ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 660780

Proj.
ECN

2. ECN Category (mark one)		3. Originator's Name, Organization, MSIN, and Telephone No.		4. USQ Required?	5. Date
Supplemental ☐		Jaka, Omar M., ISE, S7-24, 372-2322		☒ Yes ☐ No	6/28/00
Direct Revision ☒		6. Project Title/No./Work Order No.		7. Bldg./Sys./Fac. No.	8. Approval Designator
Change ECN ☐		DESIGN REVIEW REP., CONCRETE COVER		See 13a.	SQ
Temporary ☐		BLOCK REPLACED BY STEEL PLATE			
Standby ☐		9. Document Numbers Changed by this ECN (includes sheet no. and rev.)		10. Related ECN No(s).	11. Related PO No.
Supersedure ☐		RPP-5416 Rev. 1		ECN-660753	N/A
Cancel/Void ☐					
12a. Modification Work		12b. Work Package No.	12c. Modification Work Completed		12d. Restored to Original Condition (Temp. or Standby ECNs only)
☐ Yes (fill out Blk. 12b)		N/A	☐ Yes ☐ No		
☒ No (NA Blks. 12b, 12c, 12d)			N/A		
		Design Authority/Cog. Engineer Signature & Date		Design Authority/Cog. Engineer Signature & Date	
13a. Description of Change					
Revise the Formal Design Review Report for U-109 and U-105 Cover Plate to include Design Review of 7 additional Cover Plate modifications by similarity and comparison:					
1) U-103					
2) AX-101					
3) A-101					
4) SX-105					
5) S-A VALVE PIT					
6) S-C VALVE PIT					
7) SX-A VALVE PIT					
This ECN is covered by Categorical Exclusion USQ# TF-96-0690 Rev. 2 items 5,6,9					
14a. Justification (mark one)		14b. Justification Details			
Criteria Change ☒		Design verification of 7 additional cover plates were evaluated against			
Design Improvement ☐		previously approved cover plate for U-109 pump pit as per subsec 4.1.2 of			
Environmental ☐		sec 4.24 of HNF-IP-0824 vol. IV. This modification will not result in a			
Facility Deactivation ☐		change to exposure > 1 person-REM (Whole Body) or 10 person-REM			
As-Found ☐		(extremities) for the installation, maintenance and operation of the life			
Facilitate Const. ☐		of the modification. NEPA screening not required-administrative change.			
Const. Error/Omission ☐					
Design Error/Omission ☐					
15. Distribution (include name, MSIN, and no. of copies)					RELEASE STAMP
OM Jaka S7-24					
WF Zuroff S7-24					
MR Koch S7-24					
TJ Volkman S7-34					
LL Penn S7-07					
LA Flowers S7-07					
KJ Hull T4-07					
DK DeFord S7-24					
KR Ellingson S7-24					

ENGINEERING CHANGE NOTICE

Page 2 of 2

1. ECN (use no. from pg. 1)

660780

16. Design Verification Required

☒ Yes

☐ No

17. Cost Impact

ENGINEERING

Additional ☐ \$ N/A

Savings ☐ \$ N/A

CONSTRUCTION

Additional ☐ \$ N/A

Savings ☐ \$ N/A

18. Schedule Impact (days)

Improvement ☐ N/A

Delay ☐ N/A

19. 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 13. Enter the affected document number in Block 20.

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	☐	Tickler File	☐
Environmental Report	☐	Inspection Plan	☐	None	☒
Environmental Permit	☐	Inventory Adjustment Request	☐		☐

20. 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

N/A

N/A

N/A

21. Approvals

Signature	Date	Signature	Date
Design Authority WF Zuroff	7/26/00	Design Agent	
Cog. Eng. DK DeFord	7/17/00	PE	
Cog. Mgr. MR Koch	7/12/00	QA	
QA TJ Volkman	7/12/00	Safety	
Safety LA Flowers	7/20/00	Design	
Environ. LL Penn	7/17/00	Environ.	
Other OM Jaka	7/17/00	Other	
PAC. Cog KJ Hull	7/19/00		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

DESIGN REVIEW REPORT, CONCRETE COVER BLOCK REPLACED BY STEEL PLATE

O. M. Jaka

CH2MHILL HANFORD GROUP, INC

Richland, WA 99352

U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 660780

UC:

Org Code: 74D00

Charge Code: 103361

B&R Code:

Total Pages: ~~56~~ 57
d7-1-27-00.

Key Words: 241-U-109, 241-U-105, 241-U-103, 241-AX-101, 241-A-101,
241-SX-105, 241-S-A, 241-S-C, 241-SX-A, DESIGN REVIEW REPORT, COVER
PLATE, FSAR

Abstract: The design for the steel cover plates to replace concrete cover blocks for U-109 was reviewed and approved in a design review meeting. The design for steel plates to replace concrete blocks were reviewed and approved by comparison and similarity with U-109 for the following additional pits: 241-U-105, 241-U-103, 241-AX-101, 241-A-101, 241-SX-105, 241-S-A, 241-S-C, 241-SX-A.

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Release Approval Date

Approved For Public Release

[illegible]

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APPENDIX C- STRUCTURAL CALCULATIONS

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1.0 Scope

A design review meeting was held to review ECN 648492. During the review meeting all RCR comments were reviewed and dispositioned to the satisfaction of the reviewers. This review covered the modification of the existing Safety Class 1" Carbon Steel (CS) Cover Plate over the Saltwell Pump Pit for 241-U-109 tank and also adding additional 2" CS plate for shielding purposes. Modification of this 1" plate was needed to cut four additional slots for inserting the electrical wire connection from the PIC (Pumping and Instrumentation Control) Skid and to provide a 8"X6" hole to insert a sensor for the Flammable Gas Monitor (FGM).

A design review of ECN 648484 to modify existing 1" plate and add 2" steel plate is done of 241-U-105 by comparison with 241-U-109 cover plates, which has the same size cover plates.

A design review for CS cover plates to replace concrete cover blocks is done by similarity and comparison with 241-U-109 cover plates for the following pits: 241-U-103, 241-AX-101, 241-A-101, 241-SX-105, 241-S-A, 241-S-C, and 241-SX-A.

The FSAR, HNF-SD-WM-SAR-067 Rev. 1, Table 3.4.2.9-3 identifies cover blocks (or Cover Plates for Saltwell Pumping) as Safety Class to knockdown spray leak and to limit the release of waste aerosols into the atmosphere. Pit covers are also a mitigative feature for other accidents and provides radiation protection (i.e. shielding) for facility workers.

NOTE: The following are documents relevant to a particular cover plate modification. Those without a document number are included as appendices to this design review report. [See Table of Contents for a description of appendices.]

Documents Reviewed:

- 1) ECN-648492, Install 2" shielding Plate & Modify 1" cover plate on 241-U-109.
- 2) USQ TF-99-0229, Rev. 5, Install Saltwell Pumps and Jumpers, 241-U Tank Farm, Modify Cover Plate
- 3) RPP-5989, Rev. 0, Radiological Design Review Screening-Saltwell Pumping at 241-U-109 Pump Pit.
- 4) Calculations for structural Integrity of steel cover plate dated: 11/9/99.

Documents for cover plates at U-105 and U-103:

- 1) ECN-648484, Install 2" Shielding Plate: 241-U-105
- 2) RPP-6641, Rev. 0, Radiological Design Review Screening-Saltwell Pumping at 241-U-105 Pump Pit.
- 3) USQ TF-99-0229, Rev. 4, Install Saltwell Pumps and Jumpers, 241-U Tank Farm, Modify Cover Plate (for U-105)
- 4) Calculations for structural Integrity of steel cover plate U-105 and U-103 dated: 3/11/99.
- 5) ECN-648470, Install 2" Shielding Plate: 241-U-103
- 6) RPP-6640, Rev. 0, Radiological Design Review Screening-Saltwell Pumping at 241-U-103 Pump Pit.

- 7) USQ TF-99-0229, Rev. 3, Install Saltwell Pumps and Jumpers, 241-U Tank Farm, Modify Cover Plate (for U-103)

Documents for cover plates at AX-101:

- 1) ECN-659244, Fab and Install Cover Plate on Distributor Pit AX-101
- 2) RPP-5844, Rev. 0, Radiological Design Review Screening-Saltwell Pumping at 241-AX-101 Pump Pit.
- 3) USQ TF-00-0128 Rev. 3, Replace 1" and add 2" Steel Plate on Distributor Pit AX-101
- 4) Calculations for structural Integrity of steel cover plate AX-101, 3/14/00.

Documents for cover plates at A-101:

- 1) ECN-652568, Replace 241-A-101 Pit Cover blocks by 2" Steel Cover Plate
- 2) RPP-6642, Rev. 0, Radiological Design Review Screening- 2" Carbon Steel Cover Plate Installation at 241-A-101 Pump Pit
- 3) USQ TF-99-9950, Rev. 0, Replace Cover Block by 2" Steel Plate on Distributor Pit for Saltwell Pumping Tank A-101
- 4) Structural calculations for A-101 cover plate dated: 2/25/00.

Documents for cover plates at SX-105:

- 1) ECN-638579, Replace 241-SX-105 Distributor Pit Cover block by Steel Plate
- 2) RPP-6162, Rev. 0, Radiological Design Review Screening- 2" Carbon Steel Cover Plate Installation at 241-SX-105 Pump Pit
- 3) USQ TF-99-0615, Rev. 1, 241-SX-105- Distributor Pit Cover Plate
- 4) Structural calculations for SX-105 cover plate dated: 5/30/00

Documents for cover plates at S-A, S-C, and SX-A Valve Pits:

- 1) ECN-659207, Replace East Cover Block on S-A Valve Pit by 3" Steel Plate
- 2) ECN-659208, Replace West Cover Block on S-C Valve Pit by 3" Steel Plate
- 3) ECN-659209, Replace West Cover Block on SX-A Valve Pit by 3" Steel Plate
- 4) RPP- 6161, Rev. 0, Radiological Design Review Screening-241-SX-105 Hose-in-Hose Transfer System for the IS Program (screening of S-A, S-C, and SX-A Valve Pits)
- 5) USQ TF-00-0370 Rev. 0, Replace Concrete Cover Blocks by Steel Cover Plates on S and SX Farm Pits
- 6) Structural Calculations and Design of 3" Cover Plate for 241-S-A Valve Pit dated: 6/8/00.
- 7) Structural Calculations and Design of 3" Cover Plate for 241-S-C Valve Pit dated: 6/7/00.
- 8) Structural Calculations and Design of 3" Cover Plate for 241-SX-A Valve Pit dated: 6/7/00.

