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0018262

Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

9106086

DEC 11 1991

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DEC 18 1991
CORRESPONDENCE CONTROL

91-WOB-436

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DEC 10 1991
T.B. VENEZIANO
9106086

Mr. Timothy L. Nord
Hanford Project Manager
State of Washington
Department of Ecology
99 South Sound Building
Lacey, Washington 98503

Dear Mr. Nord:

LIQUID EFFLUENT RETENTION FACILITY (LERF)

The following are responses to several issues raised during various informal discussions, and construction meetings and telephone conversations with Ecology:

- Attachment 1 addresses issues raised at an informal meeting between Paul Stasch, Dale McKenney and Bill Hamilton. An additional issue dealt with the construction schedule for the LERF. The construction schedule has been transmitted to Ecology separately and will be updated as status changes.

- Attachment 2 addresses the fiberglass EPA 9090 test results reinforced thermosetting resin pipe questioned by Paul Stasch. The effects of the 9090 testing on the pipe have been discussed with Mr. Moses Jaraysi of your Kennewick staff. The attached Fact Sheet (Attachment 2) was prepared and discussed with Mr. Jaraysi.

- During the discussion mentioned in the above item, Mr. Jaraysi asked the question: "If the pipe should have to be dug up, is there any possibility for the basins being damaged during the uncovering operation?" Attachment 3 shows the the distance from the basin edge to the centerline of the pipe berm, 44.75 feet, and the distance from the corner of the catch basin to the centerline of the pipe berm, 30.50 feet. The physical distance is sufficient to prevent damage to the basins. Further, procedures for digging in a contaminated area call for hand digging. Therefore, there will be no heavy equipment used that could damage the basins.

- Ecology has requested that a copy of the investigation completed on the failure of the 8-inch carrier pipe be transmitted. Attachment 4 is the subject report.

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- Attachment 5 is a spare parts list for the LERF as of August 8, 1991, as requested by Ecology.

- Attachments 6, 7, and 8 are lists of updates to items that have periodically been given to Ecology at your request.

The Attachments have been presented to Ecology at the LERF Unit Managers meeting held on October 16, 1991, in Richland, Washington.

Should you have any questions or comments on this subject matter, please feel free to call Mr. Lance S. Mamiya, Waste Management Division, on (509) 376-1471.

Sincerely,

Steven H. Wisness
Hanford Project Manager

WMD:LSM

Enclosures

cc w/encls:
P. Stach, Ecology
G. Anderson, Ecology
M. Jaraysi, Ecology
T. Michelena, Ecology
D. E. Kelley, WHC
R. J. Julian, WHC
T. B. Veneziano, WHC

KAISER ENGINEERS HANFORD

Transmittal No. TR-W-105-PM-144

DOCUMENT TRANSMITTAL

Date: September 13, 1991

To: L. R. Tollbom

From: S. L. Petersen

Project/Work Order Number: W-105

Project/Work Order Title: 242-A Evaporator Interim Retention Basins

Subject: WHC LOI #73 Response

No. of Copies	Company and Distribution	Mailing Address
DOE		
1	A. G. Lassila	A5-18
WHC		
1	L. R. Tollbom	R3-30
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KEH		
1	S. L. Petersen	E6-50
1	R. T. French	E6-61
1	Engineering Document Control	E6-52
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Document Numbers, Titles, and/or Comments

W-105 Response to LOI #73, KEH Letter # W-105-124, Dated September 11, 1991

SLP/sjm

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KAISER ENGINEERS HANFORD

W-105-124

KAISER ENGINEERS HANFORD COMPANY
POST OFFICE BOX 888
RICHLAND, WASHINGTON 99352

REG. NO. KAISEEH134GM

September 11, 1991

L. R. Tollbom, Project Manager
Effluent Treatment Projects
Westinghouse Hanford Company
P. O. Box 1970
Richland, Washington 99352

Dear Mr. Tollbom:

W-105, RESPONSE TO LOI 73

Reference:
1.) Westinghouse Hanford Company (WHC) letter #9156336, "Letter of Instruction Number 73" dated 8/28/91.

2.) Kaiser Engineers Hanford (KEH) dike certification by Edgar A. Goakey dated May 5, 1991.

LOI 73 requested that Kaiser Engineers Hanford (KEH) prepare a formal response to three separate technical issues that the Washington Department of Ecology (WDOE) has expressed concerning the W-105 LERF project. The following will describe the issues and provide KEH's response.

Item #1

Issue 1a.) Because the dikes were reworked, Ecology has requested that a new certification be provided. The calculations and certification should not consider use of the soil/bentonite to prevent piping and scouring. The new certification must be the same as that provided by Reference 2 in that it must say "I (name) certify ..." In this context, Ecology considers the certification provided by Reference 2 null and void. Ecology requests that a new certification be provided in accordance with WAC 173-303-650(4) (c) (i) and (ii).

If the certification can not be accomplished on the basis of no soil/bentonite, the KEH is also requested to complete the calculations or analysis to determine if the extra six inches of soil/bentonite that is presently installed in Basins 42, 43, and 44 can be included in the analysis for piping and scouring. This extra thickness of soil/bentonite goes beyond the thirty six inches required by the environmental Protection Agency guidance

(EPA/530-SW-85-014) for the basin slopes, which presently have a minimum of forty two inches of soil/bentonite installed.

Response: Attachment #1 establishes the technical basis to certify the structural integrity of the dikes. As requested, the analysis does not consider the soil/bentonite liner system as part of the dike structure. Attachment #2 certifies that the dikes are structurally sound and will not fail due to piping and scouring.

Issue 1b.) In addition to the above, Ecology requested in Reference 1 that a detailed explanation be provided as to why "the certifying engineer during his process of certification did not identify the grading problem that delayed the project by nearly two months."

Response: The re-grading activities that took place in May and June of 1991 did not result from any known nonconformances. Survey data available in the March/April time frame indicated that the subgrades were constructed as designed. To provide additional assurance that the proper depths of soil/bentonite would be installed in the basins, it was decided (in April) to change our survey strategy. A far more detailed survey was performed that allowed for a higher frequency of survey points be obtained in the basins. Results of the detailed survey revealed areas that required minor rework. A number of cycles of reworking and resurveying were necessary until all three basins were deemed acceptable. The basis and net effect of this action was to provide additional Quality Assurance and Environmental Compliance.

Note: The attached and referenced certifications do not certify an as-built condition. Regardless of semantical interpretation, these engineering certifications are intended to address only approved drawings and specifications. Construction Quality Assurance documents can be provided to assure that the dikes were constructed as designed.

Item #2

Issue 2.) Ecology believes that the grading problem discussed in item one resulted in excessive drying of the stockpiled soil/bentonite, which has resulted in the introduction of unacceptable clods in the liner system. The KEH is

requested to provide the quality assurance rationale explaining how the introduction of clods into the soil/bentonite liner system was controlled, and how clods were broken up and mixed to ensure the correct density of installed soil/bentonite.

Response: Attachment #3 addresses the methods and controls employed to prevent excessive drying of stockpiled soil/bentonite and eliminate installation of clods into the basins.

Item #3

Issue 3a.) The KEH is requested to provide the rationale for the following:

Will the soil/bentonite freeze during the winter without water in the basins? Will it be necessary to heat empty basins? Assume that approximately 1 foot of water will remain in the basins to hold the liner and cover in place. This rationale should also include the freeboard area (top 5 feet) of the basins. The rationale should show that it will be acceptable to leave the basins empty (1 foot or less) through the winter months.

Response: Left empty and without an alternative heat source the soil/bentonite will freeze during the winter. Although the local design frost penetration depth is known to be approximately 18", a number of thermal variables (including the solar effects on the covers and the heat sink properties of the liner systems) make the known depth of frost penetration indeterminant at this point. Attachment #1 addresses what little is known regarding the affects of freezing to sand-bentonite liners.

Based on the input we have received from our consultants, it is KEH's position that further research is required to adequately respond to this concern.

Issue 3b.) The present construction schedule could result in the installation of liner materials during cold weather, rain or snow, or freezing conditions. The rationale for conditions for working in these environments should be provided. Be sure to address problems related to moisture, and how this problem will be handled when welding the basin liner and cover material.

Response: See attachment #3

Please feel free to contact me at 6-7216 if you have any further questions or concerns.

Sincerely,

Stephen Petersen

S. L. Petersen

SLP:kaw

cc: R. T. French
A. G. Lassila - DOE
G. P. Burchell - WHC

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Attachment #1

Chen-Northern, Inc.

Consulting Engineers and Scientists

2214 North 4th Avenue
PO Box 2601
Tri-Cities, Washington 99302

509 547-1671
509 547-1673 Facsimile

September 10, 1991

Kaiser Engineers Hanford Company
P.O. Box 888
Richland, Washington 99352

ATTENTION: Mr. Stephen Petersen

SUBJECT: Technical Response to Westinghouse Letter August 28, 1991; Regarding W-105 Project and WDOE Inquiries Regarding Same

Gentlemen:

In accordance with your request of September 3, 1991, we are providing technical responses to inquiries placed by personnel from Westinghouse Hanford Company (WHC) and the Washington State Department of Ecology (WDOE). The specific items Chen-Northern was asked to address include the "certification" of the regraded dikes, and the effects of freezing and thawing on the soil-bentonite liner.

DIKE REGRADING

During May and June of 1991, ponds AL42, AL43, and AL44 were surveyed and were found to be out of specification with regard to constructed surface grade tolerances of the gravel dikes. The grade variations were all less than 1 foot from specification. In June, 1991, the grade variations were repaired to project tolerances. Surplus dike gravel and on-site sand were used to achieve the required grades. The repairs consisted of less than 1 foot of material cut or filled from the previous as-built dike grade.

We analyzed the stability of the original gravel dikes, as designed prior to June of 1991. We analyzed slope stability, settlement, subsidence, and susceptibility to piping and scour. Our original conclusions (delivered to KEH in our letters of March 26, 1991, April 10, 1991, and April 11, 1991, and April 18, 1991) indicated that the dike slopes were expected to be stable under static and design earthquake conditions. Our analyses also indicated that the anticipated total settlement was minimal, and that the environmental conditions for subsidence were not present, and that therefore subsidence was not expected to occur.

The last of our analyses concerned the potential for piping and scour through the gravel dikes, both with and without the soil-bentonite liner. The results of our analyses indicate that, because of the high permeability of the native soils, the low impounded

fluid height (relative to adjacent exterior ground level), and the relatively finite amount of impounded fluid, neither piping nor scour are expected to develop or be possible to develop through the gravel dikes.

Considering the very minor amount of grading which occurred during June of 1991, it is our opinion that our original calculations of conditions regarding dike stability, settlement, and susceptibility to piping and scour have not materially changed. Therefore, the geotechnical design of the W-105 project, including the factors listed above, still complies with the requirements set forth in WAC 173-303-650.

SOIL-BENTONITE LINER FREEZING

To date, our research has consisted of a very limited literature search and phone conversations with Dr. David Daniel, University of Texas, Austin. The present results of our research are summarized below:

1. Freeze-thaw may adversely affect a compacted soil liner designed to a specific low permeability requirement.

2. Research performed on compacted pure clay liners has indicated that an increase in permeability of 2 to 3 orders of magnitude may occur after as few as two or three freeze-thaw cycles.

3. It was Dr. Daniel's opinion that a sandy (soil-bentonite) liner would be affected less than a pure clay liner. It was also his opinion (and is ours) that the only way to obtain any indication of freeze-thaw effect would be to perform laboratory triaxial permeability tests on liner samples which have undergone a minimum of two freeze-thaw cycles.

During our conversations with Dr. Daniel and others from the U.S. Army Corps of Engineers, it was the general concurrence that little, if any, research has been performed on the effects of freeze-thaw on a sand-bentonite liner system (or soil liners in general). At this time, we are however continuing to research the subject and the possibility of perforimng laboratory testing on samples of Test Fill #6, which was constructed using the design mix for the W-105 project.

If you have any questions regarding this letter, or if we can be of further service, please contact us.

Respectfully Submitted,
CHEN-NORTHERN, INC.

Brian J. Williams, P.G.
Geotechnical Engineer

Dee J. Burrie, P.E.
Division Manager

9212464148 0

Attachment #2

KAISER
ENGINEERS
HANFORD

KAISER ENGINEERS HANFORD COMPANY
POST OFFICE BOX 888
RICHLAND, WASHINGTON 99352

REG. NO. KAISEEH134BM

CERTIFICATION OF QUALIFIED ENGINEER

In accordance with WAC 173-303-650(4)(c)(i) and (ii), I, Edgar A. Goakey, P.E. certify that the dike portion of the W-105 Project Design has structural integrity. Specifically:

(i) The dike will withstand the stress of the pressure exerted by the types and amounts of wastes to be placed in the impoundment; and

(ii) The dike will not fail due to scouring or piping, without dependence on any liner[1] system included in the surface impoundment.

This certification is based upon the independent analysis of the structural integrity of the dike as set forth in attachment #1 of Kaiser Engineers Hanford letter W-105-124 dated September 11, 1991.

DATED THIS 12 day of September, 1991.

Kaiser Engineers Hanford, Co.

Edgar A. Goakey

Edgar A. Goakey,
Professional Engineer

EDGAR A. GOAKEY
STATE OF WASHINGTON
9813
REGISTERED
PROFESSIONAL ENGINEER
9/12/91

---

1. The soil /bentonite liner has not been considered as contributing to the integrity of the dike structure.

AttACHMENT #3

KAISER ENGINEERS HANFORD

INTEROFFICE MEMORANDUM

91-LAG-019

TO S. Petersen E6-50

DATE September 11, 1991

FROM D McShane/ L Gaddis
CQA Officers W-105

COPIES TO

JOB NO. ER0241

SUBJECT RESPONSE TO LOI NO. 73 ITEMS 1 AND 2

Item 1, Reworked Dikes:

The rework of the dikes became necessary when additional survey information indicated that the subgrade was out of tolerance. The rework was minor and for the most part material was merely shuffled around. In basin 42 approximately .5 ft. was added to the slopes on the north end and the south east corner. In basin 43 and 44 some material was removed, approximately 60 cubic yards total from both basins. In all three basins the pipe trench and sump were redone. This trench rework was anticipated as the sump was lowered .5' by ECN W105-88 (4-15-91) after the contractor demobilized from basin grading and the construction of the test fills in December 1990.

Daily inspection records indicate that there were 28 working days between the time when regrading began and the start of soil/bentonite placement in basin 42. Seven of these days the contractor did not work on regrading.

Item 2, Clods in Stockpiled Soil/ Bentonite:

The soil/bentonite material was stockpiled longer than anticipated and some surface drying did occur. However, during this period KEH successfully took action to remoisten and maintain the moisture in the soil/bentonite stockpile using a water truck and fire hoses. In addition, the following activities controlled the introduction of unacceptable material and clods into the soil/bentonite liner:

1. The contractors' operator, loading the soil/bentonite into the dump trucks, would segregate and discard unacceptable material during the loading activities.

2. The contractor had labor personnel removing clods from the material as it was being dumped into the basins.

3. The soil/bentonite was spread into 6 in. lifts with a bulldozer which reduced the size of any clods and mixed the material together.

4. The 40 ton pad foot compacting roller would further break up and remix any remains and completely mix and compact the soil/bentonite.

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INTEROFFICE MEMORANDUM

5. The contractor and KEH inspection personnel were all aware of the requirements for the soil/bentonite and everyone on the project would remove unacceptable material from the basins when found.

6. All compaction test taken on the placed and compacted material met or exceeded the moisture and density requirement.

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LAG:tam

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ENGINEERS
HANFORD

W-105-126

KAISER ENGINEERS HANFORD COMPANY
POST OFFICE BOX 888
RICHLAND, WASHINGTON 99352

REG. NO. KAISEEH1348M

September 30, 1991

L. R. Tollbom, Project Manager
Effluent Treatment Projects
Westinghouse Hanford Company
P. O. Box 1970
Richland, Washington 99352

Dear Mr. Tollbom:

ADDENDUM TO LETTER OF INSTRUCTION NUMBER 73 RESPONSE

My letter of September 13, 1991 "Westinghouse Hanford Company Letter of Instruction Number 73 Response" failed to address the following:

Issue 3b.) The present construction schedule could result in the installation of liner materials during cold weather, rain or snow, or freezing conditions. The rationale for conditions for working in these environments should be provided. Be sure to address problems related to moisture, and how this problem will be handled when welding the basin liner and cover material.

Response: Installation (handling, placing, cutting and welding) of HDPE or VLDPE liners in cold or wet weather conditions may result in an unsatisfactory product. Therefore, the specification for the C-2 liner contract (section 2755 paragraph 1.5) and the C-8 cover contract (section 2757 paragraph 1.6) require a minimum temperature of 40 degrees F., with wind less than 15 mph and no precipitation when handling (installing and welding) the liners and covers for the basins.

This was an oversight on my part, I hope it did not cause you any inconvenience.

Sincerely,

S. L. Petersen

S. L. Petersen, Project Manager
Effluent Treatment Projects

SLP:kaw

cc: R. T. French
A. G. Lassila - DOE
G. P. Burchell - WHC

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bcc: C. J. Denson
M. E. Witherspoon

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FACT SHEET - FIBERCAST PIPING TEST

Fiberglass piping samples were fabricated and tested in the simulated solutions used to perform the 9090 Tests on the LERF liner materials. The results of the tests are reported in WHC-SD-W105-TD-001, and it was concluded that the piping successfully passed the tests. Some degradation was noted in the piping tensile strength and elongation at break, but this was not sufficient to cause any concern about the material's performance for transferring process condensate water from the 242-A Evaporator to the LERF.

The following data and observations are presented to substantiate the above conclusion:

1. The tests were conservatively conducted at 50 C, a temperature much higher than actual planned service conditions in order to accelerate any chemical reactions that might occur. The Evaporator process condensate service temperature average is 27.9 C, and the maximum temperature is 39 C. The rate of the chemical reactions governing the degradation would be controlled by Arrhenius kinetics, although the activation energy associated with these reactions is not currently known. A rule of thumb is that chemical reaction kinetics are doubled for each 10 C increase in temperature.

