~~XXXX~~ RMIS View/Print Document Cover Sheet ~~XXXX~~

This document was retrieved from the Documentation and Records Management (DRM) ISEARCH System. It is intended for Information only and may not be the most recent or updated version. Contact a Document Service Center (see Hanford Info for locations) if you need additional retrieval information.

Accession #: D196093614

Document #: SD-SNF-ATR-014

Title/Desc:

ACCEPTANCE TESTING REPORT OF EDUCTOR SYSTEM TO BE
INSTALLED IN THE 105K BASINS

Pages: 45

Dist.
MAY 02 1996

ENGINEERING DATA TRANSMITTAL

Page 1 of 1
1. EDT 615831

2. To: (Receiving Organization) Distribution		3. From: (Originating Organization) Engineering Support		4. Related EDT No.: 608254	
5. Proj./Prog./Dept./Div.: Spent Nuclear Fuel Project		6. Cog. Engr.: M. J. Packer		7. Purchase Order No.: N/A	
8. Originator Remarks: Transmitted for approval and release The ATP was not released as an SD; however, the Traveller in the ATP was approved for testing.				9. Equip./Component No.: Eductor System	
				10. System/Bldg./Facility: 105 K Basins/100K	
11. Receiver Remarks:				12. Major Assm. Dwg. No.: N/A	
				13. Permit/Permit Application No.: N/A	
				14. Required Response Date: 4/19/96	

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Design- ator	Reason for Trans- mittal	Orgi- nator Dispo- sition	Receiv- er Dispo- sition
1	WHC-SD-SNF-ATR-014	All	0	Acceptance Testing Report of Eductor System to be Installed in the 105 K Basins	S,Q	1,2	1	

16. KEY	
Approval Designator (F)	Reason for Transmittal (G)
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)
	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged
(G)	(H)
17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)	
(G)	(H)
Reason	Disp.
(J) Name	(K) Signature (L) Date (M) MSIN
(J) Name	(K) Signature (L) Date (M) MSIN
Reason	Disp.
1,2	1
Cog.Eng. M. J. Packer	4/12/96
X3-48	
1,2	1
Cog. Mgr. C. J. Alderman	4/12/96
X3-48	
1,2	1
QA D. W. Smith	4/12/96
X3-85	
1,2	1
Safety T. D. Merkling	4/12/96
X3-09	
3	
R. A. Anderson	X3-86
3	
K. E. Ard	X3-85
3	
S. A. Brisbin	X3-48
3	
J. B. Crystal	X3-85
3	
J. I. Diehl	X3-85
1,2	1
M. J. Langevin	4/12/96
X3-74	

18.		19.		20.		21. DOE APPROVAL (if required) Ctrl. No.	
M. J. Packer Signature of EDT Originator		C. J. Alderman Authorized Representative for Receiving Organization		C. J. Alderman Cognizant Manager		[ ] Approved [ ] Disapproved w/comments	
4/12/96 Date		4/12/96 Date		4/12/96 Date			

Acceptance Testing Report of Eductor System to be Installed in the 105 K Basins

M. J. Packer

WHC, Richland, WA 99352

U.S. Department of Energy Contract DE-AC06-87RL10930

EDT/ECN: 615831

UC: 600

Org Code: 2C500

Charge Code: LD098

B&R Code: EW3135040

Total Pages: *AT 4.5 Kms 4/25/96*

Key Words: Eductor System, 105 K Basins, Sludge Retrieval

Abstract: This document provides acceptance testing of equipment to be installed in the 105 K Basins for retrieving sludge to support basin clean-up activities.

TRADEMARK DISCLAIMER. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

Printed in the United States of America. To obtain copies of this document, contact: WHC/BCS Document Control Services, P.O. Box 1970, Mailstop H6-08, Richland WA 99352, Phone (509) 372-2420; Fax (509) 376-4989.

Release Approval

4/25/96
Date

Approved for Public Release

WHC-SD-SNF-ATR-014, Rev. 0

TABLE OF CONTENTS

RECOMMENDATIONS	1
1.0 INTRODUCTION	2
1.1 Figure 1	4
2.0 DESCRIPTION OF TESTS	5
3.0 TEST RESULTS	5
3.1 Table 1	7
3.2 Diversion Valve Test	9
3.2.1 Table 2	9
3.2.2 Table 3	9
3.2.3 Figure 2	10
4.0 CONCLUSIONS AND RECOMMENDATIONS	11
5.0 DISPOSITION OF TEST ITEM	12
6.0 REFERENCES	12
APPENDIX A	
TEST TRAVELER	A-1
ATTACHMENT 1 Performance Criteria	A-24
ATTACHMENT 2 Equipment List	A-25
EQUIPMENT SKETCH	A-26
VACUUM HEAD SK-1-80101 Rev. 0	A-27
EQUIPMENT DRAWING	A-28

ACCEPTANCE TESTING REPORT OF EDUCTOR SYSTEM TO BE INSTALLED IN THE 105 K BASINS

The Eductor System is defined as a 15 hp Grunfos Corporation submersible pump seated in a stainless steel Tri-Nuclear Corporation housing with the pump discharge feeding a 3-inch Fox Valve Corporation eductor. Also included in the Eductor System are associated pneumatic diversion valves, vacuum head, and vacuum and discharge hoses. This system is shown on pages A-26 and A-28.

RECOMMENDATIONS

The following recommendations are based on the performances of the equipment tested in the 305 Cold Test Facility basin for retrieving sludge in the 105 K Basins:

- 1) The Eductor System is recommended for sludge pumping activities which require transferring sludge without capturing particulates in a suction side basket or filter. However, this system can be easily adapted for capturing fuel and debris in baskets or filters.
- 2) The Eductor System is recommended for use with a 15 hp Grunfos pump to provide a pump discharge pressure greater than 100 psig with a 3" stainless steel eductor for providing suction flow rates greater than 100 GPM with the ability to pass solids up to one inch in diameter. The one inch clearance requirement for the eductor is a viable dimension which ensures general passage of basin solids without clogging the eductor.
- 3) The Eductor System is recommended for sludge retrieval activities using a maximum 50' section of 2" diameter suction hose and a maximum 200' section of 3" diameter discharge hose. These hose lengths should adequately cover any sludge retrieval operations in the 105 K Basins provided the submersible Eductor System is moved about the basin.
- 4) The Halliburton Turbine Flow meter with MC-II Flow Analyzer performed adequately and provides an easy-to-read flow readout. It is recommended for use on the motive fluid side (eductor inlet) but not recommended for use on either the eductor suction or discharge because of continued contact with solids and inevitable destruction of flow meter turbine. A reliable instrument to determine suction flow within ± 5 GPM needs to be identified.

- 5) The (SK-1-80101) vacuum heads, shown on page A-27, work well for vacuuming sand, nuts, bolts, and cloth towels. Since a 1/4" screen was not installed on this head, it wasn't prone to clogging (diced plastic squares were included with the sand to simulate paint chips). Different diameter heads are recommended for different pumping activities. For example, when picking up the lighter fines and no fuel pieces over 1/4" in diameter, a 5" diameter vacuum head is necessary. For picking up fuel pieces over a 1/4" in diameter and large nuts and bolts, a 2" or 3" diameter head is preferred. It is recommended all vacuum heads should have one inch mesh at the head face to minimize plugging the eductor.
- 6) The 3" 2-way Pittsburgh Brass Manufacturer (PBM) pneumatic ball valve and the 2" 3-way PBM pneumatic ball valve are recommended for use with the Eductor System to dislodge debris occluding the suction side of the eductor. Both valves are recommended with Polyvinylidene (KYNAR) seats and seals. KYNAR is a high strength polymer suitable for moderate temperatures (up to 300 degrees F) with tested radiation exposure up to 1000 megarads with minimal property degradation. The pneumatic valves must be able to be actuated with no more than 80 psig of system air since this pressure is obtainable in the 105 K East Basin without further modifications. Also, it is recommended the four bolts attaching the actuator to the valve must be grade 8 or of equal shear strength to prevent shear failure.

1.0 Introduction

The Spent Nuclear Fuel (SNF) Project Engineering Support group cold-tested the Eductor System - a 15 horsepower multi-stage centrifugal pump manufactured by the Grunfos Corporation with the housing manufactured and sold with the pump by the Tri-Nuclear Corporation and a 3-inch diameter water jet eductor manufactured by the Fox Valve Corporation. The Eductor System was tested to gather and document information to optimize sludge retrieval operations for use in the 105 K Basins. The cold-testing took place during February 12 through February 29, 1996 in the 305 Cold Test Facility basin located in the 300 area.

