ENGINEERING CHANGE NOTICE

1. ECN **Nº 622225**

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Proj.
ECN

2. ECN Category (mark one) Supplemental ☐ Direct Revision ☒ Change ECN ☐ Temporary ☐ Standby ☐ Supersedeure ☐ Cancel/VOID ☐	3. Originator's Name, Organization, MSIN, and Telephone No. LF Dougherty, 77B12, T4-07, 376-6264	3a. USQ Required? ☐ Yes ☒ No	4. Date 8/7/96	
	5. Project Title/No./Work Order No. Installation of Drywell Casing in 241-SX Farm/N1V2R	6. Bldg./Sys./Fac. No. 241-SX	7. Approval Designator SQ	
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.) WHC-SD-WM-TRP-263, Rev 0	9. Related ECN No(s). N/A	10. Related PO No. N/A	

11a. Modification Work ☐ Yes (fill out Blk. 11b) ☒ No (NA Blks. 11b, 11c, 11d)	11b. Work Package No. N/A	11c. Modification Work Complete N/A Cog. Engineer Signature & Date	11d. Restored to Original Condition (Temp. or Standby ECN only) N/A Cog. Engineer Signature & Date
---	------------------------------	--	--

12. Description of Change *THIS IS NOT A BASELINE DOCUMENT*

This ECN incorporates changes made to WHC-SD-WM-TRP-263, Rev 0, *Developmental Test Report, Assessment of XT-70E Drill Rig Percussion Operation in Tank Farms* and authorizes the document's revision to Revision 1. The revised version provides the details of the change.

The test described in Revision 0 has been completed and therefore the document has been revised primarily to replace the "TBDs" with the as found results in sections 4.0 Test Results, 5.0 Conclusions and Recommendations, and 6.0 Disposition of Test Item.

13a. Justification (mark one)

Criteria Change ☐	Design Improvement ☐	Environmental ☐	Facility Deactivation ☐
As-Found ☒	Facilitate Const ☐	Const. Error/Omission ☐	Design Error/Omission ☐

13b. Justification Details

The document requires revision to include the test results and conclusions.

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

L. Dougherty T4-07	P. Kison T4-07	D. Scott T4-01
S. Krogsrud T4-07	J. Jimenez T7-12	M. Bailey T4-07
M. Scott H5-52	L. Julyk R1-56	

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DATE	STA 4

SEP 11 1996	

ENGINEERING CHANGE NOTICE

Page 2 of 2

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

622225

16. Design Verification Required ☒ Yes ☐ No	17. Cost Impact		18. Schedule Impact (days) Improvement ☐ Delay ☒ NA
	ENGINEERING	CONSTRUCTION	
	Additional ☐ \$ Savings ☐ \$NA	Additional ☐ \$ Savings ☐ \$NA	

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	☐	Spare 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	☐		
Environmental Permit	☐	Inventory Adjustment Request	☐	N/A	☒

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

21. Approvals

Signature	Date	Signature	Date
Design Authority PF Kison <i>W. Brown for PFK</i>	<i>8/9/96</i>	Design Agent	
Cog. Eng. LF Dougherty <i>LF Dougherty</i>	<i>8/9/96</i>	PE	
Cog. Mgr. JJ Badden <i>JJ Badden</i>	<i>8/9/96</i>	QA	
QA MJ Bailey <i>MJ Bailey</i>	<i>8/9/96</i>	Safety	
Safety LS Krogsrud <i>LS Krogsrud</i>	<i>8/9/96</i>	Design	
Environ. NA <i>NA</i>		Environ.	
Other - BHI-JM Jimenez <i>NA</i>		Other	
TWRS Engr. - MA Scott <i>MA Scott</i>	<i>8/9/96</i>		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

Developmental Test Report, Assessment of XT-70E Percussion Drill Rig Operation in Tank Farms

L.F. Dougherty
WHC, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-87RL10930

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B&R Code: EW3120071 Total Pages: 28 114 runs 9/1/96

Key Words: Drywell, Test Report, SX Farm, Practice Well, Percussion

Abstract: The following report documents the testing of the XT-70E percussion drill rig for use in the 241-SX Tank Farm. The test is necessary to support evaluation of the safety and authorization level of the proposed activity of installing up to three new drywells in the 241-SX Tank Farm. The proposed activity plans to install drywells by percussion drilling 7 inch O.D. / 6 inch I.D. pipe in close proximity of underground storage tanks and associated equipment. The load transmitted from the drill rig's percussion hammer through the ground to the tank structure and equipment is not known and therefore testing is required to ensure the activity is safe and authorized.

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[Signature]
Release Approval
7/10/96
Date

Approved for Public Release

WHC-SD-WM-TRP-263, Rev. 0
Rev. 1

INTERNATIONAL CONSTRUCTION EQUIPMENT, INC.

CORPORATE OFFICES: 301 WAREHOUSE DRIVE, MATTHEWS, NORTH CAROLINA 28105 USA, PHONES 800-438-9201 & 704-821-8200 FAX 704-821-4080

August 2, 1996

To: Westinghouse Hanford

Attn: Mr. Lee Dougherty

Ref: ICE Model 40S Energy Chart

Gentlemen:

Confirming our telephone conversation of today, Westinghouse Hanford may make any use desired, including operating plan publication, of the ICE Model 40S or 42S energy chart.

Very truly yours,

A handwritten signature in dark ink, appearing to read "SDS", written over a horizontal line.

Scot D. Simon, P.E.
Manager of Sales

TO: Lee Dougherty FAX: 509-373-5030 DATE: August 22, 1996

COMPANY: Westinghouse Hanford Company

Dear Mr. Dougherty,

In reference to your request, Entran grants Westinghouse Hanford Company permission to use excerpts from our Accelerometer Instruction and Selection Manual in your results documentation.

Once the document is released, kindly forward a copy to Entran Devices to the address below.

Regards,

Elizabeth Ticas
Sales Engineer

Entran[®]
Sensors & Electronics

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TITLE PAGE

Developmental Test Report

Assessment of XT-70 Percussion Drill Rig Operation in Tank Farms

ABSTRACT

The following report documents the testing of the XT-70 percussion drill rig for use in the 241-SX Tank Farm. The test is necessary to support evaluation of the safety and authorization level of the proposed activity of installing up to three new drywells in the 241-SX Tank Farm. The proposed activity plans to install drywells by percussion drilling 7 inch O.D. / 6 inch I.D. closed bottom pipe in close proximity of underground storage tanks and associated equipment. WHC-SD-WM-SR-005, *Single-Shell Tank Interim Operational Safety Requirements*, AC 5.22 Dome Load, requires a program to control access to the tank dome area in order to prevent structural damage. WHC-IP-0842 IV, Engineering 4.10, Rev 0b, *Waste Tank Dome Loading*, is the TWRS administration procedure for controlling access and loads by engineering and operations activities by requiring engineering evaluation of the loads on the tank. The energy ratings generated by the percussion hammer (16 K to 40 K ft-lbs) potentially exceed tank and equipment structural limits. However, the load transmitted from the drill rig through the ground to the tank structure and equipment is not known. Monitoring the response of horizontal and vertical accelerometers during installation of a practice drywell outside the farm will allow the TWRS Design Authority to make quantitative and qualitative assessments of the expected loads on the tank and equipment. This assessment will be used to draw conclusions as to the safety of the proposed activity. The assessment will also be used in preparation of the USQ Determination for the proposed activity.

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APPENDIX B - GROUND WATER WELL 2990W23-15 DATA AND FIELD
OBSERVATION SHEETS

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HAMMER BLOWS

APPENDIX E - WATER DEVELOPMENT HANFORD, INC. PROCEDURE 021, REV O
"IN SITU CHARACTERIZATION PERCUSSION PROBE INSTALLATION"

APPENDIX F - EXCERPT FORM IEC405 OPERATIONS MANUAL - DETERMINING
HAMMER ENERGY

NOTE: The proposed test is simple in nature and therefore the test plan and specification have been combined into the test procedure. The test procedure is an appendix of this test report.

1.0 INTRODUCTION

The following report documents the test plan, specification, procedure, results, and conclusions of operation of the XT-70E percussion drill rig. Testing is necessary to support evaluation of the safety and authorization level of the proposed activity of installing up to three new drywells in the 241-SX Tank Farm.

Monitoring the response of horizontal and vertical accelerometers during installation of a practice drywell outside the farm will allow the TWRS Design Authority to make quantitative and qualitative assessments of the expected loads on the tank and equipment. This assessment will be used to draw conclusions as to the safety of the proposed activity. The assessment will also be used in preparation of the USQ Determination for the proposed activity. The USQ Determination is a requirement of the work package being prepared by WTF Operations.

Funding has been provided under separate contract to Westinghouse Hanford Company (WHC) and Bechtel Hanford Company (BHI).

The practice drywell will be installed by Water Development Hanford Inc. under the direction of BHI.

The test data will be collected and evaluated by Tank Waste Remediation System (TWRS) engineering during the installation of the practice drywell.

The Water Development Hanford Inc. percussion hammer drilling option was chosen because:

- a) It has the capability of driving a closed bottom probe (casing) to the desired depth without generating any drilling waste material
- b) The capability to drive the casing with little to no vertical deviation
- c) The onsite environmental and radioactive expertise of Water Development Hanford Inc.
- d) The capacity of the XT 70E drill to utilize multiple drilling technologies if the need arose.

2.0 DESCRIPTION OF TEST

The test consists of installation of a drywell using the percussion hammer methodology while monitoring accelerometer response.

For additional detail see **Appendix A - TEST PLAN, SPECIFICATIONS, AND PROCEDURE.**

3.0 TEST METHOD AND TEST EQUIPMENT

Accelerometers will be mounted in either an existing groundwater well (see **APPENDIX B - Ground Water Well 299-W23-15 Data and Field Observation Sheets**) and/or located in a shallow excavation site of less than 10 feet deep. The accelerometers will be located approximately 10 feet from where the practice well will be installed. While driving the well casing, the response of the accelerometers will be recorded. The accelerometer readings will be correlated with their corresponding loads as documented at the test site.

4.0 TEST RESULTS

Summary

The following test result evaluation demonstrates that a drywell installed in the SX Tank Farm utilizing the XT-70E drill rig with percussion hammer will not exceed or compromise the current structural analysis of record. The loads on the tank produced by driving the well with a pile driving method are within the reserve load envelop defined in Blume, 1978.

Discussion

The following load evaluation was initiated to support a USQ Determination associated with the proposed activity of installing a well using a percussion hammer. The initial TWRS Engineering/structural analysis recommendation was to instrument the dome of the tanks with accelerometers and monitor during the first stages of pounding to assure that dynamic amplification of the loading would not overload the dome. Concern was expressed from the Design Authority that the horizontal pressures from the pounding could overload the tank side wall. Preliminary conservative evaluations resulted in tank wall side loads being increased by one quarter. More refined analysis was initiated that resulted with high frequency, high accelerations, stresses, and pressures in the soil. The results from this will be discussed later in this section.

When the opportunity was presented to instrument the preparatory test well through a nearby RCRA well with the monitoring instruments (accelerometers) for the dome, it was assumed that the results from the initial side wall pressure evaluations could be verified and preliminary data would provide assurance that the excitation levels would be low. Discussions with the several geo-scientists led away from using the RCRA monitoring well (soil vibrations would not be representative) as a mounting location for the instrumentation. The geo scientists suggested that the best results would be from burying the accelerometers to pick up the low frequency response and then matching the resulting ground response to the analytical model. It was

recommended to not pursue the high frequency response of the soil and to concentrate on the low frequency results.

The ground adjacent to the preparatory test well was then instrumented with the accelerometers and the ground response was recorded and analyzed for frequency content and levels of acceleration (g levels) (Figures 1 to 21). Axisymmetric computer models of the soil (Figure 22) were developed to evaluate the soil response to the pounding imposed by the pile driver. The resulting pressures were then applied to models of the tank (Figures 23 to 25) and the resulting imposed loads (Figures 26 to 29) were evaluated against the analysis of record, Blume 1978 (Figures 31 to 37). The soil test results were used to as the basis to modify the dynamic response of the soil model to get conservative characterization of the loading induced by the soil. Soil models developed for the initial high frequency response evaluation were also compared to the resulting test data and low frequency model data results.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Review of the high frequency data (Figures 38 to 63) shows that much of the high frequency put into the soil results from the resonance of the casing due to the impact pulse. The resulting small vibrational displacements in the soil impose little load on the structure. There is some evidence of lower frequency loading (figure 45 and 51) but the duration of the time history from the initial computer run was not long enough to capture this behavior. The high frequency pressure stresses in the soil (Figures 54 and 55) are not transferred to the tank.

Review of the low frequency model results show that there is little change in the position of the moment axial load combination on the P/M plots and that they are still within the reserve strength boundary of the curves from the structural analysis of record (Blume, 78).

