Atlantic Richfield Hanford Company
Richland, Washington 99352

ARH-CD-692

FREEZE BLOCK TESTING OF BURIED WASTE LINES

E. D. Robbins
J. C. Willi

May 20, 1976

PREPARED FOR THE U.S. ENERGY RESEARCH AND DEVELOPMENT
ADMINISTRATION UNDER CONTRACT E (45-1) 2130

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May 20, 1976

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Drawings H-2-38409, H-2-38410, H-2-38411

Standard Operating Procedure, 300.16A, "Pressure Testing by
Freeze Block Method"

FREEZE BLOCK TESTING OF BURIED WASTE LINES

1.0 INTRODUCTION

The method of freeze blocking is a possible technique to certify those waste transfer lines which terminate without access such that a standard hydrostatic pressure test cannot be employed. A shop demonstration of the freeze block method was performed followed by a field demonstration on an actual transfer pipeline. These demonstrations have exhibited that freeze blocking can be utilized for qualification of line integrity.

2.0 SUMMARY AND CONCLUSIONS

The object of this investigation is to demonstrate application of freeze blocking in waste transfer lines such that a hydrostatic pressure test can be applied. A shop test was conducted on a 20-foot length, 3-inch schedule 40, carbon steel pipe using a coolant of dry ice and Freon. The positive results from these tests prompted a similar employment of the freeze block method in hydrostatic pressure testing the feed inlet leading to 241-S-101 Waste Tank. This pipeline is a 3-inch schedule 10, stainless steel pipe approximately 800 feet long.

The freeze block was successfully formed near the lower end of the pipe as it entered the 101-S Waste Tank and a pressure hold test was successfully applied to this pipeline. This test proved the integrity of the pipeline in question, and demonstrated the validity of freeze blocking an open-ended pipeline which could not be hydrotested in other conventional ways. The field demonstration facility, costing \$30,200 was completed late in 1975.

3.0 DESCRIPTION

Atlantic Richfield Hanford Company manages 156 waste tanks in the 200 Areas of the Hanford complex. Buried pipelines leading to these waste tanks terminate at the tank walls and there is no convenient way to test the integrity of these waste lines. Many of these transfer lines have a duplicate spare line running alongside the service line so that in case of failure, the second could be placed in service.

The length of these buried waste lines varies from 200 to 1000 feet. They are fabricated from schedule 10 pipe, Type 347 or 304L stainless steel or schedule 40 carbon steel and their upper terminus is a diversion box connector. At this point the pipe may be 4 to 6 feet below grade. The typical waste line slopes gently down and enters the waste tank approximately 20 to 25 feet below grade. This depth and inaccessibility is one reason why test block valves were never installed. Another reason is that the waste line is ordinarily encased in concrete or inside another pipe. Leakage, should it occur from the waste line, would travel down the encasement to a catch tank where it can be monitored and emptied via jet or pump. Catch tanks are direct buried and situated below the encasements.

For these reasons, a suitable qualifying test has been sought to demonstrate line integrity and properly certify each line for a given period of time. The freeze block method was suggested as one possible technique to provide a temporary closure within deeply buried waste lines so that a hydrotest could then be employed in the normal fashion. Practical application of this method is common practice in industrial maintenance. For example, United Nuclear Industries, Inc., routinely employs freeze blocking for the removal of piping components from static pressurized pipelines. However, formation of an ice plug is relatively easy on these static bodies of water. Employment of freeze blocking to an empty line is considerably more difficult to achieve because it involves the formation of an ice plug in a flowing stream. Water must be trickled down the pipeline at such a slow rate that the resident time in the block is sufficient to allow phase transformation of the water molecules and formation of an ever increasing buildup of ice in the bottom of the pipe. Gradually, over a period of time, the ice block builds sufficiently to completely close the pipe. The upstream portion of the waste line can then be completely filled with water, and the hydrotest applied to inspect the integrity of the pipeline.

Pressure piping codes require visual access and observation of all welded joints during the application of acceptance hydrostatic pressure testing. This visual inspection is required because a slow leak will not release an adequate volume of water to allow relaxation of a stressed pipeline and observation of pressure loss on a pressure gauge. An alternate, for requalification of inaccessible installed piping is application of a long pressure-hold time. Current tank farm waste transfer line qualification procedures call for a 200 psig 30-minute inspection.

