underground lines or to prevent interrupting service to existing buildings.

3.2.6 Subgrade

3.2.6.1 Make excavations to depth shown on the Drawings. Make bottom of excavations, level, true, and free of loose material. Compact to 95 percent of maximum density before placing diffusion barrier.

3.2.6.2 If over-excavation occurs, correct by placement of backfill, compacted in accordance with subparagraph 3.3.1.2b.

3.2.6.3 Following excavation, moisten subgrade soil as required and proof roll with 2 passes of vibratory compaction equipment.

3.2.7 Existing Asphalt Pavement

3.2.7.1 Make vertical cut along rectangular lines of pavement to remain.

3.2.7.2 Remove and haul broken pavement to disposal site given in Section 01500.

3.3 INSTALLATION

3.3.1 Fill and Backfill

3.3.1.1 General

a. Backfill Permit: Do not start fill or backfill without approved permit as set forth in Section 01065.

b. Remove debris and organic matter from area to be filled or backfilled.

c. Use only select materials for fill or backfill. Keep materials free of frozen particles, lumps, cobbles larger than 3 inches, organic matter and trash.

d. Do not place fill or backfill on frozen ground.

e. Filling or backfilling by sluicing or flooding with water will not be permitted.

f. Bring fill or backfill up evenly on sides of walls, structures and utility lines to avoid unbalanced loading.

g. Do not place fill or backfill against concrete structure or foundation wall less than 14 days after completion of structure or wall unless written permission from KEH is obtained.

3.3.1.2 Structural

a. Before placement of fill or backfill, demonstrate, to KEH by physical test at Site, that procedure proposed for installation and compaction of soils will provide degree of compaction specified. Prepare "Soil Compaction Procedure" Form KEH-382, sample appended, in accordance with printed instructions. Forms will be furnished by KEH.

b. Place backfill in accordance with WSDOT M41-10, Section 2-03.3(14)C, Method C.

c. Compaction control tests will be in accordance with WSDOT M41-10, Section 2-03.3(14)D.

3.3.2 Plastic Sheet Marker: Place continuous over buried utility lines. Place marker tape directly over line and 1 foot below finish grade. Place marker over each outside pipe of multiple lines. Place intermediate markers at maximum of 4 feet apart.

3.4 FIELD QUALITY CONTROL

3.4.1 Soil Compaction Tests: Sampling and testing of compacted fill and backfill will be performed by KEH.

SOIL COMPACTION PROCEDURE

A

Project No.	Project Title	Date

Contract No.	Procedure No.	Location of Demonstration

REQUIREMENTS		EQUIPMENT DEMONSTRATED	
Applicable Spec./Dwg.		Type	
Compaction Required	%	Manufacturer	
Maximum Lift Size		Model	

B

LABORATORY SOIL TEST RESULTS

☐ Non-granular Materials (WSDOT Test Method No. 609)

☐ Granular Materials (WSDOT Test Method No. 606-A)

C

COMPACTION DEMONSTRATION TEST RESULTS

Formula for Percent Compaction:

$$\frac{\text{dry density}}{\text{max density}} \times 100 = \text{Percent Compaction}$$

No. of Passes	Depth of Lift	Percent Moisture	Lbs/ft^3 Dry	Maximum Density	Percent Compaction	Accept	

Observations or Comments

TEST METHOD USED FOR DEMONSTRATION

☐ Nuclear Gage (ASTM D2922 & D3017)

☐ Sand Cone (ASTM D1556)

☐ Other ______

Apparatus No. ______ ______

D

Contractor Representative		Date
Government Representative	APP 4I-407	Date

INSTRUCTIONS

This Soil Compaction Procedure form, when approved by the Government Representative, constitutes an approved compaction procedure.

Section A is the responsibility of the Construction Contractor. It is to be completed at the time of backfill compaction demonstration and presented to the Government Representative.

Section B is completed by the Government Representative. Data entered is obtained from the agency that performs the laboratory testing.

Section C is completed by the Government Representative as the demonstration is performed. Using the applicable formula, the percent compaction achieved is determined and entered. Acceptance is based on the results as compared with the compaction percent required in Section A.

Section D is signed and dated by the Construction Contractor Representative acknowledging responsibility for this procedure and compliance thereto for applicable backfill operations. Section D is signed and dated by the Government Representative to signify approval.

END OF SECTION

SECTION 02512

HOT-LAID ASPHALTIC CONCRETE PAVEMENT

PART 1 - GENERAL

1.1 REFERENCES

1.1.1 Reference Standards and Specifications: The following standards and specifications, including documents referenced therein, form part of this Section to extent designated herein.

1.1.1.1 Washington State Department of Transportation (WSDOT)

M41-10-88	Standard Specification for Road, Bridge, and Municipal Construction

1.2 SUBMITTALS: Refer to Section 01300 for submittal procedures.

1.2.1 Laboratory Reports: Submit laboratory reports for following.

1.2.1.1 Asphalt: Showing that asphalt used in mix meets the requirements of AR-4000W in accordance with WSDOT M41-10, Section 9-02.1(4).

1.2.1.2 Asphalt concrete mix: Showing compliance with WSDOT M41-10, Sections 9-03.8(2) and 9-03.8(6). Include Rice density as established by WSDOT Method 705.

1.2.2 Handling and Placing Procedures: Submit procedure that defines methods to keep diffusion barrier free of dirt or foreign material during asphalt concrete pavement placement.

PART 2 - PRODUCTS

2.1 MATERIALS

2.1.1 Asphalt: Meeting the requirements of WSDOT M41-10, Section 9-02.1(4). Grade of paving asphalt for use in asphaltic concrete mixture shall be AR-4000W.

2.1.2 Aggregate: Class "B" meeting the requirements of WSDOT M41-10, Section 9-03.8(1), (2), and (3)B.

2.1.3 Blending Sand: Meeting the requirements of WSDOT M41-10, Section 9-03.8(4).

2.1.4 Mineral Filler: Meeting the requirements of WSDOT M41-10, Section 9-03.8(5).

2.2 MIXES

2.2.1 Proportioning of Asphalt Concrete Materials: Meeting the requirements of WSDOT M41-10, Section 9-03.8(6) Class "B" asphalt concrete.

PART 3 - EXECUTION

3.1 INSTALLATION

3.1.1 Construction: In accordance with following sections of WSDOT M41-10.

3.1.1.1 Asphalt mixing plants: Section 5-04.3(1).

3.1.1.2 Hauling equipment: Section 5-04.3(2).

3.1.1.3 Asphalt pavers: Section 5-04.3(3).

3.1.1.4 Rollers: Section 5-04.3(4).

3.1.1.5 Asphalt material heating: Section 5-04.3(6).

3.1.1.6 Aggregate preparation: Section 5-04.3(7).

3.1.1.7 Mixing: Section 5-04.3(8).

3.1.1.8 Spreading and finishing: Section 5-04.3(9).

3.1.1.9 Compaction: Section 5-04.3(10).

3.1.1.10 Diffusion barrier shall remain covered as specified in Section 02145, subparagraphs 3.3.1.2 and 3.3.1.4 before placing pavement.

3.1.1.11 Weather limitations: Do not place asphalt when surface temperature of diffusion barrier is less than 45 F, when average wind speed at Hanford weather station exceeds 25 mph, or peak gusts exceed 40 mph.

3.1.1.12 Keep surrounding area free of dust by watering during paving.

3.1.1.13 Stop placing and cover diffusion barrier when average wind speed at Hanford weather station exceeds 25 mph, or peak gusts exceed 40 mph.

3.1.1.14 Clean equipment used for conveying, placing, spreading, and compacting of dirt or gravel that may contaminate diffusion barrier during paving operation.

3.1.1.15 Hauling equipment will not be allowed to be driven on diffusion barrier.

3.1.2 Patching Existing Asphalt Pavement

3.1.2.1 Prepare subgrade in area to receive asphalt patching by compacting in accordance with Section 02200, subparagraph 3.3.1.2b.

3.1.2.2 Before patch is constructed, true-up pavement cut with straight edges and vertical faces.

3.1.2.3 Place asphalt concrete to thickness required to match compacted thickness of existing pavement or to minimum compacted thickness of 1-1/2 inches, whichever is greater. Place, level, and compact to comply with adjacent paved surface.

3.2 FIELD QUALITY CONTROL

3.2.1 Sampling and testing of asphalt concrete pavement will be performed by KEH.

END OF SECTION

SECTION 02752

LEACHATE COLLECTION SUMP LINER

PART 1 - GENERAL

1.1 REFERENCES

1.1.1 Reference Standards and Specifications: The following standards and specifications, including documents referenced therein, form part of this Section to extent designated herein.

1.1.1.1 American Society of Mechanical Engineers (ASME)

1986 Edition, w/Addenda through Dec 1988	ASME Boiler and Pressure Vessel Code
Section IX	Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators

1.1.1.2 American Society for Nondestructive Testing (ASNT)

Recommended Practice No. SNT-TC-1A (1984 Edition)	Personnel Qualification and Certification in Nondestructive Testing

1.1.1.3 American Society for Testing and Materials (ASTM)

A 36-87	Standard Specification for Structural Steel
A 53-87b	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
D 3350-84	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

1.1.1.4 American Welding Society (AWS)

AWS D1.1-88	Structural Welding Code-Steel
AWS D9.1-84	Specification for Welding of Sheet Metal
AWS QC1-86	Standard for Qualification and Certification of Welding Inspectors

1.1.1.5 American Water Works Association (AWWA)

C203-86	AWWA Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines--Enamel and Tape--Hot-Applied

1.1.1.6 Steel Structures Painting Council (SSPC)

SSPC-SP 3-82	No. 3 Power Tool Cleaning
SSPC-SP 6-85	No. 6 Commercial Blast Cleaning

1.2 SUBMITTALS: Refer to Section 01300 for submittal procedures.

1.2.1 Fabricator Drawings and Procedures: Submit drawings and procedures for fabrication, erection and installation of sump liner, riser, and plastic pipe spools. Include plans, elevations, details, sections and connections. Submittal shall show thickness, type, grade, class of metal, and fasteners. Show anchorage and accessory items where applicable.

1.2.2 Certified Material Test Reports (CMTR): Submit legible reports, certified by responsible manufacturer, showing chemical analysis and physical properties of each heat steel plate, shapes, pipe and fittings, and filler material. Submit separate certified reports for each lot of steel furnished by each supplier.

1.2.3 Filler Material Control Procedure: Submit procedure for control of filler material. Specify methods of control, by heat or lot number, from receipt of material to consumption during fabrication, and control and disposal of contaminated and partially used material.

1.3 QUALITY ASSURANCE

1.3.1 Qualification of Welding Personnel and Procedures

1.3.1.1 Personnel and procedures for welding structural steel and steel pipe shall have been qualified in accordance with AWS D1.1 before welding. Qualification in accordance with ASME Section IX may be substituted for this requirement.

1.3.1.2 Personnel and procedures for welding sheet metal shall have been qualified in accordance with AWS D9.1 before welding. Qualification in accordance with ASME Section IX may be substituted for this requirement.

1.3.1.3 Personnel and procedures for welding steel pipe shall have been qualified in accordance with ASME Section IX before welding.

1.3.1.4 Deliver 2 copies of welding procedure specifications, procedure qualification records, and welder performance qualification test results to KEH 5 days before welding. Maintain additional copies as specified in Section 01400, Paragraph 1.6.2.

1.3.2 Qualification of Nondestructive Examination (NDE) Personnel

1.3.2.1 Visual weld examinations and appropriate documentation shall be performed by Certified Welding Inspectors (CWI) who have received certification in accordance with AWS QC1. Certified Associate Welding Inspectors (CAWI), certified in accordance with above standard, may be used to perform examinations when under immediate direction of CWI. Welding related examination documentation shall be signed, or stamped by individual performing examination. Where CAWI's are used for examinations, documentation shall be signed, or bear CAWI's stamp in addition to CWI's under whom examinations were performed.

1.3.2.2 Personnel performing other NDE shall have been certified in accordance with Contractor's written practice, which shall meet the requirements of ASNT No. SNT-TC-1A, before performing NDE. Use Level II or III personnel to interpret test results.

1.3.2.3 Deliver 2 copies of personnel certifications, written NDE performance procedures, and Contractor's written practice to KEH 5 days before examining. Maintain additional copies as specified in Section 01400, Paragraph 1.6.2.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Welding Material

1.4.1.1 Store separately, welding materials of different material specifications.

1.4.1.2 Store and control filler material in accordance with approved procedure.

1.4.1.3 Preserve identity from time of receipt on site until use in facility construction.

1.4.2 Sump Liner: Upon receipt examine for damage, seal openings, and store on dunnage.

1.4.3 Steel Riser Pipe: Upon receipt examine for damage.

1.4.4 Polyethylene Plastic Pipe and Fittings: Upon receipt examine for damage.

1.4.5 Deliver materials to project at time convenient for installation and store off ground. If exposed to inclement weather, protect with paper, plastic, or other weatherproof covering.

PART 2 - PRODUCTS

2.1 MATERIALS

2.1.1 Carbon Steel Plate and Shapes: ASTM A 36, except as specified on the Drawings.

2.1.2 Carbon Steel Pipe: ASTM A 53, Type S, Grade B.

2.1.3 Polyethylene Plastic Pipe and Fittings: ASTM D 3350, Class 355434C.

2.1.4 Exterior Protective Coating: Tapecoat Company "Tapecoat 20" and primer meeting the requirements of AWWA C203.

2.2 FABRICATION

2.2.1 Fabricate sump liner and pipe spools in accordance with the Drawings and approved submittals.

2.2.2 Weld plastic pipe by butt fusion method.

2.2.3 Weld Identification: Prepare weld identification drawings which show relative position of each pressure containing weld and each weld to pressure retaining components.

2.3 SOURCE QUALITY CONTROL

2.3.1 Weld Examinations

2.3.1.1 100 percent visual examination is required for fit-up, root and cover passes. Examine in welded condition. Acceptance criteria shall be in accordance with AWS D1.1, Paragraph 8.15.1.

2.3.1.2 Perform 100 percent liquid penetrant (dye penetrant) examination (PT) on root and cover passes in accordance with AWS D1.1, Paragraph 6.7.6 and Section 8.

2.3.1.3 Fabrication of sump liner is subject to examination by KEH.

2.3.1.4 NDE documentation.

a. Document examination of pressure welds and welds to pressure retaining components for pipes and liners on NDE/Weld Record Form KEH-433 furnished by KEH (sample appended).

1) See Form KEH-433 for instructions for recording weld identification drawings, weld numbers, welder identification, welding procedure specification numbers, visual examinations, nondestructive examinations, and for noting satisfactory completion of leak testing.

b. Documentation shall be kept current and is subject to review by KEH. Prepare and certify records as work progresses.

c. Required NDE/Weld examinations shall be completed and documented before start of leak testing.

d. NDE/Weld Record information and weld identification drawings may be incorporated on single format or traveler for specific work package.

e. Deliver completed NDE/Weld Record and record weld identification drawings to KEH within 7 working days after completion of system leak testing.

PART 3 - EXECUTION

3.1 INSTALLATION

3.1.1 Place sump liner and assemble plastic pipe in accordance with approved submittals and the Drawings.

3.1.2 Assemble plastic to steel flange joints without gasket. Use steel backing rings on plastic flanges.

3.1.3 Before sump liner and pipe is encased in concrete, hydrostatically test liner and flanged connections in accordance with Paragraph 3.2.1.

3.1.4 After concrete encasement has cured install riser in accordance with the Drawings and approved submittals.

3.1.5 Exterior Protective Coating

3.1.5.1 Complete NDE and leak testing before application of exterior protective coating.

3.1.5.2 Protect short lengths of carbon steel pipe and fittings exposed to earth backfill with specified coating.

a. Clean carbon steel surfaces to white metal by sandblasting in accordance with SSPC-SP 6. Where blasting is impracticable, as determined by KEH, clean by power wire brushing in accordance with SSPC-SP 3.

b. Heat and apply specified tape in accordance with AWWA C203, Section 3, and manufacturer instructions.

3.1.5.3 After installation, examine carbon steel pipe having field applied exterior protective coating materials.

a. Use electrical holiday detector in accordance with AWWA C203, Section 2.14.12.

b. Repair damage to coating in accordance with AWWA C203, Section 2.14.12.

3.2 FIELD QUALITY CONTROL

3.2.1 Hydrostatic Testing

3.2.1.1 Prepare written procedure for disposal of water used for testing. Deliver to KEH for approval 10 days before testing.

3.2.1.2 Hydrostatically test sump liner and pipe flanged connections before placing concrete by applying internal pressure of 15 psig of water to entire length of plastic pipe and steel flange. Pump water out and dry liner after test. No visible standing water.

3.2.2 Perform NDE listed on back of attached NDE/Weld Record Form KEH-433 for welds.

9 0 1 1 7 8 5 0 9 6 9

NDE/WELD RECORD	1. Project/W.O. No.		2. Weld Identification Dwgs.			3. Contractor
4. WELD INFORMATION	5. VISUAL EXAMINATION			6. LIQUID PEN. / MAG. PART.	7. RADIO. / 8. LEAK TEST	9. Other
	Fit-up	Root Pass	Cover Pass			
Weld No.				Root Pass	Radiographic	
Welder Identification						
Welding Procedure Specification				Cover Pass	Leak Test	
Weld Filler Mat'l.						
Weld No.				Root Pass	Radiographic	
Welder Identification						
Welding Procedure Specification				Cover Pass	Leak Test	
Weld Filler Mat'l.						
Weld No.				Root Pass	Radiographic	
Welder Identification						
Welding Procedure Specification				Cover Pass	Leak Test	
Weld Filler Mat'l.						
Weld No.				Root Pass	Radiographic	
Welder Identification						
Welding Procedure Specification				Cover Pass	Leak Test	
Weld Filler Mat'l.						
Weld No.				Root Pass	Radiographic	
Welder Identification						
Welding Procedure Specification				Cover Pass	Leak Test	
Weld Filler Mat'l.						
Weld No.				Root Pass	Radiographic	
Welder Identification						
Welding Procedure Specification				Cover Pass	Leak Test	
Weld Filler Mat'l.						

APP 4I-418

9 0 1 1 7 8 6 0 9 7 0

71402750.SP2

INSTRUCTIONS FOR USE

The NDE/WELD RECORD form shall be used to document the nondestructive examination/testing of the piping systems listed below. Entries shall be made as work progresses, and records are subject to review by the Government's Representative at any time.

Complete the NDE/WELD RECORD as follows (number in parenthesis corresponds to block number).

(1) Enter Project Number.
(2) Enter Weld Identification Drawing Numbers.
(3) Enter name of Contractor.
(4) Enter Weld Information:
- Weld Number
- Welder Identification
- Welding Procedure Specification
- Weld Filler Material (Type)

(5) through (9) Enter date of examination/testing in upper half of block; initial or stamp lower half of block as each weld is examined and accepted in compliance with contract requirements.

NONDESTRUCTIVE EXAMINATION/TESTING REQUIREMENTS FOR PIPING SYSTEMS

NDE/NDT METHOD \ PIPE CODES	Riser & Pit Drain	Catch Basin Drain	Liner					
VISUAL								
Fitup	C		C					
Root Pass	C		C					
Cover Pass	C	C*	C					
LIQUID PENETRANT								
Root Pass	C							
Cover Pass	C							
MAGNETIC PARTICLE								
Root Pass								
Cover Pass								
RADIOGRAPHIC								
Completed Weld								
LEAK/PRESSURE								
Completed Weld		G	G					
OTHER								

COMMENTS

*Visually examine butt fussion weld on polyethylene drain pipe.

Allowable reduction of pipe ID: 10 percent maximum. Maintain minimum wall thickness.

Legend

A. Requires witnessing concurrently by the Government Representative and acceptance prior to recording.
B. Requires acceptance of radiographs and documentation by the Government Representative prior to recording.
C. Circumferential and longitudinal butt welds.
D. Full penetration welds on branch connections.
E. Attachment welds to pipe.
F. Tie-in circumferential and longitudinal butt welds that cannot be examined by leak/pressure test.
G. Other: Welded and flanged connections.

END OF SECTION 02752

APP 41-419

SECTION 02753

EXTERIOR DRAINAGE PATH

PART 1 - GENERAL

1.1 REFERENCES

1.1.1 Reference Standards and Specifications: The following standards and specifications, including documents referenced therein, form part of this Section to the extent designated herein.

1.1.1.1 American Society for Testing and Materials (ASTM)

D 638-87b	Standard Test Method for Tensile Properties of Plastics
D 746-79 (1987)	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
D 792-86	Standard Test Methods for Specific Gravity and Density of Plastics by Displacement
D 1004-66 (1981)	Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting
D 1238-86	Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
D 1505-85	Standard Test Method for Density of Plastics by the Density-Gradient Technique
D 1593-81	Standard Specification for Nonrigid Vinyl Chloride Plastic Sheeting
D 1603-76 (1983)	Standard Test Method for Carbon Black in Olefin Plastics
D 3895-80 (1986)	Standard Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis

1.1.1.2 National Sanitation Foundation (NSF)

NFS Standard 54-85	Flexible Membrane Liners

1.2 SUBMITTALS: Refer to Section 01300 for submittal procedures.

1.2.1 Fabricator Drawings: Submit drawings showing details of factory and field joints.

1.2.2 Installation Plan: Submit procedures for installation of materials and components. Include list of equipment and amount of utilities required, proposed methods for laying materials and components, and method for holding material sections in place during installation.

1.2.2.1 Installer may submit alternate method of installation that provides complete coverage of vault exterior.

1.2.3 Manufacturer's Data: Provide data defining physical properties of drainage net and membrane to be supplied.

1.2.4 Surface Acceptance: Provide information required by Paragraph 3.1.2.

1.2.5 Care and Repair Instructions: Submit information concerning recommended care and repair procedures for membrane and components. Include recommended shoe types for construction personnel, tools for cleaning, and minimum and maximum temperatures at which cleaning, inspecting, and repair operations may be performed.

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Pack fabricated pieces in containers to prevent damage during shipment. Pack containers for minimum handling at site and clearly mark with location of installation.

1.3.2 Storage

1.3.2.1 Unload and store with minimum of handling.

1.3.2.2 Do not store materials on ground.

1.3.2.3 Storage area shall protect materials from moisture, mud, soil, dust, and debris.

1.3.3 Handling

1.3.3.1 Handle materials to ensure sound, undamaged conditions.

1.3.3.2 During unrolling of material, visually examine sheet surface. Mark and repair faulty areas in accordance with approved instructions.

1.4 PROJECT CONDITIONS

1.4.1 Environmental Requirements: Within limits given in NSF Standard 54, Appendix C while handling plastic sheeting material.

PART 2 - PRODUCTS

2.1 MATERIALS

2.1.1 HDPE Membrane

2.1.1.1 Fabricate from 60 mil HDPE sheeting meeting following requirements.

Property	Test Method	Values
Gage (mils, nominal)		60
Thickness (mils, minimum)	ASTM D 1593/ Para 9.1.3	54
Specific Gravity (min)	ASTM D 792	0.94
Minimum Tensile Properties (each direction)	ASTM D 638	
Tensile Strength Yield (lb/in. width)		120
Tensile Strength at Break (lb/in. width)		180
Elongation at Yield (percent)		10
Elongation at Break (percent)		500
Modulus of Elasticity (psi)		80,000
Tear Resistance (lb, minimum)	ASTM D 1004 Die C	30
Low Temperature (F)	ASTM D 746 Procedure B	-40

2.1.1.2 Thickness: 54 mils minimum at any point on membrane.

2.1.1.3 Fabricate liner from large pieces of sheeting to proper size and shape. Keep field joints to minimum in accordance with approved installation drawings. Preform corner pieces to proper size and shape at factory.

2.1.2 Drainage Net

2.1.2.1 Fabricate from HDPE strands. Arrange 2 sets of strands, spaced 1/2 inch center to center maximum, together to form "net" or "mesh" with minimum 2 strands per inch each direction. System shall meet the following requirements.

Property	Test Method	Values
Density (g/cm^3) (min)	ASTM D 1505	0.94
Crystallinity (%)	Differential Scanning Calorimeter	40-55
Carbon Black (%)	ASTM D 1603	1-3
Melt Flow Index (g/10 min.)	ASTM D 1238	
	(190 C, 2.16 KG)	0.2-0.5
	(190 C, 5.0 KG)	1.0-2.2
Thermal-Oxidative Stability, minutes DSC	ASTM D 3895	
	(160 C, 20 psi O_2)	20-175
	(160 C, 800 psi O_2)	6-36
Minimum Compressive Stress Imposed (psf)	----	7,000
Minimum Thickness (mm)	----	5

2.1.3 Geotextile: See Section 02756.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Before work is started examine sheet rolls for damage from transit and storage. If damaged, set aside and do not use.

3.1.2 Before installation, provide written documentation to KEH that surfaces to receive materials have been examined and are acceptable for installation.

3.2 INSTALLATION

3.2.1 Climatic Conditions: Within limits given in NSF Standard 54, Appendix C while handling sheeting material.

3.2.2 Placing: Place fabricated pieces in position shown on approved installation drawings. Unroll, position, and smooth out folds and wrinkles. Allow sheets to relax before anchoring. Fasten material temporarily, in accordance with installer's approved procedure, to prevent wind damage until material is secured.

3.2.3 Field Seams: Overlap membrane panels 6 inches, minimum, and fasten with batten plate.

3.2.4 Extrusion Weld Repair Work

3.2.4.1 Welding equipment shall be capable of continuously monitoring and controlling temperature in zone of contact so changes in environmental conditions will not effect integrity of weld.

3.2.4.2 Where "fish mouths" occur, repair area in accordance with Paragraph 3.2.5.

3.2.4.3 "Fish mouths" are not acceptable within seam area.

3.2.4.4 Replace or repair, in accordance with Paragraph 3.2.5, membrane area showing out of tolerance injury due to excessive scuffing, or puncture.

3.2.4.5 Welds, on completion of work, shall be tightly bonded.

3.2.5 Repairs

3.2.5.1 Make repairs to membrane by applying piece of sheeting, sufficient in size to extend approximately 3 to 6 inches beyond damaged area. Make patch round or oval.

3.2.5.2 Make repairs to geogrid and geotextile in accordance with manufacturer's recommended procedures.

3.3 FIELD QUALITY CONTROL

3.3.1 Final Examination and Acceptance

3.3.1.1 Verify no damage has occurred to geotextile or geomembrane.

3.3.1.2 Prepare record drawings showing field changes incorporated.

3.3.1.3 Deliver test documentation and record drawings to KEH.

END OF SECTION

SECTION 02755

WASTE DISPOSAL BASIN LINERS

PART 1 - GENERAL

1.1 REFERENCES

1.1.1 Reference Standards and Specifications: The following standards and specifications, including documents referenced therein, form part of this Section to extent designated herein.

1.1.1.1 American Society for Testing and Materials (ASTM)

D 413-82 (1988)	Standard Test Methods for Rubber Property--Adhesion to Flexible Substrate
D 570-81	Standard Test Method for Water Absorption of Plastics
D 638-87b	Standard Test Method for Tensile Properties of Plastics
D 696-79	Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics
D 746-79 (1987)	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
D 751-79	Standard Methods of Testing Coated Fabrics
D 792-86	Standard Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement
D 1004-66 (1981)	Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting
D 1203-86	Standard Test Methods for Volatile Loss from Plastics Using Activated Carbon Methods
D 1204-84	Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature

9011783.0977

D 1238-86	Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
D 1593-81	Standard Specification for Nonrigid Vinyl Chloride Plastic Sheeting
D 1603-76 (1983)	Standard Test Method for Carbon Black in Olefin Plastics
D 1693-70 (1980)	Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
D 3083-76 (1983)	Standard Specification for Flexible Poly (Vinyl Chloride) Plastic Sheeting for Pond, Canal, and Reservoir Lining
D 3985-81	Standard Test Method for Oxygen Gas Transmission Rate Through Plastic Film and Sheeting Using a Coulometric Sensor
E 96-80	Standard Test Methods for Water Vapor Transmission of Materials

1.1.1.2 Environmental Protection Agency (EPA)

EPA/530-SW-86-031	Technical Guidance Document Construction Quality Assurance for Hazardous Waste Land Disposal Facility

1.1.1.3 Federal Standards (FED STD)

FED-STD-101C, Including CHGS NOT 1, And 2	Test Procedure For Packaging Materials
Method 2065.1	Puncture Resistance And Elongation Test (1/8 Inch Radius Probe Method)

1.1.1.4 National Sanitation Foundation (NSF)

NSF Standard 54-85	Flexible Membrane Liners

1.2 SUBMITTALS: Refer to Section 01300 for submittal procedures.

1.2.1 Installation Drawings: Submit drawings showing lining sheet layout with proposed size, number, position, sequence of placing, and location of field seams. Include details and methods for anchoring at perimeter, making field seams, and making anchors/seals to pipes and structures penetrating lining.

1.2.2 Installation Procedures: Submit procedures for installation and testing of liner and components. Include list of equipment and amount of utilities required, proposed methods for laying liner and components, and following.

1.2.2.1 Procedures for welding seams in accordance with manufacturer's recommendations and this Section.

1.2.2.2 Method for holding liner sections in place during installation.

1.2.2.3 Method for examining liner and components, and testing joints, seams, welds, and bolt tightening.

1.2.3 Manufacturer's Data

1.2.3.1 Resin: Provide data defining physical properties of high density polyethylene (HDPE) resin to be supplied. For each resin batch, test as shown in Table 02755-I. Complete testing and submit for review before using.

TABLE 02755-I

PHYSICAL PROPERTIES QUALITY CONTROL

Property	Test Method	Values
Specific Gravity (min)	ASTM D 792	0.94
Melt Flow Index (gr/10 mins, max)	ASTM D 1238, Condition E	0.3
Volatile Loss (max%)	ASTM D 1203, Method A	0.1

1.2.3.2 Liner: Provide data defining physical properties of high density polyethylene (HDPE) liner to be supplied. As minimum, properties shall meet the requirements of NSF Standard 54. Provide documentation of verification of physical properties of liner sheets. For each resin batch used, test using parameters defined in subparagraph 2.1.1.2 to document material properties. Complete testing and submit for review before fabrication. Submit additional copy of documentation with each panel.

1.2.4 Samples: Submit samples of lining material and field seams.

1.2.4.1 Lining material: Submit 8 inch by 10 inch samples from same batch of liner used for construction, and totaling approximately 20 sq ft.

1.2.4.2 Field seams: Submit numbered and dated samples, measuring 12 inches plus seam width in width and 18 inches in length, fabricated with materials specified for lining in accordance with approved procedures and this Section, and tested in accordance with Paragraph 1.3.5.

1.2.5 Certified Material Test Reports (CMTR): Submit materials test reports, for each item furnished by each supplier, certified by manufacturers of resins and liners, and stating that liner and extrudate are of 100 percent virgin materials. Reports shall identify items, show results of chemical analysis and physical tests and meet following requirements.

1.2.5.1 Raw materials: Table 02755-I.

1.2.5.2 Lining material: Subparagraph 2.1.1.2.

1.2.6 Care and Repair Instructions: Submit information concerning recommended care and repair procedures for liner and components. Include recommended shoe types for construction personnel, tools for cleaning and removing wind-blown sand and debris, and minimum and maximum temperatures at which cleaning, inspecting, and repair operations may be performed.

1.2.7 Certificates of Experience: Submit "Certificates of Experience" from manufacturer and installer showing qualification in accordance with Paragraphs 1.3.1 and 1.3.2. Installer shall provide list showing names, addresses, and telephone numbers for completed projects.

1.2.8 Manufacturer's Quality Control Plan: Submit quality control plan for Project. Plan shall address requirements of Paragraph 1.3.3.

1.2.9 Certification: Submit certificates of compliance in accordance with Paragraph 1.3.6.

1.2.10 Surface Acceptance: Provide information required in Paragraph 3.1.2.

1.3 QUALITY ASSURANCE

1.3.1 Qualification of Manufacturer: Manufacturer shall have successfully manufactured minimum 5,000,000 square feet of similar liner material for hydraulic lining installations, and be listed by NSF as meeting the requirements for manufacturing HDPE. Material supply shall also include projects for Resource Conservation and Recovery Act (RCRA) Landfills and Surface Impoundments.

1.3.1.1 Make arrangements with manufacturer for KEH visit to plant before manufacture of lining material to verify quality control program, and during manufacture of material for Project to observe manufacturing methods and obtain raw materials and products for independent testing.

1.3.2 Qualification of Installer: Provide evidence of successfully installing at least 10 projects, and at least 5,000,000 square feet of liner. Projects shall include RCRA Landfills and Surface Impoundments.

1.3.3 Manufacturer's Quality Control Plan: Quality control plan to be implemented for Project shall be in accordance with EPA/530-SW-86-031. Include name of polymer resin supplier, product identification, acceptance testing, fabrication and production testing, documentation of changes, retests, and acceptance.

1.3.4 Construction Quality Assurance

1.3.4.1 Preinstallation meeting: Manufacturer and Contractor shall attend meeting, initiated by KEH, before installation of lining to review and discuss training and qualification procedures for Contractor personnel, and demonstration of making field welded seams including peel and shear tests.

1.3.4.2 Manufacturer shall provide on-site technical supervision and assistance during installation of lining.

1.3.5 Qualification of Welds: Before welding liner, provide field weld samples using same equipment and procedure to be used for welding liner. Perform nondestructive testing in accordance with Paragraph 3.3.1. Perform destructive testing in accordance with Paragraph 3.3.2. Entire seam shall pass nondestructive tests, and 2 of 3 samples shall pass destructive tests, third sample shall attain at least 95 percent of required values.

1.3.6 Upon completion of work, and as condition of acceptance, deliver to KEH 2 copies of certificate signed by authorized agent of manufacturer of liner, and cosigned by installer, stating materials and methods used meet specified requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Pack fabricated pieces and rolls wrapped with sheet of same material in containers supported and padded to prevent damage during shipment. Pack containers for minimum handling at site and clearly mark with location of installation. Provide label for each roll and prefabricated piece showing results of tests in subparagraph 2.1.1.2 and stating name of manufacturer, product type, thickness, manufactures batch code, date of manufacture, physical dimensions, panel number or placement of prefabricated pieces according to Paragraph 1.2.1, and directions for unrolling membrane. Do not remove labels.

1.4.2 Examine lining materials delivered to Site for:

1.4.2.1 Puncture from nails or splinters.

1.4.2.2 Tears from operation of equipment or inadequate packaging.

1.4.2.3 Exposure to temperature extremes resulting in unusable material.

1.4.2.4 Bonding together of adjacent membrane layers which may be caused by excessive heat.

1.4.2.5 Crumpling or tearing from inadequate packaging support.

1.4.3 Unload and store with minimum of handling.

1.4.4 Store materials off ground on padded dunnage in secure area sheltered from mud, soil, dirt, debris, adverse weather, precipitation, ultraviolet light, heavy winds, and temperature extremes.

PART 2 - <u>PRODUCTS</u>

2.1 MATERIALS

2.1.1 High Density Polyethylene (HDPE) Liner: Add carbon black, antioxidants and heat stabilizers to resin for ultraviolet resistance and manufacturing purposes. Supply HDPE as single ply continuous sheet with no factory seams and in rolls with minimum 22 foot width. Maximize roll length to provide largest manageable sheet for fewest field seams.

2.1.1.1 Materials similar to those manufactured by Gundle Lining Systems Inc, Houston, Texas; or Poly-America Inc, Grand Prairie, Texas.

2.1.1.2 Lining material shall meet following minimum physical property values.

Property	Test Method	Values
Thickness (mils ± 10 %)	ASTM D 1593	60
Specific Gravity (min)	ASTM D 792	0.94
Carbon Black Content (%)	ASTM D 1603	2 to 2-1/2
Melt Flow Index (g/10 min, maximum)	ASTM D 1238, Condition E	0.3
Tensile Properties (each direction)	ASTM D 638, Type IV Specimen, 2 ipm	
Tensile Strength at Yield (lb/in width, min)	—	120
Tensile Strength at Break (lb/in width, min)		180

Property	Test Method	Values
Elongation at Yield (%, min)		10
Elongation at Break (%, min)		500
Modulus of Elasticity (lbs/sq in., min)		80,000
Tear Resistance (lb, min)	ASTM D 1004, Die C	30
Puncture Resistance (lbs, min)	FED-STD-101, Method 2065.1	69
Low Temperature/Brittleness (F, max)	ASTM D 746, Procedure B	-40
*Dimensional Stability (max % change each direction)	ASTM D 1204, 212 F 1 hr	±2
*Volatile Loss (max %)	ASTM D 1203, Method A	0.1
*Environmental Stress Crack (min hours)	ASTM D 1693, Condition C (100 C)	750
Water Absorption (max % weight change)	ASTM D 570	0.1
Coefficient of Linear Thermal Expansion (cm/cm C, max)	ASTM D 696	1.2 X 10-4
Hydrostatic Resistance (psi, min)	ASTM D 751, Method A-1	490
Moisture Vapor Transmission (g/m^2 day, max)	ASTM E 96	0.03
Resistance to Soil Burial	ASTM D 3083, using ASTM D 638 Type IV specimen at 2 ipm	
Change in Tensile Strength at Break and Yield (%)		± 5
Change in Elongation at Break and Yield (%)		± 10

Property	Test Method	Values
Bonded Seam Strength, Field		
Tensile, min	ASTM D 638	90% of parent
Peel Adhesion, min	ASTM D 413	material film tear band
Oxidation Inductive Time (minutes, min at 130 C 800 psi O_2)	ASTM D 3985	2000

*Format uses NSF 54 table for HDPE as guide. However, RCRA values for Volatile Loss, Dimensional Stability, and Environmental Stress Crack have been added.

2.1.1.3 Resin used for extrudate fusion welding shall be HDPE produced from and same as HDPE sheet resin. Physical properties shall be same as HDPE lining sheets.

2.1.1.4 Liner thickness shall be at least 54 mils at any point on liners.

2.1.1.5 Fabricate liner from large pieces of sheeting to proper size and shape to fit contours of basin. Prefabricate corner pieces in factory. Keep field joints to minimum and in accordance with approved installation drawings.

2.1.1.6 Liner material will be required for EPA's method 9090 testing. There shall be no changes in formulation of liner material once testing has begun.

2.2 SOURCE QUALITY CONTROL

2.2.1 Tests

2.2.1.1 Preparation: Obtain 1 sample from preformed products from each form in use each day. Cut sample in half. Keep 1/2 for testing and deliver remaining half to KEH for testing.

2.2.1.2 Testing: Test samples for thickness, tensile strength at yield, and tensile strength at break as specified in subparagraph 2.1.1.2 except values may be reduced by 10 percent.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Before work is started examine sheet rolls for damage from transit. If damaged set aside. Those that cannot be repaired, shall be rejected.

3.1.2 Before installation of liner, ensure surface is free of soil rocks, standing water or other debris, and provide written documentation to KEH that surfaces to receive liner have been examined and found to be acceptable for installation.

3.1.3 During unrolling of material, visually examine sheet surface. Mark and repair faulty areas in accordance with approved procedure. Document repaired areas on installation drawings by showing location and identity of repair crew.

3.2 INSTALLATION

3.2.1 Climatic Conditions: Within limits given in NSF Standard 54, Appendix C while handling, repairing, or seaming plastic sheeting material. Maximum wind 15 mph and no precipitation or fog.

3.2.2 Placing: Place fabricated pieces in position shown on approved installation drawings. Verify preformed pieces fit snugly in position to prevent undue stress. Unroll, position, and smooth out folds and wrinkles. Allow sheets to relax before seaming. Anchor liner temporarily, in accordance with installer's approved procedure, to prevent wind damage until material is secured.

3.2.3 Field Seams: Do not make horizontal welds on vertical surfaces. Overlap panels 4 to 6 inches. Ensure liner surface is free of dirt, dust, moisture, and deleterious materials before seaming, and climatic conditions meet the requirements of Paragraph 3.2.1.

3.2.3.1 Do not place in areas where field vacuum box testing cannot be performed.

3.2.3.2 Extrusion welding: Weld sheeting together using extrudate with composition identical to sheeting material.

3.2.3.3 Fusion welding: Weld sheeting together by producing a double seam with an enclosed space.

3.2.3.4 Welding equipment shall be capable of continuously monitoring and controlling temperature in zone of contact so changes in environmental conditions will not effect integrity of weld.

3.2.3.5 Where "fish mouths" occur, repair area in accordance with Paragraph 3.2.4.

3.2.3.6 "Fish mouths" are not acceptable within seam area.

3.2.3.7 Traverse entire surface and examine for tears, punctures, and thin spots. Replace or repair, in accordance with Paragraph 3.2.4, liner area showing out of tolerance injury. Document repaired areas on installation drawings by showing location and repair crew identity.

3.2.3.8 Welds, on completion of work, shall be tightly bonded.

3.2.4 Damage Repairs: Make repairs to liner by applying piece of sheeting, sufficient in size to extend approximately 3 to 6 inches beyond damaged area. Make patch round or oval and install using same materials and procedures used in making field joints. Do not use cutting tools while working on top of installed liner except when cutting destructive test samples.

3.2.4.1 Seam repairs: Repair seam areas represented by failed samples. Area to be repaired includes failed test location and extends in both directions to location where sample passed. To reduce extent of area to be repaired, additional samples may be taken 10 feet minimum from either side of failed test location. Document failed seams on installation drawings by showing location and seaming crew identity.

3.2.5 Vault Floor Covering: Cover portion of vault floors shown on the Drawings, coated with protective coating specified in Section 09885, with HDPE after hydrostatic testing specified in Section 03301.

3.3 FIELD QUALITY CONTROL

3.3.1 Nondestructive Testing

3.3.1.1 Test fusion welds in their entirety using air pressure test or vacuum box. Pressurize channels between seams to minimum 30 psi, indicated by calibrated gage or manometer inserted in channel. Maintain pressure for minimum 15 seconds.

3.3.1.2. Vacuum test for extrusion welded seams and repairs.

a. Equipment: Aluminum frame box with calibrated vacuum gage on frame, fitted with sponge gasket on bottom, sealed with transparent Plexiglas top, and connected to vacuum pump.

b. Test: Spread soap solution over seam, press box down over seam, and apply 10 inches Hg vacuum, plus or minus 2 inches, for minimum 15 seconds to each portion of seam. If defect is present, bubble will form and indicate area for repair. Test seams and repairs in their entirety.

3.3.1.3 KEH will observe testing and review results.

3.3.2 Destructive Testing

3.3.2.1 Preparation: Obtain samples of field seams at beginning and end of each work day, and at 1 or more intervals during day if seaming conditions have been altered.

a. Use 10 foot long test weld from each welding machine, and mark with date, ambient temperature, and machine number.

b. Take 2 foot long random weld samples from installed welded sheeting at rate of 1 sample for each seaming crew for each day.

c. Cut samples in 2 parts, keep 1/2 for testing and deliver remaining half to KEH.

3.3.2.2 Tests: Test samples for bonded seam strength in accordance with ASTM D 3083, and for peel adhesion in accordance with ASTM D 413.

3.3.3 Documentation

3.3.3.1 Document field seam test results by marking installation drawings with location of sample identification number and label sample with location, date, time, crew identity, and machine number.

3.3.3.2 Certify test results.

3.3.3.3 Deliver documentation to KEH within 7 working days.

3.3.4 Final Examination and Acceptance

3.3.4.1 Measure overlap of seams and verify no damage has occurred to liner.

3.3.4.2 Prepare record drawings showing field changes.

3.3.4.3 Deliver record drawings to KEH within 10 working days after completion of liner installation.

END OF SECTION

SECTION 02756

LEACHATE COLLECTION SYSTEM

PART 1 - GENERAL

1.1 REFERENCES

1.1.1 Reference Standards and Specifications: The following standards and specifications, including documents referenced therein, form part of this Section to extent designated herein.

1.1.1.1 American National Standards Institute (ANSI)

ANSI B16.11-1980	American National Standard Forged Steel Fittings, Socket-Welding and Threaded

1.1.1.2 American Society for Testing and Materials (ASTM)

A 53-87b	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
A 105-87a	Standard Specification for Forgings, Carbon Steel, for Piping Components
A 194-87	Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
D 1117-80	Standard Methods of Testing Nonwoven Fabrics
D 1682-64 (1975)	Standard Test Methods for Breaking Load and Elongation of Textile Fabrics
D 1777-64 (1975)	Standard Method for Measuring Thickness for Textile Materials
D 3776-85	Standard Test Methods for Mass Per Unit Area (Weight) of Woven Fabric
D 3787-80a	Standard Test Method for Bursting Strength of Knitted Goods--Constant-Rate-of-Traverse (CRT) Ball Burst Test

D 4491-85	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
E 11-87	Standard Specification for Wire-Cloth Sieves for Testing Purposes

1.1.1.3 American Water Works Association (AWWA)

C203-86	AWWA Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines--Enamel and Tape--Hot-Applied

1.1.1.4 Environmental Protection Agency (EPA)

EPA/530-SW-86-031	Technical Guidance Document Construction Quality Assurance for Hazardous Waste Land Disposal Facilities

1.1.1.5 National Sanitation Foundation (NSF)

NSF Standard 54-85	Flexible Membrane Liners

1.2 SUBMITTALS: Refer to Section 01300 for submittal procedures.

1.2.1 Fabricator Drawings: Submit drawings and procedures showing layout and details of factory and field joints, and pipe penetrations.

1.2.2 Installation Plan: Submit plans and procedures for installation and testing of geotextile and carbon steel pipe. Include list of equipment and amount of utilities required, proposed method of installing materials and components, joining pipe, and following.

1.2.2.1 Method for holding materials in place during installation.

1.2.2.2 Method for examining materials, and for testing joints, seams, welds, and trench insertions.

1.2.3 Manufacturer's Data: Provide data defining physical properties of geotextile filtration and reinforcing fabrics to be supplied. As minimum, properties shall meet requirements of specified ASTM standards. Provide 20 square feet of geotextiles from same batch of material used in actual construction. These will be archived for future reference.

1.2.4 Care and Repair Instructions: Submit information concerning recommended care, maintenance, and repair procedures for geotextiles. Include recommended shoe types for construction personnel, tools for cleaning and removing wind-blown sand and debris, and minimum and maximum temperatures at which cleaning, inspecting, and repair operations may be performed.

1.2.5 Certified Material Test Reports (CMTR): Submit materials test reports, certified by manufacturer of geotextile, which identify items and show results of chemical analyses and physical tests specified in ASTM standards.

1.2.6 Certificate of Conformance: Submit legible certificate from supplier stating that drainage gravel furnished meets the requirements of Paragraph 2.1.3.

1.2.7 Certificates of Experience: Submit "Certificates of Experience" from installer showing qualification in accordance with Paragraphs 1.3.1 and 1.3.2. Provide list showing names, addresses, and telephone numbers for completed projects.

1.2.8 Manufacturer's Quality Control Plan: Submit quality control plan for Project. Plan shall address requirements of Paragraph 1.3.3.

1.3 QUALITY ASSURANCE

1.3.1 Qualification of Installer: Licensed or approved by manufacturer of geotextiles. Provide evidence of successfully installing at least 10 projects, and at least 1,000,000 square feet of geotextiles. Projects shall also include Resource Conservation and Recovery Act (RCRA) Landfills and Surface Impoundments.

1.3.2 Upon completion of work, and as condition of acceptance, deliver to KEH 2 copies of certificate signed by authorized agent of manufacturer of geotextiles, and co-signed by installer, stating materials and methods used meet specified requirements.

1.3.3 Manufacturer's Quality Control Plan: Quality control plan to be implemented for Project shall be in accordance with EPA/530-SW-86-031.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

1.4.1.1 During shipment and storage, wrap geotextiles in heavy-duty protective covering to prevent damage.

1.4.1.2 Examine geotextile delivered to site for damage. If damaged, set aside and do not use. Do not remove material identification label.

1.4.2 Storage

1.4.2.1 Unload and store with minimum of handling.

1.4.2.2 Do not store materials on ground.

1.4.2.3 Storage area shall protect geotextile from mud, soil, dust, debris, ultraviolet light, heavy winds, temperature extremes, and precipitation.

1.4.2.4 Store geotextile materials indoors in original unopened packaging.

1.4.2.5 If temporarily outdoors, place on pallet and protect from direct rays of sun under light colored heat-reflective opaque cover in manner to provide free air flowing space between materials and cover.

1.4.2.6 Cover gravel to protect from blowing sand and debris.

1.4.3 Handling: Handle materials to ensure sound, undamaged condition.

PART 2 - PRODUCTS

2.1 MATERIALS

2.1.1 Nonwoven Geotextile: Long-chain synthetic polymer composed of polypropylene and contain stabilizers and inhibitors added to base plastic to make filaments resistant to deterioration due to ultraviolet and heat exposure. Geotextile shall be composed of continuous geotextiles held together through needle-punching. Edges of fabric shall be sealed or otherwise finished to prevent outer material from pulling away from fabric, or ravelling. Geotextile shall meet following requirements.

Property	Test Method	Values
Fabric Weight (oz/sq yd)	ASTM D 3776	10
Thickness (mil)	ASTM D 1777	70
Grab Tensile Strength (lbs/min.)	ASTM D 1682	200
Grab Elongation (%, min)	ASTM D 1682	30 in any principal direction
Coefficient of Water Permeability (cm/sec)	ASTM D 4491	0.2
Puncture Strength (lbs, min.)	ASTM D 3787	100
Tear Strength (lbs, min. trapezoidal)	ASTM D 1117	100 in any principal direction
Equivalent Opening Size (EOS), US Sieve	----	70-100 in accordance with ASTM E 11
Minimum Width (ft)	----	12

2.1.2 Carbon Steel Drainage System

2.1.2.1 Pipe: Meet the requirements of ASTM A 53, Type S. Perforate by drilling four 1/4 inch holes for each foot of length.

2.1.2.2 Threaded fittings, including flanges: Meet the requirements of ASTM A 105 and ANSI B16.11. Stress relieve fitting welds and bends.

2.1.2.3 Hex nuts: Meet the requirements of ASTM A 194, Grade 2.

2.1.2.4 Gasket mating flange to liner: Full face teflon.

2.1.3 Drainage Gravel

2.1.3.1 Thoroughly washed and screened naturally occurring gravel, having following size distribution.

Sieve Size	Percent Passing
1 inch	100
3/4 inch	85-95
3/8 inch	45-55
#4	20-25
#8	0

2.1.3.2 Crushed or partially crushed gravel will not be acceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Before work is started examine sheet rolls for damage from transit and storage. If damaged set aside and do not use.

3.1.2 During unrolling of material, visually examine surfaces. Do not use material showing defects, ribs, holes, flaws, deterioration, or other damage.

3.2 INSTALLATION

3.2.1 Climatic Conditions

3.2.1.1 Within limits given in NSF Standard 54, Appendix C while handling geotextile material.

3.2.1.2 Temperature: 40 to 104 F.

3.2.1.3 Winds: 15 mph, maximum.

3.2.2 Geotextiles

3.2.2.1 Place at locations shown on approved installation drawings.

3.2.2.2 Lay smooth and free of tension, stress, folds, wrinkles, or creases, and to provide minimum 12 inch overlap for each joint.

3.2.2.3 Measure overlap joints and seams as single layer of cloth.

3.2.2.4 Use bags of clean, washed gravel to secure material during installation. Do not use securing pins.

3.2.2.5 Protect geotextile and gravel during construction from contamination.

3.2.2.6 Remove contaminated geotextile and gravel and replace with new.

3.2.3 Install leachate collection pipe as shown on the Drawings.

3.2.3.1 Coat threads of pipe and fittings with coal tar enamel meeting the requirements of AWWA C203.

3.2.3.2 Backfill with material specified in Paragraph 2.1.3, in 6 inch lifts, up to elevation shown on the Drawings. Each lift shall be compacted with 2 passes of hand operated impact tamper. Protect gravel from contamination during construction.

3.2.4 Repairs: Make repairs to geotextile in accordance with manufacturer's recommended procedures.

3.3 FIELD QUALITY CONTROL

3.3.1 Final Examination and Acceptance: Measure proper overlap of seams and verify no damage has occurred to geotextile. Prepare record drawings showing where field changes have been incorporated. Deliver test documentation and record drawings to KEH.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 REFERENCES

1.1.1 Reference Standards and Specifications: The following standards and specifications, including documents referenced therein, form part of this Section to extent designated herein.

1.1.1.1 American Concrete Institute (ACI)

ACI 301-84 (Revised 1987)	Specifications for Structural Concrete for Buildings
ACI 306.1-87	Standard Specification for Cold Weather Concreting

1.1.1.2 American Society for Testing and Materials (ASTM)

A 185-85	Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
A 615-87	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
C 33-86	Standard Specification for Concrete Aggregates
C 94-86b	Standard Specification for Ready-Mixed Concrete
C 150-86	Standard Specification for Portland Cement
C 260-86	Standard Specification for Air-Entraining Admixtures for Concrete

1.1.1.3 National Ready Mixed Concrete Association (NRMCA)

January 1, 1976 (Third Revision)	Certification of Ready Mixed Concrete Production Facilities

1.2 SUBMITTALS: Refer to Section 01300 for submittal procedures.

1.2.1 Form Coating Materials: Submit proposed form coating materials in accordance with ACI 301, Section 4.4.

1.2.2 Certification of Ready Mixed Concrete Production Facilities: Submit current legible copy of "Certificate of Conformance for Concrete Production Facilities" issued by and bearing the seal of the National Ready Mixed Concrete Association. Certificate shall contain signature and seal of registered Civil Engineer.

1.2.3 Certified Test Reports for Reinforcing Steel: Submit manufacturer's certified test reports showing chemical analysis and physical tests made on particular heat or heats of steel from which reinforcement was manufactured. Furnish separate certificates for each group of items furnished by each supplier.

1.2.4 Reinforcing Steel Fabricator Drawings: Submit complete reinforcing fabrication and placing drawings based on block diagram in accordance with ACI 301, Section 5.1, including splices not shown on the Drawings.

1.2.5 Block Diagram: Submit block diagram of scheduled concrete pours. Identify pours.

1.2.6 Concrete Materials, Mix Design and Mix Proportions: Submit concrete materials, mix design and mix proportions in accordance with ACI 301, Sections 3.8 and 16.7.3. Define each material to be used in concrete and state amount, by weight, to be utilized per cubic yard of plastic mix.

1.2.7 Cold Weather Concreting: Submit detailed procedure in accordance with ACI 306.1, Section 1.5.1.

1.2.8 Curing Procedure: Submit description of materials and methods of curing in accordance with ACI 301, Section 12.2.

1.2.9 Certificate of Conformance: Submit legible certificate, certified by manufacturer, that lifting inserts and plates meet the requirements of the Drawings. Include load capacity and factor of safety.

PART 2 - <u>PRODUCTS</u>

2.1 MATERIALS

2.1.1 Concrete

2.1.1.1 Cement: ASTM C 150, Type II (Low Alkali)

2.1.1.2 Aggregates: ASTM C 33, maximum size as follows.

a. 3/4 inch for duct banks.

b. 1-1/2 inch for all other.

2.1.1.3 Air-entraining admixture: Meeting the requirements of ASTM C 260; Sika Chemical Company "SIKA AER"; Chem-Masters Corp "Adz-Air"; or Protex Industries "Protex".

2.1.1.4 Properties

a. Minimum allowable compressive strength at 28 days.

1) 3000 psi for duct banks.

2) 4000 psi for all other.

b. Slump: 4 inch maximum in accordance with ACI 301, Section 3.5.

c. Air content: In accordance with ACI 301, Table 3.4.1.

d. Proportions: In accordance with ACI 301, Sections 3.8 and 3.9.

2.1.1.5 Mixing: In accordance with ASTM C 94.

2.1.1.6 Delivery: In accordance with ASTM C 94.

2.1.2 Reinforcing Steel

2.1.2.1 Steel bars: ASTM A 615, deformed, Grade 60.

2.1.2.2 Welded wire fabric: ASTM A 185.

2.1.2.3 Tie wire: Black annealed steel, 16 gage minimum.

2.1.3 Nonshrink Grout

2.1.3.1 Nonmetallic type: "Five Star Grout" by US Grout Corp; "Por-Rok" Anchoring Cement by Hallemite; or "Masterflow 713" by Master Builders.

2.1.4 Forms: Wood, steel, plywood, or Masonite Corporation "Concrete Form Presdwood", as required for various specified finishes.

2.1.5 Lifting Inserts and Plates: Specified on the Drawings.

PART 3 - EXECUTION

3.1 PREPARATION

3.1.1 Form Construction

3.1.1.1 Install formwork in accordance with ACI 301, Section 4.2. Interior shape and rigidity shall be such that finished concrete will meet the requirements of the Drawings within tolerances specified in ACI 301, Table 4.3.1.

3.1.1.2 Prepare form surfaces in accordance with ACI 301, Section 4.4.

3.1.1.3 Forms for surfaces which will be permanently concealed from view may be saturated with water before placing concrete instead of other treatment, except in freezing weather forms shall be treated with oil or stearate.

3.1.1.4 Clean forms of foreign material before placing concrete.

3.2 INSTALLATION

3.2.1 Reinforcing Steel

3.2.1.1 Fabricate bars accurately to dimensions shown on Drawings, within tolerances shown in ACI 301, Section 5.4.

3.2.1.2 Tag in accordance with bar list.

3.2.1.3 Place as shown on approved submittals within tolerances specified in ACI 301, Sections 5.4 and 5.5.

3.2.1.4 Tie to prevent displacement during placement of concrete.

3.2.1.5 Do not force into concrete after initial set has started.

3.2.1.6 Place with dimension of concrete protection equal to minimum given in ACI 301, Section 5.5, except where shown otherwise on the Drawings.

3.2.1.7 Place welded wire fabric on chairs and lap two mesh at splices. Tie splices with wire.

3.2.2 Concrete

3.2.2.1 Before ordering, obtain approval of required submittals.

3.2.2.2 Before batching, obtain approval of formwork and reinforcement by KEH.

3.2.2.3 Before placing:

a. Obtain approval of "Pour Slip" by KEH. "Pour Slip" shall include appropriate reference to specific portion of structure to be placed, maximum size of coarse aggregate, design strength, admixture, and slump. "Pour Slip" forms can be obtained from KEH.

b. For each truck load, deliver "Trip Ticket" to KEH. "Trip Ticket" shall contain information listed in ASTM C 94, subparagraphs 16.1.1 through 16.1.10, and include water/cement ratio.

3.2.2.4 Place in accordance with ACI 301, Sections 8.1, 8.2, and 8.3. Do not drop (free fall) more than 5 feet. Insert vibrator, vertically if possible, into concrete and reach small distance into concrete in next lower layer. Do not insert vibrators into lower courses that have reached initial set. Take care to avoid allowing head of vibrator to come in contact with forms or embedded items.

3.2.2.5 Temper only as permitted in ACI 301, Section 7.5.

3.2.2.6 Place nonshrink grout where shown on the Drawings and in accordance with manufacturer's recommendations.

3.2.2.7 Weather conditions: Protect concrete during placement in accordance with ACI 301, Section 8.4. Cold weather concreting shall be in accordance with approved procedure.

3.2.2.8 Construction joints: Make in accordance with ACI 301, Section 6.1, and as detailed on the Drawings.

3.2.2.9 Embedded items: Install in accordance with ACI 301, Sections 6.4 and 6.5.

3.2.2.10 Placing concrete against earth: Place on or against firm, damp surfaces free of frost, ice and free water. Do not place until required compaction has been obtained. Dampen earth surfaces to receive fresh concrete.

3.2.2.11 Consolidation: Consolidate concrete slabs in accordance with ACI 301, Section 11.6.

3.2.3 Concrete Repair and Form Removal

3.2.3.1 Form removal: Remove in accordance with ACI 301, Section 4.5.

3.2.3.2 Cut back form ties and examine concrete surfaces for defects. Repair only after permission for patching is given by KEH.

3.2.3.3 Place concrete repair mortar within 1 hour after mixing. Do not retemper mortar.

3.2.3.4 Surface defect repair: Repair in accordance with ACI 301, Sections 9.1, 9.2 and 9.3. Cure concrete repairs same as new concrete.

3.2.4 Concrete Finishes and Tolerances

3.2.4.1 Formed surfaces: Start finishing following concrete repair and complete within 96 hours after forms have been removed. Finish in accordance with sections of ACI 301 noted below.

a.	Surfaces exposed to earth backfill	Section 10.2.1
b.	Interior surfaces	Section 10.2.2
c.	Exterior surfaces exposed to weather	Section 10.2.2

d.	Related unformed surfaces	Section 10.5
e.	Surfaces to receive special protective coating	Section 10.3.2

3.2.4.2 Unformed surfaces: Finish in accordance with sections of ACI 301 noted below:

a.	Interior floors	Section 11.7.3
b.	Exterior equipment slabs	Section 11.7.3

3.3 FIELD QUALITY CONTROL

3.3.1 Concrete Testing: Sampling and testing of concrete will be the responsibility of KEH. Concrete will be tested to ACI 301, Sections 16.3.4, 16.3.5, 16.3.6 and 16.3.8.

3.4 CURING AND PROTECTION

3.4.1 Curing

3.4.1.1 Cure concrete in accordance with ACI 301, Section 12.2. Clear curing compounds shall be tinted or applied surfaces marked to delineate extent of spraying.

3.4.1.2 Do not use curing compound on concrete surfaces to receive flooring or special protective coating.

3.4.2 Protection

3.4.2.1 Protect concrete during extreme weather conditions in accordance with ACI 301, Section 12.3.

3.4.2.2 Protect concrete from mechanical injury in accordance with ACI 301, Section 12.4.

END OF SECTION

SECTION 03301

VAULT AND BASIN CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 REFERENCES

1.1.1 Reference Standards and Specifications: The following standards and specifications, including documents referenced therein, form part of this Section to extent designated herein.

1.1.1.1 American Concrete Institute (ACI)

ACI 301-84 (Revised 1987)	Specifications for Structural Concrete for Buildings.
ACI 306.1-87	Standard Specification for Cold Weather Concreting
ACI 315-80	Details and Detailing of Concrete Reinforcement
ACI 347-78 (Reapproved 1984)	Recommended Practice for Concrete Formwork
ACI 349-85	Code Requirements for Nuclear Safety Related Concrete Structures

1.1.1.2 American Society for Testing and Materials (ASTM)

A 108-81	Standard Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality
A 307-86a	Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
A 615-87	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
C 31-88	Standard Practice for Making and Curing Concrete Test Specimens in the Field
C 33-86	Standard Specification for Concrete Aggregates

C 39-86	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C 87-83	Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
C 94-86b	Standard Specification for Ready-Mixed Concrete
C 125-88	Standard Terminology Relating to Concrete and Concrete Aggregates
C 138-81	Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
C 143-78	Standard Test Method for Slump of Portland Cement Concrete
C 150-86	Standard Specification for Portland Cement
C 171-69 (1986)	Standard Specification for Sheet Materials for Curing Concrete
C 227-87	Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
C 233-87a	Standard Test Method for Air-Entraining Admixtures for Concrete
C 260-86	Standard Specification for Air-Entraining Admixtures for Concrete
C 289-87	Standard Test Method for Potential Reactivity of Aggregates (Chemical Method)
C 309-81	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
C 494-86	Standard Specification for Chemical Admixtures for Concrete

C 618-87	Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete
C 932-80 (1985)	Standard Specification for Surface Applied Bonding Agents for Exterior Plastering
D 75-87	Standard Practice for Sampling Aggregates
D 512-81 (1985)	Standard Test Methods for Chloride Ion in Water
D 516-82	Standard Test Methods for Test for Sulfate Ion in Water
D 3370-82	Standard Practices for Sampling Water
E 779-87	Standard Test Method for Determining Air Leakage Rate by Pressurization

1.1.1.3 American Welding Society (AWS)

AWS D1.1-88	Structural Welding Code - Steel
AWS D1.4-79	Structural Welding Code - Reinforcing Steel
AWS QC1-86	Standard for Qualification and Certification of Welding Inspectors

1.1.1.4 National Ready Mixed Concrete Association (NRMCA)

January 1, 1976 (Third Revision)	Certification of Ready Mixed Concrete Production Facilities

1.1.1.5 Washington State Department of Transportation (WSDOT)

M41-10-88	Standard Specifications for Road, Bridge, and Municipal Construction

1.2 SUBMITTALS: Refer to Section 01300 for submittal procedures.

1.2.1 Formwork: Submit fabrication drawings showing general arrangement of forms, sizes and grades of lumber, panels and related components. Include placement rate of fresh concrete in walls based on ACI 347, Chapter 2. Show control joints and method of forming, locations of inserts, tees, sleeves, and other related items.

1.2.2 Form Coating Materials: Submit proposed form coating materials in accordance with Paragraph 3.1.2 and ACI 301, Section 4.4.

1.2.3 Certification of Ready Mixed Concrete Production Facilities: Submit current legible copy of "Certificate of Conformance for Concrete Production Facilities" issued by and bearing the seal of the National Ready Mixed Concrete Association. Certificate shall be dated within past 12 months of first concrete delivery.

1.2.4 Laboratory Test Reports: Submit certified copies of test reports showing following materials meet specified requirements.

1.2.4.1 Cement

1.2.4.2 Aggregates

1.2.4.3 Admixtures

a. Air-entraining: Tested in accordance with ASTM C 233.

b. Water reducing: Tested by combining with cement and aggregates to be used to produce specified concrete having desired properties with respect to time of set, water-reduction, slump, strength, shrinkage, and pumpability.

c. Set retarding: Tested by combining with cement and aggregates to be used to produce specified concrete having desired properties with respect to retardation, water content, slump and strength.

1.2.4.4 Reinforcement

1.2.4.5 Concrete curing material

1.2.4.6 Water

1.2.5 Reinforcing Steel Fabricator Drawings: Submit complete and checked reinforcing steel fabrication and installation drawings, based on schedule for concrete placement and showing bending diagrams, assembly diagrams, splicing and laps of rods, and shapes, dimensions and details of bar reinforcing and accessories. Prepare drawings in accordance with ACI 315, Chapter 2.

1.2.6 Manufacturer's Data: Submit manufacturer's catalog cuts of reinforcing steel mechanical couplers along with data on material and installation procedures. Include type and series identification of sleeve splice for size of bars to be supplied.

1.2.7 Certified Test Reports: Submit manufacturer's certified test reports showing chemical analysis and physical tests made on particular heat or heats of steel from which reinforcing steel mechanical couplers were manufactured. Submit separate certificates for each group of like items furnished by each supplier.

1.2.8 Schedule for Concrete Placement: Submit schedule delineating location, sequence of pouring and time lapse between supporting and supported elements. Provide block diagrams and pouring sequence for slabs and walls.

1.2.9 Mix Design: Submit mix design, in accordance with ACI 349, Paragraphs 4.2 and 4.3 based on aggregate data, gradation and specific gravity determined by laboratory within past 6 months, and specified requirements.

1.2.10 Mix Certification: Submit certification of concrete mix design, by approved independent engineering testing laboratory. Certification shall include but not be limited to following.

1.2.10.1 Confirmation of aggregate test data based on available test results determined within past 6 months and date tests were made.

1.2.10.2 Evaluation of mix design: Check calculations and report cement factor, concrete plant standard deviation used in design of mix, maximum water (gallons per sack of cement), percentage of fine aggregate to total aggregate by weight, weight in pounds of saturated surface-dry aggregates per sack of cement, percentage of admixtures and yield for 1 cubic yard of concrete.

1.2.11 Control Procedures for Batching: Submit detailed procedures for controlling following activities.

1.2.11.1 Handling and storage of cement, fly ash, aggregate, and admixtures.

1.2.11.2 Limiting moisture content of fine aggregate to 5 percent.

1.2.11.3 Batching operation to include sequencing of material.

1.2.11.4 Addition of chilled water or ice.

1.2.11.5 Prohibition of added water except to adjust slump at point of placement. Additional water may be added if slump of concrete is less than specified.

1.2.11.6 Regulation of mixing drum revolutions.

1.2.12 Certificate of Conformance: Submit legible certificate stating that concrete delivery equipment meets the requirements of subparagraphs 2.2.6.2a and 2.2.6.2b.

1.2.13 Construction Joints: Submit drawings showing location and treatment of construction joints in accordance with ACI 301, Section 6.1.

1.2.14 Weather Protection During Placement: Submit protection procedures meeting the requirements of subparagraph 3.2.9.5 and ACI 301, Section 8.4.

1.2.15 Curing and Protection: Submit description of materials and methods of curing in accordance with Article 3.4 and ACI 301, Section 12.2.

1.2.16 Pump Concrete: Submit description of concrete pump and form capacity in accordance with subparagraph 3.2.9.6.

1.2.17 Methods for Controlling Heat of Hydration and Thermal Gradients: Submit control procedures meeting the requirements of subparagraph 3.2.9.7.

1.2.18 Air Leakage Test: Submit description of major components to be used in testing as defined in ASTM E 779, Paragraph 6.2 and proposed method.

1.3 QUALITY ASSURANCE

1.3.1 Qualification of Welding Personnel and Procedures

1.3.1.1 Personnel and procedures for welding shall have been qualified in accordance with AWS D1.1 and AWS D1.4 before welding.

1.3.1.2 Deliver 2 copies of welding procedure specifications, procedure qualification records, and welder performance qualification test results to KEH 5 days before welding. Maintain additional copies as specified in Section 01400, Paragraph 1.6.2.

1.3.2 Qualification of Nondestructive Examination (NDE) Personnel

1.3.2.1 Visual weld examinations and appropriate documentation shall be performed by Certified Welding Inspectors (CWI) who have received certification in accordance with AWS QC1. Welding related examination documentation shall be signed, or stamped, by individual performing examination.

1.3.2.2 Deliver 2 copies of NDE personnel qualifications to KEH 5 days before examining. Maintain additional copies as specified in Section 01400, Paragraph 1.6.2.

1.3.3 Qualification of Splicers: Personnel splicing reinforcing bars by welding or mechanical splice shall be qualified before splicing in accordance with following requirements.

1.3.3.1 Prepare 2 qualification splices on largest bar size for each splice position using reinforcing bar identical to one used in structure.

1.3.3.2 Tensile test splices with results equal to 125 percent of specified yield strength.

1.3.3.3 Deliver 2 copies of splicer performance qualification test results to KEH 5 days before splicing. Maintain additional copies as specified in Section 01400, Paragraph 1.6.2.

1.3.3.4 Requalification of personnel required if:

a. Specific splice position has not been used for period of 3 months or more.

b. Completed splices fail to pass visual examination or tensile tests.

c. Consistent visual rejects occur.

d. Requalification not required if based on single visual reject.

e. Requalification procedures shall be identical to original qualification procedure.

1.3.4 Test Records: Institute and maintain for examination by KEH complete legible records of tests performed pursuant to design of concrete mixtures. Keep records in chronological order of initial and subsequent mixture designs, and correspondence related to design and testing, along with results of tests.

1.3.5 Quarry Aggregate Testing: Determine sieve analysis of separate sizes of coarse and fine aggregates sampled at quarry source and results combined in accordance with proportions of mix design. Keep records of tests. Combined aggregates proportioned at concrete plant using separate sizes of aggregates shall meet specified gradation. Gradation of separate individual sizes of coarse and fine aggregates shall meet specified requirements. In following table, letter "X" is gradation Contractor proposes to furnish for specific sieve sizes. In addition to grading, distribution of aggregates shall be as follows.

1.3.5.1 Fine aggregate

a. Difference between total percentage passing No. 16 sieve and total percentage passing No. 30 sieve: Between 10 and 35.

b. Difference between percent passing No. 30 and No. 50 sieves: Between 10 and 30.

1.3.5.2 Make additional sieve analysis and other aggregate tests in accordance with ASTM C 33 whenever sieve analysis fails to meet requirements, there is change of aggregate source, or consecutive concrete strength results fail to meet specified strengths.

FINE AGGREGATE GRADING

	PERCENT PASSING	
Sieve Size	Individual Test Result	Moving Average of Five
3/8 in.	100	100
No. 4	95-100	96-100
No. 8	80-100	81-99
No. 16	X ± 10	X ± 8
No. 30	X ± 9	X ± 7
No. 50	X ± 6	X ± 4
No. 100	2 - 10	3 - 9
No. 200	0 - 5	0 - 4

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Packing and Shipping to Site

1.4.1.1 Identification: Each bundle of reinforcing bars shall display metal tag identifying manufacturer and heat numbers from which product was made along with ASTM specification number and type to which product complies.

1.4.2 Acceptance at Site: Reinforcement will be receipt examined by KEH for compliance with material identification tag.

1.4.3 Storage and Protection at Plant

1.4.3.1 Cement: Store immediately upon receipt.

a. Bags

1) Store in suitable weatherproof structure, as air-tight as practicable, with floors elevated above ground sufficiently to prevent absorption of moisture.

2) Stack close together to reduce circulation of air, but not against outside walls, in manner to permit easy access for examination and identification of shipments.

b. Bulk cement: Transfer to elevated airtight and weatherproof bins.

c. At time of use cement shall be free-flowing, and free of lumps. Cement stored longer than 6 months shall be tested by standard mortar tests or other tests deemed necessary by KEH to determine suitability of use, and not used without approval of KEH.

d. Cement containers shall show production date of cement.

1.4.3.2 Aggregates

a. Store on areas covered with tightly laid wood planks, sheet metal, or other hard and clean surface, and in manner to preclude inclusion of foreign material.

b. Store aggregates of different sizes in separate piles.

c. Build stock piles of coarse aggregate in horizontal layers not exceeding 4 feet in depth to minimize segregation.

d. Should coarse aggregate become segregated, remix to meet grading requirements.

e. Do not store fine aggregate from different sources of supply in same stockpile.

1.4.3.3 Admixtures

a. Store in manner to prevent damage to containers.

b. Air-entraining admixtures stored longer than 6 months, or subjected to freezing shall not be used until retest proves satisfactory.

c. Production dates of admixtures shall be shown on containers.

1.4.4 Storage and Protection at Site: Store and protect reinforcement to avoid excessive rusting or coating with grease, oil, dirt, and other objectionable materials.

PART 2 - PRODUCTS

2.1 MATERIALS

2.1.1 Reinforcing Steel

2.1.1.1 Steel bars: ASTM A 615, deformed, Grade 60.

2.1.1.2 Tie wire: Black annealed steel, 16 gage minimum.

2.1.1.3 Provide stirrups, hanger bars, wire ties, chairs, spacers, supports, and other devices shown on the Drawings or required in this Section.

2.1.1.4 Reinforcing steel mechanical couplers: Sleeves with ferrous filler material, or other types of couplers which can be used with specified reinforcing steel bars, and capable of 125 percent of yield strength of reinforcing steel.

2.1.2 Concrete: Meet construction requirements of ACI 349 and ACI 301. If conflicts between ACI 349 and ACI 301 occur, ACI 349 shall govern.

2.1.2.1 Cement: ASTM C 150, Type II. Cement content minimum required to attain specified properties.

2.1.2.2 Aggregates: ASTM C 33, maximum size 3/4 inch, free of chlorides, sulfates, and substances which may be deleteriously reactive with alkalies in cement in amount sufficient to cause excessive expansion of concrete.

a. Fine aggregates: Grade in accordance with ASTM C 33. Aggregates from different sources of supply shall not be used alternately in same structure.

1) Aggregate meeting grading requirements of WSDOT, Section 9-03.1(2)B, Class 1 may be used instead of ASTM C 33.

b. Coarse aggregate: Grade in accordance with ASTM C 33, size number 67.

2.1.2.3 Water: Water for mixing and curing, including free moisture and water in aggregates, shall be fresh, clean and potable. Turbidity of water shall not exceed 2,000 turbidity units expressed as JTU (Jackson Turbidity Units) or FTU (Formeson Turbidity Units).

2.1.2.4 Admixtures: Do not use admixtures containing chloride ions.

a. Air-entraining admixtures: Meeting the requirements of ASTM C 260.

b. Water-reducing admixture: Pozzolan meeting the requirements of ASTM C 618, Class N or F.

c. Set-retarding admixture: Meeting the requirements of ASTM C 494.

2.1.2.5 Properties

a. Minimum allowable compressive strength: 4000 psi at 28 days.

b. Slump: 2-4 inches, determined in accordance with ASTM C 143.

c. Air-entrained: 5 percent plus or minus 1 percent.

d. Water/cement ratio: 0.42 maximum.

2.1.2.6 Chloride contamination: Level of soluble chloride in fresh concrete mix from all sources shall not exceed 1000 ppm (0.1 percent) by weight of cement.

2.1.3 Waterstops: See Section 05500.

2.1.4 Concrete Curing Material

2.1.4.1 Waterproof paper: Regular, meeting the requirements of ASTM C 171.

2.1.4.2 Polyethylene film: Clear, meeting the requirements of ASTM C 171.

2.1.4.3 White-burlap-polyethylene sheet: Meeting the requirements of ASTM C 171.

2.1.4.4 Liquid membrane-forming compound: Meeting the requirements of ASTM C 309, Type 1, Class B.

2.1.5 Bonding Agent: Meeting the requirements of ASTM C 932.

2.1.6 Anchor Bolts: ASTM A 307.

2.1.7 Weld Anchors and Shear Connectors: ASTM A 108.

2.1.8 Formwork: Materials meeting the requirements of ACI 347, Chapter 4.

2.2 BATCHING AND MIXING

2.2.1 Equipment for weighing and measuring materials shall meet local and state requirements, and visually exhibit latest seals.

2.2.2 Batch concrete in plant approved by NRMCA and the Operating Contractor.

2.2.3 Aggregates

2.2.3.1 Fine aggregates: Do not mix fine aggregates from different sources of supply.

2.2.3.2 Coarse aggregates: .Combine separate sizes of coarse aggregates with other sizes in proportions by weight to produce aggregate meeting grading specified.

2.2.4 Admixtures: When more than 1 admixture is use in mix, furnish satisfactory evidence that admixtures to be used are compatible in combination with cement and aggregates, and suitable at job temperatures.

2.2.4.1 Air-entraining admixtures: Add in solution in portion of mixing water by mechanical batcher ensuring uniform distribution of agent throughout batch.

2.2.4.2 Water-reducing admixture: Replace 15 percent of cement in concrete mix with Pozzolan. Accurate batching is required.

2.2.4.3 Set-retarding admixture: Use as necessary to meet specified water/cement ratio and delay set 2 to 3 hours.

2.2.5 Proportioning Concrete Materials: In accordance with ASTM C94.

2.2.6 Ready-Mixed Concrete: Equipment for ready-mixed concrete shall meet the requirements of ASTM C 94 as modified herein. Ready-mixed concrete may be used provided plant has sufficient capacity and transportation equipment to deliver concrete at rate desired, and meets the requirements specified for equipment, measurement of materials, and mixing, except as modified herein. Cement, aggregates, water and admixtures shall meet applicable requirements of this Section. Mix and deliver ready-mixed concrete by 1 of following methods.

2.2.6.1 Central-plant mixing: Utilize central-plant mixing specified in ASTM C 94, Paragraph 11.3. Mix concrete in stationary mixer at plant and transport to site in truck agitator or truck mixer operating at agitating speed. Begin mixing within 30 minutes after cement has been added to aggregates. When authorized in writing by KEH, approved nonagitation equipment may be used for transporting concrete. Time lapse between introduction of mixing water to cement and aggregates and placing of concrete in final position in forms, shall not exceed the following.

a. For agitating equipment: 90 minutes when air temperature is less than 85 F, and 60 minutes when air temperature is equal to or greater than 85 F.

2.2.6.2 Truck-mixed concrete: Ready-mixed concrete may be batched from manually-operated batch plant and mixed and delivered in truck-mounted mixer units provided following additional requirements are adhered to.

a. Truck mixer units used meet the requirements of ASTM C 94. Demonstrate compliance by performing tests in accordance with ASTM C 94, Annex A1.

b. Establish maintenance inspection program to ensure mixer units are maintained in condition to perform in accordance with ASTM C 94. Maintenance inspection program shall address following as minimum.

1) Frequency of inspection.

2) Inspection criteria including requirements for water meters, counters, fin heights, and cleanliness.

3) Name of individual performing inspection.

4) Results of inspection.

5) Statement that units are satisfactory for use. Include equipment numbers.

c. To preclude weighing inaccuracies in batch constituents bring dial indicator on weigh scales to essentially motionless condition at each desired intermediate batch weight before addition of remainder of material or discharge of weigh hopper.

2.3 SOURCE QUALITY CONTROL

2.3.1 Sampling: Before delivery of concrete to site, sample fine and coarse aggregates in accordance with ASTM D 75. Each sample shall be in clean container, securely fastened to prevent loss of material, and tagged for identification with following information.

Contract No. ______________________________

Sample No. ____________________ Quantity ____________

Date of Sample ______________________________

Sampler's Signature ______________________________

Source ______________________________

Intended Use ______________________________

For Testing ______________________________

2.3.1.1 Fine aggregates: Take two 50 pound samples for each 200 tons for sieve analysis of fine aggregate sand and specific gravity tests. Additional samples shall be taken when analyses show deficiencies, unacceptable variances, or deviations. Sampling may be reduced to 1 when test results show fine aggregates consistently meet specified requires. Take samples of sand when sand is moist.

2.3.1.2 Coarse aggregate: Take 50 pound or larger sample for each 400 tons, from conveyor belt. Bring plant up to full operation before taking samples. Take samples so uniform cross section, accurately representing materials on belt or in bins, is obtained. Additional sampling shall be made when analyses show deficiencies or unacceptable variances or deviations from specified requirements.

2.3.1.3 Obtain water samples in accordance with ASTM D 3370, Practice A.

2.3.2 Testing: Test and record results at least 10 days before using materials.

2.3.2.1 Aggregates: Make gradation tests on each sample taken at batch plant. Make other required aggregate tests on samples, and repeat whenever there is a change of source. Tests shall include analysis of each grade of material and analysis of combined material representing aggregate part of mix. Combined aggregates proportioned at plant using separate sizes of aggregates shall meet specified gradation.

2.3.2.2 Test for potential reactivity of aggregates in accordance with ASTM C 289. Test aggregates from newly-developed quarries in accordance with ASTM C 227.

a. Fineness modulus of fine aggregate, defined in ASTM C 125, shall be at least 2.3 but nor more than 3.1. Aggregate showing variation in fineness modulus more than plus or minus 0.2 of representative sample submitted will be rejected.

2.3.2.3 Water: Test at start of work, and change of source.

a. Determine extent of chloride and sulfate contamination of water in accordance with ASTM D 512 and ASTM D 516. Water shall contain no more than 250 ppm of chlorides as CL nor more than 250 ppm of sulfates as SO_4.

b. Mortar specimens made in accordance with ASTM C 87, when compared with similar mortar specimens made with water of known satisfactory quality and using same sand and cement, shall show no unsoundness or marked change in setting, and compressive strength of mortar specimens at 28 days shall be at least 95 percent of compressive strength of specimens made with water of known satisfactory quality.

2.3.2.4 Test cement in accordance with ASTM C 150.

PART 3 - EXECUTION

3.1 PREPARATION

3.1.1 Form Construction: Construct and install forms in accordance with approved submittals, set true to line and grade, and maintained to ensure completed work within specified tolerances and mortar-tight.

3.1.1.1 Arrange bolts and rods used for internal ties so when forms are removed, metal shall be at least 2 inches from surfaces.

a. Do not use bolts or rods that must be removed when forms are removed.

3.1.1.2 Provide forms with temporary and adequate clean-out openings at base of wall forms to permit examination and easy cleaning after reinforcement has been placed.

3.1.1.3 Where forms for continuous surfaces are placed in successive units, fit over completed surface to obtain accurate alignment and prevent leakage of mortar.

3.1.1.4 Construct panel forms to provide tight joints between panels. Form repair requires KEH approval before use.

3.1.1.5 Construct forms to be removed without damaging concrete.

3.1.2 Form Coating

3.1.2.1 Coat contact surfaces of forms with nonstaining mineral oil or form coating compound, or 2 coats of nitrocellulose lacquer.

3.1.2.2 When temperature is above 40 F, sheathing may be thoroughly wetted with clean water.

3.1.2.3 Remove excess coating by wiping with cloths.

3.1.2.4 Thoroughly clean contact surfaces of reused forms.

3.1.2.5 Apply additional coating to previously coated forms.

3.1.3 Form Insulation: See subparagraph 3.2.9.7.

3.1.4 Tolerances: In accordance with ACI 347, Paragraph 3.3.5.

3.2 INSTALLATION

3.2.1 Reinforcing Steel, General: Wash reinforcement that has been in contact with the ground with water before placing to remove potential chloride contamination.

3.2.1.1 Reinforcing shall be free of rust, scale, oil, grease, clay, coatings, or foreign substances that will reduce or destroy bond between steel and concrete.

3.2.1.2 Rusting will not be basis for rejection, provided it has not reduced effective cross sectional area of reinforcement to extent that strength is reduced beyond specified values.

3.2.1.3 Remove heavy, thick rust or loose, flaky rust by rubbing with burlap or other approved method, before placing.

3.2.2 Placing

3.2.2.1 Accurately and securely place reinforcing in accordance with approved submittals.

3.2.2.2 On ground, and where otherwise subject to corrosion, use concrete or other suitable noncorrodible material for supporting reinforcing.

3.2.2.3 Support and wire reinforcing together to prevent displacement by construction loads or placing of concrete.

3.2.2.4 Unless directed otherwise by KEH do not bend reinforcing after partial embeddment in hardened concrete.

3.2.3 Splicing, General

3.2.3.1 Examine bar ends and splice sleeves before assembly for cleanliness and proper end preparation. Bars shall meet sleeve manufacturer's recommendations.

3.2.3.2 Preparation and testing of sister joints: Make sister joints, removable test splices, in place, adjacent to production joints and by same welder or splicer making production joint. Perform tests as follows.

a. For each bar direction taken separately (horizontal, vertical, or diagonal), provide sister joints in following number.

1) 1 for first 10 production splices of each type in each direction.

2) 1 for next 25 production splices of each type in each direction.

3) From then on, 1 for every 33 production splices of each type in each direction.

b. Test sister joints in tension to destruction.

1) Acceptable tensile strength of each sample: 125 percent of specified yield strength.

2) If tensile strength of test splice does not equal or exceed acceptable tensile strength, test 1 production splice on each side of failed test splice, if either production splice fails, remove splices made by welder or splicer making production splice. Additional tensile tests may be made on production splices to demonstrate acceptability of splices.

