#249413

RECORDS ADMINISTRATION
R0061018

DP-MS-87-112

DEMONSTRATION OF REMOTELY OPERATED TRU WASTE SIZE REDUCTION AND MATERIAL HANDLING EQUIPMENT

by

M. G. Looper and D. L. Charlesworth

E. I. du Pont de Nemours and Company
Savannah River Laboratory
Aiken, SC 29808

A paper for presentation at the
Waste Management '88 Conference
Tucson, AZ
February 28-March 3, 1988

and for publication in the Proceedings

This paper was prepared in connection with work done under Contract No. DE-AC09-76SR00001 with the U.S. Department of Energy. By acceptance of this paper, the publisher and/or recipient acknowledges the U.S. Government's right to retain a nonexclusive, royalty-free license in and to any copyright covering this paper, along with the right to reproduce and to authorize others to reproduce all or part of the copyrighted paper.

DEMONSTRATION OF REMOTELY OPERATED TRU WASTE SIZE REDUCTION AND MATERIAL HANDLING EQUIPMENT

Marshall G. Looper and David L. Charlesworth
E. I. du Pont de Nemours and Company
Savannah River Laboratory
Aiken, SC 29808

ABSTRACT

The Savannah River Laboratory (SRL) is developing remote size reduction and material handling equipment to prepare ^{238}Pu and ^{239}Pu contaminated waste for permanent disposal at the Waste Isolation Pilot Plant (WIPP) in New Mexico. The waste is generated at the Savannah River Plant (SRP) from normal operation and decommissioning activity and is retrievably stored onsite. A Transuranic Waste Facility for preparing, size-reducing, and packaging this waste for disposal is scheduled for completion in 1995. A cold test facility for demonstrating the size reduction and material handling equipment was built, and testing began in January 1987.

BACKGROUND

The Savannah River Plant (SRP) produces ^{238}Pu and ^{239}Pu for national defense purposes. Plutonium waste is generated from production, laboratory work, and decommissioning activities and is retrievably stored at SRP (Fig. 1). The Transuranic Waste Facility (TWF), proposed for construction in the early 1990's, will prepare SRP TRU waste for shipment to the DOE Waste Isolation Pilot Plant (WIPP) in New Mexico. The TWF will size-reduce and prepare for WIPP waste from 55-gallon drums, large concrete culverts containing drums, and large steel boxes containing decommissioned equipment like gloveboxes, cabinets, vessels, piping, etc.

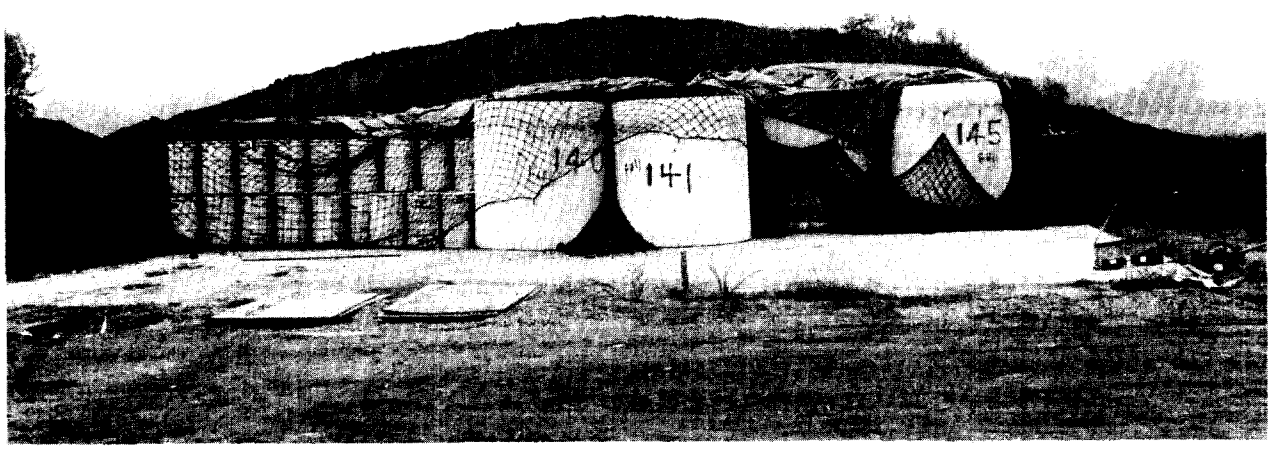

Fig. 1. Retrievably Stored TRU Waste at SRP

PROCESS

The Transuranic Waste Test Facility (TWTF) (Fig. 2) is being used to develop and demonstrate remote size reduction and material handling equipment (nonradioactive) that will be used in the TWF to process TRU waste. Waste items are initially size-reduced using a robotic manipulator, electric power tools, plasma-arc cutting torch, and electric worktable. After items are prepared into a manageable shape and size, they are loaded into a 160-hp shredder. Shredded material drops onto a conveyor and is carried to a drum hopper. When the hopper is full, a level sensing device shuts down the conveyor and shredder, and the contents drop into a drum through a bagless transfer machine. The entire facility is controlled remotely from a mobile console located in an adjacent control room with large viewing windows. Remote viewing is provided by several video cameras.

