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Integrated Water Treatment System Test Strategy

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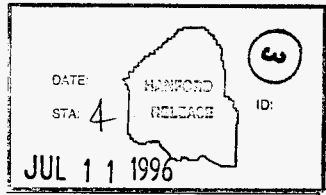
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Abstract: This document describes the operational testing at the KE Basin planned for obtaining information necessary for the successful design of the Integrated Water Treatment System and thereby facilitate the efficient removal of the fuel, sludge and debris from the K Basins within the SNF Project budgets and schedules. The document includes the description of the operational testing to be conducted, the samples and measurements to be taken, the sample analysis to be performed, and the use of the information obtained.

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Integrated Water Treatment System Test Strategy

1.0 Introduction

The current K Basins Integrated Water Treatment System (IWTS) design concepts are based on a number of assumptions that must be supported by testing. At the KW Basin, the design concept assumes that a mixed bed ion exchange module (IXM) can process unfiltered water from the fuel cleaning process and discharge water that meets stringent clarity and radiological decontamination requirements. At the KE Basin, the design concept depends on successful operation of a backwashable cartridge filter system and the operation of the existing basket style cartridge filters if large amounts of floor sludge are re-suspended during equipment installation. None of these water treatment processes, including economic operation of basket style cartridge filters has been confirmed at either basin.

As a result, there is a need to perform operational testing of the water treatment equipment in the K East (KE) Basin to obtain information necessary for the design of the Integrated Water Treatment System. There is also a need to keep the testing to a minimum due to the IWTS schedule and budget limitations, as well as the desire to minimize impacts to current K Basin operations. Even under these restrictions, it is imperative that some of the filter testing be done under typical water conditions expected during fuel removal activities, i.e. turbid water feed, in order to ensure that the IWTS supports the Spent Nuclear Fuel (SNF) Project fuel removal schedule by providing sufficient visibility and supporting off-mask operation. To this end, the main basin water will be used as the feed source for the filtering tests whenever the IWTS Design Authority (DA) and K Basin Operations determine that water has sufficient turbidity due to activities occurring at the KE Basin, e.g. fuel canister cleaning, fuel or sludge movement or sampling, or equipment installation. If the turbidity of the main basin water is insufficient, then a different, turbid water source will be required for the test. The impact to the KE Basin operation will be minimized by including conditions for quickly stopping the test if the increased turbidity is not removed by the filtering activities or when turbid water is fed unfiltered to an IXM.

2.0 Objective

The overall objective of these tests is to obtain information necessary for the successful design of the IWTS and thereby facilitate the efficient removal of the fuel, sludge and debris from the K Basins within the SNF Project budgets and schedules. More specific objectives of this test strategy are to:

1. assess the ability of the disposable cartridge filters to provide acceptable water clarity and TRU removal efficiency while treating turbid water expected during fuel removal activities and during KE Basin equipment installation,
2. assess the ability of the ion exchange modules (IXMs) to provide acceptable water clarity and TRU removal efficiency without pre-filtering, while treating turbid water expected during fuel removal activities at KW Basin,
3. assess the economic attractiveness of pre-filtering the IXM feed with disposable cartridge or backwashable filters to extend IXM run life,
4. assess the ability of an automated, high-flux backwashable filter to provide acceptable water clarity and TRU removal efficiency while treating turbid water expected during fuel removal activities, and to reduce waste volumes, floor space used, and operational complexity,
5. assess the ability of an anion-only IXM to increase the basin water pH and reduce soluble TRU concentrations, thereby extending IXM run life,
6. obtain information for detail design, such as appropriate filter pore size and water flux,
7. provide insight on the basin conditions under which it is most effective to operate the different components of the water treatment system.

3.0 Scope

The scope of this IWTS Test Strategy includes a general description of the operational testing to be conducted in the KE Basin, the samples and measurements to be taken, the sample analysis to be performed, and the use of the information obtained. Test Plans describing the details of each test will be issued as separate documents. After the results of the tests described below are known, the need for any additional testing required to support the IWTS design will be determined. However, IWTS schedule and budget limitations are likely to be even more restrictive than they are at present.

4.0 Test Descriptions

The tests to be conducted are described below. The order in which these tests are described does not necessarily reflect the order in which they will be performed. The first test described uses the KE Basin disposable cartridge filters and IXMs to support all the test objectives except the fourth and fifth objectives. The second test described uses a leased, full-scale backwashable filter to support the third, fourth, and sixth objectives. The

third test described uses a KE Basin IXM to support the fifth and sixth objective. Table 1 shows the data needed to be taken during the tests to satisfy the test objectives.