The ECN provided the layout of a 2" steel shielding plate with slot holes, a FGM sensor hole and valve handle holes to match with holes in the existing 1" plate. A layout was also provided of new slot holes and a FGM sensor hole in the existing 1" plate. The ECN provided the details for the Safety Class Shield Plug to cover the 8"X6" hole for the FGM.

The USQ TF-99-0229, Rev. 5 provided the screening for the modification of the existing 1" cover plate and 2" additional shielding plate. This screening has all "No" or "N/A" responses, therefore it did not require a USQ Determination.

The Radiological Design Review Screening provided the Dose Rate of 139 mrem/hr over the existing 1" cover plate during the pumping operation. This high Dose rate will limit the personnel occupancy over the pump pit cover which is required during the life cycle of Saltwell Pumping for 241-U-109 Tank.

By analysis, the addition of a 2" steel carbon plate on top of a 1" existing plate will drop the dose rate to 21 mrem/hr, which will allow operations personnel to spend the required time during the lifecycle of the project, and will not result in exposure to > 1 person-REM.

By analysis, an adequate factor of safety exists for maximum stress and deflection of the 1" plate. Also the 2" plate is supported in the same way on the pit wall as the 1" plate.

All documentation is related to the Interim Stabilization program for Saltwell Pumping of Tank 241-U-109 in 241-U Tank Farm. All objectives of this review has been to establish the design approval for the 1" Safety Class cover plate and additional 2" shielding plate on 241-U-109 pump pit.

As the cover plates for 241-U-105 and 241-U-109 are identical, the factor of safety for bending stress and deflection are very similar. The radiological dose rate for 241-U-105 is 20 mrem/hr, compared to 21 mrem/hr for 241-U-109. From the analysis given here, the cover plates for 241-U-105 provide adequate safety function as per FSAR requirements.

To perform saltwell pumping the concrete cover blocks were replaced with steel cover plates for seven pits in addition to 241-U-109 and 241-U-105, namely: 241-U-103, 241-AX-101, 241-A-101, 241-SX-105, 241-S-A, 241-S-C, and 241-SX-A. The cover plates for six out of seven of these pits have a higher factor of safety for bending stress and deflection than U-109, and all have adequate safety factors. The radiological dose rates for the U-103, AX-101, and A-101 pump pits, are less than or equal to that of U-109, or 21 mrem/hr. The radiological dose rates for the SX-105 pump pit and the S-A, S-C, and SX-A valve pits were between 30 and 35 mrem/hr. Although this is a higher dose rate than U-109, these pits each have a shorter duration of pumping. Thus, their total radiation exposure is close to that of U-109 and within the exposure limit. From the analysis given here, the cover plates for 241-U-103, 241-AX-101, 241-A-101, 241-SX-105, 241-S-A, 241-S-C, and 241-SX-A provide adequate safety function and shielding as per FSAR requirements.

2.0 SUMMARY

The design review meeting was held on November 9, 1999. The meeting minutes are attached in Appendix A. Comments were recorded on Review Comment Records (Appendix B) and in the meeting minutes. All comments were dispositioned in the meeting and no further comments were made. It was concluded that the 1" existing cover plate with the additional 2" steel shielding plate will meet the requirements of the FSAR. The FSAR requirements have been met for spray leak knockdown and shielding for facility workers.

There are no outstanding action items remaining on the design for the existing cover plate or shielding plate for 241-U-109 Saltwell Pump Pit.

By comparing the data from analysis of 241-U-105 cover plates shown below, it is concluded that the 241-U-105 cover plates will meet the requirements of FSAR.

By comparing the data shown in the table below from analysis of 241-U-109 cover plates with 241-U-103, 241-AX-101, 241-A-101, 241-SX-105, 241-S-A, 241-S-C, and 241-SX-A, it is concluded that the additional seven cover plate designs will meet the requirements of FSAR.

Design Review by Comparison

	Steel Plates:	Stress Safety Factor:	Deflection SF:	Radiation Dose Rate: (mrem/hr)
Design Verified Cover Plate: U-109 Pump Pit ECN-648492	1"+2" thk. 7'-8"x7'-8"	10.092	1.172	21
U-105 Pump Pit ECN-648484	1"+2" thk. 7'-8"x7'-7 1/2"	11.31	2.9	20
U-103 Pump Pit ECN-648470	1"+2" thk. 7'-8"x7'-8"	11.31	2.63	20
AX-101 Pump Pit ECN-659244	1"+2" thk. 6'-6"x11'-2"	7.963	4.732	21
A-101 Pump Pit ECN-652568	2" thk. 7'-0"x7'-6"	31.826	8.813	13
SX-105 Pump Pit ECN-638579	3" thk. 8'-0"x8'-2"	43.233	14.829	30*
S-A Valve Pit ECN-659207	3" thk. 8'-0"x11'-10"	39.26	19.573	35*
S-C Valve Pit ECN-659208	3" thk. 8'-0"x11'-10"	12.0	8.2	35*
SX-A Valve Pit ECN-659209	3" thk. 8'-0"x11'-10"	12.0	7.88	35*

*The total Radiation dose for these pits is comparable to U-109. Although their radiological dose rate is higher than that of U-109, their duration of pumping is shorter.

Conclusion:

By comparing results given in the table U-105 cover plate has the better safety factors and it will provide adequate safety functions to knock down spray leak and limit the release of waste aerosol to the atmosphere. Duration of pumping for U-105 is 9 months compared to 24 months for U-109 so total Radiation dose will be less for U-105 and it will be within the exposure limit. Hence U-105 plate is acceptable by comparison.

Comparing the data for 241-U-109 with the seven additional pits, namely: 241-U-103, 241-AX-101, 241-A-101, 241-SX-105, 241-S-A, 241-S-C, and 241-SX-A, shows that adequate safety is provided and the total Radiation dose will be within the exposure limit. Thus, the new steel cover plates for these seven pits are acceptable by comparison.

3.0 DOCUMENTATION

Design Review Committee Members:

O. M. Jaka*	Design Agent
M. A. White*	Cognizant Engineer
M. R. Koch*	Cognizant Engineering Manager
W. F. Zuroff*	Design Authority
L. L. Penn*	Environmental
T. J. Volkman*	Quality Assurance
F. A. Zak*	Safety
K. J. Hull*	Cognizant Engineer (SST)
K. R. Ellingson*	Administration

*Meeting Attendees

Documents:

Meeting Minutes, dated 11/9/99

Radiological Design Review Screening, 2" Carbon Steel Cover Plate Installation at 241-U-109 Pump Pit, dated

Unreviewed Safety Question (USQ) Screening/Determination, TF-99-0229, dated 10/28/99.

Design Calculations for Structural Integrity of existing 1" Plate for additional holes, dated

APPENDIX A

MEETING MINUTES
DESIGN REVIEW MEETING ECN 648492
241-U-109 COVER PLATE

MEETING MINUTES

SUBJECT: Design Review for the Modification of the Existing 1" Cover Plate and Adding a 2" Shielding Plate

TO: Distribution	Building: 2704-HV/G-133	Date: 11/9/99
FROM: Interim Stabilization Engineering	Chairman: W. F. Zuroff	Number Attending: 9

Design Review Committee Members:

O.M. Jaka*	Design Agent
M.A. White*	Cognizant Engineer
M.R. Koch*	Cognizant Engineering Manager
W.F. Zuroff*	Design Authority, Chairman
L.L. Penn*	Environmental
T.J. Volkman*	Quality Assurance
F.A. Zak*	Safety
KJ. Hull*	Cognizant Engineer (SST)
K.R. Ellingson*	Administration

Attendees*

This Design Review Meeting was called to review the proposed changes noted on ECN 648492, "Modification of the Existing 1" Cover Plate and Adding a 2" Shielding Plate on Tank 241-U-109, Saltwell Pump Pit"

Comments were received by Review Comment Record's (RCR) and these comments were dispositioned during the meeting to the satisfaction of the reviewers. Additional comments were taken during the meeting and are as follows:

Koch

Question:

Is the shielding plate sitting on all four sides of the pit?

Disposition:

Yes, is supported by 3 walls and adjacent cover block.

Question:

What is the structural strength?

Disposition:

Yes, Analysis treated as a dead load sitting on the plate. The 1" and 2" plate are supporting their own loads. The safety factor is adequate against yield strength and deflection.

Question:

Will the lifting bails be removed from the 1" plate?

Disposition:

No.

Question:

Will the 2" shielding plate have it's own hoisting rings?

Disposition:

Yes

Question:

Is there a painting diagram for the pit?

Disposition:

Yes

Comment:

Page 4 of ECN "CS Shielding Plate per detail "Z" change to detail "P".

Disposition:

Agreed, will correct

Comment:

Add bolt call out.

Disposition:

Agreed, will correct

Question:

Is the shielding plug 2" and the slot cover's 1"?

Disposition:

Yes

Question:

Should page 4 of this ECN be detail "P"?

Disposition:

Yes

Comment:

Specify that the holes will be plugged on the 2" plate after the hoist rings are removed.

Disposition:

Agreed

Comment:

Specify bolt length

Disposition:

Agreed

Question:

How far does the slot overhang the pit walls?

Disposition:

A little more than 6" in length.

Question:

Has the plug been fabricated yet?

Disposition:

Yes

Zuroff

Comment:

The Belhaven unit will be replaced by a remotely calibrated sensor.

Question:

Is the sheet metal box a cover for the existing slot?

Disposition:

Yes

Question:

Will the hole be covered by a safety class cover?

Disposition:

Yes, the cover will be modified to accept the sensor signal cable and the calibration gas tubing. This design review will serve as the design review for the modification of the S/C cover.

Swaney

Comment:

On Page 6 of ECN 648492, in the "Shielding Application Table" delete "Assembly X" and add "not required"

Disposition:

Agreed

Comment:

On page 4 of ECN 648492 remove the call out from the top left corner, it is repeated.

Disposition:

Agreed

Hull

Question:

Will you be using the existing slot?

Disposition:

No

Question:

Are the dimensions shown on pages 3, 4 and 5 of ECN 648492 correct?

Disposition:

Yes,

Page 3 of this ECN shows a dimension of 3'-10' for the center line of the riser.

Page 5 of this ECN shows a dimension of 3'-9' 7/8" for the 4" hole.