2. The configuration of the specimen used in the tests allowed the solution to contact both the interior and exterior surfaces of the piping. In addition, the specimens were machined prior to exposure which exposes the fiberglass strands. Normally, the thick epoxy coating on the interior pipe surface protects the fiberglass from the solutions being transported. The fiberglass by itself does not possess the extreme resistance to liquids in contact with it as well as does the epoxy; this is the reason an epoxy coating is provided. This was a recognized factor prior to the tests; therefore the exposed machined surfaces were hand painted with an epoxy coating to protect them from the test solution. The hand coated epoxy may not have been the quality of factory coatings, and it certainly wasn't nearly as thick. We don't have any way of determining whether the hand-coated surfaces provided sufficient protection from the solution. If the solution contacted the machined edges of the specimens, it could travel along the exposed fibers relatively easily. In service, the fiberglass would be protected by the thick epoxy layer on the interior of the pipe. The fact that the tensile strength of the test specimens only slowly decreased, and appeared to be leveling out at about 40,000 psi at the test conclusion, indicates that the degradation was not severe, even though the uncoated outer pipe surface was exposed to the test solution.

3. A key point in concluding that the piping provides sufficient resistance to the test solution is that absolutely no damage was observed to the protective epoxy coating. The interior epoxy layer

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is intended to prevent the solution inside the pipe from affecting the fiberglass structure. For this reason, the observed decreases for tensile strength and ductility (elongation at break) were most likely due to artifacts of the specimen design. In order to further substantiate this conclusion, additional tests are planned in which the test solutions will be in contact only with the piping interior epoxy surfaces. Specimens for tensile tests will not be machined from the piping until after the testing in order to make sure that exposed fiberglass is not in contact with the test solution.

4. The actual test duration was a substantial portion of the duration that the piping would be exposed to the Evaporator process condensate during service conditions. The Evaporator will produce condensate at an average flow rate of 49 gpm, and at a maximum flow rate of 60 gpm. The time to fill the 13 million gallon capacity of the LERF basins, as shown on the attached graph, is 184 days and 150 days for these two flow rates, respectively. Thus, the tests were conducted for a time period representing 65% of the actual projected time to fill the LERF at the average flow and 80% at the maximum flow. This long test time in proportion to the actual service time provides good confidence that the piping will provide adequate strength during service for the period that the LERF will be filling. These calculations are based on exposure times at service conditions. Total exposure will be longer since the piping will remain full during shutdown periods, but since the piping will cool to ambient temperature during shutdown, negligible deterioration would be expected during these periods.

However, on a related but completely different aspect, the test time was short compared to the time the piping would be used for subsequent programs; i.e., when the Evaporator process condensate would be routed to the Effluent Treatment Facility over a subsequent 30-year period. Assuming a 50% TOE, this is equivalent of 15 full years of service. For this reason, WHC has elected to obtain additional data on the piping by conducting the next set of tests. In addition to these laboratory tests, WHC plans on removing actual piping from the Evaporator-to-LERF pipeline during the tie-in for the ETF to obtain data from actual service conditions.

5. The Manufacturer's data show that the 3-inch carrier piping used for transporting the process condensate from the Evaporator to the LERF is rated at 200 psi at a temperature of 225 F (107 C). In comparison the pump discharge head is only 13.6 psi, a factor of 15 less than the rated pressure. Thus the 30% decrease in strength noted during the test is only a small fraction of the available rating and a large excess of strength exists for the service intended.

6. Finally, the carrier piping is installed inside a containment piping. Should an unlikely failure occur, the process condensate would be safely contained. The failure would then be diagnosed as to cause, and a repair or replacement of the carrier piping be made

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based upon the diagnosis.

7. In summary, the tensile testing of pipe material was successful in that it provide a conservative measure of susceptibility to environmental degradation. However, the test results may not be directly applicable to the LERF Project because of the higher temperatures employed in the laboratory tests, the specimen configuration which allowed solution to contact the outside and possibly the machined sides of the pipe specimens, and the fact that no discernible degradation of the epoxy layer occurred.

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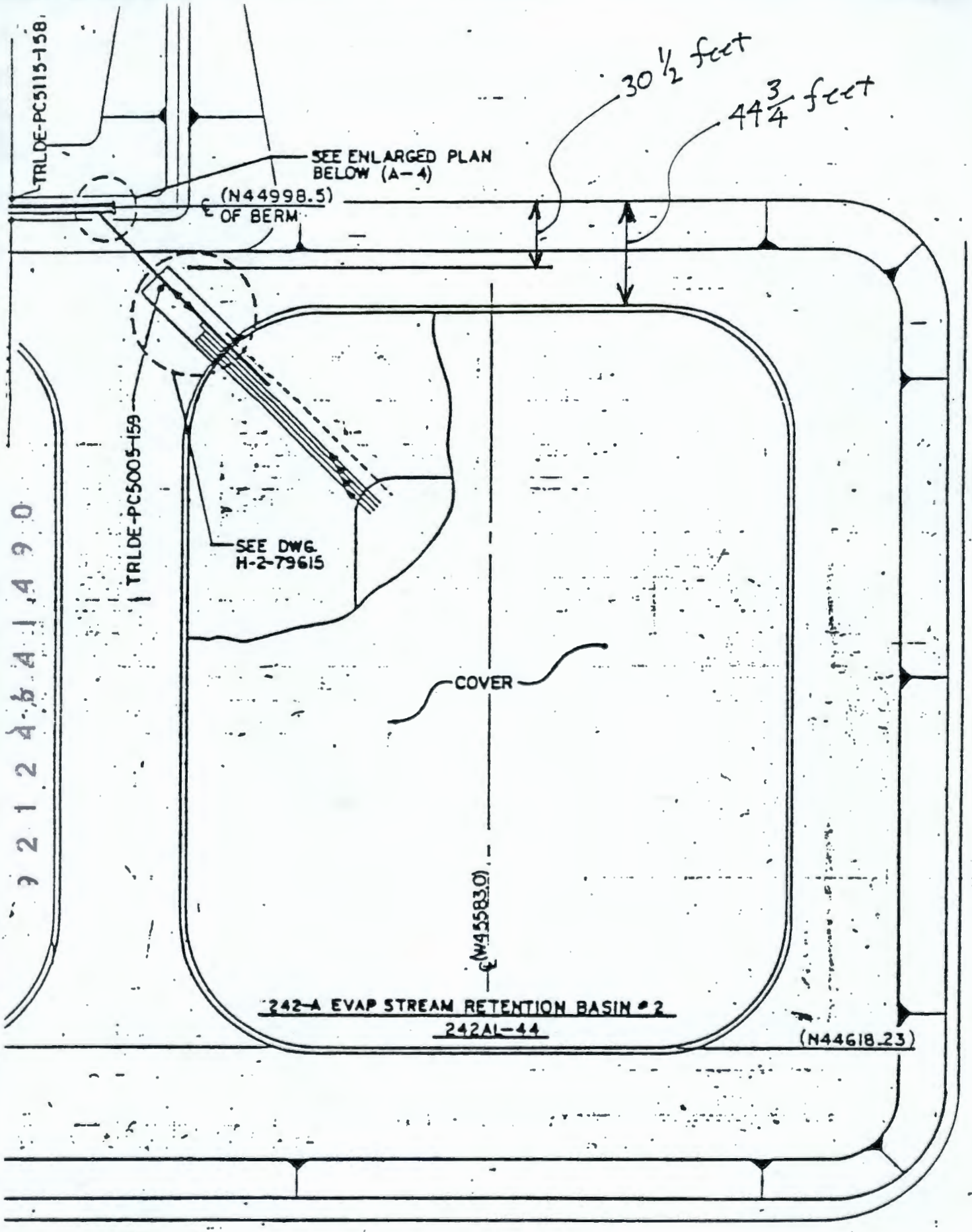

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ENGINEERS
HANFORD

W-105-125

KAISER ENGINEERS HANFORD COMPANY
POST OFFICE BOX 888
RICHLAND, WASHINGTON 99352

REG. NO. KAISEEH1348M

September 16, 1991

L. R. Tollbom, Project Manager
Effluent Treatment Projects
Westinghouse Hanford Company
P. O. Box 1970
Richland, Washington 99352

Dear Mr. Tollbom:

KAISER ENGINEERS HANFORD CONCURRENCE PERTAINING TO THE WESTINGHOUSE HANFORD COMPANY INVESTIGATION OF THE STRUCTURAL FAILURE IN THE 8" CARRIER AT 200E LERF BASINS (PROJECT W-105)

References: Westinghouse Hanford Company (WHC) letter #9156556, LOI number 74 dated September 5, 1991.

As requested in the above referenced letter, Kaiser Engineers Hanford Company (KEH) has completed a review and analysis of the WHC investigation of the W-105 8 inch pipe failures.

Kaiser Engineers Hanford Company concurs with the following:

1.) The pipe failures which occurred in the 8 inch carrier pipe, likely resulted from the overpressurization of the containment pipe.

2.) The failures occurred sometime during the hydrotesting of the 8 inch assemblies.

3.) The 8 inch pipe sections in question have been properly repaired and tested.

4.) All 8N12 and 3N6 fiberglass piping currently installed is fit for service.

Please take notice that KEH is scheduled to begin backfilling the two 8N12 pipe sections on September 25, 1991 and that said activities will not negatively impact the basins.

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Please contact me at 376-7216 if you have any questions or concerns.

Sincerely,

Stephen Petersen

S. L. Petersen, Project Manager
Effluent Treatment Projects

SLP:kaw

cc: R. T. French
S. J. Bensussen
R. T. Hallum
A. G. Lassila - DOE
G. P. Burchell - WHC
J. J. Sisk - WHC

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Westinghouse Hanford Company | **Internal Memo**

From: Materials and Welding Engineering
Phone: 3-4156 S2-03
Date: September 4, 1991
Subject: INVESTIGATION OF STRUCTURAL FAILURES IN 8 INCH CARRIER PIPES AT 200E LERF BASINS (PROJECT W-105)

To: L. R. Tollbom (10) R3-30

cc:	L. D. Blackburn LDB	H5-67	W. J. Karwoski (2)	H5-53
	G. P. Burchell	R3-30	D. E. Kelley	R1-48
	W. C. Carlos	H5-52	D. E. McKenney	R1-48
	D. J. Green	H5-53	K. V. Scott	H5-52
	L. R. Hall	S1-54	T. S. Vail	R1-43
	M. N. Islam	R3-08	R. B. Wurz	S5-14
	R. J. Julian (7)	R1-48	JJS File/LB	

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INTRODUCTION

On June 20, 1991, the Materials and Welding Engineering group was requested by Project W-105 to investigate two failures that occurred in the Liquid Effluent Retention Facility (LERF) interbasin piping during hydrostatic testing operations. This report documents the results of that investigation.

SUMMARY

Two failures occurred in double containment fiberglass reinforced thermosetting resin pipe that is to be used for transfer of effluent between the LERF basins. The failures occurred in the 8-inch carrier pipes during hydrostatic testing operations for the 12-inch containment pipe, following successful hydrostatic testing of the 8-inch carrier pipe.

The information obtained in this investigation indicates that the external overpressurization of the carrier pipe during some portion of the hydrostatic testing operations is the likely cause of failure. The failure mode is buckling from the excessive external pressure. The pipefitters devised the test equipment and carried out the hydrostatic testing operations with limited field engineering support. The process control package (PCP), by reference to the construction specification, set forth the hydrostatic test requirements which called for equalizing the pressure between the containment pipe and carrier pipe during the test operation. The precise events that led to the deviation from this requirement have not been identified.

The piping assemblies have been repaired and successfully retested using a new hydrostatic test procedure. Fibercast has examined and tested the failed pipe sections and reported that the pipe exceeds the required wall thickness and that the pipe material meets all manufacturing standards. Therefore, the piping assemblies are considered fit for service.

BACKGROUND

The LERF is designed to receive effluent from the 242-A evaporator at the 200 East area. The effluent is to be stored in up to three 6.5M gallon covered retention basins. Double containment fiberglass reinforced thermosetting resin pipe (RTRP) is used to bring the effluent to the basins and to transfer effluent from one basin to another. The pipe is manufactured by Fibercast Company, Sand Springs, Oklahoma, under the product name Centricast III EP.

The double containment pipe consists of a small diameter carrier pipe centered in a larger diameter containment pipe and supported by guides spaced uniformly. The guides are rigidly attached to the carrier but free to slide inside the containment pipe. The containment pipe has risers for the leak detection system that are spaced uniformly along its length. Three-inch carrier pipe in 6-inch containment pipe (3N6) is used to transfer effluent to the basins. Eight-inch carrier pipe in 12-inch containment pipe (8N12) is used to transfer effluent from one basin to another. Each of the two 8N12 piping assemblies are approximately 250 feet long and have 45° elbows at each end. Short sections extend from the elbows toward the basins (see Figure 1).

The carrier pipe and the containment pipe are required to pass separate hydrostatic tests. The carrier pipe is tested at 150 lbf/in^2 (gauge) and the containment pipe at 90 lbf/in^2 (gauge) (see Figure 2). The subject failures occurred in the 8-inch carrier pipes at some point during the hydrostatic testing operations (filling, venting, pressurizing and depressurizing) for the 12-inch containment pipe, following successful hydrostatic testing of the 8-inch carrier pipe (see Figures 3 through 6).

Fibercast Company has been involved extensively since the failures occurred through site visits and examination and testing of the failed pipe sections at their facility. Fibercast's conclusion is that both failures resulted from external over-pressurization of the 8-inch carrier pipe. Consultation with design engineering indicated that their investigation thus far had implicated the hydrostatic testing methods as the cause. This investigation has therefore focused on the hydrostatic testing methods for the double containment pipe.

Major portions of the 3N6 piping were fabricated and tested prior to the 8N12 piping. Therefore, hydrostatic test methods for the containment pipe were initially developed and implemented on the 3N6. Essentially the same methods were then transferred to the 8N12. No carrier pipe failures from external pressure have occurred on the 3N6 piping.

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METHOD OF INVESTIGATION

This investigation included the following activities:

- Interviews with key pipefitters and inspection personnel
- Field observations of hydrostatic tests and examination of the piping assemblies and the failed pipe sections
- Review of applicable construction specifications, construction force procedures, and quality assurance procedures
- Review of inspection and hydrostatic test records for the piping assemblies
- Consultation with Fibercast technical personnel, design engineers, and others
- Review of Fibercast design information, factory test data for Centricast III EP double containment pipe, and Fibercast's report on examination of failed pipe sections
- Review of a PNL Library literature search on the subject of failures in fiberglass reinforced thermosetting resin materials

RESULTS AND DISCUSSION

Hydrostatic Testing Operations

Independent interviews were conducted with key pipefitters involved with the set up and conducting of hydrostatic tests on the double containment fiberglass reinforced pipe. Two quality control inspectors involved with the installation of the piping were also interviewed. A compilation of the information obtained in the interviews is attached as Appendix A.

The pipefitter crews devised and set up the hydrostatic test rig (see Figure 2) to meet the general requirements of the applicable construction specification, W-105-C3, and Book 2 of the KEH Construction Force Manual, Procedure CFM 6.1 for hydrostatic tests. The crews also developed their own methods for filling, pressurizing, venting, and depressurizing the piping for the hydrostatic test operations. No engineering sketch or drawing of the specific test arrangement was available. Valve opening and closing sequences were carried out according to past experience and best judgement. This is apparently consistent with construction force practices at Hanford for hydrostatic testing of piping systems. However, most piping applications are of single wall design and prior to the use of fiberglass reinforced pipe, applications of double contained piping at Hanford involved carbon steel and stainless steel piping which are significantly less susceptible to failure from external pressure.

Fibercast Company provides minimal guidance regarding the hydrostatic testing of double containment pipe. The construction specification for the LERF also provided limited information. Section 15493, Paragraphs c, d, e, and f of W-105-C3 briefly address flow limits for filling and draining, verification that air has been vented, prevention of water hammer, and a requirement that the containment pipe (encasement) be 'jumpered' to the carrier pipe to assure that the pressure is equalized between the carrier pipe and the containment pipe during hydrostatic testing. The KEH Construction Forces - Book 2, Procedure CFM 6.1, General Requirements for Hydrostatic and Pneumatic Testing applies for the hydrostatic testing. This procedure references CFM 6.5 for American Society of Mechanical Engineers (ASME) B31.3 applications such as the LERF piping. Both procedures recognize the need for additional provisions to suit a particular job; however, neither procedure specifically addresses the hydrostatic testing of double containment piping. The process control package (PCP), which is intended to provide job control information, also provided limited instructions for hydrostatic testing of the double containment pipe.

Testing performed by the manufacturer demonstrated that an annulus pressure of approximately 34 lbf/in^2 (gauge) is sufficient to cause buckling failure of the 8-inch carrier when it is not internally pressurized. Based on information obtained in this investigation, opportunities existed during the hydrostatic testing operations for exposing the carrier pipe to excessive external pressure.

The filling and pressurizing of the containment pipe continued after noise was heard and pipe movement was observed in the case of both failures. The pipefitters later assumed that the failures occurred at the time of the noise and pipe movement during the filling. However, a subsequent test of the 8-inch carrier (by pressure decay or other method) was not performed in either case after the noise and pipe movement and prior to filling and pressurizing the 12-inch containment. Therefore, a question exists with regard to when the failures actually occurred.

The hydrostatic test rig (see Figure 2) relied on 1/4-inch tubing connected between the carrier and the containment pipes to maintain an equal pressure between the two at all times during filling, pressurizing and venting. Two gauges were used during hydrostatic tests. One gauge was installed at the fill end and one at the vent end on the containment pipe for pressure testing of the 12-inch containment pipe. The gauge at the fill end was assumed to indicate at all times the pressure in both the 12-inch containment pipe and the 8-inch carrier pipe.