Successful demonstration of freeze blocking would properly prove that:

1. The questionable 3-inch pipeline between Diversion Box 241-S-151 and Waste Tank 101-S is intact, and does not leak.
2. The freeze block method is a viable technique for pressure testing waste transfer lines which terminate such that a standard hydrostatic pressure test cannot be employed.

3.1 SHOP FREEZE BLOCK TEST

Formation of an ice plug in a simulated transfer line was evaluated during a shop demonstration program. A 20-foot, 3-inch schedule 40, carbon steel pipe was chosen to represent field piping. A mixture of Freon TA with dry ice is contained in a 4-foot-long freeze box to provide refrigerant exposure to the pipe periphery. Two preliminary tests with a 12-inch-long jacket failed to produce a plug of ice in the pipe even though the coolant temperature reached -109°F . In order to increase the resident time that water would be inside the block zone, a new 4-foot-long jacket was built. This longer jacket was used for all subsequent shop and field testing.

3.1.1 Shop Test 1

Test 1 with the new 4-foot-long jacket resulted in a line closure in a time of 5 hours and 45 minutes. Flow rate was estimated at 5 drops per second. Eleven quarts of water was collected at pipeline outfall. This water loss was considered to be a measure of an excessively high input flow rate since the ideal situation would freeze all water presented to the block zone.

3.1.2 Shop Test 2

An input flow rate of 3 quarts per minute was reduced to $2/3$ -quart per minute after an initial 15-minute period. This was subsequently and incrementally reduced to $1/3$ -pint per minute based upon observation of the outfall. Freezing occurred in 2 hours and 45 minutes and a pressure test at 275 psig held. A qualifying hold test was unsuccessful because of a pipe joint leak at a threaded connection.

3.1.3 Shop Test 3

Test 3 was aborted because of the lack of dry ice.

3.1.4 Shop Test 4

Test 4 also employed a variable input, and an ice plug was formed in 2 hours and 15 minutes. Additional piping connection leaks were detected during a 150 psig 2-hour hold period.

3.1.5 Shop Test 5

Test 5 was completed in 2 hours and 30 minutes with a constant flow rate of 1/4-pint per minute. Pressure was sustained at 200 psig for 2 hours.

3.1.6 Shop Test Discussion

The successful freeze block pressure tests conducted in the pipe shop demonstrated the possibility of freezing a plug of ice in a waste transfer line such that a hydrostatic pressure test can successfully be employed. The freeze block pressure test did have some problems that were easily solved in the shop, but might be very difficult to resolve in the field.

In the shop, the ice plug was visually open to inspection. Growth of the plug could be monitored and a change in water flow rate made to correct efficiency. On a buried waste line, this condition does not exist and although the flow rate is fixed for an optimum growth rate, a problem could develop because of the longer length of waste lines. The ice plug was determined to be complete when the water outflow stopped from the discharge end. This water was readily observable in the shop, but would not be seen on a buried line.

With the longer pipelines any elevation changes in a pipe will effect the efficiency which air can be purged from the pipe. Vacating the air during the shop pressure test was a problem until piping air traps were eliminated. In the shop it was a simple matter to visibly see these problems and correct them. Air entrapment within a pipeline under hydrotest can be a cause for failure interpretation because of the slow volume change in the air pocket due to temperature stabilization.

3.2 FIELD FREEZE BLOCK - DESIGN AND CONSTRUCTION

Based on the success of shop demonstrations, design was formulated calling for a field test site on an existing buried pipeline. Line number 541, a 3-inch schedule 10, stainless steel pipe 800 feet long, leading from Diversion Box 241-S-151 to Waste Tank 241-S-101 was selected. Reference drawings H-2-38409, 38410, and 38411, attached herein, represent the design for the field test facility. Construction was performed by J. A. Jones Construction Company, and was completed late in 1975 at a cost of \$30,200.

Design called for the erection of a vertical 6-foot diameter caisson near the 101-S Waste Tank. It intercepted the 3-inch waste line and 6-inch encasement pipe approximately 20 feet below ground surface, about 10 feet from the waste tank. The 6-inch encasement pipe was severed so that the freeze block assembly could be placed directly around the 3-inch waste line. Contamination from within the 6-inch encasement pipe escaped to the interior of the caisson resulting in radiation readings up to several rads. The annulus between the two pipes was then closed to prevent further contamination buildup, and the construction by JAJ terminated with subsequent

cleanup work performed by ARHCO field forces. After cleanup, radiation monitoring reported that readings were reduced to about 200 mr/hr., at the test pipe surface. This exposure level was considered sufficiently low to allow the freeze block test program to continue.