Page 4 of this ECN shows the 4" hole is not in the center of the cover plate.

Question:

Are all related ECNs work complete?

Disposition:

Yes

Comment:

Specify the bolt length.

Disposition:

Agree

APPENDIX B

REVIEW COMMENT RECORDS
241-U-109 COVER PLATE

[illegible]

[illegible]

REVIEW COMMENT RECORD (RCR)

[illegible]

REVIEW COMMENT RECORD (RCR)

[illegible]

REVIEW COMMENT RECORD (RCR)									
1. Date 11/9/99		2. Review No.		3. Project No.		4. Page 1 of 1		5. Document Number(s)/Title(s)	
6. Program/Project/Building Number		7. Reviewer		8. Organization/Group		9. Location/Phone		10. Agreement with indicated comment disposition(s)	
ECN 648492		W.F. Zureff		RSE		373-1003		11. CLOSED	
17. Comment Submittal Approval:		W.F. Zureff		11/9/99		11/9/99		12. Status	
Organization Manager (Optional)		Reviewer/Point of Contract		Date		Author/Originator		13. Comment(s)/Discrepancy(s) (Provide technical justification for the comment and detailed recommendation of the action required to correct/resolve the discrepancy/problem indicated.)	
		W.F. Zureff		11/9/99		m. d. m. d. m. d.		14. Hold Point	
		11/9/99		11/9/99		11/9/99		15. Disposition (Provide justification if NOT accepted.)	
		11/9/99		11/9/99		11/9/99		16. Status	
		11/9/99		11/9/99		11/9/99		17. Status	
		11/9/99		11/9/99		11/9/99		18. Status	
		11/9/99		11/9/99		11/9/99		19. Status	
		11/9/99		11/9/99		11/9/99		20. Status	
		11/9/99		11/9/99		11/9/99		21. Status	
		11/9/99		11/9/99		11/9/99		22. Status	
		11/9/99		11/9/99		11/9/99		23. Status	
		11/9/99		11/9/99		11/9/99		24. Status	
		11/9/99		11/9/99		11/9/99		25. Status	
		11/9/99		11/9/99		11/9/99		26. Status	
		11/9/99		11/9/99		11/9/99		27. Status	
		11/9/99		11/9/99		11/9/99		28. Status	
		11/9/99		11/9/99		11/9/99		29. Status	
		11/9/99		11/9/99		11/9/99		30. Status	
		11/9/99		11/9/99		11/9/99		31. Status	
		11/9/99		11/9/99		11/9/99		32. Status	
		11/9/99		11/9/99		11/9/99		33. Status	
		11/9/99		11/9/99		11/9/99		34. Status	
		11/9/99		11/9/99		11/9/99		35. Status	
		11/9/99		11/9/99		11/9/99		36. Status	
		11/9/99		11/9/99		11/9/99		37. Status	
		11/9/99		11/9/99		11/9/99		38. Status	
		11/9/99		11/9/99		11/9/99		39. Status	
		11/9/99		11/9/99		11/9/99		40. Status	
		11/9/99		11/9/99		11/9/99		41. Status	
		11/9/99		11/9/99		11/9/99		42. Status	
		11/9/99		11/9/99		11/9/99		43. Status	
		11/9/99		11/9/99		11/9/99		44. Status	
		11/9/99		11/9/99		11/9/99		45. Status	
		11/9/99		11/9/99		11/9/99		46. Status	
		11/9/99		11/9/99		11/9/99		47. Status	
		11/9/99		11/9/99		11/9/99		48. Status	
		11/9/99		11/9/99		11/9/99		49. Status	
		11/9/99		11/9/99		11/9/99		50. Status	
		11/9/99		11/9/99		11/9/99		51. Status	
		11/9/99		11/9/99		11/9/99		52. Status	
		11/9/99		11/9/99		11/9/99		53. Status	
		11/9/99		11/9/99		11/9/99		54. Status	
		11/9/99		11/9/99		11/9/99		55. Status	
		11/9/99		11/9/99		11/9/99		56. Status	
		11/9/99		11/9/99		11/9/99		57. Status	
		11/9/99		11/9/99		11/9/99		58. Status	
		11/9/99		11/9/99		11/9/99		59. Status	
		11/9/99		11/9/99		11/9/99		60. Status	
		11/9/99		11/9					

REVIEW COMMENT RECORD (RCR)		1. Date <u>11/8/99</u>	2. Review No.
		3. Project No.	4. Page 1 of 1

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[illegible]

[illegible]

RPP-5416, Rev. 2

APPENDIX C

STRUCTURAL CALCULATIONS

241-U-109

Determine factors of safety for 241-U-109 pump pit cover plate design (ECN-648492) with respect to maximum allowable deflection and bending stress:

ASSUMPTIONS -

Neglect plate penetrations (largest penetration dia (6") << plate width)

Plate is simply supported on three edges, one edge free (worst case)

Plate is uniformly loaded over entire plate

$$a := 92 \text{ in} \quad (\text{Width of plate}) \quad b := 92 \text{ in} \quad (\text{Length of plate - free side})$$

$$t_{\text{steel}} := 1 \text{ in} \quad (\text{Thickness of plate})$$

$$A := a \cdot b \quad A = 8.464 \cdot 10^3 \text{ in}^2 \quad (\text{Area of plate})$$

$$V_{\text{steel}} := a \cdot b \cdot t_{\text{steel}} \quad V_{\text{steel}} = 8.464 \cdot 10^3 \text{ in}^3 \quad (\text{Volume of plate})$$

$$\rho_{\text{steel}} := 487 \frac{\text{lb}}{\text{ft}^3} \quad (\text{Density of ASTM A36 steel}) \quad E := 29 \cdot 10^6 \text{ lb} \cdot \text{in}^{-2} \quad (\text{Modulus of elasticity, ASTM A36 steel})$$

$$W_{\text{steel}} := \rho_{\text{steel}} \cdot V_{\text{steel}} \quad W_{\text{steel}} = 2.385 \cdot 10^3 \text{ lb} \quad (\text{Weight of steel plate})$$

$$q_{\text{steel}} := \frac{W_{\text{steel}}}{A} \quad q_{\text{steel}} = 0.282 \text{ lb} \cdot \text{in}^{-2} \quad (\text{Distributed dead load due to weight of steel plate})$$

Use Uniformly distributed live load = 50 lbs/sq ft = 0.3472 lb/sq in

$$q_{\text{udl}} := 0.3472 \frac{\text{lb}}{\text{in}^2} \quad q_{\text{total}} := q_{\text{steel}} + q_{\text{udl}}$$

$$q_{\text{total}} = 0.629 \text{ lb} \cdot \text{in}^{-2}$$

$$\text{adivb} := \begin{bmatrix} .5 \\ .667 \\ 1.0 \\ 1.5 \\ 2.0 \\ 4.0 \end{bmatrix} \quad \beta := \begin{bmatrix} .36 \\ .45 \\ .67 \\ .77 \\ .79 \\ .80 \end{bmatrix} \quad \alpha := \begin{bmatrix} .080 \\ .106 \\ .140 \\ .160 \\ .165 \\ .167 \end{bmatrix} \quad \text{From Roark, Table 26, Pg.461 Case 2b.}$$

Use curve fitting to determine β :

$$\text{fit} := \text{cspline}(\text{adivb}, \beta) \quad \beta := \text{interp}(\text{fit}, \text{adivb}, \beta, \frac{a}{b}) \quad \beta = 0.67$$

Originator m. b. m. Jaka
Omar Jaka

Date 11/9/95

Checked by: Mike A. White

Date 11/9/95

Calculate maximum stress and safety factor:

$$\sigma_{\max} := \frac{\beta \cdot q_{\text{total}} \cdot b^2}{t_{\text{steel}}^2} \quad \sigma_{\max} = 3.567 \cdot 10^3 \text{ lb} \cdot \text{in}^{-2} \quad \sigma_{\text{yield}} := 36000 \text{ lb} \cdot \text{in}^{-2} \quad (\text{ASTM A36})$$

$$\sigma_{\text{allow.}} := .6 \text{ } F_y \quad (\text{AISC F1-5})$$

$$\text{Gives } SF_{\min} := 1.666$$

$$SF := \frac{\sigma_{\text{yield}}}{\sigma_{\max}} \quad SF = 10.092 \quad \underline{SF_{\min} = 1.66, SF \gg SF_{\min}, \text{ O.K.}}$$

Calculate maximum deflection and safety factor:Use curve fitting to determine α :

$$\text{fit} := \text{cspline}(\text{adivb}, \alpha) \quad \alpha := \text{interp}\left(\text{fit}, \text{adivb}, \alpha, \frac{a}{b}\right) \quad \alpha = 0.14$$

UBC Section 1608: any structural member deflection shall not exceed L/360 (Table 16-D)

$$\text{Max Deflection} := L/360 = 92/360 = 0.255 \text{ in}$$

$$y_{\max} := \frac{-\alpha \cdot q_{\text{total}} \cdot b^4}{E \cdot t_{\text{steel}}^3} \quad y_{\max} = -0.218 \text{ in} \quad \underline{< 0.255 \text{ in, O.K.}}$$

Originator: m. omar Jaka Date: 11/9/99 Checked by: MAW Date: 11/9/99
 Omar Jaka Mike A. White

APPENDIX D

STRUCTURAL CALCULATIONS

241-U-102

241-U-103

241-U-105

241-U-107

241-U-108

241-U-111

Note: Appendix D assumes structural calculations for the worst case U Farm pump

ENGINEERING CHANGE NOTICE CONTINUATION SHEET

ECN: 651971

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Date: 3/11/99

H-2-73720 SH 1, REV 2, ADD JET PUMP/JUMPER INSTALLATION AND COVER PLATE MODIFICATION STATUS TABLE AS SHOWN:

TANK NO.	JET PUMP/JUMPER INSTALLATION AND COVER PLATE MODIFICATION STATUS
241-U-102	NOT INSTALLED
241-U-103	NOT INSTALLED
241-U-105	NOT INSTALLED
241-U-106	NOT INSTALLED
241-U-107	NOT INSTALLED
241-U-108	NOT INSTALLED
241-U-109	NOT INSTALLED
241-U-111	NOT INSTALLED

**NOTE – THE FOLLOWING CALCULATIONS ARE FOR INFORMATION ONLY,
DO NOT INCORPORATE ON DRAWINGS**

Determine factors of safety for worst case 241-U pump pit cover plate design with respect to maximum allowable deflection and bending stress, considering stress concentration resulting from valve wrench penetrations:

ASSUMPTIONS -

Plate is simply supported on three edges, one edge free (worst case)

Plate is uniformly loaded over entire plate

'Worst Case' is defined as "COVER PLATE PLAN A & D" due to potential for no support on one side and valve handle penetration near center of plate (location of greatest bending stress)

$$a := 91.5 \text{ in} \quad (\text{Width of plate}) \quad b := 92 \text{ in} \quad (\text{Length of plate - free side})$$

$$t_{\text{steel}} := 1 \text{ in} \quad (\text{Thickness of plate})$$

$$A := a \cdot b \quad A = 8.418 \cdot 10^3 \text{ in}^2 \quad (\text{Area of plate})$$

$$V_{\text{steel}} := a \cdot b \cdot t_{\text{steel}} \quad V_{\text{steel}} = 8.418 \cdot 10^3 \text{ in}^3 \quad (\text{Volume of plate})$$

$$\rho_{\text{steel}} := 487 \frac{\text{lb}}{\text{ft}^3} \quad (\text{Density of ASTM A36 steel}) \quad E := 29 \cdot 10^6 \text{ lb} \cdot \text{in}^{-2} \quad (\text{Modulus of elasticity, ASTM A36 steel})$$

$$W_{\text{steel}} := \rho_{\text{steel}} \cdot V_{\text{steel}} \quad W_{\text{steel}} = 2.372 \cdot 10^3 \text{ lb} \quad (\text{Weight of steel plate})$$

Originator: M. A. White
M. A. White

Date: 3/17/99

Checked By: J. S. Boettger

J. S. Boettger

Date: 3/18/99

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Date: 3/11/99

$$q_{\text{steel}} := \frac{W_{\text{steel}}}{A} \quad q_{\text{steel}} = 0.282 \text{ lb} \cdot \text{in}^{-2} \text{ (Distributed dead load due to weight of steel plate)}$$

$$\text{adivb} := \begin{bmatrix} .5 \\ .667 \\ 1.0 \\ 1.5 \\ 2.0 \\ 4.0 \end{bmatrix}$$

$$\beta := \begin{bmatrix} .36 \\ .45 \\ .67 \\ .77 \\ .79 \\ .80 \end{bmatrix}$$

$$\alpha := \begin{bmatrix} .080 \\ .106 \\ .140 \\ .160 \\ .165 \\ .167 \end{bmatrix}$$

From Roark, Table 26, Pg.461
Case 2b.Use curve fitting to determine β :

$$\text{fit} := \text{cspline}(\text{adivb}, \beta) \quad \beta := \text{interp}(\text{fit}, \text{adivb}, \beta, \frac{a}{b}) \quad \beta = 0.667$$

Calculate bending stress:

$$\sigma_b := \frac{\beta \cdot q_{\text{steel}} \cdot b^2}{t_{\text{steel}}^2} \quad \sigma_b = 1.592 \cdot 10^3 \text{ lb} \cdot \text{in}^{-2} \quad \sigma_{\text{yield}} := 36000 \text{ lb} \cdot \text{in}^{-2} \text{ (ASTM A36)}$$

From *Advanced Mechanics of Materials*, 4th Ed., Boresi and Sidebottom, since width of plate is much greater than the diameter of the hole ($92'' \gg 4''$), for case of symmetrical plate, uniformly loaded, Stress concentration factor will be $Sc=2$ (pg.533, 570).

Calculate stress increased by concentration factor Sc :

$$Sc := 2 \quad \sigma_{Sc} := \sigma_b \cdot Sc \quad \sigma_{Sc} = 4.584 \cdot 10^3 \text{ lb} \cdot \text{ft}^{-2}$$

$$SF := \frac{\sigma_{\text{yield}}}{\sigma_{Sc}} \quad SF = 11.31 \quad SF > 2, \text{ O.K.}$$

Use curve fitting to determine α :

$$\text{fit} := \text{cspline}(\text{adivb}, \alpha) \quad \alpha := \text{interp}(\text{fit}, \text{adivb}, \alpha, \frac{a}{b}) \quad \alpha = 0.14$$

Calculate maximum deflection and safety factor:

$$y_{\text{max}} := \frac{-\alpha \cdot q_{\text{steel}} \cdot b^4}{E \cdot t_{\text{steel}}^3} \quad y_{\text{max}} = -0.097 \text{ in}$$

From US Steel Handbook, page P-39, deflection should be held to $< 1/100$ of span.

$$\frac{a}{100} = 0.915 \text{ in} \quad .097'' < .915'', \text{ O.K.}$$

Originator: M. A. White Date: 3/17/99 Checked By: J. S. Boettger Date: 3/18/99

ENGINEERING CHANGE NOTICE CONTINUATION SHEET

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Date: 3/11/99

Determine factors of safety with 1" thick lead shielding distributed evenly over plate surface:

$$\rho_{\text{lead}} := 710 \frac{\text{lb}}{\text{ft}^3} \quad (\text{Density of lead used for shielding})$$

$$t_{\text{lead}} := 1 \text{ in} \quad (\text{Thickness of lead required})$$

$$V_{\text{lead}} := a \cdot b \cdot t_{\text{lead}} \quad V_{\text{lead}} = 4.872 \text{ ft}^3 \quad (\text{Volume of lead plate})$$

$$W_{\text{lead}} := \rho_{\text{lead}} \cdot V_{\text{lead}} \quad W_{\text{lead}} = 3.459 \cdot 10^3 \text{ lb} \quad (\text{Weight of lead plate})$$

$$q_{\text{lead}} := \frac{W_{\text{lead}}}{A} \quad q_{\text{lead}} = 0.411 \text{ lb} \cdot \text{in}^{-2} \quad (\text{Loading due to lead plate})$$

$$\rho_{\text{sheet}} := 487 \frac{\text{lb}}{\text{ft}^3} \quad (\text{Density of sheet used to cover lead shielding})$$

$$t_{\text{sheet}} := 2 \cdot 0.125 \text{ in} \quad (\text{Thickness of sheet (11 Ga.) x top \& bottom})$$

$$V_{\text{sheet}} := a \cdot b \cdot t_{\text{sheet}} \quad V_{\text{sheet}} = 1.218 \text{ ft}^3 \quad (\text{Volume of sheet})$$

$$W_{\text{sheet}} := \rho_{\text{sheet}} \cdot V_{\text{sheet}} \quad W_{\text{sheet}} = 593.109 \text{ lb} \quad (\text{Weight of sheet})$$

$$q_{\text{sheet}} := \frac{W_{\text{sheet}}}{A} \quad q_{\text{sheet}} = 0.07 \text{ lb} \cdot \text{in}^{-2} \quad (\text{Loading due to sheet})$$

$$\Sigma q := q_{\text{lead}} + q_{\text{steel}} + q_{\text{sheet}} \quad \Sigma q = 0.763 \text{ lb} \cdot \text{in}^{-2} \quad (\text{Total distributed load on plate})$$

Assuming no friction between lead and steel plates-

Calculate bending stress w/lead:

$$\sigma_{\text{bl}} := \frac{\beta \cdot \Sigma q \cdot b^2}{t_{\text{steel}}^2} \quad \sigma_{\text{bl}} = 4.31 \cdot 10^3 \text{ lb} \cdot \text{in}^{-2} \quad \sigma_{\text{yield}} := 36000 \text{ lb} \cdot \text{in}^{-2} \quad (\text{ASTM A36})$$

Calculate stress increased by concentration factor S_c , w/lead:

$$S_c := 2 \quad \sigma_{\text{ScI}} := \sigma_{\text{bl}} \cdot S_c \quad \sigma_{\text{ScI}} = 1.241 \cdot 10^6 \text{ lb} \cdot \text{ft}^{-2}$$

$$SF := \frac{\sigma_{\text{yield}}}{\sigma_{\text{ScI}}} \quad SF = 4.177 \quad \text{SF} > 2, \text{ O.K.}$$

calculate maximum deflection and safety factor:

$$y_{\text{max}} := \frac{-\alpha \cdot \Sigma q \cdot b^4}{E \cdot t_{\text{steel}}^3} \quad y_{\text{max}} = -0.263 \text{ in} \quad .263" < .915", \text{ O.K.}$$

Originator: M. A. White
M. A. White

Date: 3/17/99

Checked By: J. S. Boettger

J. S. Boettger
J. S. Boettger

Date: 3/18/99

APPENDIX E
STRUCTURAL CALCULATIONS
241-AX-101

Determine factors of safety for 241-AX-101 Distributor Pit cover plate design (ECN-657823) with respect to maximum allowable bending stress and deflection:

ASSUMPTIONS -

Neglect plate penetrations (largest penetration 3"x13" << plate width)

Plate is simply supported on three edges, one edge free (worst case)

Plate is uniformly loaded over entire plate

$$a := 78.00 \text{ in} \quad (\text{Width of plate}) \quad b := 134 \text{ in} \quad (\text{Length of plate - free side})$$

$$t_{\text{steel}} := 1 \text{ in} \quad (\text{Thickness of plate, The worst case}) \quad (2" \text{ plate will support itself})$$

$$A := a \cdot b \quad A = 1.045 \cdot 10^4 \cdot \text{in}^2 \quad (\text{Area of plate})$$

$$V_{\text{steel}} := a \cdot b \cdot t_{\text{steel}} \quad V_{\text{steel}} = 1.045 \cdot 10^4 \cdot \text{in}^3 \quad (\text{Volume of plate})$$

$$\rho_{\text{steel}} := 487 \frac{\text{lb}}{\text{ft}^3} \quad (\text{Density of ASTM A36 steel}) \quad E := 29 \cdot 10^6 \text{ lb} \cdot \text{in}^{-2} \quad (\text{Modulus of elasticity, ASTM A36 steel})$$

$$W_{\text{steel}} := \rho_{\text{steel}} V_{\text{steel}} \quad W_{\text{steel}} = 2.946 \cdot 10^3 \text{ lb} \quad (\text{Weight of steel plate})$$

$$q_{\text{steel}} := \frac{W_{\text{steel}}}{A} \quad q_{\text{steel}} = 0.282 \text{ lb} \cdot \text{in}^{-2} \quad (\text{Distributed dead load due to weight of steel plate})$$

$$q_{\text{liveload}} := 50 \frac{\text{lb}}{\text{ft}^2} \quad q_{\text{liveload}} := 35 \frac{\text{lb}}{\text{in}^2} \quad q_{\text{total}} := q_{\text{steel}} + q_{\text{liveload}}$$

$$q_{\text{total}} = 90.983 \text{ lb} \cdot \text{ft}^{-2}$$

$\text{adivb} := \begin{bmatrix} .5 \\ .667 \\ 1.0 \\ 1.5 \\ 2.0 \\ 4.0 \end{bmatrix}$	$\beta := \begin{bmatrix} .36 \\ .45 \\ .67 \\ .77 \\ .79 \\ .80 \end{bmatrix}$	$\alpha := \begin{bmatrix} .080 \\ .106 \\ .140 \\ .160 \\ .165 \\ .167 \end{bmatrix}$	<p>From Roark, Ed. 6, Table 26, Case 2a, Pg. 461</p>
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Use curve fitting to determine β :

$$\text{fit} := \text{cspline}(\text{adivb}, \beta) \quad \beta := \text{interp}\left(\text{fit}, \text{adivb}, \beta, \frac{a}{b}\right) \quad \beta = 0.398$$