6.0 DISPOSITION OF TEST ITEM

The loads resulting from installation of a drywell utilizing the percussion hammer technology as tested do not exceed the original loading conditions assumed in the structural analysis of record. The loads are judged well below the design basis seismic capability of the tank systems, structures, and components. The evaluation and conclusions are based on a well installed ten feet from the tank wall. It is considered prudent practice to minimize the load needed to install the well while passing by the tank wall (e.g. the first 60 feet).

7.0 REFERENCES

Blume, 1978 RHO-A-6, Analysis of Underground Waste Storage Tanks 241-AX at Hanford, Washington. URS/John A. Blume & Associates, Engineers. June, 1978.

FIGURE 1

FIGURE 2

Summary of Maximum G-Levels from WHC Test Drill
Units are mg

File Name	Radial-Min Min	Radial-Max Max	Vertical-Min Min	Vertical-Max Max
WHC1-2	-250	150	-119	128
WHC1-3	-372	253	-548	180
WHC1-3	-196	206	-271	184
WHC1-4	-830	793	-420	384
WHC1-5	-1010	662	-811	1020
WHC2-1	-1552	1261	-914	1465
WHC2-2	-1019	1150	-491	714
WHC2-3	-1160	792	-586	731
WHC2-5	-1056	1073	-526	806
WHC2-6	-1104	856	667	473
WHC2-7	-803	1116	-535	639
WHC2-8	-465	911	-262	534
WHC2-9	-369	461	-358	725
WHC2-10	-693	902	-331	755
WHC2-11	-653	775	-333	558
WHC4-1	-702	877	-370	786
WHC4-2	-444	907	-437	304
WHC4-3	-375	786	-484	365
WHC4-4	-454	781	-436	448
WHC4-5	-444	912	-499	459
WHC4-6	-356	912	-356	440
WHC4-7	-312	472	-326	353
WHC4-8	-459	498	-261	431
WHC5-1	-266	419	-212	253
WHC5-2	-460	378	-222	289
WHC5-3	-521	401	-181	202
WHC5-4	-544	233	-247	283

Vertical

FIGURE 3

FIGURE 4

FIGURE 5

FIGURE 6

FIGURE 8

FIGURE 9

FIGURE 11

FIGURE 12

FIGURE 13

FIGURE 14

FIGURE 15

FIGURE 16

FIGURE 17

FIGURE 18

FIGURE 20

FIGURE 21

SOIL1.AVI

SOIL SHOCK WAVES-PILE AT 16 FEET

FIGURE 23
LOW FREQUENCY TANK MODEL

FIGURE 24

FIGURE 25
PRESSURE PULSE ON TANK

FIGURE 26
HOOP AXIAL LOADS

7

100

FIGURE 27

FIGURE 28

Chart2

FIGURE 29

PAGE34

ELEM	HEIGHT	P-HOOP	P-RAD	M-HOOP	M-RAD
221	549.8	210	20.499	44.32	-9.2064
241	549.74	170.02	23.243	44.11	-13.847
261	549.67	140.64	20.083	43.475	-17.071
281	549.58	119.34	13.162	42.542	-19.688
301	549.47	104.07	4.1098	41.426	-21.666
321	549.34	93.228	-5.8875	40.214	-23.122
341	549.16	85.567	-16.011	38.98	-24.132
361	548.95	80.142	-25.734	37.789	-24.724
381	548.69	76.249	-34.747	36.705	-24.87
401	548.36	73.372	-42.902	35.799	-24.477
421	547.94	71.13	-50.159	35.157	-23.356
441	547.42	69.248	-56.548	34.89	-21.189
461	546.77	67.522	-62.138	35.13	-17.515
481	545.94	65.806	-67.017	36.044	-11.648
501	544.9	64.003	-71.273	37.868	-2.4547
521	543.59	62.083	-74.984	40.935	11.894
541	541.94	60.126	-78.207	45.413	33.355
561	539.84	58.426	-80.981	51.33	64.629
581	537.2	57.71	-83.334	57.508	108.7
601	534.3	56.85	-85.107	61.316	158.3
621	531.29	62.628	-86.472	62.577	211.19
641	527.91	69.963	-87.814	59.209	263.47
661	524.16	81.842	-89.425	45.919	299.68
681	520.06	99.134	-91.634	17.735	304.5
701	515.6	122.36	-94.889	-30.214	261.72
721	510.78	151.43	-99.716	-99.298	163.61
741	505.6	185.59	-106.71	-184.99	19.726
761	500.08	223.41	-116.54	-281.75	-158.48
781	494.2	262.82	-130.02	-389.95	-374.12
801	488.54	295.96	-145.92	-494.15	-594.74
821	483.28	323.26	-163.37	-599.76	-840.03
841	478.01	349.65	-184.46	-728.41	-1172.8
861	472.75	372.44	-209.63	-883.99	-1616.6
881	467.48	387.94	-239.39	-1069.9	-2205.5
1	462.9	416.47	-269.63	-1305.8	-2767.9
21	458.64	415.69	-298.3	-1445.9	-3163.3
41	453.71	381.8	-328.36	-1496.1	-3446.7
61	448.16	312.93	-359.9	-1436.9	-3627.3
81	442.02	207.86	-392.53	-1244	-3707.2
101	435.32	59.951	-424.31	-913.41	-3671
121	428.03	-102.06	-454.22	-568.47	-3476.8
141	420.18	-251.82	-477.79	-209.53	-3067.4
161	411.82	-377.42	-491.92	183.66	-2381.1
181	403.07	-458.68	-490.85	635.95	-1308
901	391.98	-516.87	-499.54	1209.1	335.8
921	378.68	-613.2	-525.56	1973.8	1980.5
941	365.38	-714.7	-544.78	2504.1	2943.6
961	352.08	-801.68	-557.82	2831.5	3446.2
981	338.78	-864.03	-564.8	2992.4	3609.1
1001	325.47	-897.62	-565.8	3026.4	3554.2
1021	312.17	-901.68	-561.09	2970.2	3377.5
1041	298.87	-877.02	-551.16	2847.9	3138.1
1061	285.57	-824.85	-536.81	2667.5	2850.5
1081	272.27	-746.19	-519.27	2438.5	2518.4

ELEM	HEIGHT	P-HOOP	P-RAD	M-HOOP	M-RAD
1101	258.43	-727.76	-495.5	2633.6	1971.3
1121	244.03	-718.27	-474.13	2753.1	1299
1141	229.63	-694.05	-451.68	2895.2	772.24
1161	215.22	-684.92	-427.88	3063.4	387.48
1181	200.82	-637.74	-402.41	3254.7	127.72
1201	184.52	-569.69	-372.92	3453.9	199
1221	166.31	-436	-334.24	3080.4	495.08
1241	148.09	-318.52	-293.77	2733.1	710.12
1261	129.88	-209.44	-252.63	2376.7	789.54
1281	111.67	-103.52	-211.69	1991.6	710.16
1301	93.56	2.0472	-171.72	1563.9	451.02
1321	75.244	107.48	-133.5	1086.9	-3.6237
1341	57.031	210.24	-97.834	554.96	-685.95
1361	38.819	304.38	-65.455	-34.763	-1638.2
1381	20.606	379.59	-36.873	-886.93	-2930.6
1401	11.201	358.59	-106.68	-1167.7	-2959.1
1421	10.626	288.04	-96.776	-706.05	-1686.9
1441	10.095	266.32	-87.956	-409.79	-824.38
1461	9.6038	218.44	-81.413	-177.96	-318.07
1481	9.1506	204.06	-76.841	-69.439	-67.382
1501	8.7319	149.87	-73.448	-1.7456	36.195
1521	8.3452	138	-69.96	17.112	69.558
1541	7.988	129.63	-67.657	21.317	66.614
1561	7.6581	124.98	-66.76	19.707	50.282
1581	7.3533	91.957	-66.115	12.923	33.23
1601	7.0718	86.691	-64.894	8.8265	20.806
1621	6.8118	82.896	-64.046	5.8967	11.95
1641	6.5717	80.642	-63.676	3.5109	6.2012
1661	6.3499	80.161	-64.006	2.039	2.6743
1681	6.145	60.519	-64.3	0.62354	0.56394
1701	5.9557	57.99	-63.987	6.83E-02	-0.71181
1721	5.7809	55.844	-63.683	-0.23998	-1.3449
1741	5.6194	54.054	-63.379	-0.41247	-1.6609
1761	5.4703	52.615	-63.079	-0.50882	-1.8086
1781	5.3325	51.552	-62.802	-0.58441	-1.9273
1801	5.2053	50.933	-62.594	-0.65901	-2.0377
1821	5.0878	50.89	-62.549	-0.76794	-2.2095
1841	4.9792	51.659	-62.84	-0.91827	-2.4111
1861	4.8789	43.621	-63.139	-1.0144	-2.7761
1881	4.7863	42.881	-63.12	-1.1911	-3.2817
1901	4.7008	42.283	-63.107	-1.4101	-3.8715
1921	4.6218	41.778	-63.125	-1.6659	-4.6193
1941	4.5488	41.405	-63.186	-1.9736	-5.3247
1961	4.4814	41.069	-63.244	-2.293	-6.3308
1981	4.4191	40.907	-63.313	-2.5955	-7.7525

TABLE 7
LONGITUDINAL INTERNAL FORCES

Area	Nodal Point	Coordinates		Hydrostatic		Hydrodynamic		Horizontal Ground Motion		Vertical Ground Motion	
		R (ft)	Z (ft)	Moment (k-ft/ft)	Force (k/ft)	Moment (k-ft/ft)	Force (k/ft)	Moment (k-ft/ft)	Force (k/ft)	Moment (k-ft/ft)	Force (k/ft)
Base Slab	17	5.00	627.67	-1.14	4.49	-0.14	0.00	1.95	1.33	0.28	1.77
	32	10.00	627.67	-1.52	4.88	-0.18	0.06	0.71	2.79	0.30	1.70
	47	15.00	627.67	-2.01	5.98	-0.32	0.24	0.32	4.74	0.36	1.66
	62	20.00	627.67	-3.24	7.99	-0.60	0.62	0.04	6.69	0.56	1.65
	77	25.00	627.67	-5.74	10.19	-1.20	1.18	0.26	8.49	1.09	1.90
	92	29.57	627.67	-4.73	6.69	-1.56	0.76	3.02	8.17	2.25	1.91
	107	33.57	626.92	18.55	4.87	1.66	0.50	8.11	9.34	5.69	1.85
	122	37.06	626.92	47.71	-5.73	7.22	-1.14	10.27	11.87	12.12	5.65
	136	38.57	626.92	44.75	-16.75	7.58	-2.98	6.70	5.50	14.24	5.69
	151	41.07	626.92	-1.73	2.23	-0.24	-0.30	0.73	3.73	0.28	1.16
Wall	166	43.57	626.92	0.01	2.27	0.00	-0.32	0.01	1.52	0.00	1.09
	164	38.57	628.42	14.29	-8.74	3.04	-2.02	5.28	5.95	1.73	3.14
	177	38.57	629.17	7.45	-7.02	1.54	-1.64	5.82	5.95	0.57	3.52
	191	38.57	629.92	7.85	1.11	1.58	-0.06	5.70	3.09	0.95	4.51
	205	38.57	631.92	-1.84	4.66	-0.44	0.80	0.46	1.17	0.19	3.97
	219	38.57	635.42	-2.85	4.87	-0.58	0.90	3.10	1.17	0.19	3.28
	233	38.57	639.42	-0.76	3.66	-0.16	0.64	0.32	1.00	0.67	3.06
	247	38.57	643.42	0.49	5.10	0.06	0.68	0.08	1.59	0.85	5.26
	261	38.57	647.42	0.23	6.29	-0.04	0.70	1.37	2.82	1.23	7.22
	275	38.38	650.42	-0.60	6.40	-0.32	0.66	0.88	2.50	0.81	7.02
Dome	289	38.20	653.42	-1.48	6.93	-0.70	0.86	1.38	2.71	1.22	6.96
	303	38.20	657.42	-0.94	7.42	-0.96	0.52	1.23	4.14	1.19	7.74
	317	38.20	660.92	3.50	7.17	0.90	-0.20	5.01	6.34	1.87	6.93
	330	38.20	663.69	12.06	7.36	3.08	-0.32	9.67	7.87	8.07	6.85
	341	37.05	664.84	8.74	7.76	3.28	-0.46	14.40	9.04	4.66	6.96
	351	35.56	665.30	7.59	7.42	2.50	-0.72	9.26	10.34	4.76	7.07
	359	34.00	666.79	3.07	7.56	0.96	-0.96	2.36	9.53	3.01	7.35
	365	30.00	668.66	0.71	8.63	0.12	-0.86	2.36	7.71	1.53	7.91
	370	25.00	670.12	0.57	9.77	0.04	-0.72	0.85	5.71	1.18	8.86
	375	21.70	671.25	0.00	10.95	0.04	-0.58	0.80	4.91	0.69	10.01
Dome	379	17.40	672.16	-0.27	12.01	-0.10	-0.48	2.20	4.27	0.41	11.20
	383	13.07	672.83	0.02	12.92	0.16	-0.38	1.68	3.60	0.24	12.39
	387	8.72	673.23	-0.78	13.65	0.08	-0.26	1.48	2.55	0.93	13.45
	391	4.36	673.47	-1.20	14.19	0.02	-0.10	1.03	0.94	1.78	14.27

