SRTC Monthly Report (December 1994)

by

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WESTINGHOUSE SAVANNAH RIVER COMPANY
INTER-OFFICE MEMORANDUM

SRT-PIS-950028

April 12, 1995

TO: SRTC Monthly Report Distribution

FROM: J. M. Ferrell, 773-A **REDUCTION IN SRTC MONTHLY REPORT DISTRIBUTION**

As a cost savings measure SRTC would like to reduce the distribution of the SRTC Monthly Report to WSRC records, OSTI (Office of Scientific & Technical Information), and customers with a specific need. The SRTC Monthly Report is formally issued following technical editing and classification reviews by WSRC and DOE-SR Classification Officers. This degree of preparation and review delays the timely communication of SRTC activities and therefore the formal SRTC Monthly Report acts mainly as a historical document and meets our commitment to provide technical information to OSTI.

To provide more timely distribution of information to our customers, SRTC issues less formal monthly reports highlighting activities within the Environmental, Waste Management, Separations, and Tritium program areas. If interested in one or more of these program areas please contact the person(s) listed below and you will be added to the distribution. If you have a specific business need and wish to remain on the distribution for the SRTC Monthly Report contact Cynthia Kinard, 773-A, (803) 725-3828 by April 30, 1995 or your name will be deleted. Thank you for your assistance.

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Executive Summary

Tritium

- Additional progress was made on developing a high quality upset welded cap closure to seal the Terrazzo reservoir after laser reclamation. The cap and welding fixtures were redesigned to improve weld quality. Additional testing has defined the weld parameters and demonstrated weld consistency. The advantage of welding in vacuum versus air was determined and a full-scale Terrazzo reservoir was shown to fit in the existing reclamation station. (page 3)
- Equipment performance requirements to support the project for loading line modification for Terrazzo reclamation and Acorn loadings were submitted to the Nuclear Materials Processing Division's Design Authority Group for inclusion in the Functional Performance Requirements (FPR) document. (page 3)
- Support of the SRS Proposed Site Treatment Plan has been supplied through reviewing technologies proposed to treat mixed waste from the Tritium Facilities. (page 4)
- The Analytical Development Section provided technical assistance and chemical analyses for developing the Tritium Facilities Waste Characterization Plan. (page 4)

Separations

- An explosion in a separation facility in Tomsk, Russia led to studies at several DOE sites into the chemistry and conditions causing this type of accident. Calorimetry studies and computer modeling were performed to understand the potential for a similar accident in SRS facilities. A report documenting these studies was issued to support modifications to the Basis for Interim Operation for F-Canyon operation. The report concludes that an accident of this type will not occur under SRS operating conditions. (page 5)
- Cans containing plutonium-238 in F Area must be shipped to HB-Line in 1995. The cans have been in storage for a number of years and internal pressures have surpassed the can's design pressure. One packaging option is to use the 9965 Primary Containment Vessel (PCV) within the EG&G Mound Laboratory 1 kW packaging. Thermal analysis indicates that this is a potential solution as long as an aluminum sleeve is added to fill the air gap between the two containers to reduce the PVC seal temperature. (page 5)

Waste Management

- As part of general HLWIFM validation activities, plant data on evaporator operations were obtained and the model was set up to duplicate the plant data over a 120-day period. Additionally, automated control of the evaporator systems via model algorithms produced qualitatively similar system performance. (page 7)
- A new SPEEDUP™ application is being built. It is a fast-running linear programming model of the high-level waste complex, tailored for production planning purposes. Several innovative techniques were developed to implement this type of model in an equation-based, flowsheeting model environment. A prototype of the model is already running. (page 7)
- The work for the West Hill Temperature Study is complete. The E-7 Level 1 report was written, reviewed, and issued. This work supported a High-Level Waste Engineering (HLWE) milestone and was completed a week early. Based on the results of the analysis, the projected cost saving to High-Level Waste Engineering is approximately \$4 million. (page 8)
- A statistical review of the analytical results of the dip samples taken during the recent process verification tests in Tank 51H is complete. Measurement uncertainties from this study were estimated and should be applicable to the analyses of in-tank precipitation supernate samples. (page 9)

