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ENGINEERING WORK PLAN FOR DEVELOPMENT OF SLUDGE PICKUP ADAPTER FOR FUEL CLEANLINESS INSPECTIONS

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Abstract The plan for developing an adapter to suction up sludge into a calibrated tube for fuel cleanliness inspection activities is described

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**Engineering Work Plan
For
Development of Sludge Pickup Adapter for Fuel Cleanliness Inspections**

A. L. Pitner

1 0 INTRODUCTION

A primary assessment of fuel cleanliness to be performed after processing through the Primary Cleaning Machine is whether the volume of any remaining canister sludge in or on a fuel assembly exceeds the allowable 1.4 cm^3 limit (Pitner 1999). It is anticipated that a general visual inspection of the sludge inventory after fuel assembly separation will usually suffice in making this assessment, but occasions may arise where there is some question as to whether or not the observed quantity of sludge exceeds this limit. Therefore a quantitative method of collecting and measuring the sludge volume is needed for these borderline situations. It is proposed to develop an adapter that fits on the end of the secondary cleaning station vacuum wand that will suction the material from the sludge collection tray into a chamber marked with the limiting volume to permit a direct go/no-go assessment of the sludge quantity.

The safety classification of this adapter is General Service, with Quality Level 3.

2 0 SCOPE

2 1 Objectives

A basic concept for the design of the sludge pickup adapter has been conceived. In principle, the adapter will slip fit over the strainer tip of the suction wand. When the wand suction is activated, the adapter will pull material up into a transparent tube marked with the limiting volume. A fine porous metal filter at the top of the tube blocks the sludge from being suctioned on into the wand and the Integrated Water Treatment System (IWTS). Once all of the canister sludge has been vacuumed into the tube, a visual check will show whether or not the allowable volume has been exceeded.

This type of filter has been used in previous sludge sampling campaigns, where it sometimes became plugged after extensive sampling and prevented any further sludge material from being vacuumed up. A major goal of this development work is to demonstrate that the adapter will suction up at least the limiting inventory of sludge (1.4 cm^3) before the filter plugs. This may require geometry modifications, such as using filters with larger surface area to prevent premature plugging.

Another objective of the development testing is to determine whether the filter is physically strong enough to withstand the prescribed water flow rate through the vacuum wand, which is nominally 80 gpm. If the filter is shown to be susceptible to structural

failure, a more robust design may need to be developed. Alternately, increased flow bypass may be required to reduce the flow rate through the pickup nozzle and filter. It is intended to change out the pickup adapter for each quantitative sludge volume assessment. Accordingly, it is designated a throwaway item and the final design should consider economics of fabrication.

The testing will be performed in the 305 Building in the 300 Area. The testing is to be performed underwater using prototypic flow rates and the standard composition of sludge simulant employed in previous sludge testing campaigns.

2.2 Deliverables

The deliverables for this task are:

- Final design of the pickup adapter as a formal drawing
- Acceptance Test Report demonstrating satisfactory operation of the device

3.0 DESCRIPTION

3.1 Physical Description

The end result of the task will be the demonstrated functionality of the final design of the sludge pickup adapter.

A flat tray will be used to capture canister sludge that is dislodged from the fuel elements during assembly separation and examination. The inner fuel element will be pushed into this tray by the hydraulic ram separation mechanism on the process table. The configuration and dimensions of the tray are shown in Figure 1. The tray is to be fabricated from stainless steel. The tray is sized to fit into the separation station and to capture the inner fuel element. After fuel assembly separation, the inner element will be removed from the tray and the tray will be visually inspected for canister sludge content. The tray will be vacuumed clean before each fuel assembly separation and inspection operation.

The sludge pickup adapter will be affixed to the vacuum wand strainer tip as a friction fit. The configuration of this arrangement is depicted in Figure 2. The vacuum action from the wand will also help keep the adapter affixed to the strainer tip during operation. The testing in 305 building shall employ both the vacuum wand strainer tip and the sludge pickup adapter, with a nominal water flow suction rate of 80 gpm.

A conceptual design for the sludge pickup adapter has been developed and is shown in Figure 3. Bypass flow through the ends of the adapter is provided because it is not believed that the filter assembly alone could sustain a flow rate of 80 gpm. The

dimensions of the final design may change to achieve the desired fit to the strainer tip. Also, tubing and filter sizes may change depending on stock availability and testing results. Transparent material is to be used for the construction of the pickup tube on the adapter so that the vacuumed sludge inside can be visually observed. An indicator line is to be painted on as a demarcation of the 1.4 cm³ limiting sludge volume.