Element #	M K/FT	P K/FT		
1381	-2.93	-1.44		
1361	-1.64	-1.78		
1341	-1.69	-1.17		
1321	-1.00	-1.60		
1281	1.70	-2.54		
1221	1.50	-4.01		
1161	1.39	-5.13		
1101	1.97	-5.95		
1041	3.14	-6.61		
1001	3.55	-6.80		
921	1.96	-6.30		
141	-3.07	-5.74		
81	-3.70	-4.70		

FIGURE 30

TABLE 8

CIRCUMFERENTIAL INTERNAL FORCES

Area	Nodal Point	Coordinates		Hydrostatic		Hydrodynamic		Horizontal Ground Motion		Vertical Ground Motion	
		R (ft)	Z (ft)	Moment (k-ft/ft)	Force (k/ft)	Moment (k-ft/ft)	Force (k/ft)	Moment (k-ft/ft)	Force (k/ft)	Moment (k-ft/ft)	Force (k/ft)
Base Slab	17	5.00	627.67	-1.47	4.45	-0.10	-0.08	2.13	6.26	0.25	1.79
	32	10.00	627.67	-1.47	4.56	-0.10	-0.12	0.92	9.39	0.27	1.76
	47	15.00	627.67	-1.64	4.94	-0.14	-0.08	1.01	10.84	0.29	1.70
	62	20.00	627.67	-2.06	5.69	-0.24	0.06	0.75	11.51	0.36	1.61
	77	25.00	627.67	-2.84	6.79	-0.42	0.32	0.55	11.70	0.51	1.55
	92	29.57	627.67	-5.43	8.50	-0.90	0.62	0.51	15.14	0.99	2.24
	107	33.57	626.92	-6.00	22.98	-0.92	2.74	2.78	23.03	2.26	3.52
	122	37.06	626.92	-0.74	22.36	0.22	2.98	4.24	26.56	1.62	3.53
	136	38.57	626.92	-2.54	21.87	0.54	3.02	3.64	27.61	1.44	3.05
	151	41.07	626.92	-5.08	20.50	-0.50	3.22	2.38	26.65	0.45	3.31
Wall	166	43.57	626.92	-4.55	19.31	-0.42	3.36	2.02	26.34	0.38	3.15
	164	38.57	628.42	1.03	7.30	0.20	1.20	0.49	16.65	0.34	1.88
	177	38.57	629.17	0.00	6.09	-0.02	1.04	0.14	16.12	0.00	1.69
	191	38.57	629.92	0.00	6.11	-0.02	1.10	0.13	15.28	0.00	1.71
	205	38.57	631.92	0.00	14.39	-0.02	2.92	0.08	9.79	0.00	2.24
	219	38.57	635.42	0.00	33.62	-0.06	6.98	0.04	4.58	0.00	3.82
	233	38.57	639.42	0.00	39.21	-0.08	8.42	0.10	11.84	0.00	4.68
	247	38.57	643.42	0.19	37.16	-0.04	8.54	0.17	15.99	0.40	5.61
	261	38.57	647.42	0.05	29.25	-0.06	7.90	0.40	23.42	0.19	5.39
	275	38.38	650.42	-0.10	21.21	-0.08	6.62	0.36	25.29	0.12	4.93
Dome	289	38.20	653.42	-0.21	13.82	-0.12	5.16	0.19	25.05	0.18	4.43
	303	38.20	657.42	-1.41	5.29	-0.14	3.06	0.28	29.15	0.18	4.69
	317	38.20	660.92	0.25	-2.23	0.06	0.04	0.79	26.91	0.24	4.96
	330	38.20	663.69	-0.25	-4.37	0.12	-1.08	0.43	25.06	0.63	5.36
	341	37.05	664.84	-0.70	-4.74	0.22	-1.56	0.64	29.00	0.80	5.97
	351	36.56	665.30	-0.55	-6.54	0.48	-2.68	1.01	45.85	1.09	8.83
	359	34.00	666.79	-0.91	-5.00	0.36	-3.66	1.98	49.58	1.77	8.39
	365	30.00	666.66	-0.68	-0.48	0.08	-2.70	1.47	28.89	0.65	4.90
	370	26.00	670.12	-0.45	3.03	0.02	-2.02	0.59	18.55	0.34	4.06
	375	21.70	671.25	-0.62	5.83	0.02	-1.66	0.70	13.85	0.58	4.77
	379	17.40	672.16	-0.68	8.35	0.02	-1.32	0.75	11.71	0.77	6.06
	383	13.07	672.83	-0.77	10.63	0.08	-1.10	0.92	10.52	1.05	8.99
	387	8.72	673.23	-1.12	12.44	0.04	-0.76	0.76	7.83	1.60	11.62
	391	4.36	673.47	-1.41	13.95	0.02	-3.34	0.52	3.67	2.17	13.90

Elev #	M K/FT	P K/FT			
1381	-1.09	4.56			
1361	-1.35	3.65			
1341	1.55	2.92			
1321	1.29	1.29			
1281	1.49	1.24			
1221	3.08	-5.28			
1161	3.06	-7.98			
1101	2.65	-8.71			
1041	2.85	-10.52			
1001	3.03	-10.77			
921	1.97	-7.36			
141	.21	-3.02			
81	-1.24	-2.49			

FIGURE 31

FIGURE 32

HANFORD WASTE STORAGE
TANKS 241-AX

FIGURE 25

P-M CURVES
SECTIONS 4 & 5

⊗ - THE MAXIMUM COMBINATION OF
M AND P FOR A GIVEN SECTION

HANFORD WASTE STORAGE
TANKS 241-AX

FIGURE 28

FIGURE 34

P-M CURVE
SECTION G

⊗ - THE MAXIMUM COMBINATION OF
M AND P FOR SECTION G

HANFORD WASTE STORAGE
TANKS 241-A

FIGURE 35

P-M CURVES
SECTIONS 7 & 8

⊗ - THE MAXIMUM COMBINATION OF
M AND P FOR A GIVEN SECTION

HANFORD WASTE STORAGE
TANKS 241-AX

P-M CURVES
SECTIONS 9 & 10

⊗ - THE MAXIMUM COMBINATION OF
M AND P FOR A GIVEN SECTION

HANFORD WASTE STORAGE
TANKS 241-AX

FIGURE 37

P-M CURVES

SECTIONS 11 & 12

- ⊗ - THE MAXIMUM COMBINATION OF
M AND P FOR A GIVEN SECTION

HANFORD WASTE STORAGE
TANKS 241-A

XMIN 3.000E-04
XMAX 3.000E-02
YMIN -3.163E+00
YMAX 8.965E-02

Vert. Disp. of Tip of Beam at 20,000 ft. lbs

ABAQUS

— 40U5_5911
..... 40U10_5921
--- 40U15_5931

XMIN 3.000E-04
XMAX 3.000E-02
YMIN -6.963E-08
YMAX 4.512E-01

FIGURE 39

— 20U5_5911
 20U10_5921
 --- 20U15_5931

XMIN 3.000E-04
 XMAX 3.000E-02
 YMIN -7.548E-08
 YMAX 1.114E-01

ABAQUS

FIGURE 41

— 2045_5911

XMIN 3.000E-04
XMAX 3.000E-02
YMIN -1.052E+05
YMAX 8.091E+04

— 20A10_5921

XMIN 3.000E-04
XMAX 3.000E-02
YMIN -3.678E+04
YMAX 3.102E+04

— 20A15_5931

XMIN 3.000E-04
XMAX 3.000E-02
YMIN -1.824E+04
YMAX 1.709E+04

— 40A5_5911

XMIN 3.000E-04
XMAX 3.000E-02
YMIN -4.848E+05
YMAX 3.054E+05

XMIN 3.000E-04
XMAX 3.000E-02
YMIN -1.696E+05
YMAX 9.915E+04

— 40a15_5931

XMIN 3.000E-04
XMAX 3.000E-02
YMIN -8.492E+04
YMAX 5.021E+04

— 20V5_5911

XXMIN 3.000E-04
XXMAX 3.000E-02
YYMIN -3.407E+01
YYMAX 4.650E+01

— 20V10_5921

XMIN 3.000E-04
XMAX 3.000E-02
YMIN -1.405E+01
YMAX 1.699E+01

ABAQUS

— 20V15_5931

XMIN 3.000E-04
XMAX 3.000E-02
YMIN -8.231E+00
YMAX 7.139E+00

FIGURE 50

— 40V5_5911

XMIN 3.000E-04
XMAX 3.000E-02
YMIN -7.018E+01
YMAX 2.962E+02

ABAQUS

— 40V10_5921

FIGURE 52

— 40V15_5931

XMIN 3.000E-04
XMAX 3.000E-02
YMIN -3.135E+01
YMAX 5.987E+01

— 20S5_5911
.... 20S10_5921
-- 20S15_5931

XMIN 3.000E-04
XMAX 3.000E-02
YMIN -1.434E+02
YMAX 3.950E+01

— 40S5_5911
.... 40S10_5921
-- 40S15_5931

XMIN 3.000E-04
XMAX 3.000E-02
YMIN -6.847E+02
YMAX 1.300E+02

FIGURE 56

SINGLE-SHELL TANK CYLINDER MODEL

```

1  *heading
2  Single-Shell Tank Model (cylinder
   only)
3  **
4  ** Units: length = inches
5  **      force = lbf
6  **      time  = seconds
7  **
8  *****
9  *node,nset=basenode
10 1,0,-450,0
11 1601,0,-450,384
12 *ngen
13 1,1601,100
14 *nset,nset=edge1,generate
15 1,1601,100
16 *****
17 *ncopy,change    number=1,old
set=edge1,shift,multiple=30,new set=allnodes
18 0,0,0
19 0,0,0,0,0,1,3
20 *nset,nset=nbot,generate
21 1,31
22 *nset,nset=ntop,generate
23 1601,1631
24 *nset,nset=edge2,generate
25 31,1631,100
26 *****
27 ** Element Generation
28 **
29 *element,type=s4r
30 1,1,2,102,101
31 *elset,elset=ELSET1,generate
32 1,1501,100
33 *elgen,elset=CYL
34 **1,16,100,100,60,1,1,,
35 1,16,100,100,30,1,1,,
36 *elset,elset=row1,generate
37 1,1501,100
38 *elset,elset=row2,generate
39 2,1502,100
40 *elset,elset=row3,generate
41 3,1503,100
42 *elset,elset=row4,generate
43 4,1504,100
44 *elset,elset=row5,generate
45 5,1505,100
46 *elset,elset=row6,generate
47 6,1506,100
48 *elset,elset=row7,generate
49 7,1507,100
50 *elset,elset=row8,generate
51 8,1508,100
52 *elset,elset=row9,generate
53 9,1509,100
54 *elset,elset=row10,generate
55 10,1510,100
56 *elset,elset=row11,generate
57 11,1511,100
58 *elset,elset=row12,generate
59 12,1512,100
60 *elset,elset=row13,generate
61 13,1513,100
62 *elset,elset=row14,generate
63 14,1514,100
64 *elset,elset=row15,generate
65 15,1515,100
66 *elset,elset=row16,generate
67 16,1516,100
68 *elset,elset=row17,generate
69 17,1517,100
70 *elset,elset=row18,generate
71 18,1518,100
72 *elset,elset=row19,generate
73 19,1519,100
74 *elset,elset=row20,generate
75 20,1520,100
76 *elset,elset=row21,generate
77 21,1521,100
78 *elset,elset=row22,generate
79 22,1522,100

```

```

80 *elset,elset=row23,generate
81 23,1523,100
82 *elset,elset=row24,generate
83 24,1524,100
84 *elset,elset=row25,generate
85 25,1525,100
86 *elset,elset=row26,generate
87 26,1526,100
88 *elset,elset=row27,generate
89 27,1527,100
90 *elset,elset=row28,generate
91 28,1528,100
92 *elset,elset=row29,generate
93 29,1529,100
94 *elset,elset=row30,generate
95 30,1530,100
96 *elset,elset=allel,generate
97 1,2000
98 *****
99 ** Material Definition
100 **
101 *material,name=concrete
102 *elastic,type=iso
103 4.0E6,0.25
104 *density
105 2.17E-4
106 **
107 *****
108 **Boundary Conditions
109 **
110 *boundary
111 edge1,xsymm
112 edge2,ysymm
113 nbot,encastre
114 ntop,encastre
115 *****
116 ** Section Properties
117 **
118 *shell section,elset=allel,
    material=concrete
119 15.0
120 *****
121 ** History Definition
122 *step
123 *static
124 1,1
125 *amplitude,name=amp,
    definition=tabular
126 0.25,2.7,0.5,2.7,0.75,2.7,1,2.7
127 *dload,amplitude=amp
128 row1,p,-0.13
129 row2,p,-0.39
130 row3,p,-0.65
131 row4,p,-0.91
132 row5,p,-1.17
133 row6,p,-1.42
134 row7,p,-1.67
135 row8,p,-1.91
136 row9,p,-2.15
137 row10,p,-2.39
138 row11,p,-2.61
139 row12,p,-2.83
140 row13,p,-3.04
141 row14,p,-3.25
142 row15,p,-3.44
143 row16,p,-3.63
144 row17,p,-3.80
145 row18,p,-3.97
146 row19,p,-4.12
147 row20,p,-4.26
148 row21,p,-4.39
149 row22,p,-4.51
150 row23,p,-4.62
151 row24,p,-4.71
152 row25,p,-4.79
153 row26,p,-4.86
154 row27,p,-4.92
155 row28,p,-4.96
156 row29,p,-4.98
157 row30,p,-5.00
158 *restart,write
159 *node print,freq=0
160 *el print,freq=0
161 *energy print,freq=100
162 *end step

```

ABAQUS

FIGURE 58

ABAQUS

FIGURE 39

FIGURE 60

ABAQUS

ABAQUS

hoop inside surface

FIGURE 62

ABAQUS

mises outside surface

FIGURE 63

ABAQUS

mises inside surface

APPENDIX A - TEST PLAN, SPECIFICATION, AND PROCEDURE

1.0 INTRODUCTION

A drywell will be installed utilizing the percussion hammer drill method. During installation of the drywell piping, accelerometers will be used to detect ground motion. The following test procedure describes the steps necessary to install the drywell and collect drill rig and accelerometer data. This test is simple in nature and therefore the test plan and test specification documents have been combined into the test procedure.