3.2.3.3 Splice reinforcement in accordance with ACI 349 and approved submittals, except as modified by this Section and the Drawings. Do not splice at points of maximum stress. Butt splicing may be used instead of lap splicing provided splice material, equal or greater in cross-section to spliced steel, has minimum 125 percent of yield strength. Lap splices shall be Class C unless otherwise noted or dimensioned on the Drawings.

3.2.3.4 Welded

a. Weld reinforcing bar splices with full penetration buttwelds, unless shown otherwise, in accordance with AWS D1.4.

b. Do not weld until welding documents have been approved.

c. KEH may examine welding processes.

d. Weld identification: Prepare and maintain map of welded splices. Deliver to KEH at completion of work.

1) Assign weld number, prefixed by letter 'W', to each weld as made. Show numbers on splice map.

2) Place identification symbol of welder making weld and weld number adjacent to each weld. Use marking crayon or paint.

3) Do not reuse weld numbers. If weld is completely replaced, assign new number.

3.2.3.5 Mechanical

a. Where bar cutting is required, cut by sawing, shearing, or flame cutting. If bars are sheared, straighten ends after shearing. If bars are flame cut, remove slag by chipping and wire brushing before splicing.

b. Splice bars in accordance with manufacturer's approved instructions. Make connections with manufacturer's standard hardware and equipment.

c. Splice identification: Prepare and maintain map of mechanical splices. Deliver to KEH at completion of work.

1) Assign splice number, prefixed by letter "C", to each splice as made. Show splice numbers on splice map.

2) Place identification symbol of splicer making splice and splice number adjacent to each splice. Use marking crayon or paint.

3) Do not reuse splice numbers. If splice is completely replaced, assign new number.

3.2.4 Nondestructive Examination

3.2.4.1 Welds: Perform 100 percent visual examination of welds in accordance with AWS D1.4. Document examination of cover pass on splice map.

3.2.4.2 Splice sleeves with filler metal

a. Examine connections visually after cooling for longitudinal centering of sleeve on spliced ends, allowable voids in filler metal, extent of leaking of filler metal, gas blowout, amount of packing, and slag at tap hole.

b. Bar end location markers and filler metal shall be visible at each bar end and at filler hole.

c. Subject each end to maximum allowable void criteria recommended by manufacturer.

d. Splices that fail to pass visual examination shall be discarded and replaced, and not used as tensile strength samples.

3.2.4.3 Splice sleeves without filler metal

a. Mark bars with suitable marker to show depth of insertion into splice. After completion, use mark to check actual depth of insertion for compliance with manufacturer's recommendations. Insertion depth shall not vary from manufacturer's recommendations by more than 1/4 bar diameter.

b. Check assembly and swaging pressure for compliance with installation procedure described in manufacturer's instructions. Certification of calibration of gages used for registering press pressures is required.

c. Check length of each coupler after swaging for compliance with manufacturer's minimum final length requirements.

d. Replace coupler splices, rejected for not meeting visual quality acceptance standards, with new splices using new couplers.

3.2.5 Moving Reinforcing

3.2.5.1 Placing, or moving reinforcing after placement, to positions other than shown or specified, requires approval of KEH.

3.2.5.2 Bars may be moved to avoid interference with other reinforcing steel, conduits, or embedded items, but shall not impair design strength of members.

3.2.6 Protect reinforcing with concrete as shown, and in accordance with ACI 349, Paragraph 7.7.

3.2.7 Tolerances: In accordance with ACI 349, Paragraph 7.5.

3.2.8 Embedded Items: Accurately position and support waterstops and embedded items against displacement. Temporarily fill voids in sleeves, inserts, and anchor slots with readily removable material to prevent entry of concrete.

3.2.8.1 Waterstops: Locate waterstops in construction joints as shown on the Drawings. Make joints at intersections and ends of pieces with complete penetration butt splice welds. Bending plates at corners is allowable, except minimum inside radius shall be 1 inch.

3.2.8.2 Other embedded items: Place sleeves, inserts, anchors, and embedded items required for adjoining work or its support before placing concrete.

3.2.8.3 Waterstops and other embedded items shall be free of mud, oil, or other material to facilitate bonding to concrete.

3.2.9 Conveying and Placing Concrete

3.2.9.1 Before placing, obtain following.

a. Approval of required submittals.

b. Approval of formwork and reinforcement by KEH.

c. Obtain approval of "Pour Slip" by KEH. "Pour Slip" shall include project name, location of pour, concrete strength, slump, places for signoff by contractors having embedded items, estimated and actual cubic yards of concrete, date and time of placing concrete, pour slip number and signoff by Contractor with date. Contractor's signature shall indicate embedments are in place and concrete may be placed. Deliver completed pour slips to KEH upon completion of pour.

d. For each truck load, deliver "Trip Ticket" to KEH. "Trip Ticket" shall contain information listed in ASTM C 94, subparagraph 16.1.1 through 16.1.10, and include water/cement ratio, water temperature at plant, mixer discharge time, and Contractor's signature.

3.2.9.2 Conveying

a. Convey concrete from mixer to forms as rapidly as practicable by methods which will not cause segregation or loss of ingredients or interruption of continuous pour.

b. Clean conveying equipment before each run.

c. Remove and dispose of concrete which has segregated in conveying as directed by KEH.

3.2.9.3 Placing

a. Place no concrete after initial set, or when weather conditions prevent proper placement and consolidation. Placement in uncovered areas during precipitation or in water will not be permitted.

b. Deposit as nearly as practicable in final position in forms.

c. Deposit concrete as soon as practicable after forms and reinforcement have been examined and approved.

d. Forms shall be clean of dirt, construction debris, water, snow, and ice.

e. Maximum free vertical drop of concrete shall not exceed 4-1/2 feet. Chuting will be permitted only where concrete is deposited into hopper before placing in forms.

f. Deposit concrete in horizontal layers 12 to 20 inches deep in manner to preclude formation of cold joints between successive layers. Deposit by method to avoid displacing reinforcement and segregating aggregate.

g. Use telescoping drop chute to place concrete in walls and when vertical lift of forms exceeds 4 feet.

h. Work concrete about reinforcement and embedded fixtures and into corners and angles of forms. Avoid overworking which may result in segregation.

i. Remove water accumulation on surface of concrete during placing by absorption with porous materials that prevent removal of cement.

j. Pumping concrete through aluminum pipe will not be permitted.

k. Concrete that has partially hardened before placing or been contaminated or remixed after initial set shall not be used.

3.2.9.4 Vibration

a. Compact with high frequency, internal mechanical vibrating equipment supplemented by hand spading and tamping. Vibrators shall be designed to operate with vibratory element submerged in concrete, and have minimum frequency of 6,000 impulses per minute when submerged.

b. Avoid vibrating forms and reinforcement unless authorized by KEH.

c. Do not transport concrete in forms with vibrators.

d. Discontinue vibrating when concrete has been compacted and ceases to decrease in volume.

e. When concrete is placed in layers, vibrator shall penetrate previously placed layer, to prevent formation of cold joints.

3.2.9.5 Weather conditions

a. Placing concrete in cold weather: Place in accordance with ACI 306.1 except as modified herein. Concrete shall not be placed when atmospheric temperature is less than 40 F except when authorized by KEH. When freezing temperatures are likely to occur within 24 hours heat concrete materials so temperature of concrete when deposited will be between 40 and 50 F. Do not heat mixing water above 140 F. Remove lumps of frozen material and ice from aggregates before placing in mixer. Do not use calcium chloride in concrete as accelerator. Remove concrete damaged by freezing and replace with new concrete.

b. Placing concrete in hot weather: Reduce temperature of concrete being placed to prevent rapid drying. Temperature of concrete placed shall not exceed 70 F. Shade fresh concrete as soon as possible after placing. Start curing as soon as surface of fresh concrete is sufficiently hard to prevent damage.

c. Control concrete placement temperatures by 1 or combination of the following.

1) Shade aggregates from sun and keep stockpiles moist by sprinkling with water to keep temperature of aggregate at or below 60 F.

2) Avoiding use of hot cement.

3) Add sufficient crushed ice, made from water meeting the requirements of subparagraph 2.1.2.3 to concrete mix, replacing equivalent amount of mix water to maintain required water/cement ratio, to reduce temperature of concrete mix at time of mixing.

4) Insulating water supply lines and tanks.

5) Insulating mixer drums, or cooling them with sprays or wet burlap coverings.

6) Working only at night.

7) Adding retarder or water reducing retarder in mix, if approved by KEH.

3.2.9.6 Pump concrete

a. If pumping of concrete from mixer to forms is used, deliver following certification, information and data at least 10 days before placement of concrete.

1) Name, type and capacity of proposed pump.

2) Statement from manufacturer that pump will pump specified class of concrete without changes to approved mix proportions and slump.

3) Certified statement that concrete forms to receive pumped concrete have been designed to withstand concrete pressure in its plastic condition as result of proposed vertical placement rate and expected ambient temperatures during pumping.

b. Pumping concrete from mixer to forms may be permitted only if approved standby method of concrete placement, such as standby pump, is available at Site.

3.2.9.7 Control of heat of hydration and thermal gradients

a. Insulate grout vault and concrete basin forms, except construction joints, with at least 1 inch of polyurethane foam, or cover pit or provide equivalent means of reducing thermal gradients. Leave insulated forms in place for at least 14 days after completion of pour. Instead of polyurethane foam insulation remaining in place for 14 days, curing blankets with R value of at least 6 may be used to cover exterior of wall forms before concrete placement completion. Wall form removal and curing compound application may be done the fifth day after pour. Reinstall curing blankets as soon as possible, but no later than 4 hours after form removal. Curing blankets may be removed for short periods of time not exceeding 4 hours as construction practices necessitate. Curing blankets may be removed 14 days after pour.

b. Cover unformed portions of slab receiving troweled finish with insulating blankets or equivalent, having R value of 5.8 or greater, morning after finishing. Insulation shall remain for curing period specified in Article 3.4 except for short periods not exceeding 4 hours as construction practices necessitate.

3.2.10 Construction Joints: Make and locate joints shown on the Drawings in accordance with approved submittal.

3.2.10.1 Reinforcement: Continue reinforcing steel across joints. Provide keys as shown. Provide longitudinal keys at least 1-1/2 inches deep in joints in walls.

3.2.10.2 Surface preparation: Clean surface of concrete at joints and remove laitance.

3.2.10.3 Bonding: Bond construction joints and joints between new and existing concrete by 1 of following methods.

a. Use specified bonding agent.

b. Roughen surface of concrete to expose aggregate uniformly and not leave laitance, loosened particles of aggregate, or damaged concrete at surface.

c. Concrete retardant to delay concrete curing on joint surfaces may be used with approval by KEH.

3.2.11 Form Removal

3.2.11.1 Remove forms in manner to prevent damage to concrete. Remove forms after minimum periods following placement of concrete specified below, with approval of KEH.

a. Insulated forms: 14 days.

b. Uninsulated forms with curing blankets: 5 days.

3.2.11.2 If average ambient temperatures during curing are below 50 F, minimum time for removal of forms and shores shall be 50 percent greater than specified.

3.2.11.3 Protect concrete work from damage during construction.

3.2.11.4 Place no concrete for subsequent wall lifts until supporting members have reached at least 70 percent of design strength.

3.2.12 Concrete Repair: Repair surface defects including tie holes, minor honeycombing and otherwise defective concrete with cement mortar of same composition used in concrete. Patch as soon as forms are removed.

3.2.12.1 Thoroughly clean and cut out areas to be patched to solid concrete to depth of at least 1 inch. Edges of cut shall be perpendicular to surface of concrete.

3.2.12.2 Saturate area to be patched and at least 6 inches adjacent thereto with water before placing mortar. Mix mortar 1 hour before placing and remix occasionally during period with trowel and without addition of water. Brush grout of cement and water mixed to consistency of paint onto surfaces to which mortar is to be bonded. Compact mortar into place and screed slightly higher than surrounding surface.

3.2.12.3 Finish patches on exposed surfaces to match adjoining surfaces, after they have set for an hour or more. Cure patches as specified for concrete.

3.2.12.4 Fill holes extending through concrete by plunger type gun or other suitable device from exterior face. Wipe excess mortar off exposed face with cloth.

3.2.12.5 Protect finished surfaces from stains and abrasions.

3.2.12.6 Concrete with excessive honeycombing which exposes reinforcing steel or other defects which affect structural strength of member, will be rejected or defects corrected as directed by KEH.

3.2.13 Concrete Finishing: Finish formed surfaces as soon as practicable after form removal and repair of surface defects. Chamfer exposed joints, edges, and corners 3/4 inch minimum, unless specified otherwise.

3.2.13.1 Rough form finish, exterior walls of concrete basin and grout vault: No selected form facing materials are required for rough form finish surfaces. Patch tie holes and defects. Chip or rub off fins exceeding 1/8 inch in height. Otherwise, leave surfaces with texture imparted by forms.

3.2.13.2 Smooth rubbed finishes, interior walls of concrete basin: Remove forms and complete patching as soon after placement as possible without jeopardizing structure. Produce finish on newly hardened concrete no later than day following form removal. Wet and rub surfaces with carborundum brick or other abrasive until uniform texture is produced. Use no cement grout other than cement paste drawn from concrete itself by rubbing process.

3.2.14 Placing and Screeding Concrete Slabs: Place, consolidate, and strike-off concrete of slump within specified limits to bring top surface of slab to proper contour, grade and elevation. Operation may be followed by darbying or full floating of surface with wooden, aluminum or magnesium tools to correct unevenness. Complete striking-off and darbying before bleed water appears on surface of freshly-placed concrete. Perform no further work until concrete has attained set sufficient for floating and to support weight of finisher and equipment. If bleed water has not disappeared by time floating is to start, drag excess water off surface with rubber hose. Do not use dry cement to absorb bleed water.

3.2.14.1 Provide floated finish for grout vault slabs. Perform floating by hand with wood or magnesium float, or with power-driven float of suitable type. During floating, check surface with 10 foot straight edge applied at 2 different angles minimum. Cut down high spots and fill low spots to produce surface true to plane within 1/2 inch in 10 feet. Refloat slab to uniform sandy texture.

3.2.14.2 Provide troweled finish for concrete basin slabs. First give slabs floated finish as specified. Upon attaining proper set, power trowel and then hand trowel surfaces. First troweling after floating shall produce smooth surface relatively free of defects but may still show some trowel marks. Do additional trowelings with raised edge by hand after surface has hardened sufficiently to provide consolidated surface. Finished surface shall be free of troweled marks, uniform in texture and be true to plane 1/4 inch in 10 feet when checked with 10 foot straight edge placed anywhere on slab in any direction.

3.3 FIELD QUALITY CONTROL

3.3.1 Concrete Testing: Sampling and testing of concrete will be the responsibility of KEH. Concrete will be tested to ACI 301, Sections 16.3.4, 16.3.5, 16.3.6, and 16.3.8.

3.3.1.1 Strength tests: Specified strengths and design mix will be verified by testing standard cylinders of samples taken at Site. 6 test specimens for laboratory curing and 3 for field curing for each 150 cubic yards of concrete, minimum 1 set each day, will be made in accordance with ASTM C 31.

a. Tests: Specimens will be tested for compressive strength in accordance with ASTM C 39 at 7, 28, and 90 days from time of molding on laboratory cured cylinders. Strength test results will be average strengths of 3 test specimens at 28 days, except if 1 specimen in set of 3 shows evidence, other than low strength, of improper sampling, molding, handling, or curing, remaining 2 specimens will be considered strength test result.

b. Test results: Evaluation of 28 day test results will be made in accordance with ACI 349, Paragraph 4.7.2.3.

3.3.1.2 Tests for consistency: Slump will be measured in accordance with ASTM C 143. Samples will be taken for slump determination from concrete during placing in forms. Tests will be made as follows.

a. At beginning of concrete placement operation and at subsequent intervals to ensure specified requirements are met.

b. Whenever test cylinders are made.

3.3.1.3 Yield tests will be made in accordance with ASTM C 138 as follows.

a. Whenever yield of concrete mix is challenged by KEH.

b. Twice a day on concrete.

c. Whenever materials or mix proportions are changed.

3.3.1.4 Temperature tests will be made as follows.

a. In hot or cold weather conditions at frequent intervals until satisfactory control is established.

b. Whenever test cylinders are made.

3.3.1.5 Contractor-furnished mix design: If evaluation of 28 day test results show concrete strength is below specified limits and does not meet other requirements make necessary adjustments, as directed by KEH.

3.3.2 At completion of concrete work, plant's coefficient of variation and standard deviation results for each class of concrete placed will be determined by KEH.

3.3.3 Waterstop Field Joint: Perform 100 percent visual examination of fit-up, root, and cover passes of steel waterstop welds. Acceptance criteria for welds shall be in accordance with AWS D1.1, paragraph 8.15.1. Document examination of fitup and cover pass on NDE/Weld Record Form KEH-433, sample appended, furnished by KEH.

3.3.3.1 Complete and document required NDE/Weld examination, and deliver to KEH before concrete placement.

3.3.4 Vault Testing

3.3.4.1 Hydrostatic

a. Fill vault with 33 feet of water, after application of interior protective coating specified in Section 09885, and before installation of exterior drainage path specified in Section 02753. Protect interior coating with splash pad during filling operation.

b. Test for 48 hours after water reaches specified depth.

c. Monitor vault wall exterior and leachate collection sump liner for leakage throughout test. Mark visible leaks and damp spots on exterior wall for reference.

d. Water drops forming on exterior vault walls or visible leakage is unacceptable and vault shall be repaired.

e. Maximum leakage rate collected in leachate collection sump liner: 0.10 gallons per day.

f. If precipitation occurs during test period, restart test after exterior walls have dried and rainwater collected in concrete basin and leachate collection sump has been removed.

1) Contractor may provide method to prevent precipitation from entering concrete basin and wetting exterior walls.

g. Vault repair

1) Repair concrete as specified in Paragraph 3.2.12.

2) Repair interior protective coating in accordance with Section 09885.

3) Repeat vault hydrostatic testing.

h. Remove water from vault immediately after hydrostatic testing and dispose of in accordance with Section 01500.

3.3.4.2 Air leakage

a. Perform test in accordance with ASTM E 779 after installation of precast roof specific in Section 03419, concrete topping shown on the Drawings, and sealing vault penetrations.

b. Air in leakage rate: Determined at test pressure differences between 0.05 and 0.5 inch water gage vacuum.

c. Maximum air leakage rate: 3000 cfm at 0.5 inch water gage vacuum.

d. Vault and roof repair

1) Repair concrete and concrete roof topping as specified in Paragraph 3.2.12.

2) Repeat air leakage test.

e. Document test results in accordance with Paragraph 3.3.5 with following minimum information.

1) Vault number.

2) Items required in ASTM E 779, Paragraphs 10.1.2, 10.1.3, and 10.1.4.

3.3.5 Documentation

3.3.5.1 Document test results and examinations required in this Section.

3.3.5.2 Documentation shall be kept current and is subject to review by KEH. Prepare and certify records as works progresses.

3.3.5.3 Deliver documentation to KEH within 7 working days after completion of tests.

3.4 CURING AND PROTECTION

3.4.1 General

3.4.1.1 Protect concrete from injurious action by sun, rain, flowing water, frost, and mechanical injury. Do not allow to dry out from time placed until expiration of minimum curing periods specified.

3.4.1.2 Cure by moist curing, or application of liquid chemical or liquid membrane-forming compound. Continue curing following removal of forms.

3.4.1.3 Maintain temperature of air next to concrete at 40 F minimum for full curing periods. When concrete is authorized for placement in temperatures below 40 F, maintain air in contact with concrete at temperature of at least 50 F for 7 days after placing, or at 70 F minimum for 3 days after placing, and at 40 F minimum for remainder of specified curing periods.

3.4.1.4 Heating concrete in place shall be by venter heaters, steam coils under canvas covers, or other suitable means. Temperature within enclosures shall not exceed 100 F, and adequate moisture shall be applied to concrete surface during heating period to prevent it from drying out.

3.4.1.5 Rate of cooling after protection period shall be approximately 1 F per hour for first 24 hours and 2 F per hour thereafter.

3.4.1.6 Protect concrete against freezing for full curing period specified.

3.4.2 Moist Curing: Moist or wet curing with water or by complete coverage with waterproof membrane sheets shall be continuous for 7 days at 60 F and above, and for longer periods at lower temperatures.

3.4.2.1 Mats: Cover entire surface of concrete slabs with 2 thicknesses of wet burlap weighing at least 7 ounces per square yard dry weight, cotton mats, or other suitable material having high absorptive quality. Thoroughly wet material when applied and keep continuously wet during time remaining on slab. Make mats of clean material free of substances which will have deleterious effects on concrete, and at least as long as width of concrete under construction. During application, do not drag mats over finished concrete slabs or mats already placed, and place to provide complete coverage of surface with slight overlap over adjacent mats. Leave mats in place during curing period.

3.4.2.2 Impervious sheeting curing

a. Thoroughly wet entire exposed surface with fine water spray and cover with 1 of the following.

1) Waterproofed paper.

2) Polyethylene-bonded waterproof paper sheeting.

3) Polyethylene-coated burlap sheeting.

4) Polyethylene sheeting.

b. Lay sheets directly on concrete surface and overlap 12 inches when continuous sheet is not used. Curing medium shall be at least 18 inches wider than concrete surface to be cured, and be weighted down by placing bank of moist earth on edges just outside forms and over transverse laps to form closed joints. Repair or replace sheets if torn or otherwise damaged during curing. Curing medium shall remain on concrete surface for at least 7 days.

3.4.3 Liquid Membrane-Forming Compound Curing: Apply clear liquid compound, free of paraffin or petroleum, over concrete surface to restrict evaporation of mixing water. Cure for 7 days following placing of liquid membrane-forming compound.

3.4.3.1 Application of curing compound: Apply after surface looses water sheen and has dull appearance. Agitate curing compound by mechanical means during use and apply uniformly in 2 coat continuous operation by suitable power spraying equipment. Total coverage for 2 coats shall be between 150 and 200 square feet per gallon of undiluted compound. Compound shall form uniform, continuous, coherent film that will not check, crack, or peel and be free of pinholes or other imperfections. Apply additional coat of compound to areas where film is defective. Keep suitable covering, other than liquid curing compound, readily available for use to protect freshly placed concrete in event conditions occur which prevent correct application of compound at proper time. Respray concrete surfaces that are subject to heavy rainfall within 3 hours after curing compound has been applied as specified.

3.4.3.2 Protection of treated surfaces: Keep treated surfaces free from foot and vehicular traffic and other sources of abrasion for at least 72 hours. Maintain continuity of coating for entire curing period and repair damage.

3.4.3.3 Liquid chemical compound curing may be provided instead of liquid membrane-forming compound curing. Apply as specified for liquid membrane-forming compound curing except coverage and number of applications shall be in accordance with manufacturer's recommendations.

3.4.4 Additional Curing Periods: When 7 day compression test cylinders, representative of parts of structure already placed, indicate that 28 day strengths may be less than 90 percent of design strengths, give those parts of structure additional curing, as directed by KEH. Curing shall be as follows.

Time (Min.)	Concrete Element
14 days	Concrete basin slabs and walls.
14 days	Grout vault slabs and walls.
* 14 days	Construction joints (* or until adjacent concrete is placed).

3.5 CLEANING

3.5.1 Clean basin slabs with ordinary brooms or other suitable method. Keep clean and free of debris and dirt until concrete basin liner is in place.

3.5.2 Clean grout vault floor by sweeping with ordinary brooms or other suitable method.

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NDE/WELD RECORD	1. Project/W.O. No.	2. Weld Identification Dwgs.	3. Contractor

4. WELD INFORMATION	5. VISUAL EXAMINATION			6. LIQUID PEN. / MAG. PART.	7. RADIO. / 8. LEAK TEST	9. Other:
	Fit-up	Root Pass	Cover Pass			
Weld No.				Root Pass	Radiographic	
Welder Identification						
Welding Procedure Specification				Cover Pass	Leak Test	
Weld Filler Mat'l.						
Weld No.				Root Pass	Radiographic	
Welder Identification						
Welding Procedure Specification				Cover Pass	Leak Test	
Weld Filler Mat'l.						
Weld No.				Root Pass	Radiographic	
Welder Identification						
Welding Procedure Specification				Cover Pass	Leak Test	
Weld Filler Mat'l.						
Weld No.				Root Pass	Radiographic	
Welder Identification						
Welding Procedure Specification				Cover Pass	Leak Test	
Weld Filler Mat'l.						
Weld No.				Root Pass	Radiographic	
Welder Identification						
Welding Procedure Specification				Cover Pass	Leak Test	
Weld Filler Mat'l.						
Weld No.				Root Pass	Radiographic	
Welder Identification						
Welding Procedure Specification				Cover Pass	Leak Test	
Weld Filler Mat'l.						

END OF SECTION

KEH-433 (1-86)

SECTION 03419

PRECAST PRESTRESSED CONCRETE SECTIONS

PART 1 - <u>GENERAL</u>

1.1 REFERENCES

1.1.1 Reference Standards and Specifications: The following standards and specifications, including documents referenced therein, form part of this Section to extent designated herein.

1.1.1.1 American Association of State Highway and Transportation Officials (AASHTO)

1983	Standard Specification for Highway Bridges, 13th Edition

1.1.1.2 American Concrete Institute (ACI)

ACI 318-83 (Revised 1986)	Building Code Requirements for Reinforced Concrete

1.1.1.3 American Society for Testing and Materials (ASTM)

A 36-87	Standard Specification for Structural Steel
A 53-87b	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
A 185-85	Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
A 416-87a	Standard Specification for Uncoated Seven-Wire Stress-Relieved Strand for Prestressed Concrete
A 615-87	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
C 33-86	Standard Specification for Concrete Aggregates
C 150-86	Standard Specification for Portland Cement

C 260-86	Standard Specification for Air-Entraining Admixtures for Concrete
C 494-86	Standard Specification for Chemical Admixtures for Concrete

1.1.1.4 American Welding Society (AWS)

AWS D1.1-88	Structural Welding Code-Steel
AWS D1.4-79	Structural Welding Code-Reinforcing Steel

1.1.1.5 Federal Specifications (FS)

WW-U-531F	Unions, Pipe, Steel Or Malleable Iron; Threaded Connection, 150 Lb And 250 Lb

1.1.1.6 Prestressed Concrete Institute (PCI)

MNL-116-85	Manual for Quality Control for Plants and Production of Precast Prestressed Concrete Products

1.1.1.7 Washington Industrial Safety and Health Act (WISHA)

Washington Administrative Code (WAC)

Title 296, Labor and Industries
Chapter 296-155 WAC, Safety Standards for Construction Work

Part F	Material Handling, Storage, Use, and Disposal

1.2 SUBMITTALS: Refer to Section 01300 for submittal procedures.

1.2.1 Fabricator Drawings: Prepare and submit complete drawings and design calculations for prestressing and erection methods, materials and equipment. Drawings shall show plan, elevations and sections of units, and methods and sequence of stressing, including specifications and details of prestressing steel and anchoring devices, anchoring stresses, type of enclosure, arrangement of prestressing steel, erection procedures, location of lifting points for handling, method of transportation, details of lifting devices, and details of penetrations.

1.2.2 Records of Tests: Maintain and submit records of tests performed to determine properties of materials used in concrete.

1.2.3 Concrete Materials and Mix Design: Submit concrete materials and mix design established in accordance with ACI 318, Chapter 4. Define each material used in concrete and state amount, by weight, utilized per cubic yard of plastic mix.

1.2.4 Certification: Submit certification of proof-testing lifting devices in accordance with WISHA.

1.2.5 Certification of Prestressed Concrete Production Facilities: Submit current legible copy of certification by Prestressed Concrete Institute.

1.2.6 Manufacturer's Quality Assurance Plan: Submit quality assurance plan for Project that addresses requirements of Section 01400.

1.3 DESIGN REQUIREMENTS

1.3.1 Design sections in accordance with ACI 318.

1.3.2 Design Calculations: Prepared by registered engineer experienced in precast, prestressed concrete design. Calculations shall include estimated camber.

1.3.3 Loadings for Design.

1.3.3.1 Soil overburden: 500 psf.

1.3.3.2 Surcharge: 300 psf.

1.3.3.3 Dead loads including member weight and concrete topping varying in thickness from 2 inches at plank ends to 8 inches at center of span.

1.3.3.4 Thermal loading: During operation, temperature gradient will exist between top and bottom of members as follows.

a. Bottom temperature: 105 F.

b. Top temperature: 70 F.

1.3.3.5 Other loads specified on the Drawings.

1.3.4 Sections shall be able to withstand torsional, impact and point loads generated by handling from place of casting to and including installation.

1.3.5 Design and fabricate lifting devices meeting the requirements of WISHA, of malleable steel formed so considerable deformation, easily discernable to eye, is required before failure.

1.4 QUALITY ASSURANCE

1.4.1 Testing

1.4.1.1 Fabrication of precast prestressed concrete sections shall include testing in accordance with PCI MNL-116, Section 6.1.

1.4.1.2 Inspection and test records shall be in accordance with PCI MNL-116, Section 1.2, 6.1, and 6.2. Deliver to KEH upon request.

1.4.2 Personnel and procedures for welding shall have been qualified in accordance with AWS D1.1 and D1.4 before welding.

1.4.3 Deliver 2 copies of welding procedure specifications, procedure qualification records, and welder information qualification test results to KEH 5 days before welding. Maintain additional copies as specified in Section 01400, Paragraph 1.6.2.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Deliver, store and handle members in accordance with PCI MNL-116, Sections 5.1.7 and 5.1.8.

1.5.2 Lift members only at lifting points shown on fabricator drawings, using approved lifting devices. Lifting devices shall have minimum safety factor of 5.

1.5.3 Support members during manufacture, stockpiling, transporting and installing only at support points shown on fabricator drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

2.1.1 Each aggregate, cement, water and admixture shall be capable of producing consistent quality within quantity of materials required for project. Aggregates, cement and admixtures shall have been produced by same manufacturer and, when quantity required is less than one batch or mix, be from same batch or mix.

2.1.2 Aggregates: Meet the requirements of ASTM C 33.

2.1.3 Portland Cement: ASTM C 150, type or modified type compatible with aggregates, water and admixtures.

2.1.4 Water: Potable and free of foreign materials in amounts harmful to concrete and embedded steel.

2.1.5 Admixtures

2.1.5.1 Air-entraining agents: Meeting the requirements of ASTM C 260.

2.1.5.2 Water reducing agents: Meeting the requirements of ASTM C 494, Type "A."

2.1.6 Stressing Steel: 7 wire stress-relieved steel strand units meeting the requirements of ASTM A 416, Grade 250 or 270.

2.1.7 Reinforcing Steel

2.1.7.1 Steel bars: ASTM A 615, deformed, Grade 60.

2.1.7.2 Welded wire fabric: ASTM A 185.

2.1.7.3 Tie wire: Black annealed steel, 16 gage minimum.

2.1.8 Anchors and Inserts

2.1.8.1 Anchors and inserts: Structural steel, ASTM A 36 with manufacturer's standard shop prime finish.

2.1.8.2 Pipe inserts: Carbon steel meeting the requirements of ASTM A 53. Malleable iron pipe caps, threaded, in accordance with FS WW-U-531.

2.1.9 Grout

2.1.9.1 Cement grout: Portland cement, sand and water sufficient for placement and hydration. Minimum strength, 3000 psi at 28 days.

2.1.9.2 Nonshrink grout: See Section 03300.

2.1.10 Elastomeric Bearing Pads: Meeting the requirements of AASHTO "Standard Specification for Highway Bridges," Division 1, Section 25.

2.2 MIXES

2.2.1 Design each concrete mixture using data obtained from tests in Article 1.4.

2.2.1.1 Minimum allowable compressive strength: 6000 psi at 28 days.

2.2.1.2 Minimum release strength: 4500 psi.

2.2.2 Concrete may contain air-entraining agent.

2.2.3 Use of calcium chloride, chloride ions, or other salts will not be permitted.

PART 3 - EXECUTION

3.1 FABRICATION

3.1.1 Fabrication of sections shall be by PCI certified fabricator.

3.1.2 Fabrication Procedures: In accordance with PCI MNL-116.

3.1.3 Fabrication Tolerances: Meet the requirements of PCI MNL-116.

3.1.4 Finishes

3.1.4.1 Finishes for completed units shall be in accordance with PCI MNL-116, Section 3.5.

3.1.4.2 Finishing of formed surfaces shall be from casting against approved, properly cleaned forms using industry practice in placing and curing.

3.1.4.3 Strands on end surfaces shall be recessed and ends of members shall receive sack finish.

3.2 INSTALLATION

3.2.1 Install members by competent erector. Lift members in accordance with Paragraph 1.5.2.

3.2.2 Align and level members as shown on approved fabricator drawings.

3.2.3 Variation between adjacent members shall be reasonably leveled out by jacking or other feasible method acceptable to KEH.

3.3 FIELD QUALITY CONTROL

3.3.1 Sampling and testing will be the responsibility of precast fabricator.

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1 - GENERAL

1.1 REFERENCES

1.1.1 Reference Standards and Specifications: The following standards and specifications, including documents referenced therein, form part of this Section to extent designated herein.

1.1.1.1 American Society of Mechanical Engineers (ASME)

1986 Edition, w/Addenda through Dec 1988	ASME Boiler and Pressure Vessel Code
Section IX	Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators

1.1.1.2 American Society for Testing and Materials (ASTM)

A 36-87	Standard Specification for Structural Steel
A 106-87a	Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
A 500-84	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
A 569-85	Standard Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality

1.1.1.3 American Welding Society (AWS)

AWS D1.1-88	Structural Welding Code - Steel
AWS D1.3-81	Structural Welding Code - Sheet Steel

1.1.1.4 Steel Structures Painting Council (SSPC)

SSPC-SP 3-82	No. 3 Power Tool Cleaning

1.2 SUBMITTALS: Refer to Section 01300 for submittal procedures.

1.2.1 Fabricator Drawings: Submit drawings and bill of materials for waterstops. Include plans, elevations, details, sections and connections. Show thickness, type, grade, class of metal, and accessory items where applicable.

1.2.2 Certified Material Test Reports (CMTR): Submit legible reports, certified by responsible manufacturer, showing chemical analysis and physical properties of material used for waterstops. Submit separate reports for each lot of steel furnished by each supplier.

1.3 QUALITY ASSURANCE

1.3.1 Qualification of Welding Personnel and Procedures

1.3.1.1 Personnel and procedures for welding structural steel shall have been qualified in accordance with AWS D1.1 before welding. Qualification in accordance with ASME Section IX may be substituted for this requirement.

1.3.1.2 Deliver 2 copies of welding procedure specifications, procedure qualification records, and welder performance qualification test results to KEH 5 days before welding. Maintain additional copies as specified in Section 01400, Paragraph 1.6.2.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Deliver metal fabrications to project at time convenient for installation. If exposed to inclement weather, protect fabrications with paper, plastic or other weatherproof covering and store off ground.

PART 2 - PRODUCTS

2.1 MATERIALS

2.1.1 Waterstop: 6 inch wide by 1/4 thick continuous steel plate; ASTM A 36.

2.1.2 Rolled Steel Shapes and Plates: ASTM A 36.

2.1.3 Sheet Steel: ASTM A 569.

2.1.4 Steel Pipe: ASTM A 106, Grade B.

2.1.5 Steel Tubing: ASTM A 500, Grade B.

2.1.6 Weld Studs: Nelson Stud Welding Company Type H4L.

2.2 FABRICATION

2.2.1 General

2.2.1.1 Verify measurements and take field measurements necessary before fabrication. Provide miscellaneous supports and braces necessary for completion of metal fabrications.

2.2.1.2 Workmanship: Form metal fabrications to shape and size, with sharp lines, angles, and true curves.

2.2.1.3 Perform welding in accordance with AWS D1.1, Section 8, using E70XX electrodes and complete penetration welds.

2.2.1.4 Weld and examine sheet steel in accordance with AWS D1.3

2.2.2 Waterstop: Steel free of mud, oil, or other material to facilitate bonding to concrete.

2.2.2.1 Make splices by buttwelding ends of plates together.

2.2.2.2 Bending of plates at corners is allowable, except minimum inside radius shall be 1 inch.

2.2.3 Finishes

2.2.3.1 Do not coat members to be embedded in concrete, or surfaces and edges to be field welded.

2.2.3.2 Remove weld spatter, flux, slag, and other deleterious matter in accordance with SSPC-SP 3.

PART 3 - EXECUTION

3.1 INSTALLATION

3.1.1 Install metal fabrications plumb, level or as shown on the Drawings.

3.1.2 Make field connections as neatly as possible with joints flush and smooth.

END OF SECTION

SECTION 09805

SPECIAL PROTECTIVE COATING

PART 1 - <u>GENERAL</u>

1.1 REFERENCES

1.1.1 Reference Standards and Specifications: The following standards and specifications, including documents referenced therein, form part of this Section to extent designated herein.

1.1.1.1 Steel Structures Painting Council (SSPC)

SSPC-SP 6-85	No. 5 White Metal Blast Cleaning

1.2 SUBMITTALS: Refer to Section 01300 for submittal procedures.

1.2.1 List of Materials: Submit complete list of materials, colors and location to be used, to substantiate compliance with the Drawings and this Section. List shall enumerate percentage of volatile and nonvolatile materials and percentage of component parts of each type of material.

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Deliver materials to site in manufacturer's unopened containers with labels intact. Do not open containers or remove labels until after inspection and acceptance by KEH.

1.3.2 Store materials in accordance with manufacturer's recommendations and in well ventilated area not exposed to excessive heat, sparks, flame or direct rays of sun.

1.4 PROJECT CONDITIONS

1.4.1 Environment for Coating: Coat exterior surfaces only when ambient and surface temperatures are between 35 F and 120 F, and temperature is 5 F above dewpoint.

PART 2 - <u>PRODUCTS</u>

2.1 MATERIALS

2.1.1 Coating materials are products of Protective Coatings Division of Ameron, Brea, California unless otherwise specified.

2.1.2 Filler: Nu-Klad 114.

2.1.3 Primers

2.1.3.1 Dimetcote Steel Primer 205.

2.1.3.2 Amercoat 71.

2.1.3.3 Amercoat 187.

2.1.4 Finish Coatings

2.1.4.1 Amercoat 33.

2.1.4.2 Amercoat 78HB.

2.1.4.3 Amercoat 234.

2.1.5 Colors

2.1.5.1 Finish coat: White.

2.1.5.2 Symbols and flow diagrams: Black letters on yellow background, except as shown on the Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Examine surfaces scheduled to receive paint and finishes for conditions that will adversely affect execution, permanence or quality of work and which cannot be put into acceptable condition through preparatory work included in Article 3.2.

3.1.2 Report in writing to KEH conditions that may potentially affect proper application of finish. Do not commence surface preparation or coating application until defects have been corrected and conditions are made suitable.

3.2 PREPARATION

3.2.1 General: Before application, sweep and dust space or area to receive coating.

3.2.2 Pre-Priming

3.2.2.1 Prepare ferrous metals in accordance with SSPC-SP 5, remove abrasive residue and dust, and prime within 4 hours after preparation.

3.2.2.2 Clean concrete surfaces of laitance, oil, stains, dust and other foreign material.

a. Where laitance has not been removed, treat concrete with uniform application of 1 of following solutions.

1) 1 part 10 percent solution muriatic acid and 3 parts water.

2) 5 percent solution of trisodium phosphate.

b. When solution ceases to foam, rinse thoroughly with clean water and scrub with stiff bristle brush. Allow treated area to thoroughly dry. Scratches, cracks, holes and abrasions shall be cut back to proper key and filled with Nu-Klad 114.

c. Allow concrete to cure 30 days before coating is applied, except coating may be applied after concrete has cured 21 days if moisture content of concrete is less than 12 percent.

3.2.3 Post Priming

3.2.3.1 Feather abrasions, chips, skips and holidays occurring in prime coat by sanding and recoat with material and color to minimum dry film thickness specified.

3.2.3.2 Previously coated surfaces shall be recoated only after existing film is completely dry.

3.2.3.3 Protect coating from rain until dry to touch.

3.2.4 Protection

3.2.4.1 Provide and install drop cloths, shields and other protective devices required to protect surfaces adjacent to areas being coated. Keep spatter, smears, droppings and over-run of coating materials to minimum and remove as coating work progresses.

3.2.4.2 Remove and store electrical fixtures, outlets and switch plates. mechanical diffusers, escutcheons, surface hardware, fittings and fastenings before starting work. Clean and reinstall upon completion of work in each area. Use no solvent or abrasives to clean hardware that will remove lacquer finish normally used on some items.

3.3 APPLICATION

3.3.1 Apply coating materials in accordance with manufacturer's recommendations.

3.3.2 Apply with equipment recommended by manufacturer.

3.3.3 Identify each coat of opaque material by its relation to color of finish coat. Prime coat shall be darkest tint of specified color with each succeeding coat lighter, up to finish coat, which shall be color, tint and sheen specified. Tints of identical coats of identical color and material shall not vary.

3.4 FIELD QUALITY CONTROL

3.4.1 Inspection: KEH will perform tests to ascertain that coating materials have been applied in accordance with this Section.

3.5 CLEANING

3.5.1 Furnish and maintain at site, closed metal containers for disposal of waste materials. Place materials spotted or soaked with paint, oil or solvents in containers.

3.5.2 Brushes, rollers, spatulas and spray equipment shall be thoroughly cleaned after each use and shall contain no oils, thinners or other residue after such cleaning.

3.5.3 Remove empty cans from site at end of each shift.

3.5.4 At completion of coating work, remove materials, containers, rags, cloths, brushes, and other equipment from site. Clean up spills.

3.6 COATING SCHEDULE

			Minimum Wet Film Thickness and Percentage of Film Forming Solids per Volume	Minimum Dry Film Thickness
3.6.1	Concrete and Masonry			
	Prime:	Amercoat 187	4.5 mils & 22.0%	1.0 mil
	Second:	Amercoat 33	6.4 mils & 23.46%	1.5 mils
	Finish:	Amercoat 33	6.4 mils & 23.46%	1.5 mils
3.6.2	Ferrous Metals			
	Prime:	Dimetcote Steel Primer 205	1.4 mils & 35%	0.50 mil
	Second:	Amercoat 187	4.5 mils & 22.0%	1.0 mil
	Third:	Amercoat 33	6.4 mils & 23.46%	1.5 mils
	Fourth:	Amercoat 33	6.4 mils & 23.46%	1.5 mils
		OR		
	Third:	Amercoat 234	10 mils & 25%	2.5 mils
	Fourth:	Amercoat 234	10 mils & 25%	2.5 mils
3.6.3	Carbon Steel			
	Prime:	Amercoat 71	4.3 mils & 47%	2.0 mils
	Second:	Amercoat 78HB	20.5 mils & 78%	16.0 mils

END OF SECTION

SECTION 09885

PROTECTIVE COATING FOR CONCRETE VAULT INTERIOR

PART 1 - GENERAL

1.1 REFERENCES: Not Used

1.2 SUBMITTALS: Refer to Section 01300 for submittal procedures.

1.2.1 List of Materials: Submit complete list of materials. List shall enumerate percentage of volatile and nonvolatile materials and percentage of component parts of each type of material.

1.2.2 Certified Material Test Reports (CMTR): Submit materials test reports, certified by manufacturer of protective coating, which identify components and show chemical analysis and physical properties for each lot number used.

1.2.3 Samples: Submit 1 gallon sample of coating material to be used on Project, for independent testing and comparison with CMTRs.

1.3 QUALITY ASSURANCE

1.3.1 Qualification of Substrate Preparer: Provide evidence of previous successful concrete substrate preparation for coating applications.

1.3.2 Qualification of Applicator: Provide evidence of previous successful sprayed-on asphalt coating applications.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Deliver materials to site in manufacturer's unopened containers with labels intact. Do not open containers or remove labels until after inspection and acceptance by KEH.

1.4.2 Store materials in accordance with manufacturer's recommendations and in well ventilated area not exposed to excessive heat, sparks, flame or direct rays of sun.

1.5 PROJECT CONDITIONS

1.5.1 Environment for Coating

1.5.1.1 Preferred ambient and surface temperatures: 60 F or above and rising.

1.5.1.2 Minimum ambient and surface temperatures: 40 F and rising.

PART 2 - PRODUCTS

2.1 MATERIALS

2.1.1 Coating materials are products of Protective Coatings Department of Lion Oil Company, El Dorado, Arkansas. No substitutes allowed.

2.1.1.1 Primer: Nokorode 705M thinned at ratio of 1 to 1 with naptha or mineral spirits.

2.1.1.2 Finish Coating: Nokorode 705M.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Examine surfaces scheduled to receive coating for conditions that will adversely affect execution, permanence or quality of work and which cannot be put into acceptable condition through preparatory work included in Article 3.2.

3.1.2 Report in writing to KEH conditions that may potentially affect proper application of finish. Do not commence surface preparation or coating application until defects have been corrected and conditions are made suitable.

3.2 PREPARATION

3.2.1 General

3.2.1.1 Allow concrete to cure 21 days minimum before preparing surface.

3.2.1.2 Before application, sweep and dust space or area to receive coating.

3.2.2 Pre-Priming

3.2.2.1 Clean concrete surfaces of laitance, oil, stains, dust and other foreign material.

3.2.2.2 Prepare concrete by removing surface until dry, clean, contaminant-free, sound, open pore, exposed-aggregate concrete is obtained by using 1 of the following methods. Remove spalled concrete.

a. Scabbling machine: Hammer type.

b. Steel shot, for horizontal surfaces only: Wheelabrator-Frye Blastrac type. Ensure no shot remains.

c. Sandblasting.

d. Very high pressure water/sandblasting: Use clean, fresh water and dry blasting silica, maximum particle passing 16 mesh screen, at pressure sufficient to achieve specified surface.

e. Ultra high pressure waterblasting: Use clean fresh water at highest pressure necessary to achieve specified surface.

3.2.2.3 Remove dust and debris from concrete pores with clean, dry, oil-free compressed air or adequately powered, heavy duty industrial vacuum.

3.2.2.4 Thoroughly dry surface before applying primer.

3.2.3 Post Priming

3.2.3.1 Feather abrasions, chips, skips and holidays occurring in prime coat by sanding and recoat.

3.2.3.2 Previously coated surfaces shall be recoated only after existing film is completely dry.

3.2.3.3 Protect coating from rain until dry to touch.

3.2.4 Protection: Provide and install drop cloths, shields and other protective devices required to protect surfaces adjacent to areas being coated. Keep spatter, smears, droppings and over-run of coating materials to minimum and remove as coating work progresses.

3.3 APPLICATION

3.3.1 Do not apply materials when excessive wind, blowing dust, or rain is imminent.

3.3.2 Minimum Temperature of Coating Material: 70 F.

3.3.3 Spray apply coating materials in accordance with Article 3.6 and manufacturer's recommendations.

3.3.3.1 Apply second coat 5 to 60 minutes after primer.

3.3.3.2 Do not allow second coat to cure beyond elastomeric set before applying finish coat.

3.3.3.3 On vertical surfaces, apply finish coat perpendicular to second coat.

3.3.3.4 Allow finish coat to cure dry to touch before repairing.

3.3.3.5 Protect coated surfaces from dust and other foreign materials while curing.

3.3.3.6 Protect coating from sunlight until roof is installed.

3.3.4 Apply with equipment recommended by manufacturer.

3.3.5 Repair: Scratch area with wire brush before application of additional coats.

3.4 FIELD QUALITY CONTROL

3.4.1 Testing: After coating has cured, test for pinholes. Results shall be less than 1 pinhole per square yard.

3.4.2 Inspection: KEH will perform tests to ascertain that coating materials have been applied in accordance with this Section.

3.5 CLEANING

3.5.1 Furnish and maintain at site, closed metal containers for disposal of waste materials. Place materials spotted or soaked with paint, oil or solvents in containers.

3.5.2 Spray equipment shall be thoroughly cleaned after each use and shall contain no oils, thinners or other residue after such cleaning.

3.5.3 Remove empty cans from site at end of each shift.

3.5.4 At completion of coating work, remove materials, containers, rags, cloths, brushes, and other equipment from site. Clean up spills.

3.6 COATING SCHEDULE

		Approximate Rate	Min Wet Film Thickness	Min Dry Film Thickness
3.6.1 Concrete				
a. Vertical surfaces				
Prime:	Nokorode 705M, thinned	0.5-0.75 gal/ 100 ft^2	Uniform Cover	
Second:	Nokorode 705M	2.0 gal/ 100 ft^2	30 mils	26 mils
Finish:	Nokorode 705M	2.0 gal/ 100 ft^2	30 mils	26 mils

		Approximate Rate	Min Wet Film Thickness	Min Dry Film Thickness
b. Horizontal surfaces				
Prime:	Nokorode 705M, thinned	0.5-0.75 gal/ 100 ft^2	Uniform Cover	
Finish:	Nokorode 705M	4.0 gal/ 100 ft^2	60 mils	52 mils

END OF SECTION

SECTION 13440

INSTRUMENTATION

PART 1 - GENERAL

1.1 REFERENCES

1.1.1 Reference Standards and Specifications: The following standards and specifications, including documents referenced therein, form part of this Section to extent designated herein.

1.1.1.1 American National Standards Institute (ANSI)

ANSI MC96.1-1982	American National Standards for Temperature Measurement Thermocouples

1.1.1.2 National Electrical Manufacturers Association (NEMA)

Standards Publication/ No. ICS 6-1983 w/Rev through Nov 1986	Enclosures for Industrial Controls and Systems

1.2 SUBMITTALS: Refer to Section 01300 for submittal procedures.

1.2.1 Approval Data: Submit information listed in Column 5 of Vendor Data List in this Section.

1.2.2 Certified Vendor Information (CVI): Submit information listed in Column 6 of Vendor Data List in this Section.

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery field mounted equipment assemblies completely assembled, except as noted.

1.3.1.1 Thermocouple assemblies: Package with padding material and place inside pipe with cap on end. Junction box shall have door secured and be well padded, then wrapped with packaging tape. Assemblies shall then be secured to shipping pallets.

1.3.1.2 Level element assemblies: Well padded and placed in separate wooden boxes for shipment.

1.3.1.3 Cable assemblies: Individually tied and placed in padded wooden crate for shipment.

PART 2 - PRODUCTS

2.1 MATERIALS

2.1.1 Electrical Connecting Cables: Assembled from cable and connectors specified on Data Sheet Y-101.

2.1.2 Other materials required to complete instrumentation installation are specified in Section 15493, Section 16400 and on the Drawings.

2.2 EQUIPMENT

2.2.1 Instruments: In accordance with data sheets in this Section.

2.2.1.1 Identification: Attach nameplates, in readily visible locations, with manufacturer's name, model number, name of item, and serial number.

PART 3 - EXECUTION

3.1 INSTALLATION

3.1.1 Install instruments, materials, and equipment in accordance with the Drawings, manufacturers' instructions, and Section 16400.

3.2 FIELD QUALITY CONTROL

3.2.1 Test cable assembles for continuity and unintentional grounds. Resistance shall not exceed 1 ohm on continuity checks. Deliver test results to KEH upon completion of tests.

LEVEL INSTRUMENTS, CAPACITANCE TYPE

LEACHATE SUMP 218-E-16-102 & 218-E-16-103

GENERAL

1.	Tag Number	(See Note 1, Page 3 of 3)
2.	Service	Leachate solution
3.	Vessel Identification	Vault leachate sump
4.	Application	Sump level
5.	Function	Indicate and transmit level

PROBE

6.	Type	Flexible insulated cable attached to weatherproof probe head
7.	Orientation	Vertical
8.	Material	Heavy-duty stainless steel cable with polypropylene insulation
9.	Weight	Stainless steel, 2-1/2 inches diameter, 3 inches long
10.	Insertion Length	56'-10-1/2" (including attached weight)
11.	Inactive Length	40'-7-1/2"
12.	Active Length	16 feet
13.	Signal Connection	Quick-disconnect connector
14.	Process Connection	3 inch, 150 pound, RF, 304 SST flange

TRANSMITTER

15.	Enclosure	NEMA 4 steel box, surface mount
16.	Power	115V ac, 60 Hz
17.	Output	4-20 mA dc
18.	Indicator	3-1/2 Digit meter, mounted in transmitter
19.	Range	0 - 16 feet
20.	Conduit Connection	3/4 inch
21.	Probe Head Connection	Quick-disconnect connector

LEVEL INSTRUMENTS, CAPACITANCE TYPE (Cont)

LEACHATE SUMP 218-E-16-102 & 218-E-16-103

ACCESSORIES

22.	Compensation Cable	100 feet long with quick-disconnect connectors on both ends
23.	Flanges	Probe head mounted on 3 inch. 150 pound, RF, 304 stainless steel flange
24.	Power Supply	24V dc, mounted in transmitter by manufacturer
25.	Connectors	Quick-disconnect connector at both ends of compensation cable

SERVICE

26.	Fluid	Leachate solution (pH 12+)
27.	Conductivity	70+ Micromho/cm
28.	Pressure	Atmosphere
29.	Temperature (probe)	Maximum 200 F; normal 35-100 F
30.	Temperature (transmitter)	-20 to 120 F
31.	Suggested Manufacturer	Drexelbrook Engineering Co. Inc
32.	Model Numbers	System, 508-25-8; quick-disconnect connectors on 100 foot general purpose cable, 380-100-12 with Drevelbrook Std environmental mental rated quick-disconnect connector set at transmitter - 1 connector or pigtail with "Liquid-Tite" strain relief at transmitter housing with quick-disconnect pair at sensing element; probe weight, 752-287-4;

LEVEL INSTRUMENTS, CAPACITANCE TYPE (Cont)
LEACHATE SUMP 218-E-16-102 & 218-E-16-103

32. Model Numbers (Continued)	digital meter, 370-3000-1; power supply, 401-13-21. Instrumentation system shall have minimum service life of 10 years under normal use and maintenance.

NOTES: 1. Tag Numbers:

Element	Transmitter
LE-LS-102-1A	LIT-LS-102-1A
LE-LS-102-1B	LIT-LS-102-1B
LE-LS-103-1A	LIT-LS-103-1A
LE-LS-103-1B	LIT-LS-103-1B

THERMOCOUPLE ASSEMBLIES

VAULT LOCATED

1.	Tag Numbers	(See Note 1)
2.	Type	Type K, 16 point
3.	Protection Tube	1 inch Schedule 40S 304 stainless steel pipe
4.	Length	(See Note 2)
5.	Thermocouple Spacing	(See Note 2)
6.	Service	Grouted radioactive waste (pH 12+)
7.	Temperature	35 to 200 F
8.	Wire Size	Manufacturer's standard
9.	Junction	Ungrounded
10.	Insulation Material	Mineral Oxide
11.	Test Resistance	100 Mohm minimum, TC to sheath and TC to TC
12.	Accuracy	ANSI MC96.1
13.	Lead Termination	Terminal strips in NEMA 4 junction box suitable for direct burial (See Note 2)
14.	Conduit Connection	1-1/2 inches, bottom of junction box
15.	Lag Extension	(See Note 2)
16.	Special Feature	Protection tube to be factory sealed to junction box (See Note 2)
17.	Suggested Manufacturer	Thermo-Couple Products Co, Inc, Sales Aid No. 126

NOTES: 1. Tag Numbers:

TE-102-1	TE-103-1
TE-102-2	TE-103-2
TE-102-3	TE-103-3
TE-102-4	TE-103-4

2. See Drawings.

3. Instrumentation system shall have minimum service life of 10 years under normal use and maintenance.

9 0 1 1 7 8 6 1 0 5 4

Project No. B-714

Title: Vault Concrete Basin, Shell, and Leachate Sump for Grouted Waste Disposal Facilities Grouted Vault Pair (218-E-16-102 and 103)

KAISER ENGINEERS
HANFORD

VENDOR DATA LIST

("X" Indicates Required Data)

1 EPN Identification	2 Description	3 Reference Drawing	4 Specification Paragraph	5 Approval/Data: Dimensional Drawings	Equipment Weights	Specifications	Material Description	Performance Data	Circuit or Control Diagrams	Data Sheets	Illustrative Cuts	Installation Instructions	6 Certified Vendor Information (CVI): Dimensional Drawings	Equipment Weights	Specifications	Certified Test Data	Circuit or Control Diagram	Instructions: Installation	Instructions: Operation	Instructions: Maintenance	Spare Parts List	7 Remarks
Y-101	Level Instruments consisting of:																					
	Level Element Assembly			X		X				X		X					X	X	X	X	X	
	Transmitter					X				X		X		X			X	X	X	X	X	
	Indicator					X			X				X				X	X	X	X	X	
	Power Supply					X			X					X			X	X	X	X	X	
	Cables															X						
Y-102	Thermocaouple Assembly Vault Located			X		X		X	X		X	X		X			X					

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END OF SECTION 13440 - 7

APP 4I-502

B-714-C2

DOE/RL 88-27
Rev. 1, 01/17/90

SECTION 15493

CHEMICAL PROCESS PIPING SYSTEMS

PART 1 - GENERAL

1.1 REFERENCES

1.1.1 Referenced Standards and Specifications: The following standards and specifications, including documents referenced therein, form part of this Section to extent designated herein.

1.1.1.1 American National Standards Institute (ANSI)

ANSI B16.9-1986	American National Standard Factory-Made Wrought Steel Buttwelding Fittings
ANSI B31.3 - 1987 Edition, w/Addenda ANSI B31.3a and B31.3b	American National Standard Code for Pressure Piping--Chemical Plant and Petroleum Refinery Piping

1.1.1.2 American Society of Mechanical Engineers (ASME)

1986 Edition, w/Addenda through Dec 1988	ASME Boiler and Pressure Vessel Code
Section II	Material Specifications
Section IX	Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators

1.1.1.3 American Society for Nondestructive Testing (ASNT)

Recommended Practice No. SNT-TC-1A (1984 Edition)	Personnel Qualification and Certification in Nondestructive Testing

1.1.1.4 American Society for Testing and Materials (ASTM)

A 106-87a	Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
A 234-87	Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

A 307-86a	Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
A 563-84	Standard Specification for Carbon and Alloy Steel Nuts
C 518-85	Standard Test Method for Steady-State Heat Flux Measurements and Thermal Tranmission Properties by Means of the Heat Flow Meter Apparatus
D 1621-73 (1979)	Standard Test Method for Compressive Properties of Rigid Cellular Plastics
D 1622-83	Standard Test Method for Apparent Density of Rigid Cellular Plastics
D 1623-78	Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
D 2842-69 (1975)	Standard Test Method for Water Absorption of Rigid Cellular Plastics
D 2856-87	Standard Test Method for Open Cell Content of Rigid Cellular Plastics by the Air Pycnometer

1.1.1.5 American Welding Society (AWS)

AWS QCI-86	Standard for Qualification and Certification of Welding Inspectors

1.1.1.6 American Water Works Association (AWWA)

C203-86	AWWA Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines--Enamel and Tape--Hot-Applied

1.1.1.7 Pipe Fabrication Institute (PFI)

ES-24 (April 1985)	Pipe Bending Tolerances--Minimum Bending Radii--Minimum Tangents

1.1.1.8 Steel Structures Painting Council (SSPC)

SSPC-SP 3-82	No. 3 Power Tool Cleaning
SSPC-SP 6-85	No. 6 Commercial Blast Cleaning

1.2 SUBMITTALS: Refer to Section 01300 for submittal procedures.

1.2.1 Certified Material Test Reports (CMTR): Submit legible reports, certified by responsible manufacturer of materials used in fabrication of pipe, fittings and flanges for pipe code and services noted below. Reports shall present results of chemical analysis and physical tests specified in ASTM Standards of production lots and heats of materials. Submit separate reports for following.

1.2.1.1 Pipe Code M-25: Service; Grout, and Excess Water.

1.2.1.2 Pipe Code M-26a: Service; Grout Encasement, Excess Water Encasement, and Encasement Drains.

1.2.2 Certificate of Conformance: Submit legible certificate stating that polyurethane insulation materials furnished meet requirements of Drawings and this Section. Include date of manufacture, shelf life of material, physical properties, and material safety data sheets.

1.2.3 Weld Identification Drawings: Submit isometric and spool drawings which show relative location of each weldment in piping systems.

1.2.4 Filler Material Control Procedure: Submit procedure for control of filler material. Specify methods of control, by heat or lot number, from receipt of material to consumption during fabrication, and control and disposal of contaminated and partially used material.

1.2.5 Welding Filler Metal: Submit certified material test reports giving results of tests in applicable material specifications in ASME Section II, Part C. If testing is not required by material specification, submit Certificate of Conformance to applicable material specification.

1.2.6 Welding Procedures and Personnel: Submit welding procedure specifications, procedure qualification records, and welder performance qualification test results meeting the requirements of Paragraph 1.3.1.

1.2.7 Nondestructive Examination (NDE) Personnel and Procedures: Submit personnel certifications and written NDE performance procedures meeting the requirements of Paragraph 1.3.2.

1.3 QUALITY ASSURANCE

1.3.1 Qualification of Welding Personnel and Procedures

1.3.1.1 Personnel and procedures for welding pressure retaining components along with attachments thereto shall have been qualified in accordance with ANSI B31.3 before welding.

1.3.1.2 Personnel and procedures for welding structural steel, nonpressure components, shall have been qualified in accordance with ASME Section IX before welding.

1.3.1.3 Deliver 2 copies of welding procedure specifications, procedure qualification records and welder performance qualification test results to KEH 5 days before welding. Maintain additional copies as specified in Section 01400, Paragraph 1.6.2.

1.3.2 Qualification of Nondestructive Examination (NDE) Personnel

1.3.2.1 Visual weld examinations and appropriate documentation shall be performed by Certified Welding Inspectors (CWI) who have received certification in accordance with AWS QC1. Certified Associate Welding Inspectors (CAWI), certified in accordance with above standard, may perform examinations when under immediate direction of CWI. Welding related examination documentation shall be signed, or stamped by individual performing examination. Where CAWIs are used for examinations, documentation shall be signed, or bear CAWI's stamp in addition to CWIs under whom examinations were performed.

1.3.2.2 Personnel performing other NDE shall have been certified in accordance with Contractor's written practice, which shall meet the requirements of ASNT No. SNT-TC-1A, before performing NDE. Use Level II or III personnel to interpret test results.

1.3.2.3 Deliver 2 copies of personnel certifications, Contractor's written practice, and written NDE performance procedures to KEH 5 days before examining. Maintain additional copies as specified in Section 01400, Paragraph 1.6.2.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Pipe

1.4.1.1 Preserve identity of pipe and tube from time of receipt on site until installation is complete. Store pipe of different material specification and grade separately.

1.4.1.2 When pipe is removed from bundle and cut, return remaining piece to bundle or clearly and permanently mark. Do not remove manufacturer's identifying tags from bundles.

1.4.1.3 When material identifying mark is cut from length of pipe re-mark remaining section clearly and permanently. Use either original marking or field code identification symbol.

1.4.1.4 KEH may inspect materials for compliance with above storage and control procedures.

1.4.2 Welding Materials

1.4.2.1 Store separately, welding materials of different material specifications.

1.4.2.2 Store and control filler material in accordance with approved procedure.

1.4.2.3 Preserve identity from time of receipt on site until use in facility construction.

1.4.2.4 KEH may inspect materials for compliance with procedure specifications.

1.5 FURNISHED EQUIPMENT

1.5.1 Following items are furnished for Contractor installation. Upon request, KEH will furnish 1 copy of approved vendor submittal data. Submit equipment delivery requirements to KEH 10 days before need.

1.5.1.1 2 inch nozzles (PN 2).

1.5.1.2 2 inch kickplates (PN 4).

PART 2 - <u>PRODUCTS</u>

2.1 MATERIALS

2.1.1 Piping

2.1.1.1 Piping materials shall meet the requirements of attached pipe codes, and details on the Drawings.

2.1.1.2 Valves shall be as specified in pipe codes unless shown otherwise on the Drawings. Brand names and catalog numbers are shown only to illustrate type and class of valve required. Unless otherwise specified, valve packing shall be manufacturer's standard for intended service.

2.1.1.3 Integrally reinforced branch connections may be used on 2 inch and larger welded main lines instead of buttwelding tees noted in pipe codes. Material and weight shall correspond to pipe code for particular piping system.

2.1.1.4 Close or butt nipples are not permitted.

2.1.1.5 Attachments welded to pressure containment boundaries may be noncertified material, provided material bears type identifying mark, is suitable for welding, and compatible with material to which attached.

2.1.2 Pipe Joint Sealant for Threaded Joints: Chesterton "Goldend" No. 7298; Federal Process Company "JC-30"; Lake Chemical Co "Slic-tite" with teflon.

2.1.3 Protective Coating For Earth Backfill

2.1.3.1 Carbon steel piping: Factory applied exterior protective coating consisting of coal tar enamel, felt wrap and cover wrap of kraft paper in accordance with AWWA C203.

2.1.3.2 Carbon steel field joints, fittings, and short lengths of pipe: Tapecoat Company "Tapecoat 20" and primer meeting the requirements of AWWA C203.

2.1.4 Nonshrink Grout: See Section 03300.

2.1.5 Polyurethane Foam for Below Grade Piping: 2 component sprayed foam-in-place rigid product, similar to PSI-S200-25 system by Polythene Systems Inc, with the following physical properties.

2.1.5.1 Apparent overall density: 2.2 to 2.8 lb/cu ft when tested in accordance with ASTM D 1622.

2.1.5.2 Minimum compressive strength: 45 psi parallel to rise and 27 psi perpendicular to rise when tested in accordance with ASTM D 1621.

2.1.5.3 Minimum tensile strength: 60 psi when tested in accordance with ASTM D 1623.

2.1.5.4 Closed cells: 90 to 95 percent when tested in accordance with ASTM D 2856.

2.1.5.5 Maximum water absorption: 0.06 lb/cu ft of surface area in accordance with ASTM D 2842.

2.1.5.6 K factor: Approximately 0.15 Btu in./hr ft^2 at 75 F after aging 10 days at 140 F when tested in accordance with ASTM C 518.

2.1.6 Flexible Duct Liner: Similar to CA Schroeder Inc, Casco-Flex air duct CF-25.

PART 3 - EXECUTION

3.1 INSTALLATION

3.1.1 Piping, General

3.1.1.1 Fabricate and install in accordance with ANSI B31.3, the Drawings, and this Section.

3.1.1.2 Cut pipe with cutters designed specifically for task.

3.1.1.3 Ream pipe to nominal inside diameter after cutting. Remove burrs from threads before assembly.

3.1.1.4 Bend pipe using methods and equipment which produce bends free of wrinkles, bulges, or kinks. When wall thickness, diameter, and bend radius indicate possibility of wall collapse during bending, fill pipe with clean silica sand or fusible material such as Cerro-bend, manufactured by Cerro Corp. Bend pipe in accordance with ANSI B31.3, and meet tolerances given in ANSI B31.3 and PFI ES-24.

3.1.1.5 Clean interior of 4 inch M-26a pipe and exterior of 2 inch M-25 pipe to remove dirt and oily residue, before fabrication, using steam/TURCO "PLAUDIT" mixture, 1 part Plaudit to each 40 parts water in concentrate tank. Flush with filtered water and dry with clean oil-free air or nitrogen. Check for grease removal by passing swab over cleaned surface. Repeat if grease or oil is detected. After cleaning wrap exterior surface with plastic wrap and cap pipe ends.

3.1.1.6 Keep piping systems clean. Once fabrication has started plug or cap ends of piping when installation is not in progress to prevent entry of dirt and other foreign material. Cap ends if work is not to be performed on pipe or spool within 4 hours, or, if due to environmental conditions, debris or water can enter pipe. Leave ends of spare lines capped or blind flanged when installation has been completed.

3.1.2 Underground Piping

3.1.2.1 Place piping supports on undisturbed soil, or backfill placed and compacted in accordance with Section 02200, Paragraph 3.1.1.2.

3.1.2.2 Application of heat to pipe for purposes of heat bending to meet Drawing installation tolerances will not be permitted.

3.1.2.3 Cold springing of pipe will not be permitted.

3.1.2.4 Protect outdoor welding operation from rain and wind by using barriers to protect welder and weld joint. KEH will determine if environmental conditions are such that barriers are required.

3.1.2.5 Complete piping welds before tie-in welds to valve pits, risers, or fixed items.

3.1.2.6 Survey piping systems for elevation and location before final tie-in welds to valve pits, risers, or fixed items. Placement of supports shall be complete and meet Specification and Drawing requirements before survey. Elevation and location shall be in accordance with the Drawings. After final tie-ins, survey piping system again for final acceptance.

3.1.3 Welding

3.1.3.1 Weld piping and attachments to pressure retaining components in accordance with ANSI B31.3.

3.1.3.2 See Section 05500 for carbon steel fabrications.

3.1.3.3 Use gas tungsten arc welding (GTAW) process for first 2 passes on pressure retaining components. Use either GTAW or shielded metal arc welding (SMAW) process for remaining passes. Welding process for nonpressure components is optional.

3.1.3.4 When welding pipe in contact with earth, ground welding machine to same pipe being welded in close proximity to weld being made, less than 100 feet.

a. Welding machine attachments to pipe system shall be secured to bare metal with pipe clamps that apply firm pressure. Clamps shall have current carrying capacity equal to or greater than output of welding machine. Clamps shall be installed so they cannot be accidentally dislodged.

3.1.3.5 Backing strips if used shall meet the requirements of ANSI B31.3, Paragraph 327.2.2, and be removed.

3.1.4 Weld Identification

3.1.4.1 Prepare weld identification drawings, isometric and spool, which show relative position of each pressure containing weld and each attachment weld to pressure retaining components.

3.1.4.2 Assign weld number to each pressure containing weld and each attachment weld to pressure retaining components as it is made. Record weld number on weld identification drawings as weld is made.

3.1.4.3 Place identification symbol of welder and weld number adjacent to each weld upon completion. Place identification symbol approximately every 3 feet on long weld seams or large weldments. Use crayon or paint. Vibratory etching equipment may be used with approval of KEH.

3.1.4.4 Do not reuse weld numbers. If weld is completely replaced, assign new number.

3.1.4.5 Show on weld identification drawings location and extent of materials requiring CMTR. Reference each item to its specific report.

3.1.4.6 Perform nondestructive weld examination in accordance with Paragraph 3.2.2.

3.1.5 Flushing: Flush piping noted below after installation.

3.1.5.1 Piping and services are as follows.

Service	:	Pipe Code	:	Flushing Method
Grout	:	M-25	:	Water
Excess Water	:	M-25	:	Water

3.1.5.2 Water flushing

a. Prepare written procedure for disposal of flushing water. Deliver to KEH for approval 10 days before flushing. Disposal of water near ground supported pipe supports will not be permitted.

b. After fabrication and NDE is completed and before leak testing completed system, or before connecting completed system into existing system, flush piping with water until effluent is clean and contains no visible particulate matter. Duration of flush shall be at least 1 minute. Use flushing pressure, not to exceed maximum operating pressure specified on pipe codes, sufficient to produce velocity of at least 5 feet per second in largest pipe section with pipe full. Water velocity shall be verified by suitable instrument at inlet of flushing water to determine velocity at largest pipe section. If leak testing is not performed within 4 hour period, or, if due to environmental conditions, debris may enter, seal flushed lines until leak testing is performed.

3.1.6 Exterior Protective Coating

3.1.6.1 Complete NDE and leak testing before application of exterior protective coating.

3.1.6.2 Coat grout encasement and excess water encasement pipes, including sections to be covered with polyurethane foam, with specified coating.

3.1.6.3 Protect short lengths of carbon steel pipe and fittings exposed to earth backfill with specified coating.

a. Clean carbon steel surfaces to white metal by sandblasting in accordance with SSPC-SP 6. Where blasting is impracticable, as determined by KEH, clean by power wire brushing in accordance with SSPC-SP 3.

b. Heat and apply specified tape in accordance with AWWA C203, Section 3, and manufacturer's instructions.

3.1.6.4 After installation, examine carbon steel pipe having factory applied exterior protective coating, and joints, fittings, and short lengths of pipe having field applied exterior protective coating materials.

a. Use electrical holiday detector in accordance with AWWA C203, Section 2.14.12.

b. Repair damage to coating in accordance with AWWA C203, Section 2.14.12.

3.1.7 Polyurethane Foam

3.1.7.1 Install in accordance with manufacturer's recommended procedure.

3.1.7.2 Side-wall retainer may be used to assure uniform width and height of sprayed foam. Obtain approval of retainer wall installation and materials from KEH.

3.1.7.3 Secure flexible duct to pipe in position shown on the Drawings.

3.1.7.4 Repair holes left by taking of test samples. Leave no holes open over night.

3.1.7.5 Verify compressive strength of foam in accordance with Paragraph 3.2.4.

3.2 FIELD QUALITY CONTROL

3.2.1 Notify KEH before performing following.

3.2.1.1 Flushing piping systems.

3.2.1.2 Testing piping exterior protective coatings.

3.2.1.3 Hydrostatic testing.

3.2.1.4 Final weld connections into valve pits, risers, tanks, and other fixed items.

3.2.1.5 Backfilling, or covering with concrete, pipe connections.

3.2.2 Nondestructive Weld Examination (NDE)

3.2.2.1 Equipment and materials used for NDE shall be available for review and approval by KEH before performing work.

3.2.2.2 KEH may witness NDE of welds. When KEH disagrees with performance of NDE or with Contractor's acceptance of examination results, decision of KEH will be final.

3.2.2.3 Perform NDE for pressure containing welds and attachment welds to pressure retaining components specified for each pipe code listed on back of attached NDE/Weld Record Form KEH-433.

3.2.2.4 Visual examination: Perform in accordance with ANSI B31.3 paragraph 344.2.

a. Verify following and consider as part of fit-up examination. Document on NDE/Weld Record under fit-up.

1) Longitudinal alignment of pipes being joined: Within 2 degrees measured from outside diameter of pipe.

2) No cold springing.

3) Pipe symmetrically located within encasement.

3.2.2.5 Liquid penetrant (dye penetrant) examination (PT): Perform in accordance with ANSI B31.3 paragraph 344.4.

3.2.2.6 Radiographic examination: Perform in accordance with ANSI B31.3 paragraph 344.5.

a. If Iridium 192 source is used, deliver verified radiographic examination procedures to KEH before use for production radiographs. Procedures shall be verified by demonstration that required radiographic sensitivity has been obtained for material to be radiographed. Procedure shall be proven satisfactory by actual demonstration of penetrameter resolution on minimum thickness of material to be radiographed. Use of Cobalt 60 will not be permitted.

b. Identify radiographic film with project or work order number assigned to work covered by this Section.

c. Prepare radiographic examination reports as follows: List each radiographic exposure location (0-1, 1-2, ...) individually on radiographic examination report. Indicate location acceptability or rejectability and note discontinuities whether rejectable or not. When report includes radiographs of welds which have been repaired, indicate which welds are repair welds and how many times each weld has been repaired.

d. If additional welding is performed on weld area which has already been examined radiographically, this area is repair area. Identify subsequent radiographs by "R-1, R-2", etc.

e. Deliver radiographs along with original of reports to KEH within 24 hours after radiographs are taken.

3.2.2.7 Tie-in weld examination: Where leak testing of tie-in weld cannot be performed due to physical impossibility, or impracticality of pressure test application requires concurrence of KEH, perform additional NDE as follows.

Service	Pipe Code	Additional NDE
Grout (GR)	M-25	Liquid Penetrant
Excess Water (EW)	M-25	Liquid Penetrant

3.2.2.8 NDE documentation

a. Document examination of pressure welds and welds to pressure retaining components for piping systems on NDE/Weld Record Form KEH-433 furnished by KEH (sample appended).

1) See Form KEH-433 for instructions for recording weld identification drawings, weld numbers, welder identification, welding procedure specification numbers, visual examinations, nondestructive examinations, and for noting satisfactory completion of leak testing.

b. Documentation shall be kept current and is subject to review by KEH. Prepare and certify records as work progresses.

c. Required NDE/Weld examinations shall be completed and documented before start of leak testing.

d. NDE/Weld Record information and weld identification drawings defined in Paragraph 3.1.4 may be incorporated on single format or traveler for specific work package.

e. Deliver completed NDE/Weld Record and record weld identification drawings to KEH within 7 working days after completion of system leak testing.

3.2.3 Leak/Pressure Testing

3.2.3.1 General

a. Perform leak/pressure testing of pipe in accordance with ANSI B31.3 and this Section.

b. Document testing of each piping system on "Leak/Pressure Test Certification" Form KEH-1757 (sample appended). Forms will be furnished by KEH. Use 1 or more forms to describe and record each piping system. Under "Description" describe piping system in enough detail to be correlated to weld identification drawings, shop fabrication drawings, and Contract Drawings as applicable. For systems tested segmentally, indicate continuity in "Description" to ensure entire system has been tested.

c. Pipe joints, fittings and other potential leak sources to be tested shall be visible and accessible during tests.

d. Complete testing of piping before field application of foam or protective coating.

e. Install necessary restraining devices, before applying test pressure, to prevent distortion or displacement of piping.

f. Install 1 temporary relief valve during testing. Relief valve shall have discharge capacity of at least 125 percent of capacity of pressurizing device and be set to operate at not more than 110 percent of test pressure. Tag each relief valve used to show serial number, calibration date, and pressure setting.

g. Isolate instruments and other items which could be damaged by test pressures.

h. Visually examine piping and tubing joints, fittings, and other potential leak sources, includes welds which attach wear plates, anchors, etc to piping systems, during testing. Repair leaks and reexamine.

i. Duration of tests shall be at least 10 minutes with no visible leaks or drop in test pressure, and for such additional time as may be necessary to conduct examination for leakage.

j. Test gages shall have been calibrated within 2 weeks before start of test. Use gages with dial-type face and range between 1.5 and 4 times test pressure.

3.2.3.2 Hydrostatic testing

a. Prepare written procedure for disposal of water used for testing. Deliver to KEH for approval 10 days before testing.

b. Perform tests on systems listed below.

Service	Pipe Code	Test Pressure (psig)
Grout	M-25	1,200
Excess Water	M-25	1,200
Excess Water Encasement and Encasement Drain	M-26a	90

c. Piping systems with removable jumper assemblies shall be tested without jumper in place.

d. Verify that air has been expelled from piping before applying hydrostatic pressure.

e. Coat piping joints, fittings and other potential leak sources, includes welds attaching wear plates, anchors, etc, to piping systems, with mixture of powdered blue chalk and either water or isopropyl alcohol, and allow to dry before filling piping with water and inspecting for leaks.

f. Remove water from lines immediately after hydrostatic testing is completed.

3.2.3.3 Pneumatic testing

a. Perform testing with oil-free air or nitrogen on piping systems listed below.

Service	Piping Code	Test Pressure (psig)
Grout Encasement and Encasement Drain	M-26a	90

b. Coat joints and other potential leak sources with bubble forming solution approved by KEH. Soaps and detergents designed specially for cleaning shall not be used. Apply internal gas pressure before solution contacts external surface. Remove solution at completion of testing.

3.2.4 Testing Polyurethane Foam

3.2.4.1 Perform compressive properties test in accordance with ASTM D 1621 and this Section.

3.2.4.2 Take separate test samples from production batch for each day and from each batch of foam sprayed. Take samples at time work is being performed.

3.2.4.3 Test 5 specimens, minimum, from test sample. Specimens shall be 2.7 inch diameter cylinders, 2 inches long, cored and cut with saw having at least 11 teeth per inch. Dimensional tolerance shall be plus or minus 1/16 inch.

3.2.4.4 Minimum compressive load of field test specimen for Tests No. 1 and 2 shall be:

TEST	HOURS AFTER DEPOSITION OF INSULATION	FORCE (Pounds)*
No. 1	Within 2-4 hours for ambient temperature above 50 F	115
	or	
	Within 4-8 hours for ambient temperature equal to or less than 50 F	115
No. 2	Within 20-28 hours	150

*Minimum force required to reach 10 percent deformation. (0.2 inch for 2 inch high specimen when tested with Link PB3-250 Compression Tester. Tester ram diameter: 2.625 inch).

3.2.4.5 Document force and deformation results of each test specimen on Form KEH-377.00, sample appended.

3.2.4.6 Complete compressive testing of specimens before backfilling.

3.2.4.7 Remove insulation which fails tests. Replace damaged parting agent and apply new insulation, then retest.

3.2.4.8 Deliver report of results to KEH upon completion of tests.

PIPE CODE M-25

Service:	Max Operating Pressure:	Max Operating Temp:
Grout (GR)	800 psig	200 F
Excess Water (EW)	800 psig	200 F

Size	: 4" and smaller
Pipe	: Carbon steel, ASTM A 106, Grade B.
Wall Thickness	: Schedule 40, and 80*
Fittings	: Wrought carbon steel, buttwelding, in accordance with ANSI B16.9, : ASTM A 234, Grade WPB. Schedule to match pipe.
Valves	: Shown on Drawings.

*2" excess water piping on top of vault: Schedule 40.
2" grout distribution, and excess water return pipes: Schedule 80.

PIPE CODE M-26a

Service:	Max Operating Pressure:	Max Operating Temp:
Grout Encasement	60 psig	200 F
Excess Water Encasement	60 psig	200 F
Encasement Drains	60 psig	200 F

Size	: All
Pipe Grade:	Carbon Steel, ASTM A 106, Grade B.
Wall Thickness	: Schedule 40
Fittings	: Wrought carbon steel, ASTM A 234, Grade WPB, buttwelding in accordance with ANSI B16.9. Schedule to match pipe.
Bolting	: Carbon steel, heavy hex head series bolts, ASTM A 307, Grade B and heavy hex nuts, ASTM A 563, Grade A.
Gaskets	: Compressed synthetic fiber 1/16". Anchor Style #443. Use full face gasket with flat face flanges.

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NDE/WELD RECORD	1. Project/W.O. No.	2. Weld Identification Dwgs.	3. Contractor

4. WELD INFORMATION	5. VISUAL EXAMINATION Fit-up	Root Pass	Cover Pass	6. LIQUID PEN. / MAG. PART.	7. RADIO. / 8. LEAK TEST	9. Other
Weld No.				Root Pass	Radiographic	
Welder Identification						
Welding Procedure Specification				Cover Pass	Leak Test	
Weld Filler Mat'l.						
Weld No.				Root Pass	Radiographic	
Welder Identification						
Welding Procedure Specification				Cover Pass	Leak Test	
Weld Filler Mat'l.						
Weld No.				Root Pass	Radiographic	
Welder Identification						
Welding Procedure Specification				Cover Pass	Leak Test	
Weld Filler Mat'l.						
Weld No.				Root Pass	Radiographic	
Welder Identification						
Welding Procedure Specification				Cover Pass	Leak Test	
Weld Filler Mat'l.						
Weld No.				Root Pass	Radiographic	
Welder Identification						
Welding Procedure Specification				Cover Pass	Leak Test	
Weld Filler Mat'l.						
Weld No.				Root Pass	Radiographic	
Welder Identification						
Welding Procedure Specification				Cover Pass	Leak Test	
Weld Filler Mat'l.						

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APP 4I-520

INSTRUCTIONS FOR USE

The NDE/WELD RECORD form shall be used to document the nondestructive examination/testing of the piping systems listed below. Entries shall be made as work progresses, and records are subject to review by the Government's Representative at any time.

Complete the NDE/WELD RECORD as follows (number in parenthesis corresponds to block number).

(1) Enter Project Number.
(2) Enter Weld Identification Drawing Numbers.
(3) Enter name of Contractor.
(4) Enter Weld Information:
- Weld Number
- Welder Identification
- Welding Procedure Specification
- Weld Filler Material (Type)

(5) through (9) Enter date of examination/testing in upper half of block; initial or stamp lower half of block as each weld is examined and accepted in compliance with contract requirements.

NONDESTRUCTIVE EXAMINATION/TESTING REQUIREMENTS FOR PIPING SYSTEMS

NDE/NDT METHOD \ PIPE CODES	M-25	M-26a							COMMENTS
VISUAL									
Fitup	C	C, D							
Root Pass	C	C, D							
Cover Pass	C,E,G	C,D,E,G							
LIQUID PENETRANT									
Root Pass									
Cover Pass	A, F	A,C,F							
MAGNETIC PARTICLE									
Root Pass									
Cover Pass									
RADIOGRAPHIC									
Completed Weld	B,C								
LEAK/PRESSURE									
Completed Weld	A,C,E	A,C,D,E							
OTHER									

Legend

A. Requires witnessing concurrently by the Government Representative and acceptance prior to recording.

B. Requires acceptance of radiographs and documentation by the Government Representative prior to recording.

C. Circumferential and longitudinal butt welds.

D. Full penetration welds on branch connections.

E. Attachment welds to pipe.

F. Tie-in circumferential and longitudinal butt welds that cannot be examined by leak/pressure test.

G. Other: KEH will inspect 10 percent of welds, minimum.

KAISER ENGINEERS HANFORD

LEAK/PRESSURE TEST CERTIFICATION

Report No

Project or W.O. No.	Title	Dwg. Reference	Test Procedure/Re

Construction Spec./Rev.	Code or Standard	Year	Addenda	Class	Stamp Required
					☐ Yes ☐ No

Description of System or Component(s) Test Boundaries

____

____

TEST PREPARATION

Notification Requirements	Valve Line-up Requirements (for permanent valves installed)		
☐ Quality Control	Valve I.D. ______	☐ Open	☐ Close
☐ Acceptance Inspection	Valve I.D. ______	☐ Open	☐ Close
☐ Safety Engineer	Valve I.D ______	☐ Open	☐ Close
☐ Client ______	Valve I.D. ______	☐ Open	☐ Close
☐ Authorized Inspector	Valve I.D. ______	☐ Open	☐ Close
☐ ______	Valve I.D. ______	☐ Open	☐ Close

Required Test Medium	Required Test Medium Temp.	Flushing Requirements	
Medium ______	Temp. ______	Flushing ______	☐ Blue Chalking Require ☐ Soap Solution R

Design System Pressure	Design Test Pressure	Specified Hold Time	Prepared By
______	______	______	

PRETEST CHECKLIST

Item or Requirement	Craft Supervision	Quality Control Accept	Quality Control Date
Valve line-up per design requirements (see above line up).			
Flushing of system and/or component completed per design requirements.			
All lines or components not to be tested are properly isolated or disconnected.			
Vents and openings checked; proper Pressure Relief Valve installed and discharge checked.			
Test medium per design requirements; temperature equalized. Medium ______ Medium Temp. ______ (ASME only)			
Test gauge(s) correct range and currently calibrated. SN ______ Range ______ Cal. Due Date ______ SN ______ Range ______ Cal. Due Date ______ SN ______ Range ______ Cal. Due Date ______			
Pressure Relief Valve properly set and currently calibrated. SN ______ PSI Set ______ Checked Date ______ SN ______ PSI Set ______ Checked Date ______ SN ______ PSI Set ______ Checked Date ______			

9 0 1 1 7 8 5 1 0 7

KAISER ENGINEERS HANFORD	LEAK/PRESSURE TEST CERTIFICATION	Report No.	Page 2 of

TEST PERFORMANCE

Item or Requirement	Quality Control Accept	Date
RDT/NE and other if specified:		
50% Tp obtained and examination conducted = Tp ______		
Pressure increments at 0.10 Tp: = Tp ______		
= Tp ______		
= Tp ______		
= Tp ______		
= Tp ______		
Hydrostatic testing - areas to be inspected chalked prior to application of pressure.		
Hydrostatic testing - examination conducted while system/component pressurized. Specified Tp ______ PSI obtained at ______ a.m. p.m.		
Pneumatic Testing - soap solution applied to areas to be tested and system/components examined while pressurized. Specified Tp ______ PSI obtained at ______ a.m. p.m.		

