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1	1	Design Authority W. F. Zuroff	[signature]	2/3/00	S7-24	1	1	T.L. Hissong	[signature]	2-10-00	
		Design Agent									
1	1	Cog. Eng. J. J. Elsen	[signature]	2/3/00	S7-24						
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EVALUATION OF 3" SN-219 FAILURE AND S/SX TANK FARM SALTWELL PIPING

John J. Elsen
CH2MHill
Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

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direct buried pipe, Saltwell lines, pressure testing, interim stabilization, transfer piping. S/SX piping, galvanic corrosion

Abstract:
Evaluation of direct buried piping currently in use or designated for future Saltwell pumping in S and SX Farms. Documented evaluation of failed S-103 saltwell pumping transfer line 3" SN-219. This evaluation is intended to reflect current status of Saltwell piping, when taken in context with referenced documents.

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TECHNICAL EVALUATION OF 3" SN-219 FAILURE AND S/SX TANK FARM SALTWELL PIPING

FEBRUARY 2000

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1.0 INTRODUCTION

Saltwell transfer line 3" SN-219 failed during waste transfer on January 6, 2000. The transfer line is connected between tank 241-S-103 and valve pit 241-S-A. The leak was discovered following restart of the shutdown S-103 saltwell system, approximately 5 gallons of liquid waste was observed on the ground near the pump pit area. The S-103 saltwell system was immediately isolated and the area surveyed. High radiation readings in the area indicated that a transfer line failure occurred and the surface leakage came from the vicinity of the heat trace junction box located at the South side of the S-103 pump pit, see Figure 1 S-103 Leak Site Photograph.

2.0 OBJECTIVE

The following evaluation is not intended to be a detailed analysis on the condition of saltwell piping currently in use, or identified for future use. This document shall review the failure of 3" SN-219 and the potential for similar failures in other saltwell lines identified for current or future pumping within S and SX farm. After identification of cause of failure, alternatives shall be identified to address potential means of increasing the remaining life expectancy of S and SX saltwell lines.

3.0 BACKGROUND

A detailed evaluation of saltwell transfer lines in the following farms: A, AX, BY, C, S, SX, T and U was performed in reference (1). The piping in all farms with the noted exception of S and SX farms appeared to be in a favorable condition. Piping in S and SX farms has experienced numerous failures over the life of the waste transfer piping system. Waste transfer piping within S and SX farms containing schedule 40 carbon steel pipe was installed in 1972. The piping is direct buried with no pipe or concrete encasement. The installation detail of the direct buried pipe with heat trace and insulation is detailed as follows:

- Primary carbon steel pipe with heat trace conduit installed in contact with pipe via use of non-water soluble heat transfer cement.
- Stainless steel banding clamps installed every ten feet to secure conduit to pipe.
- Piping coated with epoxy material.
- Transfer pipe/heat trace conduit is wrapped in bubble wrap to create a ½" void space to allow for thermal expansion of heated pipe system.
- Transfer pipe/heat trace conduit/bubble wrap is surrounded with polyurethane foam insulation.
- Polyurethane foam insulation encases transfer pipe/heat trace conduit/bubble wrap as expanding foam fills plywood formed area containing waste transfer piping system.
- Entire waste transfer piping buried under two to three feet of soil.

4.0 EVALUATION

The presence of the escaped tank waste at ground level occurred due to the failure of the waste transfer line and breaching of the heat trace conduit. The mechanics of the suspected failure are described below and the basis for the piping failure is detailed in referenced documents (1) and (2).