The pump, utilized in conjunction with the eductor, makes up the core of the Eductor System. The pumping unit consists of a 15 hp stainless steel multi-stage centrifugal Grunfos pump which is seated in a stainless steel fabricated housing. Two baskets or filter elements make up part of the housing on the suction side of the pump. The pump can be used independent of the housing but the housing has two identified purposes. The first use is to stabilize the centrifugal pump and give the pneumatic valves and pump discharge piping a solid platform so the Eductor System can be more easily mobilized within the basin as one unit. The second use for the housing presents the option to utilize the suction-side filters for capturing larger fuel pieces after the smaller fines have been removed. This latter use would only include the

Grundfos pump and Tri-Nuclear housing with 2" diameter or larger suction and discharge hoses.

The general design of the Eductor system was derived from requirements for retrieving K-basin sludge. Paramount requirements or constraints include worker dose minimization, waste minimization, and criticality concerns with retrieving fuel larger than 1/4" in diameter with sludge (Wittekind 1993). These constraints were included to develop an optimal sludge retrieval system which includes a submersible pump to reduce worker dose when pumping sludge; an eductor to minimize waste generation by not capturing sludge in suction-side filters; a screenless or large-screened vacuum head to reduce worker dose and improve worker productivity by eliminating the need to clear a clogged 1/4" screened head - the screenless head can be sized and selected such that 1/4" diameter fuel pieces can or cannot be picked up, depending on the pumping activity required; and pneumatic valves were included to reduce worker dose should the eductor become plugged on the suction side - the obstruction can be cleared without having to expose the workers when bringing the contaminated equipment above the surface of the basin.

Much attention has been paid to developing a screenless vacuum head for pumping the lighter fines but not the 1/4" and larger pieces of fuel (uranium). A theoretical plot was initially developed comparing the different vertical terminal velocities between various density materials in the basin (such as uranium, steel, and sand) as a function of particle size. See Figure 1 on page 4. The general idea is to separate the higher density material (1/4" and larger uranium) and the lighter fines (sand and corrosion products) by assuring a maximum suction flow velocity less than or equal to the vertical terminal velocity for 1/4" diameter fuel pieces. The 1/4" screen requirement could then be removed to retrieve the lighter fines without constantly clogging the vacuum head with paint chips and debris. Criticality concerns associated with pumping sludge are eliminated by preventing large fuel pieces from forming in an uncontrolled geometry in the discharge containment area (such as the Weasel Pit). The larger fuel pieces could later be picked up by utilizing the suction side baskets with a Tri-Nuclear pump (Grundfos pump and Tri-Nuclear housing with no eductor) and a smaller diameter screenless vacuum head to increase flow velocity.

FIGURE 1

Pneumatic diversion valves were included as part of the Eductor System to aid in purging or freeing a clogged eductor without additional dose exposure to the operators. The valves would be actuated upon determination of a plugged eductor (debris caught between the suction side eductor housing and high pressure nozzle). Actuating the valves simultaneously involves the closing of the eductor discharge valve and diverting the suction-side valve. The motive (high pressure) water comes in contact with the closed discharge valve, thereby reversing course and flowing into the suction line which is diverted back into the basin water, hopefully including the removed obstruction.

The test basin dimensions are 4.6m x 6.0m x 4.6m deep (15' x 18' x 15') which contain approximately 130 cubic meters (30,000 gallons) of chlorinated water. Sand, coarse gravel, cloth towels, tungsten pieces simulating uranium fuel, plastic squares simulating paint chips, assorted nuts and bolts, and "buggy springs" were introduced into the basin water to simulate the 105 K East Basin sludge and general debris encountered during pumping operations. The varied debris were contained in three different types of containers (a steel box, an empty screened fuel canister, and a clear plexi-glass container) for pumping, viewing, and filming on video tape. The Eductor System rested on the basin floor during testing operations.

2.0 Description of Tests

The acceptance test procedure, WHC-SD-SNF-ATP-014, Cold Test Procedure for The Eductor System and Screenless Suction Head, was based on the released documents, Test Plan for Sludge Retrieval and Packaging, WHC-SD-SNF-TP-007, and Test Procedure Forms for Sludge Retrieval and Packaging, WHC-SD-SNF-TC-001.

Prototypical test equipment consisted of the 15 hp Grunfos pump and Tri-Nuclear housing, up to 200 ft. long of 2" and 3" diameter rigid plastic discharge hose (required to reach the entire basin at the farthest points). Some tests included parallel 2" diameter discharge hose configurations, two different lengths (20 and 50 ft.) of 2" diameter rigid plastic suction hose, and three different size diameters of vertical-pipe vacuum heads - 3", 3-3/4", and 5". The basic vacuum head, in drawing SK-1-80101 Rev. 0, is shown on page A-27. The vacuum heads are noted as being screenless, except the 3-3/4" head. Coarse screens approximately 1" square would be included on the heads destined for K-Basin use because the clearance from the eductor nozzle to the inside eductor body is slightly larger than one inch. The coarse-screened vacuum head (the 3-3/4" diameter head) was omitted from some tests in order to pick up large nuts and bolts to verify the ability of the system for dislodging objects in the eductor. Two PBM pneumatic valves, one 3-way 2" diameter and the other a 2-way 3" diameter ball valve, were utilized on the suction and discharge side, respectively, of the eductor for the purpose of purging an occluded eductor.

Halliburton Flow Meters and pressure gauges were also included for recording test results. An ITT Diaphragm Flow Control Valve was used to regulate suction flow to correlate with vacuum readings.

3.0 Test Results

Various Eductor System configurations were tested to determine what most affected the system to pump water and simulated sludge. Test results are as listed in Table 1 on page 7. The basic goal is to first maximize the pumping ability of the system then size the vacuum head accordingly to what is or isn't required to be picked up. Different diameters and lengths of hoses were tested for the suction and discharge hoses.

Since the 105 K East Basin already contains a large amount of 2" diameter hard plastic hose from past sludge pumping activities, the preferred hose of choice for suction and discharge hose is the 2" diameter hose. Unfortunately, test results revealed 2" diameter hose is a poor choice for the discharge side due to large pressure losses over the length required. The suction flow rate is sensitive to the back pressure in the eductor discharge. The ideal back pressure is 15 psig or less but should be no greater than 20 psig for an optimal suction flow rate.

Parallel discharge lines were tested using 200' of 2" diameter hose but the suction flow rate was only 63 GPM. The discharge hose recommended for use on the Eductor System is a 200' length of 3" diameter hose. The suction flow rate for this setup is 128 GPM. The testing didn't include any lengths of suction hose greater than 50 feet. Fifty foot lengths are common lengths existing in the 105 K East Basin and are appropriate for use as suction lines. A loss of 7 GPM of suction flow resulted with an increase of 30' of 2" diameter suction hose (from 20' to 50'). See Table 1 on page 7.

Initial tests included a 20' section of 2" diameter high pressure hose on the pump discharge leading to the eductor. This was changed to an eight foot section of 2" diameter stainless steel pipe connected to the pump housing. The pneumatic valves were then connected to the eductor which allows the entire Eductor System to be easily transported as one piece by the overhead crane. The total pick weight of the Eductor System (empty, no water), which includes the pump, housing, and two pneumatic valves, is approximately 725 lbs.

The different diameter vacuum heads didn't vary the suction flow rate when used with an identical system setup. The vacuum heads are very reliable when chosen for picking up selected materials of different densities. A vertical flow velocity limit was discovered at approximately 3.4 ft/sec for NOT picking up 1/4" diameter tungsten pieces. The 5" diameter head can be used for picking up lighter fines such as sand and suspended corrosion products while leaving the 1/4" fuel pieces in the basin. Quarter inch tungsten pieces were randomly placed in sand 12 inches deep but would not be picked up with the 5" diameter vacuum head. The 5" diameter vacuum head, used with the Eductor System at a maximum flow of 128 GPM, provides a calculated flow velocity of 2.1 ft/sec. At the same flow rate, the 3" and 3-1/2" diameter vacuum heads provide flow velocities of 5.8 and 4.3 ft/sec, respectively, but would begin to pick up the 1/4" and larger tungsten pieces.

During initial testing with the Eductor System, when a flow meter was installed on the high pressure pump discharge hose (motive flow), the motive flow rate varied from a minimum of 153 GPM to a maximum of 157 GPM. This flow rate is not sensitive to the eductor discharge back pressure. The first test in Table 1 on page 7 shows a motive flow rate (actually pump discharge) of 218 GPM but this was recorded with the pump and housing only. No eductor was installed for this test. Later tests removed the high pressure pump discharge hose and replaced it with an eight foot section of 2" diameter stainless steel pipe to keep the equipment more compact and easier to move as one unit. No flow meter or pressure gauge was installed on the stainless steel pipe since these readings went basically unchanged with the variations to the eductor discharge.

Table 1. PUMP PERFORMANCE RESULTS

	Motive Flow (GPM)	Suction Flow (GPM)	Eductor Discharge Flow (GPM)	Motive Pressure (psig)	Vacuum Pressure (in Hg)	Discharge Pressure (psig)
No fillers or baskets, suction hoses. Pumping water only.	218					

Note: The following tests, all include a 2-way 3" diameter pneumatic PBM valve connected to the eductor discharge and a 3-way 2" diameter pneumatic PBM valve connected to the eductor suction.