Pressure Test	Quality Control Signature	Stamp or PR No.	Date
☐ Accepted ☐ Rejected			

INSPECTION VERIFICATION

Documentation properly prepared.	☐ Yes	☐ No	Actual Tp during final inspection ______ PSI
All joints and welded attachments to pressure retaining components chalked/soaped as applicable.	☐ Yes	☐ No	Specified hold time verified at ______ a.m. p.m.
All joints and welded attachments to pressure retaining components visually inspected for leakage.	☐ Yes	☐ No	

Pressure Test	Acceptance Inspection Signature	Stamp or PR No.	Date
☐ Accepted ☐ Rejected			

OTHER

Comments

______

______

______

______

NCR No. (if applicable)	Client Representative		Date
	Witness - ASME Authorized Inspector		Date
☐ Document Reviewed ☐ Drawings Highlighted	Construction Engineering	PR No.	Date

B-714-C2 KEH-1757 02 (2/88

ACCEPTANCE INSPECTION REPORT

Report No.

Project No.	Inspection Plan No.	Contractor CF ☐ FP ☐	Date	Reviewed By	Extr

DISC	Site Visited	Const./Fab. in Progress
Civil ☐ Elect. ☐ Mech. ☐ NDE ☐	Jobsite ☐ Offsite ☐ NA ☐	Yes ☐ No ☐

Items Inspected	Acc.	Rej.	Other Documentation

Other Activities/General Comments

M & TE Used: ☐ NA

Description:

Number:

Expiration Date:

☐ Report continued on reverse side	Inspector's Signature	Employee No. KEH -

9 0 1 1 7 8 6 1 0 7 6

ACCEPTANCE INSPECTION REPORT	Project No.	Inspection Plan No

Items Inspected	Acc.	Rej.	Other Documentation

Other Activities/General Comments

Date this Report	Reviewed by	Inspector's Signature	Employee No. KEH-

END OF SECTION

SECTION 16300

HIGH VOLTAGE DISTRIBUTION
(Above 600-Volt)

PART 1 - GENERAL

1.1 REFERENCES

1.1.1 Reference Standards and Specifications: The following standards and specifications, including documents referenced therein, form part of this Section to extent designated herein.

1.1.1.1 American Association of State Highway and Transportation Officials (AASHTO)

1983	Standard Specifications for Highway Bridges, 13th Edition

1.1.1.2 American National Standards Institute (ANSI)

ANSI C2-1987	American National Standard National Electrical Safety Code, 1987 Edition
ANSI C57.12.00-1980	American National Standard General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers
ANSI C57.12.70-1978	American National Standard Terminal Markings and Connections for Distribution and Power Transformers
ANSI C80.1-1983	American National Standard for Rigid Steel Conduit--Zinc Coated
ANSI 05.1-1979	American National Standard Specifications and Dimensions for Wood Poles

1.1.1.3 American Wood Preservers Association (AWPA)

C7-73	Western Red Cedar, Northern White Cedar and Alaska Yellow Cedar Poles - Preservative Treatment of Incised Pole Butts by the Thermal Process
P1-78 (Revised)	Standard for Coal Tar Creosote for Land and Fresh Water Use

P8-87	Standard for Oil-Borne Preservatives
P9-87	Standard for Solvents and Formulations for Organic Preservative Systems

1.1.1.4 Federal Specifications (FS)

W-C-1094A	Conduit and Conduit Fittings Plastic, Rigid

1.1.1.5 Institute of Electrical and Electronics Engineers (IEEE)

IEEE C62.1-1984	IEEE Standard for Surge Arresters for AC Power Circuits

1.1.1.6 National Electrical Manufacturers Association (NEMA)

Standards Publication/ No. FB 1-1983 w/Rev through Sep 1984	Fittings and Supports for Conduit and Cable Assemblies
Standards Publication/ No. ICS 6-1983 w/Rev through Nov 1986	Enclosures for Industrial Controls and Systems
Standards Publication/ No. RN 1-1980	Polyvinyl-Chloride Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing
Standards Publication/ No. WC 8-1976 (R 1982) w/Rev through Jan 1983	Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

1.1.1.7 National Fire Protection Association (NFPA)

NFPA 70	National Electrical Code, 1987 Edition

1.1.1.8 Underwriters Laboratories, Inc (UL)

May 1988	Electrical Appliance and Utilization Equipment Directory
May 1988	Electrical Construction Materials Directory

UL 1242-1985	Standard for Intermediate Metal Conduit

1.1.1.9 Washington State Department of Transportation (WSDOT)

M41-10-88	Standard Specification for Road, Bridge, and Municiple Construction

1.2 SUBMITTALS: Refer to Section 01300 for submittal procedures.

1.2.1 Approval Data: Submit information listed in Column 5 of Vendor Data List in this Section.

1.2.2 Certified Vendor Information (CVI): Submit information listed in Column 6 of Vendor Data List in this Section.

1.3 QUALITY ASSURANCE

1.3.1 Standards: Products shall be identified for intended purpose by Underwriters Laboratories, Inc (UL) in the Electrical Appliance and Utilization Equipment Directory or Electrical Construction Materials Directory, and bear listing mark of laboratory. In absence of mark, submit documentation of applicable listing. Listing and marking by UL is not required for products specified to meet the requirements of a national standard, or designated by manufacturer's part number on the Drawings or in this Section.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

1.4.1.1 Cable: Upon delivery to site inspect cable and reels for shipping damage such as:

a. Marks caused by improper lifting equipment or techniques.

b. Breaks or cuts in outer covering.

c. Damaged jacket or insulation.

d. Reel damage from mishandling.

1.4.1.2 Test: Operating Contractor will perform dc overpotential test on new cable upon delivery to site. Acceptance criteria is given in subparagraph 3.3.2.1.

1.4.2 Storage

1.4.2.1 Cable

a. Store reels with flanges resting on hard surface or pallet to prevent sinking into ground.

b. Reel flanges shall not touch cable on other reels.

c. Do not store reels on side. Store with reel axis horizontal.

d. Cap or tape cable ends to prevent entrance of moisture.

1.4.2.2 Pole line materials

a. Poles stored longer than 2 weeks shall be stacked on supports at least 1 foot above ground. Strength and spacing of supports, and manner of stacking shall produce no noticeable distortion in poles.

b. Locate material stored at site to prevent damage from weather and adjacent construction operations.

1.4.3 Handling

1.4.3.1 Cable

a. Do not drop reels.

b. Slings and forklifts shall not contact cable or protective covering.

c. Use spreader bar when lifting reel with bar and sling.

1.4.3.2 Pole line material

a. Handle poles, fittings, insulators, and miscellaneous hardware with care to prevent damage. Unload carefully from truck and do not drop. Do not drag poles.

b. Do not use construction hooks, tongs, or other sharp tools on treated portion of poles.

PART 2 - PRODUCTS

2.1 MATERIALS

2.1.1 Solderless Connectors and Terminal Lugs: Pressure type, rated for use with copper or aluminum conductors.

2.1.2 Raceways, Fittings and Boxes

2.1.2.1 Conduit shall meet the requirements of appropriate standard as follows.

a.	Rigid steel	ANSI C80.1
b.	Intermediate metal	UL 1242

c. PVC (Schedule 40) FS W-C-1094, Type II

2.1.2.2 PVC coating on rigid steel conduit: Factory applied, and meet the requirements of NEMA RN 1, Type A-40.

2.1.2.3 Fittings for rigid steel conduit shall meet the requirements of NEMA FB 1.

2.1.2.4 Use "Myers" type watertight fittings or sealing type locknuts for conduit entries into sides or tops of NEMA Type 3, 3R, or 4 enclosures.

2.1.3 Cable: 15 kV single conductor meeting the requirements of NEMA WC 8 for both wet and dry conditions at normal operating temperature of 90 C max.

2.1.3.1 Conductor: Copper, annealed, Class B concentric stranding.

2.1.3.2 Conductor shield: Extruded semi-conducting thermosetting compound, 15 mils thick, minimum.

2.1.3.3 Insulation: Ethylene-propylene-rubber, 220 mils thick, minimum.

2.1.3.4 Insulation shield: Minimum 30 mil extruded nonmetallic covering over insulation with minimum 5 mil nonmagnetic metal component directly over or embedded in covering.

2.1.3.5 Jacket: Black polyethylene, 80 mils average minimum thickness.

2.1.3.6 Cable shall have continuous permanent printing on jacket showing manufacturer's name, trade name, type, size, rated voltage and footage markings. Cable reels shall be marked to show above information and length of each cable. Ends of cable shall have weatherproof seals and both ends exposed on reel, accessible for testing.

2.1.4 Wiremarkers: Imprinted tubular plastic.

2.1.5 Nameplates: Made from 1/16 inch laminated plastic stock with white surface and black core. Edges smooth, without burrs, and beveled 45 degrees. Letters sharp and clear.

2.1.6 Wire Pulling Compound: "Y-er Eas" manufactured by Electro Compound Co, or Polywater manufactured by American Polywater Corp.

2.1.7 Tape

2.1.7.1 Plastic insulating tape: Scotch No. 33+ manufactured by 3M Company.

2.1.7.2 Conduit protection tape: Scotchrap No. 50 manufactured by 3M Company.

2.1.7.3 Silicon rubber termination tape: Scotch No. 70 manufactured by 3M Company.

2.1.8 Insulating Putty: "Scotchfil" manufactured by 3M Company, GE No. 8389 manufactured by General Electric Co, or "Airseal" manufactured by Kearney Company.

2.1.9 Tie Wires: Length, material type and size, and installation method as recommended by line conductor manufacturer.

2.1.10 Connectors: For connecting copper conductors to aluminum conductors shall be manufactured for purpose and listed by UL.

2.1.11 Wood Poles: Meeting the requirements of ANSI 05.1 and be western red cedar cut from live timber. Poles shall be butt-treated by manufacturer in accordance with AWPA C7, using preservative meeting the requirements of AWPA P8 and P9, or P1. Each pole shall be given single top cut at 30 degree angle with normal to axis of pole and at right angles to sweep. Gains shall be cut so roof will be at right angles to line and sweep of pole will be in line. Roofs and gains shall be brush-treated by manufacturer with specified preservative. Each gain shall fit crossarm tightly. Bolt holes shall not be more than 1/16 inch oversize.

2.2 EQUIPMENT

2.2.1 Equipment enclosure shall meet the requirements of NEMA ICS 6-110 and be Type 3, 3R, or 4.

2.2.2 Outdoor Distribution Transformer: Meeting the requirements of ANSI C57.12.00 with kVA and voltage ratings shown on the Drawings. Transformer shall be oil filled, 55c rise, deadfront loop feed, self-cooled 3 phase with 2 primary 1-piece integral bushings for each phase as shown on the Drawings and have two 2-1/2 percent above and below normal high-voltage taps. Identify high and low voltage bushings in accordance with ANSI C57.12.70.

2.2.2.1 Transformer shall be self-protecting with metal oxide varistor elbows, deadfront arrester, 15 kV class arrester elbow, gapless, solid-state with metal oxide varistor permanently sealed into elbow shank. Primary fuses Bay-o-net fused with Kerney DEWL Cat. No. 124080-15, Kerney Back-up CLF Cat. No. 150615-65 and secondary breaker shown on the Drawings.

2.2.2.2 Transformer shall be designed for pad mounting and include following.

a. Three 400 to 5A current transformers: General Electric Type JAB-0 Cat. No. 750X36G204 with socket type kilowatt hour demand meter for 277/480V ac, wye, 3 phase, 4 wire, 400A system, Westinghouse Type D4S-8M Class 10, 240V.

b. Maximum connected load: 225kVA.

c. Pulse generator

1) KWH/pulse: 0.25.

2) Pulse ratio: 125/144.

d. Sweephand type demand register with 30 minute demand interval.

e. Combination meter socket and test switch: Superior Cat. No. W11511-MM.

2.2.3 Load break center module and load break elbows shown on the Drawings.

2.2.4 Overhead Lightning Arresters: Distribution valve type rated 15 kV, 95 BIL, for use on 13.8 kV high impedance ground system, and meeting the requirements of IEEE C62.1. Porcelain bodies shall be wet porcelain with uniform color glaze. Galvanized cap and base hardware shall have bolted clamps for both line and ground connections. Mounting bolts shall be galvanized.

2.2.5 Manholes: Reinforced precast concrete utility vault with top, configuration shown on the Drawings, and meeting AASHTO, Section 1.2.5 (E), H-20 load criteria; Arco Concrete, Inc Cat. No. 6060-7 complete with manhole ring and cover meeting the requirements of WSDOT M41-10, Section 9-05.15(1).

PART 3 - EXECUTION

3.1 PREPARATION

3.1.1 Field Measurements: Scale dimensions on the Drawings show desired and approximate location of equipment, actual locations, distances, and levels shall be governed by field conditions.

3.2 INSTALLATION

3.2.1 General

3.2.1.1 Perform work in accordance with NFPA 70 (NEC) and ANSI C2.

3.2.1.2 Install products as shown on the Drawings and specified.

a. Identify electrical equipment with nameplates engraved with designation and function shown on the Drawings.

b. Attach nameplates on or near equipment with clear RTV silicone sealant.

3.2.1.3 Use appropriate special calibrated tools when installing devices for which special installation tools are recommended by manufacturer.

3.2.2 Ground Systems: Use galvanized, stranded steel conductors for ground conductors installed in earth or concrete. Make joints connecting copper and galvanized steel conductors above grade and in dry location.

3.2.3 Conduits

3.2.3.1 Use rigid steel or intermediate metal conduit.

3.2.3.2 Use PVC coated rigid steel conduit in contact with earth. Install in accordance with manufacturer's recommendations. Repair coating, damaged during handling or installation using PVC paint recommended by conduit manufacturer.

3.2.3.3 Install #14 gage galvanized steel pull wire or 1/8 inch polyethylene rope in conduit installed and left empty for future use.

3.2.3.4 Permanently label or mark at both ends with conduit number shown on the Drawings.

3.2.3.5 Make elbows, offsets and bends uniform and symmetrical. Bend conduit with approved bending devices.

3.2.3.6 Cut square, ream and remove burrs. Conduit shall be clean, dry, and free of debris. Immediately after installation, plug or cap exposed ends with standard accessories until wires are installed.

3.2.3.7 Use galvanized steel locknuts and insulated bushings for attachment to enclosures except threaded hubs or sealing locknuts shall be used outdoors or where moisture is present. Threadless fittings will not be permitted for rigid conduit. Use Erickson type couplings where required. Do not use running threads.

3.2.3.8 Use pipe straps, 1 hole clamps equipped with clampbacks or Unistrut with clamps to secure conduits.

3.2.3.9 Set up joints in conduit installed in concrete, underground, or exposed to weather, with high temperature, antiseize, conductive thread lubricant and sealant.

3.2.3.10 Install exposed conduit stubbing up through concrete slabs straight and plumb, lined up, and uniformly spaced. Install at sufficient depth below slab to eliminate part of bend above top of slab. Couple conduit flush with surface of slab. Verify stub-up locations with final equipment arrangements.

3.2.3.11 Wrap conduit, passing from concrete to air or to direct burial, with conduit protection tape 3 inches in concrete to at least 12 inches in earth or 3 inches in air, unless conduit is PVC coated.

3.2.4 Underground Duct Banks

3.2.4.1 Use PVC conduit in concrete encased duct banks.

3.2.4.2 Install underground ducts as shown on the Drawings.

3.2.4.3 Seal conduit at both ends with duct sealing compound.

3.2.4.4 Form concrete encasements unless written waiver is obtained from KEH.

3.2.5 Nonaerial Type Conductors

3.2.5.1 Use paint or pressure-sensitive colored tape to identify conductors instead of colored insulation on #4 AWG and larger wire only. Maintain phase color coding. Identify equipment grounding conductors clearly throughout system.

3.2.5.2 Use lubricant recommended by cable manufacturer, or wire pulling compound specified, to decrease friction when pulling wire and cable through conduit.

3.2.5.3 Do not install or handle wires with thermoplastic insulation or jacket when ambient temperature is 15 F or below.

3.2.6 Splices, Taps and Cable Terminations

3.2.6.1 Make splices and taps with solderless connectors described in Paragraph 2.1.1. Use connectors in accordance with manufacturer's instructions.

3.2.6.2 Use plastic insulating tape for uninsulated splices and taps to thickness at least equal to conductor insulation. Where bolted splice or connection presents irregular surface, apply insulating putty to joints before taping.

3.2.6.3 Use crimp-on type, ring or spade lugs with turned up legs for wire terminations of stranded conductors to binder screw or stud type terminals. Lugs shall have insulated sleeves.

3.2.6.4 Follow manufacturer's instructions and directions for splices, stress cones and cable terminations.

3.2.6.5 Wrap terminations for stranded insulated conductors on aerial equipment with 2 half-lapped layers of plastic insulating tape from 2 inches back on cable insulation to cover barrel of terminal. Taping shall effect moisture barrier so moisture cannot penetrate between conductor and insulation or interstices of stranded conductor. Overlay 1 half-lapped layer of silicon rubber termination tape over plastic insulating taping.

3.2.7 Setting Poles

3.2.7.1 Excavate holes large enough to admit tamping bar around pole at butt. Do not use explosives to excavate holes.

3.2.7.2 Use backfill materials which can be solidly compacted by hand tamping in 6 inch lifts. Compact surplus earth around pole in cone 1 foot high above grade. Add additional backfill where backfill has settled, and tamp before completion of work.

3.2.7.3 Set 30 foot poles 6 feet in earth and 50 foot poles 7 feet in earth. Measure depth from lowest side, on moderately sloping ground and from point 2'-6" from center of pole toward low side on steep slopes, cuts, embankments, or where soil is likely to be washed away from pole.

3.2.7.4 Set poles plumb and in line, except that corners and other strain points which are guyed shall have butts displaced to keep tops in line where feasible. At such locations, rake against strain shall be approximately 3 inches for each 10 feet of height.

3.3 FIELD QUALITY CONTROL

3.3.1 Testing, General

3.3.1.1 Test equipment and wiring for continuity and unintentional grounds, and verify proper phase sequence and voltage at equipment served before attempt is made to operate equipment. Notify KEH before start of tests. Correct items found, during testing or examination by KEH, to be at variance with the Drawings and this Section.

3.3.1.2 Furnish instruments, labor and equipment required to conduct the testing.

3.3.1.3 Use test instruments which bear valid calibration stamp showing date of calibration and expiration date of stamp. Calibration and accuracy of test instruments shall be certified by independent testing laboratory having standards traceable to the National Bureau of Standards.

3.3.1.4 In addition to testing specified to be performed by Contractor, installation will be subject to examination by KEH for conformance with design and applicable codes. Assist KEH as requested.

3.3.2 Acceptance Testing

3.3.2.1 Upon receipt of new cable, Operating Contractor will perform following tests.

	Test	Acceptance Criteria
a.	dc Test Overpotential (Hi-Pot) 5 kV shielded and nonshielded cable tested at 25 kV dc for 15 minutes. 15 kV dc shielded cable tested at 55 kV dc for 15 minutes.	Leakage current not to exceed 5 micro-amps.

3.3.2.2 After installation Operating Contractor will perform following tests to verify acceptability of installation.

Test	Acceptance Criteria
a. Transformer	
. Routine	ANSI C57.12.00
. Resistance Measurement	Not applicable, for base data
. Combustible Gas	Less than 0.5 percent
. Oil Neutralization Number	Less than 0.1 mg KOH/gram
. Oil Dielectric	18 kV or greater
. Oil Interfacial Tension	18 dynes/Cm or greater
. Askarel Content	1 PPM
. Oil Power Factor	1 percent
. Oil PCB Content	Less than 1 PPM
b. Cable	
. ac Power Factor (not to exceed rated voltage of cable).	Power factor not to exceed 2 percent.
. dc Overpotential (Hi Pot) 5 kV shielded and nonshielded cable tested at 25 kV dc for 15 minutes. 15 kV shielded cable tested at 55 kV dc for 15 minutes.	Leakage current not to exceed 5 micro-amps.
. Shield resistance test for shield-to-termination continuity between phases and between each phase and ground. Observe uniformity between resistance readings.	Resistance readings greater than 5 ohms are generally indication of discontinuity (or open circuit) and are not acceptable.

Project No. B-714

Title: Grouted Waste Disposal Facilities

Grout Vault Pair (218-E-16-102 and 103)

KAISER ENGINEERS HANFORD

VENDOR DATA LIST

("X" Indicates Required Data)

1 EPN Identification	2 Description	3 Reference Drawing	4 Specification Paragraph	5 Approval/Data: Dimensional Drawings	Equipment Weights	Specifications	Material Description	Performance Data	Circuit or Control Diagrams	Data Sheets	Illustrative Cuts	Installation Instructions	6 Certified Vendor Information (CVI): Dimensional Drawings	Equipment Weights	Specifications	Certified Test Data	Circuit or Control Diagram	Instructions: Installation	Operation	Maintenance	Spare Parts List	7 Remarks
	Cable 15 kV		2.1.3			X	X															
	Transformers		2.2.2		X	X		X			X					X	X	X	X	X	X	

END OF SECTION

DOE Richland WA

SECTION 16400

SERVICE AND DISTRIBUTION
(600-Volt and Below)

PART 1 - GENERAL

1.1 REFERENCES

1.1.1 Reference Standards and Specifications: The following standards and specifications, including documents referenced therein, form part of this Section to extent designated herein.

1.1.1.1 American National Standards Institute (ANSI)

ANSI C80.1-1983	American National Standard for Rigid Steel Conduit--Zinc Coated

1.1.1.2 Federal Specifications (FS)

W-C-1094A	Conduit And Conduit Fittings Plastic, Rigid
W-F-406D	Fittings For Cable, Power, Electrical And Conduit, Metal, Flexible
TT-S-00230C, Including AMD 2	Sealing Compound: Elastomeric Type, Single Component (For Calking, Sealing, And Glazing In Buildings And Other Structures)
WW-C-566C	Conduit, Metal, Flexible

1.1.1.3 National Electrical Manufacturers Association (NEMA)

Standards Publication/ No. FB 1-1983 w/Rev through Sep 1984	Fittings and Supports for Conduit and Cable Assemblies
Standards Publication/ No. ICS 6-1983 w/Rev through Nov 1986	Enclosures for Industrial Controls and Systems
Standards Publication/ No. RN 1-1980	Polyvinyl-Chloride Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing

1.1.1.4 National Fire Protection Association (NFPA)

NFPA 70	National Electrical Code, 1987 Edition

1.1.1.5 Underwriters Laboratories, Inc (UL)

May 1988	Electrical Appliance and Utilization Equipment Directory
May 1988	Electrical Construction Materials Directory
UL 1242-1985	Standard for Intermediate Metal Conduit

1.2 SUBMITTALS: Refer to Section 01300 for submittal procedures.

1.3 QUALITY ASSURANCE

1.3.1 Standards: Products shall be identified for intended purpose by Underwriters Laboratories, Inc (UL) in the Electrical Appliance and Utilization Equipment Directory or Electrical Construction Materials Directory, and bear listing mark of laboratory. In absence of mark, submit documentation of applicable listing. Listing and marking by UL is not required for products specified to meet the requirements of a national standard, or designated by manufacturer's part number on the Drawings or in this Section.

PART 2 - PRODUCTS

2.1 MATERIALS

2.1.1 Solderless Connectors and Terminal Lugs: Pressure type, rated for use with copper or aluminum conductors with insulating caps or covers rated for system utilization voltage. Connectors shall be types specified below.

2.1.1.1 For conductors #8 AWG and smaller.

a. Ideal Industries, Inc "Wire-Nuts."

b. Thomas and Betts Company "Sta-Kon."

c. 3M Company "Scotchlok."

2.1.1.2 For conductors #6 AWG and larger.

a. Burndy Engineering Company "Screw Pressure Connectors" or "Hydent."

b. Thomas and Betts Company "Lock-tite."

2.1.2 Raceways, Fittings and Boxes

2.1.2.1 Conduit shall meet the requirements of appropriate standard as follows.

a.	Rigid steel	ANSI C80.1
b.	Intermediate metal	UL 1242
c.	PVC (Schedule 40)	FS W-C-1094, Type II
d.	Flexible metal	FS WW-C-566

2.1.2.2 PVC coating on rigid steel conduit: Factory applied, and meeting the requirements of NEMA RN 1, Type A-40.

2.1.2.3 Conduit fittings for rigid steel and electrical metallic tubing shall meet the requirements of NEMA FB 1. Only compression type threadless fittings shall be used with EMT.

2.1.2.4 Fittings used with flexible metal conduit shall meet the requirements of FS W-F-406 and be squeeze type only. Flexible metal conduit shall have integral ground conductor.

2.1.2.5 Use "Myers" type watertight fittings or sealing locknuts manufactured by Midwest Electric Manufacturing Corp, for conduit entries into sides or tops of NEMA Type 3 or NEMA Type 3R enclosures.

2.1.3 Conductors: Stranded copper, type and AWG size specified on the Drawings.

2.1.3.1 Conductor insulation: Type THWN/THHN or XHHW.

2.1.4 Leak Sensing and Locating Cable: Raychem TraceTek Catalog No. TT300-MSC.

2.1.4.1 Modular jumper cable: With male connector on 1 end and female connector on other end; Raychem TraceTek Catalog No. TT300-MJC.

2.1.4.2 Modular end termination: Raychem TraceTek Catalog No. TT300-MET.

2.1.4.3 Jumper cable: 3 foot long with male connector on 1 end and female connector on other end; Raychem TraceTek Catalog No. TT300-RPT.

a. Use for connecting sensing cables together, if required.

2.1.5 Wiremarkers: Imprinted tubular plastic.

2.1.6 Nameplates: Made from 1/16 inch laminated plastic stock with white surface and black core. Edges smooth, without burrs, and beveled 45 degrees. Letters sharp and clear.

2.1.7 Concrete and Masonry Anchors: Kwik-Bolt manufactured by Hilti Fastening Systems or Red Head Wedge Anchor manufactured by Phillips Drill Company.

2.1.8 Wire Pulling Compound: "Y-er Eas" manufactured by Electro Compound Company or Polywater manufactured by American Polywater Corp.

2.1.9 Tape

2.1.9.1 Plastic insulating tape: Scotch No. 33+ manufactured by 3M Company.

2.1.9.2 Conduit protection tape: Scotchrap No. 50 manufactured by 3M Company.

2.1.10 Insulating Putty: "Scotchfil" manufactured by 3M Company, GE No. 8389 manufactured by General Electric Co, or "Airseal" manufactured by Kearney Company.

2.1.11 Duct Sealing Compound: "Sealex" manufactured by Porcelain Products Co or "Kerite" manufactured by Kerite Co.

2.1.12 Nonshrink Grout: See Section 03300.

2.1.13 Hangers for Individual Conduits: Factory made springable wrought steel clamps or malleable iron, split and hinged rings. For suspended conduit, clamps or rings shall be bolted to, or interlocked with threaded suspension rod.

2.1.14 Sealant: Polysulfide meeting the requirements of FS TT-S-00230, Type II, Class B.

2.2 EQUIPMENT

2.2.1 Equipment enclosures shall meet the requirements of NEMA ICS 6-110 and be Type 3, 3R or 4.

2.2.2 Terminal Blocks

2.2.2.1 For #10 AWG conductors and smaller: Either 1-piece or factory assembled sectional double terminal, barrier type, with binder screw terminals. Terminal ampacities shall be equal to or greater than conductor ampacities; Marathon or Buchanan.

2.2.2.2 For #8 AWG conductors and larger: Either 1-piece or factory assembled sectional barrier type with box lug terminals having pressure plate between screw and conductor. Size terminals to accommodate conductors to be connected.

9 0 1 1 7 8 5 1 0 9 4

2.2.2.3 Furnish covers to cover live parts of terminations for circuits of more than 150 volts to ground. Provide with means for ready inspection and full width marking areas.

2.2.3 Annunciator: Similar to X12 Series manufactured by Ronan.

2.2.3.1 Weatherproof, in NEMA 4 enclosure, with 7 row high by 8 column wide plug-in light boxes. Input power 120V ac, 60 Hz.

2.2.3.2 Display shall have white translucent nameplates 3 inches by 2-3/4 inches nominal. Lamp boxes shall have 1 alarm point each with minimum 2 lamps for each alarm.

2.2.3.3 Solid state electronics with internal 24V dc power supply. Field contacts field selectable, NO or NC, for 24V dc.

2.2.3.4 Features

a. Lock-in of momentary alarms.

b. Auxiliary contacts.

c. Ring-back circuit by alarm audible signal.

d. Signal own failure.

e. Lamp test.

f. Flasher, common "acknowledge" pushbutton, and common "test" pushbutton located in cabinet.

2.2.3.5 Sequence of operation

STAGE	VISUAL SIGNAL	AUDIBLE SIGNAL
Normal	Off	Off
Alert, initial	Flashing	On
Acknowledge, initial	On steady	Off
Return to normal	Off	Off
Reset	Auto	Auto

2.2.3.6 Accessories: Horn, 120V ac, NEMA 4 rating, 24V dc power supply located in cabinet.

PART 3 - EXECUTION

3.1 PREPARATION

3.1.1 Field Measurements: Scale dimensions on Drawings show desired and approximate location of equipment, actual locations, distances, and levels shall be governed by field conditions.

3.2 INSTALLATION

3.2.1 General

3.2.1.1 Perform work in accordance with NFPA 70 (NEC).

3.2.1.2 Fasten equipment to structural members of building or metal supports attached to structure, or to concrete surfaces.

a. Use clamping devices for attaching to structural steel, or, when clamping is impracticable, obtain written authority from KEH to weld to, drill or cut structural members to provide attachment.

b. Fasten equipment to concrete or masonry with expansion anchors.

c. Attach to drywall by screws into studs, and to metal wall panels by weld studs, bolts or self-tapping metal screws.

d. Locate equipment, boxes and conduit approximately where shown in relation to equipment served.

e. Do not install conduit raceways and boxes in positions that interfere with work of other trades.

f. Identify components by nameplate engraved with designation and function shown on the Drawings.

g. Attach nameplates on or near equipment with clear RTV silicone sealant.

3.2.1.3 Use appropriate special calibrated tools when installing devices for which special installation tools are recommended by manufacturer.

3.2.2 Grounding Systems

3.2.2.1 Underground conductors, electrodes, and connections: Install in accordance with the Drawings. Make joints connecting copper and galvanized steel conductors above grade and in dry location.

3.2.2.2 System and equipment grounding: Solidly ground neutral conductor of 3-wire, single phase and 4-wire, 3 phase, wye-connected distribution systems. Ground equipment in accordance with the Drawings and the NEC.

3.2.3 Conduit

3.2.3.1 Use rigid steel or intermediate metal where subject to mechanical damage, installed in concrete floors and walls, installed exposed to weather, or installed 4 feet or less above floor.

3.2.3.2 Install #14 gage galvanized steel pull wire or 1/8 inch polyethylene rope in spare conduits.

3.2.3.3 Install concealed conduits as directly as possible and with bend radii as long as possible. Install exposed conduit parallel with or at right angles to building lines.

3.2.3.4 Permanently label each conduit, using black paint and stencil, at both ends, with number shown on the Drawings.

3.2.3.5 Make elbows, offsets and bends uniform and symmetrical. Bend conduit with approved bending devices.

3.2.3.6 Cut square, ream and remove burrs. Conduit shall be clean, dry, and free of debris. Immediately after installation, plug or cap exposed ends with standard accessories until wires are installed.

3.2.3.7 Use galvanized steel locknuts and insulated bushings for attachment to enclosures except threaded hubs or sealing type locknuts shall be used outdoors or where moisture is present. Threadless fittings will not be permitted for rigid conduit. Use Erickson type couplings where required. Do not use running threads.

3.2.3.8 Use 1 hole clamps equipped with clampbacks or Unistrut with clamps to secure conduits.

3.2.3.9 Install without moisture traps wherever possible. Where practicable, provide drain holes in pullboxes or fittings at low points in raceway systems and remove burrs from drilled holes.

3.2.3.10 Flexible conduit

a. Use to make connections to motors and other equipment subject to vibration. Use liquidtight flexible metal conduit where conduit and fittings are installed outdoors or exposed to moisture or chemical fumes indoors.

b. Use in lengths not exceeding 4 feet for other equipment, with approval of KEH.

c. Use for flush and recessed lighting fixtures in lengths at least 4 feet, but not exceeding 6 feet.

3.2.3.11 Set up joints in conduit installed in concrete, underground, or exposed to weather, with high temperature, antiseize, conductive thread lubricant and sealant.

3.2.3.12 Install exposed conduit stubbing up through floor slab straight and plumb, lined up, and uniformly spaced. Install at sufficient depth below slab to eliminate part of bend above top of slab. Cap or plug stub-up before placing concrete. Verify stub-up locations with final equipment arrangements.

3.2.3.13 Wrap conduit passing from concrete to air or to direct earth burial with conduit protection tape from 3 inches in concrete to at least 12 inches in earth, or 3 inches in air, unless conduit is PVC coated.

3.2.3.14 Where routing is parallel with hot water or steam pipes, maintain minimum 6 inch clearance from pipe covering. Where not run parallel with pipe it is acceptable to run closer than 6 inches, providing conduit does not touch pipe covering.

3.2.3.15 Encase conduit installed below grade with minimum 3 inches of concrete on all sides. Use PVC coated rigid steel where shown on the Drawings.

3.2.3.16 Install PVC coated conduit in accordance with manufacturer's recommendations. Repair coating, damaged during handling or installation using PVC paint recommended by conduit manufacturer.

3.2.3.17 Seal opening around conduit penetrating manhole walls with nonshrink grout.

3.2.4 Underground Duct Banks

3.2.4.1 Use either rigid steel or PVC conduit in concrete encased duct banks.

3.2.4.2 For single conduit runs, PVC coated rigid steel conduit may be used instead of concrete encased duct bank.

3.2.4.3 Install underground ducts in accordance with the Drawings and route without drains where possible.

3.2.4.4 Where drains or risers are required, install in accordance with the Drawings. Seal conduit at both ends with duct sealing compound.

3.2.4.5 Form concrete encasements unless written waiver is obtained from KEH.

3.2.5 Boxes, Enclosures and Wiring Devices

3.2.5.1 Install boxes firmly in position and plumb.

3.2.5.2 Install extension ring with blank cover on flush mounted junction boxes where box serves permanently installed equipment.

3.2.5.3 Flush mount junction boxes served by concealed conduit.

3.2.5.4 Install dust covers on junction, pull, and outlet boxes, and other types of wiring outlets at initial installation. Do not remove dust covers until wires are installed and permanent cover or device is placed on box or outlet.

3.2.6 Conductors

3.2.6.1 Do not bend cables installed in wireways to less than manufacturer's recommended minimum bending radius. Bind power and control circuits separately with nylon cable ties, at 18 inch intervals. Lay cables in wireways in straight parallel lines, and avoid crossing.

3.2.6.2 Maximum pulling tension on conductors: Recommended by manufacturer.

3.2.6.3 Identify each conductor designator by wire number on the Drawings with wire marker. Attach wire marker at each termination point within 2 inches of wire termination. Marker nomenclature shall be visible without moving wire or marker.

3.2.6.4 Paint or pressure-sensitive colored tape may be used for coding conductors instead of colored insulation on #8 AWG and larger wire only. Maintain phase color coding, in accordance with the Drawings, for branch and feeder circuits up to and including equipment connections.

a. Use colored tape to properly code existing conductors whose color does not comply.

3.2.6.5 Use lubricant recommended by cable manufacturer, or wire pulling compound specified, to decrease friction when pulling wire and cable through conduit.

3.2.6.6 Do not install or handle wires with thermoplastic insulation or jacket when ambient temperature is 15 F or below.

3.2.6.7 Install and mark direct burial cable in accordance with the Drawings.

3.2.7 Splices, Taps and Cable Terminations

3.2.7.1 Make splices and taps in building wire with solderless connectors described in Paragraph 2.1.1. Use connectors in accordance with manufacturer's instructions.

3.2.7.2 Use plastic insulating tape for uninsulated splices and taps. Apply tape to thickness at least equal to conductor insulation. Where bolted splice or connection presents irregular surface, apply insulating putty to joints before taping.

3.2.7.3 Use crimp-on type ring or spade lugs with turned up legs for wire terminations of stranded conductors to binder screw or stud type terminals. Lugs shall have insulated sleeves.

3.2.8 Sensing Cable: Install in bottom of annulus between 2 inch inside and 4 inch outside pipes of grout transfer line as follows.

3.2.8.1 Install #14 gage galvanized steel pull wire from 1 termination access port to next at time of pipe fabrication and installation. Take care to ensure pull wire is installed in bottom segment of annulus and not burned-off or welded to pipe.

3.2.8.2 Pull in cable after completion of pipe installation.

3.2.8.3 Connect cables at each termination access port using connectors supplies as part of modular sensing cable.

3.2.8.4 Install specified modular end termination on end of cable at vault pit, and lay cable back in annulus.

3.2.8.5 Contact representative of TraceTek before installation of first sensing cable, and as needed for installation of remaining cables.

3.3 FIELD QUALITY CONTROL

3.3.1 Testing, General

3.3.1.1 Test equipment and wiring for continuity and unintentional grounds, and verify proper phase sequence and voltage at equipment served before attempt is made to operate equipment. Notify KEH before start of tests. Correct items found, during testing or examination by KEH, to be at variance with the Drawings and this Section.

3.3.1.2 Furnish instruments, labor and equipment required to conduct testing.

3.3.1.3 Use test instruments which bear valid calibration stamp showing date of calibration and expiration date of stamp. Calibration and accuracy of test instruments shall be certified by independent testing laboratory having standards traceable to the National Bureau of Standards.

3.3.1.4 In addition to testing specified to be performed by Contractor, installation will be subject to examination by KEH for conformance with design and applicable codes. Assist KEH as requested.

3.3.2 Wiring Systems

3.3.2.1 Megger conductors rated 600 volts and used for services, feeders or branch circuits over 150 volts to ground, phase-to-phase, and phase-to-ground. Minimum acceptable value of insulation resistance is 200 megohms. Megger manufacturer's instruction pamphlet, furnished with megger, shall provide instructions for conducting tests. Disconnect devices not capable of withstanding voltage or current of megger test, such as indicating instruments, relays and lamps, before test is made. Voltage output of megger shall be 1000V dc, nominal.

3.3.2.2 Test wiring operating less than 150 volts to ground for continuity and unintentional grounds. Resistance shall not exceed 1 ohm on continuity checks.

3.3.2.3 Contractor may elect to group and connect together conductors within raceway while performing megger test. Record readings which indicate less than minimum acceptable value. Repeat megger test after replacement of defective wiring.

3.3.2.4 Reconnect devices disconnected during testing.

3.3.3 Sensing Cable

3.3.3.1 Before installation: Connect portable test box to 1 end and modular end termination to other end of each sensing cable and verify there is no current leakage caused by dirt, grease, or moisture. If current leakage is detected, clean or replace cable.

3.3.3.2 During installation: Connect portable test box to 1 end and modular end termination to other end of sensing cable. Monitor cable for current leakage caused by dirt, grease, or moisture during pull. If current leakage is detected, pull cable out, clean pipe annulus, and clean or replace cable. Hand pull cable with 50 pounds maximum pull tension.

END OF SECTION

SECTION 16640

CATHODIC PROTECTION

PART 1 - GENERAL

1.1 REFERENCES

1.1.1 Reference Standards and Specifications: The following standards and specifications, including documents referenced therein, form part of this Section to extent designated herein.

1.1.1.1 American National Standards Institute (ANSI)

ANSI C39.1-1981	American National Standard Requirements for Electrical Analog Indicating Instruments
ANSI C80.1-1983	American National Standard for Rigid Steel Conduit--Zinc Coated

1.1.1.2 American Society for Testing and Materials (ASTM)

B 8-86	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
D 3487-82a	Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus

1.1.1.3 American Wood-Preservers Association (AWPA)

C1-87	All Timber Products--Preservative Treatment by Pressure Processes
C2-87	Lumber, Timbers, Bridge Ties and Mine Ties--Preservative Treatment by Pressure Processes
P8-87	Standards for Oil-Borne Preservatives

1.1.1.4 National Association of Corrosion Engineers (NACE)

RP-01-69 (Rev 1983)	Recommended Practice - Control of External Corrosion on Underground or Submerged Metallic Piping Systems

1.1.1.5 National Electrical Manufacturers Association (NEMA)

Standards Publication/ No. 250-1985	Enclosures for Electrical Equipment (1000 Volts Maximum)
Standards Publication/ No. RN 1-1980	Polyvinyl-Chloride Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing
Standards Publication/ No. WC 5-1973 (R 1979) w/Rev through Mar 1985	Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

1.1.1.6 National Fire Protection Association (NFPA)

NFPA 70	National Electrical Code, 1987 Edition

1.1.1.7 Underwriters Laboratories, Inc (UL)

May 1988	Electrical Appliance and Utilization Equipment Directory
May 1988	Electrical Construction Materials Directory

1.2 SUBMITTALS: Refer to Section 01300 for submittal procedures.

1.2.1 Approval Data: Submit information listed in Column 5 of Vendor Data List in this Section.

1.2.2 Certified Vendor Information (CVI): Submit information listed in Column 6 of Vendor Data List in this Section.

1.2.3 Visual Examination Procedure: Submit examination procedure for attaching cables, wires, or leads to pipe wall by exothermic weld process.

1.2.4 Manufacturer's Instructions: Submit manufacturer's instructions for exothermic welding of conductors to horizontal and vertical pipe.

1.3 QUALITY ASSURANCE

1.3.1 Qualification and Demonstration of Exothermic Weld Process: Personnel shall be qualified in accordance with following requirements.

1.3.1.1 Prepare 2 exothermic weld connections, No. 4 or 6 AWG cable to pipe, for each weld position to be used.

1.3.1.2 Qualification tests shall meet the requirements of subparagraphs 3.3.8.3a and 3.3.8.3b.

1.3.1.3 Examine connection in accordance with manufacturer's recommended method.

1.3.1.4 KEH will witness performance qualification tests.

1.3.1.5 Deliver 2 copies of connection performance qualification test results to KEH 5 days before making exothermic weld connections. Maintain additional copies as specified in Section 01400, Paragraph 1.6.2.

1.3.2 Standards: Products shall be identified for intended purpose by Underwriters Laboratories, Inc (UL) in the Electrical Appliance and Utilization Equipment Directory or Electrical Construction Materials Directory, and bear listing mark of laboratory. In absence of mark, submit documentation of applicable listing. Listing and marking by UL is not required for products specified to meet the requirements of a national standard, or designated by manufacturer's part number on the Drawings or in this Section.

PART 2 - PRODUCTS

2.1 MATERIALS

2.1.1 Solderless Terminal Lugs: Pressure type, rated for use with copper conductors with insulating caps rated for system utilization voltage. Lugs shall be types specified below.

2.1.1.1 For conductors #8 AWG and smaller: Thomas and Betts Company "Sta-Kon."

2.1.1.2 For conductors #6 AWG and larger.

a. Burndy Engineering Company "Hydent."

b. Thomas and Betts Company "Lock-tite."

2.1.2 Compression Splice Connectors: Burndy Co "Crimpit," size shown on the Drawings.

2.1.3 Exothermic Fusion Weld Mold for Connection of Pipe Test Conductors, Jumpers, and Negative Return Cables to Steel or Cast Iron Pipe: Erico Products "Cadweld" size and part number shown on the Drawings.

2.1.3.1 Exothermic weld metal: Erico Products "Cadweld" shown on the Drawings.

2.1.4 Ground Clamp Connector: Bronze, Teledyne Penn-Union, Catalog No. GPL, size as required.

2.1.5 Conduit: Meet the requirements of ANSI C80.1 and be PVC coated in accordance with NEMA RN 1, Type A-40.

2.1.6 Conductors

2.1.6.1 Direct current (DC): High molecular weight low density polyethylene, Type "CP", meeting the requirements of ASTM B 8 and NEMA WC 5. Size specified on the Drawings.

2.1.6.2 Alternating current (AC): Stranded copper with 600 volt Type THHN/THWN insulation. Size specified on the Drawings.

2.1.7 Conductor Splice Kit: Scotchcast Brand, Catalog No. 82-B1 and 90-B1.

2.1.8 Tape

2.1.8.1 Plastic insulating: 3/4 inch wide, Scotch No. 88 manufactured by 3M Company.

2.1.8.2 Electrical splice insulating: Self-vulcanizing rubber, 3/4 inch wide.

2.1.8.3 Electrical color coding: 3/4 inch wide, Scotch No. 35 manufactured by 3M Company.

2.1.9 Plastic Sheet Marker: See Section 02200, yellow warning tape.

2.1.10 Wiremarkers: Imprinted tubular plastic.

2.1.11 Equipment Nameplates: Laminated plastic, 1/16 inch thick with white surface and black core. Edges beveled and smooth. Engraved nomenclature shall be sharp and clear.

2.1.12 Cable Marker: Field fabricate and paint as shown on the Drawings.

2.2 EQUIPMENT

2.2.1 Anodes: Durichlor 51, Type D, size 2 inch by 60 inch with 20 foot lead wire of No. 8 AWG stranded copper with high molecular weight, low density polyethylene (HMW PE) insulation, prepackaged in 8 inch by 96 inch steel canister with coke breeze backfill.

2.2.1.1 Cable to anode connection: Covered with epoxy cap, in accordance with manufacturer's standards.

2.2.1.2 Canister: 30 gage galvanized stove pipe.

2.2.1.3 Coke breeze: Compacted to total weight of approximately 200 pounds per canister.

2.2.1.4 Electrical resistivity of coke breeze shall not exceed 50 ohm/cm^3.

2.2.2 Anode Junction Box, and Test Station Enclosures: Quazite Corporation, Style "PG" service box, Model no. PG1324BA18 with locking steel cover, Part No. PG1324SA00 with logo engraved: "CATHODIC PROTECTION".

2.2.3 Anode Junction Box: Single hub, double box, slip fit for 3 inch rigid conduit, 8 standard terminals, each terminal 3/8 inch silicon bronze studs with nuts and washers; Gerome, Catalog No. 2007.

2.2.4 Test Station: Single hub, double box, slip fit for 3 inch rigid conduit, 8 standard terminals and 6 extra terminals, each terminal 3/8 inch silicon bronze with nuts and washers; Gerome, Catalog No. 2007.

2.2.5 Reference Electrode: Permanent horizontal copper-copper sulfate type, Harco Corp, Part No. IHRP-802, Matcor Part No. PRC-CU4, or Farwest Corrosion, Part No. FWCC-SP-150. Provide with 50 feet of #8 AWG HMW/PE insulated wire.

2.2.6 Rectifier

2.2.6.1 General requirements: Rectifier and associated equipment shall operate and deliver rated capacity, without exceeding temperature limitations specified, when operating in following environment.

a. Operating Environment

1) Location: Outdoors in direct sunlight.

2) Ambient temperature: Minimum minus 13 F, Maximum 113 F.

3) Relative humidity: Maximum 100 percent.

4) Dust: Exposure to dust particulate (sandstorm).

5) Precipitation: Driving rainstorm.

6) Snow: Accumulation of sleet or snow.

b. Design life: Minimum 10 years.

2.2.6.2 Design Requirements

a. Rating

1) AC line input voltage: 480V ac, minus 5 percent to plus 10 percent.

2) AC line frequency: 60 Hertz.

3) Number of phases: 3.

4) DC output voltage: 60 volts.

5) DC output current: 12 amps.

b. Oil-immersed type.

c. Suitable for mounting on concrete slab.

d. Transformer: Separate primary and secondary windings fully rated for maximum capacity. Electrostatic shield placed between primary and secondary windings and fully insulated from both windings. Arrange shield not to form complete closed loop and equip with lead wire connected to negative terminal.

e. Silicon stacks: Connected in full wave bridge circuit configuration, and coated with corrosion-resistant finish equivalent to NEMA Grade C.

f. Silicon diodes: Rated to provide margin for over-voltage surges and over-current surges, and protected by selenium surge-plates against over-voltage surges and by current-limiting devices against over-current surges. Heat sinks sized to keep diode junction and case temperatures below temperatures that could cause failure.

g. Efficiency filter: Incorporate in rectifier to increase efficiency of unit.

h. Enclosure: Meet the requirements of NEMA 250.

i. Current carrying pressure connections, such as terminal studs and current shunt connections, shall have thin layer of conductive grease applied to contact surfaces to prevent oxidation.

2.2.6.3 Construction requirements

a. Construct to permit transformer, stacks and other internal components to be immersed in oil. Inside of enclosure shall be accessible through cover mounted on top. Attach cover to cabinet by hinges and provide with quick-release clamps and padlock clasp or other means of locking cabinet. Provide stop to limit swing of lid when opened. Provide positive, oil-resistant, compressible sealing lid gasket. Cork and sponge materials are not acceptable. Gasket joints shall not have gaps.

b. Provide panel for mounting terminals, circuit breakers, shunts, etc. Board inside panel shall be micarta or similar insulating material, supported on 4 edges.

c. Enclosure and appurtenances: Approved for use in specified environmental conditions. Materials and methods used in construction and fabrication of rectifier shall be in accordance with NEMA requirements for specified service. Internal components and connections of rectifier shall be immersed under 3 inches of oil, minimum.

d. Enclosure shall be minimum 0.1196 inch steel provided with oil drain plug. Oil level shall be clearly marked.

e. Construct and protect enclosure so environmental conditions specified in subparagraph 2.2.6.1a will not affect rectifier rated performance.

f. Finish enclosure inside and outside with 1 coat of epoxy red oxide primer and 2 coats of gray baked enamel.

g. Provide engraved, manufacturer's standard nameplates on rectifier. Nameplate information shall include rating data specified in subparagraph 2.2.6.2a.

2.2.6.4 Instrumentation

a. Indicating instruments: Meet the requirements of ANSI C39.1.

b. Continuous reading, 3-1/2 inch flush mounted dc voltmeter, for measuring voltage output. Scale shall be linear and range from 0 to 125 percent of rated output voltage.

c. 3-1/2 inch flush mounted dc ammeter, connected across external shunt for reading total dc current output of rectifier. Meter circuit shall have disconnect switch which may be closed by operator when readings are being taken. Ammeter scale shall be linear and range from 0 to 125 percent of rated current output in amperes.

d. Shunt: 50 millivolt, 12 ampere mounted on front of instrument panelboard.

2.2.6.5 Voltage and current control: Output voltage manually controlled. Transformer taps shall have tap-changing devices for manual operation to permit at least 18 equal steps of adjustment.

2.2.6.6 Protection: Furnish with following protective devices and equipment.

a. AC thermal magnetic circuit breakers: Mounted within panel and provide short-circuit protection for rectifier.

b. DC fuse: Rated at 15 amperes, 125 volts, and installed in positive phase leg. Fuse shall be accessible from front of panel.

c. DC valve-type arrester: For 150 volt maximum line-to-ground fault voltage.

d. AC input surge (lightning) arresters.

e. Ground lug: Installed on cabinet so cabinet may be connected to grounding system. Size ground lug for No. 4 AWG copper ground cable.

2.2.6.7 Output terminals

a. 2 negative and 4 positive terminals mounted on front of panel and appropriately marked.

b. External shunts on output (positive and negative) circuits indicated above. Output shunts of same rating as ammeter external shunt.

2.2.6.8 Shop tests: Factory test and inspect to establish that design and construction are in accordance with this Section and applicable standards, and to determine that equipment is free from electrical and mechanical defects.

PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Where existing pipes are exposed during excavation, and usage not known and cannot be verified, do not exothermically weld test conductors to pipe unless written permission is granted by KEH. Make connections using bronze ground clamp connector. Coat connection using same materials and installation methods as for exothermic weld.

3.2 PREPARATION

3.2.1 Field Measurements: Scale dimensions on the Drawings show desired and approximate location of equipment, actual locations, distances, and levels shall be governed by field conditions.

3.3 INSTALLATION

3.3.1 General

3.3.1.1 Perform work in accordance with NFPA 70 (NEC).

3.3.1.2 Cathodic protection systems: Meet the requirements of NACE RP-01-69.

3.3.1.3 Use appropriate special calibrated tools when installing devices for which special installation tools are recommended by manufacturer.

3.3.2 Anodes: Install vertically to depth shown on the Drawings.

3.3.2.1 Drill or auger hole to enable anode to be lowered into hole. Where casing is used to maintain open hole, remove after anode has been placed in hole.

3.3.2.2 Lower anode to bottom of hole by rope and center within hole. Do not use lead wire to lower anode into hole.

3.3.2.3 Backfill and compact in accordance with Section 02200.

3.3.2.4 If temporary casing was used, lower anode into position and slowly withdraw casing while backfilling.

3.3.2.5 Repair damaged anode lead wire insulation by encapsulation with epoxy resin using conductor splice kit.

3.3.2.6 Splice anode lead conductor to anode header cable as shown on the Drawings.

3.3.2.7 Insulate splice as shown on Drawings. Provide 18 inch slack cable on anode lead at splice location.

3.3.3 Anode Junction Box Enclosure: Install 2 inches above grade at location shown on the Drawings. Install nameplate on top of enclosure. Engrave nameplate, using 3/16 inch letters, ANODE JUNCTION BOX AJB (number shown on the Drawings). Fasten nameplate to enclosure by machine screws or rivets. Install steel cover on enclosure and lock.

3.3.4 Anode Junction Box: Install inside anode junction box enclosure and terminate anode header and loop cables on terminals as shown on the Drawings. Install equipment nameplate on cover of each junction box. Engrave nameplate, using 3/16 inch letters, ANODE JUNCTION BOX AJB (number shown on the Drawings). Fasten nameplate to box by machine screws or rivets. Form slack loop in anode header and loop cables, length shown on the Drawings, and place in bottom of enclosure.

3.3.4.1 Use 1/8 inch thick bus bar of bus grade copper, cut and drilled to fit, to connect terminal studs shown on the Drawings.

3.3.5 Test Station Enclosure: Install 2 inches above grade at location shown on the Drawings. Install nameplate, on top of enclosure. Engrave nameplate, using 3/16 inch letters, TEST STATION T (numbers shown on the Drawings). Fasten nameplate to enclosure by machine screws or rivets. Install steel cover on enclosure and lock.

3.3.6 Test Station: Install inside test station enclosure and terminate pipe and reference electrode test conductors on terminals shown on the Drawings. Install nameplate on cover of test station. Engrave nameplate, using 3/16 inch letters, TEST STATION T (number shown on the Drawings). Fasten nameplate to box by machine screws or rivets. Form slack loop in pipe test conductors, length shown on the Drawings, and place in bottom of enclosure.

3.3.7 Reference Electrode

3.3.7.1 Install at each test station enclosure location as shown on the Drawings.

3.3.7.2 Soak in water for minimum 3 hours, then lower into hole with ropes. Do not use lead to lower into hole.

3.3.7.3 Install package between 6 and 18 inches below outer surface of pipe. 1 electrode is required for 2 pipes or less. For configuration of 2 parallel pipes, install electrode in center of configuration, and not adjacent to or touching foreign pipelines. KEH will assist in positioning reference electrodes.

3.3.7.4 Bring lead wire to top of hole for termination in test station.

3.3.7.5 Repair damaged lead wire insulation using conductor splice kit.

3.3.7.6 Backfill trench in accordance with Section 02200.

3.3.8 Rectifier: Attach to concrete pad with anchor bolts as shown on the Drawings.

3.3.8.1 Terminate ac wiring on input circuit breaker in rectifier.

3.3.8.2 Fill rectifier to level shown on rectifier case, with transformer oil meeting the requirements of ASTM D 3487.

3.3.8.3 Pipe test conductors

a. Verify usage of each pipe to which pipe test conductors are to be connected. If pipes are coated, cut window in coating large enough to accommodate exothermic weld mold: Wire brush each pipe and file to bright metal surface, free of oil and dirt. Make exothermic weld of test conductor to pipe in accordance with approved manufacturer's instructions, size shown on the Drawings. Install weld mold as shown on the Drawings.

b. After weld is made, test integrity of connection by tapping side of weld material with hammer. If weld fails, make another weld at least 3 inches from previous attempt.

c. Coat exothermic weld as shown on the Drawings. If pipe is coated, overlap coating 2 inches beyond cut edge of coating around exothermic weld.

d. Conductor size and color code marking specified on the Drawings.

e. Repair damaged conductor insulation using conductor splice kit.

f. Make repairs of foam insulation on pipe with sprayed polyurethane, specified in Section 15493, applied in accordance with manufacturer's instructions.

g. Identify each conductor using specified wiremarker with typewritten pipe number to which conductor is connected. Label pipe test conductors connected to unidentifiable pipes with pipe size followed by words "UNKNOWN".

h. Use solderless terminal lugs for conductor terminations in test station.

i. Where required, place plastic sheet marker 1 foot below grade and over pipe test conductors in accordance with Section 02200.

j. Backfill in accordance with Section 02200.

3.3.8.4 Reference electrode conductor

a. Wrap lead wire in test station with green electrical color coding tape.

b. Identify conductor using specified wiremarker with typewritten reference electrode number shown on the Drawings.

c. Use solderless terminal lug for conductor termination in test station.

d. Terminate lead wire in test station as shown on the Drawings. After termination, place test station in flush-mounted enclosure. Form slack loop in lead wire, length shown on the Drawings, and place at bottom of enclosure.

e. Repair damaged conductor insulation using conductor splice kit.

3.3.8.5 Backfill in accordance with Section 02200.

3.3.9 Conductors

3.3.9.1 Anode header, anode loop, and negative return cables

a. Place on bedding in trenches prepared in accordance with the Drawings.

b. Where only 1 cable is being installed, center in trench. Where more than 1 cable is installed, minimum spacing between cables shall be 1 inch. Do not transpose cables in trench.

c. Loosely bundle anode header and loop cables together with electrical tape and center in trench. Provide 12 inch slack loop in header cable at anode lead splice locations. Provide 18 inch slack loop in anode lead cable at tap splice location.

d. Maintain identity of each cable. Where 2 or more cables are in same trench, maintain relative positions of cables, as shown on the Drawings, throughout entire run. Identify cables, using specified wiremarkers, at terminations and where in-line splice is necessary, before leaving unattended.

e. Terminate anode header and loop cables at rectifier positive output terminals and anode junction box. Terminate negative return cable at rectifier negative output terminal. Use solderless terminal lugs for conductor terminations. Identify cables using specified wiremarkers, typewritten.

f. Repair damaged cable insulation by using "Scotchcast" 90-B1 splice kits for No. 2 and No. 2/0 AWG cables and "Scotchcast" 82-B1 splice kits for No. 8 AWG anode lead cables.

g. Place minimum 3 inches of bedding material, as shown on the Drawings, over cables and compact in accordance with Section 02200.

h. Place 2 inch by 12 inch wood planks, treated in accordance with AWPA C1, C2, and P8, continuous over bedding for entire length of trench. Do not place planks over individual anode leads.

i. Place plastic sheet marker 1 foot below grade directly above wood planks in accordance with Section 02200. Do not place over anode leads.

j. Identify each cable end as required with 1 of following phrases, typewritten on specified wiremarker.

1) "Anode Header Cable - (+E), (+W), (+WE), (+SE)".

2) "Anode Loop Cable - (+WL), (+NEL), (+SEL)".

3) "Neg Return Cable - (-)".

k. Cover cable ends with plastic electrical tape until ready to be terminated at rectifier, or anode junction box.

l. Cable marker

1) Install directly over cables at locations shown on the Drawings.

2) Install 5 feet from end of cable run and on turns of cable runs. Arrow on marker shall be parallel to cable.

3) Do not place marker in traffic ways. Where cathodic protection cables cross roadways, crossing shall be as shown on Drawings.

3.3.9.2 Connection of negative return and jumper cables to pipe.

a. Connections shall not be made to pipe until pipe has been identified by KEH.

b. Prepare cable and make connections to pipe as shown on the Drawings.

c. If pipes are coated or covered by foam insulation, cut windows large enough to accommodate exothermic weld mold.

d. Connect each conductor section to pipe by exothermic weld process.

e. Insulate weld as shown on the Drawings. Insulate welds on coated pipe in same manner as bare pipe welds. Weld coating material shall overlap existing pipe coating 2 inches, minimum.

f. Make repairs of foam insulation with sprayed polyurethane insulation foam specified in Section 15493.

3.3.10 Conduit: Install PVC coated conduits in accordance with manufacturer's installation instructions and as shown on the Drawings. Cut conduit square, ream and deburr. Damage to PVC coated conduits shall be touched up with "Plastic-Bond" touch-up compound.

3.4 FIELD QUALITY CONTROL

3.4.1 Testing, General

3.4.1.1 Test conductors for continuity where practicable. Resistance values shall be less than 1 ohm. Notify KEH before start of tests. Correct items found during testing or examination to be at variance with the Drawings or Specifications.

3.4.1.2 Furnish instruments, labor and equipment required to conduct testing.

3.4.1.3 Use test instruments which bear valid calibration stamp showing date of calibration and expiration date of stamp. Calibration and accuracy of test instruments shall be certified by independent testing laboratory having standards traceable to the National Bureau of Standards.

3.4.1.4 In addition to testing specified to be performed by Contractor, installation will be subject to examination by KEH for conformance with design and applicable codes.

71416640.SP2.1850

Project No. B-714

Title Grouted Waste Disposal Facilities

Grout Vault Pair (218-E-16-102 and 103)

KAISER ENGINEERS
HANFORD

VENDOR DATA LIST

("X" Indicates Required Data)

1 EPN Identification	2 Description	3 Reference Drawing	4 Specification Paragraph	5 Approval/Data: Dimensional Drawings	Equipment Weights	Specifications	Material Description	Performance Data	Circuit or Control Diagrams	Data Sheets	Illustrative Cuts	Installation Instructions	6 Certified Vendor Information (CVI): Dimensional Drawings	Equipment Weights	Specifications	Certified Test Data	Circuit or Control Diagram	Instructions: Installation	Instructions: Operation	Instructions: Maintenance	Spare Parts List	7 Remarks
	Anodes		2.2.1	X		X	X					X			X							
	Anode Junction Box, and Test Station Enclosures		2.2.2			X					X											
	Anode Junction Box		2.2.3			X					X											
	Test Station		2.2.4			X					X											
	Reference Electrode		2.2.5	X		X	X					X			X							
	Rectifier		2.2.6	X	X	X			X		X		X		X		X	X	X	X	X	

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APP 41-562

B-714-C2

DOE/RL 88-27
Rev. 1, 01/17/90

C RESULTS ON COATING WATER VAPOR TRANSMISSION TEST

Battelle
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May 8, 1989

Ms. T. B. Bergman
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P.O. Box 1970
MSIN R1-48
Richland, WA 99352

Dear Ms. Bergman:

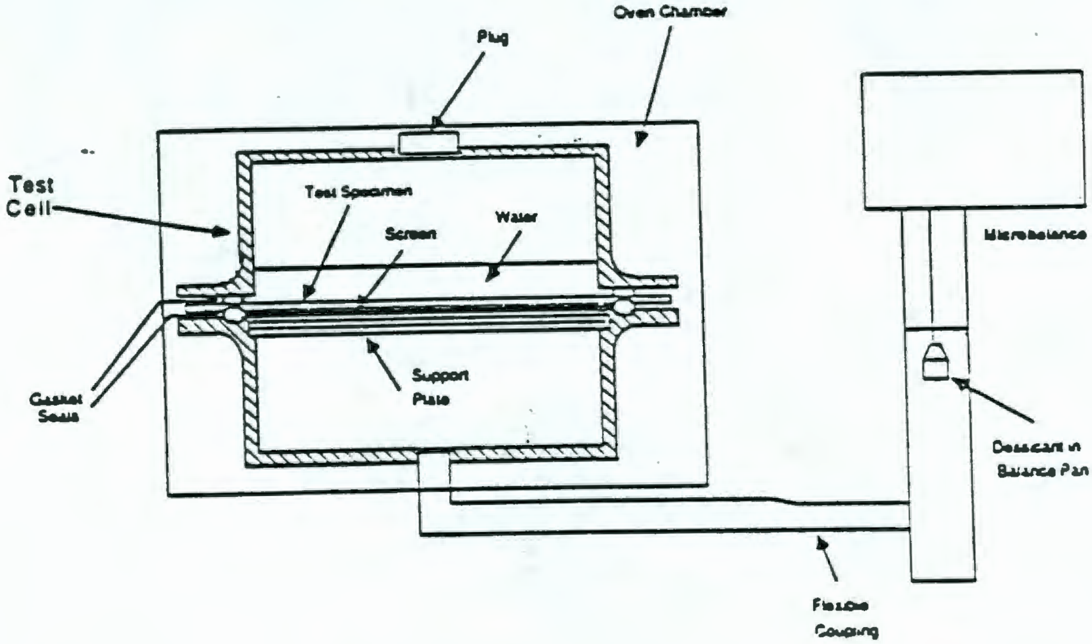
COMPLETION OF HANFORD GROUT TECHNOLOGY PROGRAM MILESTONE 89-05(I): LETTER WITH TEST RESULTS ON LINER WATER VAPOR TRANSMISSION AND COLD FLOW BEHAVIOR

The transmission of this letter, prepared by Greg Whyatt, completes Milestone 89-05(I) of the Hanford Grout Technology Program. Lion 705M is the proposed coating for the interior of grout disposal vaults. The water vapor transmission rate through the liner and the stability of the coating on concrete were measured at 90°C for use in design verification being conducted by Kaiser Engineers Hanford (KEH). The results of the two tests are discussed below.

Water Vapor Transmission

The test method used to measure water vapor transmission was a refinement of ASTM E 96, Standard Test Methods for Water Vapor Transmission of Materials. The test configuration is shown in Figure 1. The test cell is constructed of stainless steel with welded end caps. The two halves of the cell bolt together with the edge of the sample sealed between them. A perforated plate and a screen support the sample. The entire test cell was placed in an oven at 90°C. Anhydrous magnesium perchlorate (a desiccant) was placed in a pan suspended from a microbalance. The weight gain of the desiccant was recorded on a strip chart recorder and used to determine the rate of water transmission through the sample.

The samples were prepared by applying ≈0.6 mm Lion 705M to sheets of paper. The samples were then inserted into the apparatus with the paper still attached. The paper is assumed to have a negligible effect on the measurement because it is thin and should have a relatively high permeability. Samples were tested after curing 9 days or more at room temperature. In the first measurement the sample was inserted with the paper side down and butyl rubber gaskets were used to seal the edge of the sample. In the second and third measurements the samples were inserted with the paper side up and no gaskets were used in order to provide a better seal of the sample.



<u>FIGURE 1</u>. Test Configuration For Water Vapor Transmission Tests

To perform each measurement the system started with no water in the test cell, the test cell at 90°C and fresh desiccant in the balance pan. The rate of weight gain of the desiccant was then was allowed to come to a steady state. During this period, slow leakage of water vapor into the system is measured. After this rate had become steady, 50 milliliters of distilled water was placed on top of the sample and the wet side of the test cell was covered but not sealed. The rate of weight gain was then measured again. The rate of initial inleakage while the system was dry was subtracted from the rate obtained with water in the system to determine the water vapor transmission rate. This was done since the inleakage is believed to occur on the dry side of the apparatus and would continue to leak after water was added to the system. In all cases the dry inleakage rate was less than 10 percent of the rate obtained with water on the liner.

The results of the measurements are shown in Table 1. The results are listed as the water flux observed and thickness of the sample, as a permeance of the sample, and as a permeability of the material.

Permeance is the water vapor transmission rate divided by the difference in vapor pressure of water on the two sides of the sample (7.01 X 10^4 Pa). The permeance is a measure of the performance of an individual sample.

TABLE 1. Water Vapor Permeability Results

Sample No.	Sample Thickness (mm)	Water Vapor Transmission ($g/m^2/day$)	Sample Permeance (g/m^2 Pa/day)	705M Permeability[a] (g/m^2 Pa/day)
1	.56 ± .07[b]	12.73	1.82×10^{-4}	1.02×10^{-7}
2	.69 ± .02	11.55	1.65×10^{-4}	1.14×10^{-7}
3	.52 ± .10	11.51	1.64×10^{-4}	8.54×10^{-8}
Average				1.00×10^{-7}

(a) ASTM E96 does not recommend reporting permeabilities for thicknesses less than 12.7 mm (0.5 in.).
(b) Standard deviation of the thickness of the sample based on 7 measurements. Thickness does not include paper thickness.

Permeability is the permeance multiplied by the sample thickness. Permeability is a property of the material itself. It should be noted that ASTM E96 recommends that permeability not be calculated from measurements of samples less than 12.7 mm (0.5 in.) thick. However, because of the low permeability of the material measurements on samples 12.7 mm (0.5 in.) thick are not possible using the procedure described here.

Flow of Liner at 90°C

A test has been performed to determine if the Lion 705M liner will sag before the grout vault is completely filled. The concern was that high temperatures could occur in the vault and cause the liner above the level of the grout to flow. A 20.3 cm X 10.2 cm sample of the liner was applied to concrete and placed vertically in an oven at 90°C. The liner was applied by pressing liquid 705M onto the concrete with a rigid plate. The edges of the plate were supported by spacers to control the thickness. The top surface of the liner was smooth after application. Variations in thickness along the length of the sample were due to a bow in the surface of the concrete block. Measurements of thickness were taken at 8 equally spaced points on each of three vertical lines on the sample for a total of 24 points per sample.

Thickness was measured by contacting the surface of the liner with a fine penetrometer needle and then pushing through the liner material until the concrete stopped the needle. The liner thickness was measured before and after placement in the oven to detect flow.

No flow was detected in the experiment. Two samples were tested with average initial thicknesses of 0.74 mm and 1.13 mm (29.3 mils, 44.4 mils). The liners showed approximately 10% reduction in average liner thickness. This is similar to the results obtained in previous tests in which shrinkage and an 11% weight loss was observed for 705M when exposed to water vapor at 90°C. No adverse effects of shrinkage on the liner were noted. The thickness measurements of the liner samples are graphically displayed in Figures 2 and 3.

D B-714-001 SUMMARY OF STRUCTURAL VAULT CALCULATIONS

SUMMARY OF STRUCTURAL ANALYSIS

1.0 CRITERIA

1.1 Functional Design Criteria SD-714-001, Rev. 2

Paragraph

2.1.3 Non-reactor nuclear facility per DOE 5480.5, "Safety of Nuclear Facilities."

2.1.9 Vault Structure and Cover shall meet Category I per SDC 4.1, "Standard Architectural-Civil Design Criteria."

1.2 SDC 4.1, "Standard Architectural-Civil Design Criteria"

Paragraph

A.2.a General Design Criteria shall conform to DOE Order 6430.1A.

1.3 DOE Order 6430.1A, "General Design Criteria Manual"

Section

0111-99.0.8 "Concrete structures and structural members for safety class concrete structures shall meet the design and construction requirements of ACI 349."

2.0 BASIS OF DESIGN

2.1 General

The design analysis was based on the criteria established by the WHC letter of instruction and WHC functional design criteria. The maximum loading condition of both criteria was used in the design analysis.

The design of vault during construction does not include seismic and thermal loading. Wind loading was considered as insignificant during construction and produces design loading considerably less than the soil backfill load designed for in the completed structure.

Completed structure design loading includes the following loads:

- Dead loads
- Soil loads
- Surcharge loads
- Earthquake loads
- Thermal loads
- Fluid loads

2.2 Construction Design Loads Sequence

1. Build vault structure on top catch basin structure.

2. Hydrotest vault structure.

3. Backfill to top of vault walls.

4. Install precast prestressed concrete roof panels.

5. Complete backfill over roof.

Combinations of these loads are included in the basis of design.

2.3 Load Combinations

2.3.1 ACI 349-85 Code Requirements for Nuclear Safety Related Concrete Structures

Section
9.2.1 The required strength U shall be at least equal to the greatest of the following.

EQ. 1 $U = 1.4D + 1.4F + 1.7L + 1.7H + 1.7R_o$

EQ. 2 $U = 1.4D + 1.4F + 1.7L + 1.7H + 1.7E_o + 1.7R_o$

EQ. 3 $U = 1.4D + 1.4F + 1.7L + 1.7H + 1.7W + 1.7R_o$

EQ. 4 $U = D + F + L + H + T_o + R_o + E_{ss}$

EQ. 5 $U = D + F + L + H + T_o + R_o + W_t$

EQ. 6 $U = D + F + L + H + T_a + R_a + 1.25P_a$

EQ. 7 $U = D + F + L + H + T_a + R_a + 1.15P_a + 1.0(Y_r + Y_j + Y_m) + 1.15E_o$

EQ. 8 $U = D + F + L + H + T_a + R_a + 1.0P_a + 1.0(Y_r + Y_j + Y_m) + 1.0E_{ss}$

EQ. 9 $U = 1.05D + 1.05F + 1.3L + 1.3H + 1.05T_o + 1.3R_o$

EQ. 10 $U = 1.05D + 1.05F + 1.3L + 1.3H + 1.3E_o + 1.05T_o + 1.3R_o$

EQ. 11 $U = 1.05D + 1.05F + 1.3L + 1.3H + 1.3W + 1.05T_o + 1.3R_o$

Where:

D = Dead loads, or related internal moments and forces, including piping and equipment dead loads.

E_o = Load effects of OBE, or related internal moments and forces, including OBE induced piping and equipment reactions.

E_{ss} = Load effects of SSE, or related internal moments and forces, including SSE induced piping and equipment reactions.

F = Lateral and vertical pressure of liquids or related internal moments and forces.

H = Lateral earth pressure, or related internal moments and forces.

L = Live loads, or related internal moments and forces.

R_a = Piping and equipment reactions, or related internal moments and forces, under thermal conditions generated by a postulated pipe break and including R_o.

R_o = Piping and equipment reactions, or related internal moments and forces, which occur under normal operating and shutdown conditions, excluding dead load and earthquake reactions.

T_a = Internal moments and forces caused by temperature distributions within the concrete structure occurring as a result of accident conditions generated by a postulated pipe break and including T_o.

T_o = Internal moments and forces caused by temperature distributions within the concrete structure occurring as a result of normal operating or shutdown conditions.

U = Required strength to resist factored loads or related internal moments and forces.

W = Operating basis wind load, or related internal moments and forces.

W_t = Loads generated by the DBT, or related internal moments and forces. These include loads due to tornado wind pressure, tornado created differential pressures, and tornado generated missiles.

Y_j = Jet impingement load, or related internal moments and forces, on the structure generated by a postulated pipe break.

Y_m = Missile impact load, or related internal moments and forces, on the structure generated by a postulated pipe break, such as pipe whip.

Y_r = Loads, or related internal moments and forces, on the structure generated by the reaction of the broken pipe during a postulated break.

Review of loads shows that there are no wind loading (W), tornado loading (W_t), or piping and equipment loads (R_o). Equations 6, 7, and 8 do not apply as there is no postulated pipe break requirements. Equation 3 reduces to Equation 1 and Equation 11 reduces to Equation 9.

By inspection EQ. 2 > EQ. 1 and EQ. 10 > EQ. 9.

The controlling equations are EQ. 2, 4, and 10.

2.3.2 Consolidated Letter of Instruction Number 8 Dated March 11, 1988

Paragraph 1.2
"Concrete vaults shall be a box design constructed to ACI water tank standards."

Paragraph 1.9
"Design of the concrete structure shall meet the requirements of SDC 4.1, Reference 11, for Seismic Category I structures."

ACI water tank standards were assumed to mean ACI 350, "Concrete Sanitary Engineering Structures." ACI 350 design load combinations are based on ACI 318 with some modifications to control crack width. These changes were for flexure design; 1) increase the ultimate design moment by a factor of 1.3, and 2) change the load factor for fluids from 1.4 to 1.7.

ACI 318 forms a part of the general building code for live, wind, and earthquake loads (ANSI A53.1, Minimum Design Loads for Buildings and Other Structures). Earthquake loads applied to the following equations were O.B.E. loads developed by ACI 349 required analysis. This loading is considered conservative.

The ultimate strength of a concrete element shall not be less than that given by the following equations from ACI 318 and modified by ACI 350:

EQ. 9-4 $U = 1.4D + 1.7L + 1.7H + 1.4F$
$*U = 1.3(1.4D + 1.7L + 1.7H + 1.7F)$
$*U = 1.82D + 2.21L + 2.21H + 2.21F$

EQ. 9-2 $U = 0.75(1.4D + 1.7L + 1.7H + 1.7F + 1.87E)$
$*U = 1.3(0.75)(1.4D + 1.7L + 1.7H + 1.7F + 1.87E)$
$*U = 1.37D + 1.66L + 1.66H + 1.66F + 1.83E)$

EQ. 9-5 $U = 0.75(1.4D + 1.4T + 1.7L + 1.4H + 1.4F)$
$*U = 1.3(0.75)(1.4D + 1.4T + 1.7L + 1.4H + 1.7F)$
$*U = 1.37D + 1.37T + 1.66L + 1.37H + 2.21F)$

Where *U is the modified load combinations.

By inspection modified Equation 9-4 is the maximum loading condition for the basic design. This loading was used in the vault design, and other loading combinations were compared to those values and the structures final strength resistance values.

2.4 Structural Design Analysis

The preliminary design established the basic structural shape, i.e. wall and foundation thickness and wall taper. Review of this analysis verified that the end walls could be designed as a two way slab with constant thickness. ACI Committee 350 in ACI 350R (ref 3) recommends the use of ref 1 and 2 for rectangular wall panels supported at three or four sides. Ref 2 considers the base of walls as being hinged and therefore was eliminated from consideration. Ref 1 was used for the design of the end walls as the length to height ratio is approximately 1.5 which is less than the recommended maximum value of 2.0 in ACI 350R and considers the base of walls as fixed. The side walls are designed as cantilevered walls and the horizontal reinforcement at the corners were based on the end wall moments.

This approach was confirmed by a review of an article (ref 4) in the ACI Journal which covered long walls with length to height ratios of 4 to 5 and uniform thickness along with walls in which the thickness varied. Review of a typical analysis, using ref 1 with a constant end wall thickness and the base of the wall as fixed, and ref 4 with a tapered side wall thickness and the base of the wall fixed produced almost the same horizontal end wall moments. The structure was designed to meet all criteria of equation 9-4 from ACI 318 as modified by ACI 350R and discussed in the Basis of Design, paragraph 2.3.2.

The results of the seismic and thermal moments were evaluated by including the maximum values in the applicable equations listed in the basis of design and verifying that the results were less than the basic structure design.

A three dimensional finite element linear analysis was performed for the final design of the vault. Preliminary structural analyses by KEH arrived at the design forces for hydrostatic testing, dead loads, soil backfill, soil overburden, and design forces due to potential earthquakes (see appendix E). WHC performed a finite element heat transfer analysis to obtain thermal gradients due to the heat of hydration from the grout slurry and the changing volume of grout inside a vault during the filling operation. Design moments and shears were determined by WHC using the finite element linear analysis (see appendix F). KEH then combined all forces as previously described in Section 2.3 to arrive at the final wall thicknesses and reinforcing steel required by the governing criteria.

The long walls of the vault are tapered from 54 inches thick at the base to 24 inches thick at the top. Preliminary design analyses, excluding the thermal gradients, resulted in No. 7, 8, and 9 steel reinforcing bars being required for the applied loads. When the loads due to thermal gradients were added, the amount of reinforcing steel required doubles. The long walls are reinforced on both faces with vertical No. 11 steel reinforcing bars at 4 inches on center and with horizontal No. 10 bars at 4 inches on center. The end walls are 30 inches thick and are reinforced with vertical and horizontal No. 10 bars at 4 inches centers on each face. The thermal gradients created high shear stresses in the vault walls, and shear reinforcing as required by ACI 349 is included in all walls. The foundation slab is 54 inches thick and reinforced with No. 10 and No. 11 bars top and bottom at the edges and No. 7 and No. 9 bars in the center. Steel shear steel is also in the foundation slab where required. The roof planks are 26 inches thick precast-prestressed concrete panels, 4 feet wide spanning between the long walls. A concrete topping will be poured over the planks.

References:

1. Moody, W. T., "Moments and Reactions for Rectangular Plates," Engineering Monograph No. 27, U. S. Bureau of Reclamation, Denver, 1960 (Revised 1963).

2. "Rectangular Concrete Tanks," Information Sheet No. IS 003.03D, Portland Cement Association, Skokie, 1969.

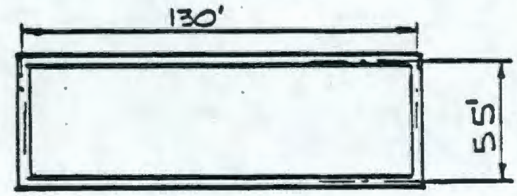
3. ACI 350R-83, "Concrete Sanitary Engineering Structures," by ACI Committee 350, American Concrete Institute, Detroit, 1983.

4. "Design of Rectangular Concrete Tank Walls," by Jan C. Jofriet, ACI Journal, July 1975, p. 329, American Concrete Institute, Detroit.

5. "Handbook of Concrete Engineering," Edited by Mark Fintel Chapter 18, Sanitary Structures - Tanks and Reservoirs by John F. Seidensticker.

APPENDIX A.

SUBJECT: STRUCTURAL ANALYSIS - B-714 GROUT VAULT February 7, 1989



PLAN

LONG WALL
THICKNESS VARIES

END WALL
THICKNESS CONSTANT

ELEV A-A
LONG WALL

ELEV B-B
END WALL

REF 1. MOODY, MOMENTS & REACTIONS FOR RECTANGULAR PLATES, ENGR MONOGRAPH NO.27
U.S. BUREAU OF RECLAMATION

REF 2. DESIGN OF RECTANGULAR CONCRETE TANK WALLS, ACI JOURNAL, JULY 1975

EVALUATE END WALLS PER REF 1. FOR SOIL, HYDRO & SEISMIC LOADS

$\frac{a}{b} = \frac{27\text{-}1/2}{34} = 0.809$ USE 3/4

EVALUATE LONG WALLS PER REF 2. FOR SOIL, HYDRO & SEISMIC LOADS

$\frac{b}{a} = \frac{130}{34} = 3.82$ USE 4.0

RESULTS OF THE REVIEW OF FIGURES 1.A THROUGH 6.B SHOWS:

* THE MAXIMUM MOMENT PRODUCED WAS FOR 3 SIDES FIXED AND THE TOP FREE FOR ALL CASES. i.e. MOMENTS FROM FIG 1.B > FIG 1.A

* THE MOMENT IN THE LONG WALL AT THE FOUNDATION APPROACHES THE MOMENT OF A CANTILEVER WALL.

* THE HORIZONTAL MOMENTS IN THE TAPERED WALL APPROACH THE HORIZONTAL MOMENT IN THE END WALL. OUR WALL TAPER OF 2-1/4 : 1 IS GREATER THAN THE 1-1/2 : 1 USED IN FIGURE 2.B AND THE MOMENT IN THE LONG WALL WILL APPROACH THAT OF THE END WALL.

CONCLUSIONS:

* DESIGN LONG WALLS AS CANTILEVER WALLS.
* DESIGN HORIZONTAL MOMENTS OF THE LONG WALLS AS A PERCENT OF THE FIXED BASE MOMENT DEVELOPED FROM FIGURE 2.B
* DESIGN END WALLS USING THE THREE DIMENSIONAL ANALYSIS OF REF 1.
* DISTRIBUTE SEISMIC LOADS FROM 2 DIMENSIONAL ANALYSIS USING FACTORS DEVELOPED FROM FIGURES 5.A & 6.A.