The localized corrosion through the waste transfer piping is a combination of water induced corrosion through the heat trace conduit and galvanic corrosion. Saltwell piping operated between 1972 and 1980, during this time period heat trace on transfer lines was maintained at approximately 180 F. This elevated temperature is credited with driving off any external moisture, which may have entered the heat trace conduit or possibly the polyurethane foam insulation. After 1980 heat trace on the majority of S and SX waste transfer lines was isolated. Following isolation in 1980, moisture entered the surface level heat trace junction boxes and began to corrode the heat trace conduit. The heat trace installation design of the junction boxes failed to seal the open ends of the conduit in the junction boxes. The open conduit ends, located in the surface level junction boxes allowed moisture (rain, snow) to enter the conduit and collect in the first horizontal section of conduit. The first horizontal section of conduit would be the contact point with the waste transfer piping – below both the polyurethane foam insulation and bubble wrap. Following complete corrosion of the heat trace conduit, the moisture then began to corrode through the exterior of the schedule 40 carbon steel waste transfer pipe. In addition to the moisture entering the conduit, sand was also allowed to enter, thus creating an environment, which once wet would tend to stay moist.

Buried pipelines have experienced a high rate of galvanic corrosion and pipeline failures prior to the application of cathodic protection. When a buried pipe is galvanically corroding it is anodic (electrically negative) and positively charged atoms of metal leave the pipe surface and enter the soil which is an electrolyte, capable of conducting electricity. Cathodic protection systems in the 200 West area were isolated in 1980 and abandoned in place due to poor system conditions and suspected line failures associated with stray currents. S and SX farm saltwell piping was not included in the cathodic protection upgrade project in 1980, due to the saltwell lines being considered temporary. There are presently no cathodically protected saltwell lines within all tank farms.

Saltwell system S-103 is pumped uphill directly to SY-102. The static head difference due to elevation between the two locations is approximately 8 psig. After complete corrosion through the heat trace conduit and final failure of the pipe under saltwell transfer pressure, the leakage from the transfer piping entered the annulus created by the bubble wrap and polyurethane foam insulation and followed the path of least resistance through the heat trace conduit. The required pressure to push the waste to SY-102 is approximately 8 psig, while the pressure to overcome the elevation between the transfer line and junction box (three feet) is approximately 2 psig. Once the waste entered the annulus between the pipe and insulation it entered the corroded heat trace conduit and finally the junction box at ground level. The junction boxes in S and SX farm are not leak tight and the waste exited out through the junction box seams. Figure 2, Leak Area Profile is included to show an illustration of the heat trace installation and leak path.

The above failure analysis is based upon the detailed analysis provided in reference (2) which was performed following the failure of 2" SL-119 in 1992. Transfer line 2" SL-119 is also connected between S-103 pump pit and valve pit S-A. This transfer line failed during a hydrostatic leak test performed on January 24, 1992. Reference (1) provides the following list of failed transfer lines within S and SX tank farms:

1) 2" SL-119 failed hydrostatic test on 1/24/92 at S farm. Reported on occurrence report number RL--WHC-TANKFARM –1992-009.
2) 2" SL-116 failed hydrostatic test on 5/15/92 at S farm. Reported on occurrence report number RL—WHC-TANKFARM-1992-049.
3) 2" SL-115 failed hydrostatic test on 6/10/92 at S farm. Reported on occurrence report number RL—WHC-TANKFARM-1992-045.
4) 3" SN-215 failed hydrostatic test on 6/12/92 at S farm. Reported on occurrence report number RL—WHC-TANKFARM-1992-046.
5) 2" SL-133 failed pressure test on 5/16/88 at SX farm. Reported on event fact sheet TFS&O-EFS-88-055.
6) 3" SN-216 failed a hydrostatic test on 5/12/92 at S farm, verified verbally – but no report found to have officially established failure date.
7) 2" SL-113 failed 5/79, 2" SL-114 failed 2/80, 2" SL-126 failed – date unknown, 2" SL-139 failed – date unknown, 2" SL-138 failed 11/80. Failure occurred during leak testing in some cases.

No detailed failure analyses were performed on the above noted pipe failures. The detailed analysis performed on the 2" SL-119 failure was initiated due to the numerous failures of piping installed with the same design within S and SX farm. Reference (1) performed internal video inspection of heat trace conduit in S and SX farm in June 1993. The results of the video inspection were that extensive corrosion was found inside the heat trace conduits. Many instances resulted in complete or sufficient corrosion, which prevented camera insertion to the desired interface location between heat trace conduit and waste transfer piping.