General

- SRTC has prepared 17 Baseline Change Control Packages in FY 95; eight packages were approved by DOE. (page 11)
- An evaluation on a proposed measuring system was made to detect water losses from the disassembly basins, other than from evaporation. It was concluded that the proposed system cannot measure the relatively large evaporation losses accurately enough to detect other expected losses. A system to globally measure water lost to evaporation was suggested. (page 11)

Progress and Accomplishments

Tritium

Upset Welded Cap Closure

W. R. Kanne and J. A. Morin

A high quality upset welded cap closure is being developed to seal the Terrazzo reservoir after laser reclamation. Reclamation of the Terrazzo reservoir will involve laser unloading by hole drilling, laser resealing of the hole after repressurization, and sealing the reclamation area with a cap that is upset welded to the body. This cap will provide the primary containment since the long-term reliability of the laser seal weld is unknown.

Since the previous successful demonstration of the feasibility of the cap weld, additional tests have increased confidence and upgraded the process. The thin wall cap that previously produced unsatisfactory results, compared with a thick wall cap, was redesigned to improve its weldability. The thin wall cap can accommodate the pinch weld on the stem without slotting the cap, a distinct advantage for assembly in a reclamation facility.

Significant improvements in fixturing for the cap weld were made to eliminate limitations of the original fixturing. Fixturing to align the cap on the base was designed, fabricated, and tested. Further improvements were made by using the body of the "old" SP-800 reclamation fixture with the cap weld electrode inserted into it. This fixture combination is more complex, but it can

be disassembled to allow removal of the reservoir if weld upset extends beyond the threads.

Two sets of samples made with the improved fixturing and cap design were used to determine weld parameters. Consistent weld quality was then demonstrated with these parameters. In addition, a weld made in air was compared with those made in a vacuum of less than 100 microns. The air weld and a companion vacuum weld were pressure-tested to failure of the cap weld by attaching a small bore stem to the sample. The strength of the air weld was approximately 75% of the vacuum weld, demonstrating the additional weld quality that a vacuum provides.

In preparing for a full-scale reclamation test, a Terrazzo reservoir was configured as it will be for the test and it was tried in the reclamation station. With all attachments removed, the reservoir fits in the existing station.

Terrazzo Reclamation and Acorn Project Status

T. J. Warren, D. L. Fish, W. N. Posey, and W. S. Rogier

Equipment performance requirements to support the project for loading line modification for Terrazzo reclamation loadings and Acorn loadings were submitted to the Nuclear Materials Processing Division's Design Authority Group for inclusion in the Functional

Performance Requirements (FPR), which they are writing for this project. This FPR will be issued on December 28, 1994.

The equipment specified for Terrazzo reclamation includes the following:

- the Terrazzo reclamation loading manifold with connections to service lines, as shown by a proposed layout for the equipment
- a reclamation drilling and welder laser
- a sealing cap resistance upset welder
- pressure and temperature sensors
- distributed control system remote operation and loading date recording capability

Specifications for the Laser Driller/Welder and the Resistance Upset Welder will be provided by the Materials Technology Sections of SRTC.

Equipment specified for the Acorn Loadings includes the following:

- a manifold with controlled flow loadings for six or seven stations
- calibrated volumes, metering valves, pressure sensors and temperature sensors
- a two-stage hydride compressor bed to provide high purity gases
- mass spectrometry gas analysis capability
- vacuum capability
- distributed central system remote operation and loading data recording capability

Tritium Mixed Waste Draft Site Treatment Plan

J. E. Klein

SRS is developing a Site Treatment Plan (STP) for all mixed (hazardous plus radioactive) wastes, which is required by the Federal Facility Compliance Act. The STP will include treatment paths for tritium contaminated mixed wastes. The unique methods needed for handling and containing tritium makes applying "generic" waste treatment processes to tritium waste difficult or undesirable due to tritium containment or radiological safety concerns. Continuous input and feedback concerning proposed tritium waste processes are given to the STP committee and DOE-SR.

One mixed waste stream, high tritium activity vacuum pump oils with mercury contamination from the Tritium Facilities, was identified as a waste stream with no treatment technology available. A review of emerging technologies to treat this waste stream is in progress. Efforts to partner SRS with commercial vendors to demonstrate some of these technologies continue. Another mixed waste stream, tritium contaminated mercury, has treatment technologies available, distillation or amalgamation, but the choice between these technologies for all or some of the DOE-contaminated mercury is undecided. Contact has been made with individuals at Pinellas, Oak Ridge, Idaho Falls, Los Alamos, and the industry to determine the limits and reliability of these treatment technologies to meet DOE and regulatory requirements. Information obtained has been directed to members of the Proposed STP group to be incorporated into the STP.

