MONITORS FOR THE CESIUM, STRONTIUM, AND TRU SALT SEPARATION PROCESS

TECHNOLOGY DESCRIPTION

Two real-time monitors are being developed to monitor the effectiveness of the cesium, strontium, and transuranics (TRU) salt separation process. The baseline technology for assay of decontaminated salt solution is sampling followed by analysis at an off-site laboratory. Two systems will be adapted to implement an on-line monitor for cesium-137, strontium-90, and total alpha-emitting transuranic elements. Both monitors will be non-intrusive to the process flow stream; they will detect gamma and neutron emissions that pass through the process pipe from the waste stream.

Cesium-137 will be detected by the 662-keV gamma radiation from its daughter isotope barium-137m. In addition, strontium-90 will be detected by the bremsstrahlung X-ray radiation caused by beta emissions from its daughter yttrium-90m. A high-resolution germanium spectrometer (energy dispersive radiation detector) will be used to detect both isotopes. Significant calibration and spectral analysis software development will be required to implement this approach to strontium-90 assay.

Total alpha radiation will be determined indirectly. Neutron radiation passing through the process pipe from the salt solution will be measured. Neutron radiation from several radionuclides will occur from both spontaneous fission (predominantly from curium-244) and alpha-n reactions (predominantly from americium-241). The calculation to translate measured neutron radiation intensity to alpha emitter concentrations will use relative concentration determinations from the process history and, most importantly, periodic laboratory assays of samples. Commercially available neutron detectors will be used for the neutron counting itself. The amounts of TRU constituents present will be calculated from historical waste composition, laboratory TRU determinations, and neutron detector counts.