Set of 1/8" baskets, with filter housings closed, with 20' of 2" diameter motive water hose (pump discharge) leading to a 3" diameter eductor with a flow meter, 20' of 2" diameter vacuum hose, and no vacuum head on suction side of eductor. A 150' length of 3" diameter discharge hose attached to the eductor discharge.	153	107	260	111	no gauge installed	14
Same as previous but w/ 3-1/2" diameter vacuum head	156	111	267	111	no gauge installed	14
Same as previous but w/ 3" diameter vacuum head	156	111	267	111	no gauge installed	14.5
Set of 1/8" baskets, with filter housings closed with 20' of 2" diameter motive water hose (pump discharge) leading to a 3" diameter eductor with a flow meter, 60' of 2" diameter vacuum hose, and a 3" diameter vacuum head on suction side of eductor. A 150' length of 3" diameter discharge hose attached to the eductor discharge.	157	104	261	109	no gauge installed	14
Same as previous but with 3-1/2" diameter vacuum head	157	104	261	109	no gauge installed	14

	Motive Flow (GPM)	Suction Flow (GPM)	Eductor Discharge Flow (GPM)	Motive Pressure (psig)	Vacuum Pressure (in Hg)	Discharge Pressure (psig)
Set of 1/8" baskets, with filter housings closed, with 8' of 2" diameter stainless steel (pump discharge) with no flow meter and pressure gauge leading to a 3" diameter eductor with a flow meter, 50' of 2" diameter vacuum hose, a vacuum gauge, and a 3-1/2" diameter vacuum head on suction side of eductor. A "Y" with a 200' length of 2" diameter discharge hose on each leg (parallel legs) attached to the eductor discharge. Flow meter attached to the eductor discharge side before the "Y".	157	63	220	no gauge installed	4.5	27
Same as previous but with a "Y" with each leg 50' in length 2" diameter hose connected to 150' of 3" diameter discharge hose.	no flow meter installed	106	no flow meter installed	no gauge installed	13	24
Set of 1/8" baskets, with filter housings closed with 8' of 2" diameter stainless steel (pump discharge) with no flow meter and pressure gauge leading to a 3" diameter eductor with a flow meter, 50' of 2" diameter vacuum hose, a vacuum gauge, and a 5" diameter vacuum head on suction side of eductor. A 200' length of 3" diameter discharge hose attached to the eductor discharge.	no flow meter installed	128	no flow meter installed	no gauge installed	15	18

The maximum discharge flow rate can be expected to be no greater than 300 GPM. Testing with a flow meter on the motive flow and suction resulted in a maximum eductor discharge flow rate of 267 GPM. However, the final test resulted in a suction flow rate of 128 GPM added to an expected motive flow rate of 157 GPM equals a maximum eductor discharge flow rate of 285 GPM. One informal test, not recorded in Table 1, which included a 50' section of 2" diameter suction hose but no eductor discharge hose attached to the Eductor System, resulted in a suction flow of 135 GPM. If a motive flow rate of 157 GPM were added to this, the total discharge flow would be 292 GPM. This total flow rate is the maximum discharge limit for the Eductor System with no eductor discharge hose.

Discharge flow rates were increased after a 2" diameter fitting for measuring pressure was replaced with a 3" diameter fitting on the 3" diameter eductor discharge. Note the increase in suction flow on the final test from the early tests in Table 1 - from 107 to 128 GPM and the final test even used a 50' vacuum hose compared to the 20' vacuum hose on the early tests.

DIVERSION VALVE TEST

Additional tests were run to correlate vacuum pressure with suction flow and to test the effectiveness of the pneumatic diversion valves. In testing the vacuum pressure/suction flow correlation, the Eductor System was set up with one set of baskets, 2" diameter stainless steel pump discharge leading to a 3" diameter eductor with 50' of 2" diameter vacuum hose. Also included on the suction side of the eductor were a vacuum gauge, flow meter and a 3-1/2" diameter vacuum head. A 2" diameter ITT flow control valve was installed just past the vacuum head to simulate a plugged vacuum head. Two hundred feet of 3" diameter discharge hose with pressure gauge was attached to the eductor discharge. The ITT flow control valve was set at various openings then suction flow with vacuum and discharge pressure were recorded in Table 2 below and plotted in Figure 2 on page 10.

Table 2

	Valve Fully Open	Valve Closed 1/4 way	Valve Closed Halfway	Valve closed 3/4 way
Suction Flow (GPM)	108-111	109-111	83-85	41-44
Vacuum (in Hg)	18.5	18	20	27.5
Discharge Pressure (psig)	17	17	14	7-12

An identical setup was tested, only with the ITT flow control valve connected to the eductor suction to simulate a plugged eductor. The results are as listed in Table 3 below and plotted in Figure 2 on page 10.

Table 3

	Valve Fully Open	Valve Closed 1/4 way	Valve Closed Halfway	Valve Closed 3/4 way	Valve Removed
Suction Flow (GPM)	106-108	98	79	44	125
Vacuum (in Hg)	21	22	25	28.5	17.5
Discharge Pressure (psig)	17.5	16	13	9.5	19

This information could be used to determine, using a vacuum gauge, if a vacuum head or eductor is plugged. For example, in Figure 2 below, a plugged vacuum head or eductor both display readings over 18 in. Hg. For optimal suction flow rates over 115 GPM, any vacuum readings over 18-19 in. Hg. would be unacceptable. At this point the operator would activate the pneumatic diversion valves to free the obstruction. If the vacuum head is obstructed (say, a large cloth rag), the diversion valve actuation would relieve pressure on the vacuum head and release the rag. If the eductor is obstructed, the diversion valves would free and divert the obstruction.

FIGURE 2

Large nuts, bolts, and "buggy springs" were introduced as simulated sludge and vacuumed with the Eductor System using the 3" diameter vacuum head (without coarse screen) with the purpose of clogging the eductor to test the pneumatic diversion valves. Sometimes several large nuts and bolts would become lodged in the eductor at once. Actuating the pneumatic valves, sometimes taking several attempts, would eventually dislodge all obstructions. In normal operation in the basin when using the Eductor System, a one inch screened vacuum head is recommended to avoid picking up pieces of debris over one inch in diameter.

The "buggy springs" were occasionally picked up with the 2" and 3" diameter vacuum heads. During one test, a "buggy spring" was discovered bent in half in the discharge canister (an empty fuel canister was located at the end of the discharge hose for catching nuts, bolts, etc.). The only force in our system to cause this probably came from the actuated 3" 2-way PBM valve on the eductor discharge.

4.0 Conclusions and Recommendations

The primary goal of sludge retrieval in the 105 K Basins is to retrieve sludge as efficiently as possible without exposing workers to unnecessary dose. Worker dose reduction can be optimized by performing sludge transfer without delays. The greatest delays caused by past sludge pumping operations have been to unclog vacuum head screens and discharge hoses. The Eductor System with the (SK-1-80101) head eliminated this problem by eliminating the 1/4" screened head which, in past sludge pumping activities in the 105 K East Basin, would become clogged with paint chips. This system is very effective in collecting the entire range of debris - from small particulate sand fines to large nuts and bolts and "buggy" springs. The Eductor System can either leave high density material 1/4" in diameter and larger, such as uranium fuel, or it can retrieve and contain it dependent on the type of vacuum head used.

The Eductor System tested concluded that efficient sludge retrieval is possible under the current constraints of 105 K Basins. To optimize this system for specific use, it is recommended that additional tests be performed consistent with the actual system being installed. The final Eductor System might not be a mobile system such as the one tested in this report. It may be a stationary Grundfos pump (or two) with a 50-100 ft. length of high pressure pump discharge hose leading to an eductor. If more than one pump is used the eductors may lead to a common eductor discharge line.

The final product of the tested Eductor System consists of a 15 hp Grundfos pump installed in a Tri Nuclear filter housing with a 2" diameter, stainless steel pump discharge leading to a 3" diameter Fox eductor. Also included were a 3" 2-way PBM pneumatic valve and 200' of 3" diameter hose on the eductor discharge and a 2" 3-way PBM pneumatic valve and 50' of 2" diameter vacuum hose on the eductor suction. The 5" diameter screenless vacuum head can be used for picking up sand and lighter fines at 125-130 GPM leaving any fuel pieces 1/4" in diameter behind. The 3" or 3-3/4" diameter vacuum head can be used with the Eductor System for picking up larger fuel pieces; however, the 15 hp Grundfos pump with the Tri Nuclear housing with filter baskets would be able to pick up and contain the larger pieces of debris and fuel, without the eductor, should this need arise (for example, on a second pass after the sand and lighter fines have been removed).

Accurate and reliable flow instruments need to be identified. Suction flow or pressure needs to be constantly monitored to determine whether obstructions are present within the system.