Tritium Facilities Waste Characterization Plan

R. A. Malstrom and P. Filpus-Luyckx

A waste characterization plan must be approved before waste is sent to the E-Area vaults. This characterization plan covers all waste streams generated in a building; for the Tritium Facilities, each building is considered separately. The Analytical Development Section has worked with the Generator Certification official for the Tritium Facilities, C. Johnson, on developing this plan. One issue raised by the Waste Characterization Board was mercury contamination of waste from work in hoods. There is a potential for waste removed from certain hoods to exceed the Resource Conservation and Recovery Act limits for mercury (0.2 milligrams/liter).

A meeting was held to discuss this issue and to develop a path forward. Process knowledge and housekeeping will be used to determine which hoods, if any, pose mercury contamination problems. It was decided that a non-radioactive set of experiments would be performed to verify that the method of removing mercury contamination in the hoods will make job control waste below RCRA limits for mercury.

Separations

Tributyl Phosphate and Nitric Acid Reactions

J. R. Smith and T. S. Rudisill

An explosion in a separation facility in Tomsk, Russia led to studies at several DOE sites into the chemistry and conditions causing this type of accident. Calorimetry studies were conducted to support computer modeling of the heat produced in SRS process tanks and evaporators containing organic layers of tributyl phosphate (TBP) saturated with nitric acid.

A report documenting this study was issued to support modifications to the Basis for Interim Operation for F-Canyon operation. The conclusions indicate that this type of reaction would not run away under our normal operating conditions and would take 12 ± 6 feet of organic TBP on top of an aqueous acid layer. Minor comments have been received and an editorial revision may be made.

Scoping Thermal Analysis of Packaging for Onsite Shipment of Plutonium-238

S. J. Hensel

Cans containing plutonium-238 in F Area must be shipped to HB-Line in 1995. The cans have been in storage for many years and internal pressures have surpassed the can's design pressure. One packaging option is to use the 9965 Primary Containment Vessel (PCV) within the EG&G Mound Laboratory 1 kW packaging. The 9965 PCV is designed to 1000 psig at 500°F. The Mound 1 kW package can accommodate various internal vessels, however using the 9965 PCV results in unacceptably large gaps between the two vessels. Scoping analyses indicate that the gap is sufficient enough for the PCV seal temperature to approach its upper limit (400°F). Analyses of potential design modifications suggest adding an aluminum sleeve between the two vessels to greatly reduce the seal temperature. Also, the vessel temperature and internal pressure resulting from rupture of two cans simultaneously is well within the vessel design limits. Thermal analyses are documented in SRT-EMS-940082.

Waste Management

Defense Waste Processing

A. Henderson

The Equipment Engineering Section is assisting the Defense Waste Processing Facility (DWPF) in repairing, re-engineering, and documenting the DWPF melter borescope assembly. The repaired borescope assembly has been reassembled, tested, and returned to DWPF for melter installation. This optics and video system is used to provide full-time views of the melt surface during operation of the melter. The documentation of the borescope in its original form is complete. The mechanical and optical design has been quantified and a complete set of fabrication blueprints has been created. They will be issued for use in offsite fabrication of additional borescope units after a final review by DWPF technical.

Partial Validation of the High-Level Waste Integrated Flowsheet Model (HLWIFM)

K. L. Shanahan

Daily operational data on all three Tank Farm evaporators were obtained from the High-Level Waste (HLW) division, including feed and receipt tank levels and evaporator up-time, as well as HLW Engineering Monthly Data Reports for the same period. The reports document all manual volume transfers in the Tank Farm and averaged evaporator performance data. Some tank conditions, such as salt, supernate, sludge volumes, and specific gravity were also included in the reports.

The operational data and tank information were converted into HLWIFM initial conditions and data files. After some model improvements, the HLWIFM model reproduced the plant data within a few percent. The most serious error involved a point digression at approximately Day 85 of the 120-day run that led to a 5% error at the 120-day point. The nature of the digression suggests either an unknown operation change (i.e., more data needed) or a model error.