Appendix A, S and SX Saltwell Transfer Lines, includes a comprehensive listing of S and SX tank farm waste transfer lines currently in use, and the lines identified for future saltwell pumping operations.

5.0 CONCLUSION

S and SX tank farm pipe failures are the result of the combination of localized corrosion in the area of heat trace hot splices and associated above ground junction boxes and galvanic corrosion. The galvanic corrosion of the process line results in deep pitting of the exterior pipe wall. The three identified means of potentially reducing or eliminating the corrosion process include: isolating the conduit and pipe, ensuring dryness and cathodic protection.

Isolation of the heat trace conduit from the process pipe would reduce the likelihood of galvanic corrosion between the two metals and associated soil. The means of original installation of the heat trace conduit onto the process piping utilized an application of heat transfer cement. Depending upon the application and installation of the conduit, cement and pipe it is unlikely that a proper isolation barrier exists between the conduit and the pipe for the entire length of the installation. The heat trace conduit is in direct contact with the surrounding soil for the distance between the surface level junction box and the pipe below. The only identified means of correcting the isolation of the two metals would require excavation of the transfer line and separation of the conduit and pipe. This approach is not recommended due to cost and worker exposure.

Ensuring the dryness of the inside of the conduit would be the simplest to implement. This would require that the heat trace on inactive lines be restored to operational status to burn off any moisture present in the conduit and then seal open ends of conduit in junction boxes, or replace junction boxes with leak tight upgrades. The downside to reactivating the heat trace is the possibility of accelerating the localized corrosion in any area which moisture has entered and cannot fully escape and accelerating potential stress corrosion cracking. Due to the installation of bubble wrap around the heat trace conduit and process pipe it is unlikely that all the moisture could be removed by turning the heat trace on prior to returning the line to service. Returning the heat trace to operational is not recommended due to the potential acceleration of corrosion. Ensuring proper leak tightness at the ground level junction boxes should be implemented to eliminate the introduction of additional water through the open ended conduits.

Installation of active cathodic protection on the transfer lines would have extended the expected lifetime of the piping installation if it was properly installed upon installation of the piping. The saltwell piping was installed as a temporary system with an intended active use of less than 10 years. A detailed analysis regarding cathodic protection of Hanford Site piping was performed by reference (5). The results of this analysis concluded that without cathodic protection the life expectancy of direct buried transfer lines are approximately 15 to 20 years. The analysis also concluded that the installation of cathodic protection on transfer piping which has already been subjected to pitting to a depth of 70% of wall thickness would not reduce the rate of corrosion within existing pits. The transfer lines in S and SX farms are 28 years old and have been without active cathodic protection for a minimum of 20 years. Extensive corrosion of all transfer lines is expected to have occurred. Due to the advanced state of corrosion of the existing transfer lines, the application of cathodic protection is not anticipated to extend the remaining life of waste transfer piping.

6.0 RECOMMENDATION

Due to the potential negative effects on the waste transfer piping by reactivating the heat trace preliminary heat trace activation is not recommended. Due to the anticipated depth of pitting associated with the piping the application of cathodic protection is not expected extend remaining pipe life and is not strongly recommended. However, due to the importance of identified waste transfer lines, for the tank stabilization project, cathodic protection may briefly extend the remaining pipe life.

The bulleted items listed below are recommended if the existing direct buried piping in S and SX farms is used for future saltwell pumping activities.

- Seal remaining electrical conduit openings in ground level junction boxes to prevent the intrusion of additional moisture.
- Perform pressure decay testing on lines intended for future use, to determine potential impact to saltwell pumping schedule, and evaluation of alternate transfer routes.
- Perform pressure decay testing on active S and SX farm direct buried piping on a semi annual basis, the testing frequency in other farms should not be increased.
- Install cathodic protection on transfer lines, if further evaluation proves potential merit of extending remaining pipe life.