The primary points to remember when using an Eductor System in the 105 K Basins are to ensure a pump discharge pressure (motive pressure) greater than 100 psig; provide an eductor able to reach suction flow rates (with 100 psig motive pressure) greater than 100 GPM and able to pass one inch diameter particles; include eductor discharge hose with back pressure less than 20 psig (ideally, 15 psig or less); and install the most reliable instrumentation to measure the suction flow rate.

5.0 Disposition of Test Item

The equipment tested, or new identical equipment, shall be provided or arranged to be provided to the 105 K basins by the originator of this document.

6.0 References

- 1) WHC-SD-SNF-TC-001, Rev.0, Test Procedure Forms for Sludge Retrieval and Packaging
- 2) WHC-SD-SNF-TP-007, Rev.0, Test Plan for Sludge Retrieval and Packaging
- 3) WHC-IP-1026, Engineering Practice Guidelines, Appendix K, Rev.1
- 4) McCabe, Smith, and Harriott, Unit Operations of Chemical Engineering, 4th ed., McGraw-Hill, New York, 1985.
- 5) Wittekind, W.D., April 1993, *MCNP Calculations of K-infinity for 100KE Basin Sludge Samples*, WHC-SD-NR-CSER-008, Rev 1, Westinghouse Hanford Company, Richland, Washington.

Appendix A

TEST TRAVELER				Page 1 of 15	Number
Job Description Testing of the Screenless Suction Head and Educator System			Work Order No.		Prepared by M. J. Packer
System Engineer Approval M. J. Packer		Phone 6-6625	Date Required 10/27/95	Approval Designator	QA Approval J. Tuttle
System Manager Approval C. J. Alderman		Phone 6-1796	305 Bldg Manager Approval M. Schulte	Date 3/13/96	Safety Approval
Operation Number	Test Instruction	Ref., Dwg., Proc., Spec.	Completion Sig/Stamps	Date	Notes
1.0	Pre-Operational Checkout		Q JAT T DCP N NA E MJP C NA	2/13/96	
1.1	Verify all test performer blanks in Section 7.0 and Appendixes A,B,C, and D are completed. Also stamp "TEST CONTROL COPY" per Section 3.4 on entire procedure.		Q JAT T DCP N NA E MJP C NA	3/04/96 3/4/96	
1.2	Conduct a "pre-job briefing" of operations, including a review of all procedures, drawings and other engineering documents required to complete the test. Sign off Appendix G.		Q JAT T DCP N NA E MJP C NA	2/13/96	
1.3	Verify that performance criteria are included as Attachment 1 to this traveler.		Q JAT T DCP N NA E MJP C NA	2/12/96	

A-1

HHC-SC-SVE-A-R-0-4, Rev. 3

TEST TRAVELER		(Continuation Sheet)	Page 2 of 15		Number
Operation Number	Test Instruction	Ref., Dwg., Proc., Spec.	Completion Sig/Stamps	Date	~~Standing List No.~~ <i>Pressure Gauge</i> Notes
2.0	Calibration Checks: Verify that all instruments and equipment have vendor calibration data.		O <u>JAT</u> I <u>OCY</u> N <u>NA</u> E <u>MP</u> C <u>NA</u>	2/12/96	List Instrument Number(s) Pressure Gauge: 0-200 (no clutch discharge) DUE 752-31-04-083 11-9
3.0	Issue and verify the equipment list (Attachment 2).		O <u>JAT</u> I <u>OCY</u> N <u>NA</u> E <u>MP</u> C <u>NA</u>	2/12/96	
4.0	Complete and verify the test layout/schematic (Attachment 3).		O <u>JAT</u> I <u>OCY</u> N <u>NA</u> E <u>MP</u> C <u>NA</u>	2/12/96	
5.0	Install the 135 gpm, 15 hp Tri-Nuc pump assembly as per attached-Assembly and Operating-Instructions. <i>Test Engineer's instructions. MP 2/12/96</i>		O <u>JAT</u> I <u>OCY</u> N <u>NA</u> E <u>MP</u> C <u>NA</u>	2/13/96	
6.0	Run the 135 gpm Pump, pumping clear water, until flow stabilizes WITHOUT any suction hoses, baskets or filters installed and with the filter housings OPEN. Record the flow rate.		O <u>NA</u> I <u>OCY</u> N <u>NA</u> E <u>MP</u> C <u>NA</u>	2/13/96	Flow rate <u>218</u> gpm $\pm$ 1

A-2

MHC-SO-SNF-ATR-014, Rev. 0

TEST TRAVELER (Continuation Sheet)			Page 3 of 15	Number	
Operation Number	Test Instruction	Ref., Dwg., Proc., Spec.	Completion Sig/Stamp	Date	Notes
7.0	Check for proper pump rotation per Section 3-7 of the Tri-Nuclear Corporation Assembly and Operating Instructions. (Not required if flow rate is >100 gpm)	2/12/96	O JAT T <u>002</u> N NA E <u>2/12/96</u> C NA	2/13/96	
8.0	Run the 135 gpm Pump, pumping clear water, until flow stabilizes with one set of the baskets installed with the filter housings closed and 20 feet of 2" diameter motive water hose leading to a flow control valve and 3" eductor followed by a second Halliburton flow meter and 20 feet of 2" diameter suction hose with vacuum head nozzle and 200 feet of 3" diameter discharge hose. Record head nozzle type. Adjust flow control valve so that suction velocity flow is at a maximum but no more than 4-1 ft/sec (See NOTE below). Record the flow rate of both flow meters. Record pressure gauge readings on motive water side and discharge side of eductor.		O JAT T <u>002</u> N NA E <u>2/13/96</u> C NA	2/13/96 #	Head nozzle diameter <u>3" nozzle</u> Flow rate of suction - <u>107 gpm</u> + Flow rate of motive water <u>153 gpm</u> = Flow rate of discharge <u>260 gpm</u> Motive water pressure <u>111</u> psig Discharge pressure <u>14</u> psig
	NOTE: Maximum suction flow for the 3" diameter vacuum head is 95 gpm and 127 gpm for the 3-1/2" diameter vacuum head.				

MHC-SO-SNF-ATR-014, Rev. 0

BEST AVAILABLE COPY

TEST TRAVELER		(Continuation Sheet)	Page	4 of 15	Number
Operation Number	Test Instruction	Ref., Dwg., Proc., Spec.	Completion Sig/Stamp	Date	Notes
9.0	Transfer the simulated sludge and/or tungsten pieces from the floor of the basin into one of the sludge boxes. Monitor and record pressures and flows. Note type and quantity of simulated sludge and tungsten transferred.		O JAT T JCK N NA E MJP C NA	2/13/96	Flow rate of suction water <u>111</u> gpm ± 1 gpm + Flow rate of motive water <u>156</u> gpm = Flow rate of discharge <u>267</u> gpm Motive water pressure <u>111</u> psig Discharge pressure <u>14</u> psig
	Equipment setup identical to 8.0, except $3\frac{1}{2}$ " diameter vacuum head used. This vacuum head is screened (~1" square).				

BEST AVAILABLE COPY

Simulated Sludge

Sludge mix

five $\frac{1}{4}$ " x $\frac{1}{4}$ " diameter tungsten pieces

five $\frac{1}{8}$ - $3\frac{1}{16}$ " x $\frac{1}{4}$ " diameter tungsten pieces

two nuts - $15\frac{1}{16}$ " long x $15\frac{1}{16}$ " hex head

one nut - $9\frac{1}{16}$ " long x $15\frac{1}{16}$ " hex head

four bolts - $4\frac{1}{16}$ " $7\frac{1}{4}$ " long x $9\frac{1}{16}$ " hex head

1 bolt - $4\frac{3}{16}$ " long x $9\frac{1}{16}$ " hex head

sand
1" square plastic pieces

Results of Simulated Sludge pickup

Not picked up:

- five $\frac{1}{4}$ " x $\frac{1}{4}$ " diameter tungsten pieces
- two $\frac{1}{8}$ - $3\frac{1}{16}$ " diameter tungsten pieces
- one $15\frac{1}{16}$ " long nut
- one $9\frac{1}{16}$ " long nut
- one $4\frac{3}{16}$ " long bolt
- two $2\frac{1}{4}$ " long 6-11
- ~cup of sand

Not in Bette mix

TEST TRAVELER (Continuation Sheet)			Page 5 of 15	Number	
Operation Number	Test Instruction	Ref., Dwg., Proc., Spec.	Completion Sig/Stamp	Date	Notes
10.0 <i>mfp</i> <i>2/13/96</i>	Change suction heads and transfer simulated sludge and tungsten pieces from the floor of the basin into one of the sludge boxes. Adjust flow-control valve so flow velocity is a maximum but no more than 4-1 ft/sec (See NOTE Below). Monitor and record flow rate. Note type and quantity of simulated sludge transferred. Record pressures and flows. <i>same simulated sludge as in 9.0.</i> NOTE: Maximum suction flow for the 3" diameter vacuum head is 95 gpm and 127 gpm for the 3-1/2" diameter vacuum head.		<i>Q JAT</i> <i>T GSK</i> <i>N NA</i> <i>E mfp</i> <i>C NA</i>	<i>2/13/96</i>	Head nozzle <i>3" diameter</i> Flow rate of suction water <i>111</i> gpm + Flow rate of motive water <i>156</i> gpm $\pm$ <i>15 gpm</i> = Flow rate of discharge <i>267</i> gpm Motive water pressure <i>111</i> psig Discharge pressure <i>14.5</i> psig
			BEST AVAILABLE COPY		