2.0 OBJECTIVE

Install a practice well while collecting ground motion data. The data is necessary to determine the potential loading on structures within the tank farm and therefore the collection of the test data must be controlled.

3.0 REQUIREMENTS

The test must be conducted in a controlled manner. The specific setup and steps of installing the practice well and collecting data must be recorded such that the data can be properly interpreted. The WTF work control system will be used to control the activities associated with this test in the field. WTF QC shall verify critical information such as dimensions and calibrations are recorded in the data package in accordance with WHC-QM-4-2, *Quality Assurance Manual*.

4.0 SPECIAL EQUIPMENT

This test is being conducted on a specific drill rig capable of being setup for percussion driving pipe into the ground (see APPENDIX C - Drilling Equipment Weight Load Information). The accelerometers have been selected for this specific application and are calibrated but are otherwise not considered special equipment.

5.0 ACCEPTANCE CRITERIA

The test results will be analyzed to determine their ability to adequately predict load. The need for additional testing will be determined.

6.0 TEST CONDITIONS

The test is not restricted to specific test conditions. However, the test conditions should be noted in the log for information.

7.0 INSTRUMENTS AND CALIBRATION

The drilling rig is a specific piece of equipment. The specific rig and setup dictates the load applied by the hammer. As long as the same rig and setup is used the loads can be repeated within reasonable accuracy by knowing how high the hammer returns. Visually observing the return stroke height is

within the range of accuracy needed to support this test effort. The accelerometers have been calibrated by the vendor.

8.0 FACILITIES, EQUIPMENT, AND MATERIALS

The test will be conducted approximately 100 feet south of the 241-SX Farm boundary. The drill rig and casing is supplied by Water Development Hanford Inc. who are working under the direction of Bechtel Hanford Incorporated. The accelerometers and associated video and sound equipment have been supplied by Mid Columbia Engineers, and will be installed under the direction of WHC.

9.0 SAFETY

A Job Hazard Analysis (JHA) has been performed for this test. A RWP is not required. Conduct of drill rig operations, noise level, and heat are primary safety considerations. A pre job briefing shall be performed in accordance with the WTP work control system.

10.0 MAINTENANCE AND FAILURES

Maintenance and equipment failures have the potential to impact tests results. Any deviation from normal operations shall be documented. An evaluation of the test results will dictate the need to repeat all or any of the test steps should there be a failure.

11.0 TEST DATA

Test data will be collected on data sheets contained within the Water Development Drill Procedure and APPENDIX D - Data Sheet For Accelerometer As Built Dimensions and Hammer Blows. During installation of the casing, the accelerometers response will be recorded. During this recording an audio channel will be used to record each blow of the hammer on the pipe. In addition, a member of the test team will announce pertinent data such that the hammer load and accelerometer response can be correlated.

12.0 PERSONNEL REQUIREMENTS

Drill rig operators and data recorders shall be qualified and experienced in accordance with Water Development Hanford Inc. procedures. The Test Engineer shall be technically qualified and familiar with accelerometer response data collection and recording devices (or be assisted by someone who is experienced), understand the data required for the test, the data collection points within the drilling procedure, and the collection intervals. The Test Director shall have an overall understanding of the test goals and procedures including the WTP work control system and safety requirements associated with the testing.

13.0 WITNESSES

The test is simple in nature and therefore does not require QC witness points. However, WTP-01 shall verify critical information such as dimensions and calibrations are recorded in the data package in accordance with WHC-QM-4-2, *Quality Assurance Manual*.

Installation of the practice well should be witnessed by all parties that will be responsible for evaluating the aspects of installation of the drywell in the farm (e.g., safety, rad control, work coordination, structural integrity).

14.0 PROCEDURE

- 14.1 Document field installed configuration of accelerometers on data sheet (see APPENDIX D - Data Sheet For Accelerometer As Built Dimensions and Hammer Blows)

Test Engineer [Signature]Date: 8/2/96

- 14.2 Verify and record calibration date of accelerometer test equipment.

Test Engineer [Signature]Calibration Date: As noted in APPD

- 14.3 Perform checkout of accelerometer test assembly including verification of audio and graphic response recording capability.

Test Engineer [Signature]Date: 8/2/96

- 14.4 When Test Engineer is ready to proceed, perform 7 inch casing installation in accordance with APPENDIX E - Water Development Hanford, INC. Procedure 021, Rev 0, In Situ Characterization Percussion Probe Installation

In addition to the requirements of Procedure 021, perform the following activities in parallel with casing installation.

- 14.4.1 Record (see APPENDIX D - Data Sheet For Accelerometer As Built Dimensions and Hammer Blows) each blow of the hammer on the casing while simultaneously recording the accelerometer response. After each blow of the hammer on the casing, record the associated operating stroke length (as measured off the ram to within the nearest half foot) and the depth of penetration of the casing. Also record when the first blow of the hammer on each new section of casing occurs.

Test Engineer [Signature]Date: 8/2/96

- 14.4.2 Begin test by raising hammer to approximately 3 - 4 foot mark on ram such that a single blow is made. Repeat single blow step at various hammer heights as directed by Test Engineer.

Note: To achieve greater than approximately 3 to 4 feet it will be necessary to prime the hammer with fuel. If a mis-fire occurs, additional fuel will be required which may result in the hammer raising higher than originally desired. This is acceptable because as long as the actual ram height is recorded the hammer force can be determined (see APPENDIX F - Excerpt From ICE405 Operations Manual - Determining Hammer Energy).

14.4.3 Complete Installation in accordance with Water Development Hanford, Inc. Procedure 021, *In Situ Characterization Percussion Probe Installation*.

14.5 WTF QC verify data has been recorded for steps 14.1, 14.2, and 14.3.

WTF QC *P. J. [Signature]* Date: *8/12/96*

15.0 DATA SHEETS

The data sheet contained in Water Development Hanford, INC. Procedure 021, Rev 0, *In Situ Characterization Percussion Probe Installation*, combined with APPENDIX D - Data Sheet For Accelerometer As Built Dimensions and Hammer Blows and the tape recording of the accelerometer response are required for evaluation of the test results. In addition the BHI log shall be available for information.

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-W23-15

WELL DESIGNATION : 299-W23-15
 PERMIT UNIT : 200 Aggregate Area Management Study
 PERM FACILITY : SST, 2/78 Form 79, 2/78 (2004-130Dec91)
 NADPND COORDINATES : N 34,573.1 M 79,211.1 (2004-130Dec91)
 NADPND COORDINATES : N 400,100 M 2,219,432 (2004-130Dec91)
 NADPND COORDINATES : N 134,127.22M 8 564,794.60M (2004-130Dec91)
 DATE DRILLED : Dec91
 DEPTH DRILLED (GS) : 125.0 ft
 MEASURED DEPTH (GS) : Not documented
 DEPTH TO WATER (GS) : 129.2 ft, Nov91
 CASING DIAMETER : 152.4 ft, 20Apr92
 ELEV TOP CASING : 4-in stainless steel, +0.20182 Y-ft
 ELEV GROUND SURFACE : 4-in stainless steel, +0.12+0.2-ft
 PERFORATED INTERVAL : 4-in stainless steel, +0.12+0.2-ft
 SCREENED INTERVAL : 4-in stainless steel, +0.12+0.2-ft
 COMMENTS : 4-in stainless steel, +0.12+0.2-ft
 AVAILABLE LOSS : Not applicable
 TV SCAN COMMENTS : Not applicable
 DATE EVALUATED : Not applicable
 EVAL RECOMMENDATION : Not applicable
 LISTED USE : SST Monthly water level measurement, 23Jan92-16Mar93
 PUMP TYPE : Not on meter sample schedule
 MAINTENANCE : Hydrostatic, intake at 222.4 ft (TDC)

WELL CONSTRUCTION AND COMPLETION SUMMARY			
Drilling Method: Cable Tool	Sample Drive Barrel Method: Hand Tool	WELL NUMBER: 299-W23-15	TEMPERARY WELL NO:
Drilling Fluid Used: Mud	Additives: None	Location: Hanford	
Driller's Name: T. Oakes/E. Henry	License No. Not Documented	Coordinates N: 154,177.23m	E: 540,794.00m
Company: Kelson Engineers	Location: Hanford	Coordinates N: 154,180	E: 2,215,432
Date Started: 1/28/91	Date Completed: 2/20/91	Start Card No. Not Documented	End Card No. Not Documented
		Elevation	
		Ground surface (ft): 452.01 (Press. Cap)	
Depth to Water: 100.0 ft. (Press. Cap)		Elevation of reference point: (452.01 ft.)	
GENERALIZED Stratigraphy Log		Height of reference point above ground surface: 2.45 ft.	
Stratigraphy		Depth of surface seal: (0-21.4 ft.)	
0-5: SAND		Type of surface seal: Pre-mix concrete	
5-10: silty SAND		1/4" x 1/2" mesh stainless steel	
10-15: SAND		4-mesh stainless steel	
15-20: silty SAND		Current about 1.5 ft. 4-in	
20-25: silty, silty SAND			
25-30: silty SAND		1.0" of riser pipe	
30-35: silty SAND		Type of riser pipe	
35-40: silty SAND		Stainless steel	
40-45: silty SAND		Diameter of borehole	
45-50: silty SAND		0-19.2-in, 15-in nominal	
50-55: silty SAND		19.2-19.5-in, 15-in nominal	
55-60: silty SAND		19.5-20.0-in, 9-in nominal	
60-65: silty SAND		Type of filter: 21.6-178.2-ft	
65-70: silty SAND		20-mesh bentonite granules	
70-75: silty SAND		Depth top of seal: (178.2 ft.)	
75-80: silty SAND		Type of seal:	
80-85: silty SAND		3/8-in bentonite pellets	
85-90: silty SAND		Depth top of sand pack: (181.0 ft.)	
90-95: silty SAND		10-20-mesh silica sand	
95-100: silty SAND		Depth top of screen: (185.2 ft.)	
100-105: silty SAND		4-in, 420-slot, continuous screen	
105-110: silty SAND		304 stainless steel	
110-115: silty SAND		No filter pack documented	
115-120: silty SAND		Depth bottom of screen: (222.5 ft.)	
120-125: silty SAND			
125-130: silty SAND			
130-135: silty SAND			
135-140: silty SAND			
140-145: silty SAND			
145-150: silty SAND			
150-155: silty SAND			
155-160: silty SAND			
160-165: silty SAND			
165-170: silty SAND			
170-175: silty SAND			
175-180: silty SAND			
180-185: silty SAND			
185-190: silty SAND			
190-195: silty SAND			
195-200: silty SAND			
200-205: silty SAND			
205-210: silty SAND			
210-215: silty SAND			
215-220: silty SAND			
220-225: silty SAND			
225-230: silty SAND			
230-235: silty SAND			
235-240: silty SAND			
240-245: silty SAND			
245-250: silty SAND			
250-255: silty SAND			
255-260: silty SAND			
260-265: silty SAND			
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370-375: silty SAND			
375-380: silty SAND			
380-385: silty SAND			
385-390: silty SAND			
390-395: silty SAND			
395-400: silty SAND			
400-405: silty SAND			
405-410: silty SAND			
410-415: silty SAND			
415-420: silty SAND			
420-425: silty SAND			
425-430: silty SAND			
430-435: silty SAND			
435-440: silty SAND			
440-445: silty SAND			
445-450: silty SAND			
450-455: silty SAND			
455-460: silty SAND			
460-465: silty SAND			
465-470: silty SAND			
470-475: silty SAND			
475-480: silty SAND			
480-485: silty SAND			
485-490: silty SAND			
490-495: silty SAND			
495-500: silty SAND			
500-505: silty SAND			
505-510: silty SAND			
510-515: silty SAND			
515-520: silty SAND			
520-525: silty SAND			
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565-570: silty SAND			
570-575: silty SAND			
575-580: silty SAND			
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615-620: silty SAND			
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630-635: silty SAND			
635-640: silty SAND			
640-645: silty SAND			
645-650: silty SAND			
650-655: silty SAND			
655-660: silty SAND			
660-665: silty SAND			
665-670: silty SAND			
670-675: silty SAND			
675-680: silty SAND			
680-685: silty SAND			
685-690: silty SAND			
690-695: silty SAND			
695-700: silty SAND			
700-705: silty SAND			
705-710: silty SAND			
710-715: silty SAND			
715-720: silty SAND			
720-725: silty SAND			
725-730: silty SAND			
730-735: silty SAND			
735-740: silty SAND			
740-745: silty SAND			
745-750: silty SAND			
750-755: silty SAND			
755-760: silty SAND			
760-765: silty SAND			
765-770: silty SAND			
770-775: silty SAND			
775-780: silty SAND			
780-785: silty SAND			
785-790: silty SAND			
790-795: silty SAND			
795-800: silty SAND			
800-805: silty SAND			
805-810: silty SAND			
810-815: silty SAND			
815-820: silty SAND			
820-825: silty SAND			
825-830: silty SAND			
830-835: silty SAND			
835-840: silty SAND			
840-845: silty SAND			
845-850: silty SAND			
850-855: silty SAND			
855-860: silty SAND			
860-865: silty SAND			
865-870: silty SAND			
870-875: silty SAND			
875-880: silty SAND			
880-885: silty SAND			
885-890: silty SAND			
890-895: silty SAND			
895-900: silty SAND			
900-905: silty SAND			
905-910: silty SAND			
910-915: silty SAND			
915-920: silty SAND			
920-925: silty SAND			
925-930: silty SAND			
930-935: silty SAND			
935-940: silty SAND			
940-945: silty SAND			
945-950: silty SAND			
950-955: silty SAND			
955-960: silty SAND			
960-965: silty SAND			
965-970: silty SAND			
970-975: silty SAND			
975-980: silty SAND			
980-985: silty SAND			
985-990: silty SAND			
990-995: silty SAND			
995-1000: silty SAND			