If further evaluation and programmatic decisions determine that the future use of existing direct buried piping in S and SX farms is inappropriate, an alternative waste transfer system will be required. Options for alternative waste transfer systems currently in use include, hose in pipe overground transfer and hose in hose overground transfer used in recent SY-101 to SY-102 pumping operations, or undefined alternative means.

7.0 REFERENCES

1) Walter, E.J., 1993, SINGLE-SHELL TANK SALTWELL TRANSFER PIPING EVALUATION, WHC-SD-WM-ES-259 Rev. 0, Westinghouse Hanford Company, Richland, Washington.

2) Carlos, W.C., 1994, S TANK FARM SL-119 SALTWELL PIPING FAILURE ANALYSIS, WHC-SD-WM-ANAL-014 Rev. 0, Westinghouse Hanford Company, Richland, Washington.

3) OSD-T-151-00010, PRESSURE CHECHING OF ALL DIRECT BURIED AND CROSS-SITE TRANSFER LINES, Tank Farm operating procedure.

4) TO-140-170, PRESSURE TESTING OF PROCESS PIPELINES AND PIPE-IN-PIPE ENCASEMENTS, Tank Farm operating procedure.

5) Jimenez, R.F., 1984, JUSTIFICATION FOR APPLYING CATHODIC PROTECTION TO UNDERGROUND WASTE LINES IN THE 200 AREAS, SD-WM-ES-033 Rev. 1, Rockwell Hanford Operations, Richland, Washington.

6) HNF-SD-WM-SAR-067, TANK WASTE REMEDIATION SYSTEM FINAL SAFETY ANALYSIS REPORT.