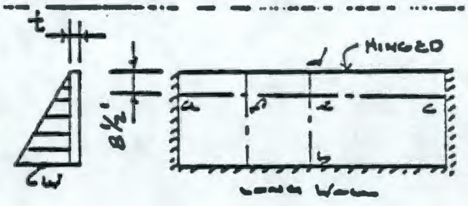
SEE ATTACHED PAGES 3 & 4 FOR FIGURES 1.A THROUGH 6.B

KAISER ENGINEERS
HANFORD

SKETCH

Attachment To Or Description:

STRUCTURAL ANALYSIS - B-714 GROUT VAULT



MAX HORIZ MOMENTS

$M_a = -.035(34)^2 w = -40.5 w$

$M_e = .006(34)^2 w = 6.9 w$

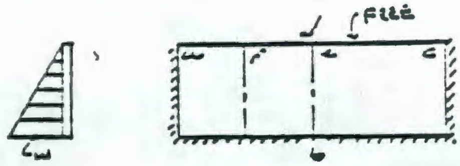
$M_f = .008(34)^2 w = 9.3 w$

MAX VERT MOMENTS

$M_b = -.065(34)^2 w = -75.1 w$

$M_d = 0$

FIGURE 1.A



MAX HORIZ MOMENTS

$M_a = -.102(34)^2 w = -117.9 w$

$M_e = .014(34)^2 w = 16.2 w$

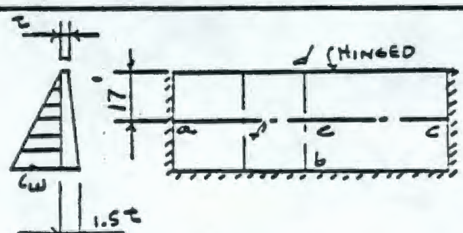
$M_f = .017(34)^2 w = 19.7 w$

MAX VERT MOMENTS

$M_b = -.148(34)^2 w = -171.1 w$

$M_d = 0$

FIGURE 1.B



MAX HORIZ MOMENTS

$M_a = -.030(34)^2 w = -34.7 w$

$M_e = .005(34)^2 w = 5.8 w$

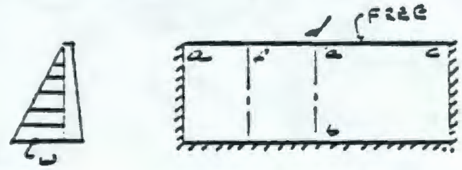
$M_f = .007(34)^2 w = 8.1 w$

MAX VERT MOMENTS

$M_b = -.076(34)^2 w = -87.9 w$

$M_d = 0$

FIGURE 2.A



MAX HORIZ MOMENTS

$M_a = -.050(34)^2 w = -57.8 w$

$M_e = .004(34)^2 w = 4.6 w$

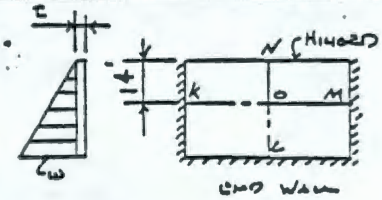
$M_f = .008(34)^2 w = 9.3 w$

MAX VERT MOMENTS

$M_b = -.159(34)^2 w = -183.8 w$

$M_d = 0$

FIGURE 2.B



MAX HORIZ MOMENTS

$M_k = -.0301(34)^2 w = -34.8 w$

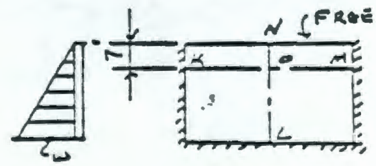
$M_o = .0119(34)^2 w = 13.8 w$

MAX VERT MOMENTS

$M_L = -.0505(34)^2 w = -58.4 w$

$M_N = 0$

FIGURE 3.A



MAX HORIZ MOMENTS

$M_K = -.0433(34)^2 w = -50.1 w$

$M_o = .0214(34)^2 w = 24.7 w$

MAX VERT MOMENTS

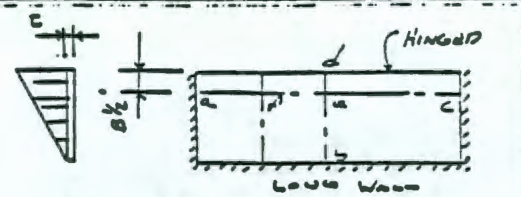
$M_L = -.0584(34)^2 w = -67.5 w$

$M_N = 0$

FIGURE 3.B

KAISER ENGINEERS HANFORD — SKETCH

Attachment To Or Description: STRUCTURAL ANALYSIS - B-714 GROUT VAULT



MAX HORIZ MOMENTS

$M_a = (-.064 + .024)(34)^2 w = -46.2w$

$M_e = (.013 - .005)(34)^2 w = 9.3w$

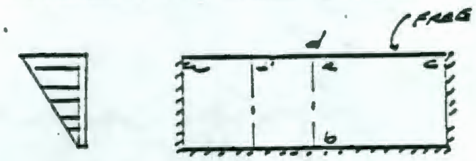
$M_f = (.016 - .006)(34)^2 w = 11.6w$

MAX VERT MOMENTS

$M_b = (-.123 + .065)(34)^2 w = -67.1w$

$M_d = 0$

FIGURE 4.A



MAX HORIZ MOMENTS

$M_a = (-.419 + .102)(34)^2 w = -366.5w$

$M_e = (.052 - .014)(34)^2 w = 43.9w$

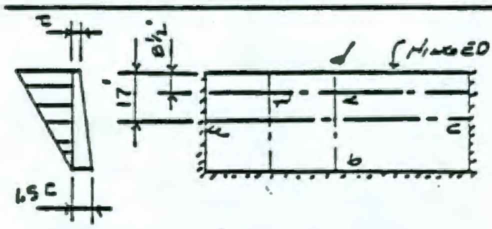
$M_f = (.060 - .017)(34)^2 w = 49.7w$

MAX VERT MOMENTS

$M_b = (-.431 + .148)(34)^2 w = -327.2w$

$M_d = 0$

FIGURE 4.B



MAX HORIZ MOMENTS

$M_a = (-.066 + .030)(34)^2 w = -41.6w$

$M_e = (.012 - .004)(34)^2 w = 9.3w$

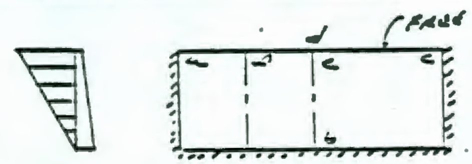
$M_f = (.014 - .005)(34)^2 w = 10.4w$

MAX VERT MOMENTS

$M_b = (-.148 + .076)(34)^2 w = -83.2w$

$M_d = 0$

FIGURE 5.A



MAX HORIZ MOMENTS

$M_a = (-.215 + .050)(34)^2 w = -194.2w$

$M_e = (.017 - .004)(34)^2 w = 15.0w$

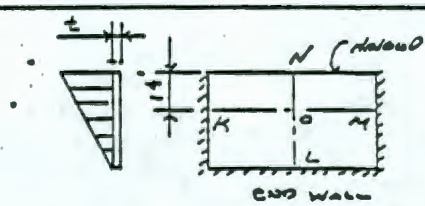
$M_f = (.030 - .008)(34)^2 w = 25.4w$

MAX VERT MOMENTS

$M_b = (-.469 + .159)(34)^2 w = -358.4w$

$M_d = 0$

FIGURE 5.B



MAX HORIZ MOMENTS

$M_K = (-.0695 + .0301)(34)^2 w = -45.5w$

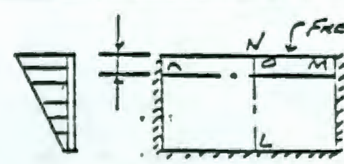
$M_O = (.0274 - .0119)(34)^2 w = 17.9w$

MAX VERT MOMENTS

$M_L = (-.0848 + .0505)(34)^2 w = -45.4w$

$M_N = 0$

FIGURE 6.A



MAX HORIZ MOMENTS

$M_K = (-.1783 + .0406)(34)^2 w = -159.3w$

$M_O = (.0507 - .0214)(34)^2 w = 63.7w$

MAX VERT MOMENTS

$M_L = (-.1212 + .0584)(34)^2 w = -72.6w$

$M_N = 0$

FIGURE 6.B

Design of Rectangular Concrete Tank Walls

By JAN C. JOFRIET*

The paper provides moment coefficients for the design of rectangular concrete tank walls. The range of length-to-height ratios has been extended beyond three, the limiting ratio provided in earlier work. Moment coefficients for sloping walls are presented. The thickness at the bottom of the wall is assumed 1.5 times that at the top. Hydrostatic and uniformly distributed loading over the full height of the wall have been considered. The walls are assumed fixed along the bottom and sides; simply supported and free boundaries have been considered along the top of the wall.

The results indicate that horizontal moments at the edge of long walls may be considerably greater than those with a length-to-height ratio of three. Sloping walls will lead to greater vertical moments at the bottom of a wall and to smaller horizontal moments at the edge.

Keywords: hydraulic structures; moments; rectangular tanks; reinforced concrete; structural design; tanks (containers); walls.

THE STRUCTURAL DESIGN of walls of rectangular concrete tanks and reservoirs is difficult due to uncertain constraints along the boundaries of the walls, the two way interaction with adjacent walls and foundations and due to the nature of the loading.

Reference 1 contains moment coefficients for slabs subjected to full and partial uniformly distributed loads, to full and partial triangular hydrostatic loads and to a uniform moment or shear force applied at the top of the wall. Five combinations of edge constraints have been considered. The ratio of length to height of wall vary from 3 to 0.25.

Reference 2 provides some additional boundary cases for full hydrostatic load only. It also contains moment coefficients for walls of covered and open rectangular tanks taking into account the rotation that takes place at intersections of walls of unequal length. Walls are considered hinged at the base. The moment coefficients in both References 1 and 2 are based on walls of constant thickness.

ACI Committee 350[3] has recommended the use of References 1 and 2 for the structural design of rectangular wall panels supported at three or four sides except for those having a length-to-height ratio greater than two. There is no recommendation for the structural design of walls with a length-to-height ratio greater than two. Such ratios, however, commonly occur in settling and aeration tanks and in water reservoirs.

It has been the writer's practice to design long walls as cantilever walls and to provide horizontal steel at the wall junction using moment coefficients based on a length-to-height ratio of three, the largest ratio available in References 1 and 2.

It is the objective of this paper to examine:

1. the influence on the bending moments of nonuniform wall thickness, namely a thickness at the base 1.5 times that at the top
2. the influence on the horizontal edge moments in walls of length-to-height ratios greater than three.

MOMENT COEFFICIENTS

The moment coefficients that are presented herein were obtained using the finite element method of analysis. The analysis is based on thin plate theory and makes use of the refined Clough-Felippa bending element.[4] The wall material is assumed to be isotropic and linear elastic with a Poisson's ratio of 0.2. Variable thickness elements can be accommodated in the computer program for this finite element analysis.

Moment coefficients are presented for two cases of wall constraints. In one case the top is free, in the other simply supported (hinged). In both cases the sides and bottom of the wall are fully fixed. Two cases of loading are considered, hydrostatic loading over the full height of the wall and uniformly distributed over the full height of the wall. For each of the above combinations of geometry and loading two wall cross sections have been analyzed, namely constant thickness and a thickness that varies from top to bottom. The thickness at the bottom of the wall was assumed to be 1.5 times that at the top.

The moment coefficients are presented in Tables 1 to 4 inclusive for constant thickness walls and in Tables 5 to 8 inclusive for variable thickness walls. The tables are identical in arrangement to those in Reference 2 and require little explanation. Moments have been subscripted as is common in design i.e.. M_x is a bending moment causing bending stresses in the x direction. Vertical bending moments M_y along the sides and horizontal moments M_x along the bottom have not been shown since they are rather meaningless. Moments that cause compression on the loaded face of wall are called positive moment

DISCUSSION OF RESULTS

The following observations can be made from an examination of the moment coefficients presented in Tables 1 to 8:

1. The moment coefficients in Tables 1 to 4 agree well with those in References 1 and 2 with the exception of the horizontal moments at the wall panel edge for large length-to-height ratios. The present results are consistently larger. For the length-to-height ratio of three the maximum negative horizontal moment M_x is 43 percent greater in Table 1, 17 percent in Table 2, 51 percent in Table 3, and 9 percent in Table 4.

2. As might be expected, the nonuniform thickness causes increases in the negative vertical moments along the base of the wall and a decrease in the negative horizontal moments along the edge. The increase in vertical negative moment is generally about 20 percent for the thickness variation selected

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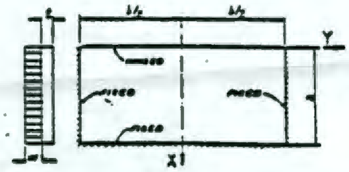
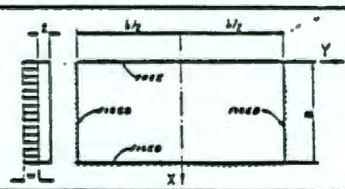
Received by the Institute June 5, 1974.

TABLE 1—MOMENT = COEFFICIENT × Wa^2



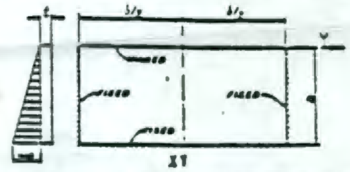
$\frac{b}{a}$	$\frac{x}{a}$	$y = 0$ M_x	$y = 0$ M_y	$y = b/4$ M_x	$y = b/4$ M_y	$y = b/2$ M_y
4.0	0	0	—	0	—	—
	1/4	0.063	0.013	0.058	0.016	−0.064
	3/8	0.071	0.014	0.066	0.018	−0.076
	1/2	0.064	0.013	0.060	0.016	−0.074
	3/4	0.002	0	0.003	0.003	−0.038
	1	−0.123	—	−0.117	—	—
3.0	0	0	—	0	—	—
	1/4	0.062	0.014	0.052	0.017	−0.064
	3/8	0.070	0.016	0.059	0.020	−0.076
	1/2	0.063	0.014	0.053	0.019	−0.074
	3/4	0.002	0.001	0.005	0.005	−0.038
	1	−0.122	—	−0.107	—	—
2.0	0	0	—	0	—	—
	1/4	0.054	0.018	0.038	0.018	−0.063
	3/8	0.061	0.022	0.041	0.021	−0.075
	1/2	0.056	0.020	0.039	0.020	−0.074
	3/4	0.005	0.005	0.006	0.007	−0.038
	1	−0.112	—	−0.082	—	—
1.5	0	0	—	0	—	—
	1/4	0.041	0.022	0.027	0.015	−0.061
	3/8	0.046	0.026	0.029	0.018	−0.072
	1/2	0.043	0.026	0.027	0.018	−0.071
	3/4	0.008	0.010	0.006	0.008	−0.037
	1	−0.091	—	−0.061	—	—
1.0	0	0	—	0	—	—
	1/4	0.020	0.021	0.012	0.010	−0.047
	3/8	0.022	0.026	0.012	0.012	−0.056
	1/2	0.021	0.026	0.011	0.011	−0.055
	3/4	0.009	0.013	0.005	0.006	−0.032
	1	−0.051	—	−0.032	—	—

TABLE 2—MOMENT = COEFFICIENT × Wa^2



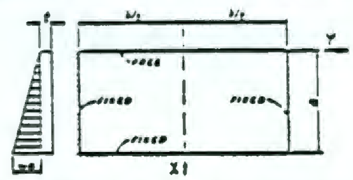
$\frac{b}{a}$	$\frac{x}{a}$	$y = 0$ M_x	$y = 0$ M_y	$y = b/4$ M_x	$y = b/4$ M_y	$y = b/2$ M_y
5.0	0	0	0.027	0	0.054	−0.426
	1/4	−0.015	0.015	0	0.039	−0.284
	1/2	−0.097	−0.010	−0.058	0.011	−0.153
	3/4	−0.248	−0.047	−0.100	0.029	−0.046
	1	−0.460	—	−0.379	—	—
4.0	0		0.052	0	0.060	−0.419
	1/4	−0.002	0.036	0.006	0.046	−0.280
	1/2	−0.070	0.004	−0.038	0.018	−0.152
	3/4	−0.211	−0.037	−0.140	−0.019	−0.046
	1	−0.431	—	−0.319	—	—
3.0	0	0	0.086	0	0.058	−0.387
	1/4	0.017	0.064	0.011	0.045	−0.265
	1/2	−0.028	0.028	−0.015	0.023	−0.174
	3/4	−0.144	−0.019	−0.088	−0.009	−0.047
	1	−0.348	—	−0.233	—	—
2.0	0	0	0.099	0	0.041	−0.280
	1/4	0.027	0.080	0.012	0.034	−0.206
	1/2	0.015	0.047	0.008	0.021	−0.127
	3/4	−0.051	0.005	−0.029	0.002	−0.046
	1	−0.202	—	−0.124	—	—
1.5	0	0	0.080	0	0.027	−0.185
	1/4	0.021	0.067	0.009	0.023	−0.148
	1/2	0.022	0.045	0.011	0.017	−0.102
	3/4	−0.012	0.013	−0.006	0.005	−0.042
	1	−0.120	—	−0.073	—	—
1.0	0	0	0.044	0	0.012	−0.088
	1/4	0.010	0.040	0.003	0.012	−0.078
	1/2	0.014	0.031	0.007	0.011	−0.063
	3/4	0.006	0.014	0.004	0.006	−0.033
	1	−0.053	—	−0.032	—	—

TABLE 3—MOMENT = COEFFICIENT × Wa^3



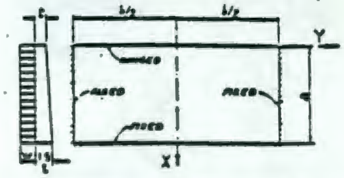
$\frac{b}{a}$	$\frac{x}{a}$	$y = 0$ M_x	$y = 0$ M_y	$y = b/4$ M_x	$y = b/4$ M_y	$y = b/2$ M_y
4.0	0	0	—	0	—	—
	1/4	0.023	0.005	0.021	0.005	−0.024
	1/2	0.030	0.006	0.028	0.003	−0.035
	3/4	0.006	0.001	0.006	0.002	−0.022
	1	−0.065	—	−0.063	—	—
3.0	0	0	—	0	—	—
	1/4	0.022	0.005	0.018	0.007	−0.024
	1/2	0.030	0.007	0.025	0.009	−0.035
	3/4	0.006	0.001	0.007	0.003	−0.022
	1	−0.065	—	−0.058	—	—
2.0	0	0	—	0	—	—
	1/4	0.019	0.007	0.013	0.007	−0.024
	1/2	0.025	0.009	0.019	0.009	−0.035
	3/4	0.007	0.003	0.007	0.005	−0.022
	1	−0.060	—	−0.047	—	—
1.5	0	0	—	0	—	—
	1/4	0.013	0.009	0.008	0.005	−0.023
	1/2	0.021	0.012	0.013	0.008	−0.034
	3/4	0.008	0.006	0.007	0.005	−0.022
	1	−0.051	—	−0.036	—	—
1.0	0	0	—	0	—	—
	1/4	0.005	0.008	0.003	0.003	−0.017
	1/2	0.010	0.012	0.006	0.005	−0.027
	3/4	0.008	0.007	0.005	0.004	−0.020
	1	−0.032	—	−0.021	—	—

TABLE 4—MOMENT = COEFFICIENT × Wa^3



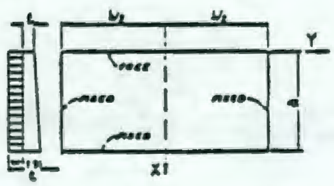
$\frac{b}{a}$	$\frac{x}{a}$	$y = 0$ M_x	$y = 0$ M_y	$y = b/4$ M_x	$y = b/4$ M_y	$y = b/2$ M_y
5.0	0	0	0.007	0	0.015	−0.104
	1/4	0.002	0.005	0.006	0.012	−0.081
	1/2	−0.013	0	−0.003	0.008	−0.055
	3/4	−0.001	−0.012	−0.043	−0.006	−0.024
	1	−0.158	—	−0.134	—	—
4.0	0	0	0.014	0	0.017	−0.102
	1/4	0.005	0.011	0.007	0.014	−0.080
	1/2	−0.006	0.004	0.002	0.008	−0.055
	3/4	−0.052	−0.009	−0.032	−0.004	−0.024
	1	−0.148	—	−0.117	—	—
3.0	0	0	0.024	0	0.015	−0.093
	1/4	0.010	0.019	0.007	0.014	−0.075
	1/2	0.005	0.010	0.007	0.010	−0.054
	3/4	−0.033	−0.004	−0.018	0	−0.025
	1	−0.126	—	−0.092	—	—
2.0	0	0	0.027	0	0.010	−0.064
	1/4	0.012	0.024	0.008	0.010	−0.060
	1/2	0.016	0.017	0.011	0.010	−0.048
	3/4	−0.007	0.003	−0.002	0.003	−0.024
	1	−0.084	—	−0.058	—	—
1.5	0	0	0.021	0	0.008	−0.039
	1/4	0.009	0.020	0.004	0.007	−0.044
	1/2	0.015	0.017	0.009	0.008	−0.041
	3/4	0.003	0.006	0.004	0.004	−0.023
	1	−0.058	—	−0.039	—	—
1.0	0	0	0.010	0	0.002	−0.014
	1/4	0.003	0.012	0.001	0.003	−0.023
	1/2	0.009	0.013	0.005	0.005	−0.023
	3/4	0.008	0.008	0.005	0.004	−0.020
	1	−0.032	—	−0.021	—	—

TABLE 5—MOMENT = COEFFICIENT × Wa^2



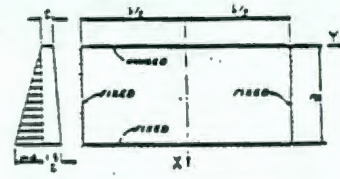
b/a	x/a	y = 0		y = b/4		y = b/2
		M_x	M_y	M_x	M_y	M_y
4.0	0	0	—	0	—	—
	1/4	0.057	0.012	0.054	0.014	-0.048
	3/8	0.062	0.013	0.058	0.016	-0.063
	1/2	0.052	0.010	0.049	0.014	-0.066
	3/4	-0.017	-0.003	-0.014	0	-0.037
	1	-0.148	—	-0.141	—	—
3.0	0	0	—	0	—	—
	1/4	0.057	0.012	0.049	0.015	-0.051
	3/8	0.062	0.014	0.053	0.018	-0.066
	1/2	0.051	0.012	0.044	0.017	-0.069
	3/4	-0.016	-0.003	-0.011	0.003	-0.039
	1	-0.147	—	-0.130	—	—
2.0	0	0	—	0	—	—
	1/4	0.052	0.016	0.038	0.016	-0.053
	3/8	0.056	0.019	0.039	0.019	-0.068
	1/2	0.047	0.018	0.033	0.019	-0.072
	3/4	-0.012	0.002	-0.006	0.006	-0.041
	1	-0.137	—	-0.101	—	—
1.5	0	0	—	0	—	—
	1/4	0.041	0.019	0.027	0.014	-0.053
	3/8	0.044	0.024	0.028	0.017	-0.068
	1/2	0.037	0.024	0.023	0.016	-0.071
	3/4	-0.008	0.008	-0.003	0.007	-0.041
	1	-0.113	—	-0.075	—	—
1.0	0	0	—	0	—	—
	1/4	0.022	0.019	0.013	0.010	-0.042
	3/8	0.022	0.024	0.012	0.011	-0.054
	1/2	0.018	0.025	0.010	0.010	-0.056
	3/4	0.002	0.013	0.001	0.006	-0.035
	1	-0.063	—	-0.039	—	—

TABLE 6—MOMENT = COEFFICIENT × Wa^2



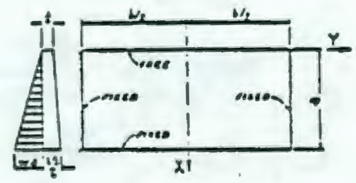
b/a	x/a	y = 0		y = b/4		y = b/2
		M_x	M_y	M_x	M_y	M_y
4.0	0	0	0.017	0	0.030	-0.218
	1/4	-0.019	0.013	-0.007	0.029	-0.197
	1/2	-0.100	-0.009	-0.063	0.010	-0.139
	3/4	-0.248	-0.046	-0.176	-0.026	-0.051
	1	-0.469	—	-0.365	—	—
3.0	0	0	0.036	0	0.033	-0.217
	1/4	-0.006	0.034	-0.001	0.033	-0.199
	1/2	-0.068	0.011	-0.040	0.017	-0.142
	3/4	-0.196	-0.030	-0.128	-0.014	-0.054
	1	-0.409	—	-0.284	—	—
2.0	0	0	0.055	0	0.027	-0.182
	1/4	0.011	0.058	0.004	0.026	-0.175
	1/2	-0.017	0.038	-0.011	0.019	-0.131
	3/4	-0.095	-0.002	-0.057	-0.002	-0.053
	1	-0.263	—	-0.163	—	—
1.5	0	0	0.051	0	0.019	-0.134
	1/4	0.013	0.055	0.004	0.020	-0.136
	1/2	0.003	0.042	0	0.016	-0.108
	3/4	-0.039	0.010	-0.023	0.003	-0.049
	1	-0.159	—	-0.095	—	—
1.0	0	0	0.032	0	0.010	-0.070
	1/4	0.009	0.036	0.002	0.011	-0.074
	1/2	0.009	0.032	0.003	0.011	-0.063
	3/4	-0.002	0.015	-0.002	0.005	-0.036
	1	-0.067	—	-0.040	—	—

TABLE 7—MOMENT = COEFFICIENT × Wa^3



b/a	x/a	y = 0		y = b/4		y = b/2
		M_x	M_y	M_x	M_y	M_y
4.0	0	0	—	0	—	—
	1/4	0.020	0.004	0.019	0.005	-0.017
	1/2	0.025	0.005	0.022	0.007	-0.020
	3/4	-0.002	0	-0.001	0	-0.021
	1	-0.076	—	-0.074	—	—
3.0	0	0	—	0	—	—
	1/4	0.020	0.004	0.017	0.006	-0.018
	1/2	0.025	0.005	0.021	0.008	-0.031
	3/4	-0.002	0	0	0.002	-0.022
	1	-0.076	—	-0.068	—	—
2.0	0	0	—	0	—	—
	1/4	0.018	0.006	0.012	0.008	-0.019
	1/2	0.023	0.008	0.018	0.009	-0.032
	3/4	0	0.002	0.002	0.004	-0.022
	1	-0.072	—	-0.055	—	—
1.5	0	0	—	0	—	—
	1/4	0.014	0.007	0.009	0.005	-0.019
	1/2	0.019	0.011	0.012	0.008	-0.032
	3/4	0.002	0.005	0.003	0.004	-0.024
	1	-0.061	—	-0.043	—	—
1.0	0	0	—	0	—	—
	1/4	0.008	0.007	0.003	0.003	-0.014
	1/2	0.010	0.012	0.005	0.005	-0.025
	3/4	0.005	0.007	0.003	0.004	-0.021
	1	-0.038	—	-0.025	—	—

TABLE 8—MOMENT = COEFFICIENT × Wa^3



b/a	x/a	y = 0		y = b/4		y = b/2
		M_x	M_y	M_x	M_y	M_y
4.0	0	0	0.004	0	0.008	-0.030
	1/4	0.001	0.004	0.003	0.009	-0.034
	1/2	-0.014	0	-0.005	0.005	-0.048
	3/4	-0.062	-0.011	-0.042	-0.006	-0.024
	1	-0.159	—	-0.131	—	—
3.0	0	0	0.010	0	0.008	-0.049
	1/4	0.004	0.010	0.004	0.010	-0.053
	1/2	-0.006	0.005	0	0.008	-0.049
	3/4	-0.048	-0.007	-0.029	-0.002	-0.025
	1	-0.143	—	-0.107	—	—
2.0	0	0	0.015	0	0.006	-0.040
	1/4	-0.008	0.017	0.004	0.008	-0.048
	1/2	0.007	0.013	0.006	0.008	-0.047
	3/4	-0.021	0.001	-0.011	0.002	-0.028
	1	-0.103	—	-0.071	—	—
1.5	0	0	0.013	0	0.004	[illegible]
	1/4	0.007	0.016	0.003	0.006	[illegible]
	1/2	0.011	0.013	0.007	0.007	[illegible]
	3/4	-0.005	0.005	-0.002	0.003	[illegible]
	1	-0.072	—	-0.048	—	—
1.0	0	0	0.007	0	0.002	-0.011
	1/4	0.004	0.010	0.001	0.003	-0.020
	1/2	0.008	0.013	0.004	0.005	-0.028
	3/4	0.004	0.008	0.003	0.004	-0.021
	1	-0.039	—	-0.025	—	—

herein. The decrease in horizontal negative moments varies widely.

3. As the ratio of length to height increases the vertical moments at the center of the wall approach those of a cantilever slab and the horizontal negative moments at the edge of the wall panel remain constant beyond a certain length-to-height ratio.

For the wall panels that are hinged along the top this length-to-height ratio is about two. For the wall panels that are free along the top, however, this length-to-height ratio is about four where the wall thickness is constant and three where it varies as assumed herein.

CONCLUSIONS

Moment coefficients for the structural design of walls of hydraulic structures have been presented. The present results consider the influence on bending moments in walls of nonuniform thickness. In addition, the design of wall panels with a length-to-height ratio of greater than three has been considered.

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2. "Rectangular Concrete Tanks," *Information Sheet* No. IS 003.02D, Portland Cement Association, Skokie, 1969, 16 pp.

3. ACI Committee 350, "Concrete Sanitary Engineering Structures," ACI JOURNAL, *Proceedings* V. 68, No. 8, Aug. 1971, pp. 560-577.

4. Clough, Ray W., and Felippa, Carlos A., "A Refined Quadrilateral Element for Analysis of Plate Bending," *Proceedings*, Second Conference on Matrix Methods in Structural Mechanics (Wright-Patterson Air Force Base, 1968), Air Force Flight Dynamics Laboratory, Wright-Patterson Air Force Base, Ohio, 1969, pp. 399-440.

Support Conditions Dictate Structural System

By DAVID E. AUSTIN*

A HEAVY ROOF LOAD was one of three reasons why cast-in-place concrete was selected for the structural system of a Colorado corporate headquarters building. It is one of several in the Inverness development, 12 miles south of downtown Denver.

The owner asked for 2 ft of soil on the roof as insulation to conserve energy during heating and cooling of the building. Also, because a high-rise motel is planned nearby, it was felt that guests would prefer looking down on a grass roof rather than a normal builtup roof.

Another reason why concrete was chosen for the structural system is the building's somewhat irregular plan due to special owner needs. This dictated irregular column locations, although a basic 20 ft square grid was used. Several curved and straight concrete bearing walls also support the second floor and roof structure.

A third reason for using the flat plate structural system was the desire of owner and architect alike to have exposed concrete surfaces for interior and exterior walls and ceiling. Concrete was cast against a rough-sawn pine board form. When rough board forming was in place for the bottom of slabs, workmen who walked on the forms did so carefully, to prevent damage which would show on the finished ceiling.

The building is founded on straight shaft caissons drilled through clay overburden into claystone bedrock. The caisson foundation system was chosen because of the relatively heavy column loads and due to the expansive nature of the clays on the site.

The upper level structural floor is an 8 in. thick flat plate, designed to carry a live load of 50 psf plus an allowance of 20 psf for partitions.

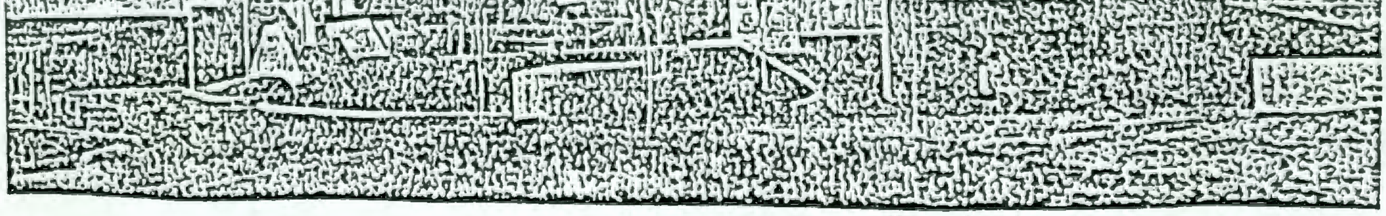
The roof construction is a flat plate with minimum thickness of 14 in. at interior roof drains and a maximum of 17 in. at the building perimeter, so as to provide drainage below the soil. The roof slab was designed to support a superimposed load of 300 psf, which includes 2 ft of saturated earth, 30 lb of snow live load, and allowance for electrical and mechanical loading. Slab thickness also was dictated by shear requirements at the columns and the desire to avoid use of shearhead reinforcing.

Cast-in-place concrete walls have nominal thickness of 10 in. and 12 in., the actual thickness varying due to the rough nature of the board formwork. All cast-in-place concrete was specified for a minimum 28 day strength of 3000 psi. Some 2500 cu yd of concrete was used; 1700 cu yd were pumped and the remaining 800 cu yd were placed with crane and bucket.

Credits

Architect: Cabell Childress Associates, Denver. Concrete supplier: Walt Flanagan & Co., Inc. General contractor: Al Cohen Construction Co., Denver. Owner: Gary Operating Co. Structural engineer: KKBNA, Denver.

*Principal, Ketchum, Konkel, Barrett, Nickel, Austin, Inc., consulting engineers, Denver, Colo.



VERTICAL MOMENTS - LONG WALL

NODE	D	L	H	F	ESS	EO	TO	RESISTING OUTSIDE MU	RESISTING INSIDE MU
2	0.1	0.3	0.0	0.0	0.0	0.0	35.3	62.3	-78.8
11	13.4	16.5	54.1	-61.0	92.5	13.5	93.2	428.1	-138.7
19	40.2	50.0	277.1	-411.6	333.3	66.7	178.7	881.0	-948.7

EQ 9-4 *U = 1.82 D +2.21 L + 2.21 H

NODE	*U
2	0.8
11	189.5
19	796.1

EQ 9-4 *U = 1.82 D +2.21 F

NODE	*U
2	0.2
11	-101.3
19	-836.5

EQ 9-2 *U = 1.37 D +1.66 L +1.66 H +1.83 EO

NODE	*U
2	0.6
11	176.3
19	720.1

EQ 9-2 *U = 1.37 D +1.66 L +1.66 H -1.83 EO

NODE	*U
2	0.6
11	108.5
19	476.0

EQ 9-2 *U = 1.37 D +1.66F

NODE	*U
2	0.1
11	-76.1
19	-628.2

EQ 9-5 *U = 1.37 D + 1.37 TO + 1.66 L +1.37 H

NODE	*U
2	49.0
11	254.4
19	762.5

VERTICAL MOMENTS - LONG WALL

EQ 9-3 *U = 1.37 D + 1.66 F

NODE	*U
2	0.1
11	-76.1
19	-628.2

EQ 2 U = 1.4 D + 1.7 L + 1.7 H

NODE	U
2	0.6
11	145.8
19	612.4

EQ 2 U = 1.4 D + 1.4 F

NODE	U
2	0.1
11	-59.6
19	-520.0

EQ 4 U = D + L + H + TO + ESS

NODE	U
2	35.7
11	274.7
19	879.3

EQ 4 U = D + L + H + TO - ESS

NODE	U
2	35.7
11	89.7
19	212.7

EQ 10 U = 1.05 D + 1.3 L + 1.3 H + 1.3 EO +1.05 TO

NODE	U
2	37.6
11	236.7
19	755.1

VERTICAL MOMENTS - SHORT WALL

NODE	D	L	H	F	ESS	EQ	TO	RESISTING OUTSIDE MU	RESISTING INSIDE MU
2	0.0	0.0	0.0	0.0	0.0	0.0	55.2	140.8	-78.8
11	0.0	-2.0	-37.7	47.8	21.3	4.3	55.2	140.8	-78.8
19	0.0	8.6	79.1	-108.9	131.4	26.3	55.2	210.5	-260.3

EQ 9-4 *U = 1.82 D +2.21 L + 2.21 H

NODE	*U
2	0.0
11	-87.7
19	193.8

EQ 9-4 *U = 1.82 D +2.21 F

NODE	*U
2	0.0
11	105.6
19	-240.7

EQ 9-2 *U = 1.37 D +1.66 L +1.66 H +1.83 EQ

NODE	*U
2	0.0
11	-58.0
19	193.7

EQ 9-2 *U = 1.37 D +1.66 L +1.66 H -1.83 EQ

NODE	*U
2	0.0
11	-73.8
19	97.5

EQ 9-2 *U = 1.37 D +1.66F

NODE	*U
2	0.0
11	79.3
19	-180.8

EQ 9-5 *U = 1.37 D + 1.37 TO + 1.66 L +1.37 H

NODE	*U
2	75.6
11	20.7
19	198.3

VERTICAL MOMENTS - SHORT WALL

EQ 9-5 *U = 1.37 D + 1.66 F

NODE	*U
2	0.0
11	79.3
19	-180.8

EQ 2 U = 1.4 D + 1.7 L + 1.7 H

NODE	U
2	0.0
11	-67.5
19	149.1

EQ 2 U = 1.4 D + 1.4 F

NODE	U
2	0.0
11	66.9
19	-152.5

EQ 4 U = D + L + H + TO + ESS

NODE	U
2	55.2
11	36.8
19	274.3

EQ 4 U = D + L + H + TO - ESS

NODE	U
2	55.2
11	-5.8
19	11.5

EQ 10 U = 1.05 D + 1.3 L + 1.3 H + 1.3 EO +1.05 TO

NODE	U
2	58.0
11	12.8
19	211.4

HORIZONTAL CENTER MOMENTS - SHORT WALL

NODE	D	L	H	F	ESS	EO	TO	RESISTING OUTSIDE MU	INSID MU
0 h	0.0	-9.0	-36.0	64.2	0.0	0.0	55.2	138.9	-143
1/4 h	0.0	-7.4	-40.0	60.2	-27.2	-5.5	55.2	138.9	-153
1/2 h	0.0	-4.9	-34.3	48.5	-27.9	-5.6	55.2	138.9	-143
3/4 h	0.0	-1.3	-12.3	17.3	-8.7	-1.8	55.2	77.3	-83

EQ 9-4 *U = 1.82 D +2.21 L + 2.21 H

NODE	*U
0 h	-99.5
1/4 h	-104.8
1/2 h	-86.6
3/4 h	-30.1

EQ 9-4 *U = 1.82 D +2.21 F

NODE	*U
0 h	141.9
1/4 h	133.0
1/2 h	107.2
3/4 h	38.2

EQ 9-2 *U = 1.37 D +1.66 L +1.66 H +1.83 EO

NODE	*U
0 h	-74.7
1/4 h	-88.7
1/2 h	-75.3
3/4 h	-25.9

EQ 9-2 *U = 1.37 D +1.66 L +1.66 H -1.83 EO

NODE	*U
0 h	-74.7
1/4 h	-68.6
1/2 h	-54.8
3/4 h	-19.3

EQ 9-2 *U = 1.37 D +1.66F

NODE	*U
0 h	106.6
1/4 h	99.9
1/2 h	80.5
3/4 h	28.7

EQ 9-5 *U = 1.37 D + 1.37 TO + 1.66 L +1.37 H

NODE	*U
0 h	11.4
1/4 h	8.5
1/2 h	20.5
3/4 h	56.6

HORIZONTAL CENTER MOMENTS - SHORT WALL

EQ 9-5 *U = 1.37 D + 1.66 F

NODE	*U
0 h	106.6
1/4 h	99.9
1/2 h	80.5
3/4 h	28.7

EQ 2 U = 1.4 D + 1.7 L + 1.7 H

NODE	U
0 h	-76.5
1/4 h	-80.6
1/2 h	-66.6
3/4 h	-23.1

EQ 2 U = 1.4 D + 1.4 F

NODE	U
0 h	89.9
1/4 h	84.3
1/2 h	67.9
3/4 h	24.2

EQ 4 U = D + L + H + TO + ESS

NODE	U
0 h	10.2
1/4 h	-19.4
1/2 h	-11.9
3/4 h	32.9

EQ 4 U = D + L + H + TO - ESS

NODE	U
0 h	10.2
1/4 h	35.0
1/2 h	43.9
3/4 h	50.3

EQ 10 U = 1.05 D + 1.3 L + 1.3 H + 1.3 EO +1.05 TO

NODE	U
0 h	-0.5
1/4 h	-11.9
1/2 h	-1.4
3/4 h	37.6

HORIZONTAL CORNER MOMENTS - SHORT WALL

NODE	D	L	H	F	ESS	EQ	TO	RESISTING OUTSIDE MU	INSIDE MU
0 h	0.0	14.0	48.4	-89.8	0.0	0.0	55.2	204.7	-212.
1/4 h	0.0	11.5	61.8	-94.4	48.4	9.7	55.2	204.7	-212.
1/2 h	0.0	7.7	58.4	-84.1	50.2	10.1	55.2	204.7	-212.
3/4 h	0.0	3.2	31.3	-45.3	21.9	4.4	55.2	204.7	-212.

EQ 9-4 *U = 1.82 D +2.21 L + 2.21 H

NODE	*U
0 h	137.9
1/4 h	162.0
1/2 h	146.1
3/4 h	76.2

EQ 9-4 *U = 1.82 D +2.21 F

NODE	*U
0 h	-198.5
1/4 h	-208.6
1/2 h	-185.9
3/4 h	-100.1

EQ 9-2 *U = 1.37 D +1.66 L +1.66 H +1.83 EQ

NODE	*U
0 h	103.6
1/4 h	139.4
1/2 h	128.2
3/4 h	65.3

EQ 9-2 *U = 1.37 D +1.66 L +1.66 H -1.83 EQ

NODE	*U
0 h	103.6
1/4 h	103.9
1/2 h	91.2
3/4 h	49.2

EQ 9-2 *U = 1.37 D +1.66F

NODE	*U
0 h	-149.1
1/4 h	-156.7
1/2 h	-139.6
3/4 h	-75.2

EQ 9-5 *U = 1.37 D + 1.37 TO + 1.66 L +1.37 H

NODE	*U
0 h	165.2
1/4 h	179.4
1/2 h	168.4
3/4 h	123.8

HORIZONTAL CORNER MOMENTS - SHORT WALL

EQ 9-5 *U = 1.37 D + 1.66 F

NODE	*U
0 h	-149.1
1/4 h	-156.7
1/2 h	-139.6
3/4 h	-75.2

EQ 2 U = 1.4 D + 1.7 L + 1.7 H

NODE	U
0 h	106.1
1/4 h	124.6
1/2 h	112.4
3/4 h	58.7

EQ 2 U = 1.4 D + 1.4 F

NODE	U
0 h	-125.7
1/4 h	-132.2
1/2 h	-117.7
3/4 h	-63.4

EQ 4 U = D + L + H + TO + ESS

NODE	U
0 h	117.6
1/4 h	176.9
1/2 h	171.5
3/4 h	111.6

EQ 4 U = D + L + H + TO - ESS

NODE	U
0 h	117.6
1/4 h	80.1
1/2 h	71.1
3/4 h	67.8

EQ 10 U = 1.05 D + 1.3 L + 1.3 H + 1.3 EQ +1.05 TO

NODE	U
0 h	139.1
1/4 h	167.8
1/2 h	159.0
3/4 h	109.4

HORIZONTAL CORNER MOMENTS - LONG WALL

NODE	D	L	H	F	ESS	EQ	TO	RESISTING OUTSIDE MU	RESISTING INSIDE MU
0 h	8.9	11.0	61.0	-90.6	0.0	0.0	35.3	156.1	-179.6
1/4 h	9.6	11.9	65.9	-97.9	100.5	20.1	71.2	216.1	-236.3
1/2 h	8.5	10.6	58.6	-87.0	116.7	23.3	107.0	276.8	-293.0
3/4 h	4.3	5.3	29.3	-43.5	51.9	10.4	142.9	254.6	-264.3

EQ 9-4 *U = 1.82 D +2.21 L + 2.21 H

NODE	*U
0 h	175.3
1/4 h	189.4
1/2 h	168.4
3/4 h	84.3

EQ 9-4 *U = 1.82 D +2.21 F

NODE	*U
0 h	-184.0
1/4 h	-198.9
1/2 h	-176.8
3/4 h	-88.3

EQ 9-2 *U = 1.37 D +1.66 L +1.66 H +1.83 EQ

NODE	*U
0 h	131.7
1/4 h	179.1
1/2 h	169.2
3/4 h	82.4

EQ 9-2 *U = 1.37 D +1.66 L +1.66 H -1.83 EQ

NODE	*U
0 h	131.7
1/4 h	105.5
1/2 h	83.9
3/4 h	44.3

EQ 9-2 *U = 1.37 D +1.66F

NODE	*U
0 h	-138.2
1/4 h	-149.4
1/2 h	-132.8
3/4 h	-66.3

EQ 9-5 *U = 1.37 D + 1.37 TO + 1.66 L +1.37 H

NODE	*U
0 h	162.4
1/4 h	220.7
1/2 h	256.1
3/4 h	250.6

HORIZONTAL CORNER MOMENTS - LONG WALL

EQ 9-5 *U = 1.37 D + 1.66 F

NODE	*U
0 h	-138.2
1/4 h	-149.4
1/2 h	-132.8
3/4 h	-66.3

EQ 2 U = 1.4 D + 1.7 L + 1.7 H

NODE	U
0 h	134.9
1/4 h	145.7
1/2 h	129.5
3/4 h	64.8

EQ 2 U = 1.4 D + 1.4 F

NODE	U
0 h	-114.4
1/4 h	-123.6
1/2 h	-109.9
3/4 h	-54.9

EQ 4 U = D + L + H + TO + ESS

NODE	U
0 h	116.2
1/4 h	259.1
1/2 h	301.4
3/4 h	233.7

EQ 4 U = D + L + H + TO - ESS

NODE	U
0 h	116.2
1/4 h	58.1
1/2 h	68.0
3/4 h	129.9

EQ 10 U = 1.05 D + 1.3 L + 1.3 H + 1.3 EO +1.05 TO

NODE	U
0 h	140.0
1/4 h	216.1
1/2 h	246.2
3/4 h	215.1

HORIZONTAL CENTER MOMENTS - LONG WALL

NODE	D	L	H	F	ESS	EQ	TO	RESISTING OUTSIDE MU	RESISTING INSIDE MU
0 h	1.4	1.8	9.8	-14.5	0.0	0.0	35.3	80.4	-92.5
1/4 h	1.6	2.0	11.0	-16.3	29.2	5.8	71.2	83.5	-91.1
1/2 h	0.9	1.1	6.1	-9.1	22.7	4.5	107.0	106.3	-112.4
3/4 h	-2.0	-2.4	-13.4	19.9	-9.7	-2.0	142.9	123.8	-133.7

EQ 9-4 *U = 1.82 D +2.21 L + 2.21 H

NODE	*U
0 h	28.2
1/4 h	31.6
1/2 h	17.6
3/4 h	-38.6

EQ 9-4 *U = 1.82 D +2.21 F

NODE	*U
0 h	-29.5
1/4 h	-33.1
1/2 h	-18.5
3/4 h	40.3

EQ 9-2 *U = 1.37 D +1.66 L +1.66 H +1.83 EQ

NODE	*U
0 h	21.2
1/4 h	34.4
1/2 h	21.4
3/4 h	-32.6

EQ 9-2 *U = 1.37 D +1.66 L +1.66 H -1.83 EQ

NODE	*U
0 h	21.2
1/4 h	13.2
1/2 h	4.9
3/4 h	-25.3

EQ 9-2 *U = 1.37 D +1.66F

NODE	*U
0 h	-22.2
1/4 h	-24.9
1/2 h	-13.9
3/4 h	30.3

EQ 9-5 *U = 1.37 D + 1.37 TO + 1.66 L +1.37 H

NODE	*U
0 h	66.7
1/4 h	118.1
1/2 h	158.0
3/4 h	170.7

HORIZONTAL CENTER MOMENTS - LONG WALL

EQ 9-5 *U = 1.37 D + 1.66 F

NODE	*U
0 h	-22.2
1/4 h	-24.9
1/2 h	-13.9
3/4 h	30.3

EQ 2 U = 1.4 D + 1.7 L + 1.7 H

NODE	U
0 h	21.7
1/4 h	24.3
1/2 h	13.5
3/4 h	-29.7

EQ 2 U = 1.4 D + 1.4 F

NODE	U
0 h	-18.3
1/4 h	-20.6
1/2 h	-11.5
3/4 h	25.1

EQ 4 U = D + L + H + TO + ESS

NODE	U
0 h	48.3
1/4 h	115.0
1/2 h	137.8
3/4 h	115.4

EQ 4 U = D + L + H + TO - ESS

NODE	U
0 h	48.3
1/4 h	56.6
1/2 h	92.4
3/4 h	134.8

EQ 10 U = 1.05 D + 1.3 L + 1.3 H + 1.3 EO +1.05 TO

NODE	U
0 h	53.6
1/4 h	102.0
1/2 h	129.4
3/4 h	124.4

1 E B-714-003 SOIL STRUCTURE INTERACTION SEISMIC CALCULATIONS

Consultants in Soil Dynamics
and Earthquake Engineering

E... UAKE ENGINEERING TECHNOLOGY, INC.
2400 Old Crow Canyon Road, Suite B-H
San Ramon, CA 94583
(415) 837-2350

November 29, 1988

Mr. Mike Ruben
Kaiser Engineers Hanford Company
P.O. Box 888
Richland, Washington 99352

Subject: Contract No. KEH-5139 (B-714)
Consulting Engineering Services, Verify KEH
Seismic Analyses For Grout Disposal Vaults.
200-East Area, Hanford Site, Richland, Washinton
(Reference Contract No. DE-AC06-87RL10900)

This letter acts as the confirmation of completion of the above mentioned consulting engineering services. The scopes of the work consisted of five phases as follows.

a. Phase 1 - Review design criteria, available soils data, construction drawings and specifications
b. Phase 2 - Review computer work Man Hour done to date by KEH Engineers or soil-structure interaction analysis
c. Phase 3 - Provide assistance to KEH for revising the computer models for advising additional analysis.
d. Phase 4 - Make final review of all computer soil-structure interaction analyses
e. Phase 5 - Provide KEH a letter stating the soil-structure interaction analyses satisfy all criteria and are accurate.

The consulting engineering services were authorized on September 9, 1988 (EET-5139-001) and first meeting was held at KEH office, Richland, Washington on September 9 and 10, 1988. The basic drawings, soil data, material curves and idealized models used for soil-stracture interaction analyses were discussed.
The followings are the key points on the meeting.

(1) Adequacy of the finite element model, element size, maximum frequency, etc.
(2) The material curves for the equivalent linear approach.
(3) The effect of the rigid base ie. the adequacy of the FEM model depth to avoid reflection from the rigid base.

The several additional analyses were discussed:

(4) Three-dimensional effects of the FLUSH analyses.
(5) New modeling technique of grout material as the complete lumped mass model using triple nodal points.
(6) Interpolation scheme
(7) New analysis in the longitudinal direction.
(8) Structure-soil-structure interaction analyses placing enphasis on the different free-field conditons at the right hand and left hand sides.

After the meeing. during the period of September 12 through October 10, 1988. several telephone conversations were placed to verify the input data preparation of FLUSH program including the modeling techniques and boundary conditions to simulate actual field condition.
The review of the FLUSH soil-structure interaction analyses started on October 14, 1988. Reviews were performed on the following cases.

(1) Single Vault model
  (a) Lumped mass representation
  (b) Independent grout disposal material accepting the separation of the material from the concrete wall.
(2) Two Valult model
  (a) One empty and one full grout material model
  (b) One empty and one full grout material model with slopping site (Right and left hand side boundary conditions are different each other)
(3) Longitudinal model.

The adequacy of the FEM model, material properties. material curves, convergency have been reviewed and final numerical results are compared each other and discussed on the telephone with Mr. Mike Ruben. (from October 10 to October 30, 1988)
The results obtained from the FLUSH soil-structure interaction analyses seem to be very reasonable and to be accurate. The moments obtained are within the design criteria.

If you have any questions on this matter, please feel free to call me at 415-837-2350.

Sincerely yours,

Takekazu Udaka

Takekazu Udaka, President

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DESIGN ANALYSIS

Client WHC	WO/Job No. ER1060		
Subject GROUT VAULT	Date 9/22/88	By MS RUBEN	
	Checked 11/5/88	By C. M. [illegible]	
Location 200E	Revised	By	

DESIGN OBJECTIVES:

DETERMINE SSE & OBE MOMENTS AND SHEARS FOR GROUT VAULT CONCRETE STRUCTURE. THE COMPUTER CODE "FLUSH" WILL BE USED TO CALCULATE THE RESPONSES OF THE VAULT TO HANFORD PLANT STANDARD SDC 4.1 FOR SSE = 0.25G ZERO PERIOD GROUND ACCELERATION. OBE RESPONSE WILL BE FOUND BY PROPORTIONING DOWN TO 0.05G ZPA.

REFERENCE DOCUMENTS:

- DWGS H-2-77580 SHTS 1 THRU 4 (APRIL 1988)
- PRELIMINARY REPORT GEOTECHNICAL & CORROSION INVESTIGATION - GROUT VAULTS HANFORD, WA. BY DAMES & MOORE, AUG. 23 1988
- FLUSH - A COMPUTER PROGRAM FOR APPROXIMATE 3D ANALYSIS OF SOIL STRUCTURE INTERACTION PROBLEM
- HANFORD PLANT STANDARDS SDC 4.1
- URS/BLUME INVESTIGATIONS OF FACILITIES IN 200E AREA FOR PUREX FACILITY, 241-AP TANK SITE & 241-AW SITE. THE STUDIES INCLUDED SOIL PROPERTIES FOR USE IN PRELIMINARY "FLUSH" MODELING

CONCLUSIONS:

AT BASE OF LONG GROUT VAULT WALL:

MAX SSE MOMENT = 331 $^{1K}/_{1}$ MAX SSE V = 40.6 $^{K}/_{1}$

MAX OBE MOMENT = 66.2 $^{1K}/_{1}$ MAX OBE V = 8.1 $^{K}/_{1}$

AT BASE OF END WALLS: M_{SSE} = 189 $^{1K}/_{1}$ V_{SSE} = 32.8 $^{K}/_{1}$

M_{OBE} = 37.8 $^{1K}/_{1}$ V_{OBE} = 6.6 $^{K}/_{1}$

DESIGN ANALYSIS

Client	WHC	WO/Job No.	ER1060		
Subject	GROUT VAULT	Date	9/22/88	By	MS RUBEN
		Checked		By	C. M.
Location	200 E	Revised		By	

INVESTIGATION

PART I

DUE TO SITE SPECIFIC SOIL PROPERTIES NOT BEING AVAILABLE A PRELIMINARY INVESTIGATION WAS MADE OF THE GROUT VAULT SOIL-STRUCTURE INTERACTION. SOIL STRUCTURE MODELS WERE MADE USING B714 VAULT DRAWINGS AND PREVIOUS SOIL STUDIES OF THE 200E AREA. THESE STUDIES WERE MADE BY URS/BLUME BETWEEN 1976 AND 1981 FOR THE PUREX FACILITY, 241-AW STORAGE TANKS AND 241-AP STORAGE TANKS. THE FOLLOWING CASES WERE MODELED AND SUBJECTED TO THE HPS SDC 4.1 0.25g EPA GROUND MOTION USING THE FLUSH CODE:

CASE I SINGLE VAULT (EMPTY) - HORIZ. GRD. MOTION

CASE II SINGLE VAULT (EMPTY) - VERT GRD. MOTION

CASE III SINGLE VAULT (FULL WITH GROUT) - HORIZ GRD MOTION

CASE IV SINGLE VAULT (FULL WITH GROUT) - VERT. GRD MOTION

CASE V 2 VAULTS - (ONE FULL & ONE EMPTY) - HORIZ MOTION

PART II

THE FLUSH MODELS WERE REVISED TO INCLUDE:

(1) DYNAMIC SOILS PROPERTIES RECOMMENDED BY DAMES & MOORE IN THEIR SITE SPECIFIC SOILS REPORT DATED AUG 23 1988 (PRELIM)

(2) CONCRETE CATCH BASIN ADDED AFTER PART I WAS COMPLETED

DESIGN ANALYSIS

Client	WHC	WO/Job No.	ER 1060		
Subject	GROUT VAULT	Date	9/22/88	By	MS RUBEN
		Checked	11/8/88	By	C. M. CARSELMAN
Location	200 E	Revised		By	

(3) CHANGES TO THE MESH

a. REVISED SOIL LAYER THICKNESS AT BOTTOM LAYERS TO OPTIMIZE RESPONSE OF SOIL TO MOTION

b. REVISED RIGHT SIDE SOIL COLUMN WIDTHS TO EQUAL LEFT SIDE.

c. REVISED VAULT ROOF TO SIMULATE "PINNED ENDS" FOR SIMPLE SPAN.

d. REMOVED CONNECTIVITY OF GROUT ELEMENTS TO WALL-BEAM ELEMENTS TO SIMULATE PROBABLE CRACKS BETWEEN THE GROUT AND CONCRETE WALLS. TWO CASES OF THIS MODEL WERE INVESTIGATED. THE FIRST USED THE GROUT DENSITY OF 100 PCF. THE SECOND USED A DENSITY OF 1 PCF AND LUMPED THE GROUT WEIGHT AROUND THE PERIMETER OF THE VAULT

e. ADD FREE FIELD OUTPUT POINTS & MORE NODAL POINTS OF VAULT STRUCTURE

f. REVISED SOIL PROPERTIES TO INCLUDE DAMES & MOORE RECOMMENDATIONS FOR DENSITIES, POISSONS RATIOS, & DYNAMIC SHEAR MODULI FOR UNDISTURBED SOIL LAYERS BELOW VAULTS, BACKFILL & GRAVEL DIFFUSSION BREAK

(4) A MODEL FOR A LONGITUDINAL CROSS SECTION WAS INVESTIGATED FOR END WALL MOMENTS DURING SSE & OBE

(5) A DOUBLE VAULT MODEL SIMULATING THE SLOPING BACKFILL AGAINST THE EMPTY VAULT WAS ALSO SUBJECTED TO THE 0.25 g GROUND ACCELERATION.

9 0 1 1 7 8 5 1 1 5 1

DESIGN ANALYSIS

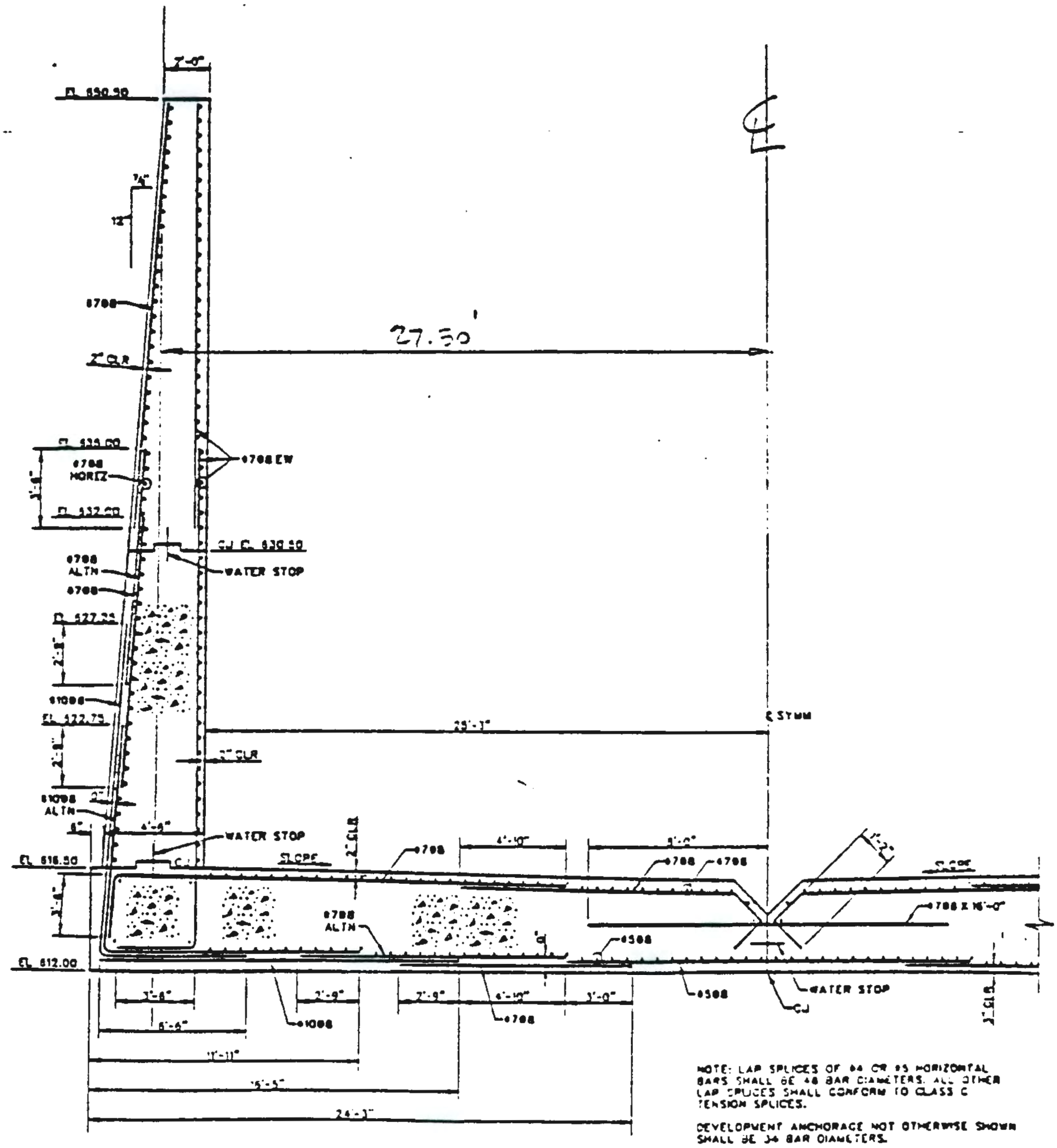
Client	WHC	WO/Job No.	ER1060		
Subject	GROUT VAULT	Date	9/23/88	By	MS RUBEN
		Checked	11/15/88	By	[illegible]
Location	200E	Revised		By	

PART I

KAISER ENGINEERS
HANFORD

DESIGN ANALYSIS

Client	WHC	WO/Job No.	242900		
Subject	GROUT VAULT	Date	MAY 10 88	By	MS RUBEN
		Checked	Sept 88	By	CCTu
Location	200E	Revised		By	



CROSS SECTION FROM DWG H-2-77580 3/4

DESIGN ANALYSIS

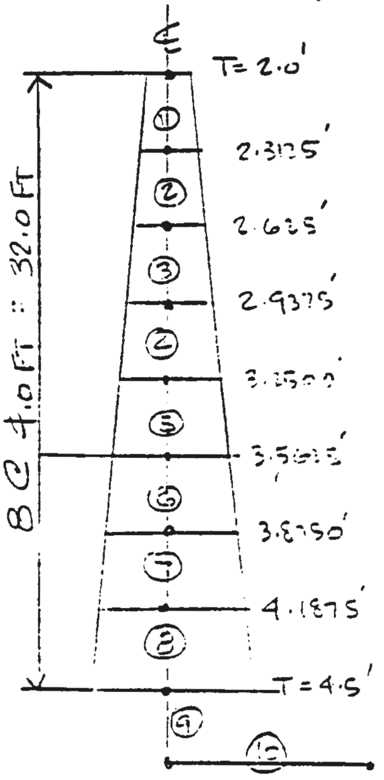
Client WHC	WO/Job No. 242500		
Subject GROUT VAULT	Date MAY 10 88	By MS RUBEN	
	Checked Sept 88	By KCTu	
Location 200E	Revised	By	

CALCULATE PROPERTIES OF VAULT WALL & BASE SLAB

ASSUME: (1) VAULT WALL IS SYMETRICAL ABOUT ℄

(2) BASE SLAB IS CONSTANT THICKNESS OF 4.5'

(3) WALL TAPERS FROM EL -4 TO EL -38 WITH THICKNESS OF 2.0 FT TO 4.5 FT



	BEAM ELEMENT	AVE THICKNESS FT	AREA FT^2	I FT^3
WALL	1 & 24	2.1563	2.156	0.8352
	2 & 23	2.4688	2.469	1.2542
	3 & 22	2.7813	2.781	1.7933
	4 & 21	3.0938	3.094	2.4622
	5 & 20	3.4063	3.406	3.2927
	6 & 19	3.7188	3.719	4.2861
	7 & 18	4.0313	4.031	5.4583
	8 & 17	4.3438	4.344	6.8311
	9 & 16	4.3438	4.344	6.8311
BASE SLAB	10 THRU 15	4.50	4.50	7.5938
ROOF SLAB	25 THRU 30	2.1667	2.1667	0.8476

ROOF SLAB,
T = 2.1667
PRECAST PLANK

DESIGN ANALYSIS

Client WHC		WO/Job No. 242500	
Subject GROUT VAULT		Date 5/15/88	By MS RUBEN
		Checked Sept-88	By KC T..
Location 200E		Revised	By

DETERMINE ~~SHEAR~~ MODULUS FOR GROUT

GROUT $f'_c = 50$ psi
$w_c = 90$ #/FT³ $\nu = 0.17$

FROM ACI 318 $E = w_c^{1.5} * 33 * \sqrt{f'_c}$

$E = 90^{1.5} * 33 * \sqrt{50}$

$E = 199{,}233$ PSI

$$G = \frac{E}{2(1+\nu)} = \frac{199233}{2(1+.17)} = 25142 \text{ PSI}$$

CONVERTING TO KSF $\frac{25142 * 144}{1000} = 12260$ K/FT²

WITH $w_c = 100$ #/FT³

$E = 100^{1.5} * 33 * \sqrt{50} = 233345$ PSI

$$G = \frac{233345}{2(1.17)} = 99720 \text{ PSI}$$

$$99720 * \frac{144}{1000} = 14359 \text{ KSF}$$

DOE Richland WA ☆ GPO 1988-592-092

54-4300-037 KEH-37 (7/82)

SINGLE GROUT VAULT MODEL ~ NODE NUMBERS

	0.00'	10.00'	20.00'	23.00'	32.1667'	41.3333'	50.50'	59.667'	68.8333'	79.000'	81.000'	91.00'	'.00'
- 0.00'										228			
4.00'	1	24	47	70, 71	103, 104	128, 129	153, 154	178, 179	203, 204	229	261	284	307
8.00'	2	25	48	72	105	130	156	180	205	230, 231	262	285	308
- 12.00'	3	26	49	74	106	131	156	181	206	233	263	286	309
- 16.00'	4	27	50	76	107	132	157	182	207	235	264	287	310
- 20.00'	5	28	51	78	108	133	158	183	208	237	265	288	311
- 24.00'	6	29	52	80	109	134	169	184	209	239	266	289	312
- 28.00'	7	30	53	82	110	135	160	185	210	241	267	290	313
- 32.00'	8	31	54	84	111	136	161	186	211	243	268	291	314
- 36.00'	9	32	55	86	112	137	162	187	212	245	269	292	315
- 40.25'	10	33	56	88, 89	113, 114	138, 139	163, 164	188, 189	213, 214	247	270	293	316
- 43.25'	11	34	57	90	115	140	165	190	215	248	271	294	317
- 46.00'	12	35	58	91	116	141	166	191	216	249	272	295	318
- 50.00'	13	36	57	92	117	142	167	192	217	250	273	296	319
- 55.00'	14	37	60	93	118	143	168	193	218	251	274	297	320
- 60.00'	15	38	61	94	119	144	169	194	219	252	275	298	321
- 70.00'	16	39	62	95	120	145	170	195	220	253, 254	276	299	322
- 80.00'	17	40	63	96	121	146	171	196	221	255	277	300	323
90.00'	18	41	64	97	122	147	172	197	222	256	278	301	324
-100.00'	19	42	65	98	123	148	173	198	223	257	279	302	325
-120.00'	20	43	66	99	124	149	174	199	224	258	280	303	326
-140.00'	21	44	67	100	126	160	175	200	225	259	281	304	327
-170.00'	22	45	68	101	126	161	176	201	226	260	282	305	328
-200.00'	23	46	69	102	127	162	177	202	227		283	306	329
	330	331	332	333	334	335	336	337	338	339	340	341	342

X

90117351156

APP 4I-604

Depth	0.00'	10.00'	20.00'	23.00'	32.1667'	41.3333'	50.50'	59.6667'	68.8333'	78.000'	81.000'	91.0'	111.0'
- 0.00'													
- 4.00'		1	24	47	70	93	116	139	162	185	208	231	254
- 8.00'		2	25	48							209	232	255
- 12.00'		3	26	49							210	233	256
- 16.00'		4	27	50							211	234	257
- 20.00'		5	28	51							212	235	258
- 24.00'		6	29	52							213	236	259
- 28.00'		7	30	53							214	237	260
- 32.00'		8	31	54							215	238	261
- 36.00'		9	32	55							216	239	262
- 40.25'		10	33	56							217	240	263
- 43.25'		11	34	57	80	103	126	149	172	195	218	241	264
- 46.00'		12	35	58	81	104	127	150	173	196	219	242	265
- 50.00'		13	36	59	82	105	128	151	174	197	220	243	266
- 55.00'		14	37	60	83	106	129	152	175	198	221	244	267
- 60.00'		15	38	61	84	107	130	153	176	199	222	245	268
- 70.00'		16	39	62	85	108	131	154	177	200	223	246	269
- 80.00'		17	40	63	86	109	132	155	178	201	224	247	270
90.00'		18	41	64	87	110	133	156	179	202	225	248	271
- 100.00'		19	42	65	88	111	184	157	180	203	226	249	272
- 120.00'		20	43	66	89	112	135	158	181	204	227	250	273
- 140.00'		21	44	67	90	113	136	159	182	205	228	251	274
- 170.00'		22	45	68	91	114	137	160	183	206	229	252	275
- 200.00'		23	46	69	92	115	138	161	184	207	230	253	276

11 KSF, $\gamma_s = 110$ PCF, $\nu = 0.20$ (0.00' to 8.00')

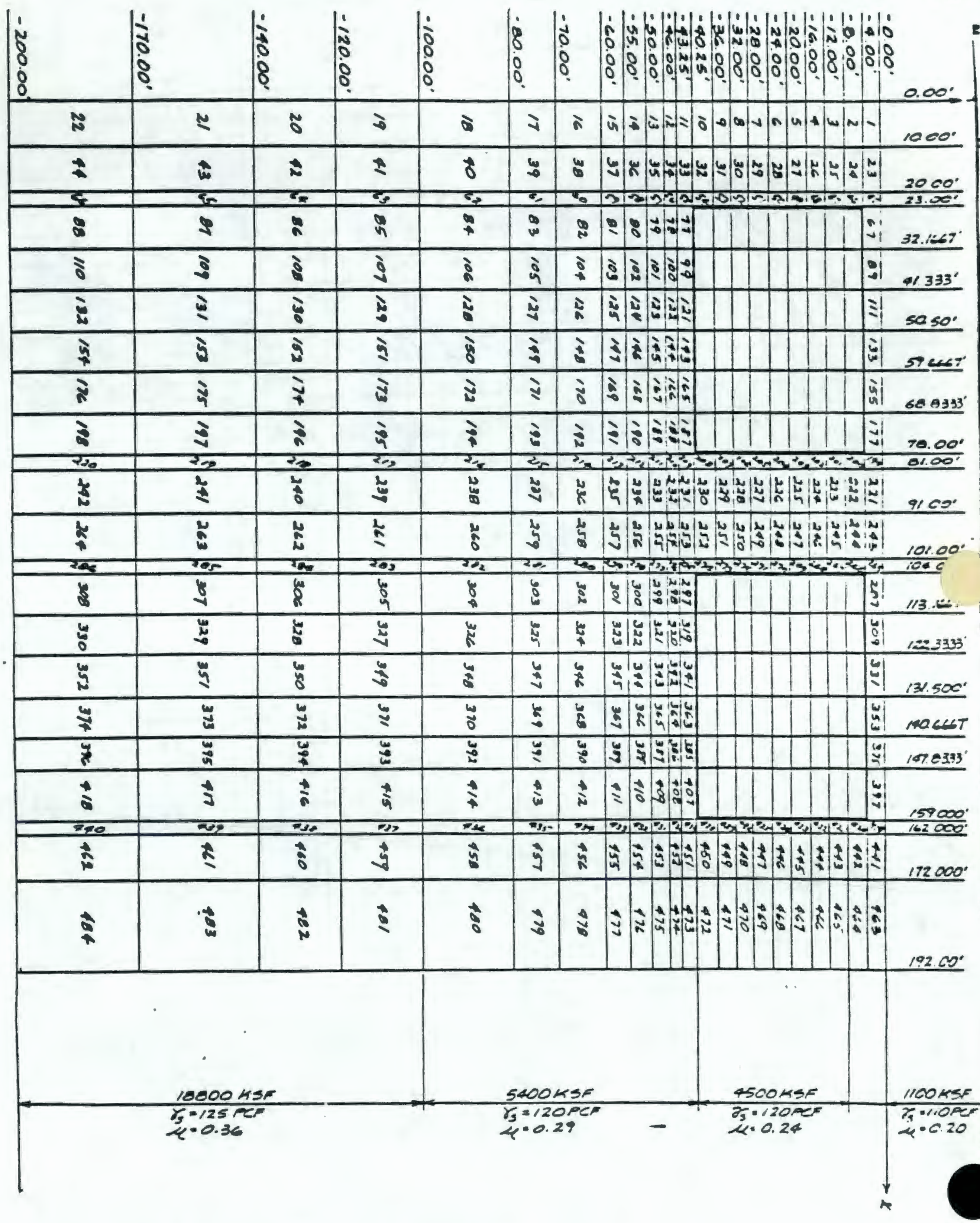
4500 KSF, $\gamma_s = 120$ PCF, $\nu = 0.24$ (8.00' to 40.25')

5400 KSF, $\gamma_s = 120$ PCF, $\nu = 0.29$ (40.25' to 100.00')

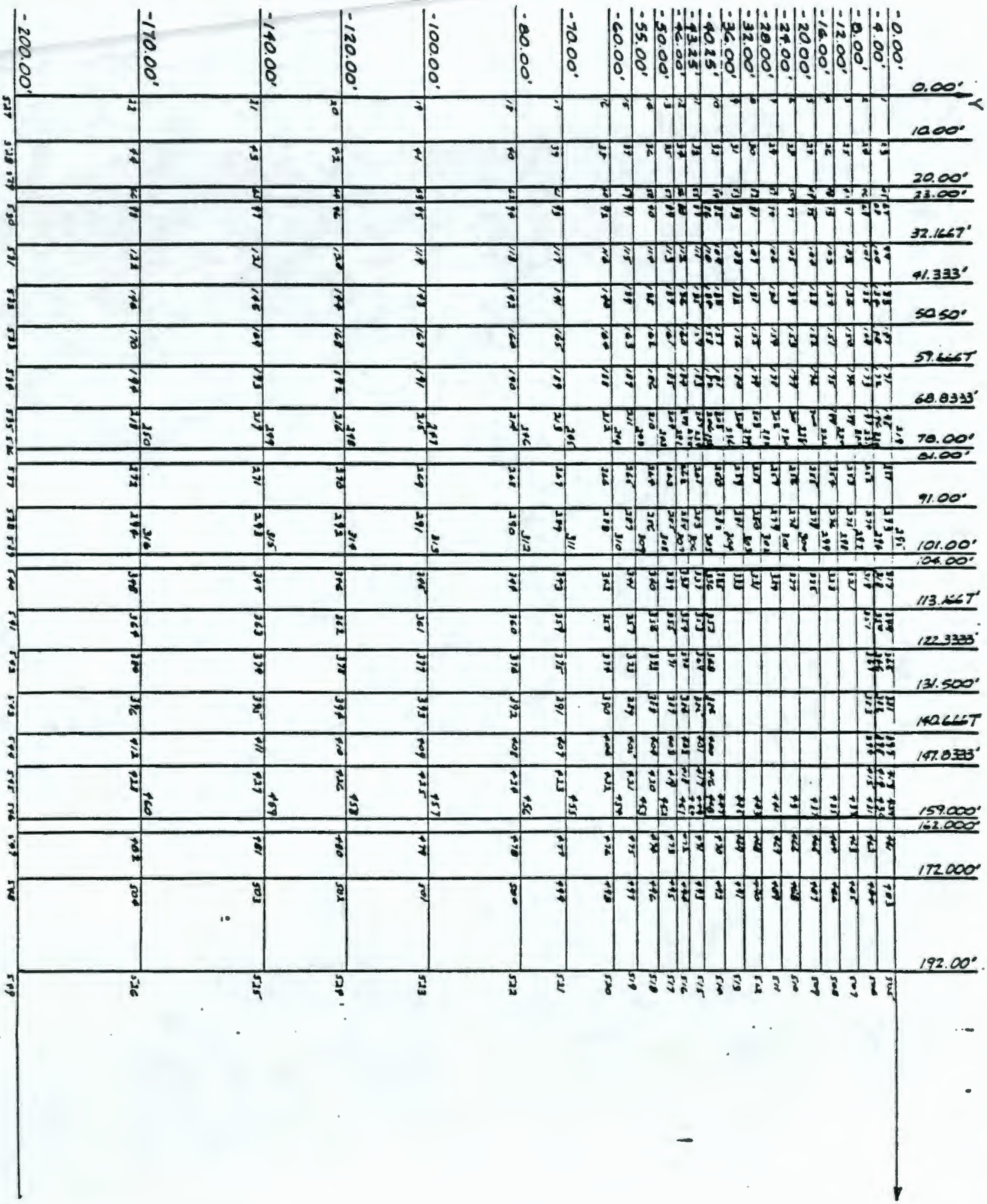
18800 KSF, $\gamma_s = 125$ PCF, $\nu = 0.36$ (100.00' to 200.00')

SINGLE GROUT VAULT MODEL ~ ELEMENT NUMBERS

9011786157



DOUBLE GROUT VAULT MODEL — ELEMENT NUMBERS

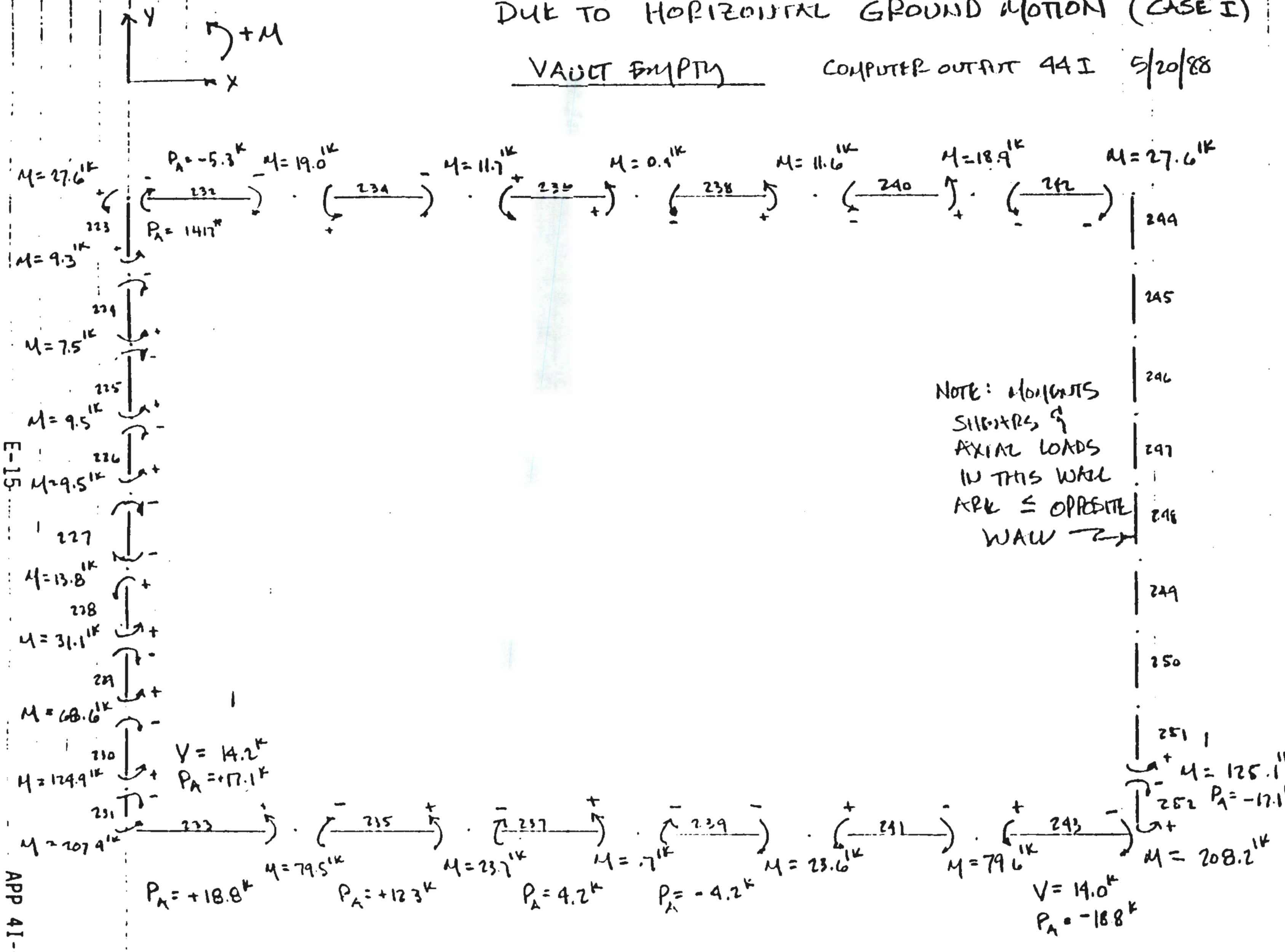


DOUBLE GROUT VAULT MODEL — NODE NUMBERS

Client	WHC
Subject	GROUT VAULT
Location	200E
WO/Job No.	242500
Date	MAY 23 88
By	MS RUBEN
Checked	11/?/??
By	C. M. [illegible]
Revised	
By	

MOMENTS, SHEARS & AXIAL FORCES DUE TO HORIZONTAL GROUND MOTION (CASE I)

VAULT EMPTY   COMPUTER OUTPUT 44I 5/20/88



KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

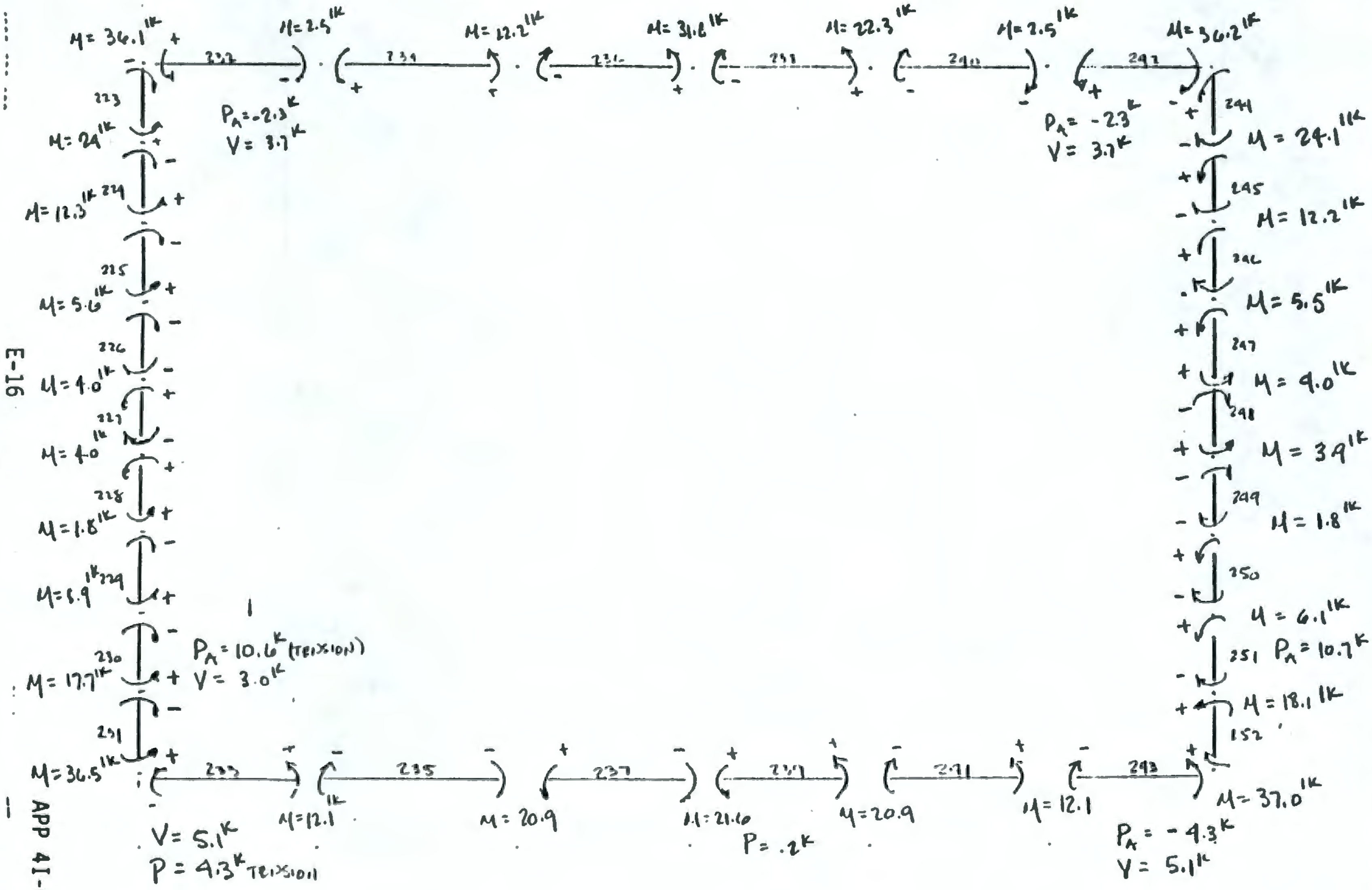
Client WHC
Subject GROUT VAULT
Location 200E
WO/Job No. 24500
Date 5/23/88 By JS RUBEN
Checked 11/8/?? By C M ...
Revised By

DOE/RL 88-27 Rev. 1, 01/17/90

MOMENTS SHEARS & AXIAL FORCES DUE TO VERTICAL GRD MOTION (CASE II)