The reproduction of plant data serves as a partial validation of the evaporator section of the HLWIFM. The model has some error in it, and work is underway to attempt to remove or understand that error.

The 120-day run's agreement was achieved by manually specifying all transfers that occurred in the time window. For a multi-year run, this would require the user to specify all particular recycle transfers within each evaporator system. The HLWIFM includes an option to run the evaporator system automatically, with recycle transfers being initiated by encoded logic, rather than manual specification. This is the preferred mode of use for multi-year simulations.

After obtaining the manual 120-day run, the manual recycle transfers were removed from the data files and the automatic control logic was enabled. The results obtained qualitatively reproduced average behavior. This leads to confidence that a multi-year simulation can be run using the automated recycle logic with the results then being usable for production planning objectives.

High-Level Waste Production Plan Model

M. V. Gregory and P. K. Paul

The High-Level Waste (HLW) division requested a fast-running (accomplishing 30-year simulations in several minutes) and less detailed (compared to the existing Integrated Flowsheet Model) model of the entire SRS high-level waste complex for use in supporting production planning efforts. SRTC has designed and prototyped such a model (called ProdMod) using the SPEEDUP™ modeling environment, which has turned out to be the computational equivalent of a Swiss Army knife—it has a multitude of uses, some unanticipated.

Previously, the HLW modeling team successfully used SPEEDUP™ to develop a dynamic, detailed model of the HLW complex with 8700 coupled differential-algebraic equations that require a couple of CPU hours per simulation year. For the ProdMod effort, the facility of SPEEDUP™ was investigated to solve

systems of purely algebraic equations; for our type of sparse equation set, its block decomposition algorithm proves to be quite efficient, taking about 1 CPU second per 1000 equations on an RS/6000 Model 560. Thus, our customer's performance criterion can be easily met since no more than 30,000 equations in the full implementation of ProdMod are anticipated.

The time-dependent process equations for ProdMod have been cast in the form of a set of algebraic equations (the value of each variable at time $n+1$ can be cast as some algebraic transform of the values at n). In addition, equations for batch processes (i.e., those described by a series of discrete process steps) were written in a non-temporal form, upon whose solution a time grid can be superimposed. Since SPEEDUP™ is an equation-based tool, one needs only concentrate on deriving the form of the equations because it automatically generates the FORTRAN coding to solve the equations and then computes the solution.

The equation-based features of SPEEDUP™ have been taken a step further by using the "repeat" facility to generate the equation set itself. Virtually all the processes can be represented by a general recursive form, thus all one needs to do is specify the recursive pattern and then instruct the SPEEDUP™ facility to generate the full set of the actual equations to be solved from that pattern. You end up with an automatic equation generator (which is more than just a convenience when considering a set of tens of thousands of equations) and an automatic equation solver for linear programming implementation.

The flowsheeting aspect of SPEEDUP™ allows one to concurrently and independently develop and test the different models that comprise ProdMod, and then later interface them together simply by describing how the overall process is coupled (i.e., the flowsheet). More importantly, the flowsheet is in fact how one "synchronizes" the various algebraic models. In the more typical dynamic implementation, the flowsheet streams are used to continuously pass material from one unit operation to another (the stream is a vector of compositions). In an interesting twist for ProdMod, the streams are used to pass data for discrete times from one algebraic model to

another (the stream is a vector of time data for a single composition). Since the stream structure is a pre-determined convention, using the stream data properly in each model automatically synchronizes all the models in time.

Finally, the purely algebraic equation set looks to SPEEDUP™ just like a steady-state even though it represents fully time-dependent processes. That means the optimizer can be invoked and have SPEEDUP™ solve system of equations subject to a constraint set, and minimize or maximize some objective function. This feature has been successfully demonstrated in the ProdMod prototype by using the optimizer to select which of several feed tanks minimize a criterion in the downstream process with that selection changing correctly during the time interval being simulated. This is an implementation of a simple form of dynamic process optimization.

West Hill Temperature Study

G. J. Hutchens

To support start-up of the Replacement High-Level Waste Evaporator (RHLWE) and operational planning of the west hill of the H-Area Tank Farm, a series of calculations were performed to determine if tank temperatures (especially Tank 30) could be maintained below administrative limits with existing equipment. Specifically, the study was undertaken to determine if the temperature in the concentrate receipt tank (initially Tank 30) could be maintained below the administrative limit of 85°C. The system was studied by assuming a conservative heat load and studying whether the existing cooling tower, heat exchangers, and pumps could dissipate the heat. Then, an analysis of Tank 30 was performed to analyze the temperature response of the tank to proposed operational scenarios.