Examination of Failed Pipe Sections

Both failed carrier pipe sections had been removed from their installed locations and moved to the pipefitter shop prior to this engineer's examination. Both pipe sections had axially oriented fractures that extended completely through the pipe wall (see Figures 3 through 6). The fracture in the pipe section in Basins 43-44 measured approximately 8 feet 5 inches long

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and was several inches longer on the inside than on the outside. The fracture extended between two carrier guides but had arrested short of passing through either guide. The fracture from the Basins 42-43 carrier pipe measured approximately 4 feet 5 inches, also being slightly longer on the inside. The fracture extended between a guide and bell type socket joint. The fracture extended to the end of the pipe but did not extend beyond the joint to the bell end section. The joint was separated when observed in the shop (see figure 6). The opposite end of the fracture arrested short of passing through the guide. The exterior fracture appearance was essentially unbranched and identical for both pipe sections. Both interior fractures exhibited branching and areas of delamination of the pure resin layer from the glass reinforced resin outer layer.

The fracture appearances of the LERF failures are similar to fractures obtained in buckling failures caused by external pressure failure tests conducted by Fibercast. Consultation with J. Tillson, Fibercast testing engineer, indicated that the branching of the interior surface of the fracture observed in the pipe sections that failed at Hanford is typical of external pressure failures. He indicated that delamination between the pure resin inner layer and outer reinforced layer is also to be expected. Delamination was observed in both failed pipe sections.

The pipe sections were subsequently shipped to Fibercast for further examination and testing. Fibercast's letter reporting their evaluation, dated July 24, 1991 (see Appendix C), is consistent with the above observations regarding the fractures and takes the position that the cause of failure was external over-pressurization. The letter indicates that the pipe sections exceed the minimum wall thickness requirement. The letter also provides test information that is consistent with the conclusion that the piping material was properly manufactured.

Information provided from a Fibercast engineer present for removal of the failed carrier pipe at Basins 42-43 indicated that the bell type coupling joint (see Figure 6) was still together (pipe end in bell) prior to removal of the failed section. However, the bonded joint had peeled completely around except at one small location near the top where the bond was still intact. The removal operation broke the remaining bond area and the joint separated. The fact that some bonded area remained intact suggests that the pipe end was forced radially inward by the pressure in the containment pipe.

CONCLUSIONS

The information obtained in this investigation indicates that the external overpressurization of the carrier pipe during some portion of the hydrostatic test operations is the likely cause of failure. The failure mode is buckling from the excessive external pressure. However, the precise events that led to the failures have not been identified.

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The pipefitters devised the test equipment and carried out the hydrostatic testing operations with limited field engineering support. The hydrostatic test requirements set forth in the construction specifications section 15493 para 3.2.2.2 required that the containment pipe and carrier pipe pressure be equalized. The precise events that led to the deviation from this requirement have not been identified.

The cause of the noise and pipe movement noted by the pipefitters during the filling of the carrier pipe and thought to have been associated with the failures may have been caused by thermal contraction of the carrier pipe within the containment pipe. Movement occurs between the carrier pipe and containment pipe, and between the containment pipe and its temporary supports as a result of temperature change. Thermal contraction results from the temperature change of the carrier pipe as the 50 to 60 °F water enters and begins to fill the carrier pipe which is hot from solar heating. Temperature of the carrier pipe is believed to have been over 100 °F during filling prior to the failures.

The necessary repairs have been made to the 8N12 piping assemblies and both repaired assemblies have been successfully hydrotested using a new procedure. No new failures have occurred. Fibercast's letter reporting their evaluation of the failed pipe sections is consistent with the conclusion that the pipe exceeds the required wall thickness and that the material was properly manufactured. Therefore, the 8N12 piping is considered fit for service.

RECOMMENDATIONS

Improved field engineering support should be provided to the pipefitters, particularly when new technology is involved as in the case of double containment fiberglass pipe. Consideration should be given to development of a modified test rig for double containment fiberglass pipe that would preclude excessive external pressure on the carrier pipe during hydrostatic testing of the containment pipe.

An informal hydrostatic testing procedure for double containment pipe has recently been developed with technical guidance from Fibercast representatives. The new procedure has been used successfully on two occasions since the subject failures, for hydrostatic testing of the LERF 8N12 piping. The procedure is based on isolating the carrier pipe from the containment pipe and maintaining the carrier pipe at a higher pressure at all times during the hydrostatic testing operations. The test rig and valving procedures are somewhat complicated. Therefore, further review and refinement is encouraged as more experience is gained with double containment piping. It is further recommended that the procedure be formalized as a KEH Construction Force procedure. The informal procedure is included in Appendix B.

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IMPLICATIONS OF 8-INCH CARRIER PIPE FAILURES ON 3-INCH CARRIER PIPE INTEGRITY

The 3-inch carrier pipe integrity is judged not affected by the failures in the 8-inch carrier pipe. The external pressure rating of the 3-inch carrier pipe is approximately 3 times the rating of the 8-inch carrier pipe because of its greater stiffness. Therefore, the 3-inch carrier pipe is less susceptible to failure by external over-pressurization. Major portions of the 3N6 piping, because of the assembly sequence used, have had both carrier and containment pressurized multiple times. It is estimated by construction forces management that major portions of the 3N6 piping have experienced 6 or more hydrostatic test cycles. No 3-inch carrier pipe failures from external pressure have occurred. The 3-inch carrier pipe will be hydrostatically tested in its completed length when the evaporator and basin final connections are bonded. This will provide additional assurance that the 3-inch carrier pipe is sound.

REFERENCES

W-105-C3, Construction Specification for Piping and Electrical for 242 A Evaporator and Purex Interim Retention Basin, Kaiser Engineers Hanford Company, Richland, Washington, released for construction, August 3, 1990.

Construction Forces - Mechanical (Book 2), CFM 6.1, "General Requirements for Hydrostatic and Pneumatic Testing," June 28, 1990 and CFM 6.5, "Hydrostatic Testing - ASME B31.3," May 1, 1991, Kaiser Engineers Hanford Company, Richland, Washington (see Appendix B).

Letter, W. J. Jones, Fibercast Company, to Ms. Penny Harvey, Kaiser Engineers Hanford, Subject: Kaiser Engineers Hanford (KEH) Purchase Order No. 51874, dated July 24, 1991 (see Appendix C).

"KEH W-105 Hydrostatic Test 8N12," not formalized (see Appendix B).

J. J. Sisk
Materials and Welding Engineering

kjs

Attachments
- Figures 1 through 6
- Appendix A
- Appendix B
- Appendix C

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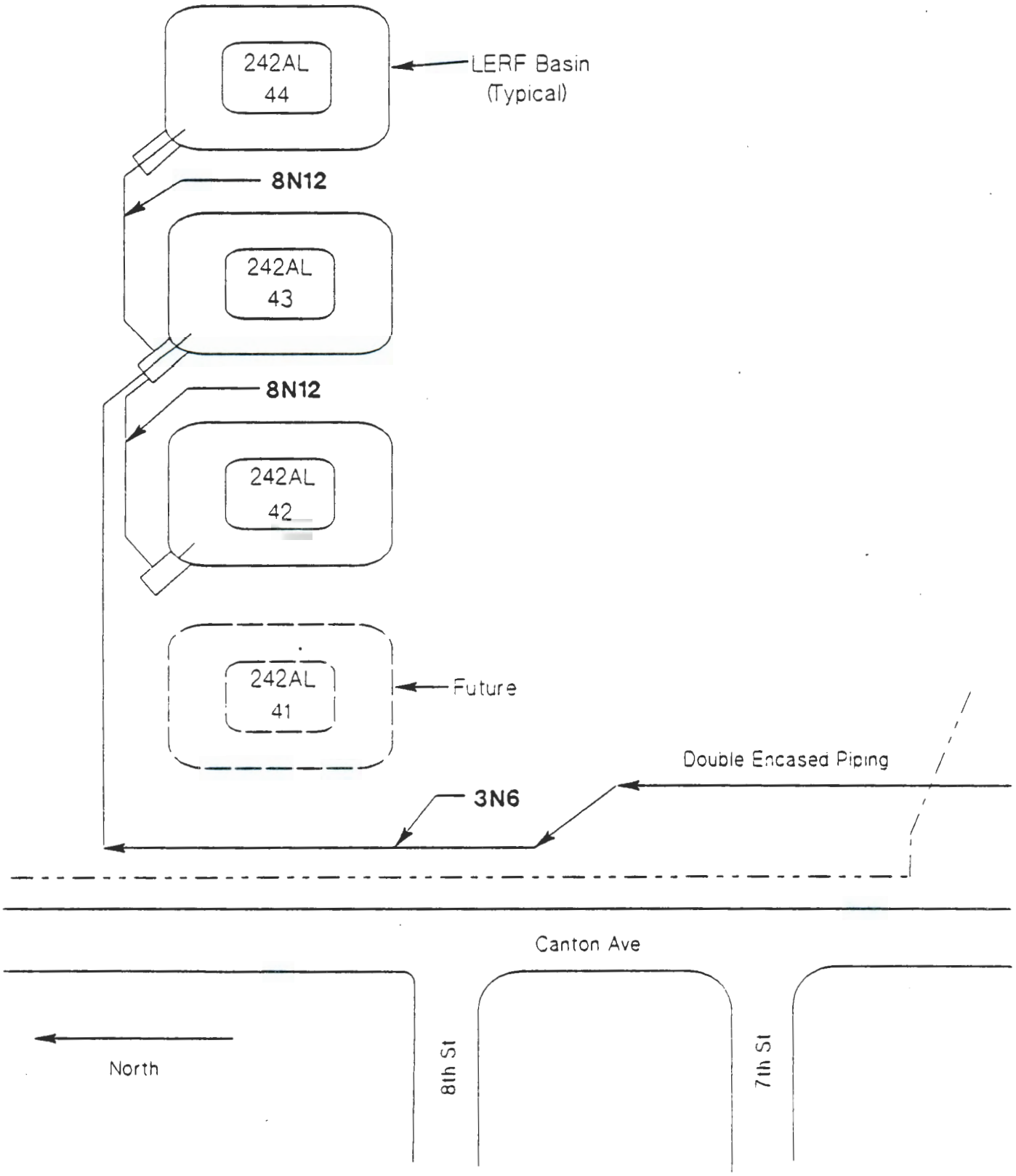

Figure 1. 242-A Evaporator Liquid Effluent Retention Facility (LERF)

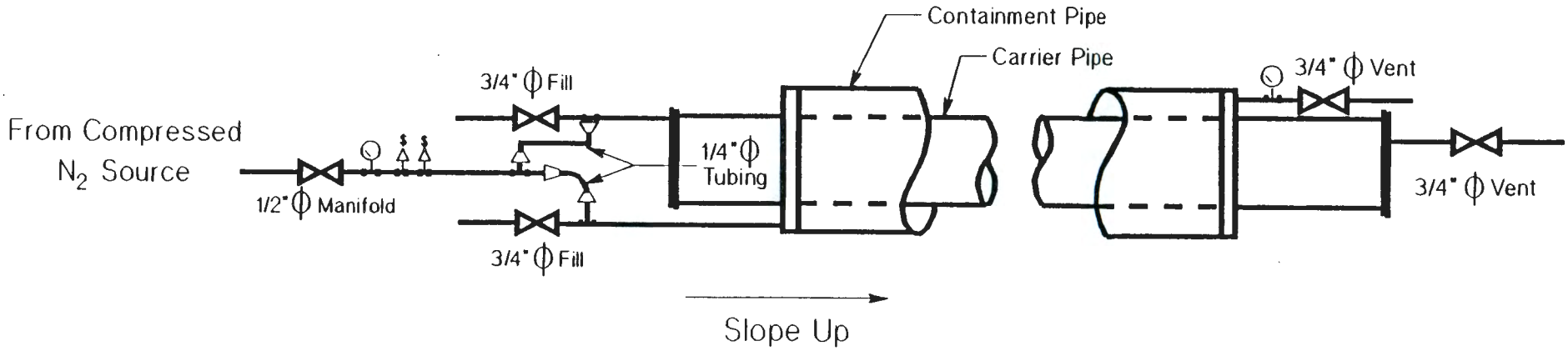

Figure 2
Liquid Effluent Retention Facility
KEH Containment Hydrostatic Test Rig

(Not to Scale)

Figure 3. Failed Section of 8-Inch Carrier Pipe at LERF Basins 42-43 Prior to Removal

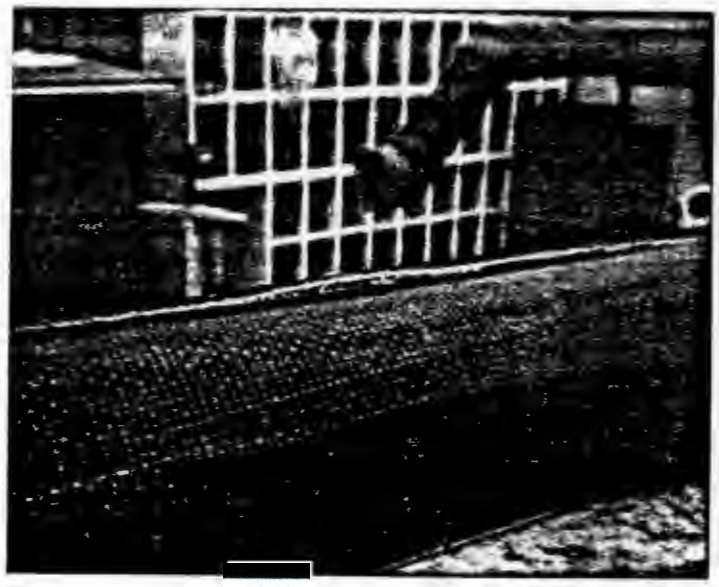

Figure 4. Failed Section of 8-Inch Carrier Pipe from LERF Basin 42-43

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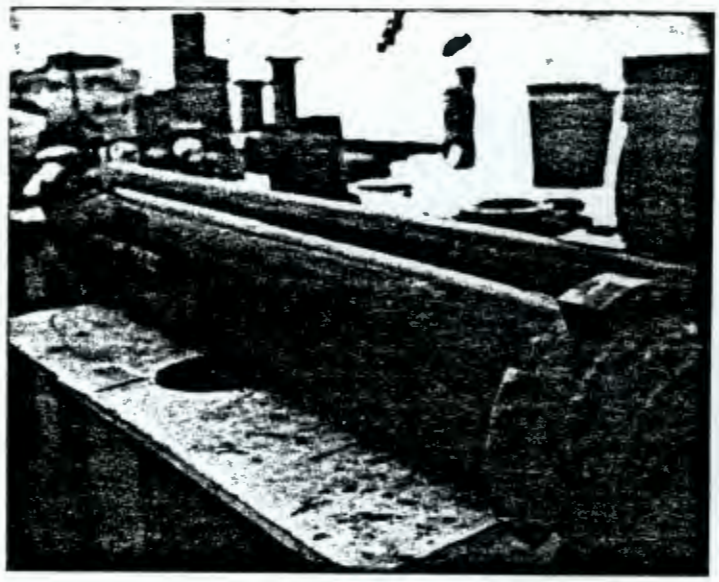

Figure 5. Failed Section of 8-Inch Carrier Pipe from LERF Basins 42-44 (Near Side)

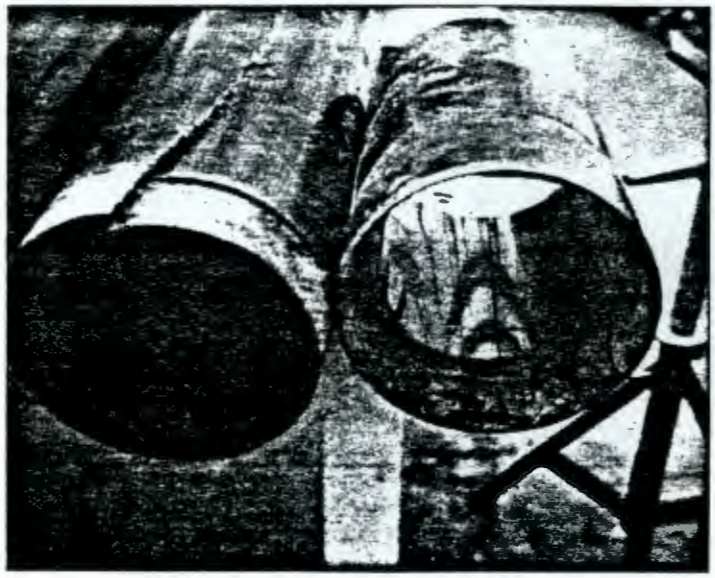

Figure 6. Failed Section of 8-Inch Carrier Pipe from LERF Basin 43-44, Bell Type Coupling

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APPENDIX A

Interviews with Pipefitters and Inspection Personnel

Independent interviews were conducted with key pipefitters involved with the set up and conducting of the hydrostatic tests on the double containment fiberglass pipe. Two quality control inspectors involved with the piping were also interviewed. The following is a compilation of the information obtained.

Service Water Supply

Service water for all hydrostatic testing was brought by hose from a hydrant near the 242-A Evaporator. Final hose size to the basin piping was 3/4-inch diameter. Water pressure at the job site varied from approximately 65 lbf/in^2 (gauge) to 160 lbf/in^2 (gauge) depending on system demand from other users. The water supply was common for all hydrostatic tests.

3N6 Assembly and Hydrostatic Testing

The double containment piping is pre-assembled in 40 foot lengths from the factory. In the field, the 3-inch carrier pipe is bonded first and then the 6-inch containment pipe is bonded except that slip collars remain unbonded. Slip collars in the 6-inch containment pipe allow access to the field bonds in the 3-inch pipe for the observation of those joints during the hydrostatic test. Following the successful hydrostatic testing of the 3-inch carrier pipe, the 6-inch containment pipe is bonded together at the remaining joints.

The 3-inch carrier pipe was filled in preparation for the hydrostatic testing of the 6-inch containment pipe. The fill point was at the low end of the sloped pipe run to be tested and the vent was at the high end (see Figure 2). Runs are quite long so radio communication was used to coordinate opening and closing of valves at each end of the test section. The vent valve was closed off immediately after the fill valve was closed but while the vent valve still had a solid stream of water. Filling of the 6-inch containment pipe was then initiated. Test risers in the 6-inch containment pipe were open when filling. As water spilled from each riser beginning at the fill (low) end, the cap was clamped tight. The last riser was at about the same elevation as the vent. There was some doubt as to whether the 6-inch containment vent valve was closed first or the fill valve closed first. Best memory was that fill valve was closed after the vent valve was closed.