Results of Simulated Sludge pickup:

Not picked up:

- o one 4 ³/₈" long bolt
- o one 2 ¹/₄" long bolt

TEST CONTROL COPY

TEST TRAVELER

(Continuation Sheet)

Page

6 of 15

Number

Operation Number	Test Instruction	Ref., Dwg., Proc., Spec.	Completion Sig/Stamps	Date	Notes
11.0	Run the 135 gpm pump, pumping clear water, until flow stabilizes with one set of the baskets installed with the filter housings closed and 20 feet of 2" diameter motive water hose leading to a flow-control valve and 3" eductor followed by a second Halliburton flow meter and 40 feet of 2" diameter suction hose with vacuum head nozzle and 200 feet of head nozzle type. Adjust flow control valve so that suction velocity flow is at a maximum but no more than 4.1 ft/sec (See NOTE below). Record the flow rate of both flow meters. Record pressure gauge readings on motive water side and discharge side of eductor. NOTE: Maximum suction flow for the 3" diameter vacuum head is 95 gpm and 127 gpm for the 3-1/2" diameter vacuum head.		Q JAT T OCL N NA E MP C NA	3/19/96	Head nozzle diameter <u>3 1/2" diameter</u> Flow rate of suction <u>109 gpm ± 1 gpm</u> + Flow rate of motive water <u>156 gpm ± 1 gpm</u> = Flow rate of discharge <u>260 gpm</u> Motive water pressure <u>109</u> psig Discharge pressure <u>13.5</u> psig

TEST TRAVELER (Continuation Sheet)			Page 7 of 15	Number	
Operation Number	Test Instruction	Ref., Dwg., Proc., Spec.	Completion Sig/Stamp	Date	Notes
12.0 MMP 2/14/96	Transfer the simulated sludge and/or tungsten pieces from the floor of the basin into one of the sludge boxes. Monitor and record pressures and flows. Note type and quantity of simulated sludge and tungsten transferred. 3" diameter vacuum head used BEST AVAILABLE COPY		Q JAT T OGY N NA E MMP C NA	3/14/96	Flow rate of suction 109 gmp $\pm$ 1 gpm + Flow rate of motive water 157 gpm = Flow rate of discharge 261 gpm Motive water pressure 109 psig Discharge pressure 14 psig

Sludge Simulant Used

no sand used

no plastic pieces used

four $\frac{1}{8}$ " - $\frac{3}{16}$ " $\times \frac{1}{4}$ " dia tungsten pieces

five $\frac{1}{4}$ " $\times \frac{1}{4}$ " diameter tungsten pieces

4 bolts $\frac{9}{16}$ " hex head - $2\frac{1}{4}$ " long

2 nuts $\frac{1}{2}$ " hex head - $\frac{7}{8}$ " long

3 bolts $\frac{3}{4}$ " hex head - $1\frac{3}{4}$ " long

1 bolt $\frac{9}{16}$ " hex head - $2\frac{1}{4}$ " long

Sludge NA picked up

two $\frac{1}{4}$ " $\times \frac{1}{4}$ " diameter tungsten pieces

one bolt $\frac{9}{16}$ " hex head - $2\frac{1}{4}$ "

one bolt $\frac{9}{16}$ " hex head - $4\frac{3}{8}$ " long

TEST CONTROL COPY

TEST TRAVELER

(Continuation Sheet)

Page

8 of 15

Number

Operation Number	Test Instruction	Ref., Dwg., Proc., Spec.	Completion Sig/Stamps	Date	Notes
13.0 <i>MPD 2/14/96</i>	Change suction heads and transfer simulant sludge and tungsten pieces from the floor of the basin into one of the sludge boxes. Monitor and record flow rate. Adjust flow-control valve so flow velocity is a maximum but no more than 4.1 ft/sec. (See NOTE below). Note type and quantity of simulated sludge transferred. Record pressures and flows.		<i>Q JAT</i> <i>T OCK</i> <i>N NA</i> <i>E MPD</i> <i>C NA</i>	3/14/96	Head nozzle diameter <u>3 1/2"</u> Flow rate of suction <u>104 gpm ± 1 gpm</u> + Flow rate of motive water <u>157 gpm ± 1 gpm</u> = Flow rate of discharge <u>261 gpm</u> Motive water pressure <u>109 psig</u> Discharge pressure <u>14 psig</u>
	NOTE: Maximum suction flow for the 3" diameter vacuum head is 95 gpm and 127 gpm for the 3-1/2" diameter vacuum head.				<i>Sludge Not picked up</i> <i>2 Nuts 1 1/16" hex head by 7/8" long</i> <i>1 bolt 9/16" hex head by 4 3/4" long</i> <i>1 bolt 9/16" hex head by 2 1/4" long</i> <i>2 1/8" by 3/16" tungsten pieces</i> <i>3 1/4" by 1/4" tungsten pieces</i>

BEST AVAILABLE COPY

Sludge Simulant

2 Nuts 13/16" hex head by 7/8" long
 3 Bolts 3/4" hex head by 1 3/4" long
 1 Bolt 9/16" hex head by 4 3/4" long
 2 bolts 9/16" hex head by 2 1/4" long
 1 bolt 9/16" hex head by 1 7/8" long

four 1/8" - 3/16" tungsten pieces
 three 1/4" x 1/4" diameter tungsten pieces

four 1/4" x 1/4" diameter tungsten pieces

TEST DATA

TEST TRAVELER (Continuation Sheet)		Page 10 of 15	Number		
Operation Number	Test Instruction	Ref., Dwg., Proc., Spec.	Completion Sig/Stamp	Date	Notes
15.0	Transfer the simulated sludge and/or tungsten pieces from the floor of the basin into one of the sludge boxes. Monitor and record pressures and flows. Note type and quantity of simulated sludge and tungsten transferred.		<u>0 JAT</u> <u>1 OCH</u> <u>N NA</u> <u>E MCH</u> <u>C NA</u>	2/14/96	Flow rate of suction <u>90</u> gpm + Flow rate of motive water <u>157</u> gpm = Flow rate of discharge <u>247</u> gpm Motive water pressure <u>107</u> psig Discharge pressure <u>15</u> psig
BEST AVAILABLE COPY					

Simulated Sludge

- four $\frac{1}{8}$ " - $\frac{3}{16}$ " $\times$ $\frac{1}{4}$ " diameter tungsten pieces
- four $\frac{1}{4}$ " $\times$ $\frac{1}{4}$ " diameter tungsten pieces
- 2 Nuts $\frac{13}{16}$ " hex head by $\frac{7}{8}$ " long
- 1 bolt $\frac{9}{16}$ " hex head by $2\frac{1}{4}$ " long
- 1 bolt $\frac{9}{16}$ " hex head by $2\frac{3}{4}$ " long
- 1 bolt $\frac{9}{16}$ " hex head by $1\frac{3}{4}$ " long (316 SS)
- 2 Nuts $\frac{13}{16}$ " hex head by $\frac{1}{2}$ " long

Sludge pieces NOT picked up

- 4 Nuts
- 2 $\frac{3}{4}$ " long bolt
- 2 $\frac{1}{4}$ " long bolt
- ? nine tungsten pieces $\left\{ \begin{array}{l} 5 \frac{1}{4}" \times \frac{1}{4}" \text{ diameter} \\ 4 \frac{1}{2}" - \frac{3}{16}" \text{ by } \frac{1}{4}" \text{ dia.} \end{array} \right.$
- see note below:

TEST CONTROL COPY

Note: the additional tungsten must have been dislodged from a pilot in the system and became ejected out suction

TEST TRAVELER (Continuation Sheet)		Page	11 of 15	Number	
Operation Number	Test Instruction	Ref., Dwg., Proc., Spec.	Completion Sig/Stamps	Date	Notes
16.0 MAR 2/14/96	Change suction heads and transfer simulant sludge and tungsten pieces from the floor of the basin into one of the sludge boxes. Monitor and record flow rate. Adjust flow-control valve so flow velocity is a maximum but no more than 4-1 ft/sec (See NOTE below). Note type and quantity of simulated sludge transferred. Record pressures and flows.		Q VAT T OCT N NA E 2400 C NA	2/14/96	Head nozzle <u>3"</u> Flow rate of suction <u>90</u> gpm + Flow rate of motive water <u>158</u> gpm = Flow rate of discharge <u>248</u> gpm Motive water pressure <u>108</u> psig Discharge pressure <u>15</u> psig
	NOTE: Maximum suction flow for the 3" diameter vacuum head is 95 gpm and 127 gpm for the 3-1/2" diameter vacuum head.				