NOTE: Hanford (Plant) and State coordinates are included.

APPENDIX C - DRILLING EQUIPMENT WEIGHT LOAD INFORMATION

The following provides technical information for weight loading analysis of drilling equipment proposed to install driven probes within SX tank farm. Scale weight were recorded at the WMC Scales for the XY-70E drill rig in a sonic configuration. The sonic head and tooling have been removed and the percussion hammer installed. Therefore an additional 2500# should be added for the pile driver configuration.

DRILL RIG MODEL: XY-70E (Modified CCC Dresser T76M)

DESCRIPTION OF AXLE WEIGHTS:

NUMBER OF AXLES: 4 each (two front & two rear)

TOTAL RIG WEIGHT: 82,120# (sonic configuration)

FRONT AXLE ASSEMBLY: 26,300#

REAR AXLE ASSEMBLY: 52,040#

REAR STABILIZERS: 64,300# (with the tower raised in the drill position)

DIMENSIONS OF THE DRILL RIG:

The following provides for general drill rig dimensions:

WIDTH: 8'6"

HEIGHT: 13' (rigged down)

HEIGHT: 48' (rigged up)

LENGTH: 11' 3" (front of bumper to the tip of the lower rigged down)

LENGTH: 43' 9" (overall length rigged down)

LENGTH: 33' 11" (rigged up to drill)

OTHER CONSIDERATIONS:

The following provides information related to the operating parameter of the proposed pile driver assembly (Model ICE 40S) which will be installed in the XY-70.

PILE DRIVER: International Construction Equipment Inc. ICE Model 40S, 40,000 ft/lbs.

ENERGY RATINGS: 16,000 ft/lbs minimum to 40,000 ft/lbs maximum

BLOWS PER MINUTE: 38 to 55

MAXIMUM RAM STROKE: 10' 2"

APPENDIX D - Data Sheet For Accelerometer As Built Dimensions and Hammer Blows

Provide Description of soil conditions:

The soil conditions in the excavated hole consist of a dark gravelly sand with some moisture evident in the freshly excavated sand. There were some larger rocks up to three inches.

Provide test data from soil analysis (if required):

N/R

Provide instrument description and serial numbers:

The following accelerometers were installed in the excavated hole adjacent to the existing 12 inch casing. The accelerometers were mounted in a three by one inch aluminum block and placed with the three inch dimension oriented along the radial axis 5 feet from the well at a depth of 4 feet.

The accelerometers were connected to an amplifier which is connected to a Power Supply which goes into the data recorder and analyzer. The system is run on 110 volt circuit supplied by the site. The recorder and analyzer were placed in a van at the site for protection.

The accelerometers were buried with little compaction around the units. The instruments were checked for functionality. The radial accelerometer had a 60Hz hum on the channel when they were connected to the generator power. This went away when connected to direct power.

Channel	Direction	Equipment	Calibration
1	Radial	Accelerometer	
		ENTRAN EGCS-D1S-6-/RS	
		Serial No. x5039	7-25-96
		Amplifier	
		ENTRAN IMV-15/15/100A-WW-/RS	
		Serial No. 96G96D18-101	7-25-96
2	Vertical	Power Supply	
		ENTRAN PS-30-1	
		Serial No. 9509A/2200	
		Accelerometer	
		ENTRAN EGCS-D1S-6-/RS	
		Serial No. U5152	7-25-96
		Amplifier	
		ENTRAN IMV-15/15/100A-WW-/RS	
		Serial No. 96G95H08-104	7-25-96
		Power Supply	
		ENTRAN PS-30-1	
		Serial No. 9509A/2202	

3	Circum.	Accelerometer	
		ENTRAN EGCS-DIS-5-/RS	7-25-96
		Serial No. x5041	
		Amplifier	
		ENTRAN IMV-15/15/100A-WW-/RS	7-25-96
		Serial No. 96G95F30-105	
		Power Supply	
		ENTRAN PS-30-1	
		Serial No. 9509A/2206	
4	Trigger	Accelerometer	
		ENTRAN EGCS-DIS-5-/RS	7-25-96
		Serial No. U5153	
		Amplifier	
		ENTRAN IMV-15/15/100A-WW-/RS	7-25-96
		Serial No. 96G95D15-103	
		Power Supply	
		ENTRAN PS-30-1	
		Serial No. 9509A/2205	
5		MHz Radial Accelerometer	5-6-96
		WPPSS 37492	

NOTE: The data from this accelerometer was not utilized other than as a check on the proper operation of the other accelerometers and to check if there was any high frequency response beyond the range of the other accelerometers.

DATA RECORDER
TEAC XR-7000 Cassette Recorder
Serial No. 772453
4-3-96

DATA ANALYZER
TEKTRONIX 2630 Fourier Analyzer
Serial No. B010466

Continued --

APPENDIX D - Data Sheet For Accelerometer As Built Dimensions and Hammer Blows

Hammer Blow Table

Depth of Casing	No. of Blows between depth read	Rebound height of hammer	Comments
6.2'	1		no fire no impact 3ft drop
6.5'	1		11:33am 3ft drop no fire no impact
7.0'	1	(5'assumed)	11:49am Sustained firing
8.3'	1	(5'assumed)	12:02pm Sustained firing
8.4'	1	(5'assumed)	Sustained firing
8.6'	1	(5'assumed)	Sustained firing
8.8'	1	(5'assumed)	Sustained firing
8.9'	1	(5'assumed)	Sustained firing
9.2'	1	(5'assumed)	Sustained firing
9.3'	1	(5'assumed)	Sustained firing
9.6'	1	(5'assumed)	Sustained firing
9.8'	1	(5'assumed)	Sustained firing
9.9'	1	(5'assumed)	Sustained firing
10'	18	5'	
11'	28	5'	
12'	15	5'	
12.5'	22	5'	Stopped to reset gain on the analyzer
13'	25	5'	
14'	23	6'	
15'	26	5'	
16'	25	5'	
17'	14	5'	

17.5'			12:02pm Stopped to add casing section 3, moved trigger from casing to stake (hor to vert)
	14	6'	
18'	29	5'	
19'	29	5'	
20'	25	6'	
21'	23	6'	
22'	26	6'	
23'	34	5.5'	
24'	28	6'	
25'	25	6'	
26'	33	6'	
27'	13	6'	
27.5'			12:40pm Stopped to add Casing section 4
	16	6' to 7'	
28.1'	25	6' to 7'	
28.75'			Stopped to refuel hammer, 1:08pm restart pounding
	8	7'	
29'	41	7'	Note: 2 ft of depth
31'	21	7'	
32'	20	7.5'	
33'	22	7' to 8'	
34'	24	7' to 8'	
35'	27	7' to 8'	
36'	33	7' to 8'	
37'	12	7' to 8'	
37.5'			1:14pm Stopped to add casing section 5, refuel and pass straightness gage at 1:25pm
	26	7'	
38'	33	7.5'	
39'	34	7.5'	1:37pm
40'	37	7.5'	

41'	37	8'	
42'	43	8'	
43'	48	8'	
44'	35	8'	
45'	33	8'	
46'	34	8'	1:43pm
47'	8	8'	
47.5'			Stopped to add casing section 6, restart 1:48pm
	30	9'	
48'	40	8'	
49'	38	8'	
50'	34	8'	
51'	36	8'	
52'	31	8'	
53'	32	8'	
54'	37	8'	
55'	35	8'	
56'	44	8.5' to 9'	
57'	9	8.5'	
57.5'			Stopped to add casing section 7, restart at 1:59pm
	51	10'	
58'	86	10'	2:09pm
59'	60	10'	
60'	54	10'	
61'	74	10'	
62'	123	10'	
63'	135	10'	
63.75'			Paused pounding due to lack of progression
	67	10'	
64'	180	10'	
65'			

66' ? 10'
67.5' ? ?

Stopped for day

Test Engineer *M.A. Scott* Date: *8/12/96*

WTF QC *PJ Plummer* Date: *8.7.96*

Chart1

Depth of Casing	# of Blows	depth/blow count
6.2	1	
6.6	1	0.4
7	1	0.4
8.3	1	1.3
8.4	1	0.1
8.6	1	0.2
8.8	1	0.2
8.9	1	0.1
9.2	1	0.3
9.3	1	0.1
9.6	1	0.3
9.8	1	0.2
9.9	1	0.1
10	18	0.1
11	28	0.0555556
12	15	0.0357143
12.5	22	0.0333333
13	25	0.0227273
14	23	0.04
15	26	0.0434783
16	25	0.0384615
17	14	0.04
17.5	14	0.0357143
18	29	0.0357143
19	29	0.0344828
20	25	0.0344828
21	23	0.04
22	26	0.0434783
23	34	0.0384615
24	28	0.0294118
25	25	0.0357143
26	33	0.04
27	13	0.030303
27.5	16	0.0384615
28.1	25	0.0375
28.75	8	0.026
29	41	0.03125
31	21	0.0487805
32	20	0.047619
33	22	0.05
34	24	0.0454545
35	27	0.0416667
36	33	0.037037
37	12	0.030303
37.5	26	0.0416667

38	33	0.0192308
39	34	0.030303
40	37	0.0294118
41	37	0.027027
42		0.027027

WHC-SD-WM-TRB-263, REV 1

Type Recorder/2630	Radial Chn 1	Vert Chn 2	CIR Chn 3	TRIGGER Chn 4	Radial Chn 5	Supply - system accuracy - ometer
Accelerometer	X 5039	U 5152	X 5041	U 5153	37492	5-6-97
Amplifier	96696 D18 - 101	96695 A08-104	96695 F30-105	96695 D15-103	Gain 1 Power Supply	
Power Supply	9509A - 2200	9509A - 2202	9509A - 2206	9509A - 2205	37502 Due 5-6-97	
+ Static Cal	1.008	1.015g	1.017g	1.006g		
- Static Cal	1.008g	-1.04g	-1.016g	-1.011g		
0 Static Cal	0.0 mg	14.2 mg	1.63 mg	1.98 mg		
Dynamic Cal File	EN 5039	EN 5152	EN 5041	EN 5153		
Volts/g	2.58	3.175	2.6	2.85	0.2	
Tektronix 2630 FFT Analyzer TAC XR 7003 Recorder	TEK. B010466 SS# 0055555 Due Date 6-19-97 SS# C021299-21 Due Date 4-3-97					

D-10

CERTIFICATE OF CALIBRATION

This instrument has been calibrated against a working standard which is directly traceable to a National Standard. All data interpreted per Entran Instruction Manuals unless otherwise indicated.