Operating Procedure SOP 300.16A was prepared to provide field instructions for both the actual freeze block and a line integrity test. The entire text of this procedure is attached.

3.2.1 Line Integrity Test

Because of the contamination problem mentioned above, a line integrity test procedure was instituted. Operating Procedure SOP 300.16A, paragraph III-A was designed to detect a gross line leak by introduction of a high water volume through the subject transfer line accompanied by simultaneous monitoring of the caisson floor and encasement catch tanks. No indication of any leak in the pipeline could be found.

3.2.2 Field Test 1

Field Test 1 was aborted because the radio that the operator carried into the caisson failed to operate.

3.2.3 Field Test 2

Field Test 2 failed to produce an ice plug after 5 hours of water input at the prescribed rate of 1/2 gpm. The operation was discontinued due to a lack of dry ice and Freon TA.

3.2.4 Field Test 3

A procedural departure was made prior to beginning Test 3. The constant input flow rate applied during Test 2 did not conform with the shop test findings which called for an incremental water addition and a very low final rate. The flowmeter in service for the water addition was replaced by a constant displacement metering pump calibrated to deliver 235 ml/min. Due to the uncertainty of the pipeline elevation and contour, a 25 gpm initial input was instituted to assure that any low spots were filled with water before initiating the controlled low flow rate. Safety improvements were also implemented which eliminated the previous requirement that an operator enter the caisson to tend the refrigerant mixture in the freeze box. A mixing box located at grade level and PVC feed pipe leading down to the freeze box were employed to improve safety and efficiency.

Test 3 was then initiated according to the following incremental flow input:

- 25 gpm for the first 5 minutes.
- 2 gpm for the next 30 minutes.
- 1/2 gpm for the next 15 minutes.

235 ml/min. for the next 7 hours.
25 gpm until line full.

After one-half hour from beginning the test, Freon and dry ice were placed in the freeze block assembly.

Upon completion of the flow input program, application of a hydrotest was attempted. The freeze block was apparently successful because a 155 psi line pressure was applied but could not be held because of a visual leak at the diversion pit nozzle connector. This aborted further testing because the problem could not be corrected with personnel available at the time.

3.2.5 Field Test 4

Test 4 was identical to Test 3 with the exception of the reduction from 7 hours to 3-1/2 hours for the controlled volume input. A time limit of 15 minutes was imposed on the 25 gpm final fill. By computation, the 800-foot waste line would require 306 gallons for total fill.

Water was added from the diversion box as follows:

25 gpm for the first 5 minutes.
2 gpm for the next 30 minutes.
1 gpm for the next 15 minutes.
1/2 gpm for the next 30 minutes.
235 ml/min. for the next 3 hours and 30 minutes.
25 gpm until line full.

Test 4 did result in a satisfactory line closure, and a full qualification hydrotest at 148 psig was held for 70 minutes followed by a 201 psig hold for 30 minutes. This finding does serve to certify integrity of the subject line.

SECTION-"A A"

DETAIL-II

SECTION-B-B

SECTIONAL ELEVATION

GENERAL NOTES

- 1- BEFORE REMOVAL OF 4" SECTION OF 3" P-8, ENGAGE DOWEL 'TIE' ELEV. 10.00' TO SMALL WINDOW IN TOP OF P-8. LEAD TO CRACK FOR LIQUID CONTAMINATION IN CASE OF 3" P-8 PLUMB AND REMOVE BEFORE CONTINUING CONSTRUCTION
- 2- QUALITY ASSURANCE LEVELS REQ'D AS SHOWN ON THIS DRAWING
- 3- PAINT ALL CARBON STEEL PARTS ONE COAT RED PRIMER AND TWO COATS BLACK ENAMEL

NAME	U S ATOMIC ENERGY COMMISSION ATTENDING OPERATIONS OFFICE Richfield Hanford Company Rich area, Washington 93112
DATE	2-27-68
TIME	10:20 AM
LOCATION	CAISSON FOR FREEZE BLOCK INSTALLATION 241-S-101 TANK
WORK ORDER NO.	H-2-38410
BY	[Signature]
CHECKED BY	[Signature]
APPROVED BY	[Signature]