VAULT EMPTY

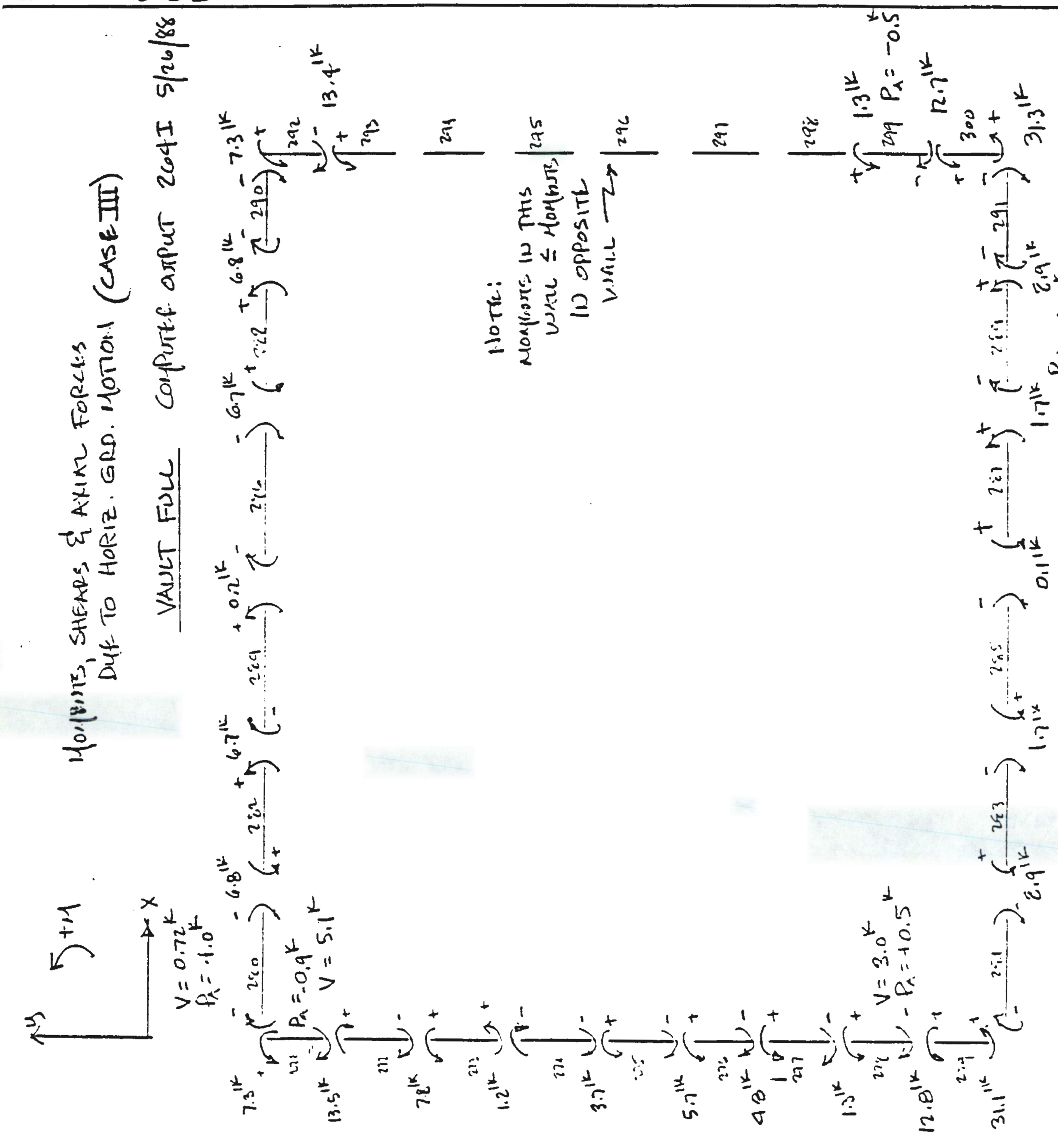
COMPUTER OUTPUT 70 I 5/30/88



KAISER ENGINEERS
HANFORD

DESIGN ANALYSIS

Client	WHC	WO/Job No.	242500
Subject	GROUT VAULT	Date 6/2/88	By MS RUBEN
		Checked 11/ /89	By C. M. CONSELMAN
Location	200E	Revised	By



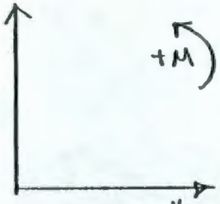
APP 4I-610

KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

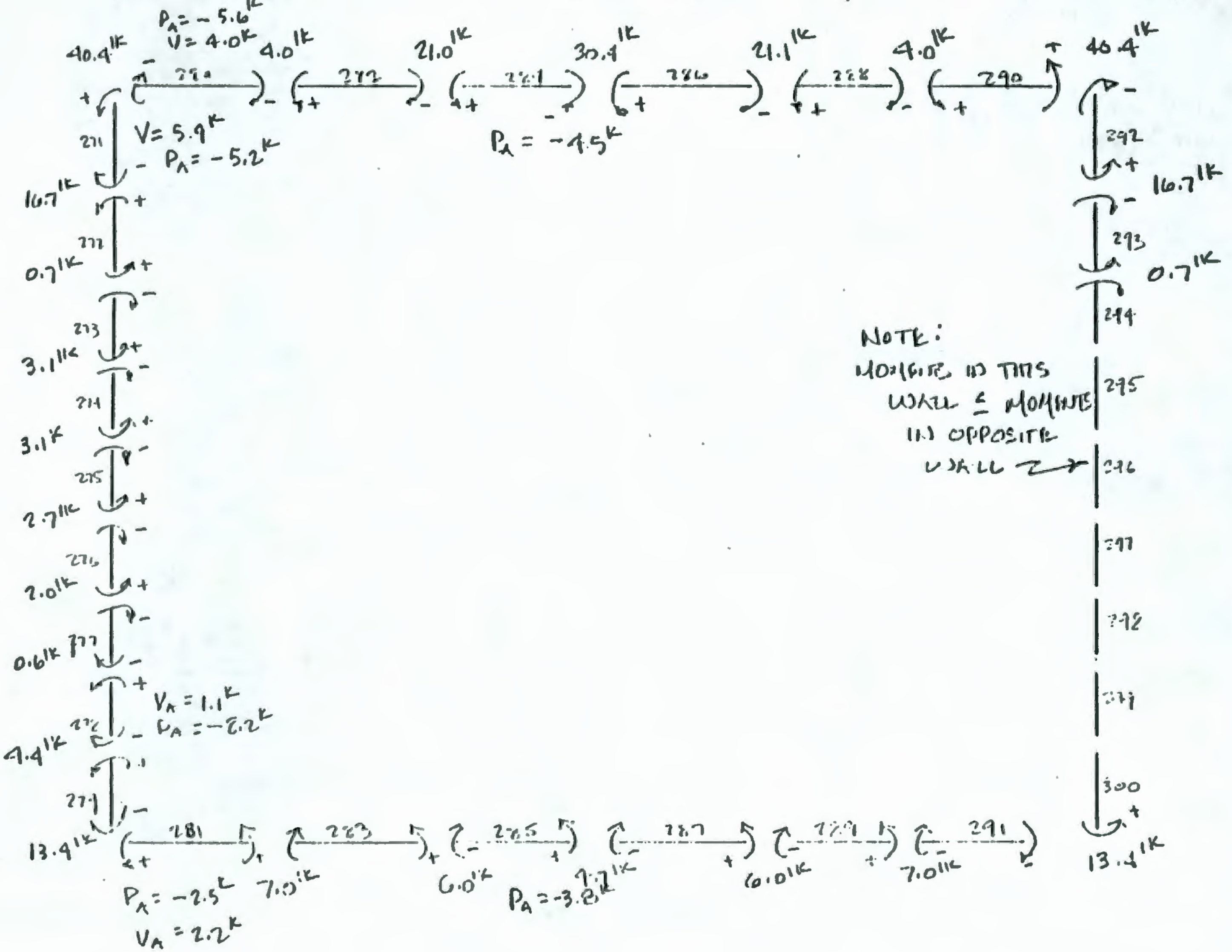
Client: WHC
Subject: GROUT VAULT
Location: 200 E
WO/Job No.: 242500
Date: 6/2/88 By: MS RUBEN
Checked: 11/2/?? By: C. ...
Revised: By:

DOE/RL 88-27
Rev. 1, 01/17/90



MOMENTS SHEARS & AXIAL FORCES
DUE TO VERTICAL GRD. MOTION (CASE III)

VAULT FULL COMPUTER OUTPUT 61 I 5/30/88

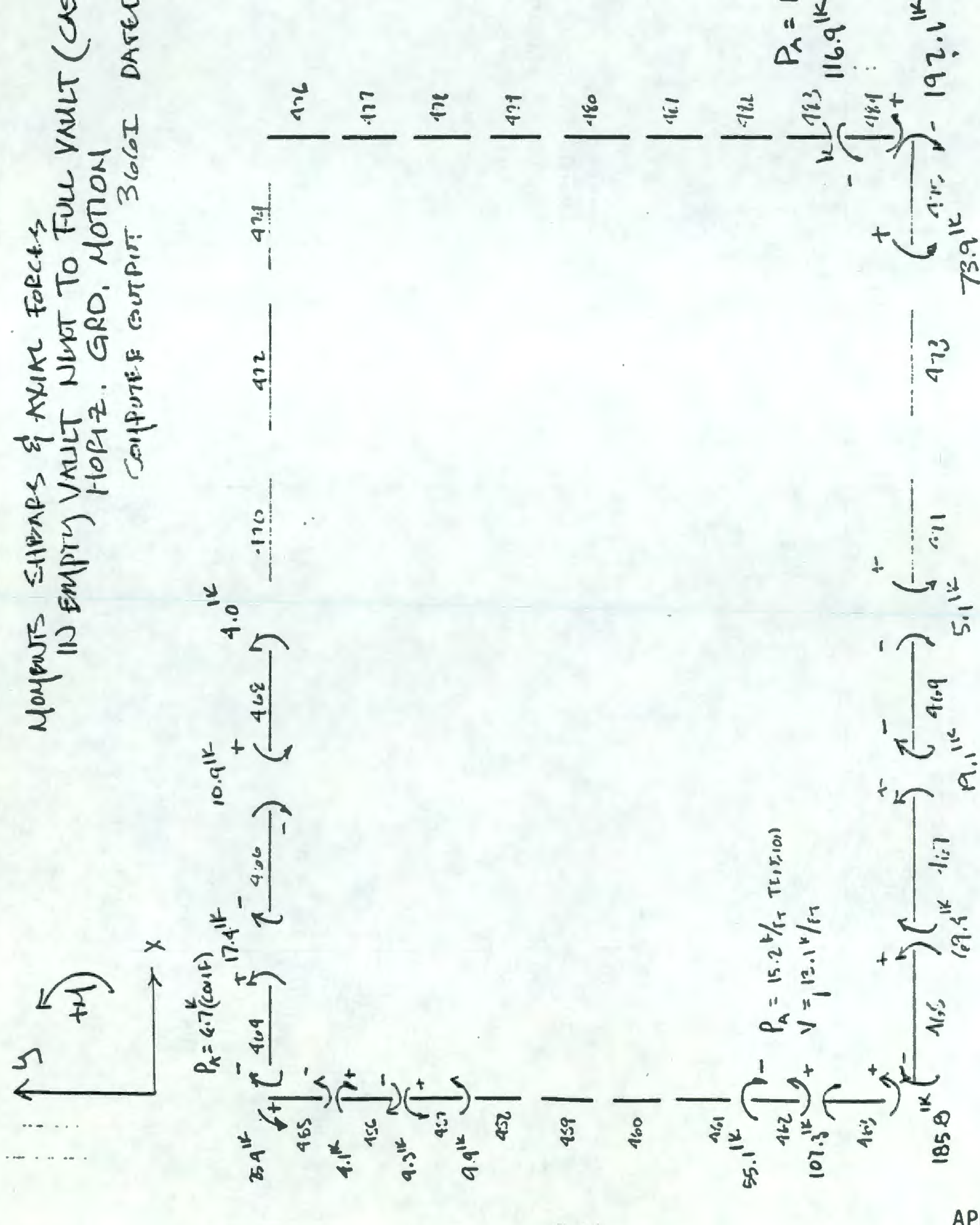


KAISER ENGINEERS HANFORD

DESIGN ANALYSIS

Client: WHC	WO/Job No. 242500		
Subject: GROUT VAULT	Date 6/14/88	By M.S. RUBEN	
	Checked 11/7/88	By C. M. CONSELMAN	
Location: 200E	Revised	By	

MOMENTS SHEARS & AXIAL FORCES IN EMPTY VAULT NEXT TO FULL VAULT (CASE II)
HORIZ. GRD. MOTION
COMPUTER OUTPUT 3606I DATED 6/13/88



APP 41-612

9 0 1 1 7 8 6 1 1 6 4

ANSYS 4.2
JUN 2 1988
15: 19: 57
ELEMENTS
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ZV=1
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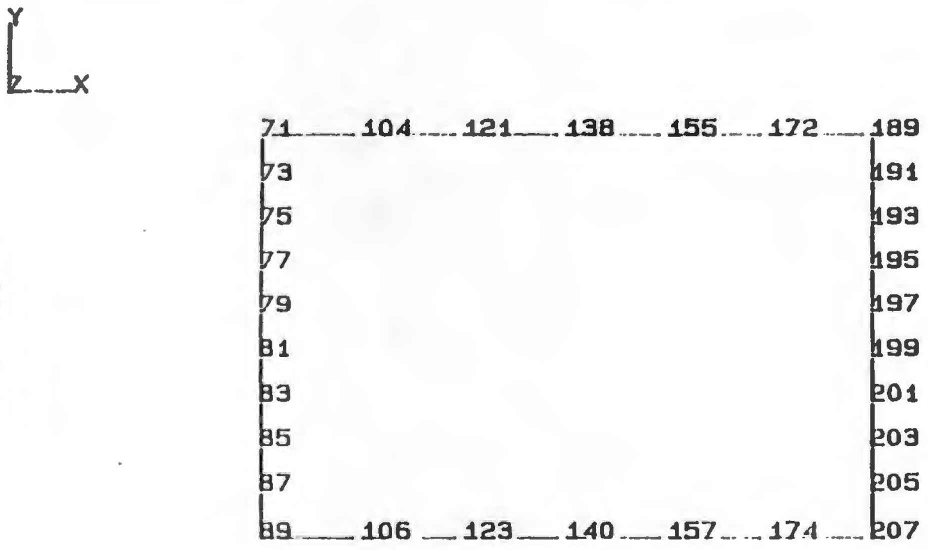
XF=55.5
YF=-30



B714 - GROUT VAULT (EMPTY) BEAM - NODE NUMBER

APP 4I-613

ANSYS 4.2
JUN 2 1988
15: 15: 19
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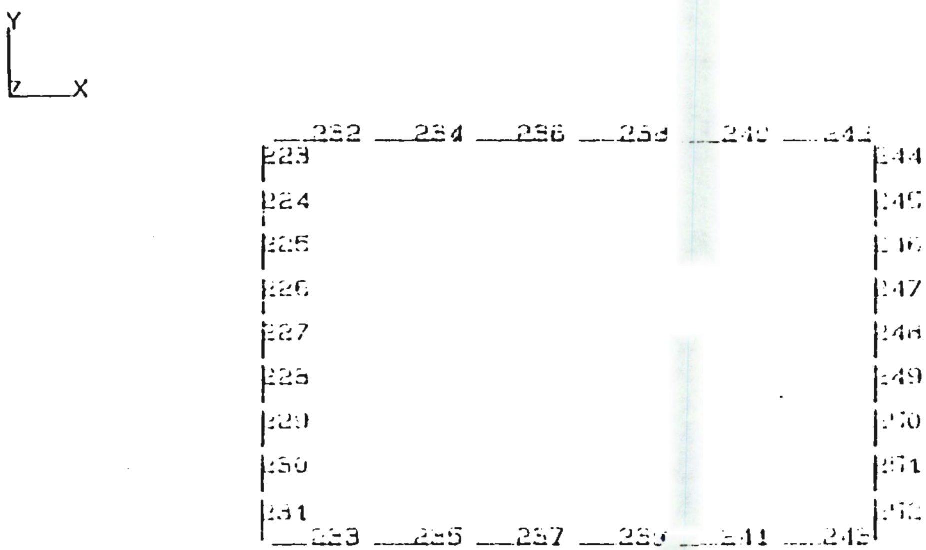
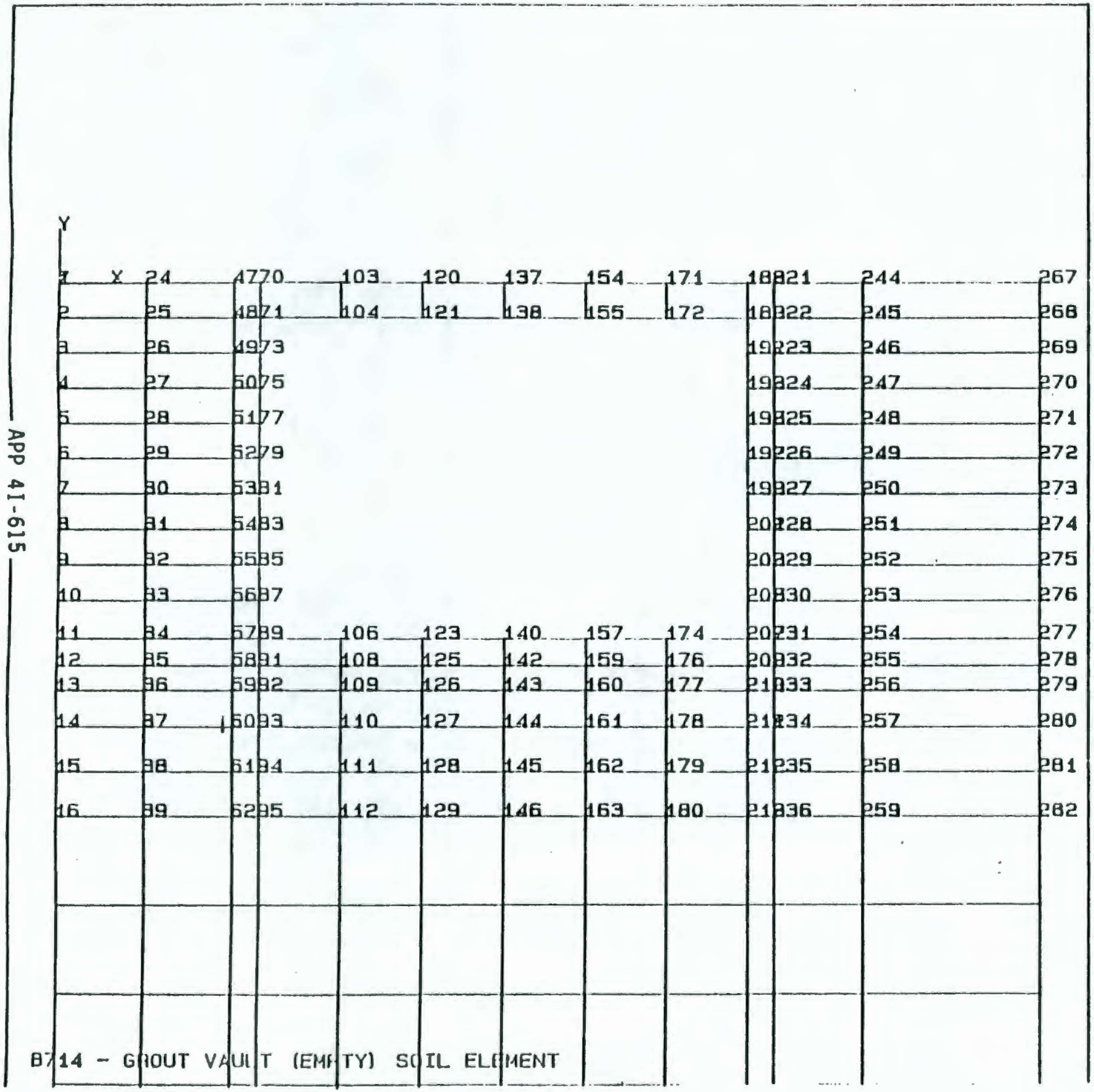
YF=-30



8714 - T VAULT (EMPTY) BEAM ELEMENT NUMBER



B714 - GROUT VAULT (EMPTY) SOIL ELEMENT

ANSYS 4.2
JUN 2 1988
14: 10: 1
ELEMENTS
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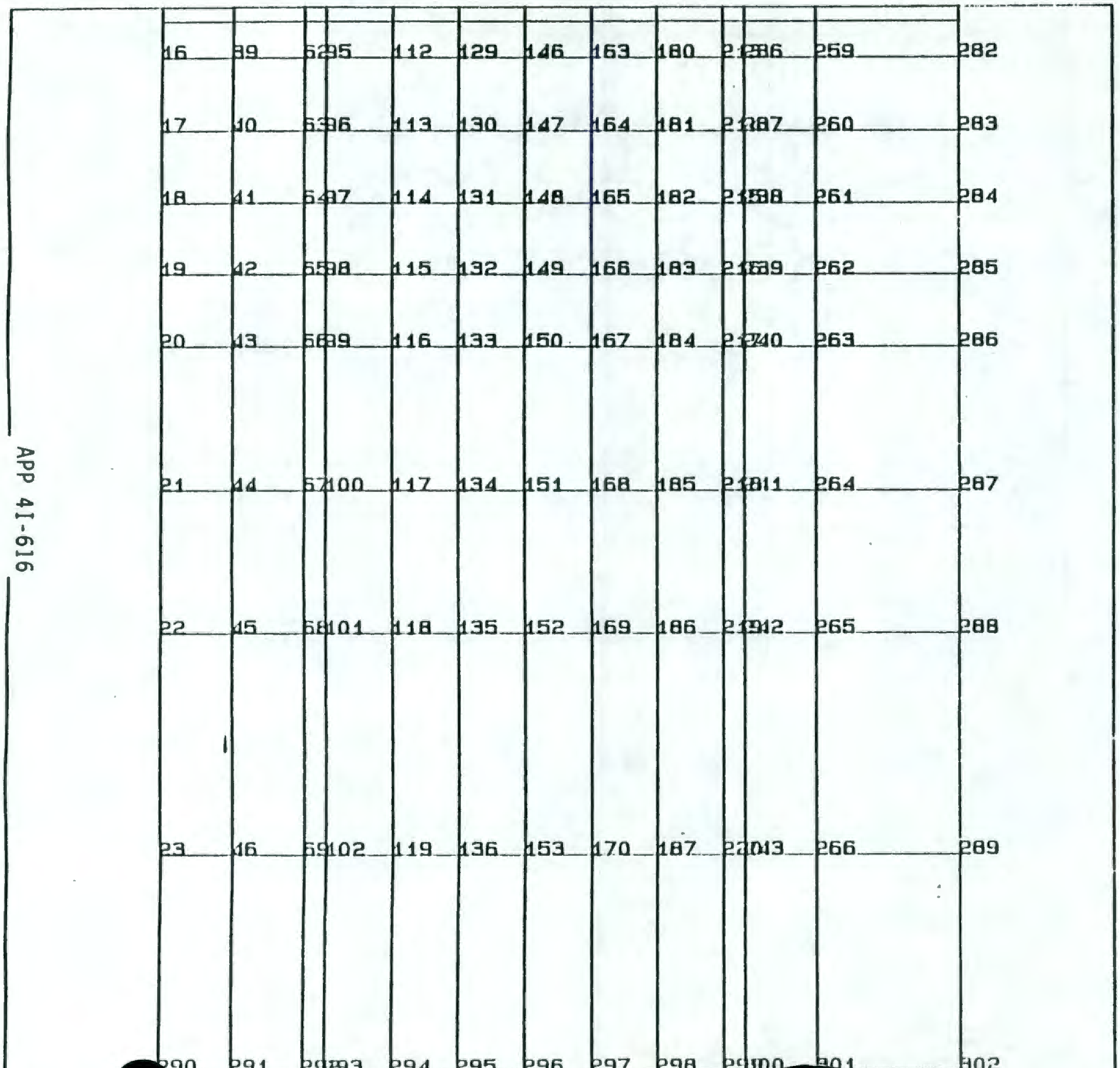
NNUM=1
ZV=1
DIST=61.1
XF=55.5
YF=-30

DOE/RL 88-27
Rev. 1, 01/17/90



ANSYS 4.2
JUN 2 1988
14:26:17
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NNUM=1
ZV=1
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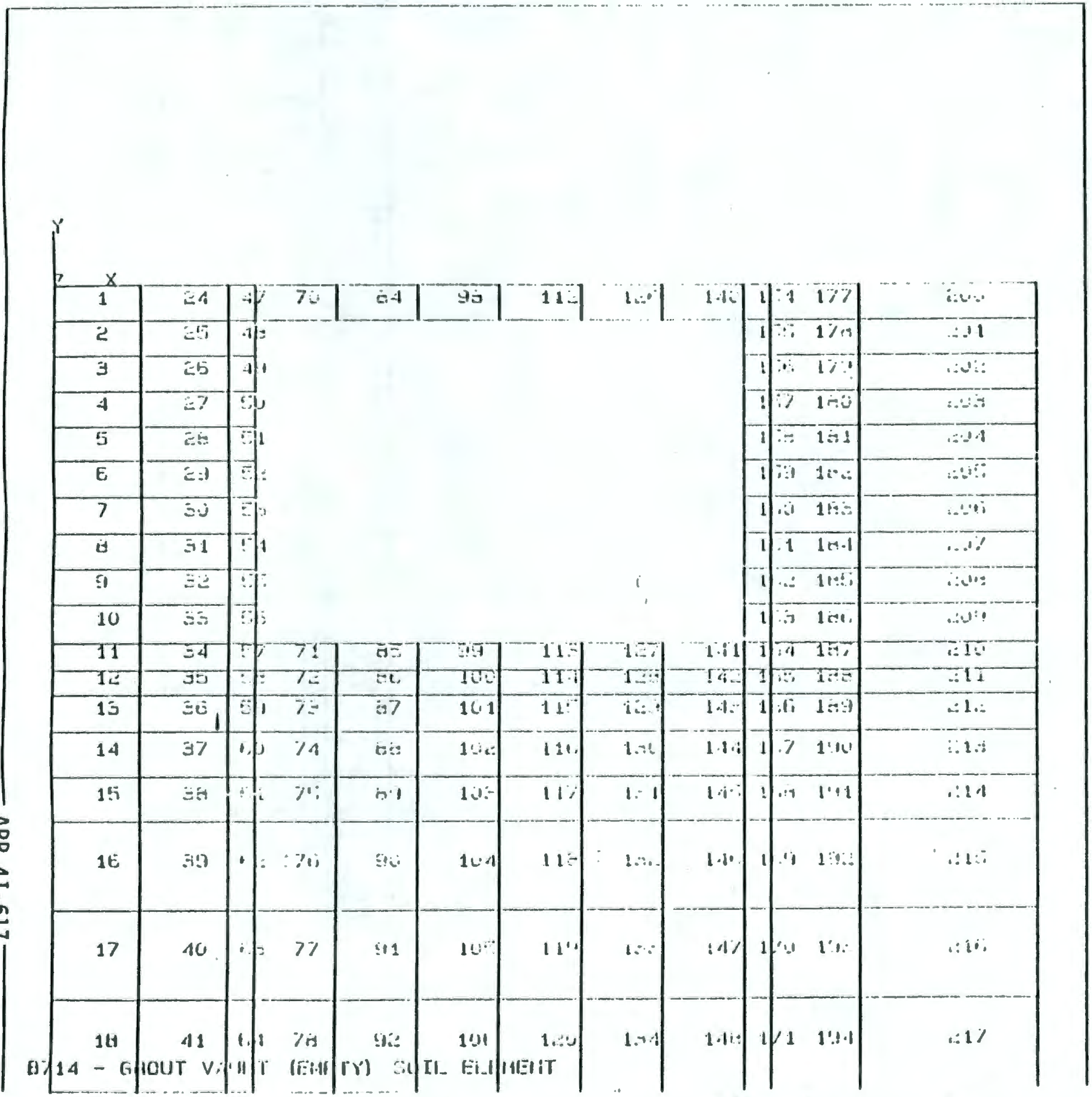
YF=-130

8714 - UT VAULT (EMPTY) SOIL ELEMENT



ANSYS 4.2
JUN 2 1988
15: 3: 52
ELEMENTS
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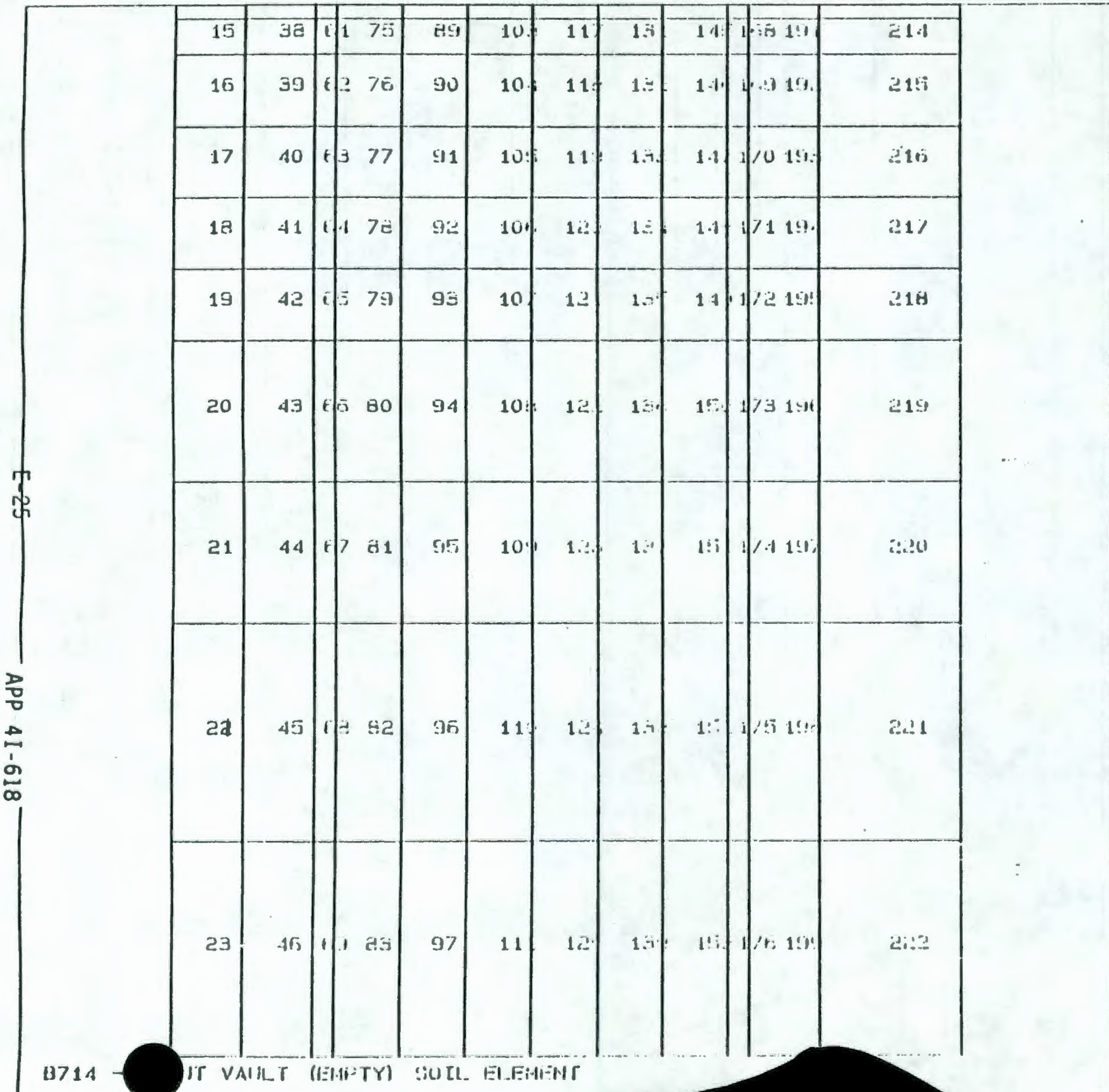
ZV=1
DIST=61.1
XF=55.5
YF=-30

B714 - GROUT VAULT (EMPTY) SOIL ELEMENT



ANSYS 4.2
JUN 2 1988
14: 48: 55
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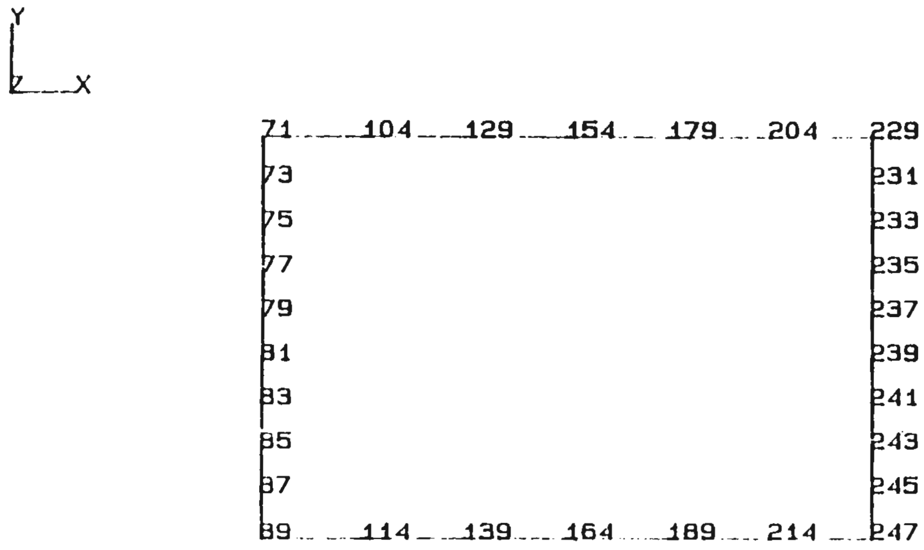
ZV=1
DIST=77
XF=55.5
YF=-150

8714 — IT VAULT (EMPTY) SOIL ELEMENT



ANSYS 4.2
JUN 3 1988
7: 48: 28
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DIST=61.1
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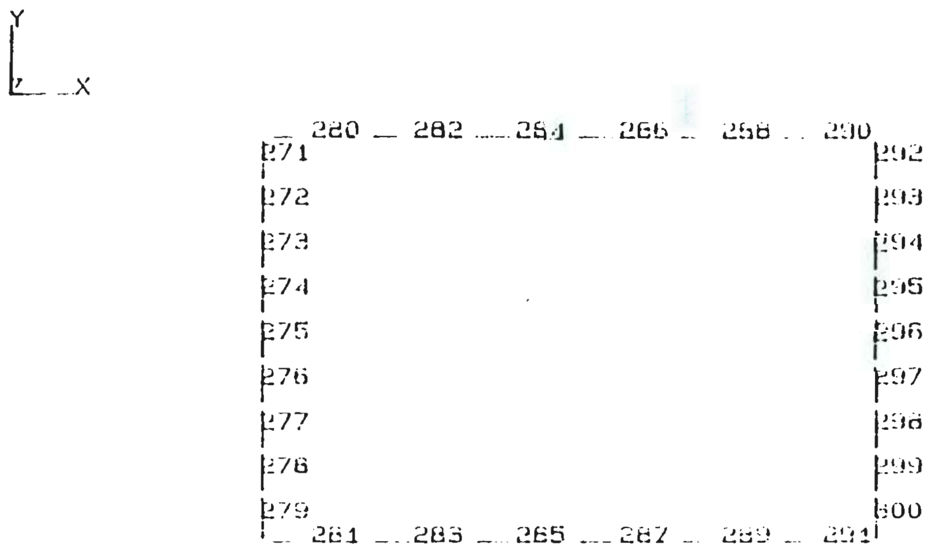
YF=-50

B714 - GROUT VAULT (FULL) BEAM - NODE NUMBER



ANSYS 4.2
JUN 3 1988
9: 11: 4
ELEMENTS
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ZV=1
DIST=61.1
XF=55.5
YF=-50

B714 UT VAULT (FULL) BEAM ELEMENT - ELEMENT NUM

APP 4I-620

ANSYS 4.2
JUN 3 1988
7:53:58
ELEMENTS
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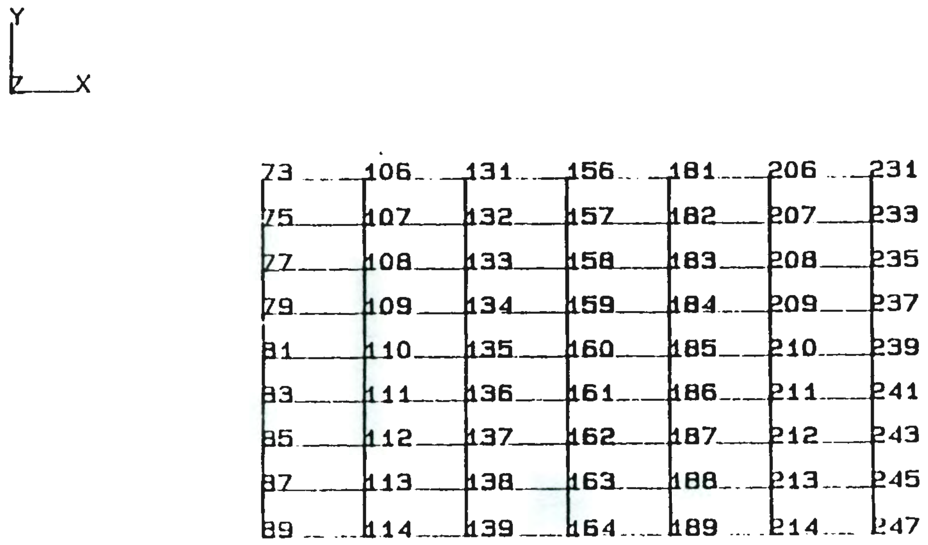
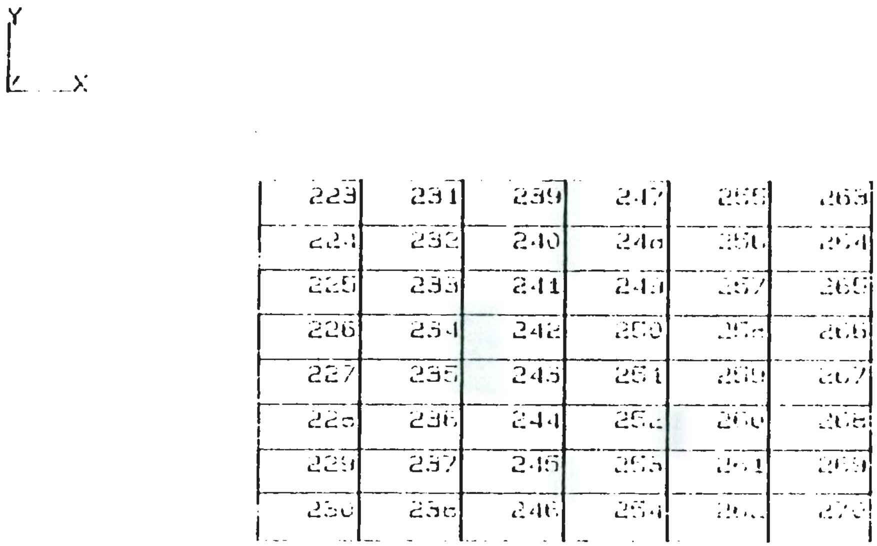
YF=-50



B714 - GROUT VAULT (FULL) - GROUT ELEMENT - NODE NUMBER

23/55



ANSYS 4.2
JUN 3 1988
9: 7: 18
ELEMENTS
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DIST=61.1
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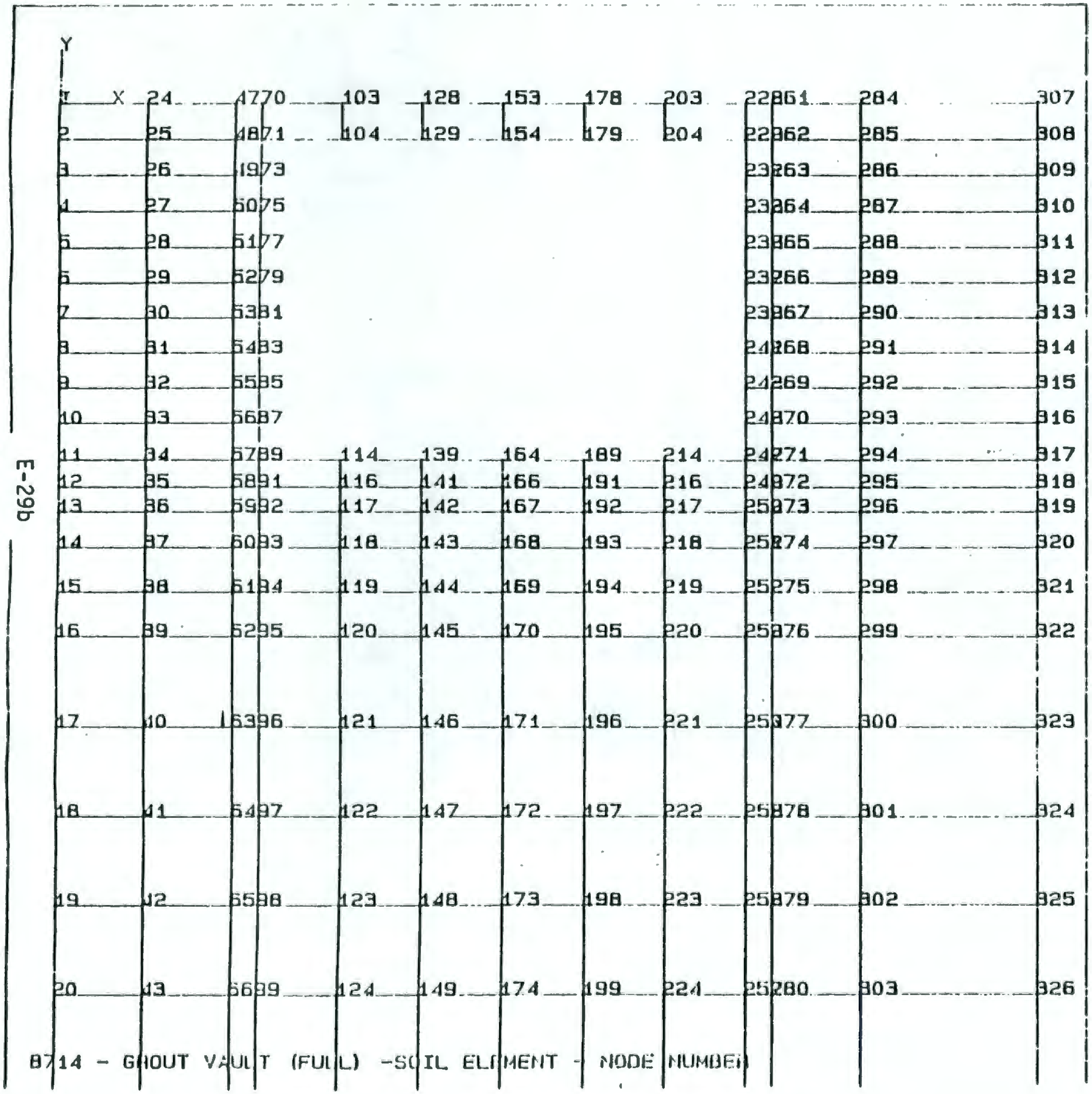
YF=-50

B714 - UT VAULT (FULL) - GROUT ELEMENT · ELEMENT



ANSYS 4.2
JUN 3 1988
8: 2: 22
ELEMENTS
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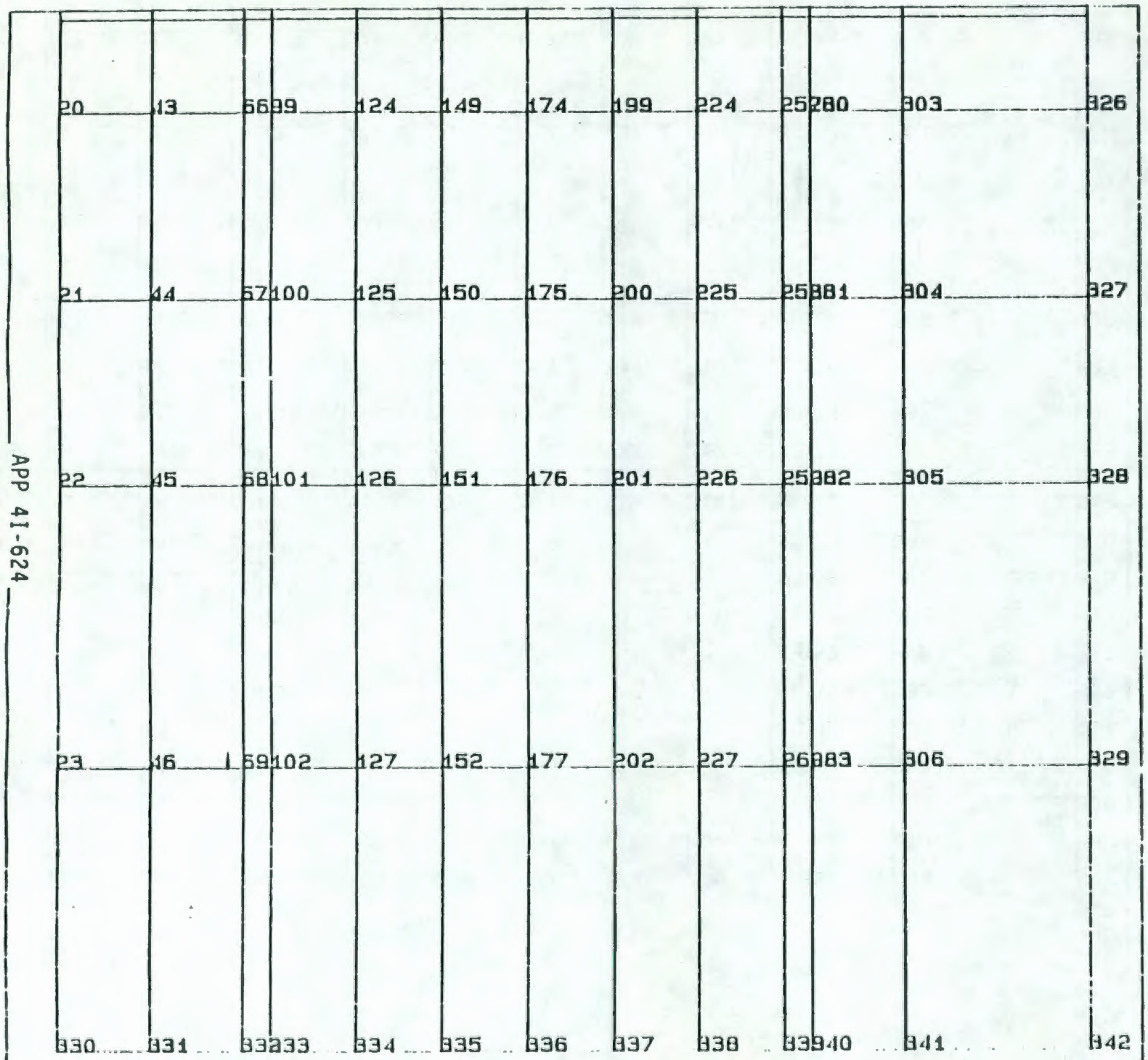
YF=-50

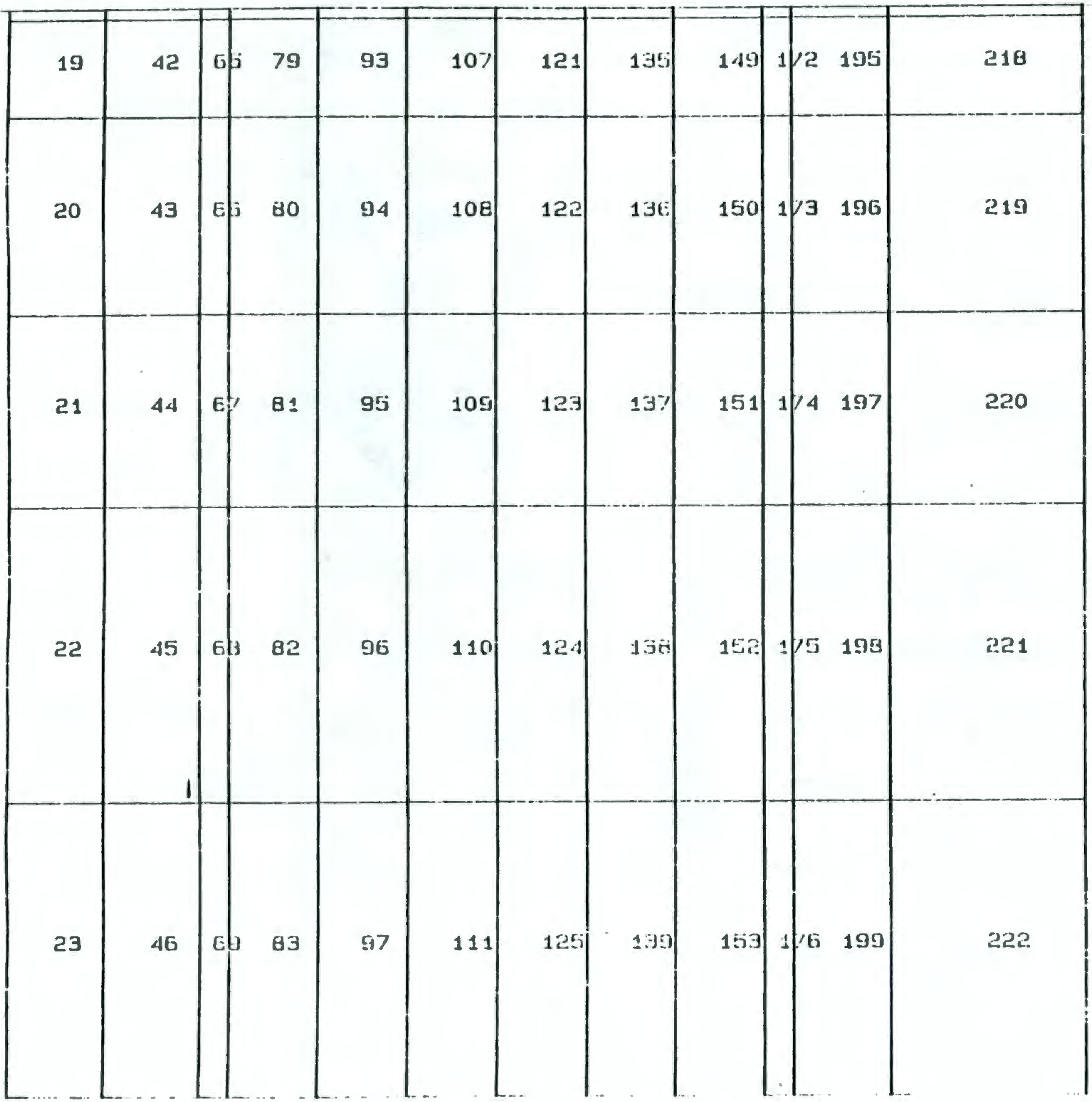


ANSYS 4.2
JUN 3 1988
8:22:56
ELEMENTS
NNUM=1
ZV=1
DIST=61.1
XF=55.5
YF=-150

8714 - UT VAULT (FULL) -SOIL ELEMENT - NODE NUMBE

APP 41-624

E-30



ANSYS 4.2
JUN 3 1988
9: 1: 38
ELEMENTS
ENUM=1
ZV=1
DIST=61.1
XF=55.5
YF=-150

B714 -GROUT VAULT (FULL) - SOIL ELEMENT - ELEMENT NUMBER

APP 4I-625

DOE/RL 88-27
Rev. 1, 01/17/90

27/55

Client	WHC	WO/Job No.	242500
Subject	GROUT VAULT	Date	MAY 2 1988 By MS RUBEN
		Checked	[illegible] By [illegible]
Location	200E	Revised	By

TABLE 8

SOIL PROPERTIES BASED ON GEOPHYSICAL DATA

FROM URS/JOHN A BLUME: "SEISMIC ANALYSIS OF THE PUREX FACILITY" DEC 1976

Depth (ft)	Layer No.	Density (pcf)	Shear Modulus (ksf)	Poisson's Ratio (μ)
	1	110	1,800	0.300
	2	110	2,304	0.301
	3	110	2,851	0.300
20				
	4	120	3,456	0.300
	5	120	3,960	0.297
	6	120	4,392	0.295
	7	120	4,896	0.292
	8	120	5,328	0.290
	9	120	5,976	0.290
	10	120	6,624	0.294
90				
	11	120	7,560	0.300
	12	123	10,656	0.315
	13	125	13,104	0.325
112.5				
	14	125	14,904	0.345
	15	125	15,984	0.362
	16	125	16,848	0.380
	17	125	17,496	0.395
	18	125	18,000	0.407
	19	125	18,288	0.420
	20	125	18,576	0.424
200				

DESIGN ANALYSIS

Client WHC		WO/Job No. 242500	
Subject GROUT VAULT		Date MAY 2 1988	By MS RUBEN
		Checked 11/7/88	By C. R. [illegible]
Location 200E		Revised	By

TABLE 1

SOIL PROPERTIES BASED ON GEOPHYSICAL DATA

FROM URS/BLUME "ANALYSIS OF UNDERGROUND WASTE STORAGE TANKS 241-AW" JULY 1976

Depth (ft)	Layer No.	Density (pcf)	Shear Modulus (ksf)	Poisson's Ratio (μ)
	1	110	1,800	0.300
	2	110	2,304	0.301
20	3	110	2,851	0.300
	4	120	3,456	0.300
	5	120	3,960	0.297
	6	120	4,392	0.295
	7	120	4,896	0.292
	8	120	5,328	0.290
	9	120	5,976	0.290
90	10	120	6,624	0.294
	11	120	7,560	0.300
	12	123	10,656	0.315
112.5	13	125	13,104	0.325
	14	125	14,904	0.345
	15	125	15,984	0.362
	16	125	16,848	0.380
	17	125	17,496	0.395
	18	125	18,000	0.407
	19	125	18,288	0.420
200	20	125	18,576	0.424

Client WHC — WO/Job No. 242500

Subject GROUT VAULT — Date MAY 2 1988 — By MS RUBEN

Checked [illegible] — By [illegible]

Location 200E — Revised — By

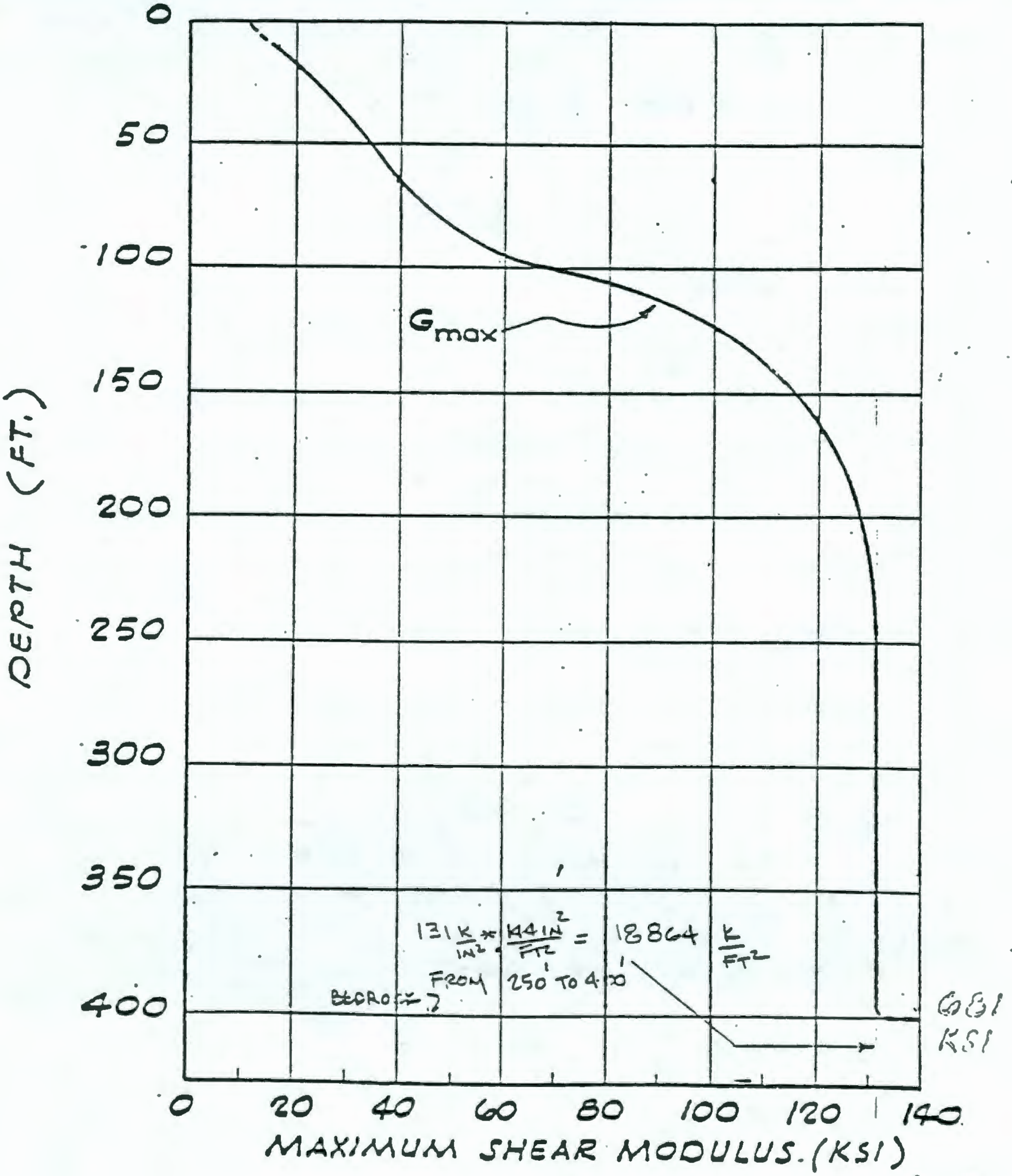
"FROM: VITRO ENGINEERING CORP.
"SEISMIC ANALYSIS OF THE PUREX FACILITY"
DECEMBER 1980

Depth (ft)	Layer No.	Poisson's Ratio	Density (PCF)	Shear Modulus (KSF)
	1	.2	110.	1100.
4.	2	.2	110.	1100.
9.	3	.24	120.	4500.
18	4	.24	120.	4500.
25.75	5	.24	120.	4500.
32.	6	.24	120.	4500.
38	7	.24	120.	4500.
43	8	.29	120.	5400.
50	9	.29	120.	5400.
60	10	.29	120.	5400.
70	11	.29	120.	5400.
80	12	.29	120.	5400.
90	13	.29	120.	5400.
100	14	.36	125.	18800.
114	15	.36	125.	18800.
128	16	.36	125.	18800.
146	17	.36	125.	18800.
164	18	.36	125.	18800.
182	19	.36	125.	18800.
200				

KAISER ENGINEERS
HANFORD

DESIGN ANALYSIS

Client: WHC		WO/Job No.: 242500	
Subject: GROUT VAULT		Date: MAY 2 1988	By: MS RUBEN
		Checked: [illegible]	By: [illegible]
Location: 200E		Revised:	By:



MAXIMUM ELASTIC MODULUS OF FOUNDATION SOILS impact distance on a time-depth graph is the vertical distance between the energy source at the ground surface and the detector, which was positioned at 10-foot intervals down the drill hole. The slope of a line connecting a series of points on these graphs is equal to the velocity of the wave passing through the ground. The depths to various soil layers beneath the ground surface can be derived from the surface refraction measurements using known principles of wave propagation and refraction. Depths to soil layers having different seismic velocities can be observed directly on the time-depth graphs.

DYNAMIC SOIL PROPERTIES

Dynamic soil properties were derived for the 241-SY tank site from on-site seismic measurements of shear and compressional wave velocities of vertically propagated seismic waves. Laboratory measurements of moduli on selected samples obtained in drilling were not undertaken because of special problems with soils of the Hanford Reservation: because the soils are uncemented, it is not possible to keep samples in an undisturbed condition throughout the sampling and testing procedures, and the relatively high content of gravels makes it impossible to test much of the material.

Calculated values of shear modulus for comparison were obtained by converting blow counts recorded during drilling into estimated soil densities using Gibbs and Holtz's criteria (1957). Using these densities, shear-wave velocities were calculated by means of formulae derived by Hardin and Richart (1963). Values of shear modulus at various depths were then derived from these calculated velocities. Although the reliability of density measurements based on blow counts has been questioned and the data of Hardin and Richart were extrapolated in these calculations, reasonable similarity was observed in the two sets of data. Shear moduli derived from measured shear-wave velocities at the tank site were lower.

The shear modulus for low strain levels, G_{max}, calculated from shear-wave velocities, is shown in Figure 5 as a function of depth below ground surface. Shear modulus is shown in Figure 6 as a decreasing function of strain level. The moduli are expressed as ratios of the maximum values shown in Figure 5.

"FROM URS/BLUME
ANALYSIS OF UNGRD. WASTE STORAGE TANKS 241-SY AT HANFORD, WA"
OCT. 1974

9 0 1 1 7 8 6 1 1 8 2

3. COMPUTATION OF BASE MOTION (DECONVOLUTION)

The SSE has been specified in terms of free-field spectra (Figure 4) and was represented by a synthetic free-field acceleration time history (Figure 5). To evaluate the response during the SSE of an underground tank and the soil surrounding it, the input motion must be applied at the base of the soil-tank model. This base motion should be equivalent to the specified surface motion.

Such a computation of the motion at the base of soil layers that will produce a given surface response motion is the reverse of the usual problem of computing the surface response of soil layers subjected to a given base motion. It is difficult if not impossible to solve such a problem in the time domain. However, for stable linear elastic systems, there exists a simple relationship between the output motion (motion at the surface or any intermediate point) and the input (base) motion in the frequency domain:

$$Y(\omega) = H(\omega) \cdot X(\omega)$$

where $Y(\omega)$ and $X(\omega)$ are the Fourier transforms of the output motion $y(t)$ and input motion $x(t)$, respectively, and $H(\omega)$ is the frequency response function of the system and is solely dependent on the system properties. Here, $Y(\omega)$ can be computed because the surface motion $y(t)$ is known. $H(\omega)$ is simply the Fourier transform of the surface response of the soil layers to unit impulse input at the base. Thus, $X(\omega)$ may be computed from the above equation and then $x(t)$ may be obtained by inverse Fourier transform of $X(\omega)$.

A soil-column model of unit area up to a depth of 200 feet was used for the deconvolution analysis described above to obtain the base motion time history. The base motion as considered in the analysis is the motion at 200 feet below the surface. The acceleration time history at the surface of the soil column was recomputed using the computed base motion as input. The acceleration response spectra of the recomputed surface motion and the original free-field motion are compared in Figure 6.

Some variability was again found in the uppermost 10 ft of soil. This is possibly due to past grading activities or temporary ground freezing. The seismic velocity profiles shown in Figures 2 and 3 indicate that below this surficial layer the soil properties are consistent within this portion of the 200 East Area.

Soil densities derived from previous URS/Blume investigations and seismic velocities obtained in a nearby well by uphole seismic techniques were incorporated to produce a model of soil properties to a depth of 400 ft.

Design Modulus Values

The dynamic shear modulus for low strain levels, G_{max}, calculated from shear wave velocities, is shown in Figure 4 as a function of depth below ground surface. The ratio of design shear modulus to G_{max} is shown in Figure 5 as a decreasing function of strain level.

The design curves in Figures 4 and 5 are recommended for the 241-AN and -AP waste storage tanks. The appropriate dynamic shear modulus can readily be computed for a desired depth and strain level. For example, the shear modulus corresponding to a shear strain of 10^{-4} in./in. at a depth of 100 ft can be evaluated as follows. From Figure 4, G_{max} = 68 ksi at 100 ft. The modulus ratio corresponding to a strain level of 10^{-4} in./in. is found from Figure 5 to be 0.73. The desired shear modulus, G, is then (0.73) (68 ksi) = 49.6 ksi.

Conclusion

The results of our seismic refraction surveys at the 241-AN and 241-AP tank sites have been compared with previous work done for the AW tanks (1976) and for the AZ tanks (1970). The similarities of the seismic velocity profiles indicate that the soil properties model used for the 241-AW tanks is applicable also to the 241-AN and 241-AP tank sites.

FROM URS/BLUME "INVESTIGATION TO DETERMINE DYNAMIC SOIL PROPERTIES AT 241-AN & 241-AP TANK SITES" MAR 1977

9011761184

Values of natural soil density were also estimated. These are shown in Figure 6 to be 107 pcf for the surficial 4 ft of soil, 110 pcf for the intermediate layer from 4 to 18 ft deep, and 118 pcf for the soils from 18 ft to the depth of the soil model (75 ft).

The soil data are limited and they vary by about ±10 pcf in density and ±2° in friction angle. An analysis of the tank foundation soils should take this range of variation into account either by applying an appropriate factor of safety or by performing a parameter sensitivity analysis.

Geophysical Measurements

Geophysical measurements at the site consisted of five seismic refraction surveys conducted on the ground surface to determine shear and compressional wave velocities in the soil. Measurements were obtained with a Bison model 1570B portable seismograph using a 10-lb sledge hammer impact as an energy source. Locations of the seismic refraction lines are shown in Figure 1. Time-distance plots of the resulting data are shown in Figures 2 through 5.

Dynamic Soil Properties

The measured seismic velocities were found to be comparable to velocities determined at other sites within the 200 East area. Some variability and generally lower shear wave velocities were found in the uppermost 18 ft of soil. This is probably due to past grading activities and the presence of loess soil of windblown origin. The seismic velocity profiles indicate that below this surficial layer the soil properties are consistent within this portion of the 200 East area.

"FROM URS/BLUME "INVESTIGATION TO DETERMINE DYNAMIC SOIL PROPERTIES AT THE 241-AP TANK SITE" JUNE 198

Design Modulus Values

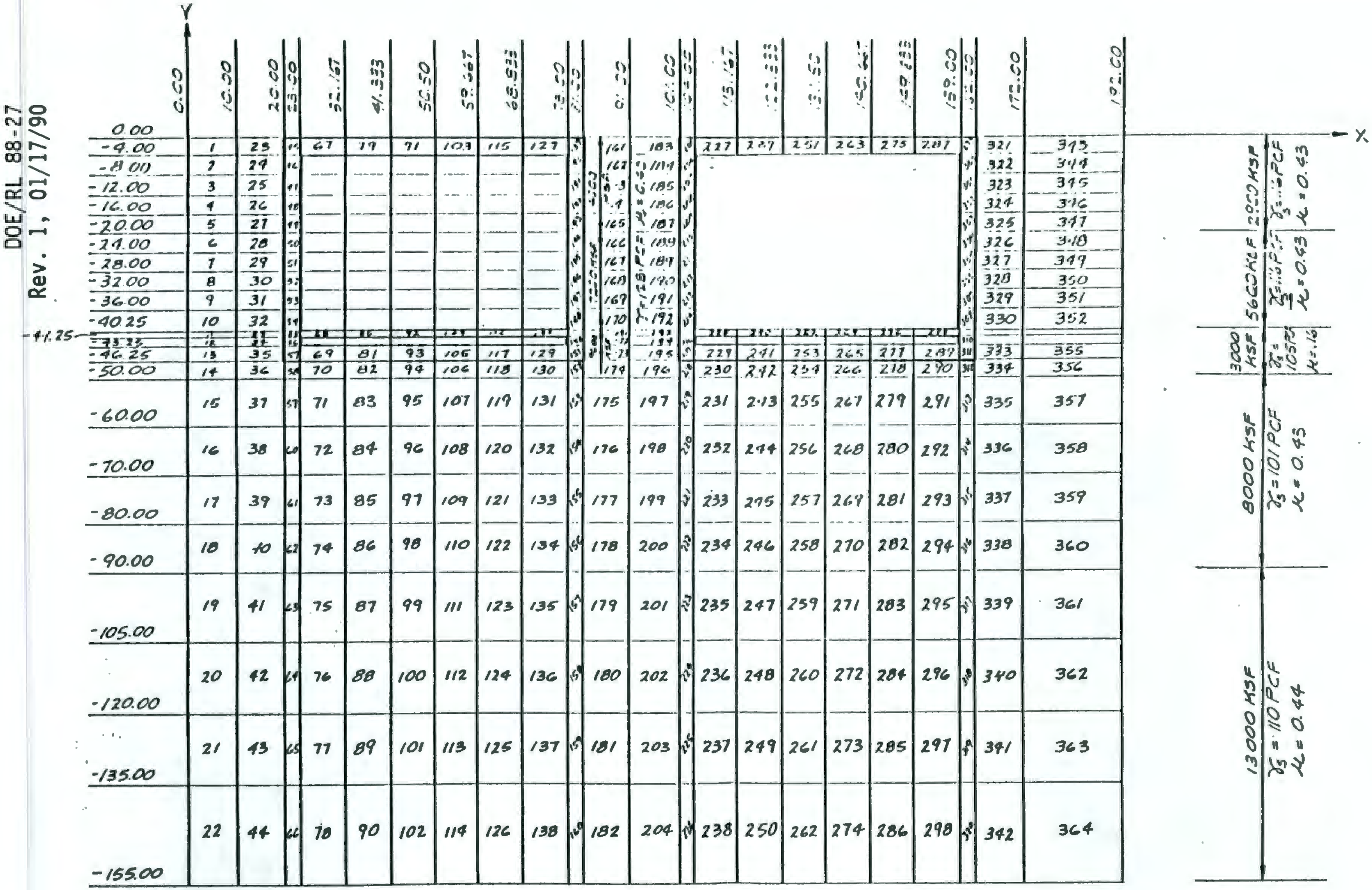
The dynamic shear modulus for low strain levels, G_{max}, calculated from shear wave velocities, is shown in Figure 6 as a function of depth below ground surface. The ratio of design shear modulus to G_{max} is shown in Figure 7 as a decreasing function of strain level.

Figures 6 and 7 are recommended for the 241-AP waste storage tanks. The appropriate dynamic shear modulus can readily be computed for a desired depth and strain level. For example, the shear modulus corresponding to a shear

Client	WHC	WO/Job No.	ER1060		
Subject	GROUT VAULT	Date	9/23/88	By	MS RUBEN
		Checked	11/4/??	By	C. M. CONSELMAN
Location	200E	Revised		By	

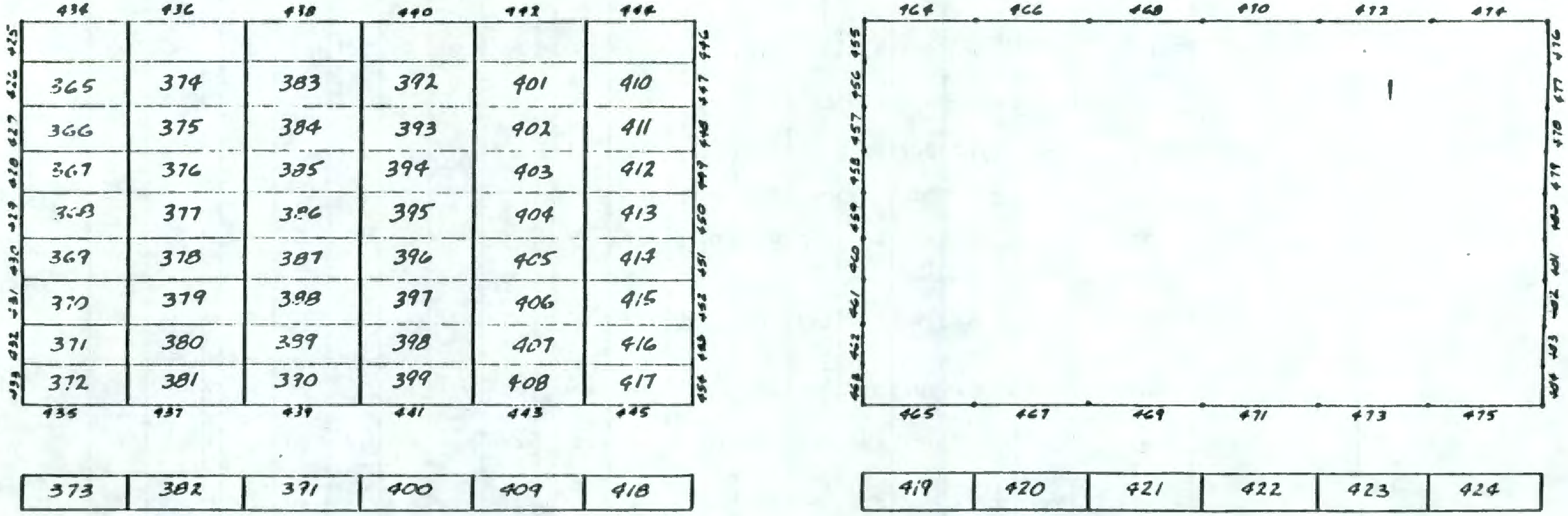
PART II

9 0 1 1 7 5 1 1 8 6



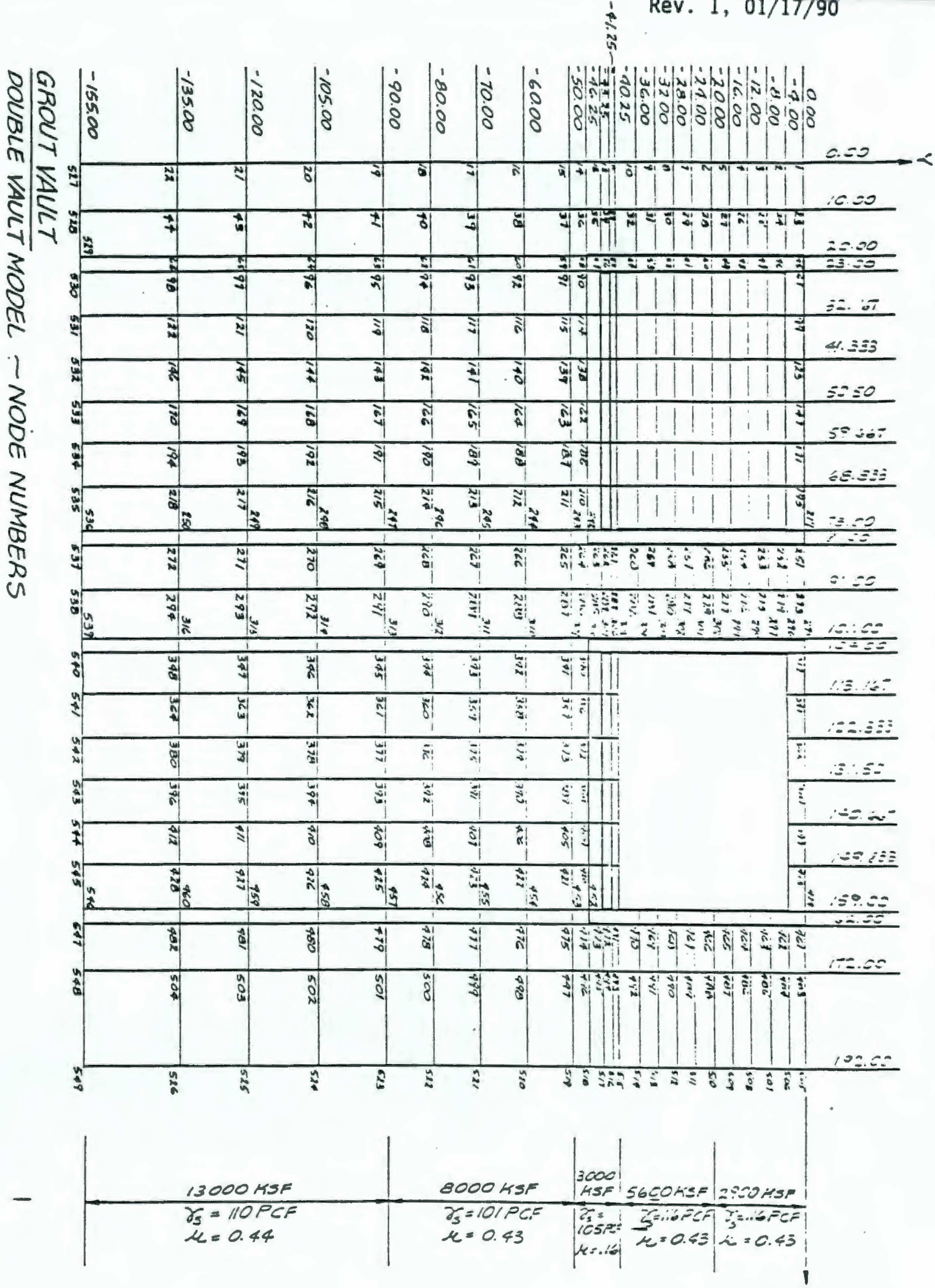
GROUT VAULT

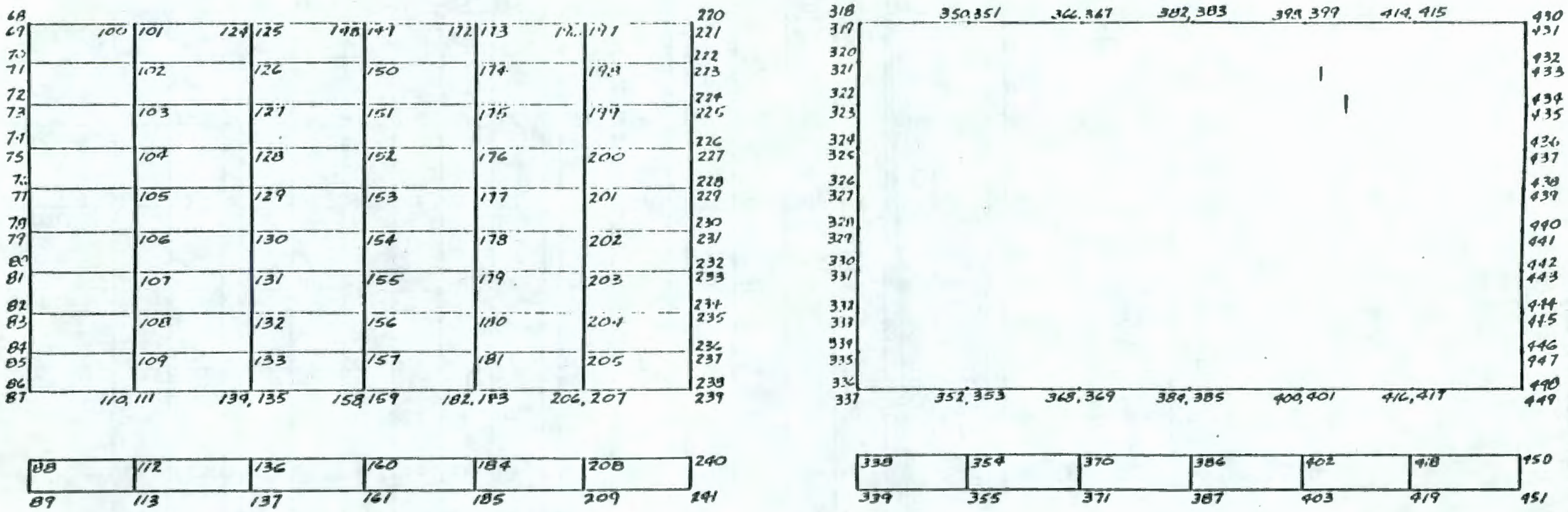
DOUBLE VAULT MODEL — ELEMENT NUMBERS



GROUT VAULT

DOUBLE VAULT MODEL ELEMENT NUMBERS


GROUT VAULT
DOUBLE VAULT MODEL — NODE NUMBERS
13000 KSF
γ_s = 110 PCF
μ = 0.44
8000 KSF
γ_s = 101 PCF
μ = 0.43
3000 KSF
5600 KSF
μ = 0.43
μ = 0.43



GROUT VAULT

DOUBLE VAULT MODEL

NODE NUMBERS

Client	WHC	WO/Job No.	ER1060		
Subject	GROUT VAULT	Date	9/23/88	By	HS RUBEN
		Checked	11/5/88	By	C. M. CONSELMAN
Location	200E	Revised		By	

DOUBLE VAULT

THE DOUBLE VAULT MODEL WAS MODIFIED TO INCLUDE SOIL PROPERTIES RECOMMENDED BY DAMES & MOORE IN THEIR REPORT DATED AUG 23 1988. THESE VALUES WERE NOT AVAILABLE WHEN ~~PART I~~ WAS DONE. ADDITIONAL REFINEMENTS TO THE DOUBLE VAULT MODEL INCLUDE CHANGING THE RIGHT SIDE COLUMN WIDTHS TO EQUAL THE LEFT SIDE AND REVISING LAYER THICKNESSES AT THE LOWER ELEVATIONS TO BETTER MATCH SOILS PROPERTIES AND ACCOUNT FOR TRANSMISSION OF MOTION THROUGH THEM. CONCRETE SOLID ELEMENTS WERE ADDED TO REPRESENT THE CONCRETE CATCH BASIN WHICH WAS ADDED ~~AFTER~~ PART I WAS COMPLETED. SINCE BELOW GROUND STRUCTURES DO NOT HAVE HIGH FREQUENCY RESPONSE, THE MAXIMUM FREQUENCY USED WAS 20 HZ.

THE COMPUTER OUTPUT OF THE REVISE DOUBLE VAULT MODEL (J978A, DATED 9/19/88) COMPARES CLOSELY WITH THE PART I DOUBLE MODEL AND CONCLUDE THAT THERE IS NO SIGNIFICANT INFLUENCE OF ONE GROUT VAULT ON ANOTHER. THEREFORE, MAXIMUM RESPONSES FOR A VAULT DUE TO SEISMIC LOADING WILL BE DETERMINED USING A SINGLE VAULT MODEL.

Client	WHC	WO/Job No.	ER 1060		
Subject	GROUT VAULT	Date	9/23/88	By	HS RUBEN
		Checked	11/8/88	By	C. R. CONISELMAN
Location	200 E	Revised		By	

PART I { SINGLE VAULT MAX. MOMENT DUE TO HORIZ. MOTION
ELEM. NO. 252 $E_{SS} = 208.2^{K}/FT$ COMPUTER RUN "44I" DATED 5/20/88
DOUBLE VAULT MAX MOMENT DUE TO HORIZ MOTION
ELEM NO. 484 $E_{SS} = 192.1^{K}/FT$ COMPUTER RUN "366I" DATED 6/14/88

PART II { DOUBLE VAULT MAX MOMENT DUE TO HORIZ MOTION
ELEM. NO 484 $E_{SS} = 179.7^{K}/FT$ COMPUTER RUN J978A DATED 9/11/88

COMPARING THE SINGLE & DOUBLE VAULT MODEL OF PART I SHOWS A REDUCED MAX. MOMENT AT THE BASE OF THE WALL IN THE EMPTY VAULT OF THE DOUBLE VAULT MODEL. THE REFINEMENTS OF THE MODEL IN PART II RESULTS IN ADDITIONAL REDUCTION OF THE MAX MOMENT. THE CONCLUSION IS THAT THE SINGLE VAULT MODEL WILL HAVE CONSERVATIVE RESULTS. THEREFORE USE A SINGLE VAULT MODEL FOR SEISMIC RESPONSES

THE DOUBLE VAULT MODEL WAS ALSO ANALYZED USING THE "FLUSH" 3D SIMULATION. NO SIGNIFICANT DIFFERENCE USING THE 3D SIMULATION WAS FOUND. THEREFORE IT WILL NOT BE USED IN THE SINGLE VAULT ANALYSIS.

Client	WHC	WO/Job No.	ER 1060		
Subject	GROUT VAULT	Date	9/23/88	By	MS RUBEN
		Checked	11/8/88	By	C. M. CONTEL...
Location	200E	Revised		By	

SINGLE VAULT MODEL

THE DOUBLE VAULT MODEL WAS MODIFIED TO ACCOUNT FOR CRACKING & NO BONDING BETWEEN THE GROUT & CONCRETE WALLS OF THE VAULT. ADDITIONAL NODES WERE PLACED AT THE VAULT WALL BEAM ELEMENT ENDS, AND THE SOLID GROUT ELEMENTS WERE "DECOUPLED" FROM THE VAULT WALLS. TWO DIFFERENT CASES WERE INVESTIGATED. ONE WITH THE GROUT HAVING A DENSITY OF 100 PCF AND THE SECOND WITH USING 1 PCF FOR THE GROUT DENSITY AND LUMPING THE GROUT MASS AROUND THE PERIMETER OF THE VAULT. ADDITIONAL CHANGES FROM THE PART 2 MODEL INCLUDE USING THE DAMES & MOORE SOIL PROPERTIES, REVISING LAYER THICKNESSES AT THE LOWER ELEVATIONS, ADDING THE CONCRETE CATCH BASIN AND REVISING THE RIGHT SIDE SOIL COLUMNS' WIDTH TO MATCH THE LEFT. ANOTHER REVISION WAS TO ADD ELEMENTS AT THE ENDS OF THE CONCRETE ROOF PLANKS THAT HAD VERY SMALL MOMENTS OF INERTIA TO SIMULATE "PINNED" ENDS OF THE ROOF PLANK BEAMS. THE MAXIMUM MOMENT AT THE CENTER OF THE ROOF SPAN FOR HORIZ. & VERTICAL EARTHQUAKE MOTION WAS USED FOR THE PLANK DESIGN.