The standard practice was for the pipefitters to perform information leak tests prior to formal hydrostatic testing. Test pressure for the 6-inch containment pipe was achieved by pressurizing with the service water and then pressurizing with compressed N2 to obtain the required 90 lbf/in^2 (gauge) test pressure for the informational check by the pipefitters. In some cases, the service water pressure alone may have been used for the information test. The test rig was fully connected (see Figure 2) for all informational and final hydrostatic tests of the containment pipe. Pressurizing with N2 generally took about 5 to 10 minutes. The pipefitters would then examine the chalked joints (a chalk solution was painted on the

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joints to show water leakage). When assured the joints were leak free, the inspectors were contacted to witness the formal hydrostatic test, normally that same day.

At completion of the test, the vent valves were opened. It was not clear whether the 3-inch carrier pipe and 6-inch containment pipe vent valves were opened simultaneously or if one before the other or, if so, which would have been opened first. The fill lines were then allowed to drain.

8N12 Assembly and Hydrostatic Testing

Basins 43-44

The 8-inch carrier pipe between Basins 43-44 was assembled first in the same manner as the 3N6. The informational test on the 8-inch carrier pipe was performed with service water pressure only and no leaks were found. The formal hydrostatic test was performed and witnessed later that day. No leaks were found. The line was drained and a second crew began assembly of the 12-inch containment pipe at Basins 43-44. The first crew began fabrication of the 8-inch carrier pipe at Basins 42-43.

The piping at Basins 43-44 was completed by the second crew and filling of the 8-inch carrier pipe was commenced by one pipefitter. Approximately 1 hour into the 8-inch carrier pipe fill a loud noise (described as a "woompf") was heard coming from the piping assembly and a sudden up and down movement of the piping was felt by the pipefitter who had been sitting on the pipe. The fill was continued until a solid stream of water was observed coming from the 8-inch carrier pipe vent. Time estimates for filling the 8-inch carrier pipe ranged from 3/4 to 1-1/2 hours. The pipefitter walked over and throttled back the fill valve and then walked down and closed the vent valve and returned to the fill end and closed the fill valve.

The fill hose was moved to the 12-inch containment pipe and filling initiated. The fill valve was throttled back after water was observed spilling out the lowest riser. The fill valve was maintained in throttled position as each riser spilled water and was capped tight. The vent valve was closed and the pipefitter returned to close the fill valve when a leak was observed in the 45° elbow at the fill end. The leak was in a factory bond and was a slow, air and water leak. The pipefitter then closed the fill valve. No N2 gas pressure had been placed on the assembly. Other pipefitters were called over to observe the leak. The hydrostatic test was called off and later that day the assembly was drained. Vents were opened first but it is not clear whether the 8-inch carrier pipe or 12-inch containment pipe vent was opened first. It was indicated that probably the 12-inch containment pipe vent was opened first. Four or five days later, filling of the Basins 43-44 assembly was again commenced in order to allow the inspectors and others to observe the leak in the 45° ell. Water was observed in the 12-inch containment pipe through a riser approximately 1/2 hour after the start of 8-inch carrier pipe fill. At that point it was recognized that the 8-inch carrier pipe had been breached. The fill was continued to completion and the assembly was pressurized to approximately 90 lbf/in^2 (gauge) to observe the 45° elbow leak. The assembly was drained. The breach in the 8-inch carrier pipe at Basins 43-44 was located and the failed section was removed.

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Basins 42-43

The 8-inch carrier pipe at Basins 42-43 was completed, hydrostatically tested, and no leaks were found. The 8-inch carrier pipe was drained and final assembly of the 12-inch containment pipe began. Filling of the 12-inch containment pipe was commenced in preparation for the containment leak test following its assembly. Approximately 1/2 to 1 hour into the filling of the 8-inch carrier pipe a noise and pipe movement was heard essentially the same as that heard on the 8-inch carrier pipe fill at Basins 43-44. The noise and movement was assumed at the time to be the 8-inch carrier pipe adjusting to changing thermal conditions. Filling of the 8-inch carrier pipe was completed. The vent valve was closed and then the fill valve was closed. No other unusual conditions were noticed. It was later assumed by the pipefitters that the noise and pipe movement on both occasions was caused by the failures.

The fill line was moved to the 12-inch containment pipe and filling was carried out as in the assembly at Basins 43-44, except that both pipes were rechecked for air in the following manner after filling was completed. The fill valve on the 8-inch carrier pipe was opened first then the vent valve was opened. The same action was taken on the 12-inch containment pipe. However, both vent valves may have been opened at the same time. There was some doubt as to exact sequence. The containment pipe was pressurized to the 90 lbf/in^2 (gauge) test pressure for an informational leak test. No leaks were found. The inspectors witnessed the formal hydrostatic test and the assembly was accepted the same shift. The piping was drained. Construction forces management determined that the 8-inch carrier pipe should be filled for a retest because of the failure found in the carrier pipe at Basins 43-44. Filling was commenced and a breach was discovered in the 8-inch carrier pipe at Basins 42-43 after observing water through a riser in the 12-inch containment pipe. The failed section was located and removed.

APPENDIX B. KEH PROCEDURES

CFM 6.1 General Requirements for Hydrostatic and Pneumatic Testing

CFM 6.5 Hydrostatic Testing - ASME B31.3

QA 11.0 Leak/Pressure Test Inspection

KEH W-105 Hydrostatic Test 8N12 (not formalized)

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KAISER ENGINEERS HANFORD	CONSTRUCTION FORCES - MECHANICAL		Qual Affecting YES [X] NO [ ]
Title: GENERAL REQUIREMENTS FOR HYDROSTATIC AND PNEUMATIC TESTING		Number: CFM 6.1	Revision: 2
Approval Authority (Title): Manager of Construction	Approved By: [signature] Date: 6/18/90	Effective Date: 06-28-90	Review Date: 06-28-92

1.0 PURPOSE

To establish the general requirements for hydrostatic and pneumatic testing of piping, piping components, pressure vessels, and/or other components performed by Kaiser Engineers Hanford Company (KEH).

2.0 SCOPE

This procedure is applicable to the performance, inspection, and documentation of hydrostatic and pneumatic tests conducted by KEH when specified in the Process Control Package (PCP) and/or design documents, and for all work performed under the American Society of Mechanical Engineers (ASME) Code by KEH. This procedure may be supplemented by other specified design requirements for a particular job or application.

3.0 RESPONSIBILITY

3.1 The Superintendent is responsible for defining the test boundaries of each test and ensuring that all participants in the test comply with the requirements of this procedure.

3.2 The Construction Engineer is responsible for including test requirements in the PCP or other documents as applicable, and evaluating test results.

3.3 The Superintendent or foreman, Construction Forces (CF), is responsible for conducting the test, and notifying the Quality Control (QC) Inspector and Acceptance Inspection, as required, at least 4 hours prior to initiation of the test. The Superintendent/foreman is also responsible for notifying the QC Supervisor and the Industrial Safety and Health (IS&H) department at least 48 hours prior to test initiation for installations requiring an ASME stamp.

3.4 For pneumatic testing, the Safety Engineer is responsible for ensuring that the test setup requirements, safety precautions, and procedures are complied with to ensure a safe pneumatic test.

3.5 The Field Contract Engineer is responsible for notifying Acceptance Inspection at least 4 hours prior to initiation of a test for Construction Management (CM) fixed-price (FP) work.

3.6 The QC Supervisor is responsible for notifying the Authorized Nuclear Inspector or Authorized Inspector, as appropriate, at least 24 hours prior to initiation of testing on ASME Code-stamped work.

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3.7 Participating employees are responsible for the performance of the test in compliance with this procedure.

4.0 DEFINITIONS

4.1 Acceptable Test Results: A test result which contains no deviations from specified requirements.

4.2 Hydrostatic Test: A pressure test conducted using water as a test medium.

4.3 In-service Test: A pressure test of a system in an operating mode, which may be at plant or line pressure.

4.4 Pneumatic Test: A pressure test conducted using gas as a test medium.

4.5 Pressure Relief Valve (PRV): An automatic pressure relieving device actuated by excessive static pressure and characterized by full-opening pop action.

4.6 Reactor Development Technology (RDT): A term which refers to a set of standards (i.e., RDT Standards) under which work may be performed. These standards contain requirements applicable to certain nuclear facilities. For purposes of this procedure, the term also includes Nuclear Energy (NE).

4.7 Static Head Test: A pressure test where the pressure is achieved by a standing column of liquid.

4.8 Test Gauge: A calibrated pressure measuring device installed in one of the system/component openings.

5.0 GENERAL REQUIREMENTS

5.1 On CF work, this procedure shall be used in conjunction with the procedures required for specific code application (e.g., procedure CFM 6.2 for ASME Section III; procedure CFM 6.3 for ASME Section VIII, etc.).

5.2 On CM FP work, this procedure shall be used as a guide insofar as it is applicable through contract documents that impose similar requirements on the FP constructor (e.g., use of the Leak/Pressure Test Certification [LPTC], etc.).

5.3 KEH personnel implementing this procedure shall be trained as required by procedure KAP 27.1.

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5.4 Each hydrostatic or pneumatic test to be performed shall be adequately planned prior to initiating the test, including requirements for personnel protection.

5.5 Initial-service leak testing to be as required in procedure CFM 6.7.

6.0 PROCEDURE

6.1 Work Flow: The general flow of activities for conducting a hydrostatic or pneumatic test is shown on Attachment CFM 6.1-A.

6.2 Test Planning and Preparation

6.2.1 The system/components are tested in operating position whenever possible and adequately supported to prevent distortion during testing.

6.2.2 Proposals to use test mediums other than water for hydrostatic tests are approved by the designer prior to use. The proposed test medium is of such quality as to minimize corrosion or deterioration of the system or components being tested.

For pneumatic tests, a nonflammable, nontoxic gas is used as the test medium.

6.2.3 The Superintendent or craft foreman and the Construction Engineer determine the extent of each test by establishing the test boundaries. The fill point, discharge point, and all vents are also determined.

6.2.4 The Construction Engineer initiates a LPTC (Attachment CFM 6.1-B), when required, by entering pertinent information required in the general section and the Test Preparation section.

6.2.5 Under the Description, the test boundaries are clearly described or appropriate drawings referenced and attached.

6.2.6 When drawings are necessary and are not provided on a job that requires hydrostatic or pneumatic testing, the Construction Engineer prepares sketches of the system or components which identify the test boundaries for each test and are traceable to project or work order numbers.

6.2.7 The LPTC is included in the PCP or provided to the person responsible for conducting the test.

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6.3 Test Setup: The test equipment is assembled in a manner similar to that shown in the Hydrostatic Test Set-Up Diagram (Attachment CFM 6.1-C) and/or the Pneumatic Test Set-Up Diagram (Attachment CFM 6.1-D), and applicable portions of this procedure.

6.3.1 Test gauge tolerance and calibration requirements are to be per procedure KAP 12.1. Test gauge(s) used are of a dial-type face with a range of not less than 1.5 nor more than 4.0 times the test pressure.

NOTE: Digital-type pressure gauges may be used without range restriction provided they have a combined error rate which does not exceed 1% of the test pressure due to calibration and readability.

6.3.2 One test gauge is installed directly ahead of the system being tested. If the test gauge is not readily visible to the operator controlling the pressure applied, an additional test gauge is provided where it will be visible to the operator throughout the duration of the test.

NOTE: Depending upon the size and configuration of the system to be tested, additional test gauges may be installed as necessary to ensure complete test pressure verification.

6.3.3 The test gauge is located at the highest point of the test or the test pressure is increased to ensure minimum test pressure is achieved at the highest point of the test.

6.3.4 The pressure is controlled by use of a pressure regulator/manifold. A dial gauge and pressure regulator are installed as an integral portion of the pressure source.

6.3.5 A block valve is installed between the regulator/manifold or pressurizing device gauge and the PRV to isolate the system being tested.

NOTE: In the event that the PRV is actuated or fails during filling or testing, the block valve is immediately closed by the test operator to isolate the system.

6.3.6 A PRV is installed between the block valve and the system to be tested. The relief valve is preset to actuate at (a maximum of) 1-1/4 times the test pressure or at the pressure called for in the design specifications, whichever is lower.

6.3.7 When the required test pressure exceeds the capacity of the plant water source, then hand pumps, air-actuated diaphragm

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pumps, pressurized inert gas, or similar types of pressurizing devices may be employed.

6.3.8 Test equipment lines are "blown out" using the test medium. In-line filters are used when required by the project specification/code or when plant air is the test medium.

6.3.9 For hydrostatic testing, vent lines are provided at all high points of the component or system being tested as necessary to ensure adequate removal of air during filling.

6.3.10 Expansion joints are restrained or isolated prior to initiation of the test. Instruments and other items which could be damaged by test pressures are also isolated.

6.3.11 Under normal test conditions, expanding plugs and/or flanges with strongbacks are used to close openings. The Safety Engineer shall be consulted as necessary.

NOTE: When high test pressures are required, and at the discretion of the Construction Engineer and/or the Safety Engineer, caps are be welded to open nozzles and gasketed blind flanges are used on flanged nozzles. In addition, friction clamp bridles are used on expanding plugs.

6.3.12 Unless specified otherwise, all joints, welds, and other potential leak sources are uninsulated and/or uncoated (i.e., paint, etc.), made visible, and remain accessible during the test.

6.3.13 Prior to application of the test pressure (if required by the specifications for hydrostatic tests), chalk of a contrasting color is applied to all joints, attachment welds, connections, and all regions of high stress to aid in their inspection (e.g., around openings, thickness transition sections, and bends). The chalk may be mixed with alcohol or acetone instead of water to reduce the evaporation time. Remove excess thread compound from threaded joints prior to application of chalk.

6.3.14 Isolation barriers, safety zones, or other safety precautions are established, as necessary, around the component or system to be tested.

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6.3.15 The following additional safety requirements are applicable for pneumatic testing.

6.3.15.1 Bridled expanding plugs are used to close openings.

6.3.15.2 Caps may be welded to open nozzles when required because of high test pressures (consult the Safety Engineer).

6.3.15.3 Blind flanges with the same rating as the system are installed with gaskets on flanged nozzles.

6.3.15.4 All personnel not participating in the test are evacuated from the test area while the tested system/component is under pressure.

6.3.15.5 Test setup is inspected by the Safety Engineer.

6.3.16 Proper valve lineup and test boundaries are verified through a system walkdown. Conditions of the items under test are evaluated. Conditions adverse to test function or quality are corrected prior to conducting test.

6.3.17 After completion of the test setup, the test equipment is checked for tightness and condition.

6.3.18 The person responsible for conducting the test initials appropriate blocks of the Pretest Checklist section on the LPTC. Other prerequisites established by approved test plans are included in the PCP and completed prior to conducting the test. The test plan may include other conditions to be met to demonstrate adequate performance to design conditions.

6.3.19 Environmental conditions are evaluated prior to and during testing activities. Unsuitable condition prerequisites are established prior to test.

6.4 Application of Pressure

6.4.1 Pressure for hydrostatic or pneumatic tests is applied in accordance with the requirements of the applicable procedure (e.g., procedure CFM 6.2, CFM 6.3, etc.).

6.4.2 Precautions are taken to avoid excessive pressure being applied to the system or component(s) being tested when the test medium is subject to thermal expansion.

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6.5 Leakage Permissibility During Testing

6.5.1 Leakage of temporary gaskets and seals installed for the purpose of conducting the hydrostatic test, and which will be replaced or removed later, may be permitted provided the system test pressure can be maintained for the required amount of time.

6.5.2 Other leaks, such as from permanent seals, seats and gaskets, or joints in components, may be permitted when specifically allowed by the design specifications.

6.5.3 Leakage as described in paragraphs 6.5.1 or 6.5.2 is directed away from the surface of the component or system under test to avoid masking potential leaks from other joints.

6.6 Acceptance Criteria: Acceptance criteria are as specified in the applicable procedure (e.g., procedure CFM 6.2, CFM 6.3, etc.).

6.7 Documentation of Test Results: Unless specified otherwise, all hydrostatic and pneumatic test and examination results are documented on the LPTC. In addition, entries are made in the Measuring and Test Equipment (M&TE) Use Record in accordance with procedure KAP 12.1.

6.7.1 Acceptable Test Results: Acceptable test results are recorded on the LPTC and the LPTC is forwarded to the acceptance party (e.g., Acceptance Inspection) for completion of the Inspection Verification section. A copy may be retained for reference.

For tests not required to be witnessed and accepted by others, the Inspection Verification section is also marked "Not Applicable" (NA). The LPTC is forwarded to the Construction Engineer for review and filing.

6.7.2 Unacceptable Test Results: Unacceptable test results that require rework to the system/component being tested are documented on the LPTC and the LPTC is forwarded to the Construction Engineer for review and filing. (The Inspection Verification section is not required to be completed.) The Construction Engineer enters the action taken in connection with any deviations noted in the comments section of the LPTC.

Unacceptable test results that require design and/or customer approved dispositions for correction are documented on the LPTC. The LPTC is forwarded to the Construction Engineer for review and filing. In addition, a Nonconformance Report

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(NCR) is initiated and processed in accordance with procedure KAP 15.1. Also, the NCR number is entered on the LPTC in the space provided. (The Inspector Verification section is not required unless the unacceptable test results are detected by the approving party [e.g., Acceptance Inspection].)

6.7.3 Inspection Verification: The acceptance party (e.g., Acceptance Inspection) completes the Inspection Verification section of the LPTC and forwards it to the Construction Engineer for review and filing.

NOTE: On CM FP work, the LPTC is processed in accordance with procedure CP 6.

6.8 Completion of Test

6.8.1 Following completion of the test, the pressure is released, and the item or system tested is drained (hydrostatic) of all test medium. When practical, the item or system should be rotated or otherwise positioned to ensure complete removal of test medium from all low spots and such areas where the test medium is likely to be trapped.

6.8.2 Drying is normally accomplished by allowing the item or system to "drip dry" until sufficient time has elapsed to ensure adequate drying. The methods described in paragraphs 6.8.3 or 6.8.4 may be used at the discretion of the Construction Engineer unless specified otherwise.