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ELEVATION

ELEVATION

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ELEVATION

9

END VIEW

ELEVATION

DETAIL - II

2

1-REMOVE ALL BURRS AND SHARP CORNERS

2. WELDING

WELDING FABRICATION REQUIREMENTS					
A	WELD STANDARDS	☐ AWS	WPS-250-4	☐ AWS	WPS-250-4
B	WELD PROCESS	☐ STAY	WPS-250-4	☐ AWS	WPS-250-4
C	PROCEDURE SPEC.	☐ AWS SEC IX	WPS DI	☐ AWS	WPS-250-4
D	PERFORMANCE QCP*	☐ AWS SEC IX	WPS DI	☐ AWS	WPS-250-4
E	MATERIAL SPEC.	☐ AWS SEC IX	WPS DI	☐ AWS	WPS-250-4
F	TESTING	☐ AWS SEC IX	WPS-250-4	☐ AWS	WPS-250-4
G	PERFORMANCE QCP*	☐ AWS SEC IX	WPS SEC V	☐ AWS	WPS SEC V
H	MAGNETIC PART QCP*	☐ AWS SEC IX	WPS SEC V	☐ AWS	WPS SEC V
I	WELDING PART QCP*	☐ AWS SEC IX	WPS SEC V	☐ AWS	WPS SEC V
J	RADIOGRAPHIC INT	☐ AWS SEC IX	WPS DI	☐ AWS	WPS DI
K	OTHER REQS.	☐ AWS SEC IX	WPS SEC V	☐ AWS	WPS SEC V

3-Quality Assurance shall be Level III

QTY	PT N ^o	DESCRIPTION
X	1	ASSEMBLY
8	2	"C CLAMPS 1 1/2" MAX OPEN
A/R	3	DUCT SEAL
A/R	4	FLAT BAR 1" x 1"
A/R	5	SHEET - #16 GA
1	6	STOPPER - SIZE "OO

[illegible]

TANK FARM MANAGEMENT DEPARTMENT

STANDARD
OPERATING
PROCEDURE

SUBJECT

PRESSURE TESTING BY FREEZE BLOCK METHOD

ISSUED BY

MANAGER -
TANK FARM OPERATIONSI. GENERAL DESCRIPTION

A freeze block installation has been constructed next to TK-101-S. The installation is intended to:

1. Prove whether the three-inch pipeline between TK-101-S and the 241-S-151 diversion box is intact, and does not leak.
2. Demonstrate the freeze block method as a possible technique for pressure testing waste transfer lines which terminate such that a standard hydrostatic pressure test cannot be employed.

Water will be added slowly to the three-inch line until a known amount has been added or until the line fills up. If the line fills up, a pressure test will be conducted.

Prior to the 'Freeze Block Pressure Test' a 'Line Integrity Test' will be performed. If the line fails the 'Integrity Test', the freeze block pressure test will not be attempted.

II. SAFETY

The procedure shall be performed in accordance with Tank Farm Safety Rules, Accident Prevention Standards, and applicable Radiation Work Procedures.

At the conclusion of construction of the freeze block installation, some airborne particle contamination was found between the three-inch pipe under test consideration and the six-inch encasing pipe. This contamination did spread to the inside of the caisson, and is sufficient to prevent much further work at the particular installation until it is cleaned up. If water shows up between the three-inch and six-inch pipe (except condensation) the test must be stopped. Thick gloves must be used when handling the dry ice.

The "Freon TA" solvent is a fluorocarbon solvent and has a significant vapor pressure at room temperature. It has an odor similar to ether and is considered to be harmful in high concentrations. Both the "Freon TA" and the dry ice will vaporize and tend to collect in the bottom of the caisson and displace the breathable air.

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3-1-78

SUPERSEDES DATE ISSUED

12-15-75

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SOP NO.

300.16A

A forced air breathing apparatus will be used prior to the addition of "Freon TA" to the freeze block. The atmosphere near the operator in the caisson will be constantly monitored with an oxygen analyzer. If the compressor fails and the oxygen concentration drops below 19.5% at any time, the caisson will be evacuated immediately.