9011786193

DESIGN ANALYSIS

Client	WHC	WO/Job No.	ER106A		
Subject	GROUT VAULT	Date	9/22/88	By	C.M CONSELMEN
		Checked	9/22/88	By	MS [illegible]
Location	200E	Revised		By	

- GROUT WEIGHT = 100#/CF

- CONSIDER 1 FT. THICK SECTION

NODE	WT. OF GROUT (KIPS)
73	5.5
76	11.0
79	11.0
82	11.0
85	11.0
88	11.0
91	11.0
94	11.0
97	1.0
125	20
151	2.0
177	2.0
203	2.0
229	2.0
249	5.5
252	11.0
255	11.0
258	11.0

90117851194

DESIGN ANALYSIS

Client	WHC	WO/Job No.	ER 1060
Subject	GROUT VAULT	Date	9/22/88 By C.M. CONSELMAN
		Checked	9/23/88 By MS Ruher
Location	200E	Revised	By

NODE	WT. OF GROUT (KIPS)
261	11.0
264	11.0
267	11.0
270	11.0
273	1.0

$\Sigma = 177.0$

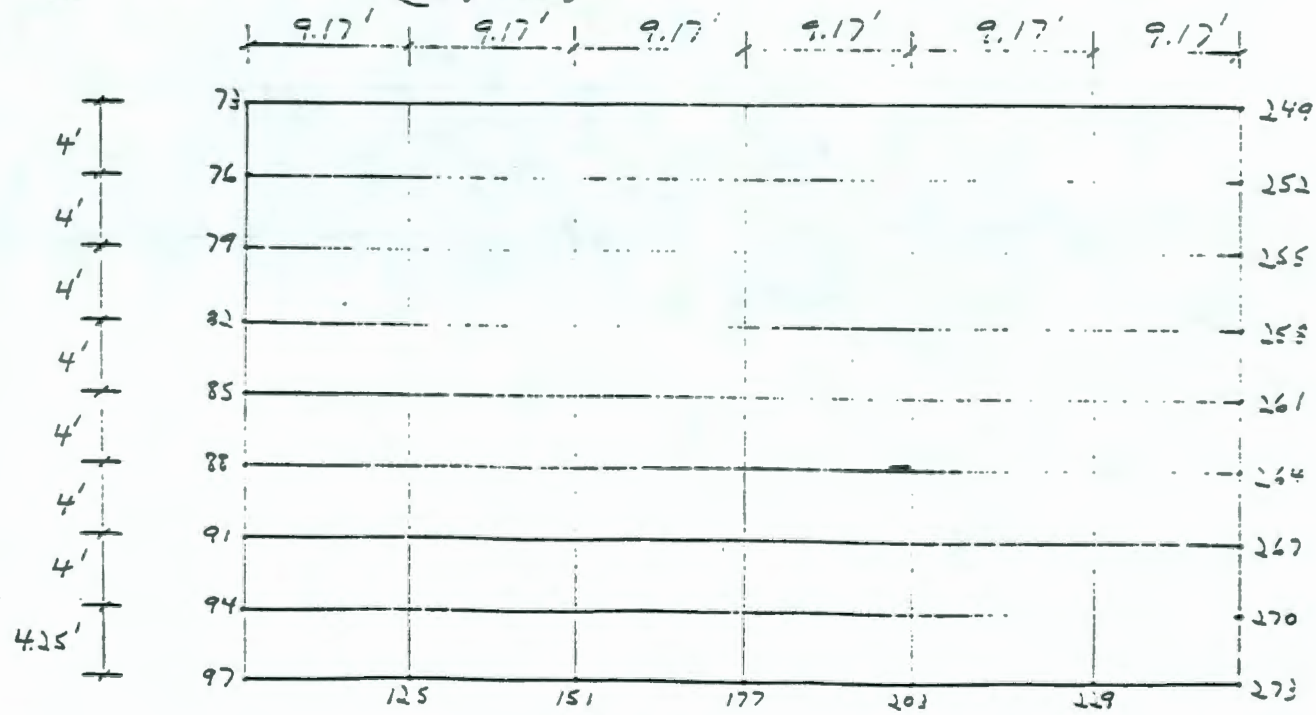
$55(32.25)\frac{100}{1000} = 177.3^K$

SAMPLE CALCS.

@ NODE 73: $(4/2)\,3(9.17)\,100 = 5500^{\#} = 5.5^K$

@ NODE 76: $4(3)(9.17)(100) = 11{,}000^{\#} = 11.0^K$

@ NODE 97: $\left(\frac{4.25}{2}\right)\left(\frac{9.17}{2}\right) 100 = 974^{\#} = 1.0^K$



Y \ X	0.00–10.00	10.00–20.00	20.00–23.00	23.00–32.167	32.167–41.333	41.333–50.50	50.50–59.667	59.667–68.833	68.833–78.00	78.00–81.00	81.00–91.00	91.00–101.00
0.00 to -4.00	1	24	47	70	83	96	109	122	135	148	171	194
-8.00	2	25	48							149		195
-12.00	3	26	49							150		196
-16.00	4	27	50							151		197
-20.00	5	28	51							152		198
-24.00	6	29	52							153		199
-28.00	7	30	53							154		200
-32.00	8	31	54							155		201
-36.00	9	32	55							156		202
-40.25	10	33	56							157		203
-41.25	11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
-43.25	12	[illegible]	[illegible]								182	205
-46.25	13	36	59	72	85	98	111	124	137	160	183	206
-50.00	14	37	60	73	86	99	112	125	138	161	184	207
-55.00	15	38	61	74	87	100	113	126	139	162	185	208
-60.00	16	39	62	75	88	101	114	127	140	163	186	209
-65.00	17	40	63	76	89	102	115	128	141	164	187	210
-70.00	18	41	64	77	90	103	116	129	142	165	188	211
-75.00	19	42	65	78	91	104	117	130	143	166	189	212
-90.00	20	43	66	79	92	105	118	131	144	167	190	213
-105.00	21	44	67	80	93	106	119	132	145	[illegible]	191	214
-120.00	22	45	68	81	94	107	120	133	146	169	192	215
-135.00	23	46	69	82	95	108	121	134	147	170	193	216

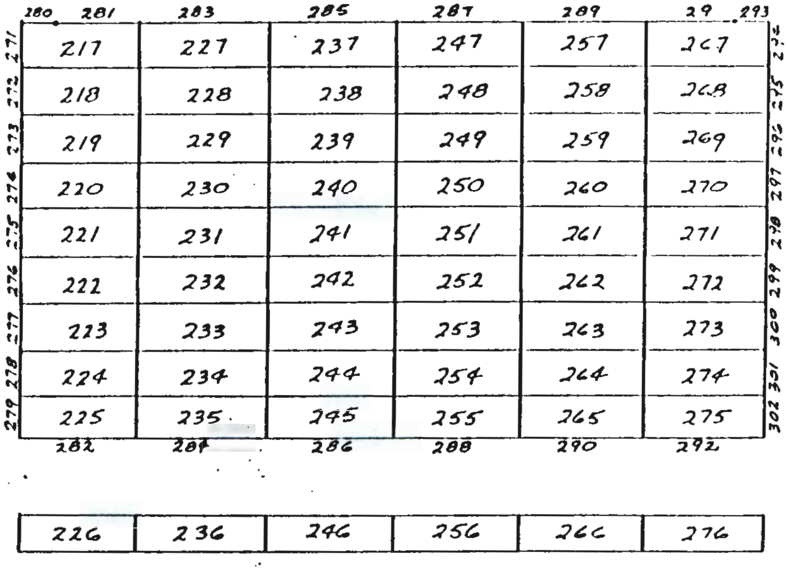
Column annotations (X = 81.00–91.00): 4000 (to -20.00); 7200 (-24.00 to -40.25); 9600 and G_S (-55.00 to -65.00); γ = 128 PCF, μ = 0.40 (0.00 to -40.25).

Right-side annotations:
- 0.00 to -20.00: G_S = 2900, γ = 116 PCF, μ = 0.43
- -20.00 to -41.25: G_S = 5600, γ = 116, μ = 0.43
- -41.25 to -50.00: G_S = 3000, γ = 105, μ = 0.16
- -50.00 to -90.00: G_S = 8000 KSF, γ = 101 PCF, μ = 0.93
- -90.00 to -135.00: G_S = 13000 KSF, γ = 110 PCF, μ = 0.44

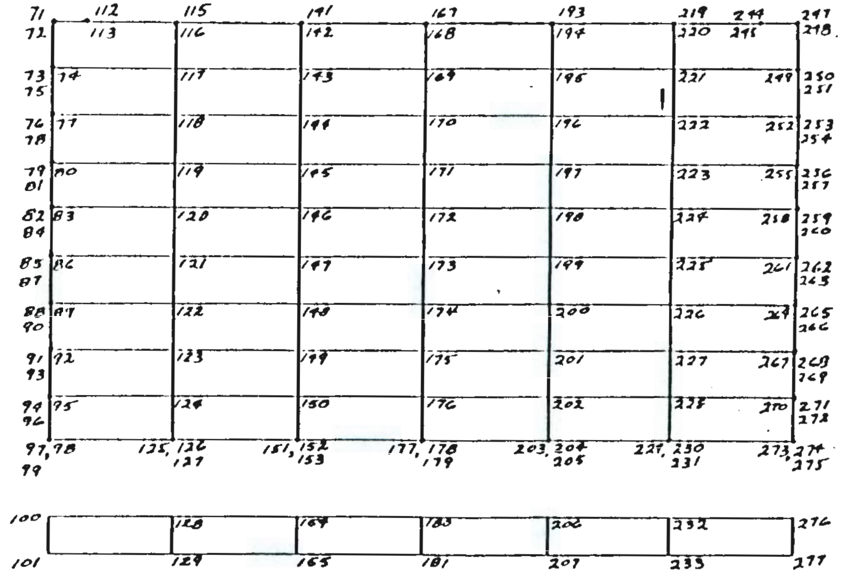
GROUT VAULT

SINGLE VAULT MODEL

ELEMENT NUMBERS



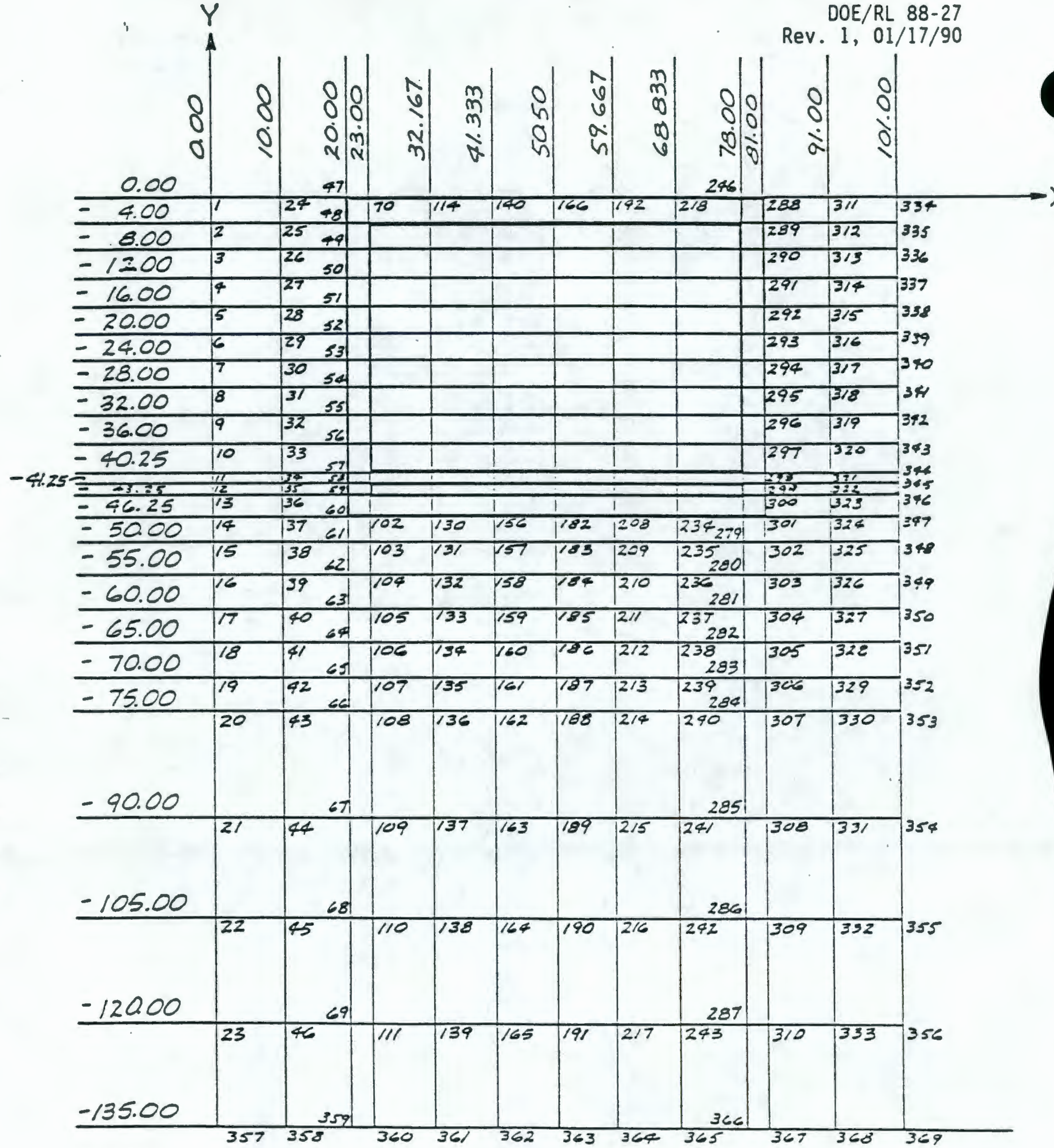
ELEMENT NUMBERS



NODE NUMBERS

GROUT VAULT

SINGLE VAULT MODEL



GROUT VAULT

SINGLE VAULT MODEL

NODE NUMBERS

Client	WHC	WO/Job No.	ER1060		
Subject	GROUT VAULT	Date	11/3/88	By	MS RUBEN
		Checked	11/7/88	By	C. M. CONSELMAN
Location	200E	Revised		By	

RESULTS OF SINGLE VAULT

MAX MOMENT AT BASE OF WALL WITH GROUT γ = 100 PCF - HORIZ MOTION

ELEM NO. 302 M_{SSE} = 147 K/FT (COMPUTER RUN 107 I 11/1/88)

MAX MOMENT AT BASE OF WALL WITH GROUT γ = 1 PCF & GROUT MASS LUMPED AROUND WALL PERIMETER - HORIZ MOTION

ELEM NO. 302 M_{SSE} = 241 K/FT (COMPUTER RUN 169 I 11/2/8

USE MAX M_{SSE} = 241 K/FT FOR MOMENT DUE TO SSE AT BASE OF GROUT WALL

MAX SHEAR FORCE = 28 K/FT ELEMENT 302 (169 I)

A VERTICAL ANALYSIS WAS MADE OF THE SINGLE VAULT MODEL. THE MAX MOMENT FOR $\frac{2}{3}$ * .25 g MOTION AT ELEMENT 302 IS 50.7 K/FT. V_{SSE} = 7.0 K (COMPUTER RUN 242 I 11/3/88)

THEREFORE SSE MOMENT AT BASE OF WALL

$$M_{SSE} = \sqrt{241^2 + 50.7^2} = 246.3 \text{ K/FT}$$

$$\& \; V_{SSE} = \sqrt{28^2 + 7^2} = 29 \text{ K/FT}$$

OBE MOMENT AT BASE OF WALL

$$M_{OBE} = 246.3 \text{ K/FT} * \frac{0.05}{0.25} = 49.3 \text{ K/FT}$$

$$V_{OBE} = 29.0 * \frac{.05}{.25} = 5.8 \text{ K/FT}$$

Client WHC	WO/Job No. ER1060		
Subject GROUT VAULT	Date SEPT 1988	By MS RUBEN	
	Checked 11/8/88	By C.M. CONSELMAN	
Location 200 E	Revised	By	

LONGITUDINAL CROSS-SECTION

A MODEL OF THE LONGITUDINAL CROSS-SECTION WAS MADE TO INVESTIGATE THE END WALL RESPONSE TO EARTHQUAKE MOTIONS. A SYMMETRICAL HALF MODEL WAS USED. THE LONG SIDE WALLS WERE TREATED AS SHEAR WALLS. THE WEIGHT OF THE GROUT WAS LUMPED AT NODE POINTS ALONG THE WALL HEIGTH AND MAT BOTTOM. TWO RUNS WERE MADE. THE FIRST ASSUMED 1/2 OF THE GROUT WEIGHT ON THE WALL. THE SECOND ASSUMED ALL OF THE GROUT WEIGHT ON THE WALL.

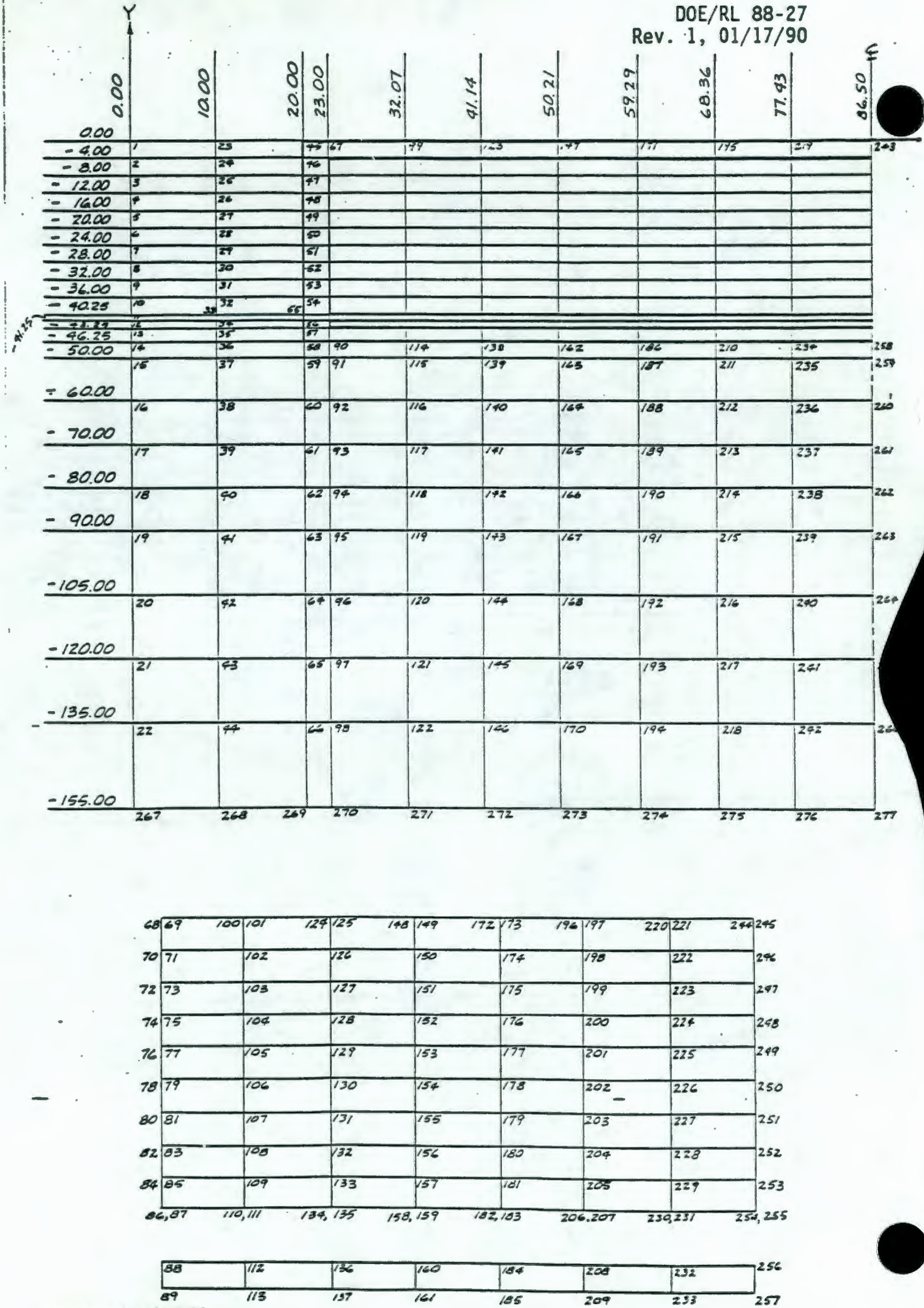
A THIRD MODEL WAS ALSO INVESTIGATED AFTER THE RESULTS OF THE FIRST TWO LONGITUDINAL MODELS WERE KNOWN. THE SHEAR MODULUS OF THE 2 SHEAR WALLS WAS REDUCED 1/100, ELIMINATING THE SHEAR WALL PER FOOT SUPPORT ON THE END WALL CREATING MORE OF A 2-WAY RESPONSE OF THE END WALL. ONLY 1/2 OF THE GROUT WEIGHT WAS "LUMPED" ON THE END WALL FOR THIS MODEL.

9 0 1 1 7 5 1 2 0 0

Y	0.00–10.00	10.00–20.00	20.00–23.00		23.00–32.07	32.07–41.14	41.14–50.21	50.21–59.29	59.29–68.36	68.36–77.43	77.43–86.50
0.00 to -4.00	1	23	45		67	79	91	103	115	127	139
- 8.00	2	24	46	214	223	225	227	229	231	233	235
- 12.00	3	25	47	215	151	160	169	178	187	196	205
- 16.00	4	26	48	216	152	161	170	179	188	197	206
- 20.00	5	27	49	217	153	162	171	180	189	198	207
- 24.00	6	28	50	218	154	163	172	181	190	199	208
- 28.00	7	29	51	219	155	164	173	182	191	200	209
- 32.00	8	30	52	220	156	165	174	183	192	201	210
- 36.00	9	31	53	221	157	166	175	184	193	202	211
- 40.25	10	32	54	222	158 224	167 226	176 228	185 230	194 232	203 234	212 236
[illegible]	11	33	55		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
- 44.25	12	34	56		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
- 46.25	13	35	57		[illegible]	81	93	[illegible]	[illegible]	[illegible]	[illegible]
- 50.00	14	36	58		70	82	94	[illegible]	118	130	142
- 60.00	15	37	59		71	83	95	107	119	131	143
- 70.00	16	38	60		72	84	96	108	120	132	144
- 80.00	17	39	61		73	85	97	109	121	133	145
- 90.00	18	40	62		74	86	98	110	122	134	146
-105.00	19	41	63		75	87	99	111	123	135	147
-120.00	20	42	64		76	88	100	112	124	136	148
-135.00	21	43	65		77	89	101	113	125	137	149
-155.00	22	44	66		78	90	102	114	126	138	150

GROUT VAULT

LONGITUDINAL CROSS-SECTION — ELEMENT NUMBERS



GROUT VAULT
LONGITUDINAL CROSS-SECTION - NODE NUMBERS

APP 4I-650

DESIGN ANALYSIS

Client	WHC	WO/Job No.	ER1060		
Subject	GROUT VAULT	Date	9/26/88	By	HS RUBEN
LONGITUDINAL X SECTION MEMBER PROPERTIES		Checked	11/8/88	By	C.M. CONSELMAN
Location	200E	Revised		By	

((SHEAR WALL THICKNESS FOR 2 WALLS)/TOTAL VAULT WIDTH) * CONCRETE SHEAR MODULUS

2 * AVE t (FT) * G K/FT² * 1/53.75' =

2 *	2.1563	* 12260	* 0.0186	=	983.4 K/FT²
	2.4688			=	1125.6
	2.7813			=	1268.5
	3.0938			=	1411.0
	3.4063			=	1553.5
	3.7188			=	1696.0
	4.0313			=	1838.6
	4.3438			=	1981.1
	4.3438	12260	0.0186	=	1981.1

$$\text{VAULT WIDTH} = 50.5 + \left(\frac{4.3438 + 2.1563}{2}\right)_{t_{AVE}} = 53.75'$$

$\frac{\text{SHEAR WALL t FOR 2 WALLS}}{\text{TOTAL VAULT WIDTH}}$ * CONCRETE DENSITY $\gamma = 0.150\ K/FT^3$

2 *	2.1563	* 0.150	* 0.0186	=	0.012
	2.4688			=	0.014
	2.7813			=	0.016
	3.0938			=	0.017
	3.4063			=	0.019
	3.7188			=	0.021
	4.0313			=	0.023
	4.3438			=	0.024
	4.3438			=	0.024

END WALL $I = 1 * 2.5^3/12 = 1.302\ FT^3$ $A_x = 2.5\ FT^2$

ROOF SLAB $I = 1 * 2.1667^3/12 = 0.8476\ FT^3$ $A_x = 2.1667\ FT^2$

BASE SLAB $I = 1 * 4.5^3/12 = 7.5938\ FT^3$ $A_x = 4.500\ FT^2$

Client	WHC	WO/Job No.	ER1060		
Subject	GROUT VAULT	Date	9/27/88	By	MS RUBEN
		Checked	11/8/88	By	C. M. CANTELMAN
Location	200E	Revised		By	

LUMPED MASSES FOR LONGITUDINAL SECTION

IT WILL BE ASSUMED THAT 1/2 OF THE TOTAL GROUT MASS WILL BE ACTING ON THE END WALL. THE REMAINING GROUT MASS WILL BE ACTING ON THE LONG WALLS, OPPOSITE WALL & MAT THROUGH THE BONDING OF THE GROUT TO THE WALLS & MAT.

NODE @ -8.0 FT SEE LONGITUDINAL MODEL

$$WT = (86.5-23) * 2 * 0.10 = 12.7^{k}$$

NODES @ -12.0 FT THRU -36.0 FT

$$WT = (86.5-23) * 4 * 0.10 = 25.4^{k}$$

NODES @ MAT

$$WT = 9.2 * 2 * 0.10 = 1.84^{k} \Rightarrow 2.0^{k}$$

Client	WHC	WO/Job No.	ER 1060		
Subject	GROUT VAULT	Date	9/29/86	By	HS RUBEN
		Checked	11/9/87	By	C. M. CONSELMAN
Location	200E	Revised		By	

RESULTS OF LONGITUDINAL CROSS SECTION "LUMPED MASSES" AROUND VAULT PERIMETER (1/2 OF GROUT WEIGHT)

SSE

MAX MOMENT @ BASE OF END WALL

ELEM NUMBER 222 $M_{SSE} = 101.5^{1K}/FT$ COMPUTER RUN J4323 A 9/23/88

MAX MOMENT @ MID HEIGHT OF WALL

ELEM. NUMBER 219 $M_{SSE} = 13.8^{1K}/FT$

SHEAR @ BASE OF END WALL ELEM 222 $V_{SSE} = 19.5^{K}$

OBE

@ BASE OF WALL $M_{OBE} = M_{SSE} * \frac{0.05}{0.25} = 101.5 * \frac{.05}{.25} = 20.3^{1K}/FT$

@ MID HEIGHT OF WALL $M_{OBE} = 13.8 * \frac{.05}{.25} = 2.76^{K}/FT$

THE LONGITUDINAL MODEL WAS RERUN WITH DOUBLE THE MASSES ON THE WALL TO SIMULATE THE TOTAL GROUT MASS ACTING ON THE WALL

SSE

MAX MOMENT @ WALL BASE ELEM 222 $M_{SSE} = 131.4^{1K}/F$ COMPUTER RUN J7912A 9/29/88

$V_{SSE} = 26.3^{K}$

MAX MOMENT @ MID HEIGHT OF WALL

ELEM 219 $M_{SSE} = 21.3^{1K}/FT$

OBE

@ BASE OF WALL

$M_{OBE} = M_{SSE} * \frac{.05}{.25} = 131.4 * \frac{.05}{.25} = 26.3^{1K}/FT$

@ MID HEIGHT $M_{OBE} = 21.3 * \frac{.05}{.25} = 4.3^{1K}/FT$

Client	WHC	WO/Job No.	ER 1060		
Subject	GROUT VAULT	Date	10/25/88	By	MS RUBEN
		Checked	11/8/88	By	C. M. CONSTANTINE
Location	200 E	Revised		By	

A THIRD LONGITUDINAL MODEL CROSS SECTION WAS ANALYZED

- THE SHEAR MODULUS OF THE SHEAR WALLS WERE REDUCED BY 1/100 TO ELIMINATE THE SUPPORT FOR THE END WALLS ON A PER FOOT BASIS. THIS WILL RESULT IN A RESPONSE OF THE END WALL THAT IS CLOSER TO THE 2 WAY LOAD DISTRIBUTION ASSUMED

- ONLY 1/2 OF THE TOTAL GROUT WT WILL BE PLACED ON THE END WALL. USING THE TOTAL WT IS TOO UNREALISTIC

FROM OUTPUT 13I DATED 10/25/88

<u>SSE</u>

MAX MOMENT @ BASE OF WALL $M_{SSE} = 189^{1K}/FT$ ELEM NO 222

SHEAR @ BASE OF WALL $V_{SSE} = 32.8^{K}/FT$

<u>OBE</u>

$$M_{OBE} = M_{SSE} * \frac{0.05}{0.25} = \frac{189 * .05}{.25} = 37.8^{1K}/FT$$

$$V_{OBE} = 32.8 * \frac{.05}{.25} = 6.6^{1K}/FT$$

Client WHC	WO/Job No. ER1060		
Subject GROUT VAULT	Date SEPT 1988	By MS RUBEN	
	Checked [illegible]	By C.M. [illegible]	
Location 200E	Revised	By	

DOUBLE VAULT MODEL WITH NO BACKFILL ON ONE SIDE OF THE EMPTY VAULT

A FINAL MODEL WAS INVESTIGATED TO DETERMINE THE EFFECT OF NO FILL ON ONE SIDE OF THE EMPTY VAULT ON THE VAULT CONTAINING GROUT. A MODIFIED DOUBLE VAULT MODEL WAS USED. THE SOIL ELEMENTS ON THE OUTSIDE OF THE EMPTY VAULT WERE REMOVED DOWN TO THE BOTTOM MAT SIMULATING NO FILL ON THE VAULT SIDE. ADDITIONAL SOIL COLUMNS WERE ADDED TO THE MESH BECAUSE NO BOUNDRY CONDITIONS WOULD EXIST AND NO ENERGY TRANSMISSION WOULD OCCUR. TO AVOID THIS PROBLEM THE 6 ADDITIONAL SOIL COLUMNS 10 FT. WIDE WILL DISSIPATE THE ENERGY. HORIZONTAL ROLLERS WERE USED TO SUPPORT THE ELEMENTS. THE GROUT IN THE FULL VAULT WAS TREATED AS A SEPERATE STRUCTURE WITH A LOW DENSITY. THE GROUT MASS WAS LUMPED AROUND THE WALLS OF THE VAULT. THIS MODEL WILL PROVIDE FOR THE UNBALANCED LOAD EFFECT ON THE FULL VAULT DUE TO NO BACKFILL AGAINST THE EMPTY VAULT

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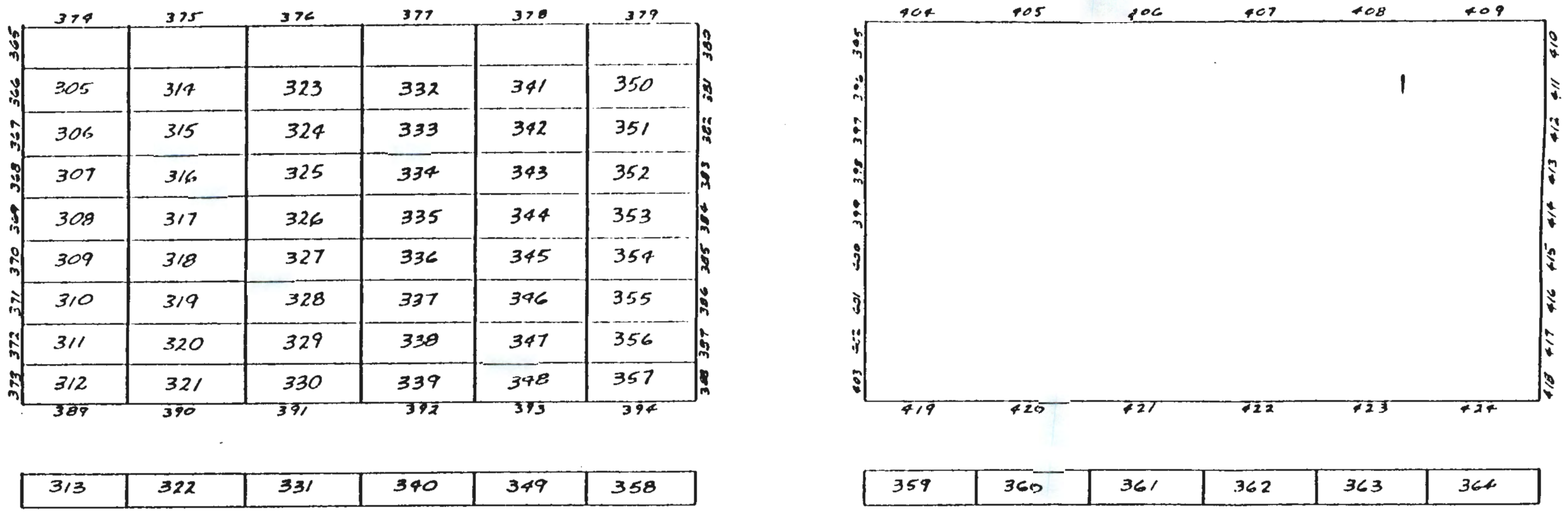
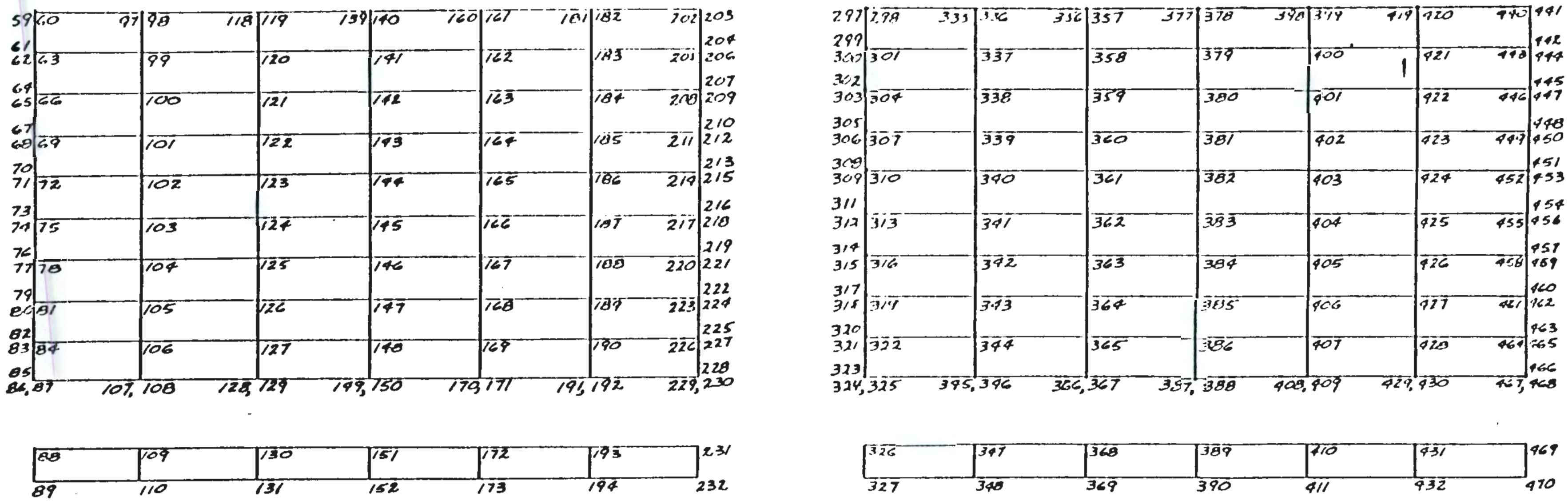


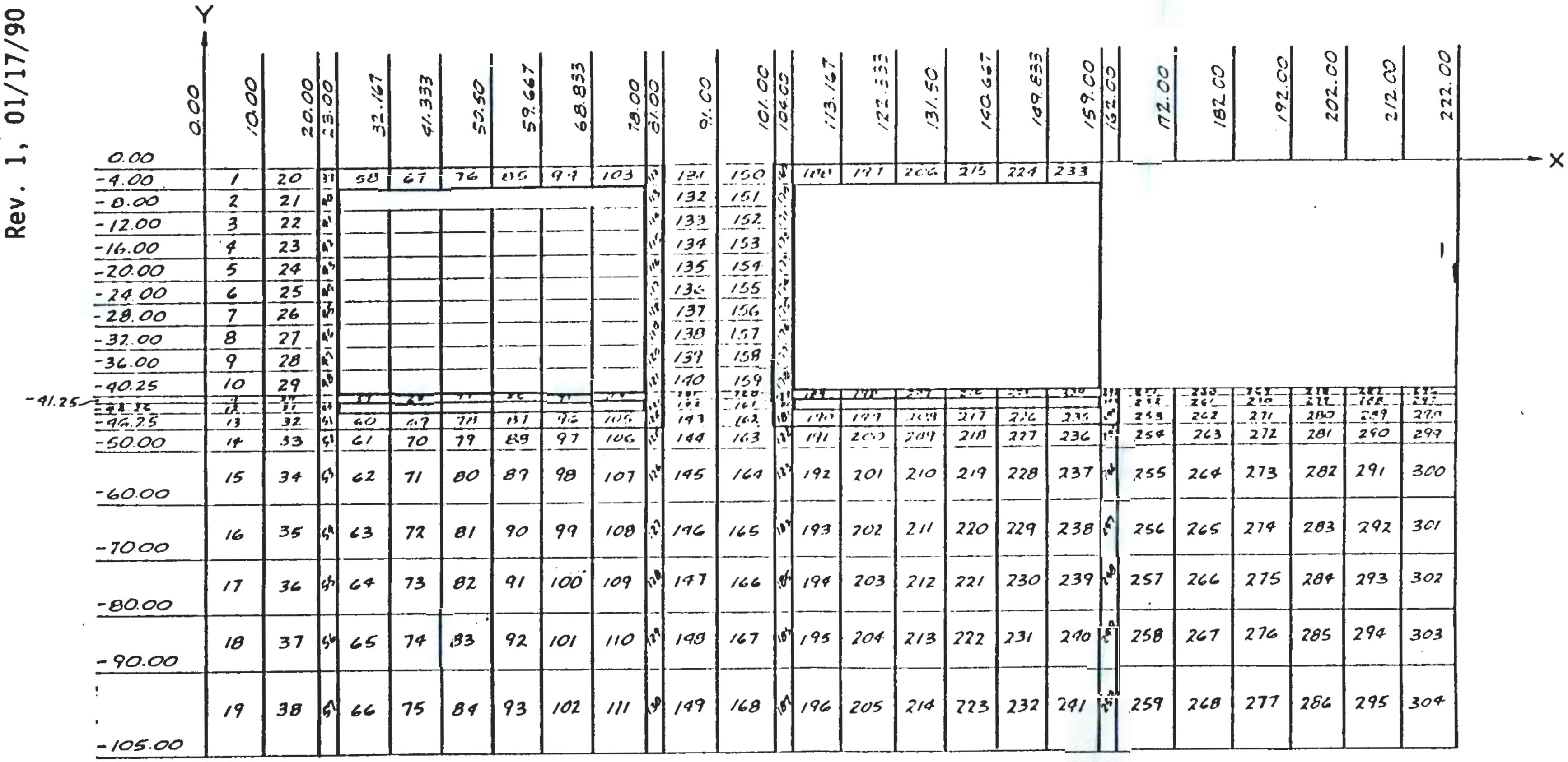
GROUT VAULT
DOUBLE VAULT MODEL WITH NO FILL ONE SIDE
ELEMENT NUMBERS



GROUT VAULT

DOUBLE VAULT MODEL WITH NO FILL ONE SIDE

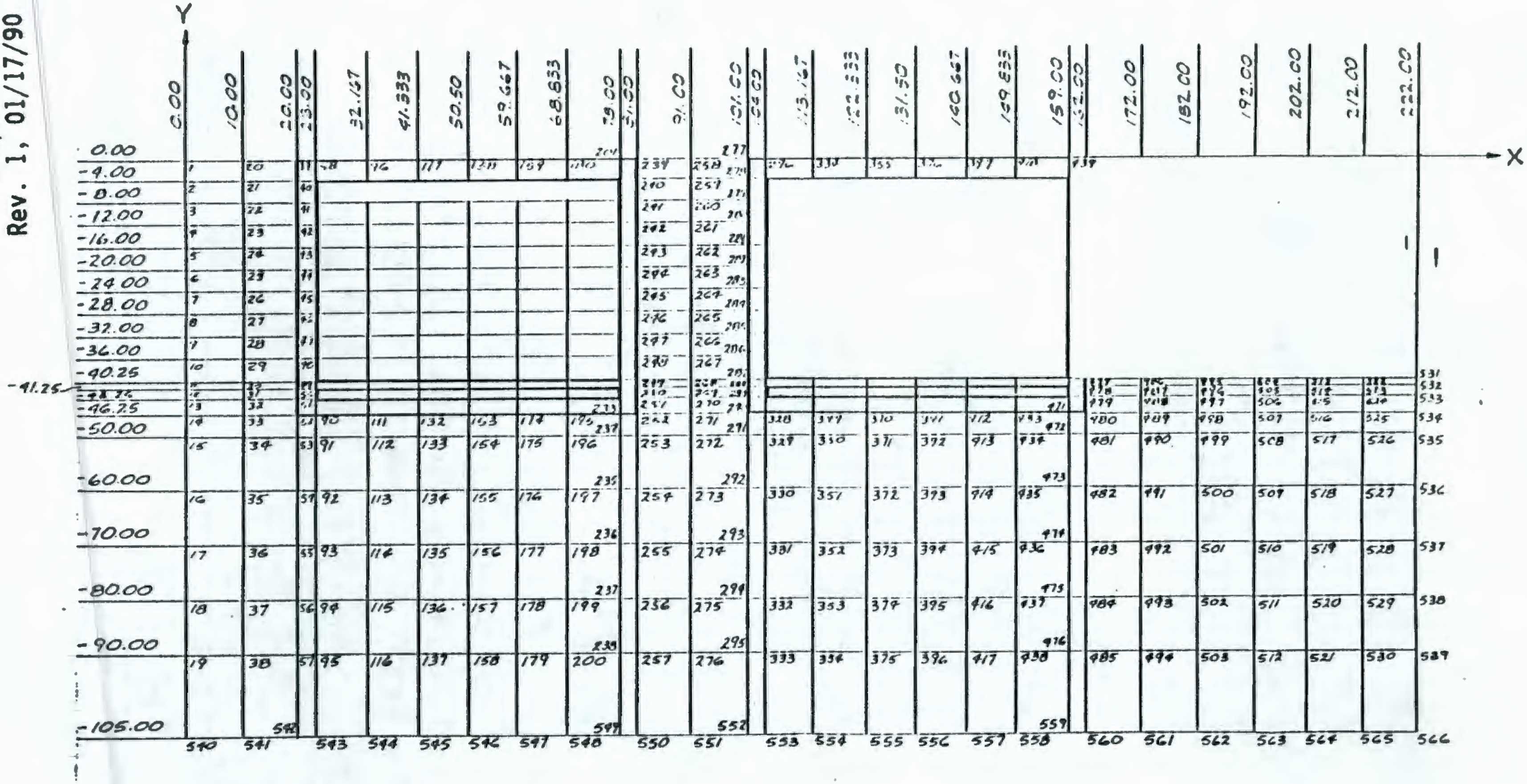
NODE NUMBERS



GROUT VAULT

DOUBLE VAULT MODEL WITH NO FILL ONE SIDE EMPTY VAULT

ELEMENT NUMBERS



GROUT VAULT

DOUBLE VAULT MODEL WITH NO FILL ONE SIDE EMPTY VAULT

NODE NUMBERS

Client WHC	WO/Job No. ER1060		
Subject GROUT VAULT	Date 9/30/88	By MS RUBEN	
	Checked 11/5/88	By C. M. COUTEMAN	
Location 200 E	Revised	By	

RESULTS OF THE DOUBLE VAULT MODEL WITH NO FILL ON ONE SIDE OF THE EMPTY VAULT

THE FULL VAULT GROUT WAS TREATED AS A SEPERATE STRUCTURE WITH THE MASS OF THE GROUT LUMPED AROUND THE PERIMETER OF THE VAULT.

SSE

MAX MOMENT @ BASE OF WALL ELEM NO. 373 — $M_{SSE} = 323.0 ^{1K}/_{FT}$

$V_{SSE} = 39.2 ^{K}/_{FT}$

COMPUTER RUN J7799 A 9/29/88

FROM SINGLE VAULT INVESTIGATION THE ADDITION OF A VERTICAL MOTION WILL INCREASE THE SSE MOMENT BY 2.5% $\left(\frac{246.3-241}{241} \approx 2.5\% \right)$

FROM SINGLE VAULT ANALYSIS P. 45

$M_{SSE} = 323.0 * 1.025 = 331 ^{1K}/_{FT}$

$V_{SSE} = 39.2 ^{K}/_{FT} * 1.035 = 40.6 ^{K}/_{FT}$

SHEAR INCREASED BY $\frac{31-30}{30} = 3.3\%$

OBE

$M_{OBE} = 331.0 * \frac{.05}{.25} = 66.2 ^{1K}/_{FT}$

$V_{OBE} = 40.6 ^{K}/_{FT} * \frac{.05}{.25} = 8.1 ^{K}/_{FT}$

F THERMAL ANALYSIS DURING HOT GROUT PLACEMENT

Westinghouse
Hanford Company

Internal
Memo

From Engineering Analysis
Phone 6-2110 H5-57
Date March 10, 1989
Subject TRANSMITTAL OF B-714 GROUT VAULT THERMAL LOADS

To D. R. Lucas R3-43

cc:				
	M. A. Cahill	R3-46	L. K. Severud	H5-53
	F. C. Han	H5-58	J. E. Van Beek	R1-48
	M. D. Northey	H5-58	B. V. Winkel	H5-55
	M. A. Scott	H5-55	M. W. Young	H5-58
			MJA/File/Lb	

Reference: Memo, M. J. Anderson to D. R. Lucas, "Structural Adequacy of the B-714 Grout Vault," March 2, 1989.

The purpose of this memo is to formally transmit the WHC generated grout vault thermal loads as specified in the "Grout Vault Plan" agreement between KEH and WHC on 3/3/89. Preliminary copies of portions of the load data have been informally provided to KEH this past week to allow them to begin their assessment of the impact of the thermal loads on the vault design.

The thermal loads were derived from an envelope of three thermal load case analyses performed by the WHC Facilities and LMR Section. Upper bound load cases were obtained by ratioing the nominal thermal analysis results to give a maximum liner temperature of 194 degrees F. The resulting temperature input is provided in Attachment 1. The "grout fill loading" cases considered in the structural analysis also included dead weight and internal pressures generated by the grout.

The grout fill loading was applied to the same three-dimensional model described in the memo referenced above. Modeling details are provided in the reference. The model described in the reference was originally developed for scoping the thermal stress problem and is not sufficiently refined to predict the peak thermal stresses. However, it is conservative in the sense that it uses gross, rather than cracked section stiffnesses and is expected to produce upper bound type thermal loads for design purposes. The conservatism of the thermal loads from the WHC scoping model is expected to be verified by the KEH nonlinear (cracking analysis) model.

Enveloping results for the three load cases are provided in Attachments 2 and 3. Attachment 2 provides the transverse and in-plane shear results. Attachment 3 addresses the moments and axial forces associated with the grout fill loading. Data descriptions and additional details associated with the results are also provided in the attachments.

If you have any questions, please call me at 6-2110.

M. J. Anderson, Act. Manager
Engineering Analysis Function

Attachments

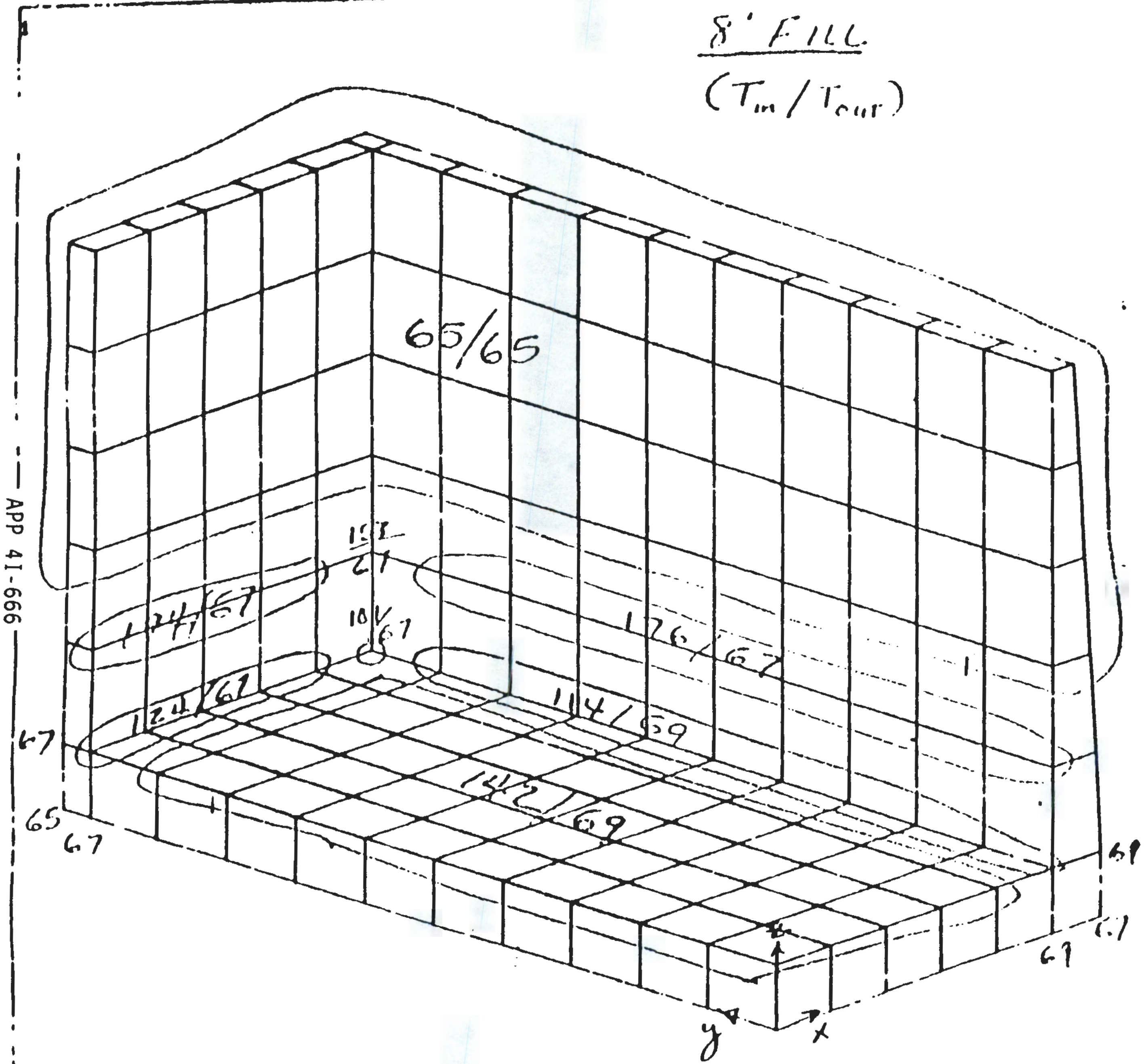
ATTACHMENT 1

DESCRIPTION OF GROUT FILL BOUNDING LOAD CASES

DATA DESCRIPTION: BOUNDING LOADING CASES

The mechanical loading imposed by the grout was input to the model as a pressure to the floor assuming 110 lbs/ft^3. For the 8 ft. depth case, it was assumed that the grout had not set and the full hydrostatic head (110 lb/in^3) wall pressure was applied. For the 18 and 30 ft. fill cases, it was assumed that the grout had set but that the full water pressure head (62 lbs/ft^3) was applied to the wall.

The temperatures associated with the upper bound three grout fill cases are shown in the attached figures. Nominal temperatures were obtained from Blaine Cray (WHC, Facilities and Liquid Metal Reactor Section). The bounding temperature results shown were obtained by ratioing up the nominal case such that the maximum inside wall temperature was equal to 194 degF, which is the liner design temperature limit. Per B. Cray's instruction, the ratioing was done on the basis of nominal temperature less 60 degF (the assumed ambient temperature prior to initiating fill).



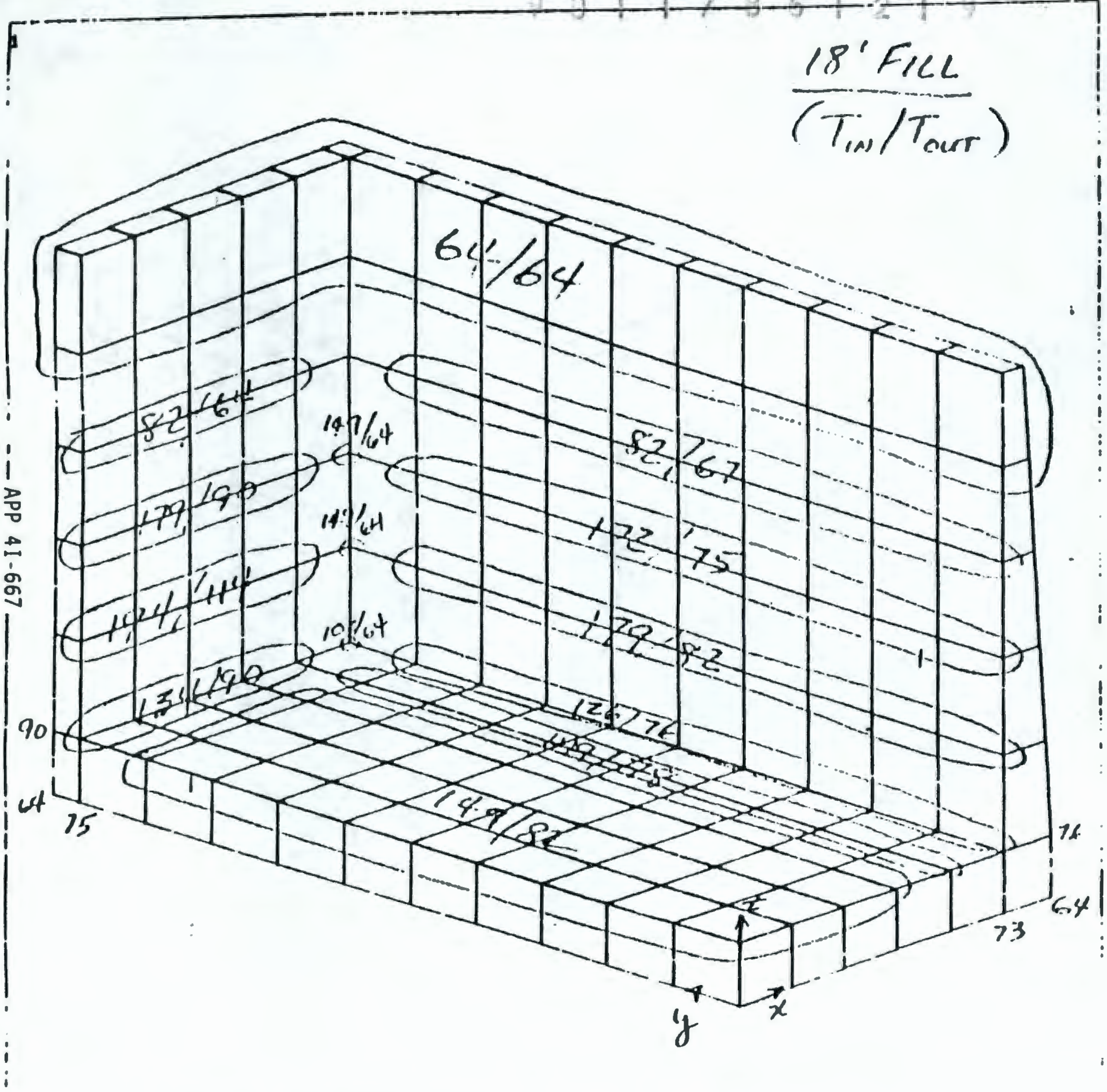
ANSYS 4.3A4
FEB 23 1989
15:51:53
ELEMENTS

XV =-1
YV =-1
ZV =0.5
DIST=443.564
XF =180
YF =390
ZF =231
ANGL=71.5
PRECISE HIDDEN

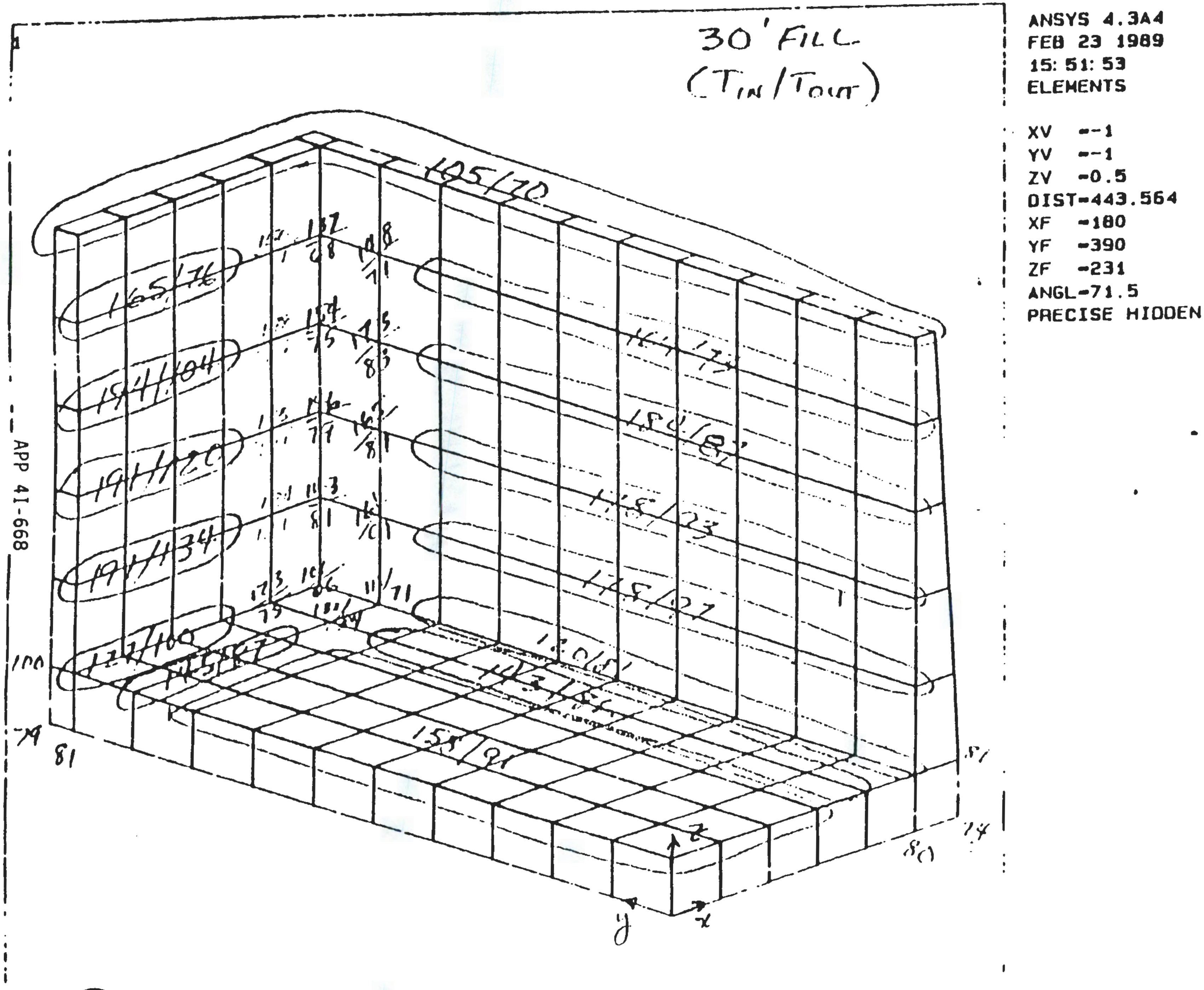
GROUT [redacted] T THERMAL WITH SOIL LOADS, 18 FEET OF GROUT

ANSYS 4.3A4
FEB 23 1989
15:01:53
ELEMENTS

XV =-1
YV =-1
ZV =0.5
DIST=443.564
XF =180
YF =390
ZF =231
ANGL=71.5
PRECISE HIDDEN



GROUT VAULT THERMAL WITH SOIL LOADS, 18 FEET OF GROUT



GROUT ... LT THERMAL WITH SOIL LOADS, 18 FEET OF GROU...

ATTACHMENT 2

SHEAR STRESS RESULTS

SHEAR STRESS DATA DESCRIPTION

The three shear stress components, SXY, SYZ and SXZ, were extracted from the three grout loading cases. Based in part on experience with predicting the shear stresses in a beam model (ANSYS verification model 17), it was decided to use the peak integration point shear for each element as an approximate upper bound estimate on the element average shear. Listings (by element number) of these peak integration point shears are provided in the first section of this attachment for each of the three load cases. Note that shear stresses are reported in psi units. The corresponding shear forces can be obtained by multiplying by the appropriate wall thickness indicated in the element plot sketch.

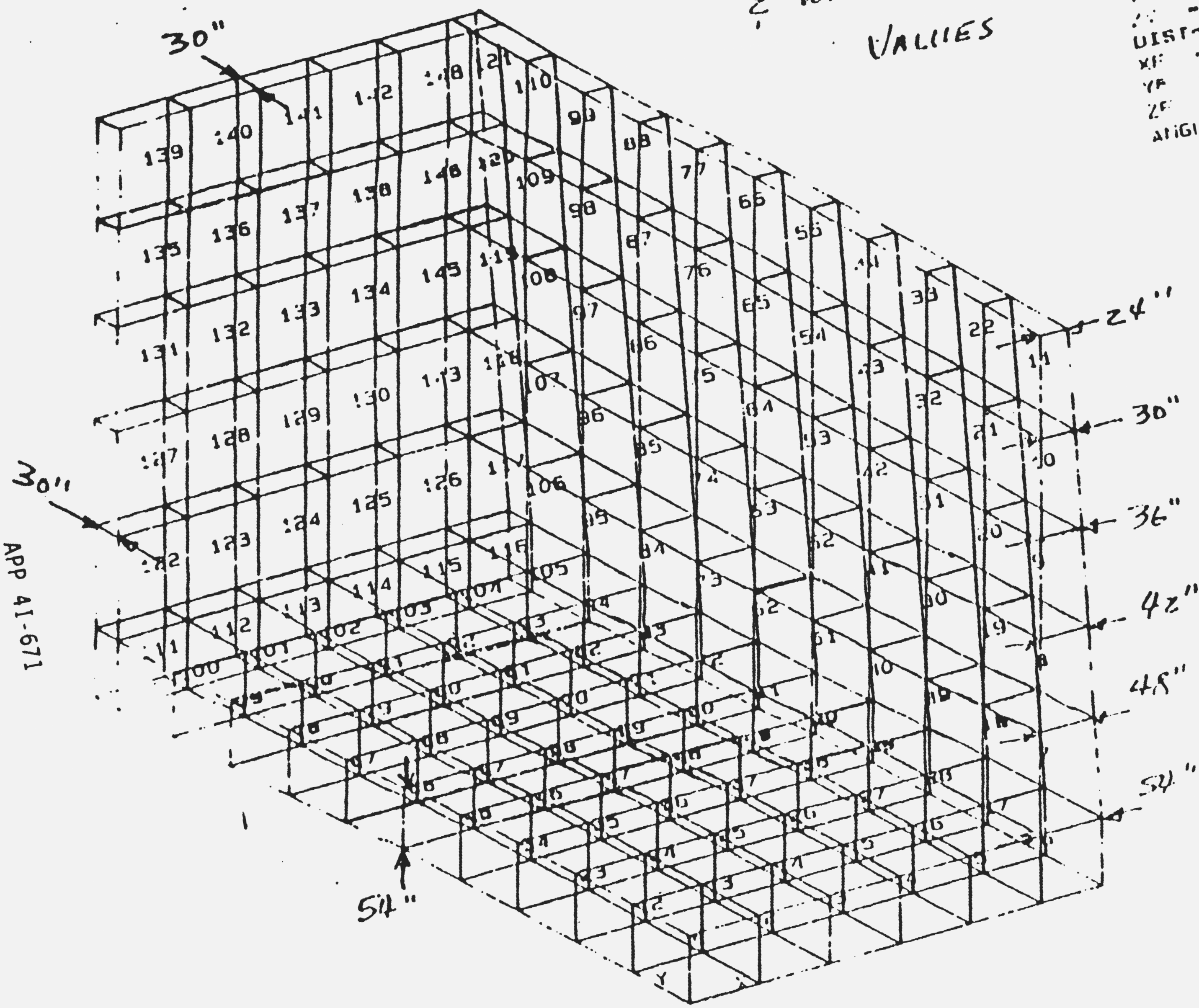
Enveloping shears for the three load cases were developed for design purposes and are provided in the form of contour plots in the second section of this attachment. Shear component directions are indicated on each sketch.

As discussed in the memo, the grout fill load cases include the dead weight of the grout and the estimated grout pressure. This pressure loading will be countered by the vault external soil pressure, which should reduce the through-wall attached peak shear predictions. For simplification and convenience in selecting the enveloping peak shears, only absolute values are reported. Absolute values should be adequate for design purposes. However, if the signs of the shear components are needed for combining with other load cases, the individual load case run results are available upon request.

ANSYS 4.3A1
FEB 14 1989
16:38: 8
ELEMENTS

DIST=420.91
XF =180
YF =390
ZF =231
ANGL=50

ELEMENT NUMBERS & WALL THICKNESS VALUES



GROUT VAULT THERMAL, 8 FT GROUT 14 30?? MAR 9,1989 CP 0.703

***** POST1 ELEMENT STRESS LISTING *****

LOAD STEP 1 ITERATION= 20 SECTION= 1
TIME= 0.00000 LOAD CASE= 1

ELEM	XYMX	YZMX	XZMX
1	0.76099826	6.3093647	86.971301
2	2.0018397	5.8941864	107.40493
3	3.8116325	4.1645060	133.16129
4	8.9741202	2.7934056	153.56481
5	15.007531	18.560204	165.77771
6	8.1678404	21.917872	145.06206
7	17.329383	32.827980	240.09544
8	39.515662	30.724804	232.30405
9	63.427135	29.561855	38.164774
10	89.439869	27.060970	15.111063
11	117.02347	23.087109	4.2132310
12	2.3370251	6.9630604	86.022386
13	6.0714774	6.5329201	106.07227
14	11.053013	5.2909658	130.68709
15	16.944155	2.6082353	148.70300
16	29.944047	23.317247	165.75116
17	28.308708	37.046121	146.72370
18	19.723606	57.466639	237.67054
19	40.429007	56.269203	240.35080
20	65.252552	54.470040	34.062640
21	90.749635	49.196237	17.291582
22	122.45804	40.625455	4.8521765
23	4.1024209	7.5126593	83.914451
24	10.741305	7.2392005	102.58293
25	18.977139	6.3761703	125.50675
26	28.431119	4.0527765	147.70163
27	49.190806	32.334843	159.32561
28	47.717900	56.820790	150.18620
29	21.008574	84.063253	232.36933
30	42.036270	82.410549	225.03210
31	67.988613	79.795623	40.891176
32	92.793135	71.680034	21.075608
33	128.05634	58.244366	5.9799165
34	6.5239132	8.3933650	80.540924
35	16.595120	8.2330971	97.203455
36	28.558175	7.6710753	117.62243
37	41.861066	5.5079671	132.14298
38	70.355955	41.449211	150.56467
39	66.179757	76.154921	155.00051
40	27.417637	111.32645	224.20792
41	44.127011	108.67537	219.36162
42	70.901701	105.11276	50.457952
43	94.636423	94.182412	26.216981
44	133.99279	75.061551	7.4973734

GROUT VAULT THERMAL, 8 FT GROUT 14.3877 NOV 9,1989 CP= 0.797

***** POST1 ELEMENT STRESS LISTING *****

LOAD STEP 1 ITERATION= 20 SECTION= 1
TIME 0.00000 LOAD CASE= 1

ELEM	XYMX	YZMX	XZMX
45	9 6191426	10.250179	73.764479
46	24 830033	9 9859410	89 759169
47	41 338160	9 3036006	106.61518
48	59 456743	7 0073678	117.49781
49	94 102100	50.920799	140.39134
50	84 322003	95.655547	161.20747
51	34 338375	130.53977	213 41138
52	46 127404	133.84410	210 99714
53	72.546681	129.42425	62.029855
54	93 519380	116.01687	32 186238
55	134.11904	92.907749	9.3498227
56	14.595255	15.089723	69.133021
57	36 687774	13.283751	80.118703
58	58.902361	11.513166	92 715541
59	79.665661	8.4060905	98.996009
60	121.14960	60.377920	127.94961
61	101 26029	115.67969	148 50709
62	41 654353	163.76406	200 87337
63	47 087555	156.26034	202.17140
64	70 520281	151.30797	73.744877
65	35 596872	135.97844	38.152649
66	124.15960	108 48429	11.842722
67	20 402407	22.649874	59 801675
68	52 099281	19.839813	68.370083
69	82 617115	15.655554	76.658402
70	107 26319	9.9363096	87.339628
71	151 53435	67.734690	114 45523
72	114.03981	135 90509	175 60116
73	48 770467	182.27608	188.60756
74	44 519491	174.00763	195.22833
75	40 601579	170.94120	83.011474
76	56 198990	151.72279	43 533710
77	96 905291	118.97535	14 700297
78	24 917739	34.170314	46 557078
79	66 604293	31.593502	53.945601
80	109 52728	24.509243	59 029316
81	143 24850	12.475834	71.797958
82	163 27915	65 415527	102.89032
83	119 07612	153.63616	179.40127
84	53 662135	184.64390	180.31386
85	31 054276	192 91676	190 76794
86	30 977994	195 05368	90 193980
87	37 693301	160.99406	44 304174
88	63 815406	116.03025	14 271834

APP 41-673F-13

DOE/RL 88-27
Rev. 1, 01/17/90

GROUT VAULT THERMAL, 8 FT GROUT 14.3872 MAR 9,1989 CP: 0 811

***** POST1 ELEMENT STRESS LISTING *****

LOAD STEP 1 ITERATION= 20 SECTION= 1
TIME= 0.00000 LOAD CASE= 1

ELEM	XYMX	YZMX	XZMX
89	25.113631	49.620912	28.791339
90	70.987699	48.573619	34.395174
91	125.30225	41.948903	41.543817
92	176.67431	35.966011	33.444911
93	216.71575	33.072039	105.01365
94	115.56134	166.68544	179.30426
95	94.344688	102.92020	174.33642
96	92.264958	248.48745	184.00040
97	82.169019	237.16055	101.13496
98	109.64366	144.09699	37.208361
99	159.29060	94.627137	8.7208839
100	22.773743	84.765611	7.9228241
101	64.896900	84.799943	9.3306872
102	109.99791	85.732614	15.399127
103	166.25240	80.759898	40.295133
104	202.64790	92.971584	106.57676
105	113.54819	188.66003	166.61741
106	160.08111	171.89708	117.31452
107	170.99274	338.20929	187.54292
108	233.24266	243.35095	67.756129
109	236.89193	106.50272	32.561620
110	246.60585	85.059858	18.799996
111	15.115660	337.34650	25.448214
112	34.857368	342.38445	61.200571
113	52.691504	342.91683	94.404218
114	54.150395	320.71859	137.13289
115	94.276612	235.27420	207.64280
116	106.59109	128.80491	125.95421
117	258.04059	147.13700	83.720112
118	222.29277	244.01395	321.52694
119	298.00327	65.757917	151.17812
120	321.62060	94.087060	67.855672
121	331.16105	82.361271	26.450900
122	40.945753	266.49612	29.859227
123	40.291572	275.15747	50.163013
124	37.495789	202.94505	72.042198
125	90.153696	276.00406	76.329496
126	111.00020	198.39017	64.974305
127	67.755916	216.77326	25.522198
128	60.155621	209.60457	44.896672
129	37.977575	190.40907	66.837784
130	99.172475	173.72246	122.92661
131	73.105127	169.96063	22.834129
132	64.292502	159.92096	38.292580

GROUT VAULT THERMAL, 30 FT GROUT 15.43.4 MAR 9,1989 CP= 0.283

***** POST1 ELEMENT STRESS LISTING *****

LOAD STEP 1 ITERATION= 20 SECTION= 1
TIME = 0.00000 LOAD CASE= 1

ELEM	XYMX	YZMX	XZMX
1	0.75847295	7.6192152	62.697190
2	1.4373000	7.2509625	96.560602
3	1.6091017	8.2252311	145.04037
4	4.8125507	8.0119534	214.03144
5	11.406501	6.0448605	235.41267
6	12.579436	9.2215635	193.18182
7	19.113030	19.648015	299.66241
8	41.366115	24.545537	260.99177
9	69.052335	27.004642	241.21039
10	100.04313	25.981432	264.89662
11	132.50758	19.761360	196.47575
12	2.0330694	8.4445759	62.817458
13	2.9671681	8.3749412	95.691912
14	1.9806240	9.2559254	143.12860
15	9.2913819	9.3306244	210.39612
16	26.660666	10.525799	230.94244
17	29.973833	28.134267	186.72685
18	20.073519	51.983936	294.46929
19	42.758013	62.551510	256.63121
20	72.079637	66.793319	239.47025
21	103.71783	62.183275	264.29503
22	140.32547	45.076226	196.55296
23	3.5874380	10.651896	63.464925
24	5.4752622	10.238128	94.239118
25	4.1350397	10.560936	138.51256
26	11.913671	10.926646	201.54517
27	40.758078	17.757016	219.63595
28	47.305836	47.464301	170.77892
29	21.245959	85.082271	201.90069
30	45.889818	101.32384	245.95210
31	77.065934	106.66235	235.35632
32	107.32793	98.255346	262.68188
33	151.09719	72.954092	196.62411
34	5.7782310	15.686550	64.033486
35	9.5969579	14.556165	91.643807
36	10.089152	12.298252	131.17349
37	17.001554	12.911659	187.29655
38	51.748132	25.801986	201.19594
39	64.189203	67.435842	145.00407
40	21.838994	119.10907	261.16578
41	49.325649	140.50219	228.63955
42	87.575741	145.22448	229.03764
43	117.78434	132.17983	260.72687
44	152.27845	99.828170	196.61114

APP 4I-676
F-16

DOE/RL 88-27
Rev. 1, 01/17/90

GROUT VAULT THERMAL, 8 FT GROUT 14.3872 MAR 9,1989 CP= 0.825

***** POST1 ELEMENT STRESS LISTING *****

LOAD STEP 1 ITERATION= 20 SECTION= 1
TIME= 0.00000 LOAD CASE= 1

ELEM	XYMX	YZMX	XZMX
133	38.955408	137.82238	66.273465
134	120.21873	107.41214	112.45884
135	70.385721	68.018074	24.788314
136	59.510436	62.400380	44.343326
137	55.058130	45.721400	70.137070
138	151.93491	19.793501	95.193454
139	57.065342	14.392396	21.989759
140	42.860457	12.787398	39.296684
141	71.349549	7.3287089	58.574119
142	152.93685	9.8641423	73.239906
143	228.36980	268.92303	198.60636
145	314.38999	70.294150	165.01434
146	304.80529	29.212400	95.562803
148	244.84163	11.413724	83.494460

***** ROUTINE COMPLETED ***** CP = 0.841

***** END OF INPUT ENCOUNTERED ON FILE18

***** RUN COMPLETED ***** CP= 0.8424 TIME= 14.3875

ANSYS - ENGINEERING ANALYSIS SYSTEM REVISION 4 ... (WEST.-HANFORD) JAN 1,1987

SUPPORT CALL Larry Gannon PHONE (509) 376-2604 TUX

GROUT VAULT THERMAL, 30 FT GROUT 15.4114 MAR 9,1989 CP= 0 HIT

***** POST1 ELEMENT STRESS LISTING *****

LOAD STEP 1 ITERATION= 20 SECTION= 1
TIME= 0.00000 LOAD CASE= 1

ELEM	XYMX	YZMX	XZMX
89	22.200179	93.350202	35.517739
90	75.815039	92.214785	48.509396
91	149.96413	89.413761	64.325105
92	219.23786	84.144710	79.318432
93	210.82663	71.973876	99.113007
94	92.600217	212.76950	151.89735
95	112.36252	274.91408	98.834638
96	125.77786	210.07434	82.439382
97	147.26945	244.79040	110.55127
98	157.67928	364.76981	188.97378
99	183.54622	340.20710	171.12710
100	26.165558	115.38706	17.141802
101	55.780808	118.23836	24.721202
102	94.227383	118.69008	40.800997
103	170.37325	111.08448	86.496380
104	180.94898	93.219506	148.00706
105	96.861718	176.40263	125.51668
106	153.13080	220.10649	110.03007
107	174.30240	191.11352	46.911381
108	190.43215	210.60963	82.126258
109	276.19772	283.24798	138.69228
110	574.24059	249.51655	139.90090
111	17.848806	271.80234	20.560304
112	40.288168	270.01079	60.242465
113	69.946943	259.17079	129.87222
114	68.900386	216.11058	252.77829
115	87.310064	136.24665	280.24870
116	81.945356	74.332102	110.95018
117	171.60535	112.60082	146.39989
118	200.27166	134.78214	150.37738
119	232.42550	163.92681	293.22379
120	297.87499	100.73062	318.02944
121	631.22913	80.404277	151.18246
122	28.573105	284.04411	32.099801
123	29.258050	283.72579	86.159966
124	34.332180	278.25550	158.45099
125	54.538344	245.63229	230.37835
126	114.85917	185.57725	278.40424
127	48.910007	159.93129	20.737060
128	41.082631	159.74946	41.048355
129	27.635454	154.80802	44.251335
130	67.862115	136.65344	75.648612
131	70.550010	59.989550	25.900973
132	54.714545	57.684807	75.005654

GROUT VAULT THERMAL, 30 FT GROUT 15 41 14 MAR 9,1989 CP= 0 797

***** POST1 ELEMENT STRESS LISTING *****

LOAD STEP 1 ITERATION= 20 SECTION= 1
TIME= 0 00000 LOAD CASE= 1

ELEM	XYMX	YZMX	XZMX
45	8 0038833	25.443194	64 052672
46	15 086409	23.172096	87.880143
47	24 048000	17.030496	121.22125
48	32.548267	15.270485	167.76137
49	60.340654	34 103581	175.23913
50	79.789409	88 301679	138.73871
51	23.070933	154.13568	231.45109
52	51.460670	178.71545	204.20518
53	85.672007	179 12824	220.63040
54	114.93937	160 37240	257 71350
55	170.04715	124 03009	196.35510
56	14 096129	41.372470	63.063072
57	33.359107	37.761726	82.761341
58	40 725525	29.197590	109.12566
59	50 823340	18.527251	143.77504
60	80.473898	41.317276	142 [illegible]
61	92.319808	110.72113	148.22392
62	27 255918	190 05201	192 [illegible]
63	48.797435	212.54256	184.8950[illegible]
64	80.908156	204 74609	209 51[illegible]
65	108 03934	176.80032	252 91409
66	169 73255	141 84259	195 14[illegible]
67	22.694510	62.708012	59.06[illegible]
68	57 204001	58 624080	75.80[illegible]
69	86 032360	40 156243	95.845117
70	101 50188	31.784181	117.74[illegible]
71	114.69632	44 854636	112 43916
72	98 271776	136 87210	156 10422
73	30 992015	226.01503	153.20437
74	35 263729	237.50176	162.65430
75	59 124052	210 51353	192.30785
76	84.174007	196.80399	243.84059
77	156.61358	164 78606	192.71834
78	27.997270	84.768003	50.232590
79	78.080455	81.649797	65.533925
80	120.32819	73 002903	82.022601
81	161 20670	57 013149	94.860949
82	165.00120	40 057707	108 97365
83	99 292688	170 54209	157.82775
84	49 412414	259.70443	127.89073
85	57 816211	238 05923	131 38041
86	67 481169	217 09759	161.40921
87	60 349605	205.57425	225 51635
88	124.68403	246.55713	186.72763

APP 4I-677
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DOE/RL 88-27
Rev. 1, 01/17/90

GROUT VAULT THERMAL, 30 FT GROUT 15.4314 MAR 9,1989 CP= 0.824

***** POST1 ELEMENT STRESS LISTING *****

LOAD STEP 1 ITERATION= 20 SECTION= 1
TIME= 0.00000 LOAD CASE= 1

ELEM	XYMX	YZMX	XZMX
133	48.796832	53.020277	119.50029
134	130.37041	68.057182	175.39552
135	94.684275	198.94906	33.981776
136	74.066214	196.40433	109.27880
137	59.530647	188.71179	196.06922
138	188.97095	170.17687	281.45057
139	125.00257	109.63461	29.970524
140	110.62494	187.56470	75.293220
141	65.928845	182.09169	131.12760
142	232.43855	170.01071	205.63537
143	107.01549	129.76622	105.18720
145	164.37256	80.236347	256.27732
146	313.00935	133.69969	343.65675
148	543.33194	144.48793	188.34713

***** ROUTINE COMPLETED ***** CP = 0.841

***** END OF INPUT ENCOUNTERED ON FILE18

***** RUN COMPLETED ***** CP= 0.8422 TIME= 15.4314

GROUT VAULT THERMAL, 18 FT GROUT   15.06.55 SEP 9,1989 CP= 3.784

***** POST1 ELEMENT STRESS LISTING *****

LOAD STEP 1 ITERATION= 20 SECTION= 1
TIME= 0.00000 LOAD CASE= 1

ELEM	XYMX	YZMX	XZMX
1	0.62274371	6.4934449	24.826494
2	1.8791419	6.3137492	95.347932
3	3.4410451	5.1120411	122.15234
4	5.8500207	2.3722049	155.24998
5	11.320160	14.516990	183.72770
6	12.595579	21.115459	191.90540
7	20.201964	31.312450	230.57835
8	42.710001	30.350365	250.00990
9	69.136002	28.999940	215.06996
10	97.930283	26.175531	19.789124
11	128.25915	22.109480	4.9301619
12	2.1113205	7.1030757	73.844439
13	5.5741242	6.7000322	94.011658
14	10.338022	5.9655696	112.56262
15	16.281037	3.6405884	132.05400
16	29.931009	23.515578	160.41057
17	41.441169	40.335526	184.01056
18	70.468992	57.942913	226.60941
19	43.709670	57.264302	255.90179
20	71.272140	55.404899	213.73865
21	99.283633	49.987521	17.300802
22	134.57155	40.899829	4.4593727
23	3.0597553	7.1725130	72.161746
24	10.021221	7.0963019	90.224904
25	17.941092	4.6451013	119.71303
26	27.497342	4.7707745	144.30606
27	49.003519	32.437364	171.59260
28	50.249116	59.761460	187.94661
29	22.022560	84.576859	220.31389
30	45.618498	84.607971	250.03084
31	74.523869	83.417130	219.52497
32	102.27144	75.420349	18.146932
33	142.55004	60.640405	5.5530523
34	6.2113241	7.4305666	49.341077
35	15.947642	7.4149506	85.522795
36	27.340841	7.2374169	106.38669
37	40.273941	5.7171319	131.09050
38	68.714577	41.803198	150.34209
39	68.969299	79.847659	191.54126
40	27.154606	110.22127	210.31117
41	47.549267	111.04435	242.87002
42	77.797419	111.20126	205.67460
43	105.09218	104.04703	14.362606
44	150.23128	82.237710	7.0731601

GROUT VAULT THERMAL, 10 FT GROUT 15.0009 MAR 9,1989 CP 0 798

***** POST1 ELEMENT STRESS LISTING *****

LOAD STEP 1 ITERATION= 20 SECTION= 1
TIME= 0 00000 LOAD CASE= 1

ELEM	XYMX	YZMX	XZMX
45	9 6301027	9 1946368	65 250532
46	24 476251	8 5390917	78 462057
47	39 966144	8 0514420	95.115574
48	55 530835	6 8958746	114 93120
49	98 956180	50 719884	141.32536
50	86 475859	100 65379	200.66053
51	32 429984	131.97261	196.68794
52	48 308568	137 30955	232.15315
53	78 834759	145 61319	199.09084
54	105 82498	138 42082	22.635612
55	153 48714	107 71960	9.1939862
56	14 401844	15.853810	59.257061
57	36 644301	12 735296	69.498985
58	57 553173	9 6617459	61 364605
59	71 920827	7.2901054	94.014103
60	105 18070	55.597936	129.57462
61	101 28087	121.93877	208 66463
62	35 509086	162.95817	179.87492
63	45 678377	157 91586	218 96304
64	73 708268	181 29067	190.43100
65	96 961728	181 99303	33 017516
66	151 59691	140.69467	13 213850
67	19 511032	25 227739	50.351676
68	51 283236	22.126664	58.751027
69	79 946841	14.120029	66.327427
70	99 691510	7 7559238	77.130393
71	127 96630	52 867217	119.11489
72	110 66959	142 44612	215.86876
73	37 990086	194 91969	161 19355
74	35 570446	100 70373	201.47006
75	56 512893	222 12579	177.85604
76	75 087068	217 06001	50 121270
77	135 93377	193 01085	22.578577
78	21 059417	36 592077	37 392716
79	60 597632	33 910143	45 504377
80	101 30630	20 823041	51.624927
81	125 44246	10 629415	65.245520
82	144 13156	30.790807	109 47273
83	117 94962	157 74089	218.79349
84	50 354112	220 42675	142 03024
85	15 419039	166 45974	103 38011
86	59 312900	227 90315	157.56452
87	32 304580	297.75619	75 741983
88	95 027256	226 54920	34 066103

GROUT VAULT THERMAL, 10 FT GROUT 15.0029 MAR 9,1989 CP: 0.812

***** POST1 ELEMENT STRESS LISTING *****

LOAD STEP 1 ITERATION= 20 SECTION= 1
TIME= 0.00000 LOAD CASE= 1

ELEM	XYMX	YZMX	XZMX
89	21.054499	33.303349	19.960455
90	51.000084	57.395996	22.325044
91	101.38112	47.543717	15.024084
92	152.17514	52.539239	46.716344
93	156.22885	49.932231	102.35771
94	109.26709	197.83240	216.93063
95	106.10962	232.45343	116.72232
96	127.10704	191.35148	146.31971
97	119.96636	372.46361	132.65108
98	104.25199	350.40400	94.376743
99	193.16026	223.45290	33.985735
100	30.519403	97.167692	17.515297
101	68.631105	99.730883	19.944027
102	104.75043	102.11864	32.368018
103	132.55718	98.540135	74.175371
104	141.90176	143.17259	168.74084
105	116.68000	196.86060	194.59497
106	152.60099	233.39396	136.18373
107	158.13461	210.67404	84.550252
108	206.07713	442.27518	194.55431
109	312.31633	296.29410	62.749274
110	371.69552	137.51426	28.883763
111	16.762638	346.98097	29.291136
112	37.819507	345.70401	65.571095
113	58.675813	337.01690	195.53064
114	40.473747	307.49857	194.86412
115	84.222765	214.52375	285.72113
116	62.715443	100.76316	151.22246
117	196.33172	177.11034	148.23009
118	250.03001	171.34494	254.35558
119	205.26595	193.41452	411.35631
120	381.40702	81.584331	173.71515
121	492.74482	111.54434	31.908945
122	28.664352	337.37999	30.588129
123	25.867234	337.38465	78.873569
124	16.982066	333.13845	127.33940
125	32.406688	302.46462	187.21012
126	95.497894	276.69316	343.14922
127	46.124151	132.97603	21.787333
128	38.698983	135.82316	37.911423
129	29.895191	132.91381	17.769158
130	84.287610	132.80755	51.758958
131	57.775553	132.28525	38.443917
132	47.140462	130.05561	77.449716