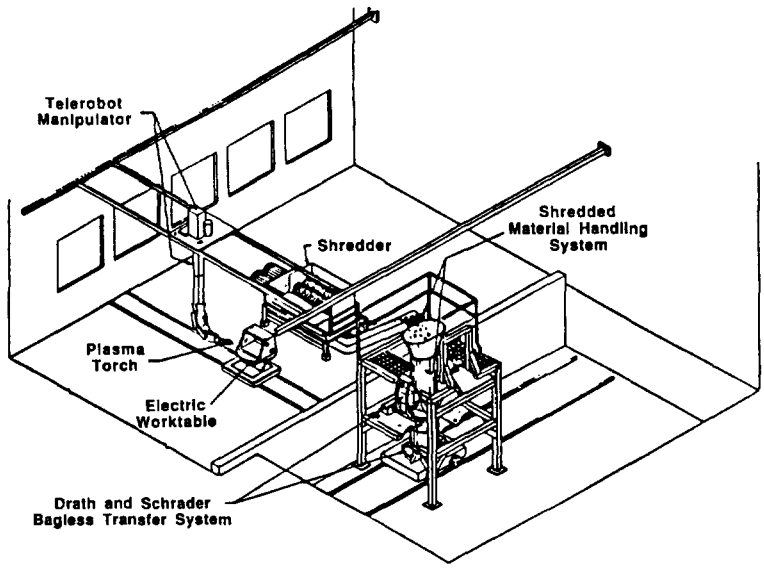

Fig. 2. Transuranic Waste Test Facility

Telerobot - The robotic manipulator, or Telerobot (Fig. 3), is a combination of a gantry-mounted industrial robot and a nuclear hot cell manipulator. Capacity is 300 lb at the manipulator hand and 2,000 lb at the hook beneath the shoulder joint. The support structure is 20 ft high, 20 ft wide, and 70 ft long. A supervisory processor controls all executive functions, and a trajectory processor controls all linear interpolated movements. The Telerobot operates in either manual, semiautomatic, or automatic mode. Two 3-axis joysticks are used to control the bridge and manipulator axes in manual and semiautomatic mode and also teaching programmed steps for automatic operation. The Telerobot uses a variety of specially adapted hand tools to prepare items for shredding. Items too large to fit into the shredder, or unshreddables such as metal greater than 1/2-in. thick, are partially size-reduced using a plasma-arc cutting torch and circular, reciprocating, hole, and chop saws. Arm removal is performed remotely using a three-step procedure (push up, rotate, let down) and a special frame attachment on the remote worktable.

Remote Worktable - The remote worktable can accurately clamp, lift up to 5 ft, tilt 30°, and move back and forth on rails objects weighing up to 3,800 lb. These motions are used during size reduction with the Telerobot to remotely position waste items for easier cutting. The worktable is electrically driven and designed for remote maintenance.

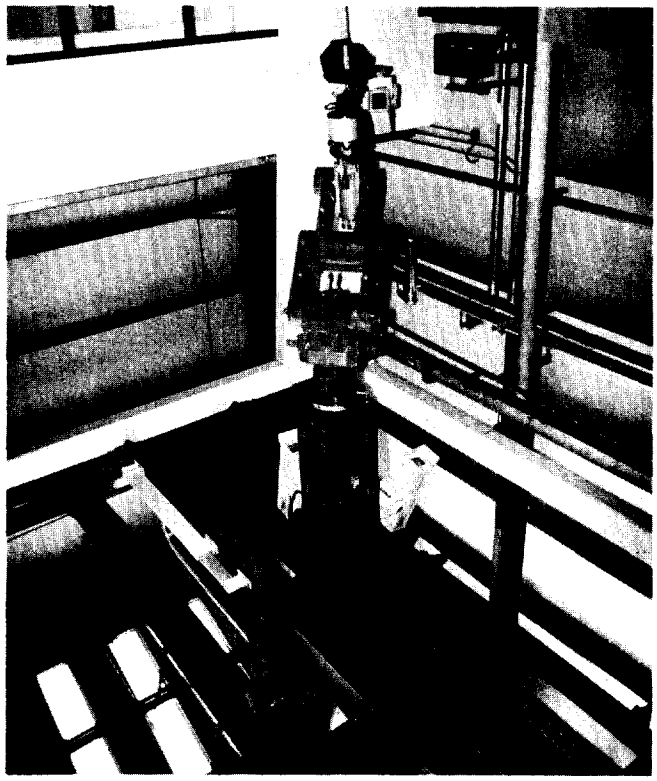

Fig. 3. Telerobot

Shredder - The shredder is a Shred-Pax Model AZ-160, low-speed, 160-hp, electrically driven unit (Fig. 4). The shredder hopper is completely enclosed during operation to avoid material kickback and lower noise levels. Hopper inner wall construction includes a steel-backed rubber (with the steel facing in) to absorb the high impact forces during shredding. The shredder is able to accept items up to 3.5 ft x 5.5 ft x 7.5 ft and weighing up to 1,000 lb.