6.8.3 All exposed areas and piping with sufficiently large internal diameters may be dried using clean, low-lint rags. The rags may be dampened with alcohol.

6.8.4 To expedite the drying time of the item or system, forced air may be used. When forced air is used, it is clean, dry, oil-free air or inert gas. Filters are utilized as necessary to ensure the required purity.

6.8.5 Temporary installation of high point bleeds and/or low point drains not shown on design drawings is removed along with the hydrostatic testing equipment.

6.8.6 The system/component is cleaned and protected to the extent necessary to comply with specified cleanliness requirements.

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6.9 Document Review and Filing

6.9.1 Upon receipt of the LPTC, the Construction Engineer evaluates the test results for adequacy and proper signatures.

6.9.2 The Construction Engineer highlights a "master" drawing or sketch for each test conducted and references the LPTC Report Number used to document the test results.

6.9.3 These actions are indicated by checkmarks, signature, and date on the LPTC in the space provided.

6.9.4 The completed LPTC is included in the PCP or processed in accordance with procedure CP 6.

7.0 RECORDS

7.1 LPTCs which are included in the PCP are processed in accordance with procedures CP 6 and CP 9.

7.2 When a PCP is not required, the LPTC is processed in accordance with procedure CP 6.

8.0 REFERENCES

ASME B31.1	Power Piping
ASME/ANSI B31.3	Chemical Plant and Petroleum Refinery Piping
ASME Section III	Rules for Construction of Nuclear Power Plant Components
ASME Section VIII	Rules for Construction of Pressure Vessels
RDT/NE F5-1T	Cleaning and Cleanliness Requirements for Nuclear Components
RDT/NE E15-2T	Requirements for Nuclear Components (Supplement for Boiler and Pressure Vessel Code, Section III)
CFM 6.2	Hydrostatic Testing - ASME Section III
CFM 6.3	Hydrostatic Testing - ASME Section VIII
CFM 6.4	Hydrostatic Testing - ANSI B31.1
CFM 6.5	Hydrostatic Testing - ANSI B31.3
CFM 6.6	Hydrostatic Testing - Static Head

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CFM 6.7	Initial Service Leak Testing
CFM 6.8	Pneumatic Testing - ASME Section III
CFM 6.9	Pneumatic Testing - ASME Section VIII
CFM 6.10	Pneumatic Testing - ANSI B31.1
CFM 6.11	Pneumatic Testing - ANSI B31.3
CP 6	Construction Document Control
CP 9	Process Control for Construction
KAP 12.1	Control of Measuring and Test Equipment
KAP 15.1	Control of Nonconforming Items
KAP 27.1	Organizational Training

9.0 ATTACHMENTS

CFM 6.1-A Hydrostatic and Pneumatic Testing Process Flow Chart
CFM 6.1-B Leak/Pressure Test Certification
CFM 6.1-C Hydrostatic Test Set-Up Diagram
CFM 6.1-D Pneumatic Test Set-Up Diagram

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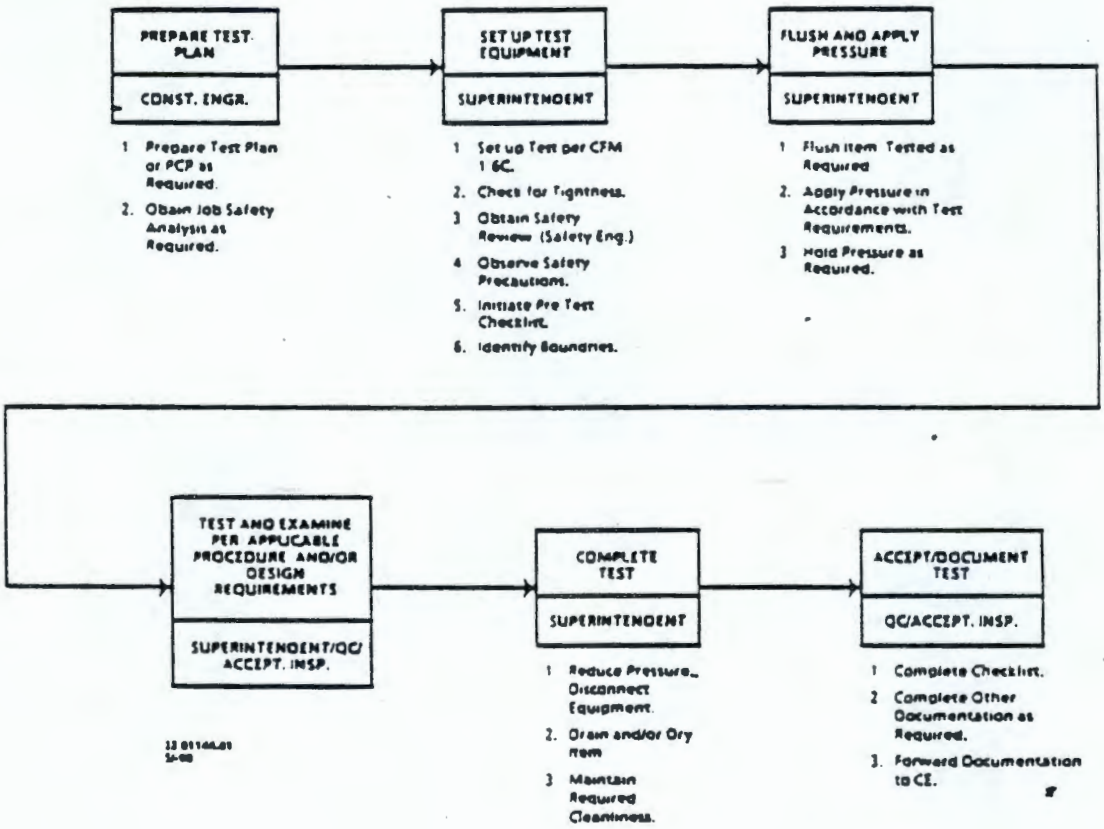
HYDROSTATIC AND PNEUMATIC TESTING PROCESS



ATTACHMENT CFM 6.1-A

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KAISER ENGINEERS HANFORD

LEAK/PRESSURE TEST CERTIFICATION

Report No. 328 — Page 1 of 2

Project or W.O. No.	Title	Dwg. Reference	Test Procedure/Rev.

Construction Spec./Rev.	Code or Standard	Year	Addenda	Class	Stamp Required
					☐ Yes ☐ No

Description of System or Component(s) Test Boundaries

_____

_____

TEST PREPARATION

Notification Requirements	Valve Line-up Requirements (for permanent valves installed)		
☐ Quality Control	Valve I.D. _____	☐ Open	☐ Close
☐ Acceptance Inspection	Valve I.D. _____	☐ Open	☐ Close
☐ Safety Engineer	Valve I.D. _____	☐ Open	☐ Close
☐ Client _____	Valve I.D. _____	☐ Open	☐ Close
☐ Authorized Inspector	Valve I.D. _____	☐ Open	☐ Close
☐ _____	Valve I.D. _____	☐ Open	☐ Close

Required Test Medium	Required Test Medium Temp.	Flushing Requirements	
Medium _____	Temp. _____	Flushing _____	☐ Blue Checking Required ☐ Soap Solution Required

Design System Pressure	Design Test Pressure	Specified Hold Time	Prepared By	Date
_____	_____	_____		

PRETEST CHECKLIST

Item or Requirement	Craft Supervision	Quality Control Accept	Quality Control Date
Valve line-up per design requirements (see above line up).			
Flushing of system and/or component completed per design requirements.			
All lines or components not to be tested are properly isolated or disconnected.			
Vents and openings checked; proper Pressure Relief Valve installed and discharge checked.			
Test medium per design requirements; temperature equalized. Medium _____ Medium Temp. _____ (ASME only)			
Test gauge(s) correct range and currently calibrated. SN _____ Range _____ Cal. Due Date _____ SN _____ Range _____ Cal. Due Date _____ SN _____ Range _____ Cal. Due Date _____			
Pressure Relief Valve properly set and currently calibrated. SN _____ PSI Set _____ Checked Date _____ SN _____ PSI Set _____ Checked Date _____ SN _____ PSI Set _____ Checked Date _____			

KEH-175/01 (2/88)

ATTACHMENT CFM 6.1-B-1

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KAISER ENGINEERS HANFORD

LEAK/PRESSURE TEST CERTIFICATION

Report No. 328 — Page 2 of 2

TEST PERFORMANCE

Item or Requirement	Quality Control Accept	Quality Control Date
RDT/NE and other if specified:		
50% Tp obtained and examination conducted = Tp _____		
Pressure increments at 0.10 Tp: = Tp _____		
= Tp _____		
= Tp _____		
= Tp _____		
= Tp _____		
Hydrostatic testing - areas to be inspected chalked prior to application of pressure.		
Hydrostatic testing - examination conducted while system/component pressurized. Specified Tp _____ PSI obtained at _____ a.m. p.m.		
Pneumatic Testing - soap solution applied to areas to be tested and system/components examined while pressurized. Specified Tp _____ PSI obtained at _____ a.m. p.m.		

Pressure Test	Quality Control Signature	Stamp or PR No.	Date
[ ] Accepted [ ] Rejected			

INSPECTION VERIFICATION

Documentation properly prepared.	[ ] Yes [ ] No	Actual Tp during final inspection _____ PSI	
All joints and welded attachments to pressure retaining components chalked/soaped as applicable.	[ ] Yes [ ] No		
All joints and welded attachments to pressure retaining components visually inspected for leakage.	[ ] Yes [ ] No	Specified hold time verified at _____ a.m. p.m.	

Pressure Test	Acceptance Inspection Signature	Stamp or PR No.	Date
[ ] Accepted [ ] Rejected			

OTHER

Comments

_____

_____

_____

_____

NCR No. (if applicable)	Client Representative		Date
	Witness - ASME Authorized Inspector		Date
[ ] Document Reviewed [ ] Drawings Highlighted	Construction Engineering	PR No.	Date

KEH-1/57 02 (2/88)

ATTACHMENT CFM 6.1-B-2

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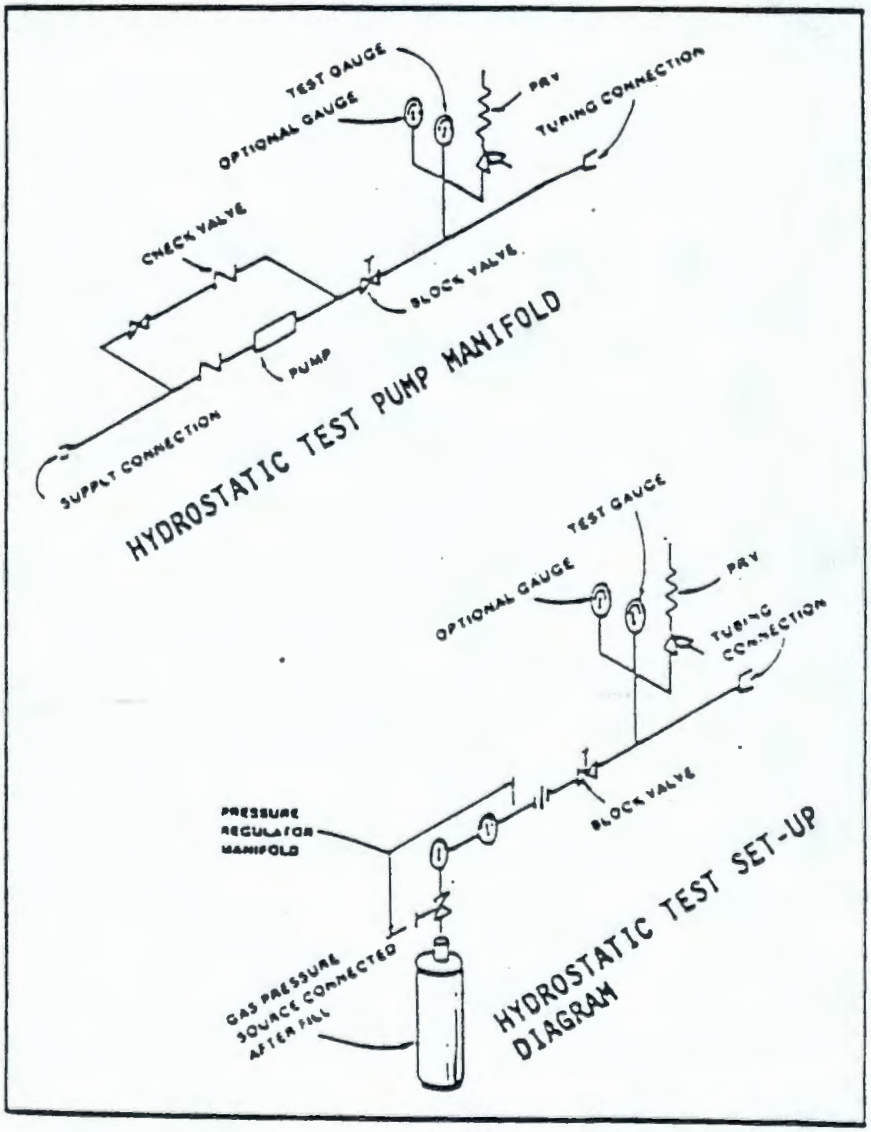

KEH-306a (1-87)

ATTACHMENT CFM 6.1-C

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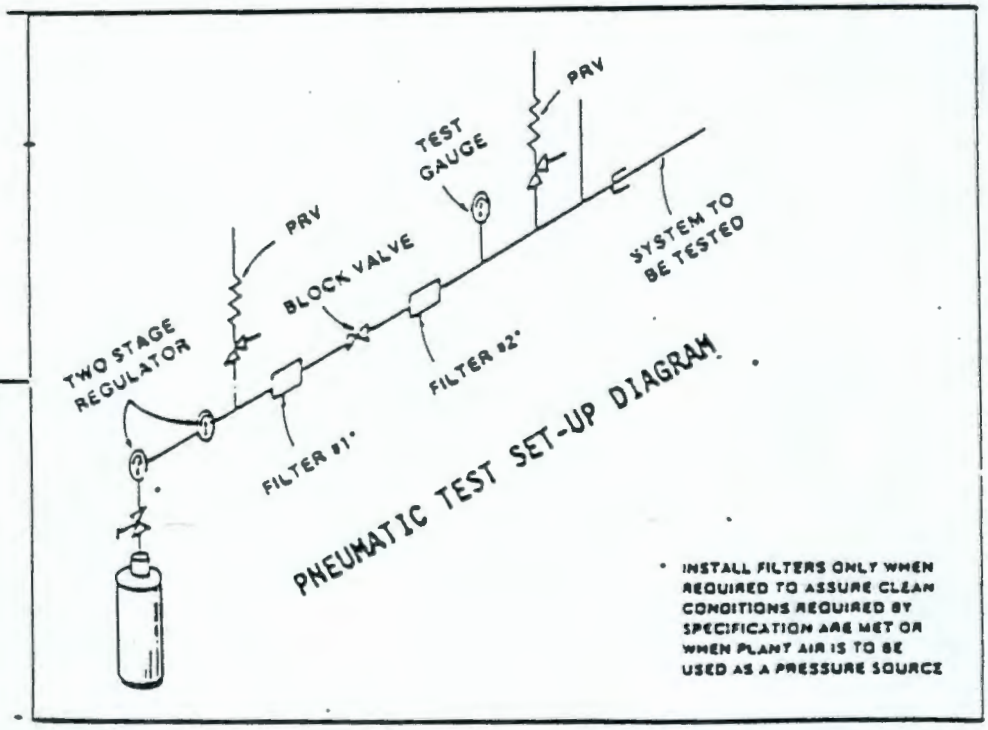

KEH-306a (1-87)

ATTACHMENT CFM 6.1-D

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KAISER ENGINEERS HANFORD	CONSTRUCTION FORCES - MECHANICAL		Qual Affecting YES [X] NO [ ]
Title: HYDROSTATIC TESTING - ASME B31.3		Number: CFM 6.5	Revision: 1
Approval Authority (Title): Manager of Construction	Approved By: R.W. [illegible] Date: 4/17/91	Effective Date: 05-01-91	Review Date: 05-01-93

1.0 PURPOSE

To establish the procedure for conducting hydrostatic tests in accordance with Society of Mechanical Engineers (ASME) B31.3.

2.0 SCOPE

This procedure is applicable to the performance, inspection, and documentation of hydrostatic tests (per ASME B31.3) by Kaiser Engineers Hanford Company (KEH) when specified in the Process Control Package (PCP) and/or design documents. This procedure may be supplemented by other specified design requirements for a particular job or application.

3.0 RESPONSIBILITY

Refer to procedures CP 1 and CFM 6.1.

4.0 DEFINITIONS

Not Applicable

5.0 GENERAL REQUIREMENTS

This procedure shall be used in conjunction with procedure CFM 6.1, which provides the general requirements for hydrostatic testing.

6.0 PROCEDURE

6.1 Preparation

6.1.1 Prepare test in accordance with procedure CFM 6.1.

6.1.2 Review requirements of applicable sections in this procedure (e.g., testing of piping systems, etc.) before proceeding, and perform additional test preparation where applicable.

6.1.3 Notify other personnel of test readiness as required.

6.1.4 Flush system with specified test medium if required.

6.1.5 Fill system or component with the specified test medium and allow sufficient time for the temperature of both the system or component and the test medium to reach the test

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temperature. Unless otherwise specified, the test temperature is that of the test medium source.

6.2 Testing of Bellows

6.2.1 Ensure that any special requirements for testing of expansion joints in accordance with the design are met prior to applying pressure (e.g., restraints installed, etc.).

6.2.2 Take measurements before, during, and after the application of pressure to examine for evidence of meridional yielding and squirm. Record these measurements in the Comment section of the Leak/Pressure Test Certification (LPTC).

6.3 Testing of Valves and Pumps

6.3.1 Hydrostatically test the valves and pumps prior to installation. (Normally this is performed by the manufacturer in accordance with the material specification and design.)

NOTE: When permitted by the material specification and design, the system subassembly hydrostatic test may be substituted in lieu of the hydrostatic test provided the minimum test pressure for the piping system is met.