Calculate maximum stress and safety factor:

$$\sigma_{\text{max}} := \frac{\beta \cdot q_{\text{total}} \cdot b^2}{t_{\text{steel}}^2} \quad \sigma_{\text{max}} = 6.51 \cdot 10^5 \text{ lb} \cdot \text{ft}^{-2} \quad \sigma_{\text{yield}} := 36000 \text{ lb} \cdot \text{in}^{-2} \quad (\text{ASTM A36})$$

$$\text{SF} := \frac{\sigma_{\text{yield}}}{\sigma_{\text{max}}} \quad \text{SF} = 7.963 \quad \text{SFmin}=5, \text{SF}>\text{SFMIN}, \text{O.K.}$$

Originator: m. b. Omar Jaka
Omar Jaka

Date: 3/4/00

Checked by: J. S. Boettger
J. S. Boettger

Date: 3/14/00

Calculate maximum deflection and safety factor
using 2" thick plate which is on top:

Use curve fitting to determine α :

$$\text{fit} := \text{cspline}(\text{adivb}, \alpha) \quad \alpha := \text{interp}\left(\text{fit}, \text{adivb}, \alpha, \frac{a}{b}\right) \quad \alpha = 0.094$$

$$t_{\text{steel}} := 2 \text{ in}$$

UBC section 1608, table 16-D deflection not to exceed $L/360$: (L=Length of span)

$$y_{\text{allow}} := \frac{L}{360} \quad \frac{140}{360} = 0.389$$

$$y_{\text{allow}} := -0.389 \text{ in}$$

$$y_{\text{max}} := \frac{-\alpha \cdot q_{\text{total}} \cdot b^4}{E \cdot t_{\text{steel}}^3} \quad y_{\text{max}} = -0.082 \text{ in} \quad \underline{\ll 0.389 \text{ in, O.K.}}$$

$$\text{SF} := \frac{y_{\text{allow}}}{y_{\text{max}}}$$

$$\text{SF} = 4.732 \quad \text{Good}$$

Originator: m. Omar Jaka Date: 3/4/00
Omar Jaka

Checked by: J. S. Boettger Date: 3/14/00
J. S. Boettger

ANALYTICAL CALCULATIONS

Page 3 of 3Subject 241-A-X-101 DISTRIBUTOR PIT COVER PLATESOriginator OMAR JAKA Date 3/3/2000Checker J. Betty Date 3/14/2000CHECK THE HOIST RINGS & 3/4" Φ CONNECTION BOLTS:

1. WT. OF 1" PLATE = $\frac{1}{12} \times 6.5 \times 11.16 \times 490 = 2962 \text{ lb}$

2. WT. OF 2" PLATE = $\frac{2}{12} \times 6.5 \times 11.16 \times 490 = 5924 \text{ lb}$

(USING UNIT WT. OF STEEL = 490 lbs/ft³) 8886 lb

1. CHECK HOIST RINGS:

USING McMASTER-CARR HOIST RINGS 3052T67 (CATALOG LOG)

WORK LOAD LIMIT = 10,000 lbs.

4 - HOIST RINGS CAPACITY = 40,000 lbs.

WORST CASE 2 - HOIST RINGS SUPPORTING THE PLATES = 20,000 lbs.

HENCE 4 - HOIST RINGS 3052T67 ARE ADEQUATE $\therefore$ O.K.2. CHECK 8-3/4" Φ A307 GR.B BOLTS HOLDING 2 PLATES TOGETHER:

(AISC 8TH EDITION) PAGES 4-344-5)

3/4" Φ A 307 THREADED BOLT SHEAR CAPACITY = 4.4 K/BOLT

" " " " TENSION " = 8.8 K/BOLT

(a) CHECK FOR TENSION IF 1" PLATE DEFLECTS (WORST CASE):

TENSION = WT. OF 1" PLATE = 2962 lb = 2.962 K < 8 x 8.8 K
 $\therefore$ O.K.

(b) CHECK FOR SHEAR DURING SEISMIC EVENT:

2" PLATE SLIDING OVER 1" PLATE

* AISC 8TH ED.
PAGE 5-15

SHEARING FORCE = WT. OF PLATE + * IMPACT (50%)

= 5924 + 0.5 x 5924

= 8886 lbs

= 8.89 K < 8 BOLTS x 4.4 K/BOLT = 35.2 K

 $\therefore$ O.K. $\therefore$ 8-3/4" Φ A-307 BOLTS ARE ADEQUATE

APPENDIX F

STRUCTURAL CALCULATIONS
241-A-101

Determine factors of safety for 241-A-101 pump pit cover plate design (ECN-652568) with respect to maximum allowable deflection and bending stress:

ASSUMPTIONS -

Neglect plate penetrations (largest penetration dia (8"x6") << plate width)

Plate is simply supported on four edges, Plate is uniformly loaded over entire plate

$$a := 90.00 \text{ in} \quad (\text{Width of plate}) \quad b := 84.00 \text{ in} \quad (\text{All edges simply supported})$$

$$t_{\text{steel}} := 2 \text{ in} \quad (\text{Thickness of plate})$$

$$A := a \cdot b \quad A = 52.5 \text{ ft}^2 \quad (\text{Area of plate})$$

$$V_{\text{steel}} := a \cdot b \cdot t_{\text{steel}} \quad V_{\text{steel}} = 8.75 \text{ ft}^3 \quad (\text{Volume of plate})$$

$$\rho_{\text{steel}} := 487 \frac{\text{lb}}{\text{ft}^3} \quad (\text{Density of ASTM A36 steel}) \quad E := 29 \cdot 10^6 \text{ lb} \cdot \text{in}^{-2} \quad (\text{Modulus of elasticity, ASTM A36 steel})$$

$$W_{\text{steel}} := \rho_{\text{steel}} \cdot V_{\text{steel}} \quad W_{\text{steel}} = 4.261 \cdot 10^3 \text{ lb} \quad (\text{Weight of steel plate})$$

$$q_{\text{steel}} := \frac{W_{\text{steel}}}{A} \quad q_{\text{steel}} = 81.167 \text{ lb} \cdot \text{ft}^{-2} \quad (\text{Distributed dead load due to weight of steel plate})$$

$$q_{\text{liveload}} := 50 \frac{\text{lb}}{\text{ft}^2} \quad q_{\text{liveload}} := 35 \frac{\text{lb}}{\text{in}^2} \quad q_{\text{total}} := q_{\text{steel}} + q_{\text{liveload}}$$

$$q_{\text{total}} = 131.567 \text{ lb} \cdot \text{ft}^{-2}$$

From Roark, Ed. 6, Table 26,
Case 2a, Pg. 461

adivb :=	1.0	$\beta :=$	0.2874	$\alpha :=$	0.0444	$\gamma :=$	0.420
	1.2		0.3762		0.0616		0.455
	1.4		0.4530		0.0770		0.478
	1.6		0.5172		0.0906		0.491
	1.8		0.5688		0.1017		0.499
	2.0		0.6102		0.1110		0.503
	3.0		0.7134		0.1335		0.505
	4.0		0.7410		0.1400		0.502
	5.0		0.7476		0.1417		0.501
	1000.0		0.7500		0.1421		0.500

Use curve fitting to determine β :

$$\text{fit} := \text{cspline}(\text{adivb}, \beta) \quad \beta := \text{interp}\left(\text{fit}, \text{adivb}, \beta, \frac{a}{b}\right) \quad \beta = 0.32$$

Originator M. D. Omar Date 1/13/00 Checked by D.D. Wiggins Date 02/25/00
Omar Jaka D.D. Wiggins

Calculate maximum stress and safety factor:

$$\sigma_{\max} := \frac{\beta \cdot q_{\text{total}} \cdot b^2}{t_{\text{steel}}^2} \quad \sigma_{\max} = 7.437 \cdot 10^4 \text{ lb} \cdot \text{ft}^{-2} \quad \sigma_{\text{yield}} := 36000 \text{ lb} \cdot \text{in}^{-2} \quad (\text{ASTM A36})$$

$$\text{SF} := \frac{\sigma_{\text{yield}}}{\sigma_{\max}} \quad \text{SF} = 69.703 \quad \underline{\text{SFmin}=5, \text{SF}>\text{SFMIN}, \text{O.K.}}$$

Calculate maximum deflection and safety factor: :

Use curve fitting to determine α :

$$\text{fit} := \text{cspline}(\text{adivb}, \alpha) \quad \alpha := \text{interp}\left(\text{fit}, \text{adivb}, \alpha, \frac{a}{b}\right) \quad \alpha = 0.051$$

$$t_{\text{steel}} := 2 \text{ in}$$

UBC section 1608, table 16-D deflection not to exceed $L/360$: (L=Length of span)

$$y_{\text{allow}} := \frac{L}{360} \quad \frac{140}{360} = 0.389$$

$$y_{\text{allow}} = 0.389 \text{ in}$$

$$y_{\max} := \frac{-\alpha \cdot q_{\text{total}} \cdot b^4}{E \cdot t_{\text{steel}}^3} \quad y_{\max} = -9.954 \cdot 10^{-3} \text{ in} \quad \underline{\ll 0.389 \text{ in}, \text{O.K.}}$$

$$\text{SF} := \frac{y_{\text{allow}}}{y_{\max}}$$

$$\text{SF} = 39.079 \quad \text{Good}$$

Originator: M. Omar Jaka Date: 1/13/00 Checked by: Dirk Wiggins Date: 12/25/00
Omar Jaka D. D. Wiggins