Sludge Simulant

four $\frac{1}{8}$ " x $\frac{3}{16}$ " x $\frac{1}{4}$ " diameter tungsten pieces
four $\frac{1}{4}$ " x $\frac{1}{4}$ " diameter tungsten pieces
2 Nuts $\frac{13}{16}$ " hex head by $\frac{7}{8}$ " long
3 Nuts $\frac{13}{16}$ " hex head by $\frac{1}{2}$ " long
1 Bolt $\frac{9}{16}$ " hex head by $2\frac{3}{4}$ " long
1 Bolt $\frac{9}{16}$ " hex head by $2\frac{1}{4}$ " long

Sludge pieces NOT picked up

four $\frac{1}{4}$ " x $\frac{1}{4}$ " diameter tungsten pieces
three $\frac{1}{8}$ " x $\frac{3}{16}$ " diameter tungsten pieces
2 bolts

TEST CONTROL COPY

BEST AVAILABLE COPY

TEST TRAVELER

(Continuation Sheet)

Page

12 of 15

Number

Operation Number	Test Instruction	Ref., Dwg., Proc., Spec.	Completion Sig/Stamps	Date	Notes
17.0	Run the 135 gpm pump, pumping clear water, until flow stabilizes with one set of the baskets installed with the filter housings closed, 3" eductor directly attached to Halliburton flow meter and flow control valve—(remove 20 feet of 2" diameter motive water hose — just connect pump to flow control valve to flow meter to eductor). Attach second Halliburton flow meter to suction eductor-discharge section. Attach 20-50 feet section of 2" diameter suction hose. Include 200 feet of 3" diameter discharge hose. Record head-nozzle type. Adjust flow control valve so flow velocity is at maximum suction but no more than 4.1 ft/sec (See NOTE below). <i>on each leg after 2" Y of discharge section to be correlated legs</i>		Q <u>NA</u> T <u>NA</u> N <u>NA</u> E <u>NA</u> C <u>NA</u>		Head-nozzle-diameter <u>3 1/2"</u> Flow rate of suction <u>39</u> gpm $\pm$ 1 gpm + Flow rate of motive water <u>159</u> gpm $\pm$ 1 gpm = Flow rate of discharge suction <u>198</u> gpm Motive water pressure <u>107</u> psig Discharge pressure <u>22</u> psig
	Replace the last 50 feet of 3" diameter discharge hose with 50 feet of 2" diameter hose. Run the 135 gpm pump. Record the flows and pressures. NOTE: Maximum suction flow for the 3" diameter vacuum head is 95 gpm and 127 gpm for the 3 1/2" diameter vacuum head. * The last 50 feet shall be a 2" "Y" with 2 ~~1/2~~ runs of 2" diameter discharge hose				Flow rate of suction <u>52</u> gpm $\pm$ 1 gpm + Flow rate of motive water <u>158</u> gpm = Flow rate of discharge suction <u>210</u> gpm Motive water pressure <u>107</u> psig Discharge pressure <u>20</u> psig <u>18-19</u>

MHC-SD-SNF-ATR-014, Rev. 0

TEST CONTROL COPY

TEST TRAVELER (Continuation Sheet)		Page 13 of 15	Number		
Operation Number	Test Instruction	Ref., Dwg., Proc., Spec.	Completion Sig/Stamp	Date	Notes
18.0	<i>Continued from Operation 17.2.</i> Transfer the simulated sludge and/or tungsten pieces from the floor of the basin into one of the sludge boxes. Monitor and record pressures and flows. Note type and quantity of simulated sludge and tungsten transferred. <i>Not performed</i> <i>MPD 3/3/96</i>		Q ☒ T ☒ N NA E ☒ C NA		Flow rate of suction _____ gpm + Flow rate of motive water _____ gpm - Flow rate of discharge _____ gpm - Motive water pressure _____ psig Discharge pressure ☒ psig Suction head size _____

Simulated sludge

- Four $\frac{1}{4}$ " x $\frac{1}{4}$ " diameter tungsten pieces
- Three $\frac{1}{8}$ " x $\frac{3}{16}$ " by $\frac{1}{8}$ " diameter tungsten pieces
- 1 bolt "2 $\frac{3}{4}$ " long ($\frac{9}{16}$ " hex head)
- 1 bolt 2 $\frac{1}{4}$ " long ($\frac{9}{16}$ " hex head)
- 2 nuts $\frac{7}{8}$ " hex head by $\frac{1}{2}$ " long
- 1 nut 1 $\frac{5}{16}$ " hex head by $\frac{1}{2}$ " long

- include traces

BEST AVAILABLE COPY

TEST CONTROL COPY

TEST TRAVELER (Continuation Sheet)

Page

14 of 15

Number

Operation Number	Test Instruction	Ref., Dwg., Proc., Spec.	Completion Sig/Stamps	Date	Notes
19.0	Change suction heads and transfer simulant sludge and tungsten pieces from the floor of the basin into one of the sludge boxes. Monitor and record flow rate. Adjust flow control valve so flow velocity is a maximum but no more than 4.1 ft/sec. (See NOTE below). Note type and quantity of simulated sludge transferred. Record pressures and flows. NOTE: Maximum suction flow for the 3" diameter vacuum head is 95 gpm and 127 gpm for the 3-1/2" diameter vacuum head.		Q ~~NA~~ T ~~NA~~ N ~~NA~~ E ~~NA~~ C ~~NA~~		Head nozzle diameter ~~X~~ Flow rate of suction ~~X~~ gpm + Flow rate of motive water _____ gpm - Flow rate of discharge _____ gpm - Motive water pressure _____ psig Discharge pressure ~~X~~ psig
20.0	Remove all pump hose. Locate pump in the center of one side of the basin. Locate the discharge hose(s) along the opposite wall. BEST AVAILABLE COPY		Q NA T ~~NA~~ N NA E ~~NA~~ C NA	2/04/96 3/3/96	

MHC-SO-SNF-ATR-014, Rev. 0

A-14

APPENDIX F

RETEST PROCEDURE AND DATA SHEETS

Q = Quality T = Test Performer E = Test Engineer 0 = Other DEFINED E

Index additions by hand-written entries, initial, and date.

Set up equipment with the 135 gpm pump, hand-piped discharge leading to 3" eductor, 2" 3-wy pneumatic PBM valve connected directly to suction side of eductor with Halliburton flow meter and 20' 2" diameter suction hose and 3 1/2" dia vacuum bnd. Eductor discharge is connected to 2-way 3" diameter PBM pneumatic valve and 3" 2-way pneumatic valve (when installed). Vacuum gauge is installed on suction side of 2" 3-wy PBM valve. Eductor discharge gauge is installed past the 3" 2-wy PBM valve.

2" diameter discharge has "less" used 20' each leg (w/ "4")

Suction pressure 4.5 in Hg

Flow Rate of Suction 63 gpm

Discharge hose pressure 27 psig

Discharge hose flow rate 220 gpm

Motive Flow Rate 157 gpm

(Discharge flow - Suction flow)

220
- 63
157

BEST AVAILABLE COPY

TEST CONTROL COPY

APPENDIX F

RETEST PROCEDURE AND DATA SHEETS

Q = Quality T = Test Performer E = Test Engineer O = Other DEFINED E

Index additions by hand-written entries, initial, and date.

Set up equipment with the 135 gpm pump, hand-piped discharge leading to 3" eductor, 2" 3-way pneumatic PBM valve connected directly to suction side of eductor with Halliburton flow meter and 20' 2" diameter suction hose and 3 1/2" dia vacuum head. Eductor discharge is connected to 2-way 3" diameter PBM pneumatic valve and 3" diameter discharge hose (when installed). Vacuum gauge is installed on suction side of 2" 3-way PBM valve. Eductor discharge gauge is installed past the 3" 2-way PBM valve.

Length of Discharge Hose 150' 3" dia plus 2" 1/4" with two 5' 2" dia hoses

Suction Pressure 13 in Hg

Flow Rate of Suction 106 gpm ± 1 gpm T OCL 03/05/96

Discharge Hose Pressure 24 psig E MPR 2/16/96

4 NA

BEST AVAILABLE COPY

TEST CONTROL COPY

APPENDIX F

RETEST PROCEDURE AND DATA SHEETS

Q = Quality T = Test Performer E = Test Engineer O = Other DEFINED LF

Index additions by hand-written entries, initial, and date.

Set up 15 hp Tri-Nuclear pump with baskets in section-side filters hard-fixed (2" dia) discharge leading to 3" diameter eductor with 50' of 3" diameter section hose. ^{with vacuum 3-way 2" diameter piston pressure valve with} Include vacuum gauge and flowmeter connected to eductor (on suction side) and pressure gauge connected to eductor on discharge side. Also include 200' of 3" diameter hard plastic discharge hose on discharge side. Run pump and record pressures and flow as listed below.