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APP 4I-682

GROUT VAULT THERMAL, 18 FT GROUT 15.8009 MAR 9,1989 CP= 0.826

***** POST1 ELEMENT STRESS LISTING *****

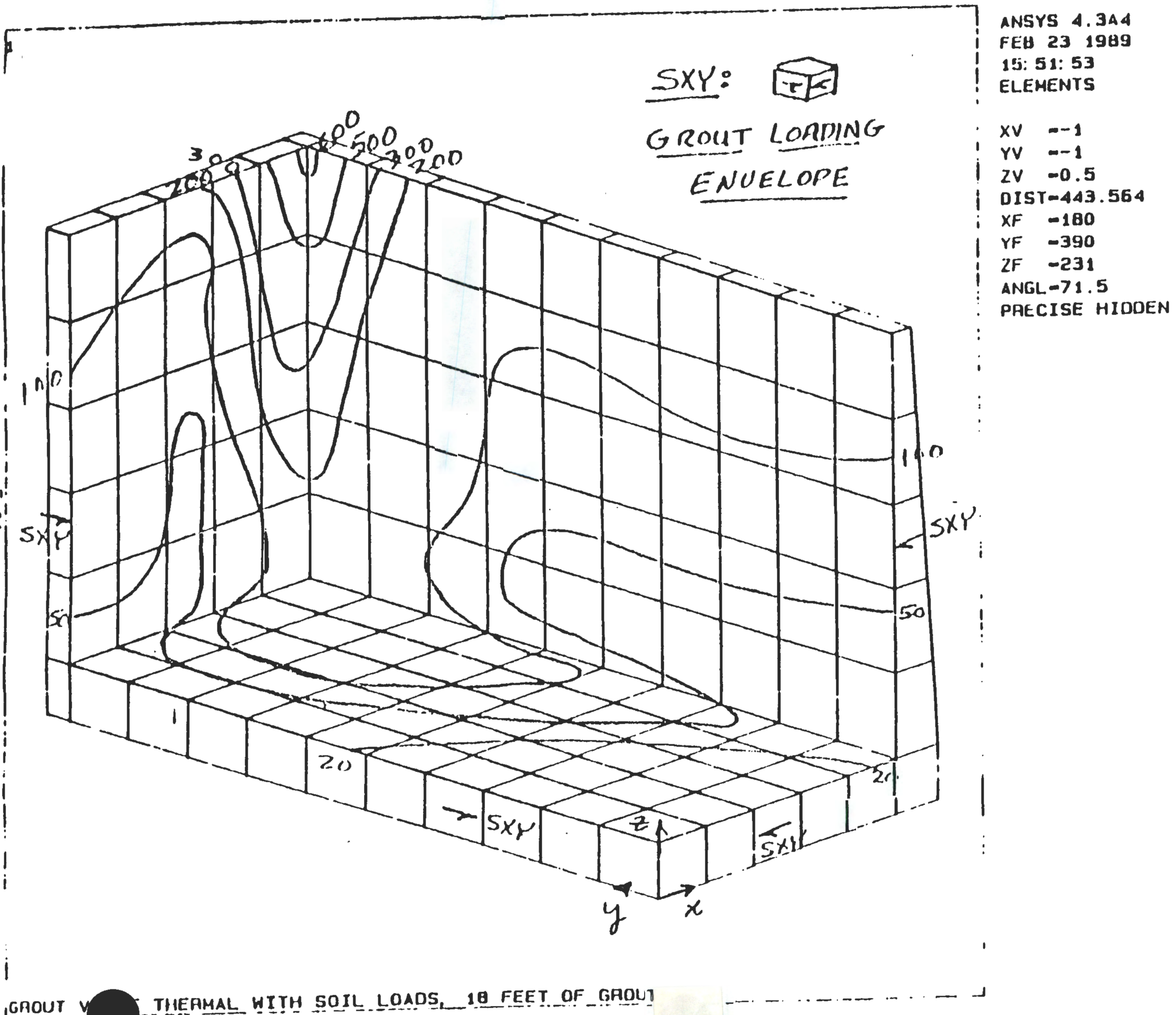
LOAD STEP 1 ITERATION= 20 SECTION= 1
TIME= 0.00000 LOAD CASE= 1

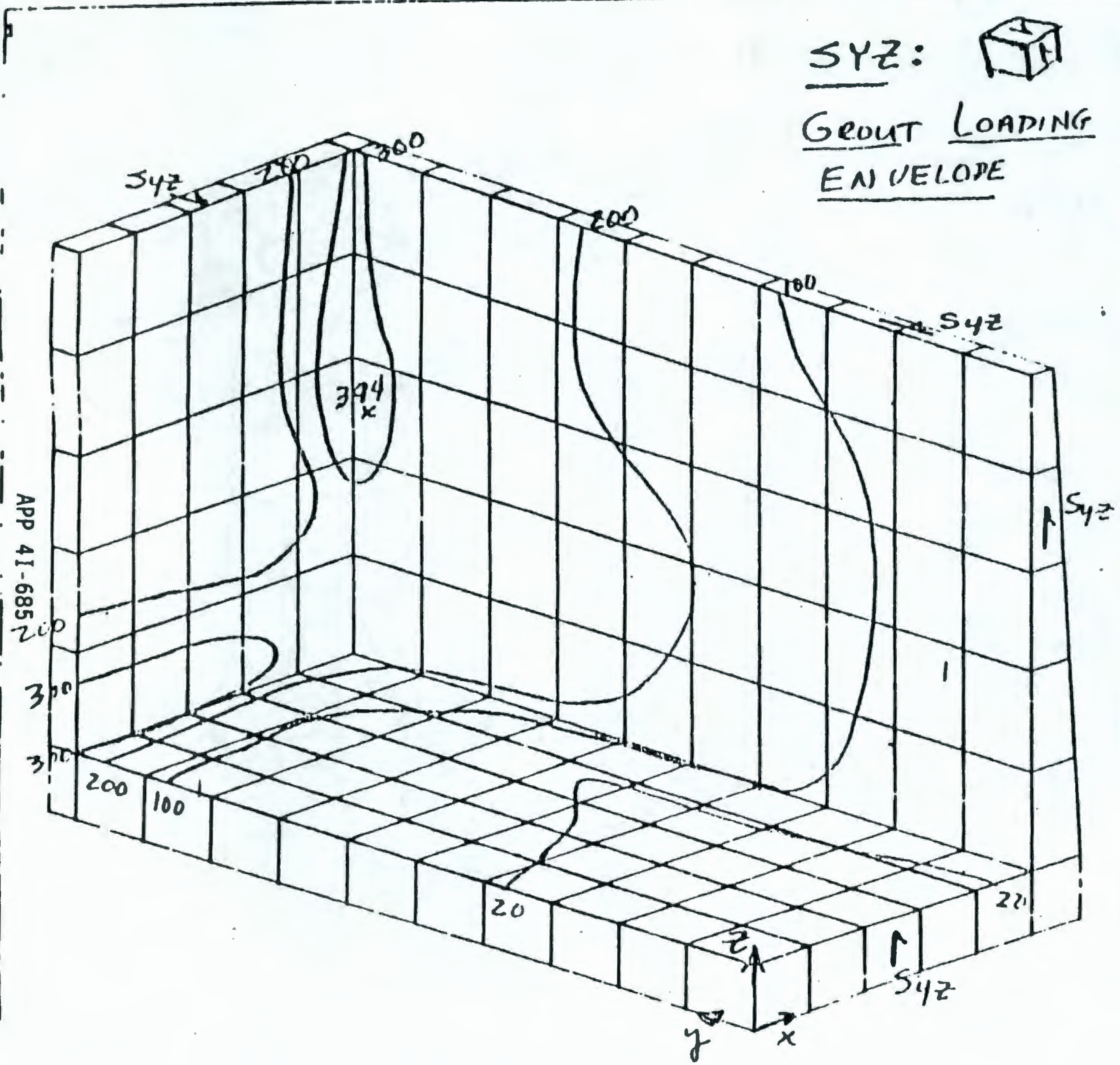
ELEM	XYMX	YZMX	XZMX
133	33.356014	128.93593	130.83158
134	101.74008	149.45532	220.62575
135	46.891690	75.603122	44.266930
136	57.065722	75.410734	89.657696
137	45.005729	74.038438	132.75221
138	154.13637	62.514726	185.77721
139	78.100771	22.909834	31.350379
140	41.456647	24.881290	55.637889
141	81.446028	24.403230	74.478404
142	197.95527	14.579072	107.02042
143	105.65701	178.10240	130.25345
145	241.61080	219.46199	359.51259
146	362.39709	81.425611	236.77208
148	356.79907	14.297795	98.702131

***** ROUTINE COMPLETED ***** CP = 0.843

***** END OF INPUT ENCOUNTERED ON FILE18

***** RUN COMPLETED ***** CP= 0.8435 TIME= 15.8009

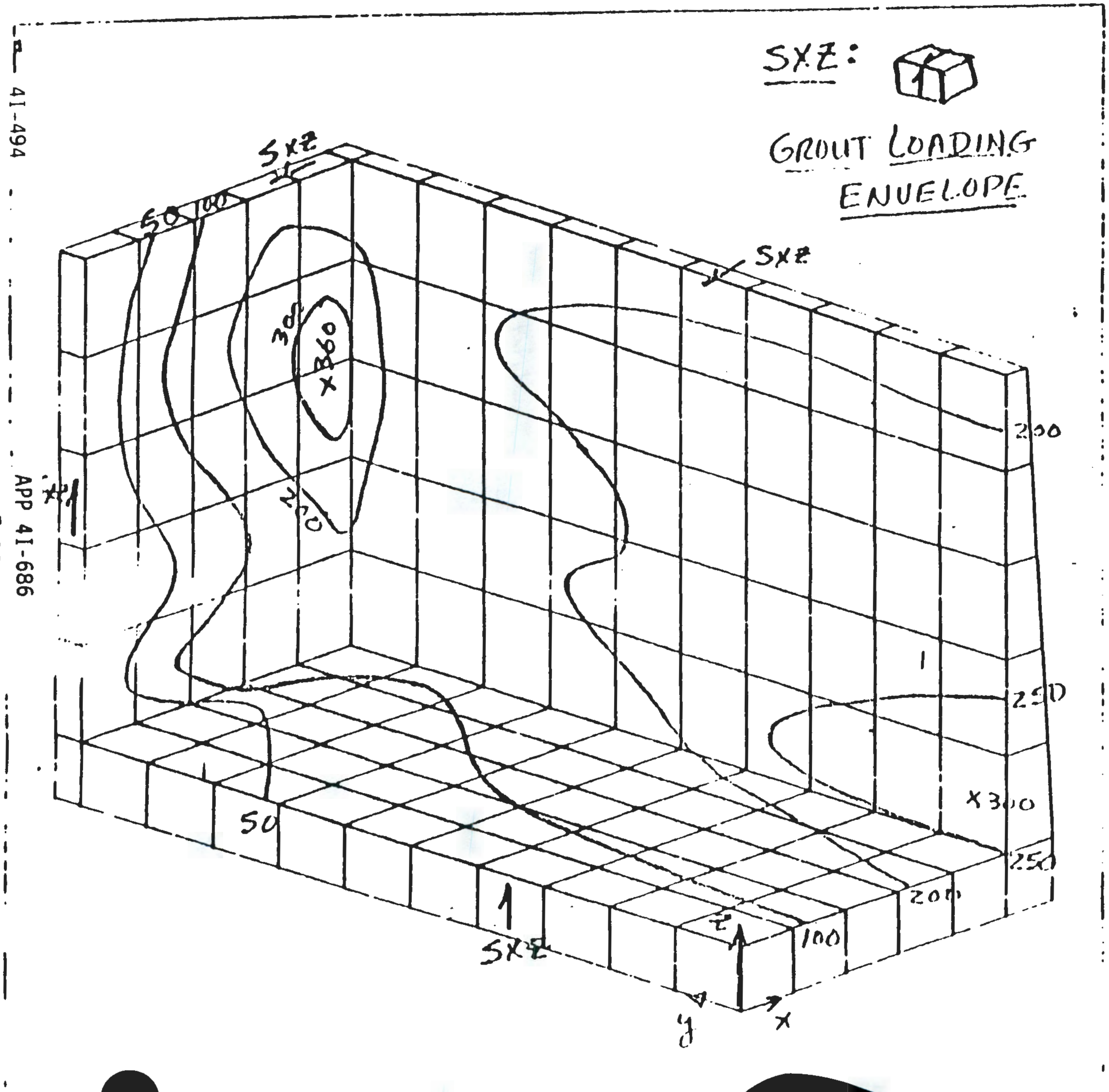

SXY:
GROUT LOADING
ENVELOPE
ANSYS 4.3A4
FEB 23 1989
15:51:53
ELEMENTS
XV =-1
YV =-1
ZV =0.5
DIST=443.564
XF =180
YF =390
ZF =231
ANGL=71.5
PRECISE HIDDEN
300
200
600
500
400
200
100
50
SXY
20
z
y
x
GROUT W THERMAL WITH SOIL LOADS, 18 FEET OF GROUT



ANSYS 4.3A4
FEB 23 1989
15: 51: 53
ELEMENTS

XV =-1
YV =-1
ZV =0.5
DIST=443.564
XF =180
YF =390
ZF =231
ANGL=71.5
PRECISE HIDDEN

GROUT VAULT THERMAL WITH SOIL LOADS, 18 FEET OF GROUT



ANSYS 4.3A4
FEB 23 1989
15:51:53
ELEMENTS

XV =-1
YV =-1
ZV =-0.5
DIST=443.564
XF =180
YF =390
ZF =231
ANGL=71.5
PRECISE HIDDEN

...NERAL WITH SOIL LOADS, 18 FEET OF GROU...

ATTACHMENT 3

MOMENT & MEMBRANE STRESS RESULTS

9011785123 9

MOMENT AND MEMBRANE STRESS DATA DESCRIPTION

The moments and their related membrane stress values presented in the following tables were extracted from the three grout loading cases with fill elevations of 8, 18 and 30 feet. The data were chosen based on both maximum moment and maximum tensile membrane stress. The maximum moment is presented with its load case related membrane stress. The maximum tensile (or minimum compressive) membrane stress is presented with its load case related moment. The maximum moment and maximum tensile membrane stress are not necessarily from the same load case. It was considered to be overly conservative to impose both maxima simultaneously if they were not imposed in the same load case.

The moments were calculated from the average nodal stresses from the POST1 output. The average difference of the inside and outside tensile stresses divided by the section modulus produces the applied moment. This follows the convention presented for moment calculation for element STIF 93 in the ANSYS Theoretical Manual. The membrane stress is the average of the sum of the nodal tensile stresses. The moments are presented in units of Kip-feet per foot and the membrane stress in pounds per square inch. One set of tables presents the vertical moments (My and Mx) with the positive moment having compression on the inside face of the vault. The horizontal moments (Mz) are presented with the same convention of positive moment compressive force on the inside face. The membrane stresses are positive for tension and negative for compression.

My (K-FT/FT) / σ_z (PSI)

	INS COL	675	600	525	450	375	300	225	150	75	[illegible]	
462	42 (-14/[illegible])	60/500	51/531	52/589	52/607	52/617	52/620	52/621	52/621	52/6[illegible]	[illegible]/6[illegible]	[illegible]
380	82/67	119/-290	120/-305	130/-322	128/-308	128/-29[illegible]	127/-284	126/-280	125/-278	125/-[illegible]	124/-[illegible]	[illegible]
299	185/266	248/-116	253/-296	246/-242	238/-203	233/-17[illegible]	229/-162	225/-159	222/-151	220/-1[illegible]	[illegible]/[illegible]	36
217	254/440	326/1	327/-202	314/-139	296/-92	281/-59	269/-40	250/-30	251/-25	246/-[illegible]	244/-23	4[illegible]
136	340/78	438/-331	440/-346	415/-32[illegible]	392/-30[illegible]	368/-297	347/-282	333/-290	321/-277	315/-279	312/-279	[illegible]
[illegible]	231/102	391/-71	351/-87	332/-76	303/-64	206/-61	267/-60	251/-60	241/-60	235/-54	225/-131	[illegible]
		400/-16	371/-171	351/-157	325/-146	290/-138	275/-130					

MAX Mx (K-FT/FT) / σ_z (PSI)

	0	61.2	122.4	183.6	244.8	INS COL
462	88/684	87/678	85/659	79/607	66/53[illegible]	[illegible]/479
380	134/-232	134/-24[illegible]	132/-2[illegible]	129/-291	117/-27[illegible]	78/63
299	184/-255	184/-268	183/-305	184/-34[illegible]	173/-296	106/232
217	185/-58	183/-73	183/-29	184/-300	172/-206	190/-219
136	210/-[illegible]	213/-670	209/-617	205/-[illegible]	190/-545	127/41
56	171/46	171/46	170/37	167/17	147/-18	90/132

B714 GROUT VAULT

POSITIVE MOMENT IS COMPRESSION ON INSIDE FACE OF THE WALL, TENSION ON THE OUTSIDE FACE

AXIAL LOAD IS POSITIVE IN TENSION NEGATIVE IN COMPRESSION

APP 41-689

DESIGN CALCULATION

ATT 3

(1) Drawing ______ (2) Doc No ______ (3) Page 2 of 5

(4) Building GROUT VAULT B-714 (5) Rev ______ (6) Job No. ______

(7) Subject PRELIMINARY THERMAL LOADS - 3D FINITE ELEMENT

(8) Originator MA SST Date 3/10/99

(9) Checker [illegible signature] Date 3/[illegible]/[illegible]

DOE/RL 88-27, Rev. 1, 01/17/90

My (K-FT/FT) / σ_z (PSI) (MAX T / MIN C)

	INS COR	675	600	525	450	375	300	225	150	75	℄
462	47/430	68/54	61/581	57/589	62/609	57/617	57/620	52/621	53/621	53/620	53/[illegible]
380	37/67	5/36	-53/258	-53/231	-52/233	-51/238	-50/242	-49/242	-47/241	-48/239	-48/239
299	60/352	94/187	101/141	97/153	93/149	90/165	87/175	84/181	82/183	81/184	80/184
217	254/440	100/256	122/264	123/272	120/281	114/286	107/289	101/290	96/290	93/290	116/336
136	255/148	438/-331	410/-316	415/-325	372/-305	368/-292	267/-293	333/-280	321/-279	315/-277	24/[illegible]
54	148/163 (223/67)	227/33	259/-56	249/-9	215/17	179/36	147/49	121/57	104/61	94/64	175/359

B714 GROUT VAULT

POSITIVE MOMENT IS COMPRESSION ON INSIDE FACE OF THE WALL, TENSION ON THE OUTSIDE FACE

AXIAL LOAD IS POSITIVE IN TENSION NEGATIVE IN COMPRESSION

Mx (K-FT/FT) / σ_z (PSI) (MAX T / MIN C)

	℄	61.2	122.4	183.6	244.8	INS CORN
462	93/684	87/675	85/659	79/607	[illegible]	42/370
380	21/12	20/13	17/14	10/31	-2/55	-8/116
299	84/241	84/239	81/233	76/236	63/243	42/353
217	103/337	101/347	95/341	85/331	67/259	33/314
136	210/-492	209/-500	209/-517	205/-460	149/-509	127/41
54	171/46	171/46	170/37	167/17	90/46	55/245

DESIGN CALCULATION

ATT 3

(1) Drawing ________ (2) Doc. No. ________ (3) Page 3 of 5

(4) Building GROUT VAULT B-714 (5) Rev. ________ (6) Job No. ________

(7) Subject PRELIMINARY THERMAL LOADS - 3D FINITE ELEMENT

(8) Originator MA Soto Date 3/10/99

(9) Checker MD Notitz Date 3/10/89

Y X

APP 4I-690

Max Mz (K-FT/FT) / σy (PSI)

	INS MC	675	600	525	450	375	300	225	150	75	℄	+
462	8/-25	47/464	76/652	99/815	95/862	97/853	99/827	98/797	97/773	97/753	96/753	[illegible]
380	-49-110	113/97	159/78	184/120	195/123	201/113	202/99	202/91	200/68	199/59	199/55	[illegible]
299	120/-252	214/-110	260/-195	300/-188	319/-223	327/-249	329/-266	328/-275	326/-285	292/-273	323/-291	[illegible]
217			357/-163	377/-177	397/-226	405/-252	405/-264	403/-270	399/-272	390/-273	396/-275	[illegible]
136	228/-183	399/-371	459/-437	486/-506	499/-542	504/-561	502/-562	499/-[illegible]	497/-563	494/-[illegible]	492/-[illegible]	[illegible]
54	165/-52	295/43	366/47	389/75	389/131	384/157	382/171	376/190	373/185	373/187	369/199	[illegible]

Max Mz (K-FT/FT) / σx (PSI)

	℄	61.2	122.4	183.6	244.8	INS
462	171/226	165/1233	107/1132	112/969	53/660	7/39
380	199/355	193/319	176/320	165/354	71/136	-50/36
299	216/-209	211/-257	197/-232	176/-226	132/-147	85/-269
217	197/-405	194/-388	176/-336	164/-749	142/-226	91/-205
136	201/-972	195/-934	194/-806	131/-754	153/-716	106/-581
54	152/115	153/112	150/104	106/72	129/23	73/4

B714 GROUT VAULT

POSITIVE MOMENT IS COMPRESSION ON INSIDE FACE OF THE WALL, TENSION ON THE OUTSIDE FACE

AXIAL LOAD IS POSITIVE IN TENSION NEGATIVE IN COMPRESSION

DESIGN CALCULATION

(1) Drawing ____ (2) Doc. No. ____ (3) Page 4 of 5 ATT 3
(4) Building GROUT VAULT B-714 (5) Rev. ____ (6) Job No. ____
(7) Subject PRELIMINARY THERMAL LOADS - 3D FINITE ELEMENT
(8) Originator MA S[illegible] Date 3/10/89
(9) Checker M O'[illegible] Date 3/10/89

Y
X

9 0 1 1 7 8 6 1 2 4 3

MAX T, MIN C

Mz (K-FT/FT) / σY (PSI)

	INS FACE	675	600	525	450	375	300	225	150	75	℄
462	8/-25	47/464	76/652	89/815	75/862	97/953	93/821	79/797	47/773	97/753	76/753
380	-47/75	113/97	2/316	20/364	30/373	35/414	37/423	37/427	56/428	35/429	35/428
299	-57/74	49/330	87/408	110/411	123/400	130/387	132/384	132/382	131/392	130/382	130/382
217	1/173	57/385	109/464	133/450	145/445	149/442	148/443	146/444	145/446	143/447	167/535
136	169/209	289/-200	366/-370	433/-349	470/-373	422/-379	420/-378	412/-376	410/-371	404/-373	404/-371
54	544/835	207/122	275/167	305/288	309/347	304/386	298/412	292/429	285/437	285/440	285/501

Mz (KFT/FT) / σX (PSI)
MAX C, MIN T

	℄	61.2	122.4	183.6	244.8	INS FACE
462						-62/-22
380	32/417	73/411	-0/387	-10/347	-47/250	-59/39
299	29/523	88/526	79/529	60/515	31/419	11/136
217	98/489	46/502	97/506	69/510	36/223	4/238
136	102/-676	102/-665	139/-664	136/-605	172/-535	74/-397
54	81/276	91/272	52/260	94/191	77/152	52/100

B714 GROUT VAULT

POSITIVE MOMENT IS COMPRESSION ON INSIDE FACE OF THE WALL, TENSION ON THE OUTSIDE FACE

AXIAL LOAD IS POSITIVE IN TENSION NEGATIVE IN COMPRESSION

DESIGN CALCULATION

ATT E

(1) Drawing ______ (2) Doc. No. ______ (3) Page 5 of 5

(4) Building GROUT VAULT B-714 (5) Rev ______ (6) Job No. ______

(7) Subject PRELIMINARY THERMAL LOADS - 3D FINITE ELEMENT

(8) Originator MA SGT Date 3/10/89

(9) Checker MD Noorkey Date 3/10/89

Y

X

G B-714-029 LEAK DETECTION COLLECTION AND REMOVAL SYSTEM

KAISER ENGINEERS HANFORD	CALCULATION IDENTIFICATION AND INDEX	WO/Job No. B714/ER1061 Date

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline 22- Environmental / Process

Project No. & Name Grout Vault Design Report

Calculation Item LDCRS B-714-Ø29

These calculations apply to:

Dwg. No. H-2-77583 Rev. No. ____

Dwg. No. ____ Rev. No. ____

Other (Study, CDR) Vault Design Report

Rev. No. ____

The status of these calculations is:

- ☐ Preliminary Calculations
- ☒ Final Calculations
- ☐ Check Calculations (On Calculation Dated ____)
- ☐ Void Calculation (Reason Voided ____

Incorporated in Final Drawings? ☒ Yes ☐ No

This calculation verified by independent "check" calculations? ☐ Yes ☒ No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	[signature] 8/9/88	[signature] 8/11/89	
Checked by	R H Hollenbeck 5/10/89	[signature] 8/11/89	
Approved by	[signature] 5/10/89	JK Marshall 8-11-89	
Checked Against Approved Vendor Data			

INDEX

Design Analysis Page No.	Description
1a	Objective and Design Basis
1-6	Drainage System Head calculations
6-32	Perforated Pipe Design
32-35	Maximum LDCRS flow
△32a&b	CS metal pipe analysis for LDCRS, Rev 1

KEH-378 (2-

DESIGN ANALYSIS

Client WHC	WO/Job No. B714		
Subject Grout Leachate	Date 8/9788	By SC Ashworth	
	Checked 5/10/89	By RG Hollenbeck	
Location 200E	Revised	By	

Objective:

The purpose of these calculations is to:

i) Show that the drainage layer meets EPA guidelines and requirements

ii) Design perforated drainage piping to withstand loads

Design Basis:

The following information sources were used in performing these calculations:

1. EPA/530-SW-85-014
2. EPA SW-869 (Revised)
3. EPA SW-870-83, March 83
4. Vendor information on plastic pipe, Harrington

Assumptions:

Stated within

Conclusions

Stated within

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DOE/RL 88-27
Rev. 1, 01/17/90

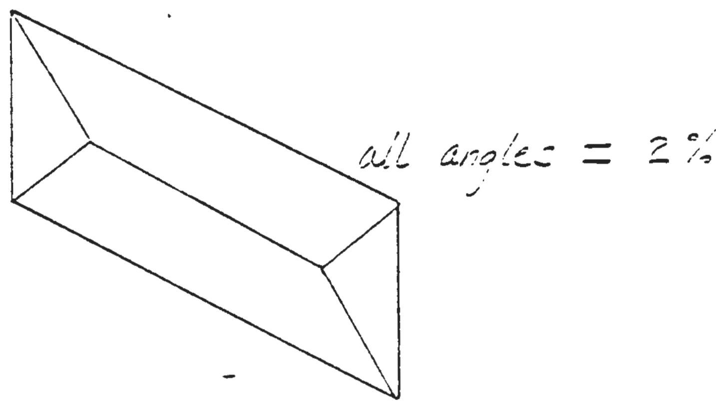
Revision 0

DESIGN ANALYSIS

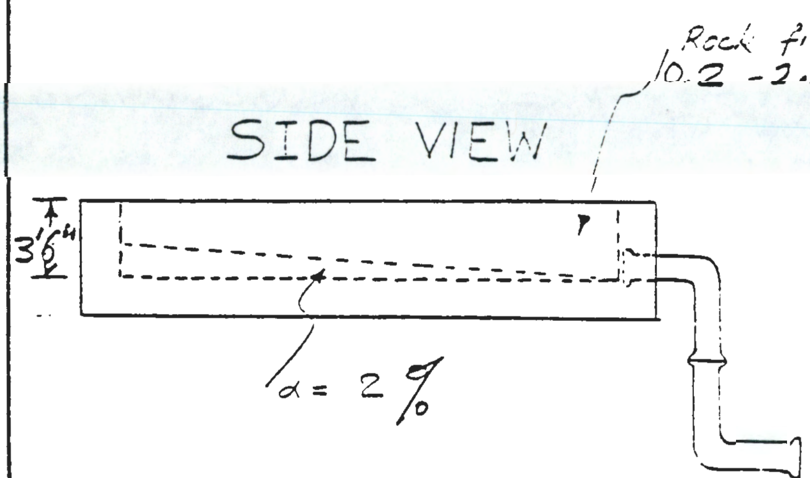
Client WHC	WO/Job No. B714		
Subject LDCRS	Date 8/9/88	By SC Ashworth	
	Checked 8-9-88	By RG Hollenbeck	
Location 200E	Revised	By	

Objective: Determine if head is adequate for leachate drainage.

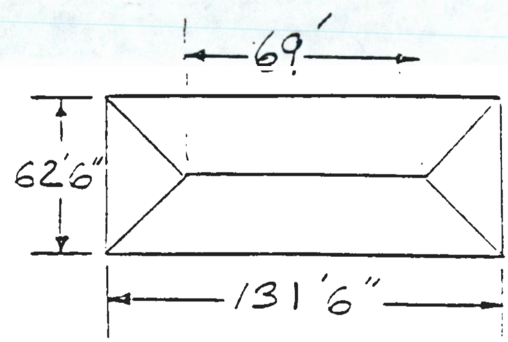
ISOMETRIC VIEW of liner configuration;



SIDE VIEW



PLAN



DESIGN ANALYSIS

Client WHC	WO/Job No. B-714		
Subject LDCRS	Date 8/9/88	By SC Ashworth	
	Checked 5/10/89	By RG Hollenbeck	
Location 200E	Revised	By	

Design flow Assumption

The design flow is based on the fact that there is no expected flows from solutions in the vault and will come from rainfall only until the RCRA cover is installed. This worse case rainfall has been determined to be 9.5 gpm by calculations shown on pages 33 through 34.

Calculate Impingement or face Velocity from 9.5 gpm

$$\frac{9.5\ gal/min.}{131.5\ ft \times 62.5\ ft} * 0.1337\ ft^3/gal * 30.48\ cm/ft * \frac{min}{60\ sec}$$

$$= 7.9 * 10^{-5}\ cm/sec$$

Determine Particle Size Distribution of Gravel

	% Greater Than	Size
	10	0.75 inch
B-714-C2	50	0.375 inch
spec.	77.5	0.187 inch
Section ____	95	0.094 inch

DESIGN ANALYSIS

Client WHC		WO/Job No. B714	
Subject LDCRS		Date 8/9/88	By SC Ashworth
		Checked 8-9-88	By RG Hollenbeck
Location 200 E		Revised	By

Basis: 1000 gm rock

100 gm stays in 0.75 inch sieve, 900 gm remaining.

400 gm stays in 0.375 inch sieve, 500 gm remaining.

275 gm stays in 0.187 inch sieve 225 gm remaining.

175 gm stays in 0.094 inch sieve.
50 < 0.094 inch.

Mass in Sieve	Size
100 gm	0.75 inch
400 "	0.375 "
275 "	0.187 "
175 "	0.094 "

The mass mean particle diameter (average) is

$$mmpd = \frac{100 * 0.75 + 400 * 0.375 + 275 * 0.187 + 175 * 0.094}{950}$$

$$= 0.31 \text{ inch } (0.78 \text{ cm})$$

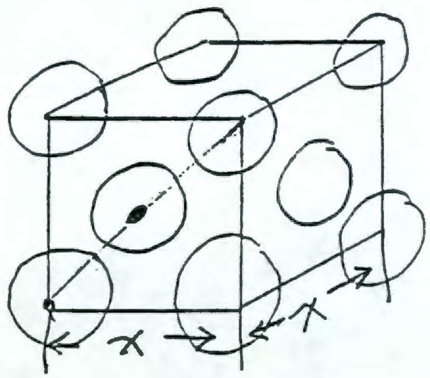
Need to determine porosity

Client: WHC		WO/Job No.: B-714	
Subject: LDCRS		Date: 8/9/88	By: SC Ashworth
		Checked: 5/10/89	By: RG Hollenbeck
Location: 200E		Revised	By

Determine Porosity

Assume gravel is uniform spheres of $D = 0.31$ inch. Porosity would depend on packing and would fall between the two extremes face centered cubic (FCC) which is maximum packing and minimum porosity, and body centered cubic, bcc, which is maximum porosity.

1. FCC packing



# of spheres in Cube

$$= \frac{1}{2} \frac{\text{sphere}}{\text{face}} * 6 \text{ faces} + \frac{1}{8} \frac{\text{sphere}}{\text{corner}} * 8 \text{ corners}$$

$$= 4$$

Volume of 4 spheres $= 4\left(\frac{\pi}{6} D^3\right) = \frac{2\pi}{3} D^3$

Determine cube volume: The face diagonal $= 2D$ so $x = 2D \frac{\sqrt{2}}{2} = \sqrt{2} D$

$$V_{cube} = (\sqrt{2} D)^3 = 2\sqrt{2} D^3$$

DESIGN ANALYSIS

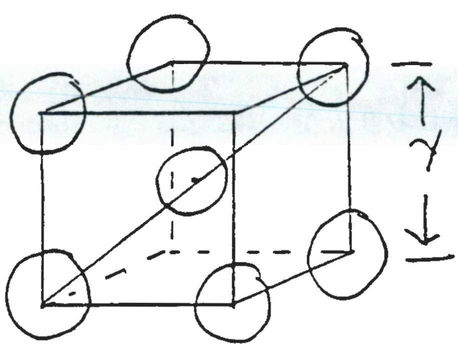
Client	WHC	WO/Job No.	B-714
Subject	LDCRS	Date 8/9/88	By SC Ashworth
		Checked 5/10/89	By RG Hollenbeck
Location	209E	Revised	By

$$\text{porosity} = \frac{V_{cube} - V_{spheres}}{V_{cube}}$$

$$= \frac{2\sqrt{2}D^3 - 2\frac{\pi}{3}D^3}{2\sqrt{2}D^3} = 1 - \frac{\pi}{3\sqrt{2}}$$

$$= 0.26 \quad \text{or } 26\%$$

bcc



$$\# \text{ spheres/cube} = 8 \text{ corners} * \frac{1}{8}\frac{\text{spheres}}{\text{corners}} + 1 = 2$$

$$V_{spheres} = 2\left(\frac{\pi}{6}D^3\right) = \frac{\pi}{3}D^3$$

$$V_{cube} = y^3$$

main diagonal = 2D

$$y = 2D\frac{\sqrt{2}}{2} = \sqrt{2}D$$

$$V_c = y^3 = \sqrt{2}^3 D^3 = 2\sqrt{2}D^3$$

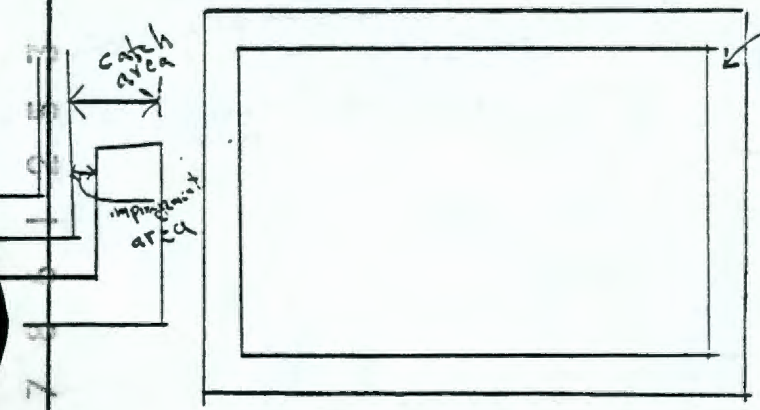
$$\text{porosity} = \frac{2\sqrt{2} - \pi/3}{2\sqrt{2}} = 1 - \frac{\pi}{6\sqrt{2}} = 0.63$$

or 63% will use worst case of 26%

DESIGN ANALYSIS

Client: WHC		WO/Job No.: B-714	
Subject: LDCRS		Date: 8/9/88	By: SC Ashworth
		Checked: 5/10/89	By: RG Hollenbeck
Location: 200E		Revised:	By:

Since the rainwater will not impinge the Area directly beneath the vault, An impingement velocity on the Annular area as shown below:



Impingement Area $= 1164\ ft^2$

$$e = \frac{9.5\ gpm}{1164\ ft^2} * \frac{ft^3}{7.48\ gal} * \frac{30.48\ cm}{ft} * \frac{min}{60\ sec}$$

$$= 5.5 * 10^{-4}\ cm/sec$$

Using this for the previous 2 cases results in:

$$h_{max_1} = \frac{62.5\ ft}{2 * 0.26}\left[\sqrt{\frac{5.5 * 10^{-4}\ cm/s}{1.0\ cm/s} + \tan^2 1.15} - \tan 1.15\right]$$

$$= 1.3\ ft$$

$$h_{max_2} = \frac{69\ ft}{2 * 0.26}\left[\sqrt{\frac{5.5 * 10^{-4}\ cm/s}{1.0\ cm/s} + \tan^2 1.15} - \tan 1.15\right]$$

$$= 1.44\ ft$$

Both of which are high but considering the conservancies will be well below the recommended 1 ft head.

DESIGN ANALYSIS

Client WHC	WO/Job No. ~~B~~-744		
Subject LDCRS	Date 8/9/88	By SC Ashwin	
	Checked 5/10/89	By RG Hollenbeck	
Location 200E	Revised	By	

Repeat The calculation for the less conservative case for $K = 5.0 \text{ cm/s}$

$$h_{max_1} = \frac{62.5}{2 * 0.26}\left[\sqrt{\frac{5.5 \times 10^{-4} \text{cm/s}}{5 \text{ cm/s}} + \tan^2 1.15} - \tan 1.15\right]$$

$= 0.31 \text{ ft}$ < O.K.

$h_{max_2} = 0.34 \text{ ft}$ < O.K.

which indicates no problem with head build up when using less conservative case

For flow from one side to the other on 2% slope

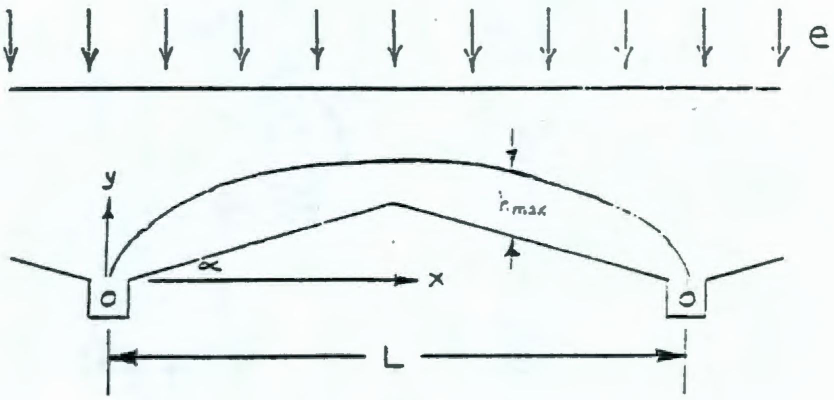
$h_{max} = 2 * h_{max_2} = 0.68 \text{ ft}$ < O.K.

The coefficient of permeability, K

Although K is greater than 1 cm/sec (actually > 5 cm/sec) will use 1 cm/sec for calculation purposes

Determine head from flow in this Drain

Figure 5 in SW-869



(C)

– Geometry assumed for bounding solution for effectiveness of sand drains.

Shows head distribution for a drain field and the same equations can be used for our system, one drain, as can be seen by shifting the diagram by L/2.

Client WHC	WO/Job No. B744		
Subject LDCRS	Date 8/9/88	By SC Ashworth	
	Checked 8-9-88	By RG Hollenbeck	
Location 200E	Revised	By	

using eqn. 3 from SW-869

$$h_{max} = \frac{L}{2n}\left[\sqrt{\frac{e}{K_{s1}} + \tan^2\alpha} - \tan\alpha\right] \qquad (3)$$

$$h_{max} = \frac{62.5\ ft}{2*0.26}\left[\sqrt{\frac{7.9*10^{-5}\ cm/sec}{1.0\ cm/sec} + \tan^2 1.15} - \tan 1.15\right]$$

$= 0.226\ ft$

which is less than 1 foot recommended & $\alpha > 5\%$ greater than $1\ cm/sec$ proposed

<u>So drain field is adequate from [illegible] slopes;</u>
<u>calculate lateral max head expected.</u>

$$h_{max} = \frac{69\ ft}{2*0.26}\left[\sqrt{\frac{7.9*10^{-5}\ cm/sec}{1.0\ cm/sec} + \tan^2 1.15} - \tan 1.15\right]$$

$= 0.25\ ft$ which is also $< 1.0\ ft$ & lateral drain slope is adequate.

DESIGN ANALYSIS

Client: WHC		WO/Job No.: B-714	
Subject: LDCRS		Date: 8/9/88	By: SC Ashworth
		Checked: 5/10/89	By: RG Hollenbeck
Location: 200E		Revised:	By:

Objective: Determine the coefficient of permeability for the following gravel distribution

Seive Size	% Smaller than
0.75 inch	85 - 95
0.375 inch	45 - 55
#4 (0.187 inch)	20 - 25
#8 (0.094 inch)	0 - 10 ← D_{10}

$$D_{10} = 0.094\ \text{inch} * 2.54\ \frac{\text{cm}}{\text{inch}} * 10\ \frac{\text{mm}}{\text{cm}} = 2.4\ \text{mm}$$

according to the chart from Navy 1982 (Fig 8), K, coefficient of permeability is greater than

$$10\ \text{ft/min} * 30.48\ \frac{\text{cm}}{\text{ft}} * \frac{\text{min}}{60\ \text{sec}} = 5.08\ \text{cm/sec}$$

This is a factor of 5 greater than the 1.0 cm/sec proposed.

DESIGN ANALYSIS

Client NHC
WO/Job No. B-714
Subject LDCRS
Date 8/9/88 By SC Aelumriti
Checked 5/10/89 By RC Hollenbeck
Location 200E
Revised By

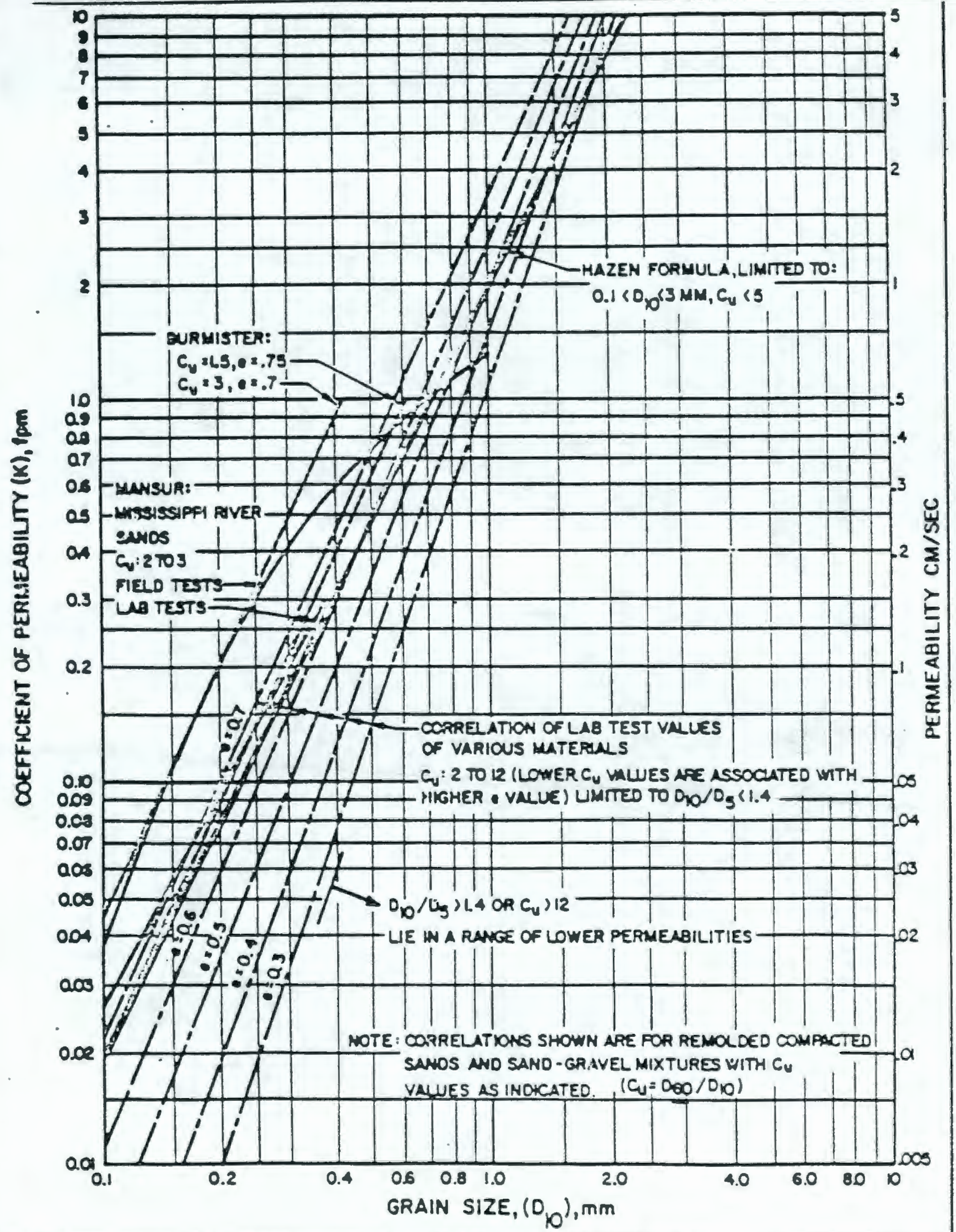


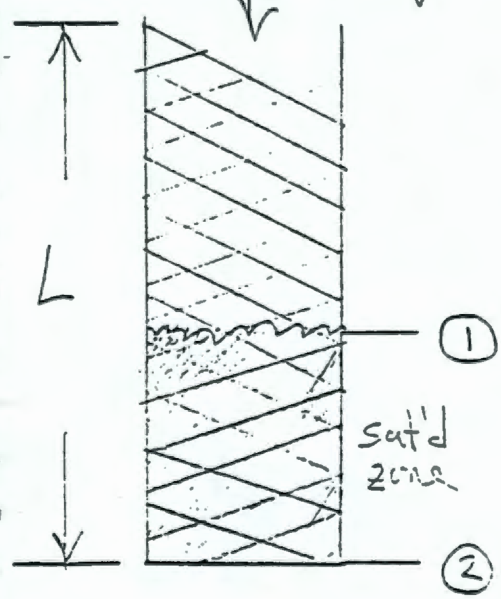
FIGURE 1
Permeability of Sands and Sand-Gravel Mixtures

DESIGN ANALYSIS

Client WHC	WO/Job No. ~~B~~-714		
Subject LDCRS	Date 8/9/88	By SC Ashurst	
	Checked 5/10/89	By RG Hillenbeck	
Location 200 E	Revised	By	

consider head buildup in the gravel barrier from rainfall

Determine head from Bernoulli's equation:



$$\frac{P_1}{\gamma} + Z_1 + \frac{v_1^2}{2g_c} = \frac{P_2}{\gamma} + Z_2 + \frac{v_2^2}{2g_c} + h_L$$

Since free surface and no geometry change

$\Delta P = 0$, $\Delta v^2 = 0$

so $\Delta Z = h_L$

from Perrys Chemical Engineers Manual the head loss across a packed bed is:

$$h_L = \left(\frac{4 f_m (1-\epsilon)^{3-n}}{\phi_s^{3-n} \epsilon^3} \right) \frac{L}{D_p} \frac{\bar{v}^2}{2 g_c}$$

Client	WHC	WO/Job No.	B-714		
Subject	LDCRS	Date	8/9/88	By	SC Ashurn
		Checked	5/10/89	By	RG Hollenbeck
Location	200E	Revised		By	

So the head loss is equal to the head build-up

where

P = Pressure

Z = saturated head

v = velocity

h_L = head loss

γ = Specific Weight

g = gravity

g_c = gravity constant

f_m = modified friction factor

ϵ = Void fraction

ϕ_s = shape factor

L = Bed height

D_p = particle diameter

G = mass velocity

μ = viscosity

KAISER ENGINEERS
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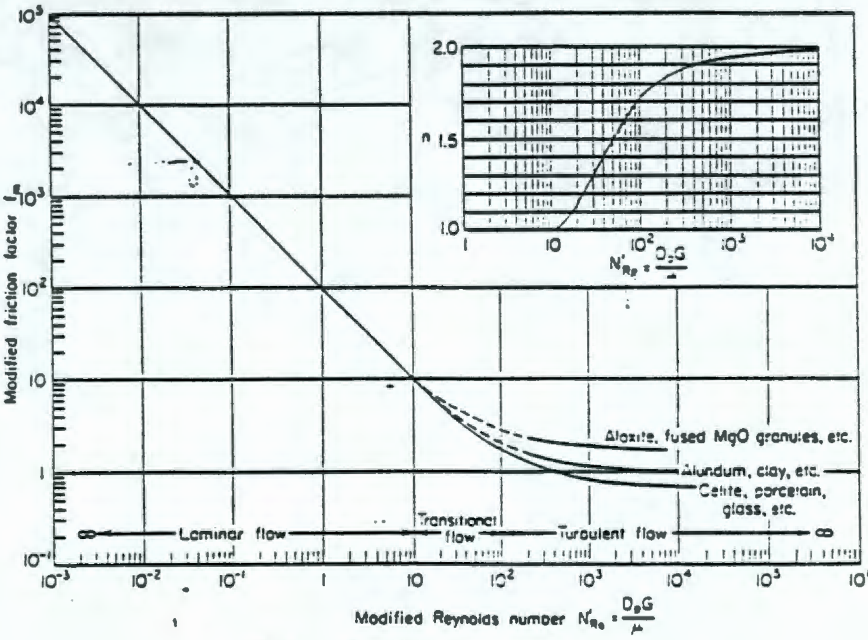
DOE/RL 88-27
Rev. 1, 01/17/90

Revision 0

DESIGN ANALYSIS

Client: WHC WO/Job No.: B-714
Subject: LDCRS Date: 8/9/88 By: SC Ashwani
Checked: 5/6/89 By: RG Hollenbeck
Location: 200E Revised: By:



Ref: B 714-C2
Section 2145

Size	% greater
1"	0
3/4	0 - 50
1/2	50 - 90
3/8	85 - 100
#4	95 - 100
#200	99 - 100

ave. grain size = 0.51 inch

using above chart, first find

$$Re = \frac{\frac{0.31}{12}\,ft * 5.5\times10^{-4}\,cm/s * 62.4\,\frac{lbm}{ft^3} * \frac{ft}{30.48\,cm}}{6.7\times10^{-4}\,\frac{lbm}{ft\,sec}} = 0.043$$

$f_m = 2\times10^3$

$n = 1.0$ Assume $\phi_s = 1.0$

$$v = 5.5\times10^{-4}\,cm/s * \frac{ft}{30.48\,cm} = 1.8\times10^{-5}\,ft/sec$$

$$\Delta Z = \frac{4 * 2 * 10^3 (1-0.26)^2}{(0.26)^3} * \frac{34\,ft}{0.51/12\,ft} * \frac{(1.8\times10^{-5})^2}{64.4}$$

$= 0.001$ ft

APP 4I-709

DESIGN ANALYSIS

Client WHC	WO/Job No. B-714		
Subject B-714	Date 8/9/88	By SC Ashw[illegible]	
	Checked 5/10/89	By RG Hollenbeck	
Location 200E	Revised	By	

This is well below 1 ft & no problem is expected from head build up.

DESIGN ANALYSIS

Client WHC	WO/Job No. 8714		
Subject LDCRS	Date 8/9/88	By SC Ashworth	
	Checked 8-9-88	By RG Hollenbeck	
Location 200E	Revised	By	

Objective : Design liner perforated pipe for drainage.

I. choose perforation size.

page 275 of reference (SW-870) says: use.

$$\frac{D_{85} \text{ of media near pipe}}{\text{maximum pipe opening}} = 2 \text{ or more}$$

$D_{85} \approx 0.75$ inch

let $\frac{D_{85}}{D_{PO}} = 3$ so diameter of hole in pipe is 0.25 inch

II. Arbitrarily choose 4" drain pipe.

III. Determine number of holes

$$Q = 9.5 \frac{gal}{min} * 0.1337 \frac{ft^3}{gal} * \frac{min}{60 sec}$$
$$= 2.11 * 10^{-2} ft^3/sec$$

use orifice eqn.

$Q = N * A * C \sqrt{2gh}$, derived from Perry's, 197[illegible]

where $A = area = \frac{\pi}{4}\left(\frac{0.25}{12} ft\right)^2 = 3.4 \times 10^{-4} ft^2$

9 0 1 1 1 7 8 5 1 2 6 3

DESIGN ANALYSIS

Client WHC — WO/Job No. B-714
Subject LDCRS — Date 8/9/88 — By SC Achurra
Checked 5/10/89 — By RG Hollenbeck
Location 200 E — Revised — By

The Reynolds number, $R_e = \frac{DV\rho}{\mu}$

can be re-written as

$$R_e = \frac{4Q\rho}{N\pi D\mu}$$

Using this and the chart on pg 19 with:

$$N = \frac{Q}{AC\sqrt{2gh}}$$

The number of holes (N) can be found by trial & error with the following procedure:

1. Pick N
2. Calc R_e
3. find C from graph
4. Calc. N
5. Compare Pick & calc

Nomenclature

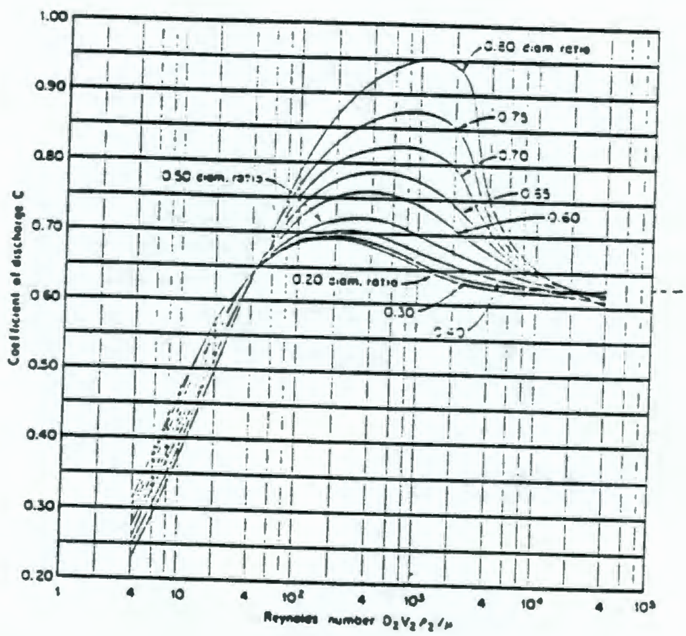
- Q — flow rate
- e — Impingement rate
- ρ — liquid density
- D — orifice diameter
- μ — liquid viscosity
- A — orifice Area
- V — velocity through orifice
- h — head
- C — coefficient

DESIGN ANALYSIS

Client WHC		WO/Job No. B-714	
Subject LDCRS		Date 8/9/88	By S C Ashworth
		Checked 5/10/89	By RG Hillenbeck
Location 200E		Revised	By

The maximum number, N, of holes occurs as $h \rightarrow 0$, so will use lowest average head:

$$h = \frac{0.226\ ft + 0\ ft}{2} = 0.113\ ft$$



The orifice coefficient can be found with the above chart observing that the diameter ratio should be small and converges at 0.20.

Client WHC | WO/Job No. B-714
Subject LDCRS | Date 8/9/88 By SC Ashworth
Checked 5/10/89 By RG Hollenbeck
Location 200E | Revised | By

Pick $N = 22$

Calc, $R_e = \dfrac{4 * 2.1 * 10^{-2}\ ft^3/sec * 62.4\ lbm/ft^3}{\pi * 22 * \frac{0.25}{12} ft * 1\,cp * 6.7*10^{-4}\ lbm/ft\text{-}sec\text{-}cp}$

$= 5400$

find $C = 0.63$

Calc, $N = \dfrac{2.1 * 10^{-2}\ ft^3/sec}{3.4*10^{-4}\ ft^2 * 0.63 * \sqrt{2 * 32.2\frac{ft}{sec^2} * 0.113}}$

$= 36$

Try $N = 36$

$R_e = 3300$
$C = 0.63$
$N = 36 \rightarrow$ 36 holes 1/4" diam minimum

use 4 holes/ft pipe $* 69$ ft $= 276$ ho[les]

Design ratio $= \dfrac{276}{36} = 7.7$ OK

DESIGN ANALYSIS

Client WHC		WO/Job No. B714	
Subject LDCRS		Date 8/9/88	By SC Ashworth
		Checked 8-9-88	By RG Hollenbeck
Location 2UDE		Revised	By

voided

N = number holes

C = orifice coeff., use 0.1 (low value for worse case)

g = gravity = 32 ft/sec²

h = head, ft

for h, use average of

$$\frac{0.155 + 0}{2} \simeq 0.0775 \text{ ft}$$

then,

$$N = \frac{5.2 \times 10^{-3} \text{ ft}^3/\text{sec.}}{3.4 \times 10^{-5} \text{ ft}^2 * 0.1 * \sqrt{2 * 32.2 \frac{ft}{sec^2} * 0.0775 \text{ ft}}}$$

= 69 holes

use 4 holes/ft or 4 * 69 = 276 holes.
which is factor of 4 over sized

IV. check flow through pipe

use manning eqn.

$$Q = \frac{A * 1.486}{n} * S^{1/2} * R^{2/3}$$, Perrys 1976

where: A = pipe cross-sectional area

n = coefficient of roughness

R = hydraulic Radius

S = slope

9 0 1 1 7 8 5 1 2 6 7

DOE Richland, WA · GPO 1988-592-092

DESIGN ANALYSIS

Client: WHC		WO/Job No.: 8-714	
Subject: LDCRS		Date: 8/9/88	By: SC Ashu...
		Checked: 5/10/89	By: RG Hollenbeck
Location: 200E		Revised:	By:

Now determine the maximum flow expected via Mannings Equation:

$$Q = \frac{A * 1.486}{n} * S^{1/2} * R^{2/3}$$ per Perry's 1976

where

A = pipe cross-sectional Area

n = Roughness Coefficient

R = hydraulic Radius

S = slope

$$A = \frac{\pi}{4}\left(\frac{4}{12} ft\right)^2 = 0.0873 \, ft^2$$

n = 0.011 (Perrys Eng. Manual)

$$R = 2/2 = 1$$

$$S = 2\% \ (0.02)$$

$$Q = \frac{0.0873 * 1.486}{0.011} * \left(\frac{1}{12}\right)^{2/3} * (0.002)^{1/2}$$

$$= 0.32 \, ft^3/sec$$

Since $Q_{actual} = 2.11 * 10^{-2} \, ft^3/sec$

$$\text{Design Ratio} = \frac{0.32}{2.11 \times 10^{-2}} = 15$$

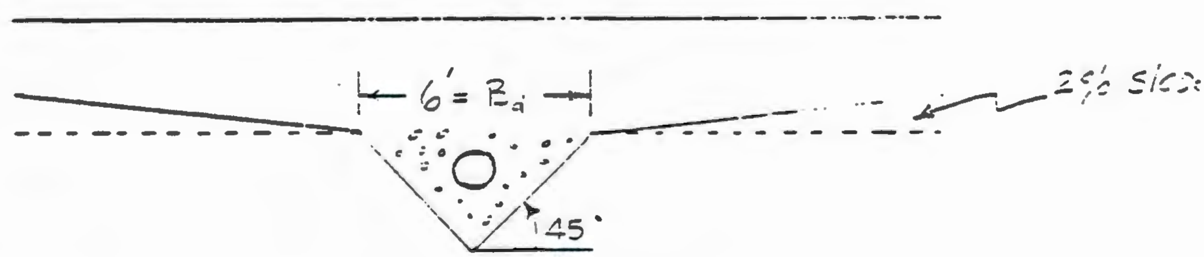
APP 4I-716

DESIGN ANALYSIS

Client WHC		WO/Job No. B774	
Subject LDCRS		Date 8/9/88	By SC Ashworth
		Checked 8-9-88	By RG Hollenbeck
Location 200 E		Revised	By

Objective: Determine type of pipe & strength for drainage pipe.

TRENCH - general configuration



assume D = 4" for calculation purposes.

for trench condition use equations from SW-870

$\sigma_p = W_f * H_f$

where:

σ_p = vertical pressure at the base of the refuse due load above (lbs/ft²)

W_f = unit weight of the waste fill (lbm/ft³); values between 45 & 65 for municipal waste with soil cover, will be 120 lbs/ft³ (concrete etc) as worse case.

H_f = height of waste fill (ft)

The value of the vertical pressure at the top of

DESIGN ANALYSIS

Client WHC		WO/Job No. B714	
Subject LDCRS		Date 8/9/88	By SC Ashworth
		Checked 8-9-88	By RG Hollenbeck
Location 200 E		Revised	By

the pipe due to the waste fill may be determined from the following equation:

$$\sigma_{V1} = Q_f * C_{\mu s}$$

$$Q_f = 120 \frac{lbf}{ft^3} * 54 ft = 6500 \frac{lbf}{ft^2} \quad (45 psi)$$

$$C_{\mu s} = e^{-2K\mu'(Z/B_d)}$$

where:

K = lateral pressure coefficient of the trench backfill.

μ' = coefficient of friction between backfill & the walls of the trench.

Z = depth of trench from original ground surface to top of pipe (ft)

Bd = width of trench at top of pipe (ft).

Since the trench is triangular and the equations are for rectangular, will do for worst case.

Type of soil	Maximum Value of Kμ'
Sand & gravel	0.165
Saturated top soil	0.150
Clay	0.130
Saturated clay	0.110

Client WHC	WO/Job No. B744 —		
Subject LDCRS	Date 8/9/88	By SC Ashworth	
	Checked 8-9-88	By RG Hollenbeck	
Location 200E	Revised	By	

using $K\mu' = 0.165$ for sand & gravel

$$C_{\mu s} = e^{-2 * 0.165 * (\frac{54}{6})} = 0.051 \text{ (at top)}$$

$$C_{\mu s} = e^{-\infty} = 0 \text{ at bottom}$$

$$\sigma_{y1} = 6500 * 0.051$$ ← at ~~top~~ is worst case

$$= 333.5 \frac{lbf}{ft^2} \quad (2.3 \text{ psi})$$

The value of the vertical pressure at the top of the pipe due to trench backfill may be determined from the following equation developed by Marston from SW-870;

$$\sigma_{v2} = B_d * w * C_d$$

where: w = unit weight of trench backfill (lbs/ft^3)

The term C_d is a load coefficient which is a function of the ratio H/B_d and the friction between the backfill and sides of the trench. It may be computed from the following equation.

$$C_d = \frac{1 - e^{-2K\mu'(H/B_d)}}{2K\mu'}$$

where the terms are as defined above.

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The total vertical pressure is equal to:

$$\sigma_v = \sigma_{v1} + \sigma_{v2} = q_s C_{us} + B_d w C_d.$$

The force per unit length of pipe is equal to:

$$W = \sigma_v * B_c$$

where: W = force per unit length of pipe.

B_c = outside diameter of pipe

$$C_d = \frac{1 - e^{-2*0.165*\left(\frac{54}{6}\right)}}{2*0.165} = 2.87 \quad \text{(for top)}$$

$$C_d = \frac{1}{2*0.165} = 3.03 \quad \text{(for bottom)}$$

$$\sigma_{v2} = 6*120*2.87 \quad \text{(for top)}$$

$$= 2066 \tfrac{lb}{ft^2} \ (14.35 \text{ psi})$$

$$\sigma_{v2} = 6*120*3.03 = 2182 \tfrac{lbf}{ft^2} (15.15 \text{ psi}) \ \text{(for bottom)}$$

σ_v total worst case = 2.3+15.15 = 17.45 psi

Perforated Pipe

Perforations will reduce the effective length of pipe available to carry loads and resist pressure. The effect of perforations can be taken into account by using an increased load per nominal unit length of

DESIGN ANALYSIS

Client WHC		WO/Job No. B714	
Subject LDCRS		Date 8/9/88	By SC Ashworth
		Checked 8-9-88	By RG Hollenbeck
Location 200 E		Revised	By

the pipe. If l_p equals the cumulative length in inches of perforations per foot of pipe, the increased vertical stress to be used equals:

$$(\sigma_v)_{design} = \frac{12}{12 - l_p} * (\sigma_v)_{actual}$$

$$l_p = 0.25 \text{ inch} * \frac{276 \text{ holes}}{69 \text{ ft}} = 1$$

$$(\sigma_v)_{design} = \frac{12}{11} * 17.45 = 19 \text{ psi}$$

will use Table and plot to determine pipe

$\frac{\Delta Y}{B_c}$	$\frac{\sigma_{v\,max}}{\Delta Y / B_c}$	E' 300	E' 700
0.05	344	6" sch 80 PVC or stronger	6" sch 80 PVC or stronger
0.09	172	6" sch 40 PVC	Any stiffness

9 0 1 1 7 8 5 1 2 7 3

APP 4I-721

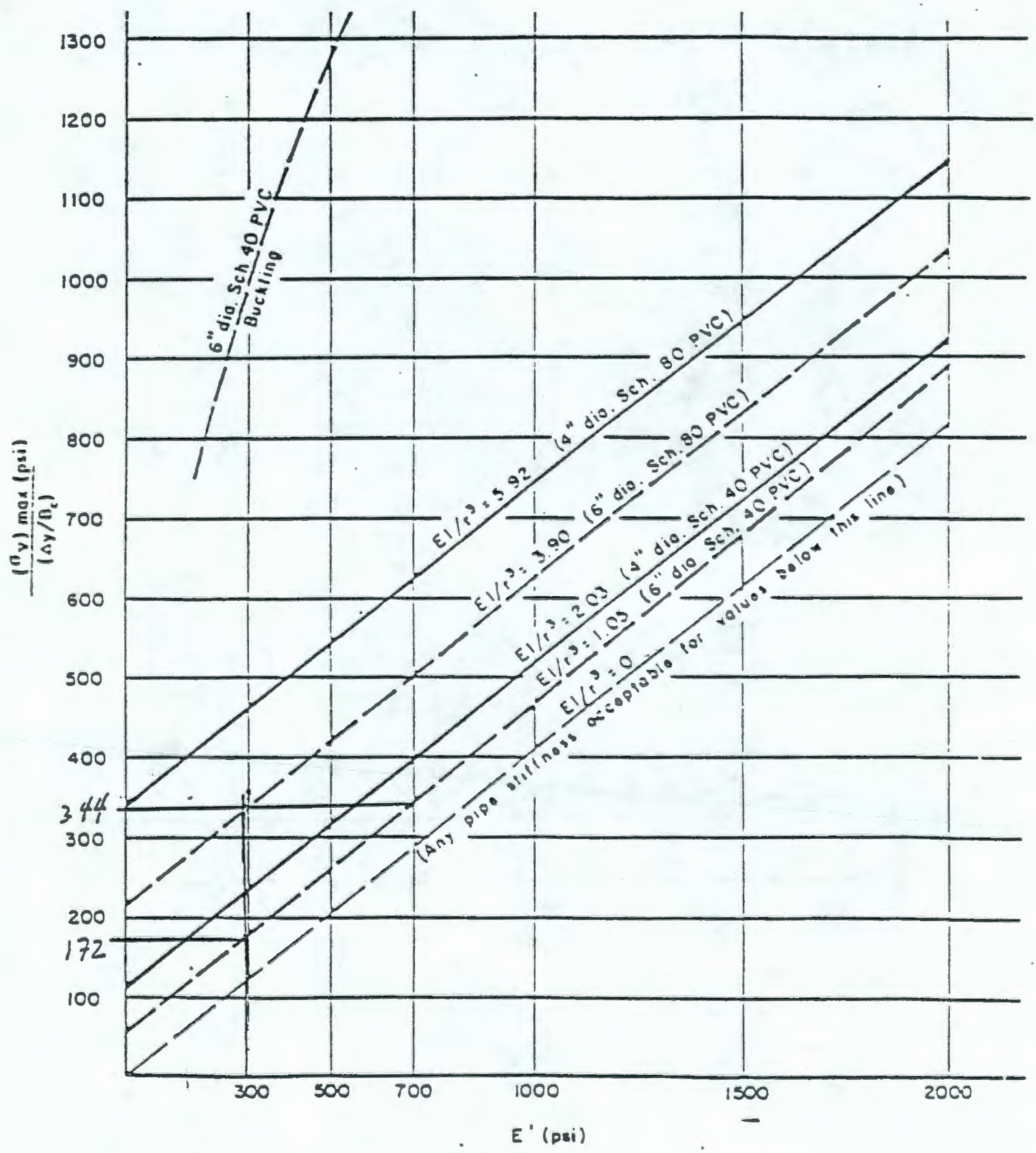
DESIGN ANALYSIS

Client WHC — WO/Job No. B714

Subject LDCRS — Date 8/9/88 By SC Ashworth

Checked 8-9-88 By RG Hollenbeck

Location 200 E — Revised — By



$$\frac{\sigma_y}{(\Delta y / B_c)} = \frac{[EI + 0.061\ E' r^3]^*}{D_o K r^3}$$

Assumed: $D_o = 1.5$, $K = 0.1$ *

Figure V-6. Selection of Pipe Strength
* (ASCE, 1969)

DESIGN ANALYSIS

Client WHC	WO/Job No. 8714		
Subject LDCRS	Date 8/9/88	By SC Ashworth	
	Checked 8-9-88	By RG Hollenbeck	
Location 200 E	Revised	By	

Although the PVC is acceptable strength wise, want Polypropylene (PP) or Polyethylene since they are compatible with the liner and contain less plasticizers.

Specify 4" PP and determine if strength is adequate. The following is the modulus of elasticity (E) for two types of polypropylene, Fuseal and Pressure at different temperatures from Harrington Plastics catalog:

TEMP.	170°F	180°F	200°F
Fuseal	0.61×10^5	0.59×10^5 (from linear interpolation)	0.55×10^5
Pressure	0.77×10^5	0.71×10^5 (from linear interpolation)	0.59×10^5

The following equation from EPA-SW-870 is used to determine if strength is adequate;

$$\frac{W}{B_c} = \sigma_r = \frac{(\Delta y)}{(B_c)} \frac{(EI + 0.061 E' r^3)}{(D_e K r^3)}.$$

Client WHC	WO/Job No. B714	
Subject LDCRS	Date 8/9/88	By SC Ashworth
	Checked 8-9-88	By RG Hallenbeck
Location 200 E	Revised	By

Where: Δy = horizontal and vertical deflection of the pipe (in).

D_e = a factor, generally taken at a conservative value of 1.5, compensating for the lag or time dependent behavior of the soil/pipe systems (dimensionless).

W = vertical load acting on the pipe per unit of pipe length (lb/in).

r = mean radius of the pipe (in).

E = modulus of elasticity of the pipe material (psi).

E' = modulus of passive soil resistance (psi) (normally estimated to be 300 psi for soils of Proctor density of 85% and 700 psi for soils of Proctor density of at least 90%).

K = bedding constant, reflecting the support the pipe receives from the bottom of the trench (dimensionless). (a conservative value generally taken 0.10).

I = moment of inertia of pipe wall per unit of length (in^4/in); for any round pipe, $I = t^3/12$ where t is the average thickness (in).

The above equation can be re-arranged with $I = \frac{t^3}{12}$ and dividing top & bottom by r^3 to get;

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HANFORD

Revision

DESIGN ANALYSIS

Client WHC		WO/Job No. 8714	
Subject LDCRS		Date 8/9/88	By SC Ashworth
		Checked 8-9-88	By RG Hollenbeck
Location 200 E		Revised	By

$$\sigma_v = \frac{(\Delta y)}{(B_c)} \frac{\left(E\frac{t^3}{12r^3} + 0.061E'\right)}{(D_eK)}$$

using previous assumptions about $D_eK = 0.15$ etc;

$$\sigma_v = \frac{(\Delta y)}{(B_c)} \frac{\left(E\frac{t^3}{12r^3} + 0.061E'\right)}{(0.15)}$$

Look at 4" pressure pipe, from Harrington:

$D_o = 4.331$ in., $t = 0.394$ in. $r =$ mean radius $= \frac{4.331-0.394}{2} = 1.97$

SDR 11 $\sigma_v = \frac{(\Delta y)}{(B_c)} \frac{(0.00067E + 0.061E')}{(0.15)}$, $E = 0.71 \times 10^5$

σ_v

$\frac{\Delta y}{B_c}$	$E' = 300$	$E' = 700$
0.05	22 psi	30 psi
0.09	40 psi	54 psi

And for sch 80 Fuseal

$D_o = 4.5$ in., $t = 0.337$ in. , $r = \frac{4.5 - 0.337}{2} = 2.08$

$$\sigma_v = \frac{(\Delta y)}{(B_c)} \frac{(0.000354E + 0.061E')}{(0.15)}$$

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DESIGN ANALYSIS

Client WHC	WO/Job No. 8714		
Subject LDCRS	Date 8/9/88	By SC Ashworth	
	Checked 8-9-88	By RG Hollenbeck	
Location 200 E	Revised	By	

σ_y

$\frac{\Delta y}{D_c}$	E' = 300	E' = 700
0.05	13 psi	21 psi
0.09	23 psi	38 psi

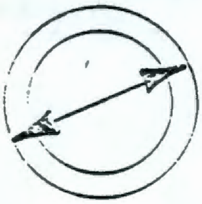
Since the σ_y total from previous analysis is 19 psi, the 4" pressure pipe is adequate (SDR 11). The other pipe is not adequate for all cases so the SDR 11 is chosen

Note that polyethylene pipe was also considered but its strength diminishes too much with temperature increases, e.g. E = 50,000 psi at 140°F. Telecom with Jules Williams of J.T. Ryerson, who manufacture PE pipe: He recommends something other than PE pipe for this usage so PP will be used.
Was determined to use Carbon steel pipe which can replace Plastic pipe for all strength conditions.

DESIGN ANALYSIS

Client WHC		WO/Job No. ER 9090	
Subject B-714		Date 8/11/89	By S C Ashwin
		Checked HPkay	By 8/11/89
Location 200 E		Revised	By

for Carbon steel pipe corroded 30 mils on the Inside and outside



The thickness decreases 60 mils so now Thickness is:

$$t = 0.337 \text{ (for Sch. 80)} - 0.060$$

$$= 0.277 \text{ inch}$$

The new outside radius is:

$$\frac{3.826 + 2 \times 0.337}{2} - 0.030$$

$$= 2.22$$

new inside radius

$$\frac{3.826}{2} + 0.030 = 1.943$$

thickness check: 2.22 − 1.943 = 0.277 ← o.k.

DESIGN ANALYSIS

Client WHC		WO/Job No. ER9090	
Subject B-714		Date 8/11/89	By SC Ackerson
		Checked [signature]	By 8/11/89
Location 200E		Revised	By

$$\sigma_v = \left(\frac{\Delta Y}{B_c}\right) \frac{\left(E\frac{t^3}{12\bar{r}^3} + 0.061E'\right)}{0.15}$$

All variables previously defined except E for carbon steel which is 27.7×10^6 lbf/in²

Also need mean pipe radius

$$\bar{r} = \frac{2.22 - 1.943}{\ln\frac{2.22}{1.943}} = 2.08$$

$$\sigma_v(0.05, 300) = 0.05 * \frac{\left(27.7\times10^6\ \text{lbf/in}^2 * \left(\frac{0.22^3}{12 * 2.08^3}\right) + 0.061 * 300\right)}{0.15}$$

= 1006 psi which will be the lowest pipe withstanding stress S and is much greater than the 19 psi expected.

DESIGN ANALYSIS

Client WHC		WO/Job No. ER9090	
Subject B-714 CALCULATIONS OF PEAK FLOWRATE FROM INFILTRATING PRECIPITATION		Date 3/16/89	By S.D. CONSORT
		Checked 5/10/89	By RG Hollenbeck
Location 200 E		Revised	By

PURPOSE

DETERMINE PEAK FLOWRATE FROM INFILTRATING PRECIPITATION THAT COULD REACH THE LEACHATE DETECTION, COLLECTION AND REMOVAL SYSTEM (LDCRS) OF ONE VAULT AT THE GROUT TREATMENT FACILITY.

DESIGN CRITERIA

DESIGN STORM = 100 YEAR FREQUENCY, 24 HOUR DURATION

ASSUMPTIONS

GRAVEL DIFFUSION BARRIER AROUND VAULT.

CLOSURE COVER NOT IN PLACE.

NO EVAPORATION OF PRECIPITATION.

WORST CASE - ALL PRECIPITATION REACHES THE LDCRS.

REFERENCES

1) CLIMATOLOGICAL SUMMARY FOR THE HANFORD AREA, W. A. STONE ET AL, JUNE 1983.

RESULTS

THE PEAK FLOWRATE CALCULATED IS 9.46 GAL/MIN, ASSUMING ALL THE PRECIPITATION REACHES THE LDCRS. THE ACTUAL FLOWRATE FROM THE DESIGN STORM WILL PROBABLY BE LESS BECAUSE NOT ALL THE WATER WILL FLOW INTO THE CATCH BASIN. ALSO, THERE WILL BE A DELAY FOR WATER FLOWING THROUGH THE GRAVEL ACROSS THE VAULT ROOF BEFORE IT PERCOLATES THROUGH 40 FEET OF MORE GRAVEL.

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DESIGN ANALYSIS

Client	WHC	WO/Job No.	ER9090
Subject	B-714 LDCRS	Date 5/16/89	By SD Cornett
		Checked 5/10/89	By RG Hollenbeck
Location	200E	Revised	By

AREA OF VAULT PAIR + GRAVEL DIFFUSION BARRIER:

$145.5 \text{ FT} \times 151.0 \text{ FT} = 21\,970.5 \text{ FT}^2$

PRECIPITATION OVER HALF THIS AREA IS EXPECTED TO CONTRIBUTE TO THE LEACHATE DETECTION, COLLECTION AND REMOVAL SYSTEM (LDCRS) OF ONE VAULT.

ONE HALF AREA = $\frac{1}{2}(21970.5) = 10\,985.25 \text{ FT}^2$

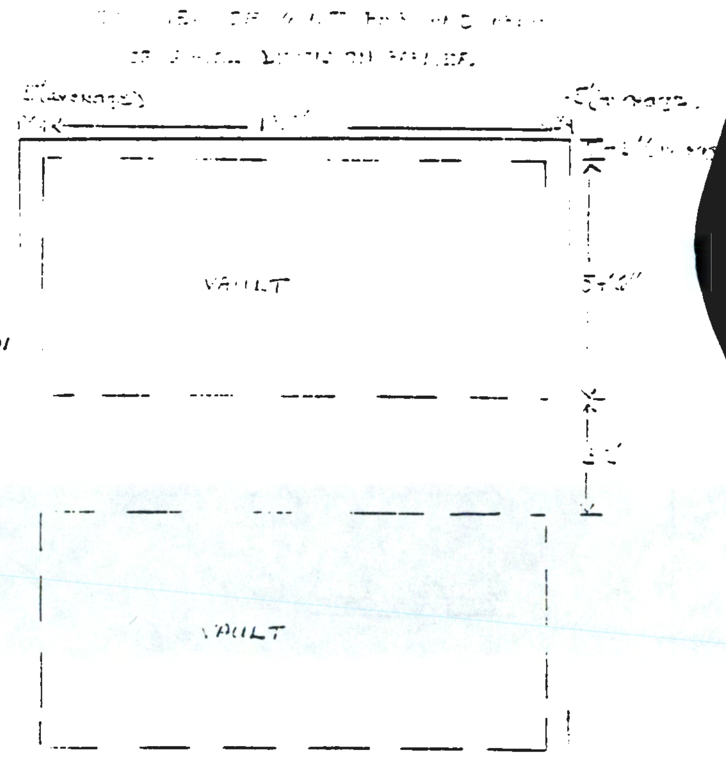
DESIGN STORM = $0.083 \text{ IN/HR} \times 24 \text{ HRS} = 1.99 \text{ IN}$ (SEE ATTACH 1)

VOLUME OF WATER AVAILABLE TO INFILTRATE GRAVEL DIFFUSION BARRIER AROUND VAULT:

$1.99 \text{ IN} \times 10985.25 \text{ FT}^2 = 1821.72 \text{ FT}^3$

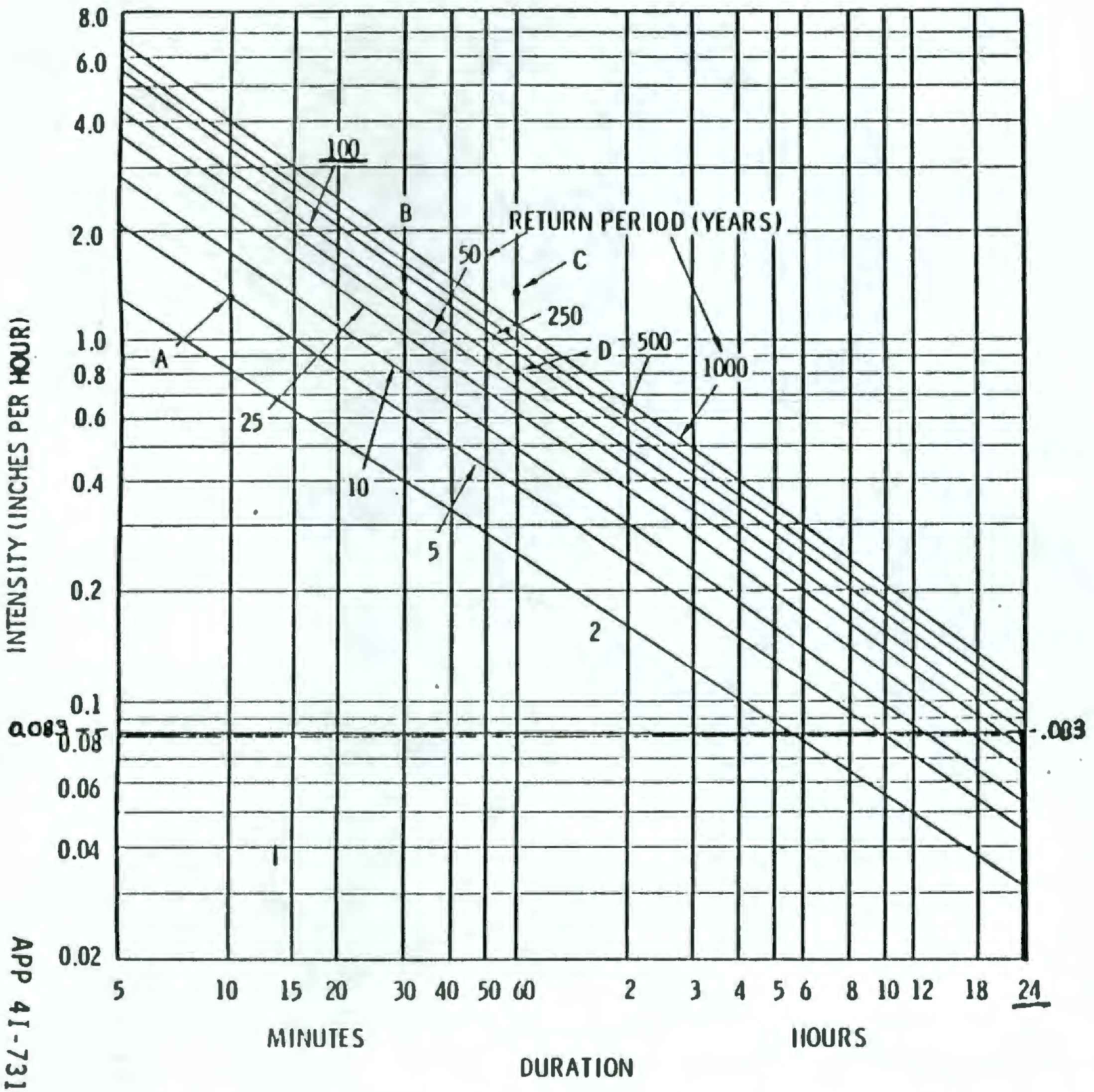
PEAK FLOWRATE:

$$\frac{1821.72 \text{ FT}^3}{24 \text{ HRS}} \times \frac{1 \text{ GAL}}{0.1337 \text{ FT}^3} \times \frac{\text{hr}}{60 \text{ min}} = 9.46 \text{ GAL/MIN}$$



DOE Richland WA

ATTACH 1



TO USE THIS CHART, SELECT ANY DESIRED RAINFALL INTENSITY AND DURATION AND READ FROM THE DIAGONAL LINES THE EXPECTED FREQUENCY OF SUCH INTENSITY AND DURATION. FOR EXAMPLE, RAINFALL INTENSITY OF 1.3 INCHES PER HOUR FOR 10 MINUTES CAN BE EXPECTED TO OCCUR, ON AVERAGE, ONCE EVERY 5 YEARS (POINT A). HOWEVER, SUCH INTENSITY CAN BE EXPECTED FOR 30 MINUTES DURATION ONLY ABOUT ONCE IN 100 YEARS (POINT B). THE RETURN PERIOD FOR THIS INTENSITY FOR 60 MINUTES DURATION IS GREATER THAN 1000 YEARS (POINT C).

THERE ARE, OF COURSE, VARIATIONS IN USE OF THE CHART. SUPPOSE, FOR EXAMPLE, IT IS DESIRED TO FIND THE "100-YEAR STORM" FOR 60 MINUTES. THIS IS 0.8 INCH (POINT D).

FIGURE 36. Rainfall Intensity, Duration and Frequency Based on the Period 1947 to 1969 at Hanford

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H B-714-030 FML FINAL LINER STRESS STRAIN AND IMPACT

B-714-Ø3Ø

KAISER ENGINEERS HANFORD | **CALCULATION IDENTIFICATION AND INDEX** | WO/Job No. B-714 | Date

This sheet shows the status and description of the attached Design Analysis sheets.