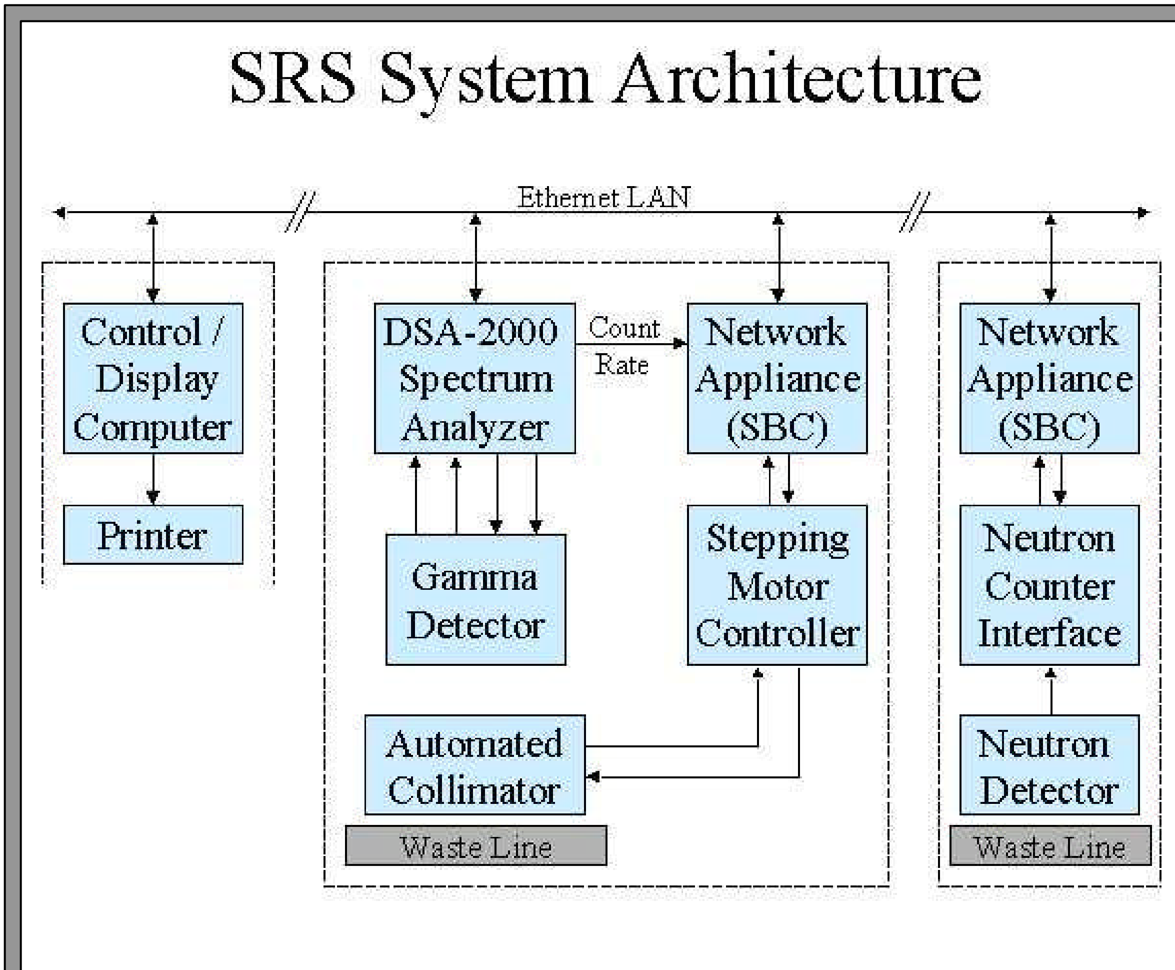
TECHNOLOGY NEED

At U.S. Department of Energy sites (Savannah River, Hanford, West Valley, Oak Ridge), high-level tank waste is neutralized with strong caustic soda (sodium hydroxide) and is stored in carbon steel tanks. The waste is processed to remove an insoluble sludge fraction (about 10 percent) of hydrated metal oxides containing most of the radionuclides (strontium, plutonium, uranium, and others). The remaining salt solution is primarily sodium nitrate, hydroxide, and nitrite, with cesium-137 as the predominant radionuclide; the solution also contains lower concentrations of transuranics, strontium-90, and other isotopes. This salt solution is stored as a concentrated solution or saltcake.

At the Savannah Rivers Site (SRS) the salt solution will be treated to remove cesium, strontium, and transuranic elements. Monosodium titanate will be used to precipitate strontium and the transuranic elements. Cesium will be removed by precipitation with tetraphenyl borate, an ion exchange process, or a solvent extraction process. The decontaminated salt solution will then be fed to a lower cost saltstone grouting facility for on-site disposal.

The maximum allowable radionuclide content of decontaminated salt solution is limited by the Saltstone Facility Waste Acceptance Criteria. At-line/on-line instrumentation must be developed for cesium-137, strontium-90, and total alpha radiation to ensure that the waste streams going to the Saltstone Facility comply with the Waste Acceptance Criteria. Concentrations of other nuclides are also of interest. By using process knowledge, many of these can be estimated if the cesium-137 and strontium-90 content is known. The ability to detect these other nuclides with little or no extra effort would be beneficial–even if not essential.

The Site Technology Coordination Group Need Number is: SR99-2034, Second Generation Salt Feed Preparation.



Conceptual design of the Cesium-137, Strontium-90, and Transuranics Monitoring System for the Salt Separation Process being developed for the Savannah Rivers Site (SRS). The Automated Collimator adjusts an aperture to control the amount of radiation reaching the gamma detector to maintain the count rate at the detector within an acceptable range.

TECHNOLOGY BENEFITS

- Uses existing laboratory and characterization technologies to monitor chemical process environment.
- Replaces time-consuming and labor-intensive sampling and analysis in laboratory environment.
- Reduces time delay and cost of obtaining analytical results in support of the process.
- Reduces radiological exposure risk because less labor is required and no process samples are taken.
- Reduces wastes because no process samples are taken.
- Improves worker safety by significantly reducing the amount of labor needed; labor is needed only for maintenance activities.

TECHNOLOGY CAPABILITIES/LIMITATIONS

- Gamma detector requires a supply of liquid nitrogen (not considered limiting).
- Cesium-137 detection depends on its equilibrium with barium-137m (not considered limiting).
- Strontium-90 detection depends on its equilibrium with yttrium-90m (considered somewhat limiting in

that the separation process timing must be controlled to ensure sufficient time to characterize the daughter in-growth).

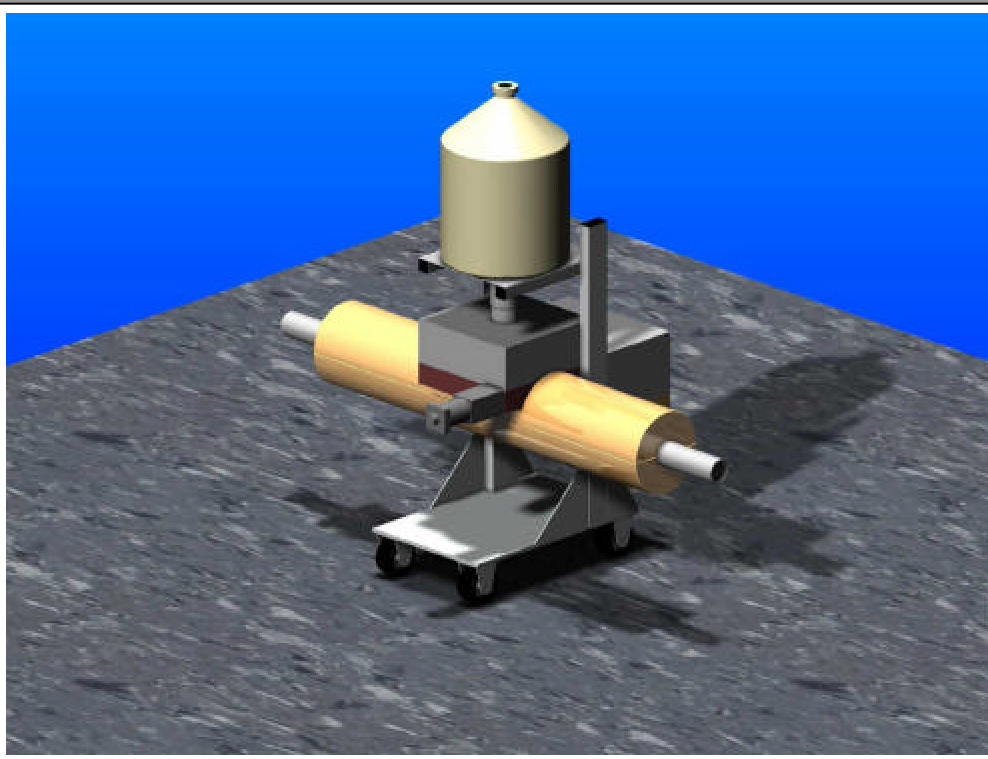
- Neutron detection is dependent on adequate signal-to-noise ratio (not considered limiting).