CONSERVATIVE CALCULATION WITH 3-SIDE SUPPORTED

Determine factors of safety for 241-A101 pump pit cover plate design (ECN-652568) with respect to maximum allowable deflection and bending stress:

ASSUMPTIONS -

Neglect plate penetrations (largest penetration dia (3"x9") << plate width)

Plate is simply supported on three edges, one edge free (worst case)

Plate is uniformly loaded over entire plate

$$a := 90.00 \text{ in} \quad (\text{Width of plate}) \quad b := 84.00 \text{ in} \quad (\text{Length of plate - free side})$$

$$t_{\text{steel}} := 2 \text{ in} \quad (\text{Thickness of plate})$$

$$A := a \cdot b \quad A = 52.5 \text{ ft}^2 \quad (\text{Area of plate})$$

$$V_{\text{steel}} := a \cdot b \cdot t_{\text{steel}} \quad V_{\text{steel}} = 8.75 \text{ ft}^3 \quad (\text{Volume of plate})$$

$$\rho_{\text{steel}} := 487 \frac{\text{lb}}{\text{ft}^3} \quad (\text{Density of ASTM A36 steel}) \quad E := 29 \cdot 10^6 \text{ lb} \cdot \text{in}^{-2} \quad (\text{Modulus of elasticity, ASTM A36 steel})$$

$$W_{\text{steel}} := \rho_{\text{steel}} \cdot V_{\text{steel}} \quad W_{\text{steel}} = 4.261 \cdot 10^3 \text{ lb} \quad (\text{Weight of steel plate})$$

$$q_{\text{steel}} := \frac{W_{\text{steel}}}{A} \quad q_{\text{steel}} = 81.167 \text{ lb} \cdot \text{ft}^{-2} \quad (\text{Distributed dead load due to weight of steel plate})$$

$$q_{\text{liveload}} := 50 \frac{\text{lb}}{\text{ft}^2} \quad q_{\text{liveload}} := .35 \frac{\text{lb}}{\text{in}^2} \quad q_{\text{total}} := q_{\text{steel}} + q_{\text{liveload}}$$

$$q_{\text{total}} = 131.567 \text{ lb} \cdot \text{ft}^{-2}$$

$$\text{adivb} := \begin{bmatrix} .5 \\ .667 \\ 1.0 \\ 1.5 \\ 2.0 \\ 4.0 \end{bmatrix} \quad \beta := \begin{bmatrix} .36 \\ .45 \\ .67 \\ .77 \\ .79 \\ .80 \end{bmatrix} \quad \alpha := \begin{bmatrix} .080 \\ .106 \\ .140 \\ .160 \\ .165 \\ .167 \end{bmatrix} \quad \begin{array}{l} \text{From Roark, Ed. 6, Table 26,} \\ \text{Case 2a, Pg.461} \end{array}$$

Use curve fitting to determine β :

$$\text{fit} := \text{cspline}(\text{adivb}, \beta) \quad \beta := \text{interp}\left(\text{fit}, \text{adivb}, \beta, \frac{a}{b}\right) \quad \beta = 0.702$$

Calculate maximum stress and safety factor:

$$\sigma_{\text{max}} := \frac{\beta \cdot q_{\text{total}} \cdot b^2}{t_{\text{steel}}^2} \quad \sigma_{\text{max}} = 1.629 \cdot 10^5 \text{ lb} \cdot \text{ft}^{-2} \quad \sigma_{\text{yield}} := 36000 \text{ lb} \cdot \text{in}^{-2} \quad (\text{ASTM A36})$$

$$SF := \frac{\sigma_{\text{yield}}}{\sigma_{\text{max}}} \quad SF = 31.826 \quad \underline{SF_{\text{min}}=5, SF > SF_{\text{MIN}}, \text{O.K.}}$$

Originator: m. Omar Jaka Date: 1/13/00 Checked by: Dick Wiggins Date: 02/25/00
Omar Jaka D. D. Wiggins

Calculate maximum deflection and safety factor:

Use curve fitting to determine α :

$$\text{fit} := \text{cspline}(\text{adivb}, \alpha) \quad \alpha := \text{interp}\left(\text{fit}, \text{adivb}, \alpha, \frac{a}{b}\right) \quad \alpha = 0.145$$

$$t_{\text{steel}} := 2 \text{ in}$$

UBC section 1608, table 16-D deflection not to exceed $L/360$: (L=Length of span)

$$y_{\text{allow}} := \frac{b}{360} \quad \frac{90}{360} = 0.25$$

$$y_{\text{allow}} := -0.25 \text{ in}$$

$$y_{\text{max}} := \frac{-\alpha \cdot q_{\text{total}} \cdot b^4}{E \cdot t_{\text{steel}}^3} \quad y_{\text{max}} = -0.028 \text{ in} \quad \underline{\ll 0.25 \text{ in, O.K.}}$$

$$\text{SF} := \frac{y_{\text{allow}}}{y_{\text{max}}}$$

$$\text{SF} = 8.813 \quad \text{Good}$$

Originator: m. Omar Jaka Date: 1/13/00 Checked by: D. D. Wiggins Date: 02/25/00
Omar Jaka D. D. Wiggins

APPENDIX G
STRUCTURAL CALCULATIONS
241-SX-105

CONSERVATIVE CALCULATION WITH 3-SIDE SUPPORTED

Determine factors of safety for 241-SX-105 Distributor pit cover plate design (ECN-638579) with respect to maximum allowable deflection and bending stress:

ASSUMPTIONS -

Neglect plate penetrations (largest penetration dia (8"x6") << plate width)

Plate is simply supported on three edges, one edge free (worst case)

Plate is uniformly loaded over entire plate

$$a := 98.00 \text{ in} \quad (\text{Width of plate}) \quad b := 96.00 \text{ in} \quad (\text{Length of plate - free side})$$

$$t_{\text{steel}} := 3 \text{ in} \quad (\text{Thickness of plate})$$

$$A := a \cdot b \quad A = 65.333 \text{ ft}^2 \quad (\text{Area of plate})$$

$$V_{\text{steel}} := a \cdot b \cdot t_{\text{steel}} \quad V_{\text{steel}} = 16.333 \text{ ft}^3 \quad (\text{Volume of plate})$$

$$\rho_{\text{steel}} := 487 \frac{\text{lb}}{\text{ft}^3} \quad (\text{Density of ASTM A36 steel}) \quad E := 29 \cdot 10^6 \text{ lb} \cdot \text{in}^{-2} \quad (\text{Modulus of elasticity, ASTM A36 steel})$$

$$W_{\text{steel}} := \rho_{\text{steel}} \cdot V_{\text{steel}} \quad W_{\text{steel}} = 7.954 \times 10^3 \text{ lb} \quad (\text{Weight of steel plate})$$

$$q_{\text{steel}} := \frac{W_{\text{steel}}}{A} \quad q_{\text{steel}} = 121.75 \text{ lb ft}^{-2} \quad (\text{Distributed dead load due to weight of steel plate})$$

$$q_{\text{liveload}} := 50 \frac{\text{lb}}{\text{ft}^2} \quad q_{\text{liveload}} := .35 \frac{\text{lb}}{\text{in}^2} \quad q_{\text{total}} := q_{\text{steel}} + q_{\text{liveload}}$$

$$q_{\text{total}} = 172.15 \text{ lb ft}^{-2}$$

$$\text{adivb} := \begin{pmatrix} .5 \\ .667 \\ 1.0 \\ 1.5 \\ 2.0 \\ 4.0 \end{pmatrix} \quad \beta := \begin{pmatrix} .36 \\ .45 \\ .67 \\ .77 \\ .79 \\ .80 \end{pmatrix} \quad \alpha := \begin{pmatrix} .080 \\ .106 \\ .140 \\ .160 \\ .165 \\ .167 \end{pmatrix} \quad \begin{array}{l} \text{From Roark, Ed. 6, Table 26,} \\ \text{Case 2a, Pg. 461} \end{array}$$

Use curve fitting to determine β :

$$\text{fit} := \text{cspline}(\text{adivb}, \beta) \quad \beta := \text{interp}\left(\text{fit}, \text{adivb}, \beta, \frac{a}{b}\right) \quad \beta = 0.68$$

Calculate maximum stress and safety factor:

$$\sigma_{\text{max}} := \frac{\beta \cdot q_{\text{total}} \cdot b^2}{t_{\text{steel}}^2} \quad \sigma_{\text{max}} = 1.199 \times 10^5 \text{ lb ft}^{-2} \quad \sigma_{\text{yield}} := 36000 \text{ lb} \cdot \text{in}^{-2} \quad (\text{ASTM A36})$$

$$SF := \frac{\sigma_{\text{yield}}}{\sigma_{\text{max}}} \quad SF = 43.233 \quad \underline{SF_{\text{min}}=5, SF > SF_{\text{MIN}}, \text{O.K.}}$$

Originator: M. Omar Jaka Date: 5/23/00 Checked by: D. K. DeFord Date: 5/30/00
Omar Jaka D. K. DeFord

Calculate maximum deflection and safety factor:

Use curve fitting to determine α :

$$\text{fit} := \text{cspline}(\text{adivb}, \alpha) \quad \alpha := \text{interp}\left(\text{fit}, \text{adivb}, \alpha, \frac{a}{b}\right) \quad \alpha = 0.141$$

$$t_{\text{steel}} := 3 \text{ in}$$

UBC section 1608, table 16-D deflection not to exceed $L/360$: (L =Length of span)

$$y_{\text{allow}} := \frac{b}{360} \quad \frac{98}{360} = 0.272$$

$$y_{\text{allow}} := .272 \text{ in}$$

$$y_{\text{max}} := \frac{-\alpha \cdot q_{\text{total}} \cdot b^4}{E \cdot t_{\text{steel}}^3} \quad y_{\text{max}} = -0.018 \text{ in} \quad \ll 0.272 \text{ in, O.K.}$$

$$\text{SF} := \frac{y_{\text{allow}}}{y_{\text{max}}}$$

$$\text{SF} = -14.829 \quad \text{Good}$$

Originator: m. Omar Jaka Date: 5/23/20 Checked by: D. DeFord Date: 5/30/20
Omar Jaka D. K. DeFord