Discipline 22 - Env / Proc. Engineering

Project No. & Name

Calculation Item Stress/strain & impact B-714-Ø3Ø

These calculations apply to:

Dwg. No. ________ Rev. No. ________

Dwg. No. ________ Rev. No. ________

Other (Study, CDR) Vault Design Report

________ Rev. No. ________

The status of these calculations is:

- ☐ Preliminary Calculations
- ☒ Final Calculations
- ☐ Check Calculations (On Calculation Dated ________)
- ☐ Void Calculation (Reason Voided ________

Incorporated in Final Drawings? ☐ Yes ☒ No

This calculation verified by independent "check" calculations? ☐ Yes ☐ No

Original and Revised Calculation Approvals:

	Rev. 0 Signature/Date	Rev. 1 Signature/Date	Rev. 2 Signature/Date
Originator	[signature] 5/8/89		
Checked by	R. [signature] 5/10/89		
Approved by	[signature] 5/10/89		
Checked Against Approved Vendor Data			

INDEX

Design Analysis Page No.	Description
1	Objective / Reference / assumptions
2-3	Seam strength
4	FML strength
5-9	Puncture resistance
10-24	Wall stress
25-28	Exterior drainage Path strength

APP 4I-734

9 0 1 1 7 3 5 1 2 8 6

KAISER ENGINEERS
HANFORD

DOE/RL 88-27
Rev. 1, 01/17/90

Revision 0

DESIGN ANALYSIS

Client WHC		WO/Job No. B-714	
Subject B-714 Stress		Date 5/8/89	By SC Ashworth
		Checked 5/10/89	By R G Hollenbeck
Location 2077 E.		Revised	By

Objective of Calculations:
Determine ability of lining systems to withstand stresses during construction and operation

References:

Precision laboratories, 90 day Interim Report, HDPE Seam tests, April 12, 1985

2. PNL Test Results

3. Roark, formulas for stress and strain, 4th ed,

Assumptions: Stated within

Conclusions: Stated within

APP 4I-735

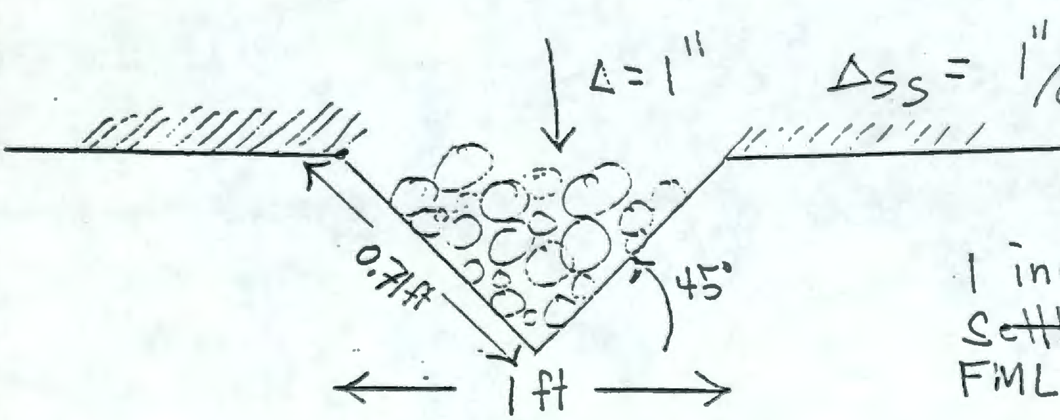
DESIGN ANALYSIS

Client WHC		WO/Job No. B-714	
Subject B-714 Stress		Date 5/8/89	By SC Ashurst
		Checked 5/10/89	By RG Hollenbeck
Location 200 E		Revised	By

Objective: Calculate Design ratios for seams using Data from precision labs

Assumption: The gravel drainage media settles 1 inch vertically

The worst case will be within the trench as shown below



1 inch vertical settlement causes FML to Elongate

$$\epsilon(\%) = \frac{1.41 \text{ inch} / 12 \text{ inch/ft}}{0.71 \text{ ft}} \times 100 = 16.6\%$$

9 0 1 1 7 8 6 1 2 8 8

KAISER ENGINEERS
HANFORD

Revision 0

DESIGN ANALYSIS

Client WHC		WO/Job No. B-714	
Subject B-714 Stress		Date 5/8/89	By S C Tshudy
		Checked 5/10/89	By R G Hollenbeck
Location 2025E		Revised	By

The elongation at break was determined by precision laboratories as

$$\epsilon_{ult} = 217 \pm 54 \ \%$$

using a worst case value of

$$217 - 54 = 163\,\%$$

Calc. a design ratio of

$$\frac{163}{16.6} = 9.8$$ O.K. at ambient

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DESIGN ANALYSIS

Client WHC | WO/Job No. B-714
Subject B-714 Stress | Date 5/8/89 | By SC Ashworth
Checked 5/10/89 | By RG Hollenbeck
Location 200 E | Revised | By

Objective: Calculate Design ratios for the secondary Containment FML - strains

Assumptions: Same as for seam calculations

Using Data @ 90°C, Ref. 2

ϵ_y = 0.767 - 0.957 inches (strain yiel

ϵ_u = 23.1 - 25.6 inches (Ultimate strain

$DR_y = \frac{0.767 \text{ inch}}{1.41 \text{ inch}} = 0.54$ O.K.

$DR_u = \frac{23.5 \text{ inch}}{1.41 \text{ inch}} = 16.7$ O.K.

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DESIGN ANALYSIS

Client WHC		WO/Job No. 8-714	
Subject Puncture Resistance Grout Vault FML		Date 5/1/89	By SC Ashurst
		Checked 5/1/89	By K. Allen
Location 200E		Revised	By

Objective: Determine ability of a Geotextile to protect the FML at 6500 psf at 90° C

Assumptions: Stated within

References: PNL Test Result Report

Test probe = 5/16" with 1/8" radius of curvature

Force = 56 lbf

T = 90°C

Thickness = 120 mils

9011786129 1

DESIGN ANALYSIS

Client WHC | WO/Job No. B-714
Subject Puncture Resistance Grout Vault FML | Date 5/1/89 | By SC Ashworth
Checked 5/1/89 | By [illegible]
Location 200E | Revised | By

Puncture Resistance determined at breakthrough is 56 lbf

loading at breakthrough $= \dfrac{56 \text{ lbf}}{2\pi \left(\frac{1}{8}\right)^2} = 570 \text{ psi}$

calculate design ratio with actual loading of 6500 psf

$$D.R. = \frac{\text{loading at Breakthrough}}{\text{Actual loading}} = \frac{570 \text{ psi}}{6500 \text{ psf}} * 144$$

$= 12.6$ O.K.

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DESIGN ANALYSIS

Client WHC	WO/Job No. B-714		
Subject B-714 Stress	Date 5/8/89	By SC Ashurst	
	Checked 5/10/89	By PC Hollenbeck	
Location 200E	Revised	By	

This shows static load DR also need to look at Dynamic load transmitted during fill. Momentum balance leads to the following equation for force transmitted Vertically.

$$F = \frac{Q \rho v}{g_c}$$

Q = volumetric flow rate
ρ = grout density
v = velocity of grout

Determine Q

$$Q = \frac{1.4 \times 10^6 \text{ gallons}}{21 \text{ days}} * \frac{\text{day}}{24 \text{ hr}} * \frac{8.33 \text{ ft}^3}{62.4 \text{ gal}} \times \frac{\text{hr}}{60} * \frac{\text{min}}{60 \text{ sec}} = 0.10 \text{ ft}^3/\text{sec}$$

Determine v_o

$$v_o = \frac{Q}{A} = \frac{0.10 \text{ ft}^3/\text{sec}}{\text{[illegible]}} = 4.72 \text{ ft/sec}$$

APP 4I-741

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Client	WHC	WO/Job No.	B-714
Subject	B-714 Stress	Date	5/8/89	By SC Ashurst
		Checked	5/10/89	By EC-[illegible]
Location	200 E	Revised		By

Determine Acceleration:

$$a = \frac{d^2x}{dt^2} = g$$

Assumption: conservative zero drag or air resistance

$$\frac{dx}{dt} = gt + c_1$$

$$x = \frac{gt^2}{2} + c_1 t + c_2$$

B.C.'s

$t=0,\ x=0 \Rightarrow c_2 = 0$

$t=0,\ v=v_0 \Rightarrow c_1 = v_0$

$$v = \frac{dx}{dt} = gt + v_0$$

$$= 32.2\frac{ft}{sec^2}t + 4.72\ ft/sec$$

at $x = 33$ ft

$$g\frac{t^2}{2} = 33 - 4.72t$$

$t = 1.29$ sec $\quad v = 46.26$ ft/sec

DESIGN ANALYSIS

Client	WHC	WO/Job No.	B-714		
Subject	B-714 Stress	Date	5/8/89	By	SC Ashworth
		Checked	5/10/89	By	RG Hollenback
Location	200 E	Revised		By	

$$F = \frac{0.10\ ft^3/sec * 120\ lbm/ft^3 * 46.2\ ft/sec}{32.2\ lbm\ ft/lbf\ sec^2}$$

$= 17.24\ lbf$

Total static + dynamic

$$= 6500\ psf + \frac{17.24\ lbf}{\frac{\pi}{4}(2/12\ ft)^2}$$

Assumes 0 spread during fall

$= 6528\ psf$

$$DR = \frac{570}{6528} * 144 = 12.57$$

OK

DESIGN ANALYSIS

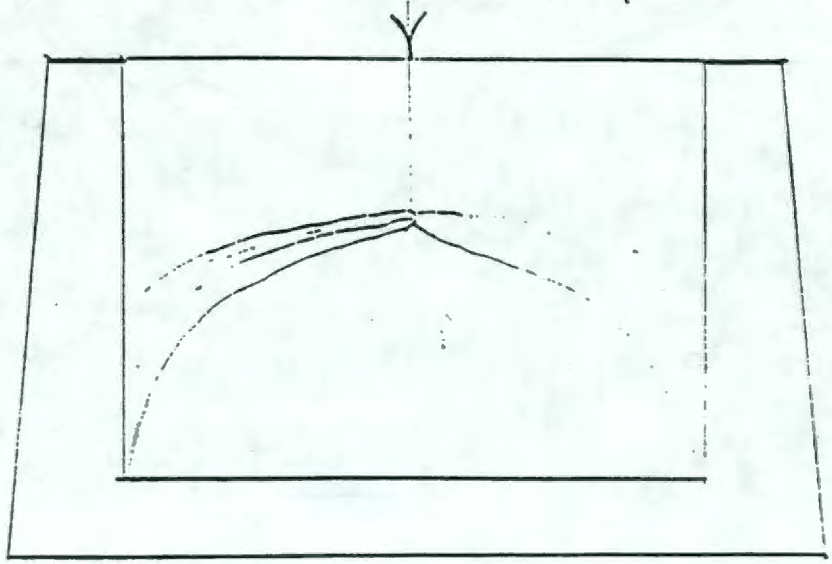
Client: WHC — WO/Job No.: B-714

Subject: Shear & Bond Strength Vault Coating — Date: 5/1/89 — By: SC Ashurst

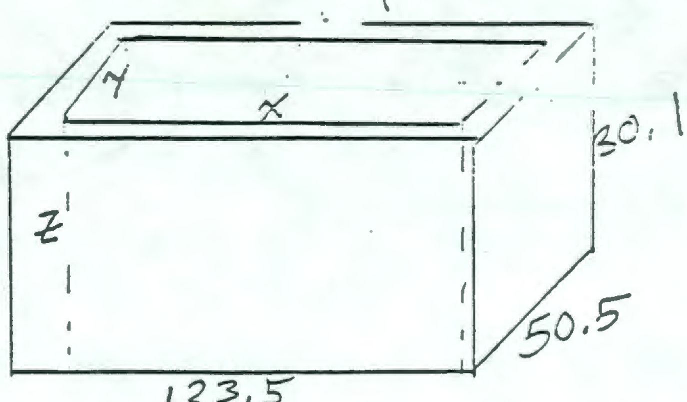
Checked: 5/1/89 — By: RG Hollenbeck

Location: 200E — Revised: — By:

Objective: Determine wall shear stress during pour



Determine flow path width from shrinkage



Assuming 3 vol% shrinkage

Vol after is 0.97 * 123.5 * 50.5 * 30.1 =

182094 ft^3

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DESIGN ANALYSIS

Client WHC
WO/Job No. B-714
Subject Shear & Bond Strength Vault coating
Date 5/1/89 By SC Ashworth
Checked 5/1/89 By RG [illegible]
Location 200 E
Revised
By

$$xyz = 182094$$

Assume shrinkage is proportional in all 3 directions

$$y = \frac{50.5}{123.5}x$$

$$z = \frac{30.1}{123.5}x$$

$$x\left(\frac{50.5}{123.5}\right)x\left(\frac{30.1}{123.5}\right)x = 182094$$

$$x^3 = 1,827,139 \text{ ft}^3$$

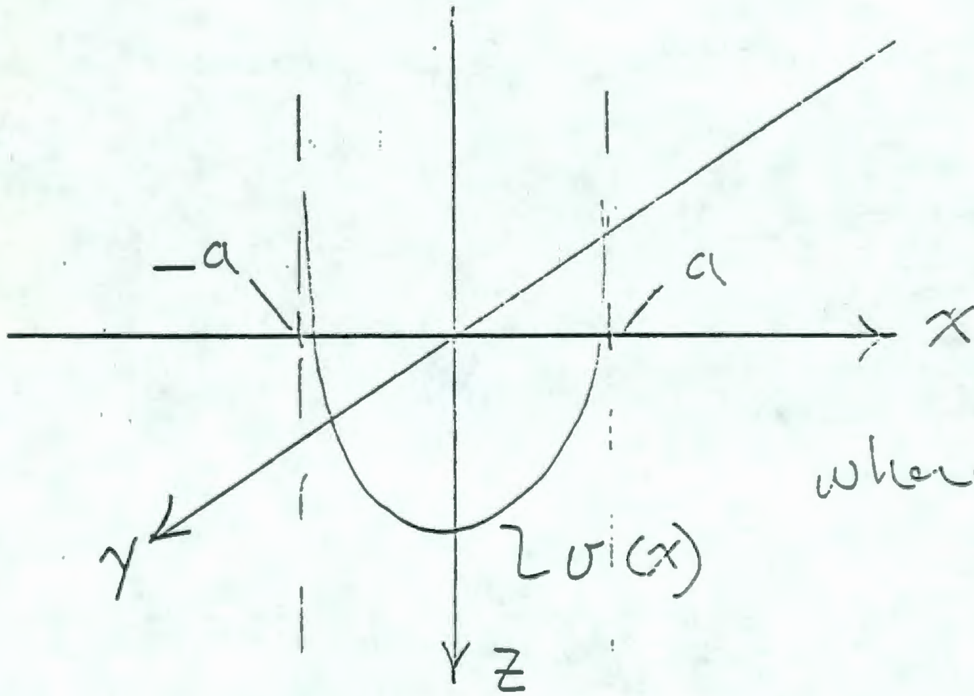
$$x = 122.25$$

Max Flow channel width $= \frac{123.5 - 122.25}{2}$

$= 0.624$ ft

Min width $= \frac{50.5 - \frac{50.5}{123.5} * 122.25}{2} = 0.264$

Rectangular coordinate system



where 2a = max path width

Assume:

- Steady state
- No x or y velocity
- No acceleration

Using the Equation of Motion in Rectangular coordinates.

$$-\frac{\partial P}{\partial z} - \frac{\partial \tau_{xz}}{\partial x} + \rho g_z = 0$$

DESIGN ANALYSIS

Client: WHC		WO/Job No. B-714	
Subject: Shear & Bond Strength Vault Coating		Date 5/1/89	By SC Ashworth
		Checked 5/1/89	By RC Hollenbeck
Location 200E		Revised	By

For this particular material, grout, has been determined to be non-Newtonian and follows pseudoplastic behavior. The following form for the shear stress, τ, has been determined with parameters also given & the apparent viscosity was found to be

$$\eta = 47880 K' \left(\frac{\partial v_z}{\partial x}\right)^{n'-1}$$

from PNL Data

Rheology Data

Sample No.	Time	n'	K'	Density lb/gal	Critical Flow Rate, gpm 2-in. Pipe	Critical Flow Rate, gpm 3/4" Pipe
DCG-01	9:45 AM	0.9931	4.53E-04		17.3	6.35
DCG-02	10:15 AM	0.7943	2.27E-03	13.85	30.9	8.29
DCG-03	10:40 AM	0.8540	1.35E-03	13.89	25.5	7.47
DCG-04	11:57 AM	0.8622	5.76E-04	13.09	13.2	5.69
DCG-05	12:30 PM	0.8291	1.54E-03	13.87	25.7	7.25
DCG-06	1:00 PM	0.8210	1.82E-03	13.91	28.4	8.02
DCG-07	1:30 PM	0.8346	1.57E-03	13.89	25.5	7.6
DCG-08	2:05 PM	0.7513	3.90E-03	13.92	40.0	10.15
DCG-09	2:30 PM	0.8230	1.95E-03	13.92	30.7	8.57
	Average			13.73		
	SD			0.28		

DESIGN ANALYSIS

Client: WHC		WO/Job No. R-714	
Subject: Shear & Bond Strength Vault coating		Date 5/1/89	By SC Ashworth
		Checked 5/1/89	By RG Hollenbeck
Location: 200E		Revised	By

Since the shear stress is $\tau = -\eta \frac{\partial v_z}{\partial x}$ we get

$$\tau = -\underbrace{47880k'}_{k''}\left(\frac{\partial v_z}{\partial x}\right)^{n'-1}\left(\frac{\partial v_z}{\partial x}\right)$$

Since no pressure drop (free surfa

$$\frac{\partial \tau}{\partial x} = \rho g_z$$

$$\frac{\partial \tau}{\partial x} = \frac{\partial}{\partial x}\left(k''\left(\frac{\partial v_z}{\partial x}\right)^{n'-1}\frac{\partial v_z}{\partial x}\right)$$

$$= k''\left[\frac{\partial v_z}{\partial x}\left((n'-1)\left(\frac{\partial v_z}{\partial x}\right)^{n'-2}\frac{\partial^2 v_z}{\partial x^2}\right) + \left(\frac{\partial v_z}{\partial x}\right)^{n'-1}\frac{\partial^2 v_z}{\partial x^2}\right]$$

$$= k''\left[\frac{\partial^2 v_z}{\partial x^2}\left((n'-1)\left(\frac{\partial v_z}{\partial x}\right)^{n'-2}\frac{\partial v_z}{\partial x} + \left(\frac{\partial v_z}{\partial x}\right)^{n'-1}\right)\right]$$

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DESIGN ANALYSIS

Client: WHC		WO/Job No. B-714	
Subject: Shear & Bond Strength Vault Coating		Date 5/1/89	By SC Ashurst
		Checked 5/1/89	By RG Hollenbeck
Location: 200E		Revised	By

$$= -K'' \left[\frac{\partial^2 v_z}{\partial x^2} \left((n'-1) \left(\frac{\partial v_z}{\partial x} \right)^{n'-1} + \left(\frac{\partial v_z}{\partial x} \right)^{n'-1} \right) \right]$$

$$= -K'' n' \left(\frac{\partial v_z}{\partial x} \right)^{n'-1} \frac{\partial^2 v_z}{\partial x^2}$$

Note that n' varies from 0.5 - 1.0 so will solve ~~for~~ 2 extremes and check τ

Case I $n = 1$

for this case the solution is the same as ~~for~~ a newtonian fluid

$$\rho g_z = -K'' \frac{\partial^2 v_z}{\partial x^2}$$

The solution to this is well known

$$v_z = \frac{\rho g (a^2 - x^2)}{2 K''} \quad \& \quad \tau_{wall} = -\rho g_z a$$

DESIGN ANALYSIS

Client WHC		WO/Job No. B-714	
Subject Shear & Bond Strength Vault Coating		Date 5/1/89	By SC Ashurst
		Checked 5/1/89	By RG Hollenbeck
Location 200 E		Revised	By

Case II $n = 0.5$

Then

$$\rho g_z = -\frac{K''}{2}\left(\frac{\partial v_z}{\partial x}\right)^{-1/2}\frac{\partial^2 v_z}{\partial x^2}$$

or $$\rho g_z\sqrt{\left(\frac{\partial v_z}{\partial x}\right)} = \frac{-K''}{2}\frac{\partial^2 v_z}{\partial x^2}$$

let $$Y^2 = \frac{\partial v_z}{\partial x}$$

$$\frac{\partial^2 v_z}{\partial x^2} = 2Y\frac{\partial Y}{\partial x}$$

$$\rho g_z \not{Y} = \frac{-K''}{\not{2}}\,\not{2}\not{Y}\frac{\partial Y}{\partial x}$$

$$\frac{\partial Y}{\partial x} = \frac{-\rho g_z}{K''}$$

9011785130 2

DESIGN ANALYSIS

Client WHC	WO/Job No. B-714		
Subject Shear & Bond Strength Vault coating	Date 5/1/89	By SC Ashworth	
	Checked 5/1/89	By RG Hollenbeck	
Location 200F	Revised	By	

solving for y:

$$y = -\frac{\rho g_z}{K''}x + C_1$$

$$\frac{\partial v_z}{\partial x} = \left(\frac{\rho g_z}{K''}\right)^2 x^2 - \frac{2C_1 \rho g_z}{K''}x + C_1^2$$

$$\xi \quad v_z = \left(\frac{\rho g_z}{K''}\right)^2 \frac{x^3}{3} - \frac{2C_1\rho g_z}{K''}\frac{x^2}{2} + C_1^2 x + C_2$$

$v_z = 0$ @ $x = a$

$= 0$ @ $x = -a$

$$\left(\frac{\rho g_z}{K''}\right)^2 \frac{a^3}{3} - \frac{C_1 \rho g_z}{K''}a^2 + C_1^2 a + C_2 = 0$$

(α marked at ρ in both terms)

$$-\left(\frac{\rho g_z}{K''}\right)^2 \frac{a^3}{3} - \frac{C_1 \rho g_z}{K''}a^2 - C_1^2 a + C_2 = 0$$

DESIGN ANALYSIS

Client WHC | WO/Job No. B-714
Subject Shear & Bond Strength Vault Coating | Date 5/1/89 | By SC Schumm
Checked 5/1/89 | By RG Hillenbrand
Location 2019 E | Revised | By

Equating both Equations:

$$\cancel{2} C_1^2 \cancel{\alpha} = \cancel{2}\alpha^2 \frac{a^{\cancel{3}\,2}}{3}$$

$$C_1 = \frac{\alpha a}{\sqrt{3}}$$

$$C_2 = C_1 \alpha a^2 - C_1^2 a - \frac{\alpha^2 a^3}{3}$$

$$= \frac{\alpha^2 a^3}{\sqrt{3}} - \frac{\alpha^2 a^3}{3} - \frac{\alpha^2 a^3}{3}$$

$$= \frac{\alpha^2 a^3}{\sqrt{3}} - \frac{2\alpha^2 a^3}{3}$$

$$= \alpha^2 a^3 \left(\frac{1}{\sqrt{3}} - \frac{2}{3}\right)$$

$$\frac{3 - 2\sqrt{3}}{3\sqrt{3}}$$

$$C_2 = \frac{3-2\sqrt{\ }}{3\sqrt{3}}\ \alpha^2 \ldots$$

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APP 4I-752

DESIGN ANALYSIS

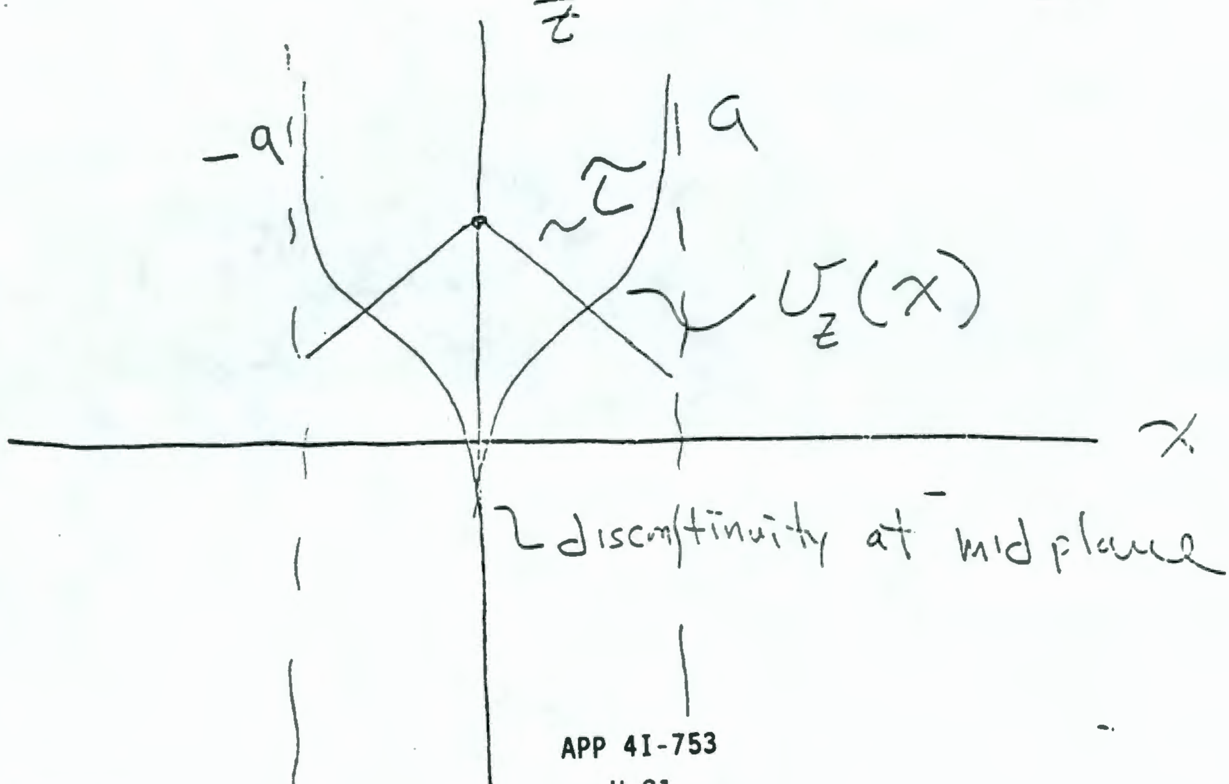
Client WHC
WO/Job No. B-714
Subject Shear & Bond Strength Vault coating
Date 5/1/89 By SC Achmint
Checked 5/1/89 By RG Hollenbeck
Location 200 E
Revised
By

$$v_z = \alpha^2 \frac{x^3}{3} - \frac{\alpha^2 a}{\sqrt{3}} x^2 + \frac{\alpha^2 a^2}{3} x + \frac{3-2\sqrt{3}}{3\sqrt{3}} \alpha^2 a$$

$$\tau = -\eta \frac{\partial v_z}{\partial x}$$

$$\frac{\partial v_z}{\partial x} = \alpha^2 x^2 - \frac{2\alpha^2 a}{\sqrt{3}} x + \frac{\alpha^2 a^2}{3}$$

$$\tau = K'' \sqrt{\alpha^2 x^2 - \frac{2\alpha^2 a}{\sqrt{3}} x + \frac{\alpha^2 a^2}{3}}$$



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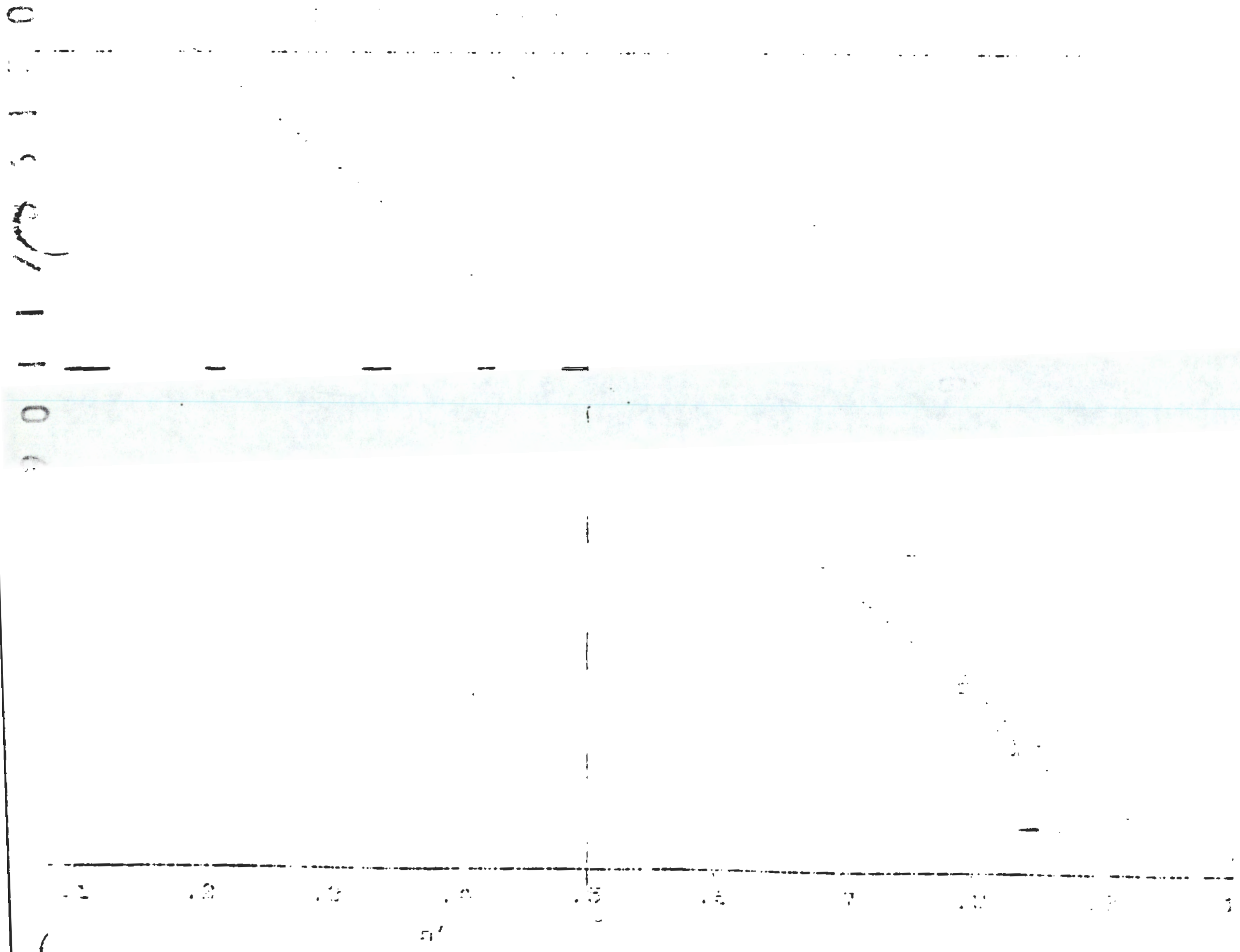
DESIGN ANALYSIS

ent	WHC	WO/Job No.	B-714		
	Shear & Bond Strength	Date	5/1/89	By	SC Ashworth
	Vault Coating	Checked	5/1/89	By	EG Hollenbeck
ation	200 E	Revised		By	

For Case I $n' = 1$ will use
$K' = 0.000453$ from data

For Case II $n' = 0.5$ will use
Extrapolation from data regression



RESSION POLYNOMIAL OF LINE 1 -

.246E-02) + (-1.279E-02)*X
VARIANCE - 2.794E-07

DESIGN ANALYSIS

Client WHC		WO/Job No. B-714	
Subject Shear & Bond Strength Vault Coating		Date 5/1/89	By SC Achumi
		Checked 5/1/89	By R.C. Hollenbeck
Location 200 E		Revised	By

Calc. wall stress for Case I

$$\tau_{wall} = \frac{-90 \frac{lbm}{ft^3} * 32.2 \frac{ft}{sec^2} * \frac{0.624}{2} ft}{32.2 \frac{lbm\ ft}{lbf\ sec^2}}$$

$$= 28\ lbf/ft^2$$

The measured shear strength @ 25°C is 78 lbf/in² from Lion Nokorode Data sheet

Design ratio @ 25°C is $\frac{78\ psi}{28\ psf} \times 144 \frac{in^2}{ft^2}$

D.R. = 401 OK at ambient

The Bond strength to steel is 135 psi

$$D.R. = \frac{135}{28} * 144 = 694\ OK$$

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Revision 0

DESIGN ANALYSIS

Client WHC | WO/Job No. B-714
Subject Shear & Bond Strength Vault Coating | Date 5/1/89 | By
Checked 5/1/89 | By
Location 200 E | Revised | By

case II

$$\tau = K'' \sqrt{\alpha^2 a^2 - \frac{2\alpha^2 a^2}{\sqrt{3}} + \frac{\alpha^2 a^2}{3}}$$

$$\alpha^2 a \left(a - \frac{2a}{\sqrt{3}} + \frac{a}{3} \right)$$

$$\frac{4}{3}a - \frac{2a}{\sqrt{3}}$$

$$\tau = K'' \alpha * a \sqrt{\left(\frac{4}{3} - \frac{2}{\sqrt{3}}\right)}$$

$$\alpha = \frac{\rho g}{K''}$$

$$\tau = K'' \left(\frac{\rho g}{K''}\right) \sqrt{\left(\frac{4}{3} - \frac{2}{\sqrt{3}}\right)}$$

DESIGN ANALYSIS

Client WHC	WO/Job No. B-714		
Subject Ground, Bond Strength Vault + Coating	Date 5/1/89	By SC Achuurrt
	Checked 5/1/89	By RG Hailenbach
Location 200E	Revised	By

from previous analysis

2a maximum = 0.624

$$\tau = (\text{Prev. Case}) * \sqrt{\left(\frac{4}{3} - \frac{2}{\sqrt{3}}\right)}$$

$$= 28 \text{ psf} * \sqrt{\frac{4}{3} - \frac{2}{\sqrt{3}}} \cong 12 \text{ psf}$$

for shear strength

$$D.R. = \frac{78}{12} * 144 = 936 \text{ OK}$$

for bond strength to steel

$$D.R. = \frac{135}{12} * 144 = 1620 \text{ OK}$$

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HANFORD

DOE/RL 88-27
Rev. 1, 01/17/90

Sheet No. 24 of 28

Revision 0

DESIGN ANALYSIS

Client WHC		WO/Job No. B-714	
Subject Shear & Bond Strength Vault Coating		Date 5/1/89	By SC Ashurst
		Checked 5/1/89	By [illegible]
Location 200 E		Revised	By

As both cases show, for laminar flow the viscosity is not required.

For case I & II the [illegible]

The Design ratio for ambient is 401 for case I

shear strength

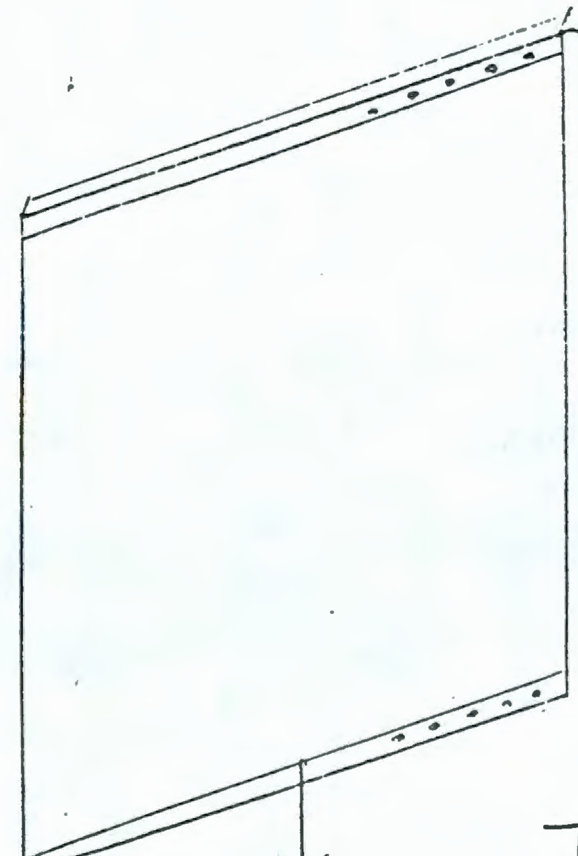
The D.R. for ambient of bond strength to steel is 694

DESIGN ANALYSIS

Client WHC	WO/Job No. B-714		
Subject B-714 stress	Date 5/8/89	By SC Ashurst	
	Checked 5/1/89	By RC Hollenbeck	
Location 200 E	Revised	By	

Objective: Determine stresses in Exterior drainage path
Ability of FML to support its own weight

Assumption: $T_{max} = 70°C$



use conservative ... for 40 mil HDPE data attached.

Determine Tensile stress

$$T = W = 0.94 * 62.4 \frac{lbf}{ft^3} * 0.06 \text{ inch} * 34 \text{ ft} * \frac{ft^2}{144 \text{ in}^2}$$

$$T = 0.83 \text{ lbf/in}$$

DESIGN ANALYSIS

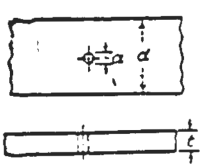
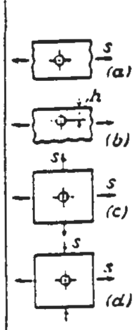
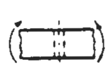
Client	WHC	WO/Job No.	B-714		
Subject	B-714 Stress	Date	5/8/89	By	SC [illegible]
		Checked	5/11/89	By	[illegible]
Location	200E	Revised		By	

The yield stress per the attached data is 48 lbf/in² @ 70 °C

$$DR = \frac{48}{0.83} = 58 \quad O.K.$$

Check stress concentration where fitter is connected from Roark data below

TABLE XVII.—FACTORS OF STRESS CONCENTRATION FOR ELASTIC STRESS (k), FOR REPEATED STRESS (k_f), AND FOR RUPTURE (k_r).—(*Continued*)

Type of form irregularity or stress raiser	Stress condition	Manner of loading	Factor of stress concentration k, k_f, k_r for various dimensions
5. Circular hole in plate or rectangular bar 	Elastic stress	Tension 	$k = 3 - 3.13\frac{a}{d} + 3.76\left(\frac{a}{d}\right)^2 - 1.71\left(\frac{a}{d}\right)^3$ (empirical formula, Ref. 22) (a) Uniaxial stress, hole central $k = \frac{3d}{a+d}$ (approximate formula, Ref. 20) (b) Uniaxial stress, hole near edge of wide plate $\frac{h}{a}$ = 0.67 0.77 0.91 1.07 1.29 1.56 k = 4.37 3.92 3.61 3.40 3.25 3.10 (Ref. 21) (c) Biaxial stress, $\frac{a}{d}$ small $k = 2$ (d) Biaxial stress, $\frac{a}{d}$ small $k = 4$
		Bending 	$k = \frac{(1+\nu)(5-\nu)}{3+\nu}$, $\frac{a}{d}$ small (Ref. 20)

DESIGN ANALYSIS

Client	WHC	WO/Job No.	B-714		
Subject	B-714 Stress	Date	5/8/89	By	SC Ashworth
		Checked	5/1/89	By	RG Hollenbeck
Location	200E	Revised		By	

from Drawing H-2-77582

$h = 1/8$ ft

$$h/a = \frac{1/8 \text{ ft} * \frac{12 \text{ inch}}{\text{ft}}}{1/4 \text{ inch}} = 6$$

Since no data for h/a=6 will ~~use~~ more conservative h/a = 1.56

so k = 3.16

This will decrease the DR

by $DR_{holes} = \frac{64}{3.16} = 20$ O.K.

DESIGN ANALYSIS

Client WHC | WO/Job No. B-714
Subject B-714 Stress | Date 5/8/89 | By SC Ashworth
Checked 5/10/89 | By RG Hollenbeck
Location 200E | Revised | By

Attached Data

Gundle Lining Systems Inc

Gundle™

LABORATORY REPORT #307

MARCH 7, 1983

SUBJECT

Tensile & Elongation Properties of GUNDLINE HD® and 36 mil Hypalon at Elevated and Subnormal Temperatures

INTRODUCTION

GUNDLINE HD® and 36 mil 10 x 10 x 1,000 denier scrim-reinforced Goodrich Hypalon were tested at various temperatures in order to determine the effect of temperature on the tensile and elongation properties of the two materials.

TEST METHOD

Tensile and elongation properties were evaluated according to ASTM D638-80 utilizing a crosshead separation rate of 2 ipm. A Type IV dumb-bell specimen was used.

Temperatures were maintained in an Instron Environmental Test Chamber according to ASTM D3947-79 at an accuracy of ±1°C. The tensile specimens were acclimated to the test temperatures of -15, Ø, +10, +20, +35, +50, and +70°C for 30 minutes before testing.

In the event that the material did not break in the first 400% elongation allowed due to space limitations of the test chamber, the sample was reclamped and stressed until failure. This method has limitations, as the material tends to fail in the grips when reclamped, giving low values. For this reason, the ultimate elongation and break values of the GUNDLINE® material at temperatures other than 20°C should be viewed as indicative but not accurate. The yield values and data up to 400% elongation is accurate. The Hypalon material failed within 250% elongation. The Hypalon data obtained is, therefore, accurate.

TEST RESULTS

Temperature	Yield Strength (Lb/In) 40 HD	Yield Strength (Lb/In) 100 HD	Scrim Failure 36 Hypalon
70°C	43	123	122
50°C	76	192	144
35°C	94	243	126
20°C	104	320	132
10°C	132	363	133
Ø°C	150	430	162
-15°C	176	460	218

I COATING CRACK SPANNING TEST RESULTS

Battelle
Pacific Northwest Laboratories
P.O. Box 999
Richland, Washington U.S.A. 99352
Telephone (509) 376-0983
Telex 15-2874
Facsimile (509) 375-2718

June 16, 1989

Ms. T. B. Bergman
Westinghouse Hanford Company
MS R1-48
Richland, WA 99352

Dear Theresa:

NOKORODE 705M CRACK-SPANNING TEST RESULTS

Tests to determine the ability of the Nokorode 705M spray-on liner inside the grout vault to span cracks have been completed. Results were generally favorable, indicating that the liner should span cracks up to 1/16 in. (63 mil) wide without failure. The liner fails at smaller crack widths at elevated temperature than at ambient temperature, which was unexpected. Increasing the liner thickness increases the size of crack that can be spanned. Although failure was never observed in any sample for crack widths less than 63 mil, some failures of 50-mil-thick liners at elevated temperature were very close to 63 mil, which means that if the liner is required to span this distance, there is little or no margin of safety. The tests and results are described below.

Sample Preparation

The liner product used was Nokorode 705M produced by Lion Oil Company. Six-inch square patches of the liner were applied to reinforced concrete slabs with dimensions of 12 in. X 24 in. X 2 in. Before applying the liner, the concrete was sandblasted until aggregate could be seen on the surface. A 6 in. X 6 in. paper template was placed in the center of the block surface. An excess quantity of 705M liner product was placed on the concrete. The liner material was covered with siliconized paper (like the backing of a mailing label) and pressed flat with a steel plate. The liner thickness was controlled by spacers placed around the perimeter of the sample. The surface of the concrete blocks were often slightly bowed, so liner thickness was measured in the specific location of failure after the liner was tested. The liner sample was allowed to cure at least 6 days prior to testing. Before testing, the siliconized paper was peeled off and the paper template was pulled up, leaving a 6-in.-square sample on the concrete.

Note that this application method differs significantly from the spray application planned for use in the grout vault. The method used resulted in an excellent bond to the concrete. As long as the spray application provides a similar bond to the concrete, the results of these tests should be directly applicable to the crack-spanning performance of the liner in the vault.

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Test Method

Cracks in the top of the concrete slab were produced by restraining the ends in a steel frame and slowly raising a hydraulic jack under the center of the slab. The liner sample was located on the top of the slab directly opposite the jack. The reinforcement inside the slab allowed the development of cracks to be controlled. The width of cracks at the edge of the liner was measured prior to failure using a dial caliper. When failure occurred, the location of the initial failure was marked, the width of the crack and the thickness of the liner at that location measured, and if applicable the temperature was recorded. Occasionally, several cracks under one liner sample were large enough to cause a failure. One data point was collected at each failure point.

Tests were performed using nominal liner thicknesses of 50 and 80 mil. Tests were conducted at ambient temperature and elevated temperature for each liner thickness. To obtain elevated temperatures in 50-mil-thick liner samples, the entire concrete block was heated to 90°C in an oven. The concrete was then removed from the oven and placed in the test frame. A heat lamp was used to maintain the temperature of the liner surface during testing. Temperatures were measured by inserting a small thermocouple into the liner at the concrete-liner interface.

We attempted to improve the temperature control for tests with the 80-mil-thick liners. These samples were heated to 90°C and then removed from the oven and placed in the test frame. Putty was used to build a wall around the liner sample, thus forming a small reservoir. Water at 100°C was poured into the reservoir and covered with clear plastic and a heat lamp was used to maintain the water temperature at approximately 90°C. Although the water was initially at 100°C, the temperature dropped to 90°C by the time it was covered with plastic. The presence of the water helped maintain a uniform temperature and limited any local overheating of the liner to 100°C since temperatures in excess of 100°C would have caused the water to vaporize. After the first failure in a liner sample, the water drained through the crack. Subsequent failures of the same liner sample at different locations, therefore, did not have the same degree of temperature control. The temperature at each of these failure points was recorded.

Results

The results of 50-mil and 80-mil liner tests are summarized in Figure 1. Each point in Figure 1 corresponds to an initial failure observed in a liner sample. Each line shows the distribution of crack widths at which the liner first fails for the listed conditions of liner thickness and temperature. A few data points had temperatures or liner thicknesses which did not fall into the range of one of the lines in Figure 1. These points are identified in Appendix A. When the concrete cracks, the crack may open either by the two sides moving apart (in the same plane) or by one piece moving perpendicular relative to the plane of the concrete. The latter type of crack separation is termed an "elevation change". The two types of cracks normally combine in some degree to form the crack, although the elevation change is usually the less significant effect. In all cases the cracks have been categorized by the horizontal crack separation. In most cases the elevation change was less than 40 mil. Cracks for which the elevation change exceeded 40 mil are denoted in Figure 1 by special symbols.

Ambient temperature tests with nominal 50-mil-thick liners indicated that cracks less than 120 mil wide are always spanned. Cracks widths larger than 195 mil always resulted in failure. When the 50-mil liner was heated to elevated temperature (74°C-91°C), the liner spanned all cracks less than 65 mil and failed over all cracks larger than 88 mil. Initially it was suspected that being in the oven at 90°C for an extended time might cause some irreversible change in the liner. To check this, a liner that had been placed in the oven overnight was allowed to cool and then tested at ambient temperature. The results were in excellent agreement with the ambient temperature results. Therefore, it appears that the temperature effect is simply due to reversible changes in the liner product with temperature.

Ambient temperature tests with nominal 80-mil-thick liners indicated that cracks less than 120 mil wide were always spanned. The size of crack always spanned increases to 165 mil if only cracks with 40 mil or less elevation change are included (120 mil failure had 110 mil elevation change). Cracks widths larger than 240 mil always resulted in failure. Elevated temperature results for 80 mil liners are divided into two temperature regimes. The first (85°C-95°C) includes points in which the surface temperature was controlled using a layer of water as described in the test method section. The second temperature range (50°C-75°C) includes data collected after initial failure of a crack caused the water to drain from the surface. At temperatures of 85°C-95°C, the liner always spanned cracks smaller than 28 mil and always failed above 135 mil. At temperatures of 50°C-75°C the liner always spanned cracks of less than 80 mil (117 mil if data is limited to <40 mil elevation change) and always failed over cracks of more than 210 mil.

The effect of the liner thickness is shown in Figures 2 and 3. Figure 2 shows the effect of thickness at ambient temperature (less than 30°C) and Figure 3 shows the effect of thickness at temperatures between 65°C and 95°C. In both figures the data has been limited to data where the elevation change of the crack was 40 mil or less. The lines in Figures 2 and 3 are influenced by significant scatter. Because of this, extrapolation of the data is not recommended. Additional tests would be required to determine the crack spanning ability of liners with thicknesses outside the range of available data.

Miscellaneous Observation

In several samples bubbles were inadvertently introduced in the liner material during preparation. A few cracks initially failed at these points, although the failure of the liner did not appear to be significantly affected by the presence of a small bubble. The failure point, of course, is constrained by the location of the crack in the concrete. Therefore, only if a bubble and a crack coincide can a bubble affect liner performance. When heated to 90°C

9 0 1 1 7 8 6 1 3 1 8

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overnight, subsurface bubbles under the surface become clearly visible as bulges in the surface of the liner.

Records for this work are traceable to Hanford Grout Technology Program FY-89 files PFI-05. If you have questions please contact Greg Whyatt at 376-0011.

Sincerely,

Don

D. H. Mitchell, Manager
Hanford Grout Technology Program

cc : S. R. Briggs
D. W. Hendrickson

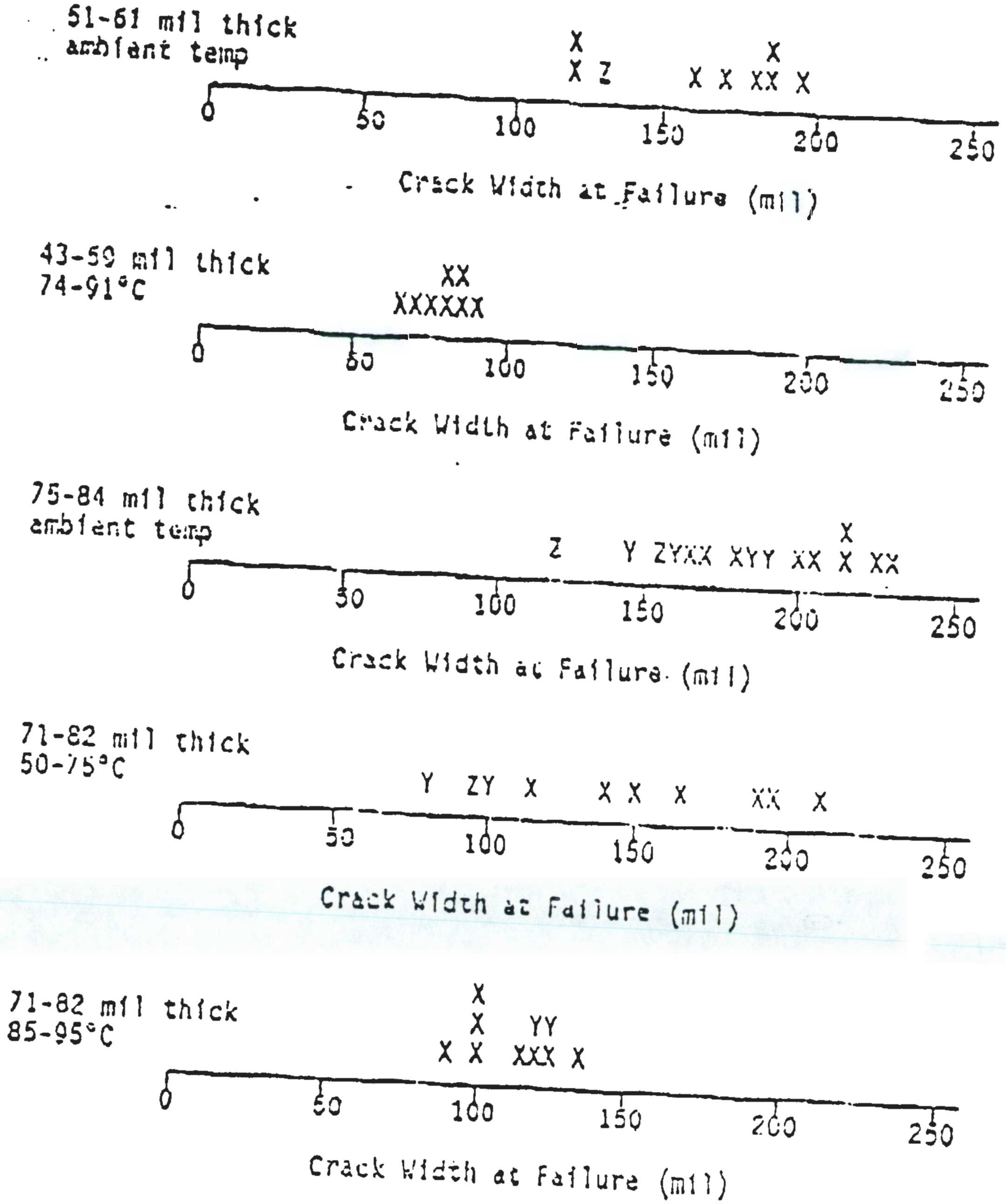

Figure 1: Distribution of crack widths at initial failures. Elevation changes: X= 0-40 mil, Y= 41-80 mil, Z= 81-120 mil. Liner temperature and thickness at failure point ranges are indicated to the left of each line.

Ms. T. B. Bergman
June 16, 1989
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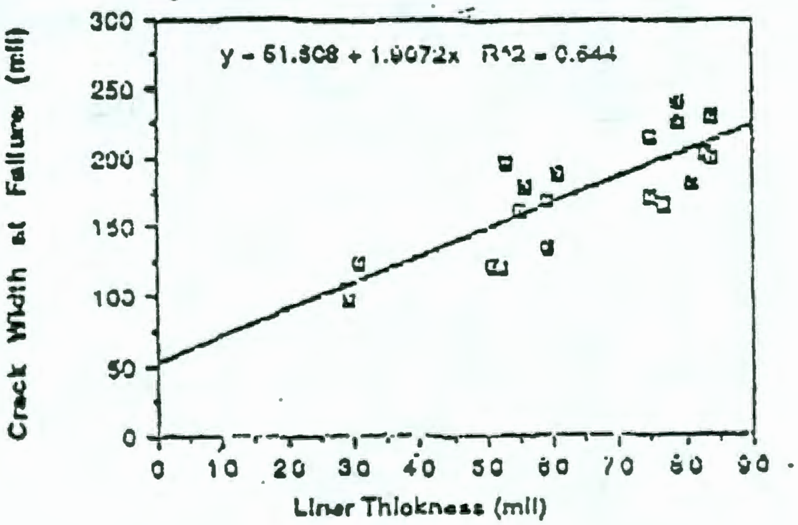

Figure 2: Crack spanning ability as a function of liner thickness (Temp ≤30°C, Elevation change ≤40 mil)

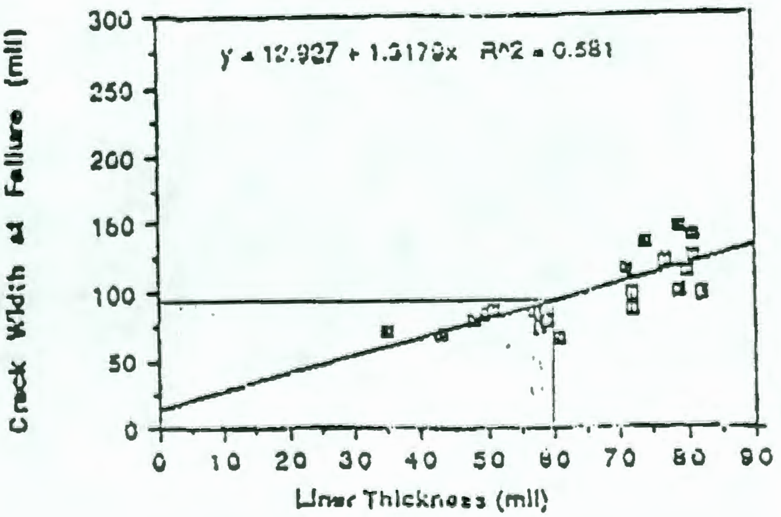

Figure 3: Crack spanning ability as a function of liner thickness (Temp 65°C-95°C, Elevation change ≤40 mil)

Ms. T. B. Bergman
June 16, 1989
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Appendix A

SUMMARY OF ALL FAILURE OBSERVATIONS

Failure I.D.	Crack Width (mil)	Elev. Change (mil)	Temp (°C)	Liner Thickness (mil)	Notes
50C-2, X1	135		A	59	
50C-2, X2	160		A	55	
50C-3, X1	120		A	52	
50C-3, X2	130	90	A	61	
50C-4, X1	170		A	75	
50C-4, X2	168		A	69	
50C-4, X3	195		A	53	
50C-5, X1	97		A	29	stuck to paper, NP
50C-5, X2	124		A	31	stuck to paper, NP
50H-1, X1	55		82-86	61	
50H-1, X2	85		82-86	57	
50H-2, X1	80	40	88-91	48	
50H-2, X2	85	40	88-91	50	
50H-2, X3	70	40	88-91	43	
50H-3, X1	73		74	58	
50H-3, X2	80		84	59	
50H-3, X3	88		75	51	
50H-4, X1	72		65-67	35	NP
50H-5, X1	178		30	56	
50H-5, X2	187		30	61	
50H-5, X3	122		30	51	
85C-1, b	215		A	-	
85C-1, X1	204		A	83	
85C-1, X2	228		A	84	
85C-1, X3	160	50	A	-	
85C-2, b	145	60	A	-	
85C-2, X1	165		A	77	
85C-2, X2	200		A	84	
85C-2, X3	180		A	81	
85C-3, X1	155	90	A	77	
85C-3, X2	185	50	A	82	
85C-3, X3	190	80	A	82	
85C-5, X1	215		A	75	
85C-5, X2	225		A	79	
85C-5, X3	120	110	A	81	
85C-5, X4	240		A	79	
85H-1, d	208		42	-	NP
85H-1, X1	140	50	85-95	88	NP

85H-1, X2	125	50	85-95	79	
85H-1, X3	118	50	85-95	80	
85H-1, X4	145		49	80	NP
85H-1, X5	200		45	81	NP
85H-2, X1	135		85-90	74	
85H-2, X2	86		85-90	72	
85H-2, X3	98		85-90	72	
85H-2, X4	80	50	65	-	
85H-3, X1	122		85-89	77	
85H-3, X2	114		85-89	80	
85H-3, X3	117		70	71	
85H-3, X4	195		56	77	
85H-4, X1	125		85-90	81	
85H-4, X2	98		85-90	82	
85H-4, X3	95	90	60	79.5	
85H-4, X4	142	40	68	81	
85H-4, X5	190		56	81	
85H-5, d	210		54	-	
85H-5, X1	100		88-92	79	
85H-5, X2	148		72	79	
85H-5, X3	102	50	65	-	
85H-5, X4	165		63	81	

A ambient temperature (20°C-25°C), temperature not recorded
\- local thickness measurements not taken
NP Not Plotted in figure 1 due to thickness or temperature deviations from the majority of other points in grouping

Blank entries under elevation change indicate an elevation change <40 mil.

Series 50C-1 and 85C-4 provided no data due to noncontinuous rebar in concrete which prevented proper control of crack development.

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J LEACHATE DETECTION COLLECTION AND REMOVAL GRAVEL PENETRATION TEST

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July 14, 1989

Ms. T. B. Bergman
Westinghouse Hanford Company
MS R1-48
Richland, WA 99352

Dear Theresa:

MEASUREMENT OF THE CREEP OF GRAVEL INTO GEOTEXTILE AND HDPE LINER AT 90°C

The concrete catch basin under a grout vault will be filled with gravel through which any leaking liquid will drain. The catch basin will be lined with HDPE, which in turn will be covered with a geotextile to protect the liner from puncture. Due to heat produced by grout hydration reactions and radiolytic decay, temperatures as high as 90°C may be reached in a vault. There was a concern that high temperatures may allow gravel to creep into the liner and cause a puncture while liquid is still present in the vault.

To address this concern, tests were conducted in which liner covered by geotextile and then gravel was exposed to static loads at 90°C for 32 days. The test resulted in only minor dents in the liner, none of which were close to causing a puncture. From the test results, it is concluded that the liner will not be punctured by gravel creeping into the liner under static loads at 90°C for at least 180 days. Creep prior to a grout vault being filled should be negligible due to the relatively low overburden and temperature. Therefore, the liner will not be punctured by this mechanism during the period in which liquid may be present in the vault (~60 days).

<u>Test Procedure</u>

Duplicate tests were performed in which an HDPE liner covered with geotextile and then gravel was subjected to a static load at 90°C. The displacement of the system over time was measured for 32 days, after which the liner was removed and inspected for damage and the thickness measured at various points.

A static load of 6500 psf (45.1 psi) ± 1.0% was applied using a mechanical test machine enclosed in an oven maintained at 90°C ± 3°C. The two tests were performed simultaneously in separate test machines. The test cell configuration consisted of the steel bottom of the test cell covered by a layer of mortar, the HDPE flexible membrane liner, the polypropylene geotextile, a bed of gravel, and finally the upper platen of the test machine. The test cell was 6 in. in diameter and contained approximately 3 in. of gravel.

Prior to installation in the test cell, the thickness of the liner was measured on a 1-in. grid. The grid points were marked on the sample in order to obtain accurate comparison measurements at the conclusion of the test. At the end of the 32-day test period the liners were removed, inspected for damage, and photographed. Changes in thickness of the liner at the grid points were measured. The minimum thickness at the deepest indentation was measured to determine how close the liner was to being punctured at the conclusion of the test.

Test Materials

The liner was 60-mil HDPE liner from National Seal Company (TMI# HGTP-036). The two liner samples were labeled "X" and "Y." The geotextile used to cover the liner was Polyfelt TS750, which is a 120-mil-thick polypropylene geotextile with a weight of 10.3 oz/yd^2 (TMI# HGTP-037).

The gravel in the test cell was nonfractured (round) gravel, obtained from ACME Concrete Co., in Richland, Washington. The gravel was sieved and recombined to meet the following specification:

wt% material retained on 1-in. screen	0%
wt% material retained on 1/2-in. screen	10%
wt% material retained on 3/8-in. screen	40%
wt% material retained on No. 4 screen	28%
wt% material retained on No. 8 screen	22%
wt% material passing No. 8 screen	0%

This specification is identical to that for the gravel specified for use in the catch basin of a grout vault.

Results

All initial measurements of liner thickness ranged from 59 to 65 mil for both liner samples. After being exposed to the load at 90°C for 32 days, the thinnest points in the liners were 39 and 41 mil for samples "X" and "Y", respectively. These measurements were taken at the bottom of indentations created by rocks pressing on the liner. The thickness of the liner where indentations did not occur was unchanged. The liners after exposure are shown in Figures 1 and 2.

The data can be extrapolated by looking at the rate of creep occurring in the liner near the end of the test. The creep behavior over time is shown in Figures 3 and 4. These figures show the displacement of the test machine platen, which corresponds to a reduction in the total thickness of the mortar, liner, geotextile, and gravel in the test cell. The displacement measurement was affected by disturbances in the temperature and load.

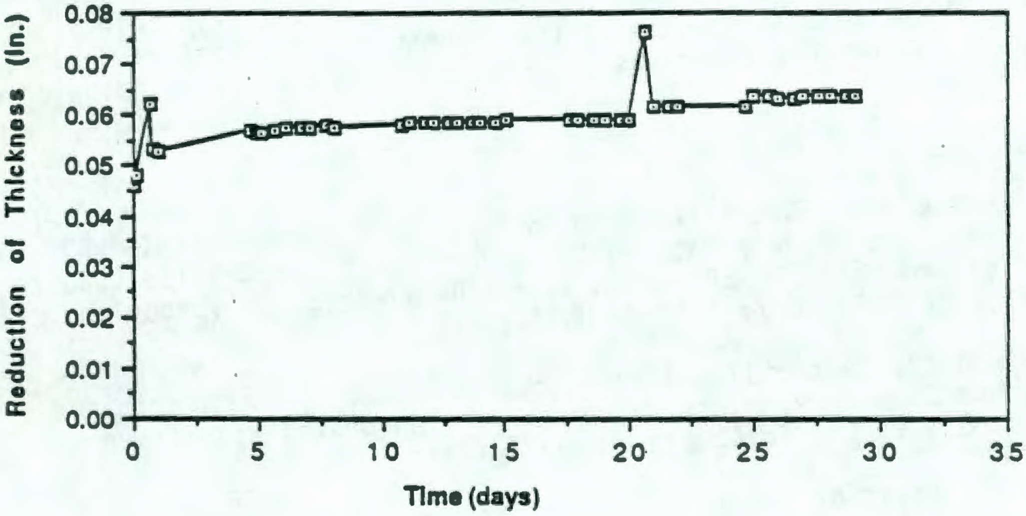

FIGURE 1. Photograph of sample "X" at completion of test

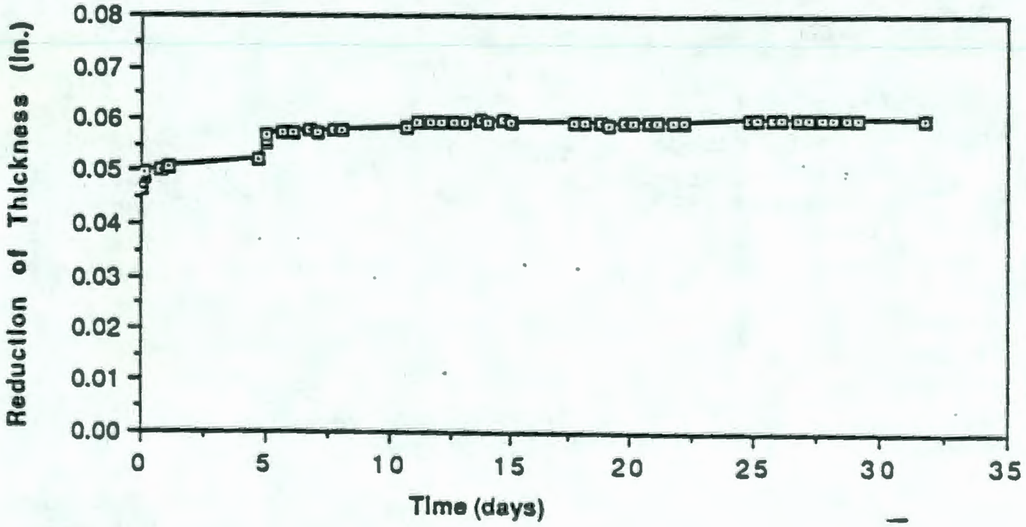

FIGURE 2. Photograph of sample "Y" after completion of test

9 0 1 1 7 8 5 1 3 2 8

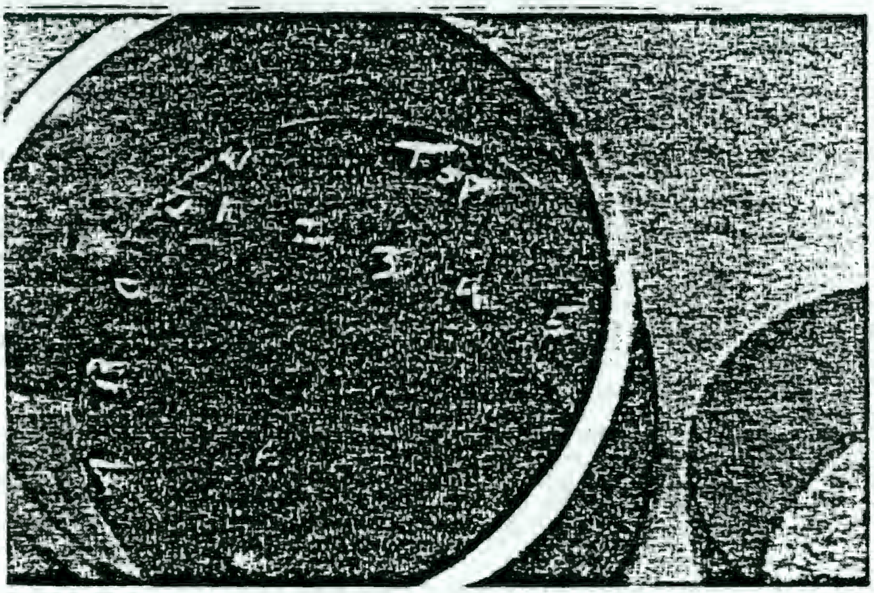

FIGURE 3. Reduction of test cell "X" thickness over time. The thickness reduction includes contributions from steel container, mortar, HDPE liner, polypropylene geotextile, and gravel.

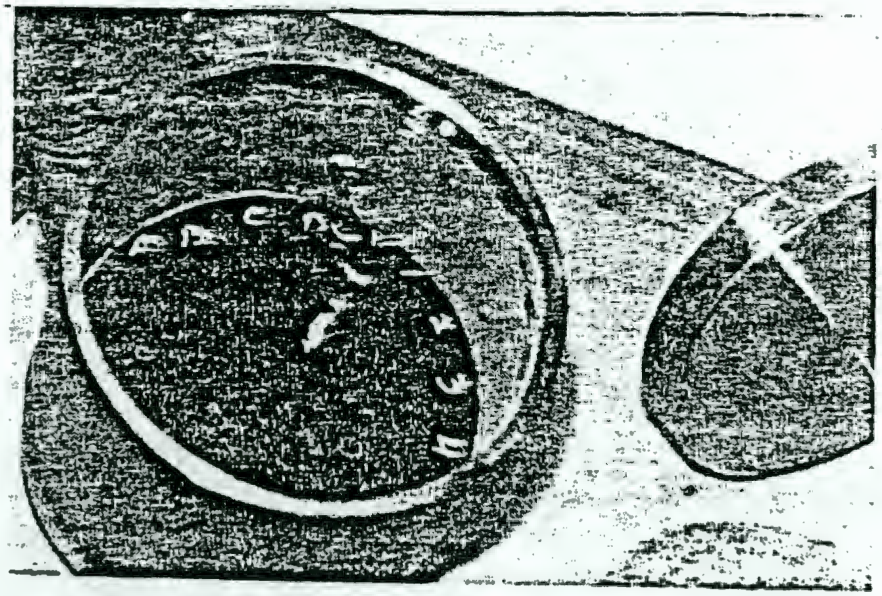

FIGURE 4. Reduction of test cell "Y" thickness over time. The thickness reduction includes contributions from steel container, mortar, HDPE liner, polypropylene geotextile, and gravel.

The control of the load for both samples was disturbed 5 days into the experiment when the hydraulic pump maintaining the constant load required replacement. This resulted in a loss of the load for approximately 45 minutes, after which time the load was restored. The load was disturbed again 11 days into the run when another test machine placed a large hydraulic demand on the pump, thus lowering the pressure and momentarily reducing the static load.

The temperature of sample "Y" dropped from 90°C to 52°C over a period of less than 16 hours during the first day of the test. The same problem occurred again on day 21, when the temperature dropped to 31°C. The temperature control was lost again between day 29 and 32. The sample was removed on day 32 without restoring the temperature. Since days 30 and 31 fell on a weekend, the final displacement data on sample "Y" is the day 29 data. No problems with temperature control were experienced with sample "X."

Changes in load and temperature resulted in residual reductions in the test cell thickness after the desired conditions were restored. This is believed to have been due to consolidation of the gravel, which allowed a small reduction in the cell thickness to occur.

If the conservative assumption is made that at the end of the test the entire rate of creep was due to movement of gravel into the liner material, the creep rate can be linearly extrapolated (also conservative) over longer periods of time. (Note that the creep as measured by displacement of the test machine platen indicated approximately 60 mil, but that the maximum reduction in liner thickness was only about 20 mil.) Looking first at sample "X" the data can be extrapolated from just after the last disturbance at day 11. The linear rate of creep is 0.024 mil/day, which is approximately the detection limit of the experiment. When extrapolated, the rate of creep requires 4.4 years after the test to penetrate the remaining 39 mil of liner. When added to the test period itself, this predicts a total of 4.5 years before the liner is punctured.

For sample "Y" the rate of creep can be extrapolated from just after the last temperature disturbance at day 21. At this point the rate of creep is 0.275 mil/day, which should prevent puncture of the liner for 181 days. Eighty-six percent of the displacement occurred between two measurements separated by 8 hours, indicating that there may have been a disturbance to the sample during this period. The source of the possible disturbance is unknown. If the displacement during this period is ignored, then the extrapolation would yield a resistance to puncture for 3.1 years. However, since the source of disturbance is not known this cannot be done with confidence.

It is anticipated that the creep in the installed liner will be negligible prior to filling the grout vault since the overburden and temperature will be relatively low. There is high confidence that the liner will resist puncture for at least 180 days after filling the vault. Therefore, the liner will not be punctured by creep during the period when liquid is in the vault.

Records for this work are traceable to Hanford Grout Technology Program FY-89 Files, PFI-05. If you have questions about this work please contact Greg Whyatt at 376-0011.

Sincerely,

Don

D. H. Mitchell, Manager
Hanford Grout Technology Program

DHM:GAW:rt

cc : S. R. Briggs
D. W. Hendrickson

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K COMPATIBILITY OF CATCH BASIN GRAVEL

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July 12, 1989

Ms. T. B. Bergman
Westinghouse Hanford Company
MS R1-48
Richland, WA 99352

Dear Theresa:

COMPATIBILITY OF CATCH BASIN GRAVEL WITH DOUBLE-SHELL SLURRY FEED (DSSF): Rev. 1.0

Tests to assess the compatibility of gravel with simulated DSSF at 90°C have been completed. In the current grout vault design, any liquid leaking through the internal liner and concrete grout vault will drain to the catch basin. Kaiser Engineers Hanford suggested that the gravel in the catch basin might be incompatible with the waste and that waste draining through the gravel might result in subsidence. This letter transmits the results of tests performed to address this concern. The results show no indication that subsidence will occur due to contact between the waste and the gravel. Although some reactions were evident on the gravel particle surface, changes in size distribution, total weight, and deflection under load of a gravel bed were extremely small. Details of the work are provided below.

<u>Gravel Immersion</u>

Rounded river gravel similar to that intended for use in the grout vault catch basin was obtained from ACME Concrete Co. in Richland, WA. The gravel was washed, dried, and sieved into 3 samples of 15,090 g each. The size distribution before immersion was:

wt% retained on 1 in.	0
wt% retained on 1/2 in.	10
wt% retained on 3/8 in.	40
wt% retained on No. 4	28
wt% retained on No. 8	22
wt% in pan	0

Simulated DSSF originating from the November pilot-scale test was used in the test. The waste was decanted to remove the solids since it is unlikely that solid particles would be able to pass through cracks in the concrete vault. The gravel was placed in three separate immersion cells and covered with 4800 to 5000 g DSSF supernatant. The immersion cells were then covered and placed in an oven at 90°C. Every 30 days one immersion cell was removed and the DSSF was drained from the gravel. The gravel was rinsed, dried, sieved, and weighed to determine the changes in weight and size distribution of the gravel. The gravel was then recombined into samples for compression testing.

The immersion procedure is believed to have been conservative for the following reasons:

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Ms. T. B. Bergman, Rev. 1.0
July 12, 1989
Page 2

1) The gravel was completely submerged, whereas if the vault leaked the liquid would drain freely through the gravel, leaving only a thin layer of DSSF on the gravel surface.

2) The immersion was maintained at 90°C, which is the maximum temperature expected in the grout. The temperature in the catch basin may be lower than 90°C.

3) The immersion was performed in a covered vessel, which reduces the rate at which atmospheric carbon dioxide neutralizes the sodium hydroxide in the waste. In the catch basin, the rate of neutralization would be expected to be higher.

Compression Testing

Compression testing was used to detect changes in the strength of the gravel particles. To perform the compression tests, the gravel was loaded into a cylindrical test cell. The test cell constrained the bottom and sides of the gravel bed while a plunger applied the load from the top of the cell. Prior to testing, the gravel in the test cell was compacted by firmly striking the bottom of the test cell 5 times on a hard surface. The test cell was then placed in the test machine and the plunger lowered to rest on the surface of the gravel. A constantly increasing load was applied while the deflection was recorded. Initially, the gravel bed was approximately 7.25 in. high and 4.9 in. in diameter. The load was applied from 0 to 70,000 pounds (3,703 psi) at a rate of 5000 lb/min (265 psi/min). Typically, the height of the gravel bed was reduced by 0.7 to 0.9 in. as this load was applied. After achieving the maximum load, the load was held steady for 2 minutes to measure the extent of creep under constant load.

Tests were performed after each 30-day period using both immersed and non-immersed gravel. The non-immersed gravel was tested at 30-day intervals rather than all at once to detect unintentional changes in the execution of the test procedure (compaction, segregation during loading, etc.), which might affect results.

The maximum load applied was much larger than the load expected due to the overburden in the catch basin (≈45 psi). The large loads were used in order to detect changes in the strength properties of the gravel and were not intended to simulate expected conditions in the catch basin.

Results

The immersion tests measured changes in total weight of gravel and particle size distribution. These results are summarized in Table 1. Note that all changes were small and do not indicate incompatibility between the gravel and the waste. After 30 days of immersion, small specks were observed on the gravel surface, indicating that some type of reaction was occurring. The majority of the reaction appeared to occur in the first 30 days of immersion. Some particles were more affected than others, but all particles appeared to

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Ms. T. B. Bergman, Rev. 1.0
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Page 3

be sound. Individual particles became cemented together where they touched each other. Because of this, a screwdriver was required to remove the gravel from the cell. Once removed, however, the particles could be separated by hand. The cementing behavior at the contact points does not create a problem and may actually be beneficial in preventing subsidence of the gravel bed. At the conclusion of the 90-day immersion, the pH had dropped below 11 from an initial level greater than 14. Further reactions resulting from high pH would be expected to be significantly decreased due to the 3 order of magnitude decrease in hydroxide concentration, .

TABLE 1: Changes in Gravel Weight and Size Distribution

	Initial	30 day	60 day	90 day
Dry Gravel Weight	15090 g	15147 g	15172 g	15287 g
wt% retained on 1 in.	0	0	0	0
wt% retained on 1/2 in.	10.0	11.2	11.5	11.0
wt% retained on 3/8 in.	40.0	39.7	38.8	40.0
wt% retained on No. 4	28.0	27.6	28.2	27.5
wt% retained on No. 8	22.0	20.1	20.1	19.9
wt% in pan	0	1.5	1.4	1.7

Results of compression testing of both immersed and non-immersed gravel are shown in Table 2. The displacement is listed for both the maximum 70,000 lb loading and at 851 lb (45 psi), which more accurately represents the overburden in the catch basin. It should be noted that this would not correspond to the subsidence in the disposal scenario since the gravel in the catch basin would be better compacted than the gravel in the test.

The average and standard deviation of the deflections for immersed (combined 30, 60 and 90 day) and non-immersed gravel are displayed at the bottom of the table. The average and standard deviation was calculated for all immersed gravel tests combined because there did not appear to be a trend with immersion time for these samples.

The immersed and non-immersed averages are within one standard deviation of each other. The difference in average deflection is not believed to indicate a subsidence problem in the gravel. These averages and standard deviations were calculated after omitting several data points. Samples N60A,B were omitted because they may have been exposed to loads of up to 5000 lb prior to the start of the compression testing. Sample I30B was omitted since the gravel was segregated while loading the test cell, which resulted in greater displacements than would have otherwise occurred.

The amount of creep measured when the maximum load was maintained constant for 2 minutes varied between 0.020 and 0.025 in. The amount of creep was very consistent and did not appear to be correlated with immersion of the gravel.

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TABLE 2: Gravel Compression Test Results

Deflection (in.) of Nonimmersed Samples			Deflection (in.) of Immersed Samples		
Sample #	851 lb 45 psi(b)	70,000 lb(a) (3703 psi)	Sample #	851 lb 45 psi(b)	70,000 lb(a) (3703 psi)
N30A	0.11	0.86	I30A	0.06	0.79
N30B	0.04	0.79	I30B(c)	0.18	0.99
N30C	0.06	0.75	I30C	0.05	0.81
N60A(d)	0.01	0.57	I60A	0.03	0.71
N60B(d)	0.07	0.79	I60B	0.05	0.70
N60C	0.04	0.69	I60C	0.06	0.73
N90A	0.03	0.66	I90A	0.06	0.74
N90B	0.02	0.69	I90B	0.06	0.85
N90C	0.02	0.68	I90C	0.04	0.76
			I90D	0.06	0.85
Average(e)	0.046	0.73	Average(f)	0.052	0.77
Std. Dev.	0.032	0.07	Std. Dev.	0.011	0.06

a) Adjusted for test machine compliance of 0.05 in. at 70,000 lb; does not include creep of 0.020 - 0.025 in. that occurred when load held constant at 70,000 lb for 2 minutes.
b) Approximate overburden pressure in disposal system.
c) Sample was partially segregated during placement in the test cell, which resulted in greater-than-normal deformation.
d) These samples may have experienced loads of up to 5000 lb during initial adjustments of ram position due to a faulty potentiometer. The potentiometer was subsequently replaced.
e) Samples N60A and N60B omitted from average and standard deviation.
f) Sample I30B omitted from average and standard deviation.

Records for this work are traceable to Hanford Grout Technology Program FY-89 files PFI-05. If you have questions, please contact Greg Whyatt at 376-0011.

Sincerely,

Don

D. H. Mitchell, Manager
Hanford Grout Technology Program

cc: S. R. Briggs
D. W. Hendrickson

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L LEACHATE COLLECTION PIPE

To: J E Van Beek February 7, 1989
cc: D F Washburn, M J Anderson

Subject: Grout Vault Leachate Collection Pipe Material Evaluation

The drainable liquids (leachate) from the grout vault will be collected in the leachate collection pipe. The pipe material is presently specified as 4" schedule 80 (.377 inches wall thickness) High Density Polyethylene. The material backfilled around the outside of the pipe will be "drainable gravel". Drainable gravel is described as washed and screened naturally occurring gravel, no crushing, with 100% passing though a 1 inch screen. Resistivity values taken on a sample measured 150 K ohm-cm.

The expected operating temperature will be 90 C (194 F).

The leachate in the pipe will have a pH around 13.2. At worst case the leachate will resemble the waste in the large waste tanks.

The drainable gravel could become, during the 30 year design life of the leachate collection pipe, saturated with salts, (mostly sodium nitrates) that would at worst case resemble the wastes stored in the large waste tanks and which penetrates though the vault walls and will have a pH of around 12.5. Summaries of the waste elements are included in the appendix.

What affect would the above described environments have on a 4" schedule 80, carbon steel grade ASTM-A 53 pipe with a wall thickness of .337 inches.

A worst case scenario is to assume that the waste liquids from the large steel waste tanks (without any grout) are both inside the steel leachate pipe and surrounds the pipe for the whole design life of 30 years.

The design corrosion rates of the tank carbon steel, grades ASTM-A 516 and A 537, are assumed to be less than 1 mpy in the waste tank environiment.

If the same corrosion rate is applied to the carbon steel pipe, the maximum corrosion in 30 years would be about 30 mils. For both sides of the pipe the total corrosion would be about 60 mils. Thus at the end of 30 years the pipe would have .277 inches of wall thickness.

Three tank wastes (241-AN-103, 241-AN-106 and the design grout waste) were analyzed by the PNL Waste Tank Corrosion Data Model Program. The computer results are included in this report in the appendix. The analyses shows that the three wastes have corrosion rates of less than 1 mpy.

A 4" sch 80 steel pipe can always replace a 4" sch 80 plastic pipe for every loading condition. Steel is many times stronger than plastic.

Thus based on the above analysis, the 4" sch 80 steel pipe can be selected to replace the 4" sch 80 plastic pipe.

If thewre are any questions, please contact me on 3-1221.

William C Carlos
Corrosion Engineer
Materials Application

Grout Design Waste Analysis

USING THE
FOR ALLOY 516
WITH EXPOSURE TIME = 8760 HOURS
TEMPERATURE = 90 DEGREES CENTIGRADE

CHEMICAL CONTENTS IN MOLE/LITER

HYDROXIDE =	2.0600
ALUMINATE =	0.2600
NITRATE =	1.6300
NITRITE =	0.9600
COMPLEXANT =	0.0000
FLOURIDE =	0.0198
CARBONATE =	0.1710
PHOSPHATE =	0.0570
SULPHATE =	0.0203
CITRATE =	0.0003

THE PREDICTED PENETRATION IS ---------------------------- 0.12 MPY

STANDARD DEVIATION OF THE PREDICTED PENETRATION IS ---- 0.03 MPY

THE STANDARD DEVIATION OF THE PREDICTED VALUE IS '--------------- 12%
OF THE EXPERIMENTAL ERROR STANDARD DEVIATION

UNDER THESE CONDITIONS, THERE IS A 90 % PROBABILITY THAT
THE AVERAGE PENETRATION IS LESS THAN '------------------------- 0.16 MPY
AND THAT 90% OF THE ACTUAL PENETRATION VALUES ARE LESS THAN 0.55 MPY

UNDER THESE CONDITIONS, THERE IS A 95 % PROBABILITY THAT
THE AVERAGE PENETRATION IS LESS THAN '------------------------- 0.17 MPY
AND THAT 90% OF THE ACTUAL PENETRATION VALUES ARE LESS THAN 0.57 MPY

UNDER THESE CONDITIONS, THERE IS A 99 % PROBABILITY THAT
THE AVERAGE PENETRATION IS LESS THAN '------------------------- 0.19 MPY
AND THAT 90% OF THE ACTUAL PENETRATION VALUES ARE LESS THAN 0.60 MPY

THE
LLOY 516
EXPOSURE TIME = 8760 HOURS
TEMPERATURE = 90 DEGREES CENTIGRADE

CAL CONTENTS IN MOLE/LITER

HYDROXIDE	=	5.7400
ALUMINATE	=	0.9760
NITRATE	=	2.5800
NITRITE	=	2.9900
COMPLEXANT	=	0.0000
FLOURIDE	=	0.0387
CARBONATE	=	0.1490
PHOSPHATE	=	0.0098
SULFHATE	=	0.0166
CITRATE	=	0.0001

PREDICTED PENETRATION IS ---------------------------- 0.12 MPY

STANDARD DEVIATION OF THE PREDICTED PENETRATION IS ---- 0.04 MPY

STANDARD DEVIATION OF THE PREDICTED VALUE IS '---------------- 13%
HE EXPERIMENTAL ERROR STANDARD DEVIATION

R THESE CONDITIONS, THERE IS A 90 % PROBABILITY THAT
AVERAGE PENETRATION IS LESS THAN '------------------------ 0.17 MPY
THAT 90% OF THE ACTUAL PENETRATION VALUES ARE LESS THAN 0.56 MPY

R THESE CONDITIONS, THERE IS A 95 % PROBABILITY THAT
AVERAGE PENETRATION IS LESS THAN '------------------------ 0.18 MPY
THAT 90% OF THE ACTUAL PENETRATION VALUES ARE LESS THAN 0.58 MPY

R THESE CONDITIONS, THERE IS A 99 % PROBABILITY THAT
AVERAGE PENETRATION IS LESS THAN '------------------------ 0.20 MPY
THAT 90% OF THE ACTUAL PENETRATION VALUES ARE LESS THAN 0.61 MPY

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