6.3.2 Hydrostatically test all pumps, valves, and other components or appurtenances containing brazed joints prior to installation.

6.4 Testing of Piping Systems: When the piping configuration is such that a significant increase in pressure may result and cause overpressurization at system low points, install a Pressure Relief Valve (PRV) at the system low point.

6.5 Testing of Piping with Vessels as a System: Where piping is attached to a vessel and is to be tested as a system, the Construction Engineer is consulted for test pressures, limitations, etc.

6.6 Application of Pressure

6.6.1 After the test temperature is attained, gradually apply the pressure until the required test pressure is obtained. If deformation or unacceptable leakage is noted during

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pressure application, abort the test and take corrective action.

NOTE: The test pressure may need to be increased to ensure that the minimum test pressure is achieved at the highest point of the test.

6.6.2 Do not exceed the maximum allowable test pressure of any nonisolated vessel, pump, or valve in the system.

6.6.3 Hold the test pressure for a minimum of 10 minutes or as required to conduct an examination.

6.6.4 Examine the component/system in accordance with section 6.7.

6.7 Inspection

6.7.1 Inspection of hydrostatic tests is performed when required and the results are documented in accordance with procedure CFM 6.1.

6.7.2 Conduct a visual examination on all weld joints and areas of high stress (i.e., thickness transition sections and regions around openings).

6.8 Acceptance Criteria

6.8.1 Unless specified otherwise, the test is unacceptable if any leaks occur.

6.8.2 The test is unacceptable if permanent distortion is visible in the system or component being tested.

6.9 Test Completion: Complete the hydrostatic test in accordance with procedure CFM 6.1.

7.0 RECORDS

Refer to procedure CFM 6.1.

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8.0 REFERENCES

ASME B31.3	Chemical Plant and Petroleum Refinery Piping
CFM 6.1	General Requirements for Hydrostatic and Pneumatic Testing
CP 1	Construction Organization and Responsibility
CP 9	Process Control for Construction

9.0 ATTACHMENTS

Not Applicable

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KAISER ENGINEERS HANFORD	QUALITY SERVICES		Qual Affecting YES [X] NO [ ]
Title: LEAK/PRESSURE TEST INSPECTION		Number: QS 11.0	Revision: 3
Approval Authority (Title): Manager of Quality Services	Approved By: M A Lacey Date: 6-1-90	Effective Date: 06-14-90	Review Date: 06-14-92

1.0 PURPOSE

To define the system for the inspection of leak/pressure testing of piping, pressure vessels, etc. performed by Quality Services.

2.0 SCOPE

This procedure applies to the verification and documentation of pressure tests by Kaiser Engineers Hanford Company (KEH) Quality Control (QC) and Acceptance Inspection (AI) personnel.

3.0 RESPONSIBILITY

3.1 The Quality Services Manager is responsible for implementation of this procedure.

3.2 The QC/AI Supervisors are responsible for ensuring that verification of testing activities are performed by certified Inspectors.

3.3 The Inspector is responsible for verifying that tests are performed in accordance with this procedure and applicable Construction procedures for pneumatic, hydrostatic, or pressure decay tests. The Inspector is also responsible for the proper documentation of test results. Refer to Attachment QS 11.0-A.

4.0 DEFINITIONS

Not Applicable

5.0 GENERAL REQUIREMENTS

5.1 Inspectors shall have available at the test site all drawings, weld maps, or other data which are necessary to identify welds and items tested and to identify test boundaries.

5.2 Leak/pressure testing, either hydrostatic, pneumatic, or pressure decay shall be conducted in accordance with applicable Construction procedures. The Inspector shall witness the test, inspect for leaks, and document the results on the Leak/Pressure Test Certification (LPTC) form (Attachment QS 11.0-B) or the Pressure Decay Test Report shown in procedure CFM 6.12 as Attachment CFM 6.12-A.

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5.3 Leak/pressure testing is performed by the Inspector in accordance with this procedure. Inspection personnel who perform and evaluate leak/pressure testing shall be certified in accordance with procedure QS 2.3. Leak/pressure testing may be performed by certified Level I inspection personnel, but evaluation and acceptance shall be by certified Level II or III inspection personnel.

6.0 PROCEDURE

6.1 Upon notification of a scheduled hydrostatic, pneumatic, or pressure decay leak/pressure test, the QC Inspector reviews applicable project design documents to determine specified test requirements, methods, and parameters.

6.2 The Inspector receives the LPTC from the person responsible for conducting the test (foreman or superintendent) with adequate direction provided in the heading and the Test Preparation section of the form.

6.3 The Inspector performs inspections required by the Pretest Checklist section of the LPTC and documents the inspections on the form.

6.4 As part of the pretest inspection, the Inspector also verifies that the areas to be tested are free of oil, grease, paint, or contaminants which might mask a leak. If liquids are used to clean the component, the component is thoroughly dried before testing. Satisfactory completion of this activity is indicated as part of the pretest flushing signoff on the LPTC.

6.5 As the test proceeds, the Inspector completes the form, recording actual test conditions and inspection results. It is essential that the Inspector verifies that the test boundaries described are accurate.

The Inspector also records the pressure gauges used for the test on the M & TE Use Record (Attachment QS 11.0-C) for the work order.

6.6 At the conclusion of the test, the inspector completes the appropriate section of the form. The form is forwarded to AI for completion of the verification section and then to the cognizant Construction Engineer. When AI is not required, the Inspector indicates (N/A), initials and dates, and forwards to Construction Engineering.

Upon receipt of the LPTC, the Construction Engineer highlights a "master" drawing for each test conducted and references the LPTC report number in accordance with procedure CFM 6.1.

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6.7 Colored Chalk Use for Hydrostatic Testing

6.7.1 When required by specifications pertaining to hydrostatic testing, a colored chalk solution is applied to all weld joints, attachment welds, connections, and all regions of high stress such as around openings, thickness transition sections, and bends.

6.7.2 Once the chalk has dried to a light color, the system/item may be pressurized in accordance with applicable Construction procedures.

6.7.3 During the inspection, any water leaks will show as dark areas against the light chalk. If leaks are observed, the component is depressurized, repaired, and retested in accordance with the original testing procedure.

6.8 Soap Solution Used for Pneumatic Testing

6.8.1 When required by specifications pertaining to pneumatic testing, a soap solution is applied to all weld joints, attachment welds, connections, and all regions of high stress, such as around openings, thickness transition sections, and bends.

6.8.2 The soap solution should produce a uniform film over the area to be tested such that any leakage bubbles that may form will not rapidly break.

6.8.3 Leaks are identified by the formation of bubbles in the soap solution caused by escaping gas.

6.9 Acceptance Criteria

6.9.1 Unless otherwise specified, the testing for piping, vessels, tanks, pumps, and valves is unacceptable if leaks occur, other than those incidental leaks around temporary gaskets, seals, etc. as allowed in applicable Construction procedures.

6.9.2 The testing is unacceptable if permanent distortion is visible in the system and/or component being tested.

6.9.3 Other acceptance criteria may be specified by the design.

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7.0 RECORDS

The Leak/Pressure Test Certification, Pressure Decay Test Report, and M & TE Use Records are all considered to be quality assurance records. The Quality Services department is responsible for maintaining these records in accordance with procedure QS 17.0. Dual storage requirements are in accordance with procedure KAP 17.1.

8.0 REFERENCES

CFM 6.1	General Requirements for Hydrostatic and Pneumatic Testing
CFM 6.12	Pressure Decay Testing
KAP 11.0	Test Control Requirements
KAP 11.1	Acceptance Test Procedures Preparation
KAP 17.1	Quality Assurance Records Management
QS 2.3	Qualification and Certification of Quality Services Personnel
QS 10.5	Visual Inspection (Weldments)
QS 17.0	Quality Services Records and Documentation

9.0 ATTACHMENTS

QS 11.0-A	Leak/Pressure Test Inspection Flow Chart
QS 11.0-B	Leak/Pressure Test Certification
QS 11.0-C	M & TE Use Record

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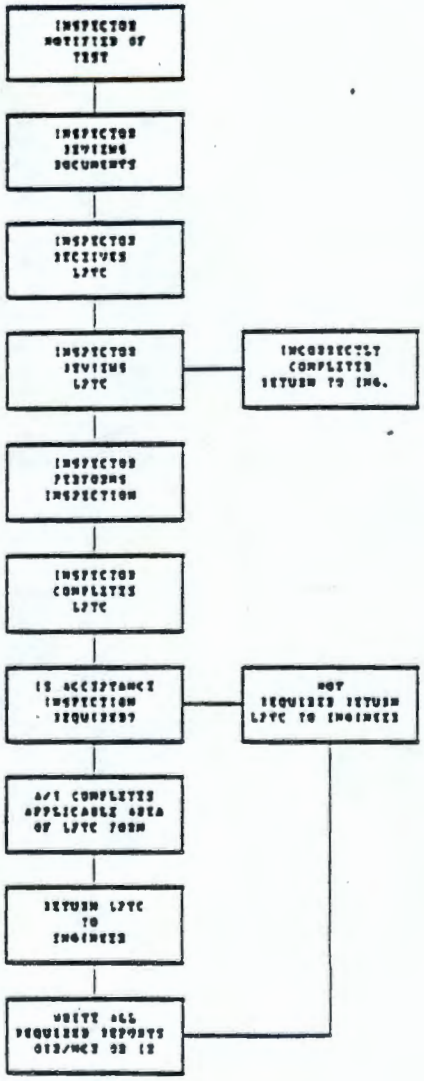
LEAK/PRESSURE TEST INSPECTION
FLOW CHART



ATTACHMENT QS 11.0-A

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KAISER ENGINEERS HANFORD

LEAK/PRESSURE TEST CERTIFICATION

Report No

Page 1 of 2

Project or W.O. No	Title	Dwg. Reference	Test Procedure/Rev

Construction Spec /Rev	Code or Standard	Year	Addenda	Class	Stamp Required
					[ ] Yes [ ] No

Description of System or Component(s) Test Boundaries

_____

_____

TEST PREPARATION

Notification Requirements	Valve Line-up Requirements (for permanent valves installed)		
[ ] Quality Control	Valve I.D. _____	[ ] Open	[ ] Close
[ ] Acceptance Inspection	Valve I.D. _____	[ ] Open	[ ] Close
[ ] Safety Engineer	Valve I.D. _____	[ ] Open	[ ] Close
[ ] Client _____	Valve I.D. _____	[ ] Open	[ ] Close
[ ] Authorized Inspector	Valve I.D. _____	[ ] Open	[ ] Close
[ ] _____	Valve I.D. _____	[ ] Open	[ ] Close

Required Test Medium	Required Test Medium Temp	Flushing Requirements	
Medium _____	Temp _____	Flushing _____	[ ] Blue Chalking Required
			[ ] Soap Solution Required

Design System Pressure	Design Test Pressure	Specified Hold Time	Prepared By	Date
_____	_____	_____		

PRETEST CHECKLIST

Item or Requirement	Craft Supervision	Quality Control Accept	Quality Control Date
Valve line up per design requirements (see above line up)			
Flushing of system and/or component completed per design requirements			
All lines or components not to be tested are properly isolated or disconnected			
Vents and openings checked; proper Pressure Relief Valve installed and discharge checked.			
Test medium per design requirements; temperature equalized. Medium _____ Medium Temp. _____ (ASME only)			
Test gauge(s) correct range and currently calibrated. SN _____ Range _____ Cal Due Date _____ SN _____ Range _____ Cal Due Date _____ SN _____ Range _____ Cal Due Date _____			
Pressure Relief Valve properly set and currently calibrated. SN _____ PSI Set _____ Checked Date _____ SN _____ PSI Set _____ Checked Date _____ SN _____ PSI Set _____ Checked Date _____			

RCH 1/5/01 (2-88)

ATTACHMENT QS 11.0-B-1

9 2 1 2 4 6 4 1 5 3 2

KAISER ENGINEERS HANFORD | LEAK/PRESSURE TEST CERTIFICATION | Report No | Page 2 of 2

TEST PERFORMANCE

Item or Requirement	Quality Control Accept	Quality Control Date
ROTINE and other if specified:		
50% Tp obtained and examination conducted - Tp _____		
Pressure increments at 0 10 Tp: - Tp _____		
- Tp _____		
- Tp _____		
- Tp _____		
- Tp _____		
Hydrostatic testing - areas to be inspected chalked prior to application of pressure		
Hydrostatic testing - examination conducted while system/component pressurized Specified Tp _____ PSI obtained at _____ a m / p m		
Pneumatic Testing - soap solution applied to areas to be tested and system/components examined while pressurized Specified Tp _____ PSI obtained at _____ a m / p m		

Pressure Test	Quality Control Signature	Stamp or PR No.	Date
[ ] Accepted [ ] Rejected			

INSPECTION VERIFICATION

Documentation properly prepared	[ ] Yes	[ ] No	Actual Tp during final inspection _____ PSI
All joints and welded attachments to pressure retaining components chalked/tagged as applicable	[ ] Yes	[ ] No	Specified hold time verified at _____ a m / p m
All joints and welded attachments to pressure retaining components visually inspected for leakage.	[ ] Yes	[ ] No	

Pressure Test	Acceptance Inspection Signature	Stamp or PR No.	Date
[ ] Accepted [ ] Rejected			

OTHER

Comments

NCR No (if applicable)	Client Representative		Date
	Witness - ASME Authorized Inspector		Date
[ ] Document Reviewed [ ] Drawings Highlighted	Construction Engineering	PR No	Date

KEH-1757 02 (2-88)

ATTACHMENT QS 11.0-B-2

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MEASURING AND TEST EQUIPMENT USE RECORD

PCP or IP No.

Page of

VERIFICATION	METER NO.	CALIBRATION DUE DATE	INSPECTOR	DATE USED	DESCRIPTION OF SPECIFIC USE

KEH-2047 00(12-89)

ATTACHMENT QS 11.0-C

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KEH W-105

HYDROSTATIC TEST 8 N 12

THE FOLLOWING IS A STEP BY STEP OF ACTIVITIES ANTICIPATED, TO COMPLETE AN 8" CARRIER AND 12" ENCASEMENT "HYDRO" TEST.
ACTUAL FIELD CONDITIONS OR CIRCUMSTANCE MAY REQUIRE DEVIATION.

ASSURE A STARTING POSITION OF ALL VALVES CLOSED 8" AND 12"

1.) FILLING AND PRESSURIZATION OF 8"

A. PRESSURE RELIEF VALVE TO BE SET 130 PSIG

B. OPEN VALVES ON THE 8" SIDE IN THE FOLLOWING SEQ.

1. F HIGH POINT VENT
2. A SUPPLY (MAIN)
3. B 3/4" SUPPLY (8" IS NOW FILLING)
4. C 1/4" PRV SIDE

NOTE B & C MAY BE OPENED SIMULTANEOUSLY

CONSTANT MONITORING OF FILLING OPERATION AND GAUGES IS REQUIRED.
WHEN THE 8" SYSTEM IS FULL (ALL AIR VENTED)
CLOSE VALVES F & B

PROCEED TO PRESSURIZE THE 8" WITH THE IN-LINE PRESSURE DEVICE
ATTAIN APPROX 120 PSIG
CLOSE VALVE C AND A
THE 8" LINE IS NOW PRESSURIZED AND ISOLATED. MONITORING OF GAUGES DURING STEP 2 (12" FILLING) WILL ASSURE PRESSURE DIFFERENTIAL

ALL VALVES SHOULD STILL BE IN THE CLOSED POSITION FROM STEP 1

2.) FILLING AND PRESSURIZATION of 12" ENCASEMENT

A. PRESSURE RELIEF VALVES SET TO 120 PSI

B. OPEN VALVES ON THE 12" SIDE IN THE FOLLOWING SEQUENCE

1. G HIGH POINT VENT
2. A MAIN SUPPLY
3. D 3/4" - 12" SUPPLY (12" IS NOW FILLING)
4. E 1/4" PRV SIDE

NOTE D & E MAY BE OPENED SIMULTANEOUSLY

AGAIN MONITERING of GAUGES DURING THE FILLING OPERATION IS REQUIRED TO ASSURE 12" ENC. PRESSURE DOES NOT EXCEED CARRIER PRESSURE

WHEN THE 12" SYSTEM IS FULL (ALL AIR VENTED)

CLOSE VALVES G & D

PROCEED TO PRESSURIZE THE 12" ENC WITH THE IN-LINE PRESSURE DEVICE.

ATTAIN A MIN. 90 PSI

CLOSE VALVE E AND A

THE SYSTEM SHALL BE HELD IN THIS CONDITION FOR A MIN. of 10 MINUTES AND UNTILL ALL CONNECTIONS HAVE BEEN INSPECTED.