ANALYTICAL CALCULATIONS

Page 3 of 3Subject CALCS FOR SX-105 COVER PLATEOriginator OMAR JAKADate 5/30/00Checker D. Def. dDate 5/30/00CHECK $3\frac{1}{2}" \phi$ HOIST RING FOR OGT COVERWT. OF TEMPORARY COVER FOR OGT = $12 \times 17.5 \times 3 +$

$$(12 \times 17.5 \times 3) + (12 \times 18 \times 3) =$$

$$630 + 648 = 1278 \text{ CU. IN.}$$

$$= 0.739 \text{ CU. FT.}$$

(REF. TO McMASTER-CARR
CATALOG FOR $3\frac{1}{2}" \phi$
HOIST RING 3052T56
CAPACITY 1000 #)

$$\text{WT.} = 0.739 \times 490 = 363 \# < 1000 \# \text{ CAPACITY } \therefore \text{O.K.}$$

CHECK FOR $1" \phi$ HOIST RINGS FOR PLATE (4 USED)

McMaster-CARR 3052T67 CAPACITY 10,000 # EACH

$$\text{TOTAL WT. OF PLATES} = 8 \times 8.16 \times \frac{3}{12} \times 490 + 1.25 \times (5 + 7.2) \times \frac{3}{12} \times 490$$

$$= 9099 \# < 4 \times 10,000 \#$$

$$< 40,000 \therefore \text{O.K.}$$

DOME LOAD CHECK:

$$\text{WT. OF CONC. BLOCK REMOVED} = (6' - 5\frac{1}{2}" \times 7' - 1\frac{3}{4}" \times 1' - 3") 150$$

$$= 6.458 \times 7.146 \times 1.25 \times 150$$

$$= 8653 \#$$

$$\text{WT. OF CONC. BLOCK REMOVED} = 8653 \# > \text{WT. OF STEEL PLATE}$$

HENCE THERE IS NO ADDITIONAL LOAD ON THE DOME.

S. O.K.

APPENDIX H
STRUCTURAL CALCULATIONS
241-S-A

Determine factors of safety for 241-S-A valve pit cover plate design (ECN-659207) with respect to maximum allowable deflection and bending stress:

ASSUMPTIONS -

Neglect plate penetrations (largest penetration 20"x22") << plate width)

Plate is simply supported on three edges, one edge free (worst case). Plate is uniformly loaded over entire plate with 50 lbs/sft.

$$a := 142.00 \text{ in} \quad (\text{Width of plate}) \quad b := 96.00 \text{ in} \quad (\text{Length of plate - free side})$$

$$t_{\text{steel}} := 3 \text{ in} \quad (\text{Thickness of plate, The worst case})$$

$$A := a \cdot b \quad A = 1.363 \times 10^4 \text{ in}^2 \quad (\text{Area of plate})$$

$$V_{\text{steel}} := a \cdot b \cdot t_{\text{steel}} \quad V_{\text{steel}} = 4.09 \times 10^4 \text{ in}^3 \quad (\text{Volume of plate})$$

$$\rho_{\text{steel}} := 487 \frac{\text{lb}}{\text{ft}^3} \quad (\text{Density of ASTM A36 steel}) \quad E := 29 \cdot 10^6 \text{ lb} \cdot \text{in}^{-2} \quad (\text{Modulus of elasticity, ASTM A36 steel})$$

$$W_{\text{steel}} := \rho_{\text{steel}} \cdot V_{\text{steel}} \quad W_{\text{steel}} = 1.153 \times 10^4 \text{ lb} \quad (\text{Weight of steel plate})$$

$$q_{\text{steel}} := \frac{W_{\text{steel}}}{A} \quad q_{\text{steel}} = 0.845 \text{ lb} \cdot \text{in}^{-2} \quad (\text{Distributed dead load due to weight of steel plate})$$

$$q_{\text{liveload}} := 50 \frac{\text{lb}}{\text{ft}^2} \quad q_{\text{liveload}} := .35 \frac{\text{lb}}{\text{in}^2} \quad q_{\text{total}} := q_{\text{steel}} + q_{\text{liveload}}$$

$$q_{\text{total}} = 172.15 \text{ lb} \cdot \text{ft}^{-2}$$

$$\text{adivb} := \begin{pmatrix} .5 \\ .667 \\ 1.0 \\ 1.5 \\ 2.0 \\ 4.0 \end{pmatrix} \quad \beta := \begin{pmatrix} .36 \\ .45 \\ .67 \\ .77 \\ .79 \\ .80 \end{pmatrix} \quad \alpha := \begin{pmatrix} .080 \\ .106 \\ .140 \\ .160 \\ .165 \\ .167 \end{pmatrix} \quad \begin{array}{l} \text{From Roark, Ed. 6, Table 26,} \\ \text{Case 2a, Pg.461} \end{array}$$

Use curve fitting to determine β :

$$\text{fit} := \text{cspline}(\text{adivb}, \beta) \quad \beta := \text{interp}\left(\text{fit}, \text{adivb}, \beta, \frac{a}{b}\right) \quad \beta = 0.769$$

Calculate maximum stress and safety factor:

$$\sigma_{\text{max}} := \frac{\beta \cdot q_{\text{total}} \cdot b^2}{t_{\text{steel}}^2} \quad \sigma_{\text{max}} = 1.356 \times 10^5 \text{ lb} \cdot \text{ft}^{-2} \quad \sigma_{\text{yield}} := 36000 \text{ lb} \cdot \text{in}^{-2} \quad (\text{ASTM A36})$$

$$\text{SF} := \frac{\sigma_{\text{yield}}}{\sigma_{\text{max}}} \quad \text{SF} = 38.237 \quad \underline{\text{SFmin}=5, \text{SF}>\text{SFMIN}, \text{O.K.}}$$

Originator: m. O. Jaka Date: 5/27/00 Checked by: D. DeFord Date: 6/8/00
Omar Jaka Doug DeFord

Calculate maximum deflection and safety factor
using 3" thick plate.

Use curve fitting to determine α :

$$\text{fit} := \text{cspline}(\text{adivb}, \alpha) \quad \alpha := \text{interp}\left(\text{fit}, \text{adivb}, \alpha, \frac{a}{b}\right) \quad \alpha = 0.16$$

$$t_{\text{steel}} := 3 \text{ in}$$

UBC section 1608, table 16-D deflection not to exceed $L/360$: (L=Length of span)

$$y_{\text{allow}} := \frac{L}{360} \quad \frac{142}{360} = 0.394$$

$$y_{\text{allow}} := -0.394 \text{ in}$$

$$y_{\text{max}} := \frac{-\alpha \cdot q_{\text{total}} \cdot b^4}{E \cdot t_{\text{steel}}^3} \quad y_{\text{max}} = -0.021 \text{ in} \quad \underline{\ll 0.394 \text{ in, O.K.}}$$

$$\text{SF} := \frac{y_{\text{allow}}}{y_{\text{max}}}$$

$$\text{SF} = 19.038 \quad \underline{\text{O.K.}}$$

Originator: _____ Date: _____ Checked by: D. DeFord Date: 6/8/00
Omar Jaka Doug DeFord

ANALYTICAL CALCULATIONS

Page 3 of 3Subject DESIGN OF 3" COVER PLATE FOR 241-S-A VALVE PITOriginator OMAR JAKADate 6/2/00Checker Ray B. F. L.Date 6/8/00ALTERNATE CALCULATIONS: PLATE IS 3"X11'-10"X 8'-0" ASSUMPTIONS:

① DUE TO SEVERAL CUTOUT FROM PLATE USE DIAGONAL STRIP FOR ANALYSIS.

② USE LIVE LOAD OF 50 #/ft²

MAX. MOMENT

REF. AISC MANUAL
8TH. EDITION
P. 2-114

$$M_{MAX} = \frac{w l^2}{8}$$

$$= \frac{1.195 \times 171^2}{8}$$

$$= 4368 \text{ LB-IN}$$

BENDING STRESS @ CENTER

$$f_b = \frac{M c}{I} = \frac{4368 \times 1.5}{6.75} = 971 \text{ PSI}$$

$$F_y = 36000 \text{ PSI}$$

BENDING STRESS SAFETY FACTOR:

$$S.F. = \frac{36000}{971} = 37.1 > 5.0 \therefore \text{O.K.}$$

$$l = \sqrt{11.83^2 + 8^2}$$

$$= \sqrt{203.95}$$

$$= 14.28' = 171''$$

$$w = \text{WT. OF STEEL} + \text{LIVE LOAD}$$

$$= 1' \times 1' \times 3' \times \frac{490 \text{ #/ft}^2}{12^3} + \frac{50 \text{ #/ft}^2}{12^2}$$

$$= 3 \times \frac{490}{12^3} + \frac{50}{12^2}$$

$$= 0.851 + 0.344 = 1.195 \text{ #/ft}^2$$

TO CALCULATE I & C

$$3'' = d \quad c = \frac{d}{2} = \frac{3}{2} = 1.5''$$

$$I = \frac{d^4}{12} = \frac{3^4}{12} = 6.75 \text{ IN}^4$$

DEFLECTION SAFETY FACTOR (S.F.):

MAX. DEFLEC @ CENTER

REF. AISC MANUAL
8TH. EDITION
P. 2-114

$$\Delta_{MAX} = \frac{5 w l^4}{384 E I}$$

$$= \frac{5 \times 1.195 \times 171^4}{384 \times 29000 \times 10^3 \times 6.75}$$

$$= 0.068''$$

E = MODULUS OF ELASTICITY
= 29000 KSI FOR STEELI = MOMENT OF INERTIA (IN⁴)

$$\Delta_{ALLOW} = \frac{l}{360} \quad \left(\text{FROM UBC, SEC. 1608} \right)$$

$$= \frac{171}{360}$$

$$= 0.475$$

l = SPAN LENGTH

$$S.F. = \frac{\Delta_{ALLOW}}{\Delta_{ACTUAL}} = \frac{0.475}{0.068}$$

$$= 7.0 > 1.0 \therefore \text{O.K.}$$

APPENDIX I
STRUCTURAL CALCULATIONS
241-S-C

ANALYTICAL CALCULATIONS

Page 1 of 4Subject DESIGN OF 3" COVER PLATE FOR 241-S-C VALVE PITOriginator OMAR JAKA Date 6/6/00Checker Dong De-fu Date 6/7/00

REF. DWG. H-2-46153

REPLACING WEST CORR. COVER BLOCK BY 3" COVER PLATE
AS SHOWN IN ECN 659208(11'-10" x 8'-0")
3" COVER PLATE WITH PENETRATIONS AS SHOWN ON
PAGE A OF B OF ECN 659208.PLATE HAS BEEN ANALYZED BY COSMOS GEOSTAR 2.5 AND
ON 6/5/00 AND RESULTS FOR STRESS AND DEFLECTIONS
ARE SHOWN ON PAGE 3 & 4