3.2 Engineering Tasks

A sludge collection tray is to be fabricated per Figure 1. Prototype sludge pickup adapters shall be fabricated based on the concept presented in Figure 3.

Appropriate pumping equipment and associated hoses and connections shall be installed to perform the developmental testing. A flowmeter shall be included in the pumping system. The pumping system shall be capable of controlling the flow rate at 80 ± 10 gpm.

Prescribed amounts of standard canister sludge simulant shall be loaded into the sludge collection tray and placed underwater for vacuum testing. The tray shall be cleaned between test runs.

Testing shall be conducted to determine whether the sludge pickup adapter can structurally withstand the prescribed flow rates and whether the prescribed volume of sludge can be collected before the filter becomes plugged. Should the device fail in either of these modes, redesign and re-testing will be required until satisfactory performance is demonstrated.

If structural failure of the filter occurs, a more robust design must be developed. This could entail using a thicker filter disc or employing some kind of structural support grid. If the filter can not be made sufficiently strong, then methods of reducing the flow rate through the filter may be investigated. One method would be to add openings in the sides of the adapter body so that more of the flow is diverted directly through the strainer tip without coursing through the filter disc. In the end, it must be demonstrated that the desired sludge vacuuming performance is still achieved.

If premature plugging of the filter is a problem, then a redesign that increases the available surface flow area may be required. Alternately a coarser filter may be the solution, although it must be demonstrated that significant loss of sludge by suction through the filter does not occur.

3.3 Verification

Once a satisfactory design has been developed through prototype testing and appropriate design adjustments, a formal acceptance test shall be performed on the final design. The test shall demonstrate the complete underwater vacuuming of a measured 1.4 cm³ volume.

of sludge from the collection tray as confirmed by the observed level of sludge in the pickup adapter (fills the tube to the demarcation line) The cognizant engineer and a quality assurance representative shall witness the acceptance test The test results shall be documented in an Acceptance Test Report

Following the demonstrated functionality of the sludge pickup adapter, K Basin operators will be familiarized with use of the device in the 305 Building test facility This will involve underwater sludge pickup activities using the prototype adapter and collection tray containing simulated sludge

3 4 Procurement Tasks

The procurement phase of this task is considered to be normal and not require special controls Certification of the filter pore size shall be required

3 5 Installation Tasks

Once a satisfactory design has been developed and demonstrated, installation of the sludge pickup adapter onto the vacuum wand strainer tip by K Basins Operations personnel shall be considered a routine operation A new sludge pickup adapter shall be installed for each inspection occasion

4 0 ORGANIZATION

Process Engineering has overall responsibility for this task, and will issue this work plan and interact with the performing organization in the development of the sludge pickup adapter The manager of Process Engineering is J R Frederickson, and the Cognizant Engineer for this effort is A. L Pitner

The actual development testing will be performed by Engineering Laboratories in the 305 Building facilities Manager of Engineering Laboratories is M J Schliebe, and the Test Engineer for this task is J W Oliver This organization will also issue the Acceptance Test Report upon completion of the activity, and will fabricate the units required for field application

5 0 SCHEDULE

It is intended to have operational units available for possible use and checkout in K West Basin during Phase 2 (Cold Testing) of the Phased Startup Initiative, tentatively scheduled for April 2000 The schedule projected below supports this objective The overall duration of this activity is estimated at 8 weeks

Setup/Procurement/Fabrication	Jan 3-14, 2000
Development Testing	Jan 17-28, 2000
Acceptance Test	Feb 1, 2000
Issue Test Report	Feb 2-11, 2000

6 0 COST ESTIMATE

Unknown factors such as actual development testing time required to achieve a functional design do not permit an accurate estimate of the total cost. For planning purposes based on the general schedule presented above and a facility charge-out rate of \$90/hour for exempt support and \$70/hour for technician support, the estimated cost is \$25,000.

7 0 QUALITY ASSURANCE

Quality Assurance approval of this work plan is required.

Equipment will be installed and operated by 305 Building personnel in accordance with approved procedures. Certification of the filter material pore size is required.

The Acceptance Test will be witnessed by a qualified Quality Control Inspector, who will sign off on the test plan confirming acceptable performance of the final design of the sludge pickup adapter.

8 0 REFERENCES

Pitner, A. L., 2000, *Planning Document for Spent Nuclear Fuel Cleanliness Inspection Process*, HNF-5271, Rev 0, Fluor Daniel Hanford, Inc. Richland, Washington.

Figure 1 Canister Sludge Collection Tray

Figure 2 Vacuum Wand Strainer Tip and Sludge Pickup Adapter

Figure 3 Conceptual Design of Sludge Pickup Adapter
SLUDGE PICKUP ADAPTER