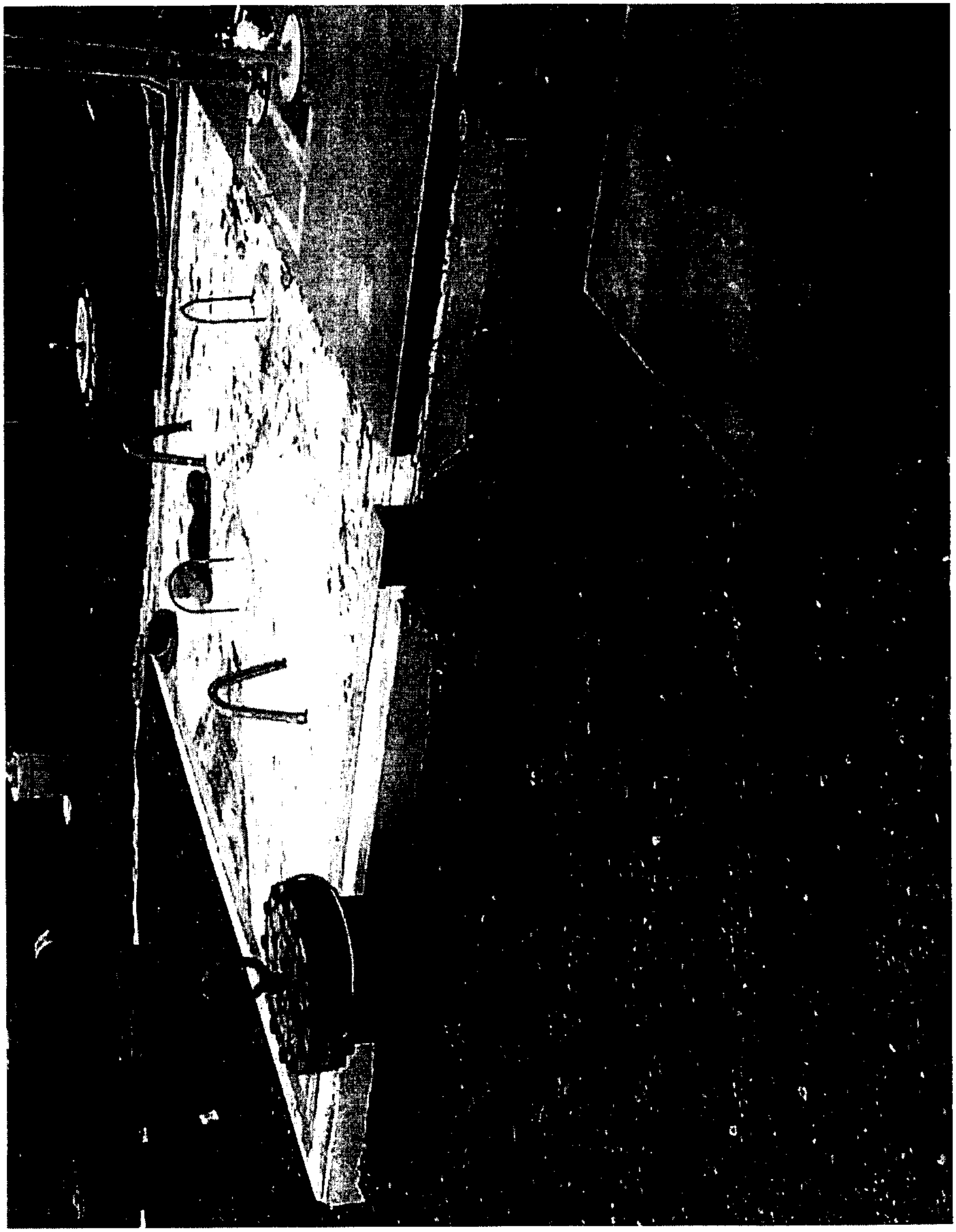

Figure 1: S-103 Leak Site Photograph

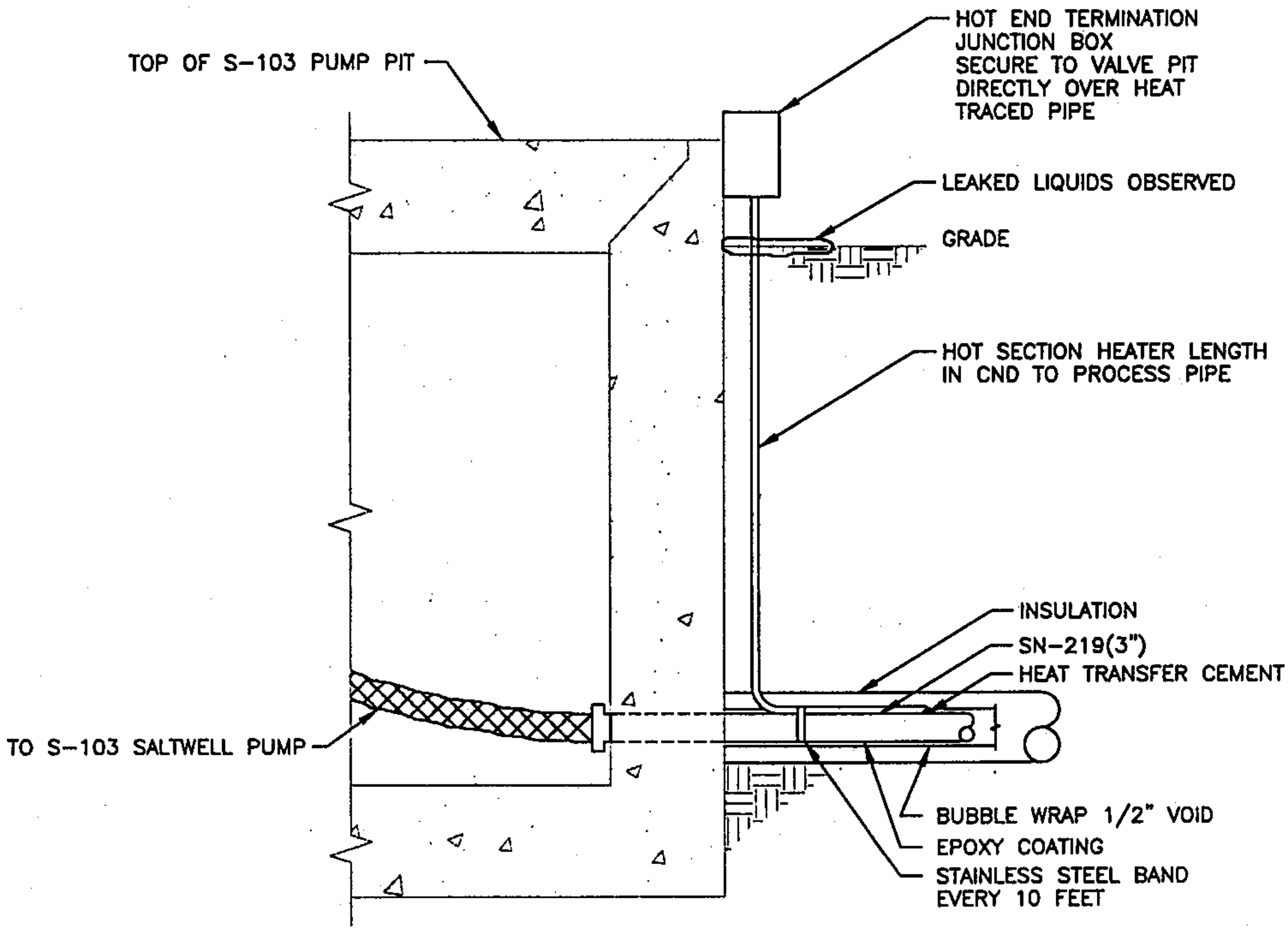

FIGURE 2
LEAK AREA PROFILE

APPENDIX A
S and SX Saltwell Transfer Lines

The following lists include transfer lines currently in use and lines identified for future use which are of the same design as those lines which have previously failed in S and SX farms. All transfer lines are subjected to a pressure decay test prior to being returned to active service in accordance with references (3) and (4). In addition, all direct buried lines are subjected to an annual pressure decay test in accordance with reference (5).

Additional waste transfer lines consisting of a pipe in pipe encased design shall also be used to support saltwell pumping of S and SX farm. These encased lines are subject to a pressure decay test prior to returning them to service. Due to the design of the pipe in pipe encased waste transfer system, the primary line is not subjected to the external corrosion of a direct buried line, and is not subjected to the annual retest.

Transfer lines used in support of saltwell pumping activities for tanks SX-106, S-103 and S-106 are not included in the listing. These tanks are currently under review for declaration of stabilization at the time of this report.

S/SX Lines in Use

3" SN-233; SX-104 to SX-B, last pressure decay test passed.