Run vacuum head over 10 pieces of $\frac{1}{4}" \times \frac{1}{4}"$ diameter tungsten. ^{Result}

Suction Flow Rate — 128 — gpm ± 1

Vacuum Pressure — 15 — in Hg (12 mm ^{40 flow} _{meter}) (JAT VERIFIED DATA ONLY)

Discharge Pressure — 18 — psig T DCX 03/05/96
E JAP 2/29/96

Results of picking up tungsten pieces:

no pieces were picked up. The pieces moved horizontal to vacuum head but did not lift vertical.

WHC-SD-SNF-ATR-014, Rev. 0

BEST AVAILABLE COPY

TEST CONTROL COPY

Run 1: valve fully open
 Run 2: valve closed $1\frac{1}{2}$ turns
 Run 3: valve closed halfway ($3\frac{1}{2}$ turns)
 Run 4: valve closed 5 turns

Additional Tests

T oel 2/05/91
 E MP 2/23/96

APPENDIX F

RETEST PROCEDURE AND DATA SHEETS

Q = Quality T = Test Performer E = Test Engineer O = Other DEFINED E

Index additions by hand-written entries, initial, and date.

Set up 15 hp Tri-Nuclear pump with baskets in suction filters, hard-piped discharge leading to 3" diameter eductor with (50' of 2" diameter suction side hose. Include vacuum gauge ^{and flow meter} connected to eductor (on suction side) and pressure gauge connected to eductor on discharge side. Include 200' of 3" diameter hard plastic discharge hose. Also include 2" ITT valve on suction side. Record one of two locations of valve. Run pump and record pressures and flows as listed. Install $3\frac{1}{2}$ " diameter vacuum head.

VALVE LOCATION: vacuum head (eductor or vacuum head)

	<u>Run 1</u>	<u>Run 2</u>	<u>Run 3</u>	<u>Run 4</u>
Suction Flow (GPM)	108-111	109-111	83-85	41-44
Vacuum Pressure (inHg)	13.5	13	20	27.5
Discharge Pressure (psig)	17	17	14	7-12

then
 Took 2" ITT valve off and ran pump: Results below:

BEST AVAILABLE COPY

Suction Flow (GPM) 124-125

Vacuum Pressure (inHg) 17.5

Discharge Pressure (psig) 19

TEST CONTROL COPY

Run 1: valve fully open
 Run 2: valve closed $\frac{1}{2}$ turns
 Run 3: valve closed halfway ($3\frac{1}{2}$ turns)
 Run 4: valve closed 5 turns

T OCR 3/05/96
 E MJP 2/23/96
 Q N/A

APPENDIX F

RETEST PROCEDURE AND DATA SHEETS

Q = Quality T = Test Performer E = Test Engineer O = Other DEFINED E

Index additions by hand-written entries, initial, and date.

Set up 15 hp Tri-Nuclear pump with baskets in suction filters, hard-piped discharge leading to 3" diameter eductor with (50' of 2" diameter suction side hose. Include vacuum gauge ^{and flow meter} connected to eductor (on suction side) and pressure gauge connected to eductor on discharge side. Include 200' of 3" diameter hard plastic discharge hose. Also include 2" ITT valve on suction side. Record one of two locations of valve. Run pump and record pressures and flows as listed. Install $3\frac{1}{2}$ " diameter vacuum head.

VALVE LOCATION: eductor (eductor or vacuum head)

	Run 1	Run 2	Run 3	Run 4
Suction Flow (GPM) ^{MJP 106-1-8}	98	79	44	
Vacuum Pressure (in Hg)	28.5	22	25	28.5
Discharge Pressure (psig)	17.5	16	13	9.5

WHC-SD-SNF-ATR-014, Rev. 0

BEST AVAILABLE COPY

TEST CONTROL COPY

mm Retest

Note: Also installed flow meter on discharge hose — in front of 2" 4"

APPENDIX F

RETEST PROCEDURE AND DATA SHEETS

Q = Quality T = Test Performer E = Test Engineer O = Other DEFINED E

Index additions by hand-written entries, initial, and date.

Set up equipment, with the 135 gpm pump, hard-piped discharge leading to 3" eductor, 2" 3-way pneumatic PBM valve connected directly to suction side of eductor with Halliketon flow meter and 20' 2" diameter suction hose and 3 1/2" dia vacuum hard. Eductor discharge is connected to 2-way 3" diameter PBM pneumatic valve and 3" 2" diameter discharge hose (when installed). Vacuum gauge is installed on suction side of 2" 3-way PBM valve. Eductor discharge gauge is installed past the 3" 2-way PBM valve. Note that two 50' long 2" diameter discharge hose "legs" used.

Suction Pressure 9 in Hg

Flow Rate of Suction 107 gpm ± 1 gpm

Discharge hose pressure 13 psig

Discharge hose flow rate 269 gpm

Net Flow Rate 157 gpm

(Discharge Flow - Suction Flow)

T. OLG 3/05/96

E. MJP 2/26/96

C. NA

BEST AVAILABLE COPY

Note: Also injected large nut in suction side of eductor, operated/actuated both PBM valves, manual pump on, and the nut was ejected out easily.

TEST CONTROL COPY

MHC-SO-SNF-A18-014 Rev. 0

Note: One bolt and two large nuts found in eductor (on suction side)
 - not able to pass.

APPENDIX F

RETEST PROCEDURE AND DATA SHEETS

Q = Quality T = Test Performer E = Test Engineer O = Other DEFINED E

Index additions by hand-written entries, initial, and date.

17.1	Run the 135 gpm Pump, pumping clear water, until flow stabilizes with no set of baskets installed with the filter housings closed and 20 feet of 2" diameter motive water hose leading to a 3" eductor followed by a second Halliburton flow meter and 20 feet of 2" diameter suction hose. No hard hose to be included.	
	Flow Rate of Suction <u>38</u> gpm ± 1 gpm	Q JAT VERIFIED DATA
+	Flow Rate of Motive Water <u>158</u> gpm ± 1 gpm	T OCL 3/05/96
=	Flow Rate of Discharge <u>196</u> gpm	W - NA
	Motive Water Pressure <u>107</u> psig	E JMR 2/15/96
	Discharge Pressure <u>22</u> psig	C NA

BEST AVAILABLE COPY

TEST CONTROL COPY

Note: This equipment setup includes a section of 2" diameter section of pipe above the eductor discharge, which is 3" diameter, then expanded to 3" diameter discharge hose.

APPENDIX F

RETEST PROCEDURE AND DATA SHEETS

Q = Quality T = Test Performer E = Test Engineer O = Other DEFINED E

Index additions by hand-written entries, initial, and date.

8.1 Run the 135 gpm Pump, pumping clear water, until flow stabilizes with no set of leaks installed with the filter to house closed and 20 feet of 2" diameter motive water hose leading to a 3" eductor followed by a second Hollister flow meter and 20 feet of 2" diameter suction hose with vacuum head nozzle and 150 feet of 3" diameter plus 50 feet of 2" diameter (total 200') discharge hose.		
Head nozzle diameter <u>3"</u>		
Flow rate of motive water	<u>154 gpm</u>	<u>QJAT</u>
Flow rate of suction	<u>41 gpm $\pm$ 1 gpm</u>	<u>T.O.C.F.</u>
= Flow rate of discharge	<u>195 gpm</u>	<u>NA</u>
Motive water pressure	<u>112 psig</u>	<u>E.M.P. 2/13/96</u>
Discharge pressure	<u>27 psig</u>	<u>NA</u>

BEST AVAILABLE COPY

TEST CONTROL COPY

TEST TRAVELER (Continuation Sheet)			Page 15 of 15	Number	
Operation Number	Test Instruction	Ref., Dwg., Proc., Spec.	Completion Sig/Stamp	Date	Notes
21.0	Verify that all steps in this traveler have been completed.		Q JAT T DCK N NA E MJO C NA	2/10/96 3/3/96	
NOTE SURROGATE DEBRIS, E.G., "BUGGY SPRINGS," PAINT CHIPS, TAPE, STRING, GLOVES, ETC. SHALL BE INTRODUCED INTO THE SLUDGE AT THE DISCRETION OF THE TEST ENGINEER. The term "135 gpm pump" is the nominal reference to the Tri-Nuclear Model UFV-100 15 hp pump. List of Required Attachments: 1. Performance Criteria 2. Equipment List 3. Test Layout/Schematic Optional Attachment: 4. Acceptance Criteria for K-Basin Equipment					

E = Engineer

Q = QA Inspector

T = Technician

C = Craft

N = NDE Inspector

TEST CONTROL COPY

ATTACHMENT 1.

PERFORMANCE CRITERIA

Scope

The purpose for cold testing the screenless vacuum head and eductor system is to optimize the efficiency of this system. Optimization goals include maximizing suction flow rates for picking up sludge while leaving fuel particulates 1/4" diameter and greater on basin floor. The unretrieved fuel pieces would then be collected in suction-side baskets or filters at a later pass.