The differential equations that made up the Tank 30 model were solved using SPEEDUP™. With SPEEDUP™, it was possible to simulate the transient behavior of Tank 30 resulting from a variety of process scenarios over extended periods of time (the simulations examined approximately seven months of Tank 30 operation).

The report defined the administrative constraints under which RHLWE could operate under heavy feed conditions and quantified the significance of upgrading west pump house equipment versus increasing the number of cooling bundles in Tank 30. It was found that changing the waste tank cooling water inlet temperature by some quantity (ΔT) by upgrading west pump house equipment resulted in a corresponding change in Tank 30 temperature of approximately $\Delta T/2$.

Statistical Analysis of Extended Sludge Processing Process Verification Test Samples

T. B. Edwards

During the Process Verification Tests in Tank 51H, 31 dip samples were taken. Analyses were performed for the primary species of interest for

controlling the Extended Sludge Processing process. In a joint effort with M. S. Hay of Interim Waste Technology, a statistical review was conducted on the data resulting from these analyses.

The objective of this review was to estimate the analytical uncertainties (the repeatability) for the procedures used in the analyses. These estimates should be applicable in assessing the uncertainties of these procedures when used for analyses of in-tank precipitation supernate samples. The analytical uncertainties range from 2% to 24% (with 95% confidence), depending on the type of analysis.

The results of this analysis were issued in report WSRC-RP-94-1224.

General

Change Control Status

L. R. Chandler

The current status of the Baseline Change Proposal (BCP) packages developed by SRTC for FY 95 includes the following:

- seventeen were prepared
- one is routing in SRTC for approval
- eight are awaiting DOE approval
- eight were approved by DOE
- four have been entered into FY 95 Annual Operating Plan electronic database

Disassembly Basin Upgrades

M. R. Duignan

Reactor Engineering requested that the Effluent Treatment Facility group evaluate a portion of a proposed upgrade to the disassembly basins, specifically, the specific part of that upgrade to be evaluated is to the liquid-level measuring system. The three main enhancements to the level detection system are to measure liquid level more accurately [by factor of 8 (i.e., 1/4 inch to 1/32 inch), relative humidity, and the

rate of evaporation with the aid of an isolated container that can only lose water by evaporation, after its equalizing valve is closed]. These proposed changes will enable the detection of a water loss from the basins, which may be on the order of 20,000 gallons/year. (This may be converted to approximately 1.5 inches/year for the K-Reactor basin.) Currently, the disassembly basins can measure the average level and temperature of the basin water. Because of evaporation, controlled and uncontrolled mass transfers into the basins and controlled and uncontrolled mass transfers out of the basins, the existing instrumentation is unable to detect a 20,000-gallon per year water loss, if and when it occurs. Conclusions assert the following:

1. The magnitude of the uncertainties in the proposed measurement system is too large to detect a 20,000-gallons/year water loss (0.12 inch per month for K-Reactor basin).
2. A global measurement of the amount of water lost to evaporation will be more accurate than the proposed local measurements; that is, measuring the water content in the atmosphere around a basin's building and the water content leaving a basin through the exhaust fan.

Items of Interest

In 1994, members of the Applied Statistics Group presented five offerings of two statistical training courses, Statistical Process Control and Design of Experiments. Over 150 technical and operations personnel benefited from this training. These courses were developed under the sponsorship of the WSRC Statistical Process Management Council to promote the use of statistical thinking in process improvement efforts. These courses will be offered on an approximately bi-monthly schedule in 1995.

Presentations

On November 5–11, 1994, S. J. Hensel presented a paper entitled, "Development and Application of a Deflagration Pressure Analysis Coded for High-Level Waste Processing" in Chicago, IL at the ASME winter meeting.

On November 6–10, 1994, K. L. Shanahan gave a presentation at the ASPENWORLD '94 Conference in Boston, MA for the HLWIFM development team. The discussion was entitled, "SPEEDUP™ Simulation of Liquid Waste Batch Processing."