CAL EQUIPMENT S/N'S: Acc: 486

Entran by: BY Cal. Date: 7/25/90

Property of: PO: 5

DIV: 458013

FO#: 29648

10Hz 2 3 4 5 6 7 8 9 100Hz

10dB 1dB

PLEASE READ OPERATING INSTRUCTIONS

BEFORE POWERING UNIT

2 3 4 5 6 7 8 9 1KHz

2 3 4 5 6 7 8 9 1

Entran

10 Fairfield, N.J. USA
1000 Chrysler Square, Fremont, CA 94538-1000

SPECIFICATIONS

Model : EGCS-D1S-5-/RS
Range : $\pm 5g$

Limit: $\pm 500g$
Temperature Range Compensated: 70 to 170°F

S/N: X5039

Axis:

Operating: -40 to 250°F

CALIBRATION DATA

Subject to 10,000g Shock In: () Sensitive Axis Only () All Axes

1,2 Non-Linearity: $\pm 1\%$

1 Zero :

R Cal :

Output : 25.80 $\frac{mV}{g}$

Ref. Temp : 75°F

Tested with:

Input Ω :

1847

Hysteresis:

1 Term. Z: $\pm 2.1\%$ FS/100°F

with :

Max. In : 15.0Vdc

Ref. Hz : 50

S/N:

Max. In :

See Over : ()

2 X-axis :

2 TSS : $\pm 2.1\%$ /100°F

across :

Max. In : 18.0 VDC

4 Approx. In:

S/N:

Max. In :

See Over : ()

ACCELEROMETER WIRING

To Module:
+In: $\times$ Red ()
-In: $\times$ Blk ()
Total: 3, 3
+Out: $\times$ Gm ()
() Gm & Blue
-Out: $\times$ Wht ()

Male:

ELECTRONICS

Signal In :
+Signal In :
-Signal In :
Male :
+Signal Out :
-Signal Out :
Common :
Signal In :
+Signal In :
-Signal In :
Male :
+Signal Out :
-Signal Out :
Common :

(for $\pm 15V$ Input, Do not use
unipolar 30V power supply)

If calibrated data equals or exceeds data sheet specifications, value shown is the data sheet value unless purchase order specifies actual calibrated value. 2 Value given is by manufacturing design and not calibrated unless purchase order specifies actual calibrated value. TSS is Thermal Sensitivity Shift. Input/Output Impedance is recorded for transducer alone if separate item from electronics. 4 In means Resonant Frequency.

CERTIFICATE OF CALIBRATION

This instrument has been calibrated against a working standard which is directly traceable to a National Standard. All data interpreted per Entran Instruction Manuals unless otherwise indicated.

CAL EQUIPMENT S/N'S: Acc. 486 DVM: 458013
 Entran by: BY Cal. Date: 7/25/96 QC: 06 FO#: 29648
 Property of: PO:

PLEASE READ OPERATING INSTRUCTIONS
 BEFORE POWERING UNIT

Entran

(X) Fairfield, N.J., USA
 () Los Angeles, CA, USA
 () Carson, Watford, Herts., UK

SPECIFICATIONS

Model : EGCS-D1S-5-/RS
 Range : $\pm 5g$
 Limit: $\pm 500g$
 Temperature Range, Compensated: 70 to 170°F
 Operating: -40 to 250°F

CALIBRATION DATA

Subject to 10,000g Shock in () Sensitive Axis Only () All Axes

1,2 Non-Linearity: $\pm 1\%$	2 X-axis:
1 Zero:	Therm. Z: $\pm 2\%FS/100^\circ F$
R Cal:	with across:
Output:	Max. In: 18.0 VDC
Ref. Temp: 75°F	4 Approx. In:
Tested with:	S/N:
Output:	Max. In:
3 Input Q: 1863	3 Output Q: 910
	See Over ()

ACCELEROMETER WIRING

To Module:
 +In: $\times$ Red ()
 -In: $\times$ Blk ()
 Connector:
 Male:
 +Signal In: $\times$ Red ()
 -Signal In: $\times$ Blk ()
 +Signal Out: $\times$ Red ()
 -Signal Out: $\times$ Blk ()
 Common: $\times$ ()

ELECTRONICS

Signal In: $\times$ Red ()
 +Sensor Power: $\times$ Red ()
 -Sensor Power: $\times$ Blk ()
 Amp Out Conn: $\times$ Red ()
 +Supply: $\times$ Red ()
 -Supply: $\times$ Blk ()
 +Signal Out: $\times$ Red ()
 -Signal Out: $\times$ Blk ()
 Common: $\times$ ()

1) If calibrated data equals or exceeds data sheet specifications, value shown is the data sheet value unless purchase order specifies actual calibrated value. 2) Value given is by manufacturing design and not calibrated unless otherwise specified. 3) If calibrated data equals or exceeds data sheet specifications, value shown is the data sheet value unless purchase order specifies actual calibrated value. 4) In means resonant frequency.

CERTIFICATE OF CALIBRATION

This instrument has been calibrated against a working standard which is directly traceable to a National Standard. All data interpreted per Entran Instruction Manuals unless otherwise indicated.

CAL EQUIPMENT S/N'S: Acc: 486
Entran by: BY Cal. Date: 7/25/86 QC: 06 FO#: 29648
Property of: PO:

DIV. 458013

10Hz 2 3 4 5 6 7 8 9 100Hz 2 3 4 5 6 7 8 9 1KHz 2 3 4 5 6 7 8 9 1

Y = $\sqrt{X}$ 1dB ()

PLEASE READ OPERATING INSTRUCTIONS
BEFORE POWERING UNIT

dB

dB

dB

Entran

(X1 Fairfield, NJ, USA)

() Lees Clayco/S/Bois France () Garston, Watford, Herts., UK

SPECIFICATIONS

Model : EGCS-D1S-5-/RS
Range : $\pm 5g$
Limit: $\pm 500g$
Operating: -40 to $250^{\circ}F$
Temperature Range, Compensated: 70 to $170^{\circ}F$

S/N: X5041

Axis:

Operating: -40 to $250^{\circ}F$

CALIBRATION DATA

Subject to 10,000g Shock In: () Sensitive Axis Only () All Axes

1,2 Non-Linearity: $\pm 1\%$

1 Zero :

R Cal : $26.00 \frac{mV}{g}$

Output : $26.00 \frac{mV}{g}$

Ref. Temp : $75^{\circ}F$

Tested with:

Output :

Output Q : 1846

with In :

Output Q : 892

Max. In :

See Over ()

2X-axis :

2TSS : $\pm 2\frac{1}{2}\%FS/100^{\circ}F$

across :

Max. In : 18.0 VDC

4 Approx. In:

S/N:

ACCELEROMETER WIRING

To Module :
+In: $\sqrt{X}$ Red ()
-In: $\sqrt{X}$ blk ()
Total: 3 ± 1
+Out: $\sqrt{X}$ Grn ()
() Grn & Blue
-Out: $\sqrt{X}$ Wht ()

Male:

ELECTRONICS

Male :

+Signal In :

-Signal In :

Male :

+Signal Out :

-Signal Out :

Common :

(For $\pm 15V$ input, Do not use
unipolar 30V power supply)

¹ If calibrated data equals or exceeds data sheet specifications, value shown is the data sheet value unless purchase order specifies actual calibrated value. ² Value given is by manufacturing design and not calibrated unless purchase order specifies actual calibrated value. TSS is Thermal Sensitivity Shift. ³ Input/Output Impedance is recorded for transducer alone if separate item from electronics. 4 In means Resonant Frequency.

CERTIFICATE OF CALIBRATION

Proper ty of : P.O.#: Entran FO# : 29648

PLEASE READ OPERATING INSTRUCTIONS BEFORE POWERING UNIT
CAUT ON: DO NOT PRESS OR LOAD THE SENSITIVE AREA WITH SHARP OR POINTED OBJECT

Mode: 1MW-15/15/100A-WW-R/S
Type :
Range :
Temperature Range :
Reference Compensated :
NOTE: Exceeding Installation Torque of
4 Mode :
Do Not Exceed :
Operating :
may damage unit.

CALIBRATION DATA

1 CNL&H :
1 Zero :
1 Ref. Temp :
1 Shunt Cal :
1 Sensitivity : Gain = 100
1 Tested with :
1 Sensitivity :
1 Input ohms :
1 Cal Equip. :
Notes : 1MW is adjustable; sensitivity shown above is as shipped.

WIRING

Transducer to Compensation Module
+In: (X) Red ()
+Out: (X) Grn () Grn&Blu ()
-Out: () Yel () Yel&Blu ()
-In: (X) Black ()
Connector :
Signal in Connector :
+Sensor Power: Red (+15 VDC)
-Sensor Power: Black (0)
Mate: +Signal in: Green or Yellow
-Signal in: White
Amp Out Connector :
+Signal Out: Yellow
-Signal Out: White
Mate: Common: White
Notes:
+Supply: Red (+15 VDC)
-Supply: Black (-15 VDC)

If calibrated data equals or exceeds data sheet specifications, value shown is the data sheet value unless purchase order specifies actual calibrated value. CNL&H is combined non-linearity and hysteresis. Value given by manufacturing design and not calibrated unless purchase order specifies actual calibrated value. Input/Output impedance recorded for transducer alone if separate item from electronics. Load cells must be loaded with load on-center and perpendicular to the flat surface of the device. The load must be equally distributed over the load bearing surface. DO NOT load with a ball type press or any device which makes a point or line contact. DO NOT load only one edge or unevenly. DO NOT torque the body of a thread mounted load cell during mounting. For $\pm 15V$ input, DO NOT USE unpolar 30V power supply.

Entran® by: CE Calibration Date: 7/25/96 QC : 0.5

(X) Fairfield, N.J., USA () Garston, Watford, Herts., UK () Les Clayes-sous-Bois, France

CERTIFICATE OF CALIBRATION

Property of :

P.O.#:

Entran FO# : 29648

PLEASE READ OPERATING INSTRUCTIONS BEFORE POWERING UNIT

CAUTION: DO NOT PRESS OR LOAD THE SENSITIVE AREA WITH SHARP OR POINTED OBJECT

Model : IMV-15/15/100A-WM/RS

S/N : 96G96E20-102

Type :

⁴ Mode :

⁴ Range :

Reference :

Do Not Exceed :

Temperature Range :

Compensated :

Operating :

NOTE: Exceeding Installation Torque of

may damage unit.

CALIBRATION DATA

¹ CNL&H :

¹ Hysteresis :

¹ Non-linearity :

¹ Zero :

Thermal Zero Shift :

² Thermal Sens. Shift :

Ref. Temp :

:

² Non-repeatability :

Shunt Cal :

with

across

Sensitivity : Gain = 100

with Excitation : ± 15 VDC

Max. Excitation : ± 18 VDC

Tested with :

S/N :

Sensitivity :

⁵ with Excitation :

Max. Excitation :

³ Input ohms :

³ Output ohms :

Cal Equip. :

Notes : IMV is adjustable; sensitivity shown above is as shipped.

WIRING

Transducer to Compensation Module

+In: (X) Red ()

+Out: (X) Grn () Grn&Blu ()

Total:

() Yel () Yel&Blu ()

-In: (X) Black ()

-Out: (X) Wht ()

Connector :

Mate:

⁵ Electronics :

Signal In Connector:

Mate:

+Sensor Power: Red (+15 VDC)

+Signal In: Green or Yellow

-Sensor Power: Black (0)

-Signal In: White

Amp Out Connector:

Mate:

+Supply: Red (+15 VDC)

+Signal Out: Yellow

Common: White

-Supply: Black (-15 VDC)

-Signal Out: White

Notes:

¹ If calibrated data equals or exceeds data sheet specifications, value shown is the data sheet value unless purchase order specifies actual calibrated value. CNL&H is combined non-linearity and hysteresis. ² Value given is by manufacturing design and not calibrated unless purchase order specifies actual calibrated value. ³ Input/Output impedance recorded for transducer alone if separate item from electronics. ⁴ Load cells must be loaded with load on-center and perpendicular to the flat surface of the device. The load must be equally distributed over the load bearing surface. DO NOT load with a ball type press or any device which makes a point or line contact. DO NOT load only one edge or unevenly. DO NOT torque the body of a thread mounted load cell during mounting. ⁵ For ± 15 V input, DO NOT USE unipolar 30V power supply.

The above instrument has been calibrated against a working standard which is directly traceable to a National Standard. All data interpreted per Entran Instruction Manuals unless otherwise indicated.

Entran[®] by: C.B.

Calibration Date: 7/25/96

QC : 5
O.C.

(X) Fairfield, N.J., USA

() Garston, Watford, Herts., UK

() Les Clayes-sous-Bois, France

CERTIFICATE OF CALIBRATION

Property of

P.O.#:

Entran FO#: 29648

PLEASE READ OPERATING INSTRUCTIONS BEFORE POWERING UNIT

CAUTION: DO NOT PRESS OR LOAD THE SENSITIVE AREA WITH SHARP OR POINTED OBJECT

Model: IMV-15/15/100A-WW-/RS

S/N: 96695D15-103

Type

⁴ Range

Temperature Range

Reference

Compensated

⁴ Mode

Do Not Exceed

Operating

NOTE: Exceeding Installation Torque of

may damage unit.