CHECK FACTORS OF SAFETY FOR STRESS AND DEFLECTION

STRESS SAFETY FACTOR: REFER TO SHEET # 3 OF 4
PLATE IS $F_y = 36 \text{ KSI} = \sigma_{\text{YIELD}}$ ACTUAL MAX STRESS $\sigma_{\text{MAX}} = 3000 \text{ PSI}$

$$S.F. = \frac{\sigma_{\text{YIELD}}}{\sigma_{\text{MAX}}} = \frac{36000}{3000} = 12 > 5 \quad \therefore \text{O.K.}$$

DEFLECTION SAFETY FACTOR:

REFER TO SHEET # 4 OF 4

$$\Delta_{\text{ALLOW}} = \frac{l}{360} = \frac{142}{360} = 0.394"$$

ALLOW. DEFLECTION = $\frac{l}{360}$
(UBC, SECTION 1602 TABLE 16-D)
 $l = \text{span length}$

$$\Delta_{\text{ACTUAL}} = 0.048"$$

$$S.F. = \frac{\Delta_{\text{ALLOW}}}{\Delta_{\text{ACTUAL}}} = \frac{0.394}{0.048} = 8.2 > 1.0 \quad \therefore \text{O.K.}$$

ANALYTICAL CALCULATIONS

Page 2 of 4Subject DESIGN OF 3" COVER PLATE FOR 241-S-C VALVE PITOriginator OMAR JAKADate 6/6/00Checker Doug PelfDate 6/7/00ALTERNATE CALCULATIONS:

PLATE IS 11'-0" X 8'-0"

ASSUMPTION:

DUE TO SEVERAL CUTOUT IN THE PLATE, USE DIAGONAL STRIP FOR SPANNING

MAXIMUM MOMENT

$$M_{max} = \frac{Wl^2}{8}$$

$$= \frac{1.195 \times 171^2}{8}$$

$$= 4368 \text{ lb-in}$$

REF. AISC MANUAL
8TH. EDITION
P. 2-114

$$L = \sqrt{11.83^2 + 8^2}$$

$$= \sqrt{203.95}$$

$$= 14.28' = 171"$$

$$W = \text{WT. OF STEEL} + \text{LIVE LOAD}$$

$$= 1' \times 1' \times 3' \times 490 \frac{\text{#}}{\text{ft}^3} + 50 \frac{\text{#}}{\text{ft}^2}$$

$$= \frac{3 \times 490}{12^3} + \frac{50}{12^2}$$

$$= 0.851 + 0.344$$

$$= 1.195 \frac{\text{#}}{\text{ft}^2}$$

BENDING MOMENT @ CENTER

$$f_b = \frac{Mc}{I} = \frac{4368 \times 1.5}{6.75}$$

$$= 971 \text{ PSI}$$

$$F_y = 36000 \text{ PSI}$$

$$\text{STRESS } SF = \frac{36000}{971} = \boxed{37.1} > 5 \therefore \text{O.K. (TOO HIGH COMPARED TO COMPUTER RESULT)}$$

TO CALCULATE I

$$I = \frac{d^4}{12}$$

$$= \frac{3^4}{12} = 6.75 \text{ in}^4$$

DEFLECTION SAFETY FACTOR (SF):

MAX DEFLECTION AT CENTER

$$\Delta_{max} = \frac{5Wl^4}{384EI} = \frac{5 \times 1.195 \times 171^4}{384 \times 29000 \times 10^3 \times 6.75}$$

$$= 0.068"$$

$$E = 29000 \text{ KSI}$$

$$\Delta_{allow} = \frac{l}{360} = \frac{171}{360} = 0.475"$$

$$SF = \frac{0.475}{0.068} = 7.0 > 1.0 \therefore \text{O.K. (CLOSE TO COMPUTER RESULT)}$$

USE SAFETY FACTOR ANALYZED BY COMPUTER PROGRAM

PAGE 3 OF 4

Geostar 2.5 (128K Version): 241-S-C - [Main]

FOR BENDING STRESSES

LIN STRESS LC=1

ANALYZED BY *By Gwendolyn*CHECKED BY *m.d. m. Jula*

DATED: 6/5/00

PAGE 4 OF 4

GeoStar 2.5 (128K Version) : 241-S-C - [Main]

Lin DISP (c=1)

FOR DEFLECTION

MAX DEFLECTION

0.048"

Disp. Res

0.0478198
0.0418410
0.0358640
0.0298870
0.0239890
0.0179320
0.0119550
0.0059773
1.00E-033

ANALYZED BY BT Corryell

CHECKED BY m.o. m.Jtk

DATED: 6/5/00

APPENDIX J
STRUCTURAL CALCULATIONS
241-SX-A

ANALYTICAL CALCULATIONS

Page 1 of 4Subject DESIGN OF 3" COVER PLATE FOR 241-SX-A VALVE PITOriginator OMAR JAKADate 6/6/00Checker Doug DeLidDate 6/7/00

REPLACING WEST CONCRETE COVER BLOCK BY 3" THK.
STEEL COVER PLATE AS SHOWN IN ECN 659209

3" COVER PLATE (11'-10" x 8'-0") WITH PENETRATION AS
SHOWN ON PAGE 4 OF 8 OF ECN 659209

PLATE HAS BEEN ANALYZED COSMOS "GEOSTAR 2.5"
COMPUTER PROGRAM ON 6/5/00, RESULTS FOR STRESSES
AND DEFLECTION ARE ATTACHED AS PAGE 3 & 4.

CHECK FACTORS OF SAFETY FOR STRESS AND DEFLECTIONSTRESS SAFETY FACTOR: REFER TO PAGE 3 OF 4PLATE IS $F_y = 36 \text{ ksi} = \sigma_{YIELD}$ ACTUAL MAX STRESS = $\sigma_{MAX} = 3000 \text{ PSI}$

$$S.F. = \frac{\sigma_{YIELD}}{\sigma_{MAX}} = \frac{36000}{3000} = \boxed{12} > 5 \therefore \text{O.K.}$$

DEFLECTION SAFETY FACTOR:

REFER TO PAGE 4 OF 4

$$Y_{ALLOW} = \frac{l}{360} = \frac{142}{360} = 0.394"$$

$$ALLOW DEFLECTION = \frac{l}{360}$$

$$Y_{ACTUAL} = 0.05"$$

(UBC, SECTION 1608 TABLE
16-D) $l = \text{SPAN LENGTH}$

$$S.F. = \frac{Y_{ALLOW}}{Y_{ACTUAL}} = \frac{0.394}{0.05}$$

$$= \boxed{7.88} > 1.0 \therefore \text{O.K.}$$

$$1 - 8\frac{3}{8} \times 1 - 10\frac{3}{4}$$

$$1.698 \times 1.857$$

$$WT. OF PLATE = 11.83 \times 8 \times \frac{3}{12} \times 490 = 11593 \# - 5 \times 1.698 \times 1.854 \times \frac{3}{12} \times 490$$

$$EACH CUTOUT = \frac{1928}{5} = 386 \# < 1000 = 9669 \# < 4 \times 10000 \text{ O.K.}$$

ANALYTICAL CALCULATIONS

Page 2 of 4

Subject DESIGN OF 3" COVER PLATE FOR 241-SX-A VALVE PIT
 Originator OMAR JAKA Date 6/6/00
 Checker Doug Defd Date 6/7/00

ALTERNATE CALCULATIONS:

PLATE IS 11'-10" X 8'-0"

ASSUMPTION: ① DUE TO SEVERAL

CUTOUT IN THE PLATE, USE

DIAGONAL STRIP FOR SPAN

② USE LIVE LOAD OF 50 #/ft²

$$l = \sqrt{11.83^2 + 8^2}$$

$$= \sqrt{203.95}$$

$$= 14.28' \approx 171"$$

MAX. MOMENT AISC MANUAL
 8th. EDITION
 P. 2-114

$$MAX = \frac{W l^2}{8}$$

$$= \frac{1.195 \times 171^2}{8}$$

$$= 4368 \text{ lb-in}$$

BENDING MOMENT @ CENTER:

$$f_b \approx \frac{M_c}{I} = \frac{4368 \times 1.5}{6.75}$$

$$= 971 \text{ psi}$$

$$F_y = 36000 \text{ psi}$$

BENDING STRESS SAFETY FACTOR:

$$SF = \frac{36000}{971} = \boxed{37.1} > 5 \therefore \text{O.K.}$$

(TOO HIGH COMPARED TO COMPUTER VALUE)

DEFLECTION SAFETY FACTOR:

$$E = 29000 \text{ KSI} = 29000 \times 10^3 \text{ psi}$$

MAX. DEFLECTION @ CENTER

$$\Delta_{MAX} = \frac{5 W l^4}{384 E I}$$

ISC MANUAL
P. 2-114

$$= \frac{5 \times 1.195 \times 171^4}{384 \times 29000 \times 1000 \times 6.75}$$

$$= 0.068"$$

$$\Delta_{ALLOW} = \frac{l}{360} = \frac{171}{360} = 0.475"$$

$$S.F. = \frac{0.475}{0.068} = \boxed{7.0} > 1.0 \therefore \text{O.K. (COMPARABLE TO COMPUTER VALUE)}$$

 $\therefore$ USE SAFETY FACTOR ANALYZED BY COMPUTER PROGRAM

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FOR BENDING STRESSES

GeoStar 2.5 (128K Version): 241-SX-A - [Main]

Lin STRESS Loc=1

Von Mises
3785.500
3079.900
4373.300
2666.700
2969.100
2253.500
1546.900
848.3200
133.7200

MAX STRESS
≈ 3000 PSI

ANALYZED BY BJ Carroll

CHECKED BY m. b. m. J. d. m.

DATED: 6/5/00

Y
Z X

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FOR DEFLECTION

GeoStar 2.5 (128K Version) : 241-SX-A - [Main]

Lin DISP Lev=1

MAX. DEFLECTION 0.05"
 Disp_Res
 0.0499300
 0.0436899
 0.0374480
 0.0312070
 0.0249650
 0.0187240
 0.0124830
 0.0062413
 1.09E-033

Y
Z X

ANALYZED BY *B. J. Crandall*
CHECKED BY *M. J. Crandall*
DATED 6/5/00