4.1 Full Scale Disposable Cartridge Filter and IXM Filtration Tests

In the KE Basin, the IXMs can be operated without pre-filtering, with pre-filtering by the sand filter in the skimmer loop, or with pre-filtering by the disposable cartridge filters in the recirculation loop. The function of the filters is to improve water clarity and to remove radioactive particulates. Operating the disposable cartridge filters adds value only if they sufficiently improve otherwise unacceptable water quality leaving the IXMs or if they sufficiently extend the life of IXMs to offset their operating and disposal costs.

The specific test plan for this series of tests will be developed using WHC-SD-SNF-TP-020, "Cartridge Filter Performance Test" as a basis. The objectives of this test are to provide information on the separate filtering performance of the IXMs and the disposable cartridge filters, and on the benefit of operating the disposable cartridge filters as a pre-filter to the IXMs.

The specific test objectives are to:

1. assess the ability of the disposable cartridge filters to provide acceptable water clarity and TRU removal efficiency while treating both turbid and clear water expected during fuel removal activities and during KE Basin equipment installation,
2. assess the ability of the IXMs to provide acceptable water clarity and TRU removal efficiency without pre-filtering, while treating both turbid and clear water expected during fuel removal activities at KW Basin,
3. assess the economic attractiveness of pre-filtering the IXM feed to extend IXM run life,
4. obtain information for detail design, such as appropriate filter pore size and water flux,
5. provide insight on the basin conditions under which it is most effective to operate the different components of the water treatment system.
6. estimate the particulate capacity (lbs.) and TRU capacity (Ci) of the cartridge filters when operated with both typical basin water and turbid water at the above flux;
7. estimate the total cost (procurement, operation, and disposal) to remove 1 Ci of TRU from both turbid and relatively clear basin water;

8. identify any inlet conditions (highly turbid, mildly turbid, etc.) under which it would be economically justified to pre-filter IXM inlet streams in order to extend IXM life.

This test will also provide information on filtering performance under two water fluxes, when its data is combined with that from the backwashable filter test described in Section 4.2. Four sets of fresh filter cartridges (56 filter elements) may be run to end-of-life, since the low water fluxes in this test will use the two filters operated in parallel. The tests are expected to be run during July or August 1996.

The test will use existing KE Basin equipment. K Basin operating personnel will operate the equipment and take measurements and samples during the test. Many of the measurements and samples are routinely taken during current operations.

The operating parameters for the tests, and the samples and measurements to be taken are described below. The initial operating conditions for the test assume that the cartridge filters are not being operated and that the feed water clarity is high. Subsequent test conditions place the cartridge filters in operation and route turbid water to the filters and an IXM (the specific method of feeding turbid water will be identified in the Test Plan and will be developed with input and concurrence from K Basins Operations). However, if at the scheduled start of the test period, the cartridge filters are already in operation upstream of the IXMs, the order of described testing will be revised to minimize the impact to the K Basin operations.

Test A: Base Case (unfiltered feed to IXM). An IXM will be operated with approximately 100 gpm of basin water from the recirculation loop passing through the IXM mixed bed resin. The test is expected to provide information on the capability of the IXM to meet the filtering needs of the IWTS without adversely affecting its ion exchange capability or capacity. It is expected to provide information on improvements in water clarity and TRU removal. It will also provide base information on system performance against which other test results will be compared.

The pressure differential through the IXM and the cumulative water throughput will be recorded at the start, end, and intermittently during the test. Similarly, inlet and outlet water samples will be taken periodically and analyzed for turbidity, conductivity and TRU isotope concentration. Periodically video recordings will be made of the inlet and outlet areas to provide qualitative clarity data and to assist in correlating the turbidity measurements. The solids content and the distribution of particle sizes in the initial and final inlet and outlet water samples will be determined in a small number of the samples.

A series of range targets will be suspended from the operating deck in front of the video camera to assist in evaluating the water clarity in the filter discharge stream. As a minimum, each range target should be labelled with its approximate depth from the water surface, marked in 2 inch black

letters on a white background. Each range target should be illuminated by a lamp, placed approximately 2 feet in front and back of the range target. In addition to the video records, personal observations will be recorded periodically.

Since this test scenario is similar to recent operations, one day of successful operation should provide sufficient data.