CALIBRATION DATA

¹ CNL&H

¹ Zero

Ref. Temp

Shunt Cal

Sensitivity: Gain = 100

Tested with

Sensitivity

³ Input ohms

Cal Equip.

Notes

¹ Hysteresis

Thermal Zero Shift:

with

with Excitation: ± 15 VDC

⁵ with Excitation

³ Output ohms

¹ Non-linearity

² Thermal Sens. Shift:

² Non-repeatability

across

Max. Excitation: ± 18 VDC

S/N:

Max. Excitation

IMV is adjustable; sensitivity shown above is as shipped.

WIRING

Transducer to Compensation Module

+In: (X) Red ()

-In: (X) Black ()

Connector

+Out: (X) Grn () Grn&Blu ()

() Yel () Yel&Blu ()

-Out: (X) Wht ()

Mate:

Total:

⁵ Electronics

Signal In Connector:

+Sensor Power: Red (+15 VDC)

-Sensor Power: Black (0)

Mate:

+Signal In: Green or Yellow

-Signal In: White

Ampl Out Connector:

+Supply: Red (+15 VDC)

-Supply: Black (-15 VDC)

Notes:

+Signal Out: Yellow

-Signal Out: White

Mate:

Common: White

¹ If calibrated data equals or exceeds data sheet specifications, value shown is the data sheet value unless purchase order specifies actual calibrated value. CNL&H is combined non-linearity and hysteresis. ² Value given is by manufacturing design and not calibrated unless purchase order specifies actual calibrated value. ³ Input/Output impedance recorded for transducer alone if separate item from electronics. ⁴ Load cells must be loaded with load on-center and perpendicular to the flat surface of the device. The load must be equally distributed over the load bearing surface. DO NOT load with a ball type press or any device which makes a point or line contact. DO NOT load only one edge or unevenly. DO NOT torque the body of a thread mounted load cell during mounting. ⁵ For ± 15 V Input, DO NOT USE unipolar 30V power supply.

The above instrument has been calibrated against a working standard which is directly traceable to a National Standard. All data interpreted per Entran Instruction Manuals unless otherwise indicated.

Entran® by: CB

Calibration Date: 7/25/96

QC: 5
O.C.

(X) Fairfield, N.J., USA

() Garston, Watford, Herts., UK

() Les Clayes-sous-Bois, France

CERTIFICATE OF CALIBRATION

PORT OF

P.O.#:

Entran FO#: 29648

PLEASE READ OPERATING INSTRUCTIONS BEFORE POWERING UNIT
CAUTION: DO NOT PRESS OR LOAD THE SENSITIVE AREA WITH SHARP OR POINTED OBJECT

Model: HV-15/15/100A-WW-/RS

S/N: 96G95H08-104

Type

4 Mode :

Range

Reference :

Do Not Exceed :

Temperature Range

Compensated :

Operating :

NOTE: Exceeding Installation Torque of

may damage unit.

CALIBRATION DATA

1 CNL&H :

1 Hysteresis :

1 Non-linearity :

1 Zero :

Thermal Zero Shift:

2 Thermal Sens. Shift:

Ref. Temp :

:

2 Non-repeatability :

Shunt Cal :

with

across

Sensitivity : Gain = 100

with Excitation : ± 15 VDCMax. Excitation : ± 18 VDC

Tested with :

S/N :

Sensitivity :

5 with Excitation :

Max. Excitation :

3 Input ohms :

3 Output ohms :

Cal Equip. :

Notes : (MY is adjustable; sensitivity shown above is as shipped.)

WIRING

Transducer to Compensation Module

:

Total:

+In: (X) Red ()

+Out: (X) Grn () Grn & Blu ()

-In: (X) Black ()

-Out: (X) Yel () Yel & Blu ()

Connector :

Mate:

5 Electronics :

Signal In Connector:

Mate:

+ Sensor Power: Red (+15 VDC)

+ Signal In: Green or Yellow

- Sensor Power: Black (0)

- Signal In: White

Amp Out Connector:

Mate:

+ Supply: Red (+15 VDC)

+ Signal Out: Yellow

Common: White

- Supply: Black (-15 VDC)

- Signal Out: White

Notes:

¹If calibrated data equals or exceeds data sheet specifications, value shown is the data sheet value unless purchase order specifies actual calibrated value. CNL&H is combined non-linearity and hysteresis. ²Value given is by manufacturing design and not calibrated unless purchase order specifies actual calibrated value. ³Input/Output impedance recorded for transducer alone if separate item from electronics. ⁴Load cells must be loaded with load on-center and perpendicular to the flat surface of the device. The load must be equally distributed over the load bearing surface. DO NOT load with a ball type press or any device which makes a point or line contact. DO NOT load only one edge or unevenly. DO NOT torque the body of a thread mounted load cell during mounting. ⁵For ± 15 V input, DO NOT USE unipolar 30V power supply.

The above instrument has been calibrated against a working standard which is directly traceable to a National Standard. All data interpreted per Entran Instruction Manuals unless otherwise indicated.

Entran® by: CR

Calibration Date: 7/25/96

QC: 5
O.C.

(X) Fairfield, N.J., USA

() Jarston, Watford, Herts., UK

() Les Clayes-sous-Bois, France

CERTIFICATE OF CALIBRATION

Extrant

P.O.#:

Extrant FO#: 29648

PLEASE READ OPERATING INSTRUCTIONS BEFORE POWERING UNIT
CAUTION: DO NOT PRESS OR LOAD THE SENSITIVE AREA WITH SHARP OR POINTED OBJECT

Mode: 1MV-15/15/100A-WW-RS

S/N: 96G95F30-105

Type:
Range:
Temperature Range:
Reference:
Compensated:
NOTE: Exceeding Installation Torque of

Mode:
Do Not Exceed:
Operating:
may damage unit.

CALIBRATION DATA

¹ CNL&H :	¹ Hysteresis :	¹ Non-linearity :
¹ Zero :	Thermal Zero Shift:	² Thermal Sens. Shift:
Ref. Temp :	:	² Non-repeatability :
Shunt Cal :	with	across
Sensitivity : Gain = 100	with Excitation : ±15 VDC	Max. Excitation : ±18 VDC
Tested with :		S/N :
Sensitivity :	⁵ with Excitation :	Max. Excitation :
³ Input ohms :	³ Output ohms :	
Cal Equip. :		
Notes : 1MV is adjustable; sensitivity shown above is as shipped.		

WIRING

Transducer to Compensation Module

+In: (X) Red ()

+Out: (X) Grn () Grn&Blu ()

Total:

-In: (X) Black ()

-Out: (X) Wht ()

Connector :

Mate:

⁵ Electronics :

Signal In Connector:

Mate:

+ Sensor Power: Red (+15 VDC)

+Signal In: Green or Yellow

- Sensor Power: Black (0)

-Signal In: White

Amper Out Connector:

Mate:

+Supply: Red (+15 VDC)

+Signal Out: Yellow

Common: White

-Supply: Black (-15 VDC)

-Signal Out: White

Notes:

¹If calibrated data equals or exceeds data sheet specifications, value shown is the data sheet value unless purchase order specifies actual calibrated value. CNL&H is combined non-linearity and hysteresis. ²Value given is by manufacturing design and not calibrated unless purchase order specifies actual calibrated value. ³Input/Output impedance recorded for transducer alone if separate item from electronics. ⁴Load cells must be loaded with load on-center and perpendicular to the flat surface of the device. The load must be equally distributed over the load bearing surface. DO NOT load with a ball type press or any device which makes a point or line contact. DO NOT load only one edge or unevenly. DO NOT torque the body of a thread mounted load cell during mounting. ⁵For ± 15V Input, DO NOT USE unipolar 30V power supply.

The above instrument has been calibrated against a working standard which is directly traceable to a National Standard. All data interpreted per Extrant Instruction Manuals unless otherwise indicated.

Extrant® by: CB

Calibration Date: 7/25/96

QC: 5
3.C.

(X) Fairfield, N.J., USA

() Garston, Watford, Herts., UK

() Les Clayes-sous-Bois, France

Figure 1

© Entran's EOC-240 Accelerometer Cutaway

INSTRUCTION & SELECTION MANUAL FOR ENTRAN ACCELEROMETERS

1. PRINCIPLE OF OPERATION:

Entran accelerometers employ either a fully active or half active Wheatstone Bridge consisting of semiconductor strain gages. The strain gages are bonded to a simple cantilever beam which is end loaded with a mass (See Figure 1). Under acceleration, a "g" force, the force on the cantilever is created by the g effect on the mass ($F = ma$). The accelerated mass creates a force which in turn provides a bending moment to the beam. This moment creates a strain (proportional to the acceleration) which results in a bridge unbalance. With an applied voltage, this unbalance produces a mV deviation at the bridge output, which is proportional to the acceleration vector.

2. RANGE:

The range of the accelerometer represents the recommended maximum peak 'g' level for a linear response. Standard units are designed so that the Full Scale Range is well within a 1% error band for non-linearity. Deviations from linearity are prominent in the region of the range closest to its full scale. The accelerometer is extremely linear as it approaches zero "g" from full scale. In fact, for most standard units, non-linearity approximates 1% of reading rather than 1% of full scale. This enables the user to employ an accelerometer at as much as 0.01% of full scale without being effected by the linearity error. For example, a 500g accelerometer can be employed to measure 5g FS and still maintain a relative non-linearity of 1% of the 5g.

Above the Range, the response becomes increasingly non-linear but the transducer continues to operate. **CAUTION: DO NOT APPLY FULL SCALE RANGE AT FREQUENCIES ABOVE 50% OF RESONANT FREQUENCY.** This may cause damage to the unit. (DO NOT SWEEP THROUGH RESONANT FREQUENCY WITH HIGHER THAN A 5% FS "g" LEVEL WHEN TESTING UNDAMPED ACCELEROMETERS.)

3. OVERRANGE:

Overrange represents the maximum suggested "g" level (applied from 0 to 30% resonant frequency) that the accelerometer will sustain without damage. Data sheet values are conservative and accelerometers can withstand higher values. Check with Entran directly if you require higher overranging than posted in the data sheets. **CAUTION: DO NOT OVERRANGE ACCELEROMETERS BEYOND 30% OF RESONANT FREQUENCY.** This can result in failure due to the extreme multiplicative effect of the resonance. Be aware of the fact that dropping an accelerometer from 10" can represent a 500g shock impact and also excites the resonant frequency. This will exceed the overrange of most low to medium "g" accelerometers.

IF ROUGH HANDLING WILL BE PRESENT, contact Entran for alternative approaches to overload protection. Entran has developed three techniques for increasing handling capability for rough usage. With the use of viscous damping, overrange stops and/or special protective housings, accelerometers have been fabricated with 1000 times overrange and capability to take a 6 ft. drop to a steel surface. FOR LOW "G" RANGE ACCELEROMETERS, ENTRAN STRONGLY RECOMMENDS PURCHASE OF THE DAMPING OPTION TO REDUCE THE CHANCE OF OVERRANGE FAILURE DURING HANDLING AND MOUNTING, OR MODELS WHICH INCLUDE OVERRANGE STOPS SUCH AS THE EGAX OR EGC-500DS SERIES.

4. RESONANT FREQUENCY AND FREQUENCY RESPONSE:

Standard undamped accelerometers are a single degree of freedom oscillating system. The useful frequency range is linear to within $\pm 5\%$ at up to 20% of the resonant frequency. From 20% of resonance to resonance, the accelerometer's sensitivity can increase to over +40dB (over 100 times the linear output. See Figure 2). Above resonance, the sensitivity decreases to a point at which the accelerometer no longer responds to an acceleration input. All Entran semiconductor strain gage accelerometers operate in a DC or static mode (0 Hz.). This allows the accelerometer to read unidirectional acceleration or even gravity. With the sensitive axis parallel to the earth's gravity vector, the units read 1g. Exciting the transducer above its linear range (20% of resonant frequency) can be dangerous and should be done with extreme care. **CAUTION:** AT RESONANCE, THE ACCELEROMETER SEES AN APPARENT LOAD OF OVER 100 TIMES THE INPUT ACCELERATION. THIS CAN CAUSE FAILURE IF IT EXCEEDS THE OVERRANGE OF THE ACCELEROMETER. If input signals near the resonant frequency exist in the system to be measured, we suggest using a damped accelerometer. Viscous damping can reduce the resonant peak to less than +3dB and eliminate resonant excitation problems.

If small resonant excitations exist and present a noise problem in signal interpretation, simple filtering can be used to remove them from the signal output. For shock measurements, the shock pulse should also be at a time interval less than 20% of resonance as it will excite the resonance. For best shock data, we suggest using an accelerometer with viscous damping or a high resonant frequency.

All standard Entran accelerometers are supplied with a continuous calibration of sensitivity versus frequency. This permits the user to see the exact response of the accelerometer. If data is apparent above 20% of the resonant frequency, the user can refer to the calibration curve for sensitivity corrections to obtain useful data.