A harness attached to a lifeline will be used when entering the caisson while dry ice or freon are present. A cable from the hydro-crane will also be attached to the harness for emergency evacuation purposes. The hook and weight on the end of the cable will be removed to prevent the operator from being injured.

If at any time, visibility in the caisson is decreased to the point that the operator cannot be seen from grade level, the test will be stopped. The caisson will be evacuated immediately and no one will be allowed to enter the caisson until the visibility has improved.

Constant radio contact will be maintained between the operator and ground level supervision.

III. PROCEDURE

The operator and other assigned personnel shall follow the written procedure. Temporary written procedural changes may be made by the operations supervisor per instructions in ARH-CD-271.

A. Line Integrity Test Procedure

1. Figures 1 and 2 show the piping plan for the test. The TFO supervisor will ensure that the assembly is connected to nozzle L19.
2. A hose will be connected near valve #6 (air bleed) and run back into DB151S.
3. Open valve #6, #5, #4, #3, #2. Close valve #1.
4. Check and record as closely as possible the liquid levels in :
 - a) Water tank supply truck. 1500 $\pm$ 10 gallons are needed for the pretest.
 - b) Catch tank 241-S-302-B.
 - c) Test riser along northsouth encasement run.
 - d) Waste Tank 101S.
 - e) Freeze block caisson should be completely dry at the bottom before further pretesting.

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5. Connect the raw water hose from the tank truck to hose connection #1 and add 1500 gallons of water, at approximately 50 GPM.
6. Observe and record liquid levels as closely as possible at all points mentioned above in item 4.
7. STOP THE WATER ADDITION IF:
 - a) Liquid level of any catch tank rises.
 - b) Water is seen coming out of the annulus between the 3inch and 6inch pipe, (inside the new caisson). Pump out the liquid to TK101S.
 - c) Water comes out of the hose connected to the air bleed.
 - d) 1,500 gallons of water has been used.
- 8 If there is any liquid buildup at any of the points above, the decision may be made at this time to suspend further testing.

B. Freeze Block Test

The freeze block test procedure shall not be attempted until the line integrity test has proved successful. An operator will always be present at the water truck and another at the caisson. They will be in radio contact with each other. Wrap all radio equipment entering the caisson to reduce possibility of contamination.

Preliminary Instructions

1. Prior to entering the caisson, the operator will equip himself with thick rubber gloves, breathing apparatus, radio and harness. The harness will be worn while the operator is in the caisson and will be attached to a lifeline and a cable from the hydro-crane. The radio is equipped with an earphone attachment that will enable two way communications through the operators ear, operators and standby emergency breathing and retrieval equipment will be available while freon, or dry ice and an operator are in the caisson.
2. The oxygen (O_2) analyzer must be calibrated before entering the caisson. The sensor should be refrigerated prior to use. Wrap the sensor and cable in plastic, leaving the white plastic tip of the sensor exposed.

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- a. Check the battery on the O_2 analyser by pressing the battery check² button. The needle should read in the green zone. If it doesn't, replace the battery.
 - b. To calibrate the instrument, press the "ON" button with the sensor in open air. Rotate the "calibrate" knob to align the needle to 20.7% on the scale. (If this is not possible, the sensor needs to be recharged).
3. Lower the sensor into the caisson near the freeze block and monitor the atmosphere in the caisson before and during the time the operator is working there. Immediately move the operator to fresh air. (The temperature of the O_2 sensor and instrument must be between 32° F and 155° F to operate properly).
 4. Record information requested in Step III.A.4.

Freeze Block Testing

5. Add the "Freon TA" solvent until the liquid covers 1/2 of the pipe, Figure 4, end view. Break up the dry ice into small pieces, by hand, and add it to the solvent. The solvent and dry ice should cover the pipe by approximately 2 inches. Add more ice and liquid as needed during the test. Cover entire assembly with burlap.
6. Open valve #6, #5, #4, #3, and #2. Close valve #1.
7. Connect the raw water hose from the tank truck to hose connection #1 and adjust the water flow to less than 0.5 gpm. Record the flow rate on the data sheet.
8. STOP THE WATER ADDITION IF:
 - a) Liquid level of any catch tank rises.
 - b) Water is seen coming out of the annulus between the 3-inch and 6-inch pipe, (inside the new caisson). Pump out the liquid to TK-101-S.
 - c) Water comes out of the hose connected to the air bleed.
 - d) 1,500 gallons of water has been used.