This system is planned for use in the overall sludge mitigation efforts for the removal of sludge concentrations in all basin areas. This also includes sludge transfer support with debris cleanup and fuel removal. Of course, all testing is to take place in a non-radiation zone to reduce worker exposure.

In past sludge pumping activities, a 1/4" meshed screen was utilized on the vacuum head to prevent fuel pieces 1/4" diameter and greater from being transferred to the Weasel Pit and settled in an uncontrolled configuration to possibly cause a criticality concern. The paramount drawback with the screened head is its constant clogging and occluding with paint chips and assorted basin debris. Since fuel (uranium) has a specific gravity of 18.95 with the remaining basin sludge being much lower, it should be possible to separate the fuel pieces 1/4" diameter and larger from the remaining sludge by setting the suction velocity just below the vertical terminal velocity of uranium pieces 1/4" diameter. The first pass would pick up all the sludge while a second pass, using a faster suction velocity, would pick up the remaining fuel.

Performance criteria would, therefore, include optimization activities such as seeking a maximum suction velocity while leaving the 1/4" diameter and greater heavy density pieces behind. Optimization activities are defined as improving the entire eductor system for the most efficient and effective use.

TEST CONTROL COPY

ATTACHMENT 2

EQUIPMENT LIST

1. Tri-Nuclear pump, UFV-100, 15 hp with stainless steel housing which includes suction-side baskets or filters.
  2. 2" diameter rigid plastic suction and motive hose and 3" diameter discharge hose with miscellaneous "Cam-Lok" fittings
  3. 2" ITT Dia-Flo Weir-diaphragm Flow Control Valve or substitute
  4. Halliburton Turbine Flow Meter with MC-II Flow Analyzer
  5. Vacuum heads, assorted 2", 3", 3-1/2" diameters and possibly greater, if required by initial test results
  6. 1-1/2" diameter aluminum pool poles with buoyancy floats
  7. Tri-Nuclear Discharge Piping Counterweight, if needed
  8. Sand box container(s) with surrogate sludge consisting of sand, pea gravel, assorted steel pieces, and pure tungsten pieces
  9. Pressure gauges - a 0-200 psig range gauge for the motive pressure line (pump discharge) and a 0-30 psig range gauge for the eductor discharge line
  10. Pneumatic Ball valves - 2" diversion and/or 3" shutoff valves
11. 2" "Y" for parallel runs of 2" diameter discharge hose.

mjl

BEST AVAILABLE COPY

CAPULE FLOW TEST
WHC-SD-SNF-ATR-014
REVISED: C

- 1 VACUUM HEAD ASSEMBLY
SCALE 1/2
2 VACUUM HEAD ASSEMBLY
SCALE 1/2

SECTION A-A
SCALE 1/2

VIEW B
SCALE FULL
VIEW 2 ONLY

PARTS/MATERIAL LIST

QTY	PART NO.	DESCRIPTION	UNIT	QTY
1	1012	VACUUM HEAD ASSEMBLY		1
1	1013	VACUUM HEAD ASSEMBLY		1
1	1014	VACUUM HEAD ASSEMBLY		1
1	1015	VACUUM HEAD ASSEMBLY		1
1	1016	VACUUM HEAD ASSEMBLY		1
1	1017	VACUUM HEAD ASSEMBLY		1
1	1018	VACUUM HEAD ASSEMBLY		1
1	1019	VACUUM HEAD ASSEMBLY		1
1	1020	VACUUM HEAD ASSEMBLY		1
1	1021	VACUUM HEAD ASSEMBLY		1
1	1022	VACUUM HEAD ASSEMBLY		1
1	1023	VACUUM HEAD ASSEMBLY		1
1	1024	VACUUM HEAD ASSEMBLY		1
1	1025	VACUUM HEAD ASSEMBLY		1
1	1026	VACUUM HEAD ASSEMBLY		1
1	1027	VACUUM HEAD ASSEMBLY		1
1	1028	VACUUM HEAD ASSEMBLY		1
1	1029	VACUUM HEAD ASSEMBLY		1
1	1030	VACUUM HEAD ASSEMBLY		1
1	1031	VACUUM HEAD ASSEMBLY		1
1	1032	VACUUM HEAD ASSEMBLY		1
1	1033	VACUUM HEAD ASSEMBLY		1
1	1034	VACUUM HEAD ASSEMBLY		1
1	1035	VACUUM HEAD ASSEMBLY		1
1	1036	VACUUM HEAD ASSEMBLY		1
1	1037	VACUUM HEAD ASSEMBLY		1
1	1038	VACUUM HEAD ASSEMBLY		1
1	1039	VACUUM HEAD ASSEMBLY		1
1	1040	VACUUM HEAD ASSEMBLY		1
1	1041	VACUUM HEAD ASSEMBLY		1
1	1042	VACUUM HEAD ASSEMBLY		1
1	1043	VACUUM HEAD ASSEMBLY		1
1	1044	VACUUM HEAD ASSEMBLY		1
1	1045	VACUUM HEAD ASSEMBLY		1
1	1046	VACUUM HEAD ASSEMBLY		1
1	1047	VACUUM HEAD ASSEMBLY		1
1	1048	VACUUM HEAD ASSEMBLY		1
1	1049	VACUUM HEAD ASSEMBLY		1
1	1050	VACUUM HEAD ASSEMBLY		1
1	1051	VACUUM HEAD ASSEMBLY		1
1	1052	VACUUM HEAD ASSEMBLY		1
1	1053	VACUUM HEAD ASSEMBLY		1
1	1054	VACUUM HEAD ASSEMBLY		1
1	1055	VACUUM HEAD ASSEMBLY		1
1	1056	VACUUM HEAD ASSEMBLY		1
1	1057	VACUUM HEAD ASSEMBLY		1
1	1058	VACUUM HEAD ASSEMBLY		1
1	1059	VACUUM HEAD ASSEMBLY		1
1	1060	VACUUM HEAD ASSEMBLY		1
1	1061	VACUUM HEAD ASSEMBLY		1
1	1062	VACUUM HEAD ASSEMBLY		1
1	1063	VACUUM HEAD ASSEMBLY		1
1	1064	VACUUM HEAD ASSEMBLY		1
1	1065	VACUUM HEAD ASSEMBLY		1
1	1066	VACUUM HEAD ASSEMBLY		1
1	1067	VACUUM HEAD ASSEMBLY		1
1	1068	VACUUM HEAD ASSEMBLY		1
1	1069	VACUUM HEAD ASSEMBLY		1
1	1070	VACUUM HEAD ASSEMBLY		1
1	1071	VACUUM HEAD ASSEMBLY		1
1	1072	VACUUM HEAD ASSEMBLY		1
1	1073	VACUUM HEAD ASSEMBLY		1
1	1074	VACUUM HEAD ASSEMBLY		1
1	1075	VACUUM HEAD ASSEMBLY		1
1	1076	VACUUM HEAD ASSEMBLY		1
1	1077	VACUUM HEAD ASSEMBLY		1
1	1078	VACUUM HEAD ASSEMBLY		1
1	1079	VACUUM HEAD ASSEMBLY		1
1	1080	VACUUM HEAD ASSEMBLY		1
1	1081	VACUUM HEAD ASSEMBLY		1
1	1082	VACUUM HEAD ASSEMBLY		1
1	1083	VACUUM HEAD ASSEMBLY		1
1	1084	VACUUM HEAD ASSEMBLY		1
1	1085	VACUUM HEAD ASSEMBLY		1
1	1086	VACUUM HEAD ASSEMBLY		1
1	1087	VACUUM HEAD ASSEMBLY		1
1	1088	VACUUM HEAD ASSEMBLY		1
1	1089	VACUUM HEAD ASSEMBLY		1
1	1090	VACUUM HEAD ASSEMBLY		1
1	1091	VACUUM HEAD ASSEMBLY		1
1	1092	VACUUM HEAD ASSEMBLY		1
1	1093	VACUUM HEAD ASSEMBLY		1
1	1094	VACUUM HEAD ASSEMBLY		1
1	1095	VACUUM HEAD ASSEMBLY		1
1	1096	VACUUM HEAD ASSEMBLY		1
1	1097	VACUUM HEAD ASSEMBLY		1
1	1098	VACUUM HEAD ASSEMBLY		1
1	1099	VACUUM HEAD ASSEMBLY		1
1	1100	VACUUM HEAD ASSEMBLY		1

GENERAL NOTES: UNLESS OTHERWISE SPECIFIED:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5-1987. DIMENSIONS ARE IN INCHES. TOLERANCES ARE: .001 IN. ANGULAR ±.2°.
- BRAKE ALL SHARP EDGES AND REMOVE ALL BURRS.
- WELD PER AWS D1.1-1967.

U.S. DEPARTMENT OF ENERGY	
K-BASIN	
SLUDGE SUCKING	
VACUUM HEAD	
F 10586(4750)SK-1-801010	