2" SL-118; SX-B to S-D, last pressure decay test passed.
2" SL-134; S-B to S-A, last pressure decay test passed.
1" OGT; S-D to S-B, last pressure decay test passed, hose in pipe encased.
2" SL-140; S-102 to S-A, last pressure decay test passed, pipe in pipe encased.
3" SN-275; S-A to SY-A, last pressure decay test passed, pipe in pipe encased.
2" SL-177; SY-A to SY-102, last pressure decay test passed, pipe in pipe encased.

S/SX Lines For Future Use
All lines require pressure decay testing prior to returning to active service.

2" SL-132; SX-105 to SX-B
2" SL-129; SX-103 to SX-A
2" SL-117; SX-A to S-C
3" SN-239; S-C to S-D
2" SL-137; SX-101 to S-C
2" SL-128; S-111 to S-D
2" SL-130; SX-102 to SX-A
2" SL-123; S-109 to S-C
2" SL-125; S-112 to S-C
2" SL-121; S-101 to S-B
3" SN-226; S-107 to S-D

The above lists are subject to change due to potential line failures discovered during testing or use, this list should be used on an informal basis only.

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	Interim Stabilization Engineering	Date 1/3/200
Project Title/Work Order: Technical Evaluation of 3" SN-219 Failure and S/SX-Farms Saltwell Piping		EDT No. 624870
		ECN No.

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
J. J. Elsen (4)	S7-24	X			
K. J. Hull	T4-07	X			
J. N. Doeler	T4-07	X			
M. R. Koch	S7-24	X			
P. F. Kison	T4-07	X			
T. C. Oten	R1-56	X			
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