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If water comes out of the line near valve #6, then pressure test the line according to SOP 300.16 (pressure Testing Supernatant Transfer Lines), and as noted below. The pipeline engineer will evaluate all other stoppage of water addition to see if the line can be pressure tested.

C. Pre-Pressure Testing

1. Disconnect the flowmeter at hose connection #2, and shut off the RW from the tank truck.
2. Leave the dry ice and liquid in place. Replenish as needed to keep freeze block.
3. Connect the RW hose from the tank truck to hose connection #2.
4. When water again comes out of the line from valve #6, close valve #6 and increase line pressure to 200 psig.
5. After the test pressure of 200 psig is reached, close valves #4 and #5, and proceed according to SOP 300.16.

D. Shut-Down

1. Upon completion of freeze block test, pull plug 6, (see p.10) and allow the freon to drain.
2. Clear the caisson of all personnel at this time.
3. Remove the senser and dispose of plastic wrapping as contaminated waste.
4. Discard plastic tip of senser as contaminated waste.

E. Data Sheet Transmittal

Pressure test data sheets are to be forwarded to the TFO offices and in turn to the TFPE offices within 24 hours (72 hours, if the tests are completed on Friday) after completion of all pressure tests including those for pressure tests which indicate line failure.

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PREPARED BY J. E. Enten DATE 3/10/76
 Engineer, TFPE
 REVIEWED BY J. D. Johnson DATE 3/10/76
 Engineer, TFPE
 APPROVED BY J. L. Walker DATE 3/10/76
 Manager/Delegate, WH & PFPE
 REVIEWED BY M. W. Winston DATE 3/10/76
 Quality Assurance Department
 APPROVED BY J. K. Pope DATE 3/10/76
 Radiation Monitoring
 REVIEWED BY J. C. Borjesson DATE 3/10/76
 Tank Farm Operations
 ACCEPTED & ISSUED BY [Signature] DATE 10 MAR 76
 Manager, Tank Farm Operations

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FIGURE 2

NEW CAISSON AND
FREEZE BLOCK

FIGURE 3

FIGURE 4

P. AIR

- DETAIL I

END VIEW

ELEVATION

- DETAIL II

(1) ASSEMBLY

FIGURE 5

DATA SHEET I

PRESSURE TESTING BY FREEZE BLOCK METHOD LINE INTEGRITY TEST

Operator(s) _____

Put a check in box or sign
(initial) lines.

Date _____

III. A.L.Route checked

TFO Supervisor _____

2. Hose into DB-151-S

Date _____

3. Valves set

4. LL's

	Start		End	
	Inches	Gallons	Inches	Gallons
CT-241-S-302-A	_____	_____	_____	_____
CT-241-S-302-B	_____	_____	_____	_____
TK-101-S	_____	_____	_____	_____
DB-151-S	_____	_____	_____	_____
Tank Truck	_____	_____	_____	_____

Supervisor review _____

Date _____

TFPE review _____

Date _____

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DATA SHEET II

PRESSURE TESTING BY FREEZE BLOCK METHOD

III. B. Freeze Block Test

Preliminary Check-Off List:

Line integrity test complete and successful ☐

The following equipment is available at the caisson:

Thick rubber gloves ☐	Freon ☐
Hydro Crane ☐	Dry ice ☐
Harness ☐	Burlap ☐
Life-line ☐	O ₂ Analyzer ☐
Earphone radio apparatus ☐	O ₂ Sensor and cable ☐
Standby breathing apparatus ☐	2-way radio ☐

Radio contact with water truck and TFO supervision ☐

Radio contact on earphone radio communication system checked out ☐

O₂ analyser battery checked ☐

O₂ analyser and sensor calibrated ☐

Sensor attached to breathing apparatus ☐

Approval to begin freeze block test: _____
TFO Supervisor, Date _____

B.L LL's

	Start		End	
	Inches	Gallons	Inches	Gallons
CT-241-S-302-A	_____	_____	_____	_____
CT-241-S-302-B	_____	_____	_____	_____
TK-101-S	_____	_____	_____	_____
DB-151-S	_____	_____	_____	_____
Tank Truck	_____	_____	_____	_____

4. Flow Rate _____ gpm

_____ gpm

Supervisor review _____ Date _____

TFPE review _____ Date _____

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