Test B: Filtered Feed to the IXM. This test is expected to provide information on the value of operating the disposable cartridge filters upstream of the IXMs by determining changes in water clarity and TRU isotope removal compared to Test A. Information will also be obtained on filter run life and possible on-line indication of the proximity of the end-of-life condition during the filter run.

In this test, the disposable cartridge filters will be placed in service upstream of the IXMs. Other operating conditions of Test A will remain the same. The existing, partially spent, filter media with its 1.0 micron nominal rating, will be used. The flow through the cartridge filters will be reduced to approximately 50% of normal flow rates to improve filter performance, in recognition of the pressure drop increase that occurred during the initial operation of the cartridge filters. The lower flow rate will be achieved by operating the two filters in parallel rather than operating a single filter as was normally done.

The same samples and measurements will be taken as during Test A (at the inlet and outlet to the IXMs) and additional, similar samples and measurements will be taken at the inlet to the cartridge filters (the conditions at the outlet of the cartridge filters are those identified for the inlet to the IXMs).

This test will end when either the filter pressure drop reaches 30 psi or the pressure drop remains relatively stable for 5 days, suggesting a long operating period between filter plugging. If the filter pressure drop in the partially spent filters rises rapidly, fresh filter cartridges should be installed and the test continued. Spent filter cartridges should be disposed of in the normal manner.

Test C: Feed Source. This test is expected to provide information on the capability to filter water typical of the fuel and sludge removal operations, and in conjunction with Test A, the capability to treat the wide range of water turbidity that may be experienced. The test is identical to Test B, except for using a turbid water feed source that is similar to the conditions expected during fuel and sludge removal and debris cleanup. Additional conditions ending the test are included to reduce impacts to operations.

As described in Section 1.0, the main basin water will be used as the feed source for the test if the IWTS DA and K Basins operations determine that the water has sufficient turbidity due to activities occurring at the K East

Basin, e.g. fuel canister cleaning, fuel or sludge movement or sampling, or equipment installation. If the main basin water has insufficient turbidity, then a turbid water source for the test will have to be provided. The details of providing this source will be included in the Test Plans and Test Procedures for these filtration tests.

As in Test B, this test will end if the filter pressure drop reaches 30 psi or the pressure drop remains relatively stable for 5 days, suggesting a long operating period between filter plugging. If the test begins using filter cartridges partially spent during a previous test and the filter pressure drop in the partially spent filters rises rapidly, fresh filter cartridges should be installed and the test continued. In order to limit the impact on KE Basin, this test will be stopped and reevaluated if the water leaving the filters or IXMs remains unacceptably turbid for one hour (unacceptability will be determined by the Shift Manager, in consultation the Test Engineer if available).

Test D: Unfiltered Turbid Feed to the IXMs. This test is expected to provide information on the capability of the IXM to filter water typical of the fuel and sludge removal operations, without adversely impacting their ability to remove soluble chemical species. It is also expected to provide information on the capability of the IXMs to treat the wide range of water turbidity that may be experienced, in conjunction with the information provided in Test A. This test is identical Test C, except the cartridge filters are valved out of service.

This test scenario only needs to last for a few hours. Without pre-filtering, IXM would be expected to require change out because of TRU loadings, rather than Cs-137 loading, high conductivity, or high differential pressure. TRU removal efficiency is not expected to change during the filtering period, allowing IXM run-life to be extrapolated from the short test period. The short test period will also minimize the impact on K Basins operations. The sample and measurements to be taken are the same as described for Test A.

4.2 Backwashable Filter Test

This test is described in detail in the drafted "Test Plan for High Flux Backwashable Filter at 105 KE Fuel Storage Basin" and is summarized below. This test evaluates the effectiveness and practicality of using an automated, high-flux backwashable filter to provide adequate water clarity and particulate radionuclide removal. The particulate accumulated on the filter would be periodically flushed to one of the basin pits, such as the north load out pit or the weasel pit, and would be removed from the basin as part of the SNF Project sludge removal activities. Filtering capability provided by a backwashable filter would reduce the waste volume generated, the space used, and the operational complexity compared to disposable cartridge filters.

The backwashable filter used in this test is likely to be the specific filter that would be included in the IWTS. It would be installed within the KE Basin because of its relatively small size and high water flux. It is one of the few proven high flux designs, reducing procurement time and performance risk.