COLLABORATION/TECHNOLOGY TRANSFER

The SRS will provide the engineering design and installation via an industry contract and/or in-house resources. Pacific Northwest National Laboratory is providing the expert knowledge of detection technology.

ACCOMPLISHMENTS AND ONGOING WORK

The cesium-137 technology was originally developed for deployment at Oak Ridge National Laboratory. The design for the SRS application has progressed to the conceptual design level. Typical analysis for gamma emitters is being tested in the laboratory environment to demonstrate that strontium-90 can be determined in the radiological environment that exists at the Savannah River Site. Neutron background measurements are planned for the Savannah River Site.



A remotely operated, high-resolution germanium spectrometer, shielded from the process flow stream in the pipeline, will measure radiation through a small window. Data from this energy dispersive radiation detector will be fed into a spectrum analyzer to identify the daughter-product indicators of cesium-137 and strontium-90.

TECHNICAL TASK PLAN/ TECHNICAL MANAGEMENT SYSTEM INFORMATION

TTP Number/Title: RL30C211 - Salt-Cesium Separation Process Monitor
Tech ID/Title: 1515 - Salt-Cesium Separation Process Monitors

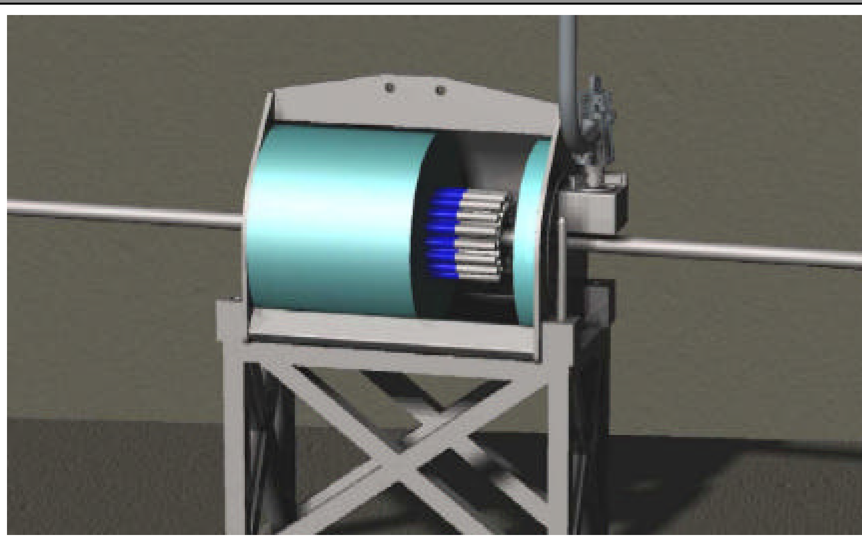
This TTP is a follow-on to a similar TTP for deployment at ORNL in FY 1999.
TTP Number: RL30C211 PNNL CMST - Salt-Cesium Separation Process Monitor

CONTACTS

Ron Brodzinski and Joe Brothers
Principal Investigator(s)
Pacific Northwest National Laboratory
P.O. Box 999
Richland, WA 99352
(509) 376-3529 fax: 372-0672
(509) 375-2396 fax: 372-4600
ron.brodzinski@pnl.gov
joe.bros@pnl.gov

Craig Richins
Technical Program Officer
Science and Technology Programs
U. S. Department of Energy
Richland Operations Office
3230 Q Street
P.O. Box 550, MSIN K8-50
Richland, WA 99352
(509) 372-4020 fax: -4549
craig_r_richins@rl.gov

Joe Carter
Technology User (for deployments)
Westinghouse Savannah River Company
Savannah River Site
Building 704-3N, Room 152,
Aiken, SC 29802
(803) 557-4467 fax: - -4461
joe.carter@srs.gov



Cutaway view of a neutron detector installed around the waste process pipeline. The tubes surrounding the pipeline contain boron trifluoride gas which is used to measure the total neutron flux.