NO. 1242 M – 21.5 x 28cm 35° 16' ISOMETRIC

NO. 1242 M – 21.5 x 28cm 35° 16' ISOMETRIC
9 2 1 2 4 6 4 1 5 3 7

CAUTION DE PRESSURIZATION

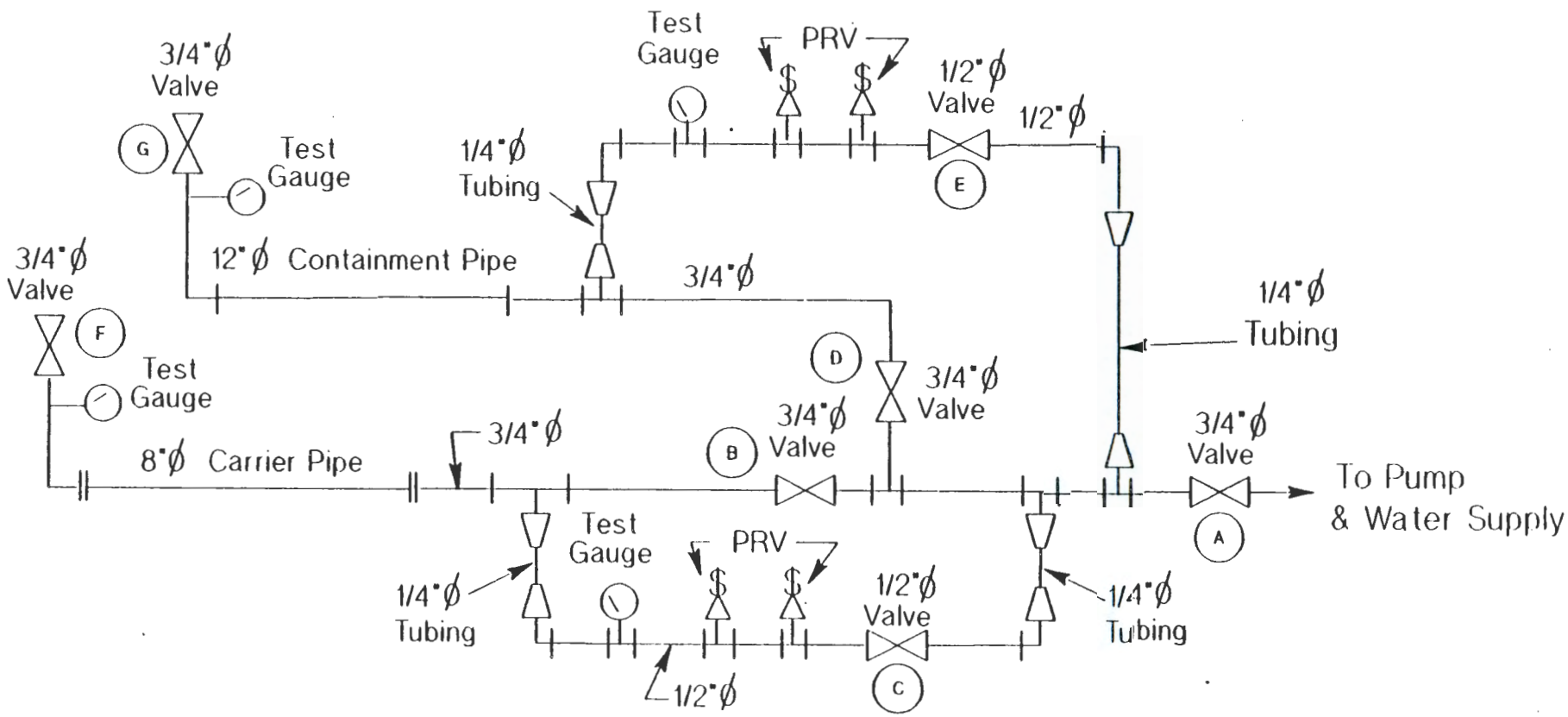
NOTE IT IS IMPERATIVE THAT 12" ENCASEMENT PRESSURE IS RELIEVED FIRST!

WHEN THE INSPECTIONS HAVE BEEN COMPLETED, PROCEED WITH DE-PRESSURIZATION IN ACCORDANCE WITH THE FOLLOWING

1.) 12" HIGH POINT VENT SHALL BE OPENED FIRST AND REMAIN OPEN THRU ALL DRAINING ACTIVITIES.
VALVE G
   A. VERIFY PRESSURE HAS BEEN RELIEVED BY VISUAL OF SYSTEM GAUGES PRIOR TO STEP 2.

2. 8" HIGH POINT VENT SHALL BE OPENED AND REMAIN OPEN DURING ALL DRAINING ACTIVITIES.
VALVE F
   A VERIFY PRESSURE HAS BEEN RELIEVED BY VISUAL OF SYSTEM GAGES.

3. PROCEED WITH NORMAL DRAINING ACTIVITIES.



Hydrostatic Test Set-up Diagram

APPENDIX C. FIBERCAST COMPANY LETTER REPORT ON EXAMINATION OF FAILED PIPE SECTION

9 2 1 2 4 6 4 1 5 3 9

Fibercast Company
P.O. Box 968
Sand Springs, Oklahoma 74063
(918) 245-6651 Telex 49-7403

Fibercast

July 24, 1991

Ms. Penny Harvey
Sr. Purchasing Agent
KAISER ENGINEERS HANFORD COMPANY
P. O. Box 888
Richland, WA 99352

Dear Ms. Harvey:

SUBJECT: KAISER ENGINEERS HANFORD (KEH)
Purchase Order No. 51874
Our File No. CC-9143

Our Laboratory has completed its examination of the two pieces approximately 4 ft. long of 8" CENTRICAST III EP pipe sections which were returned for our evaluation. Lab analysis was as follows:

The returned samples were checked for proper manufacture of the pipe. Pipe wall measurements were taken and compared to our standards. Pipe No. 1 was 0.223 inches total thickness, and Pipe No. 2 was 0.205 inches, as compared with our published total wall thickness of 0.140 inches. The reinforced wall thickness of Pipe No. 1 was 0.124 inches and for Pipe No. 2 was 0.122 inches. These values are above our published nominal catalog value of 0.110 inches for 8" CENTRICAST III EP pipe.

Ignition loss testing (resin burn-off) and Differential Scanning Calorimetry (DSC) tests were conducted on the returned samples. The results of these tests confirm the pipe had the proper number of layers and total thickness of fiberglass reinforcement, had the proper type of fiberglass reinforcement, and that the fiberglass was properly oriented. DSC testing verified that the resin and catalyst were in proper proportion, thoroughly mixed and properly cured when the pipe was manufactured.

The mode of failure was a longitudinal split in both pipe sections which extended completely through the pipe wall. These splits are similar in nature on both returned samples. They extend axially for approximately three feet and have some cracks branching from the split in the internal corrosion barrier. Isolated separation of the corrosion barrier from the reinforced structure occurred at some of the branching cracks (see Photo No. 5). This mode of failure is similar to that which we observe in our factory external pressure tests which we conduct in accordance with ASTM D 2924 Standard Test Method for External Pressure Resistance of Reinforced Thermosetting Resin Pipe. After receiving the returned pipe we conducted an external pressure test per this method as well as an internal pressure test per ASTM D 1599 Short Time Hydraulic Failure on two 8" CENTRICAST III EP pipe sections. The purpose of conducting these tests was to demonstrate the difference of external from internal pressure failures in this pipe grade.

As can be seen from the accompanying photographs, the test results of our ASTM D2924 testing (quick collapse test), (Photo Nos. 11, 12, and 13) show similarities to the returned pipe samples. Failure occurred in this test at 83 psig.

In our test, per ASTM D 1599, the pipe was pressured internally until failure occurred at 1,008 psig. The mode of failure was a longitudinal split with an outward displacement of reinforcing fibers on the pipe OD (see Photo No. 14), and a shattering effect on the internal corrosion barrier. This shattering of the internal corrosion barrier produces many more branch cracks which are straighter cracks. The crack pattern propagates in oppposite directions from the point of initial failure. (See Photo Nos. 15 and 16). This more severe branch cracking is typical of internal pressure failure, which always occurs at a much greater pressure than external collapse failures. This different crack pattern is due to the higher crack energy from the greater stress at time of failure. As is apparent from the photographs, this type failure differs substantially from that in the returned pipe sections.

Conclusions:

Based on our Laboratory findings, it is our opinion that the returned pipe samples failed from external pressure in excess of the pipe's capability.

Our recommended field pressure test procedures (See our enclosed Specifications for FIBERCAST Single Carrier Double Containment Pipe, Paragraph 5.4. under Hydrostatic Testing) state that "When testing the outer containment pipe, the inner carrier pipe shall be full of fluid and pressurized at a pressure equal to,or higher than, the annulus pressure." This same information was provided to your Company during the design phases of this project.

We sincerely regret that this problem occurred during your testing of our piping system, and assure you that we have made every effort to assist you in making recommendations for repairs and corrective action with the visits of our Engineers and Field Technician, as requested.

We will be happy to provide you with any additional information or assistance you require in this matter.

Sincerely yours,

W. J. Jones

W. J. Jones
Manager, Quotations

WJJ/td
cc: J. S. CHAPIN, INC.
D. F. Tate
R. A. Sparks
M. A. LaPrade
J. J. Tillson

9 2 1 2 4 5 4 1 5 4 1

Fibercast Company
P.O. Box 968
Sand Springs, Oklahoma 74063
(918) 245-6651 Telex 49-7403

Fibercast

May 11, 1989

SPECIFICATIONS FOR FIBERCAST SINGLE CARRIER DOUBLE CONTAINMENT PIPE

1.0 SCOPE

1.1 This specification covers requirements for a dual containment (pipe-in-a-pipe) system using centrifugally cast, fiberglass reinforced epoxy or vinyl ester thermoset resin pressure pipe as designated in ASTM D 2997 for both the inner fluid carrying pipe and the outer containment pipe in size ranges up through 14" diameter. In sizes above 14" the pipe shall be manufactured by the filament winding process in accordance with ASTM D 2996, RTRP Type 1 Grade 1 or 2 Class E or F and have a 20 mil or greater resin liner.

1.2 The inner carrier pipe shall have a size range from 1" through 14" for centrifugally cast pipe and 14" through 42" for filament wound pipe. The outer containment pipe shall have a size range from 3" through 14" for centrifugally cast pipe and 14" through 48" for filament wound pipe.

1.3 Standard and specification referred to herein or in any referenced document, form a part of the requirements of this specification in the manner and to the extent specified.

2.0 INNER CARRIER PIPE

2.1 The inner carrier pipe shall be of the resin system and size as indicated in the FIBERCAST Chemical Resistance Charts and Piping Design Manual.

2.2 Joint adhesives and bonding materials shall be of the same manufacturer as the pipe and fittings and shall be of the same resin system.

2.3 Field tapering or machining of pipe ends for joining shall not be allowed.

2.4 The inner carrier pipe shall be centered and supported by pipe centering supports of the same manufacturer as the pipe. Support spacing shall conform to the unsupported span requirements as specified by the manufacturer.

9 2 1 2 1 5 4 1 5 4 2

3.0 OUTER CONTAINMENT PIPE

3.1 The outer containment pipe shall be of the resin system and size as indicated in the FIBERCAST Chemical Resistance Charts and Piping Design Manual.

3.2 Adhesives and bonding materials shall be of the same manufacturer as the pipe and fittings and shall be of the same resin system.

3.3 Field tapering or machining of pipe ends for joining shall not be allowed.

3.4 Pipe supports, guides, and anchors shall be per manufacturer's recommendations.

3.5 Pipe burial shall be per manufacturer's recommendations.

3.6 Contact FIBERCAST Engineering for specific recommendations on leak detection system compatability.

3.7 The outer containment pipe and fittings shall have a minimum internal pressure rating of 125 psi through 8" and 50 psi for larger sizes.

4.0 FITTINGS

4.1 Fittings shall be compression molded, contact molded or mitered, and of the same resin system as the pipe.

4.2 The fitting assembly shall be of an integral design consisting of an inner carrier fitting and an outer containment fitting with provisions for thermal expansion anchoring of the carrier pipe.

4.3 Clam-shell fitting shall not be allowed.

5.0 HYDROSTATIC TESTING

5.1 The system design shall allow for visual inspection of the inner carrier pipe connections during initial hydrostatic test.

5.2 Hydrostatic test shall not exceed 1-1/2 times the operating pressure of the system.

5.3 When filling the system with fluid for hydrostatic testing, all entrapped air shall be bled off in accordance with good piping practices.

5.4 When testing the outer containment pipe, the inner carrier pipe shall be full of fluid and pressurized at a pressure equal to, or higher than, the annulus pressure.

CEH/kw

Photo No. 5

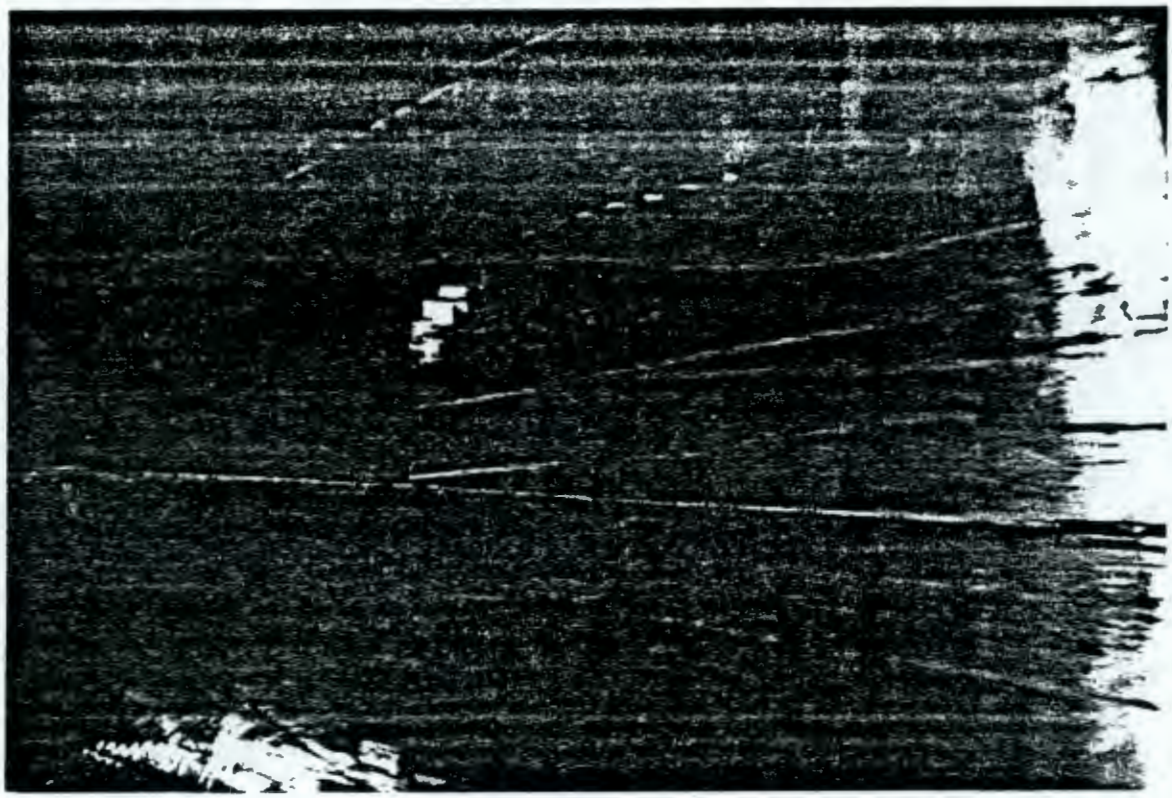
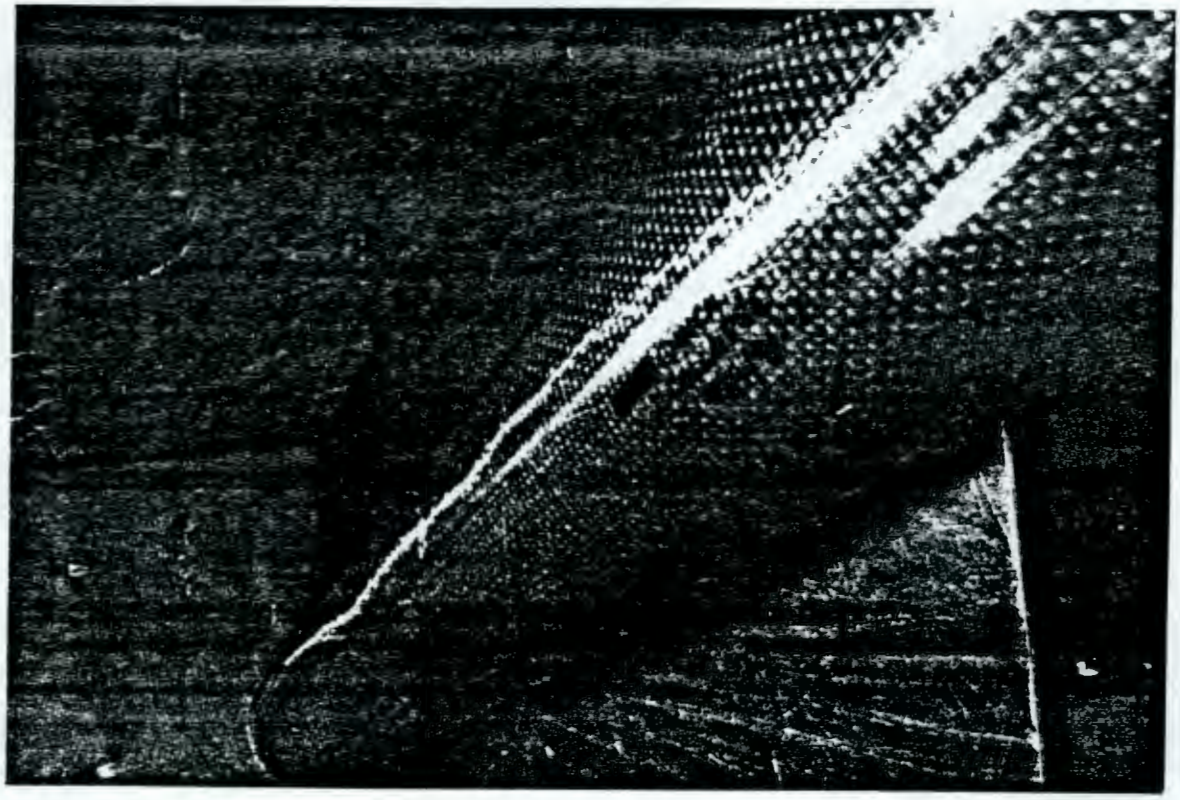