TO: Milon Myer FAX: 509-943-1835 DATE: August 6, 1996COMPANY: MCE

Dear Mr. Myer,

In reference to the calibration certificates for the EGCS-D1S-5-/RS where the calibration curve begins is where our equipment starts to record. We will not be able to fill it in before that point. The units are however flat to ± 1 db from DC to 30% of the Resonant Frequency. The Resonant Frequency for those units is 370Hz nominal. There is no zero on the calibration certificates because the calibration is done using a reference frequency. The reference frequency is listed under "CALIBRATION DATA" on your certificates. For the 5 EGCS-D1S-5-/RS for your order the reference frequency is 50Hz.

Also, in reference to the magnetic influence you wanted to reduce, a 17-4 stainless steel standoff would be better than the aluminum.

Please let me know the result of the 1g flig test for the units. If you should need anything else, please feel free to contact me.

Regards,

Elizabeth Ticas
Sales Engineer**Entran**[®]
Sensors & ElectronicsEntran Devices, Inc.
10 Washington Avenue, Fairfield, N.J. 07004-3877, USAFax: (201)227-6865
Tel : (888)8-ENTRAN or (201)227-1002

Continued -

Sketch the test setup and relative position of the accelerometers:

(Include pre-mounted bracket description and dimensions, field installed orientation, distance between accelerometers, distance between accelerometers and casing(s), depth of accelerometers, and instrument staging/setup.)

APPENDIX E - Water Development Hanford, INC. Procedure 021, Rev 0, *In Situ*
Characterization Percussion Probe Installation

In Situ Characterization Percussion
Probe Installation

Approval, D. J. Moak
Vice President Administration

1.0 Purpose

This procedure provides requirements for the materials and the installation of percussion installed in situ characterization probes. The in situ probe is constructed from a closed bottom steel casing or pile and is driven into the soil by a high power to weight ratio hammer (e.g. ICE Model 40S) that can be mounted in the mast of a large multi-purpose drill rig such as the XT*70E.

2.0 Responsibilities

The percussion hammer/driller operator should:

- Maintain and supply the equipment in a state of readiness,
- Monitor equipment performance and take immediate measures to correct problems,
- Assure probe installation meets client's requirements for straightness, penetration rates, depths etc. and immediately notify supervisor of any deviations,
- Ensure records are prepared and processed in accordance with this procedure,
- Comply with all applicable procedures and safety precautions.

3.0 Requirements

3.1 Qualifications

The drill operator must demonstrate experience, training and qualifications in the safe operation of the equipment to the satisfaction of management. The operator must possess a current well construction operator's license and the required safety training. Personnel assisting the operator must possess training and experience applicable to the tasks assigned them. Qualifications of personnel shall be documented and maintained with permanent training records.

3.2 Safety Requirements

All in situ probe installation activities conducted at characterization or well construction sites shall comply with applicable site safety plans, Radiological Work Permits (RWP), applicable federal and state regulations as well as applicable portions of the WDH company safety plan, this procedure, and any additional safety requirements required by the client.

WATER DEVELOPMENT HANFORD, INC.

Procedure 021
Revision 0
July 26, 1996
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Safety equipment may include steel-toed shoes/boots, hard hat, gloves, eye and hearing protection, and site specific personal protective equipment.

Specific safety precautions for operation of the ICE 40S diesel pile hammer are contained in the Operator's Manual. The Manual states, "Safety is basically a matter of common sense. There are standard safety rules, but each situation has its own peculiarities which cannot always be covered by rules." Key items to be attentive to include:

- Keep hands away from intake/exhaust ports when hammer is running,
- Use care when working around the hammer as it becomes very hot,
- Stay clear of hammer when it is in operation,
- Do not work under boom, hammer, leads or piling and stay away from area where piling enters the ground,
- Inspect wire rope frequently for wear and assure bolts are properly torqued
- Coordinate all work activities near operating equipment with the drill operator.

3.3 Activities Conducted Within Surface or Underground Contaminated Areas

Movement of equipment into and out of areas identified as having the potential for surface or subsurface radiological contamination will be conducted in accordance with client's procedures. Special instructions pertaining to activities in these areas (i.e. dosimetry, personal protective equipment) will be outlined in the RWP. The client shall provide applicable surveys prior to mobilizing into the area to document the equipment is free of contamination, shall have applicable procedures for the survey and release of the equipment upon completion of the job and assure appropriate compensation policies are in place if the equipment becomes contaminated.

4.0 Equipment

4.1 Surface and subsurface equipment for in situ probe installation includes:

- Deployment system (e.g. XT*70E drill) including casing handling tools,
- Generally a high power-to-weight ratio hammer (e.g. ICE Model 40S),
- Casing and tips to meet client's requirements; it is recommended that for depths greater than 50 feet and in greater than 8 inch diameter that Schedule 80, or P-110, or equivalent pipe be utilized. The pipe should be flush-coupled with a casing hammer thread.

Alternatively, consideration can be given to welded casing joints. Casing lengths with the XT*70E and an ICE 40S hammer can be no longer than 10 feet. With a large hammer, such as the ICE 40S, a flat plate welded inside and out, to the bottom casing shoe joint provides the best tip in meeting the client's

WATER DEVELOPMENT HANFORD, INC.

Procedure 021
Revision 0
July 26, 1996
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vertical/angle requirements. Conical tips are more likely to deviate when encountering hard layers or boulders. Tips can be fabricated per client's direction.

- Equipment to assist client, as directed, in installation of characterization tools,
- Manufacturer's operating manuals.

note: When operating in areas of radiation and to minimize radiological contamination of tools and equipment mobilize only the minimum equipment needed to the area. Extra materials should remain in a nearby "clean" area for use as needed.

4.2 Cleaning/Decontamination

Decontamination/Cleaning of the probe driving equipment and materials shall be performed and in accordance with WAC-173-160-173 or client's procedures appropriate for the equipment being used. Radiological surveying will be performed by qualified technicians. Radiological decontamination will be performed if required and at the direction of the radiological control technicians.

5.0 Procedure for Installation of In Situ Characterization Probe

5.1 Preparations

5.1.1 Equipment and Materials

Verify all equipment is available and in working order (drill, diesel hammer) and safety/maintenance inspections are current and documented.

5.1.2 Daily Summary Sheet and Decontamination Records

Use the Daily Summary Sheet to record pertinent information and equipment decontamination for each in situ probe installation workday:

- If a particular data field is not applicable to a particular workday, indicate by entering N/A in that field
- Make all log entries with permanent black ink
- Line out corrections with a single line and place the correct entry as close as possible to the incorrect one. Initial and date the correction
- The log entries should be signed and dated by the individual entering the information.

5.1.3 Elevation Datum

The casing reference zero shall be the estimated ground surface at drilling/well construction sites. The ground surface elevation, if known, shall be recorded on the Daily Sheet. Total depth of the probe and length of casing above surface shall be recorded.

5.1.4 Equipment Setup

Only the minimal amount of equipment shall be mobilized into areas where it may become contaminated. Any maintenance and operational testing of the equipment shall take place prior to setup at the site of the probe installation. If the casing shoe is to be welded to the bottom casing joint, it should be done prior to mobilizing onto the site. The equipment should be mobilized and staged in accordance with any special instructions provided by the client. The equipment should be setup in accordance with safe operating practices.

5.2 In Situ Characterization Probe Installation

- 5.2.1 Inspect lines, sheaves and hydraulic system prior to rig-up. Assure all wire rope clips are properly installed.
- 5.2.2 Drill rig will be leveled and the mast erected using sufficient blocking under each jack.
- 5.2.3 Hammer will be lowered and temporarily supported on the table.
- 5.2.4 The top plate on the hammer will be removed prior to firing the hammer.
- 5.2.5 Hammer will be lifted to a height of approximately 12 ft.
- 5.2.6 The lead joint of casing which will consist of a 10 ft. piece of casing and a closed bottom shoe will be set on the ground, clamped with a casing guide and the hammer will then be placed on the top of the joint.
- 5.2.7 Hammer will then be placed in a float position with the brake release so as to advance downward with the pipe.

CAUTION: Assure all personnel have ear plugs in place.

- 5.2.8 The hammer should then be latched and the steel run in to the bit.

- 5.2.9 The anvil is then lifted and released to begin the hammer operation.
- 5.2.10 The hammer power is adjusted by the driller adjusting the fuel flow.
- 5.2.11 When the casing joint is driven down to the top of the table, approximately 45 inches from the ground, the hammer is then lifted to a height of approximately 12 ft., the brake set and the drive head on the driver casing is removed.
- 5.2.12 A removable drive head is attached to the next piece of casing and a winch used to lift the next joint of casing. Each joint is lubricated with a biodegradable lubricant, such as Wellguard.
- 5.2.13 The casing is threaded together using a spinning rope and cathead. The joints are tightened with the hydraulic wrenches to assure the energy is not lost in joint flex and to assure straightness of the probe.
Pipe is torqued to between 40,000 to 50,000 ft/lbs..
- 5.2.14 The driving process is repeated until total depth is reached, verifying straightness of the casing as identified below.

5.3 Straightness Test

The casing must frequently be checked to assure it is not deviating from the alignment requirements required to accept the probes, sensors or devices planned to be inserted into the casing. The casing alignment can either be determined by lowering a dummy probe slightly larger and longer than the largest characterization tool planned to be run.

The alignment test should be performed at least every 30 feet depending on the casing size, depth and any suspected deviation. As an example, for a probe hole of approximately 6 inch casing requiring close vertical tolerances, and using 10 foot lengths of pipe, the alignment will be checked every 10 feet. Other survey methods can be used per client's direction. If the casing appears to be deviating, the driller should immediately contact the client to ascertain whether to proceed or not.

6.0 Completion/Demobilization

After reaching the total depth, the characterization probe hole will be completed in accordance with direction from the regulatory agency (e.g. WDOE) and at the direction of the client, the drill will be rigged down, surveyed and decontaminated as applicable. The drill will be moved to the next site or demobilized from the project.

The in situ characterization probe casing will have a surface completion pad installed in accordance with regulatory requirements.

7.0 Records / Submittals

The Water Development Hanford operator, or field supervisor, shall complete the WDH Daily Summary Sheet and the In Situ Characterization Probe Data Sheet. The report shall legibly record all daily activities such that an accurate and detail reconstruction of the daily activities can be performed by an independent reviewer. The reports shall also record any additional information, or complete any additional documentation / forms required by the client in accordance with the subcontract. As a minimum the reports shall:

- have all blocks on the form completely filled out,
- record all field activities such as driving time, downtime etc.
- record the specifications and dimensions of all materials and equipment used
- record the driven depth of each casing to the nearest 0.1 ft.

Prior to installation of the characterization probes the operator shall assure that applicable information has been submitted:

- WAC 173-160, "Minimum Standards for the Construction and Maintenance of Wells", requires a variance be approved by the State since the probe will not have an annular seal as required. Other variances may be required. A "Start Card" is required to be filed with the State at least 72 hours prior to initiating the installation of the probe other state and federal requirements, if applicable,
- any submittals required by the client per the subcontract (e.g. resumes, training records, material conformance specifications, cleaning/decontamination records
- the client has provided assurances that all client-provided permits, approvals, training and documents are complete. Examples of these could include excavation permits, cutting/welding permits, Radiation Work Permits, Site Specific Safety Plans.

At completion of the project WDH shall also prepare completion reports, per WAC 173-160 and provide copies of these, and any other required documentation to the client.

Water
Development
Hanford, Inc.

WHC-SD-WM-TRP-263, Rev. 8/1

IN SITU-CHARACTERIZATION PROBE DATA SHEET

DATE: _____

OPERATOR: _____

LOCATION: _____

PERSONNEL: _____

PROBE ID. NUMBER: _____

RIG: _____ HAMMER: _____

STARTER CASING SIZE _____

STARTER CASING DEPTH _____

DRIVE CASING SIZE/TYPE _____

TIP: FLAT _____

CONICAL _____

JOINTS: WELDED _____

THREADED _____

Casing Section	Blows/min	Operating Stroke	Driving Time	Tie Depth
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

REFER TO APPENDIX D

Reviewed By: _____

WCH Representative

WATER DEVELOPMENT HANFORD INC.

APPENDIX F - Excerpt From ICE405 Operations Manual - Determining Hammer Energy

3. Determining hammer energy

The energy at which the hammer is operating may be determined by measuring the operating stroke and multiplying the stroke by the weight of the ram (4,000 lbs) to get energy in ft-lbs. The ram is marked at the 6' and 8' stroke positions with yellow bands. The operating energy can also be determined by counting the blows per minute and referring to the table below.

Blows per minute	Operating stroke	Operating energy
37.8	10.00'	40,000 ft-lbs
38	9.90	39,600
39	9.36	37,440
40	8.83	35,320
41	8.39	33,560
42	7.97	31,880
43	7.57	30,280
44	7.20	28,800
45	6.84	27,360
46	6.54	26,160
47	6.23	24,920
48	5.91	23,640
49	5.63	22,520
50	5.33	21,320
51	5.07	20,280
52	4.80	19,200
53	4.52	18,080
54	4.24	16,760
55	3.93	15,720