The primary objectives of this test are to:

- assess the ability of an automated, high-flux backwashable filter to provide acceptable water clarity and TRU removal efficiency, while treating turbid water feed expected during fuel removal activities,
- Evaluate the operation of the automated backwashable filter system at two different flux rates, and with at least two different filter element ratings, one of which has a similar rating (i.e., 1 micron nominal to the filters used in the disposable cartridge filter tests;
- demonstrate the ability of the automated backwashable filter to reduce waste volumes, floor space used, and operational complexity.
- Combine the results of the backwashable filter testing with those of the other tests to establish the appropriate filter pore size and water flux for pre-IXM filtration via backwashable cartridge filters at KE Basin.

The first two objectives include determining whether the backwashable filter removes actual basin particulate, provides the 16 feet of visibility required for fuel removal activities, reduces the TRU loading on the IXMs, and extends IXM run life. The third objective includes determining whether the backwashable filter operates with minimal operations involvement, acceptable regeneration frequency, and acceptable filter run life.

The test would use a leased, commercially available backwashable filter that would be operated by the filter vendor. The feed sources would be water from areas adjacent to the canister cleaning activities. Water flow rate would be predominately 500 gpm, approximating the full filtering requirement of the IWTS, although testing would also be done with a 200 gpm flow. Both a 1 and a 4 micron nominally rated filter would be evaluated, since the leased filter unit includes parallel filter beds. The filter automatically cycles between the filters as required based on the filter differential pressure.

The duration of the test will be approximately 120 hours of operation during weekday day and swing shifts over a two week period assuming a 2 hour preparation period each morning and a 2 hour shutdown period each evening. If shorter preparation and shutdown periods occur, more operating time will be achieved; however total operating time will be less than 160 hours. The inlet flow rate, filter differential pressure, turbidity of the inlet and outlet streams and backwash frequency will be monitored during the test. A small number of samples will be analyzed for total alpha radiation to evaluate the TRU removal by the filter. The solids content and the distribution of particle sizes in the initial and final inlet and outlet water samples will be

determined in a small number of the samples. Samples of the backwash will be taken as necessary to adequately characterize the sludge. If the sludge is sent to the north loadout pit, the sampling method will be developed with concurrence of K Basins Operations and K Basins Standards and Requirements. Periodically, video recordings will be made of the inlet and outlet areas to provide qualitative clarity data and to assist in correlating the turbidity measurements. In addition, the turbidity of the inlet and outlet streams to the IXMs will be monitored during the test period, while the backwashable filter is operating and while it is not. The data routinely collected on IXM TRU and water conductivity removal will also be analyzed.

A series of range targets will be suspended from the operating deck in front of the video camera to assist in evaluation of the water clarity in the filter discharge stream. Each range target shall be labelled with its approximate depth from the water surface. Each range target shall be illuminated by a lamp, placed approximately 2 feet in front and back of the range target. In addition to the video records, personal observations will be recorded on an hourly basis.

If the filter fails to clarify the water or plugs too quickly, the test will stop and the test parameters would be re-evaluated. The test could resume using different nominally rated filters, water flow rates or higher allowable filter pressure differentials. Changes will be made upon agreement between WHC and the vendor.

No significant waste streams are expected during the test. The backflushed particulate would be accumulated in the north loadout pit and eventually removed from the basin during the general sludge removal activities. Waste from normal radiation area entry is expected to be disposed of by K Basins Operations with its normal waste disposal activities. The filters are expected to be returned to the vendor, after flushing with clean water at the end of the test. However if this cannot be done adequately, K Basin operations will have to dispose of the filters in ECOROK containers.

4.3 Anion IXM to raise pH

This test is described in detail in "Dual IXM Operation With Anion and Mixed-bed Resin", WHC-SD-TP-021 Draft, and is summarized below. This test evaluates the feasibility of using anion exchange resin to maintain the KE Basin at a basic pH and to evaluate the impact on TRU isotopes solubility and filterability. The test consists of operating both IXMs at normal flow rates in parallel flow pattern. One IXM will be filled with anion exchange resin, the other IXM will be filled with mixed anion-cation resin. The data routinely collected on IXM operation will be analyzed to:

- assess the ability of an anion-only IXM to maintain the KE Basin pool's pH above 7 when operated in parallel with a mixed bed IXM,

- estimate the total water throughput capacity of an anion-only IXM when operated in parallel with mixed bed IX,
- determine the change in the TRU removal efficiency of the sandfilter, cartridge filters and IXMs, and
- determine the TRU accumulation in the IXMs, the concentration of TRU isotopes in basin water and the conductivity of the IXM effluents and basin water.

DISTRIBUTION SHEET

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