Photo No. 11



9 2 1 2 4 6 4 1 5 4 4

Photo No. 12

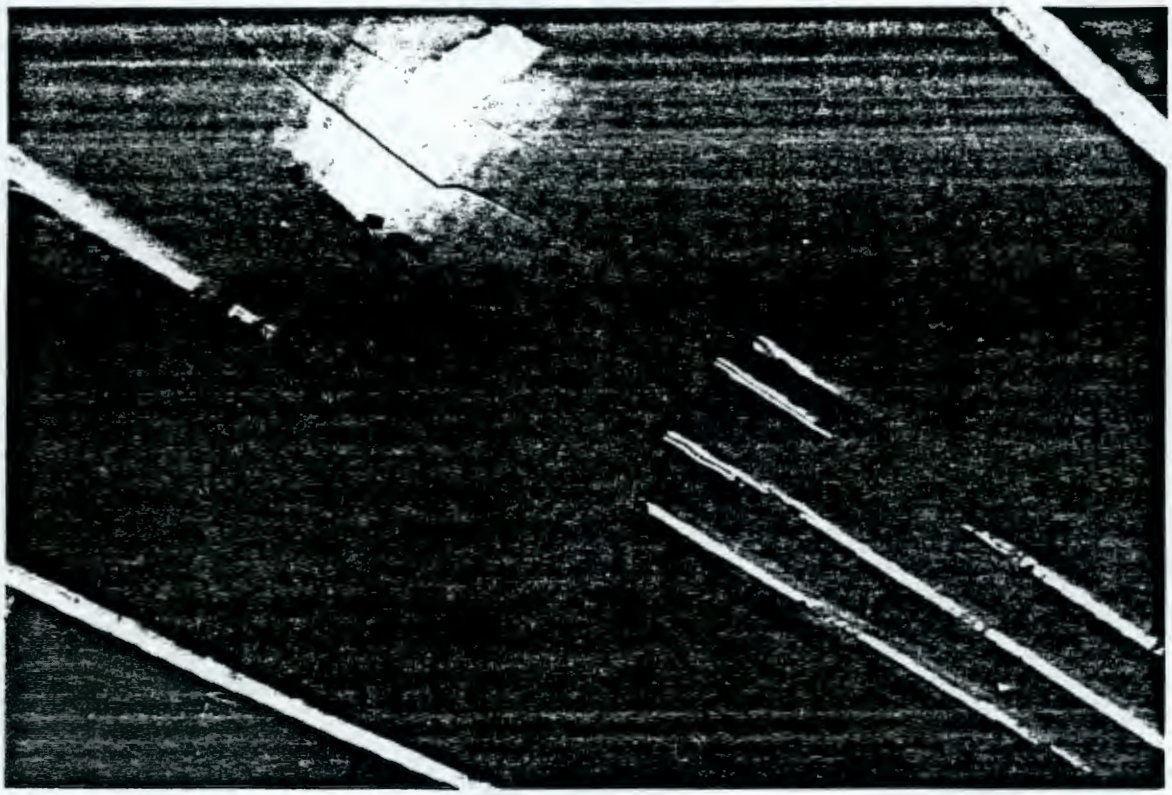
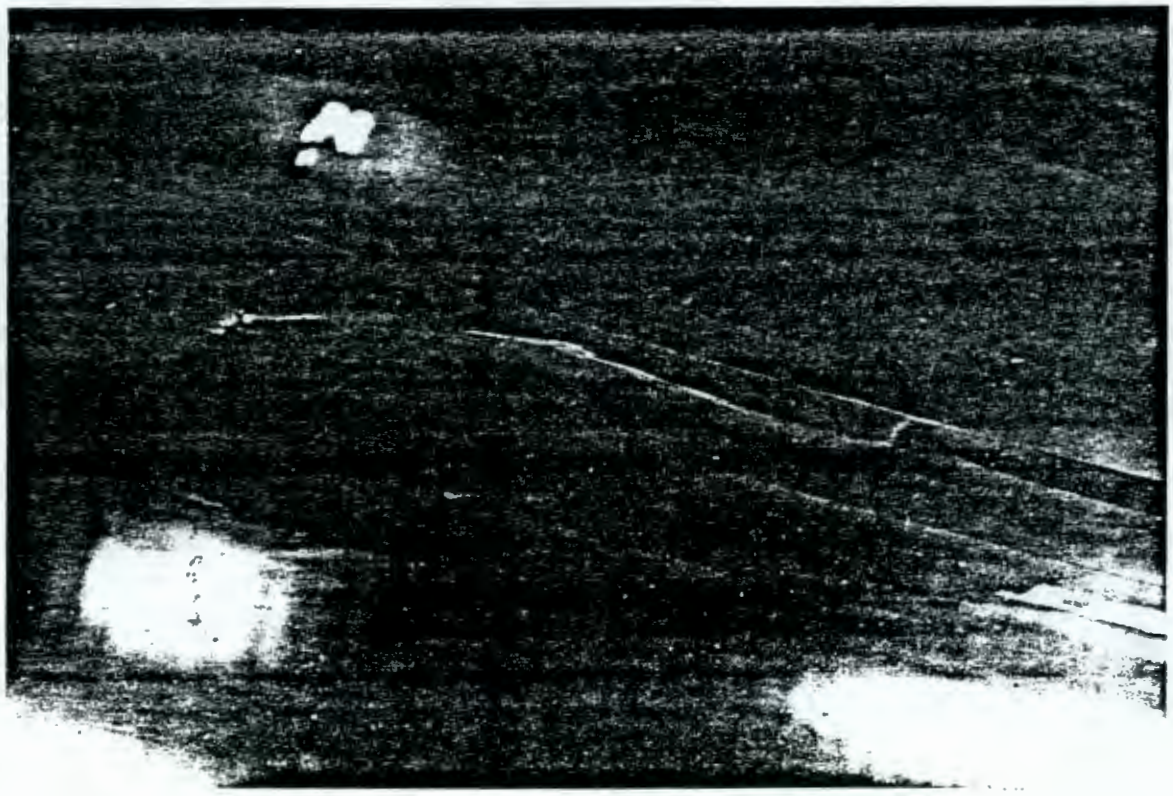


Photo No. 13



9 2 1 2 4 6 4 1 5 4 5

Photo No. 14

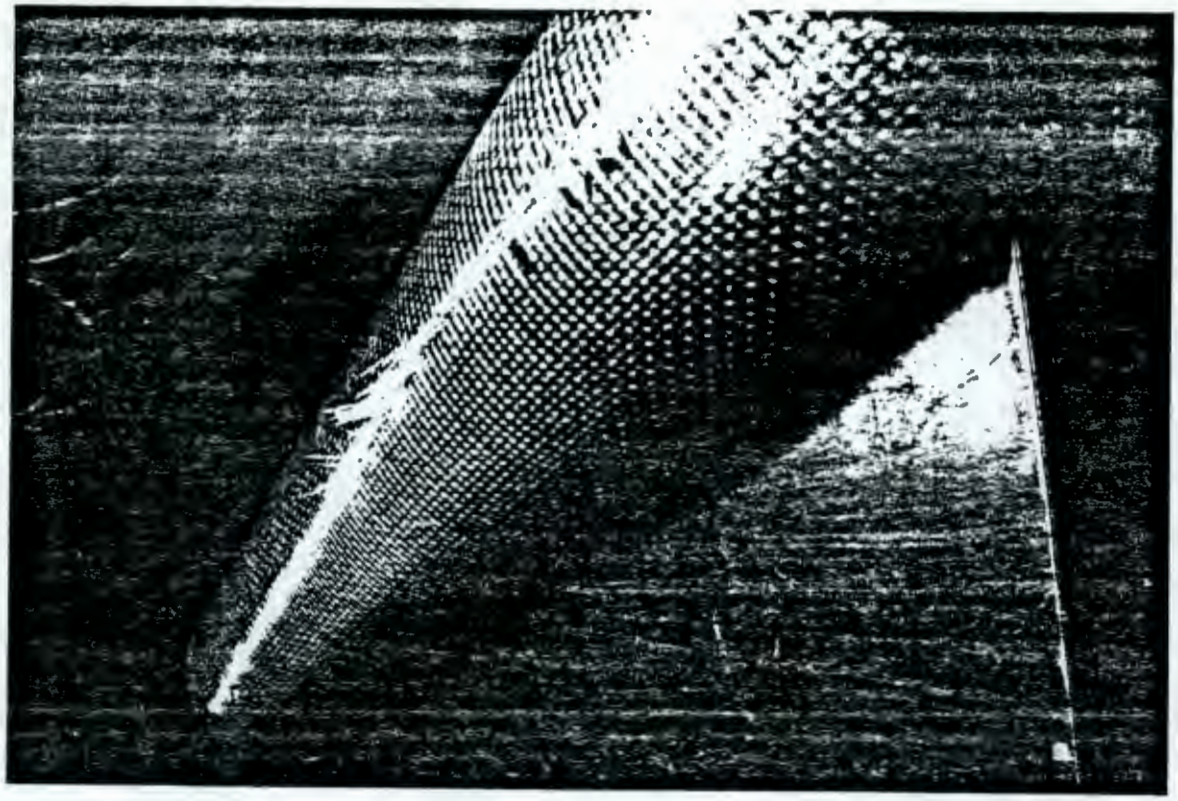
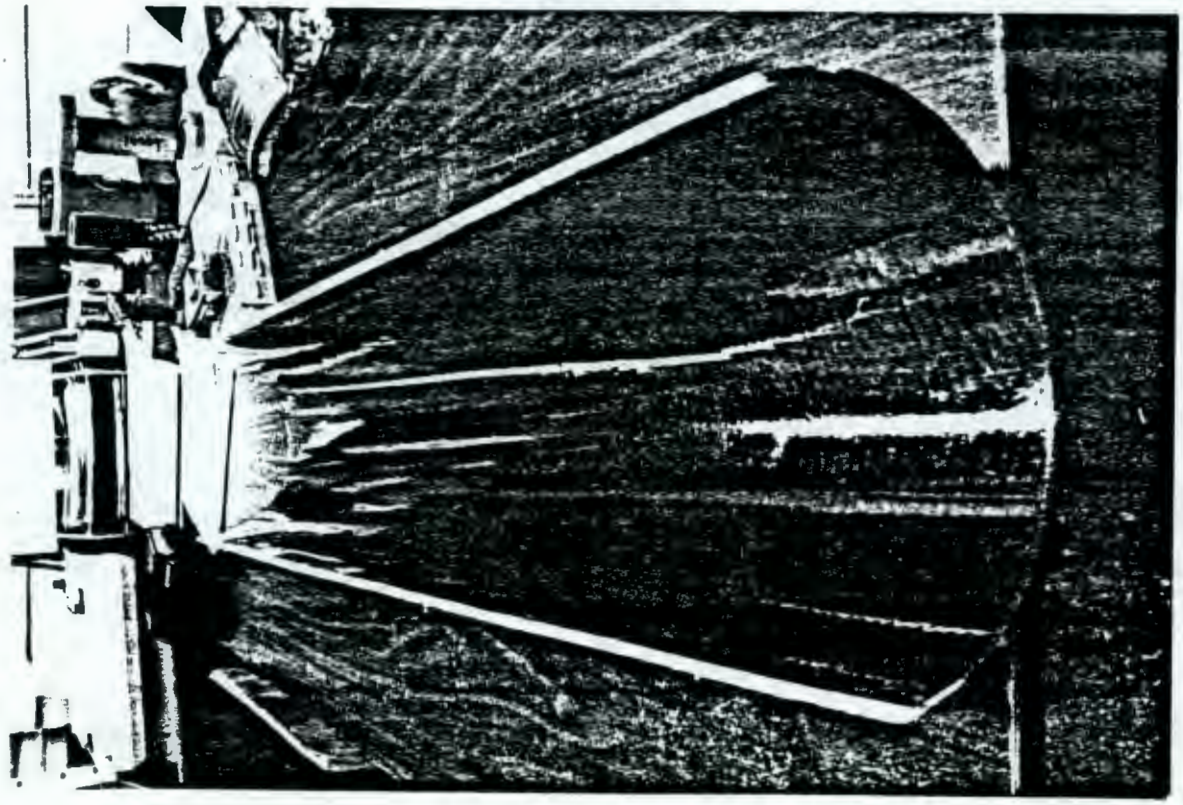


Photo No. 15



9 2 1 2 1 6 4 1 5 4 6

Photo No. 16

CC 9143 Photo #5

Closeup of internal crack showing offshoot cracking and delamination of corrosion barrier

CC 9143 Photo #11

Exterior of quick collapse test (ASTM 2924)

CC 9143 Photo #12

Interior view of pipe wall showing offshoot cracking in quick collapse test (ASTM 2924)

CC 9143 Photo #13

Another interior view of cracking associated with ASTM 2924 quick collapse. Delamination of the corrosion barrier can be seen

CC 9143 Photo #14

ASTM 1599 - Internal pressure failure. Note reinforcing fiber protrusion

CC 9143 Photo #15

ASTM 1599 - Internal pressure. Typical "shattering" of corrosion barrier. Numerous offshoot cracks evident. High crack energy.

CC 9143 Photo #16

ASTM 1599 - Internal pressure. Closeup of "shattering" of inner corrosion barrier. Cracks point away from point of initial failure at A

9 2 1 2 4 6 4 1 5 4 7

SPARE PARTS LIST FOR LERF

As of 8/28/91 * Indicates items changed since last update.

Thermostat control for heat trace system

Tracetek sensor cable with plug-in

3 inch castiron butterfly valve

4 inch castiron butterfly valve

8 inch castiron butterfly valve

Geoguard shallow well sampler pump

Medical grade silicone 3/8 inch tubing

1.5 hp Berkley leachate submersible pump

5 hp Berkley leachate submersible pump

Ashcroft pressure switch model B400

Ashcroft pressure switch model B700

Lengths of fiberglass pipe and assorted fittings

LERF DOCUMENT SUBMITTALS TO ECOLOGY

As of 10/16/91 * Indicates items changed since last update.

Engineering Study - Submitted

Functional Design Criteria - Submitted

Conceptual Design Report - Submitted

Sitework Specification C-1 - Submitted

Basin Liners and Basin Piping Specification C-2 - Submitted

Basin Cover Specification C-8 - Submitted

Draft Groundwater Monitoring Plan - Submitted

Design Specifications and Drawings as developed - Submitted

Soil/Bentonite Mixing and Placement Specifications C4 - Submitted

Notice of Intent - Submitted

SEPA documentation - Submitted

Part A Permit Application - Submitted

*Final Groundwater Monitoring Plan - Submitted

Engineering Change Notices - Being Submitted as prepared

*Part B Permit - Submitted

CQA Plan for construction - Submitted

Waste Analysis Plan - Submitted

Inspection Plan - Submitted

Contingency/Emergency Plan - Submitted

Training Plan - Submitted

Preparedness/Prevention Plan - Submitted

Soil/Bentonite repair procedures - Not Required To be Submitted

Cover performance standards and air quality plans - To be Submitted

*Roads, Fencing, Storage Building, Site Trailer, and Site Electrical specification C5 - Submitted

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LERF ECN SUBMITTALS TO ECOLOGY

As of 10/16/91

ECN NUMBER	DATE RELEASED	DATE SUBMITTED
W-105-72	3-11-91	4-11-91
W-105-2	5-11-90	5-1-91
W-105-3	5-11-90	5-1-91
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W-105-5	5-11-90	5-1-91
W-105-7	6-5-90	5-1-91
W-105-8	5-22-90	5-1-91
W-105-9	5-29-90	5-1-91
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W-105-102	6-24-91	10-16-91
W-105-103	7-16-91	10-16-91
W-105-104	6-28-91	10-16-91

LERF VENDOR SUBMITTALS TO ECOLOGY

As of 10/16/91

ITEM REQUESTED	DATE DELIVERED
Bentonite Carpet Liner	
High-density Polyethylene Liner	
Geotextile Fabric	5/17/91 FAX
Drainage Net (Synthetic Media)	
Very-low-density Polyethylene Cover	
Basin Piping	
Elastomeric Sealant	
Pipe fittings bonding	
Catalog data of piping system components	
Certified results of Mfgs pressure tests	10/16/91 Unit Manager's Meeting
Coatings, List of Materials	6/3/91 Unit Manager's Meeting
Plumbing	
Leachate pumps	
Transfer pumps	
Valves	
- MOV-W60-03 Ball Valve	6/3/91 Unit Manager's Meeting
- 8 inch hand operated Butterfly Valve	6/3/91 Unit Manager's Meeting
- Buterfly Valves	6/3/91 Unit Manager's Meeting
- Hand operated Centerline Butterfly Valves	6/3/91 Unit Manager's Meeting 10/16/91 Unit Manager's Meeting
Accessories	
- MOV-W60-03 Actuator	6/3/91 Unit Manager's Meeting
- Pressure Gage Y-103	6/3/91 Unit Manager's Meeting
- Pressure Switch Y-104	6/3/91 Unit Manager's Meeting
- Piston Meter Y-105	6/3/91 Unit Manager's Meeting
- Strainer and Cross Reference for P.D. Meters (Y-105)	6/3/91 Unit Manager's Meeting
Operation and maintenance manuals	

Electrical

Leak sensing and locating cables

Level detection system

- Leak Detection System Y-10	6/3/91 Unit Manager's Meeting
- Leak Detection System Y-102	10/16/91 Unit Manager's Meeting
- Leak Detection System Y-101	10/16/91 Unit Manager's Meeting

Transformers

- 60 KVA Transformer	6/3/91 Unit Manager's Meeting

Accessories

- Breakers, Receptacle, Vapor Fixture	6/3/91 Unit Manager's Meeting
- Mini Power Center and Motor Controllers	6/3/91 Unit Manager's Meeting
- Mini Power Zone Supply	6/3/91 Unit Manager's Meeting

Cables

- Heat trace casble, thermostats and power connection box kits	10/16/91 Unit Manager's Meeting

CORRESPONDENCE DISTRIBUTION COVERSHEET

Author	Addressee	Correspondence No.
S. H. Wisness, RL	T. L. Nord, Ecology	9106086

Subject: LIQUID EFFLUENT RETENTION FACILITY (LERF)

INTERNAL DISTRIBUTION

Approval	Date	Name	Location	w/att
		Correspondence Control	A3-01	X
		B. A. Austin		
		R. J. Bliss, Level 1		
		L. E. Borneman	B2-35	X
		S. L. Bradley		
		L. C. Brown	H4-51	X
		C. J. Geier	B2-19	X
		W. H. Hamilton, Jr., Assignee		X
		H. D. Harmon		
		K. R. Jordan		
		R. J. Julian	R1-48	X
		D. E. Kelley	R1-48	X
		M. K. Korenko		
		R. E. Lerch		X
		P. J. Mackey	B3-15	X
		H. E. McGuire		
		D. J. Newland		
		L. L. Powers	B2-35	X
		W. G. Ruff		
		T. B. Veneziano		
		R. D. Wojtasek	L4-92	
		EDMC	H4-22	X

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DEC 18 1991
CORRESPONDENCE CONTROL

List 2 - Milestone M-17