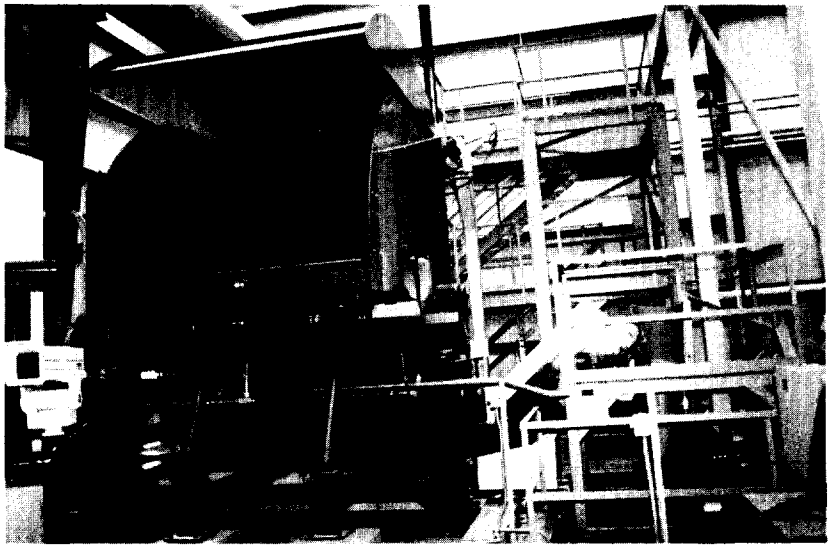

Fig. 4. Shredder and Material Handling System

Material Handling and Bagless Transfer System - The material handling system includes a conveyor, hopper, and bagless transfer system. The conveyor carries shredded material from beneath the shredder to a hopper that measures, by volume, one drum of material. A light sensor automatically shuts down the conveyor and shredder when the hopper is full. A clam shell at the hopper bottom opens and drops the material into a bagless transfer drum below. The bagless transfer system is a converted Drath and Schrader double-lid machine (Fig. 5). This machine is used to remotely transfer shredded material into drums instead of the "hands on" bagout technique. The system eliminates the potential release of contamination, especially when removing sharp-edged shredded metals. The double-lid system has proven reliable in over 10 years of operation in Europe.

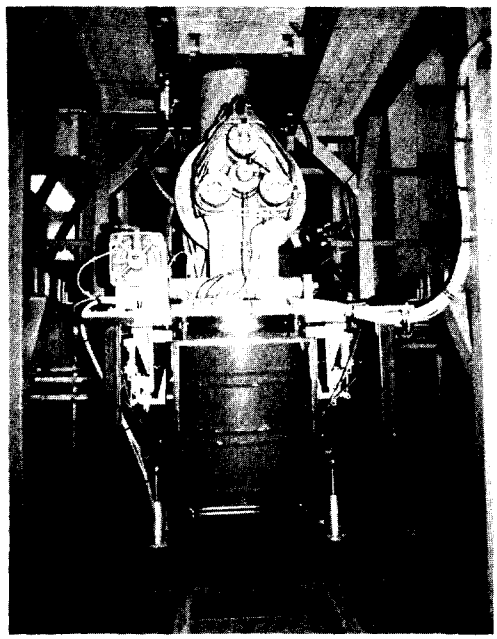

Fig. 5. Bagless Transfer Machine

SIZE REDUCTION TESTING

Telerobot and Tool Development - The Telerobot was used to partially size-reduce a glovebox, cabinets, wooden boxes, and scrap electrical equipment. The tools used include a plasma-arc cutting torch, circular saw, and reciprocating saw.

The plasma-arc torch is a Thermal Dynamics PAK 45 unit rated to 400 amps. Torch height is controlled using a motorized torch arm and standoff controller. The primary gas is a 65% hydrogen/45% argon mixture to minimize cutting smoke. Nitrogen is used as the secondary gas. Metal items up to 1/2-in.-thick stainless steel, including a 3/16-in. glovebox, were cut apart using the torch. The 4-ft x 4-ft x 2-ft glovebox was size-reduced into four pieces in less than 2 hours (Fig. 6).

The cutting saws are standard handtools modified to fit as end effectors on the manipulator. Accurate cuts can be manually performed easily and quickly using the joysticks. Multi-axis positioning of the manipulator can be learned with only a few days experience. Positioning three or four axes simultaneously during a cutting operation is typical.

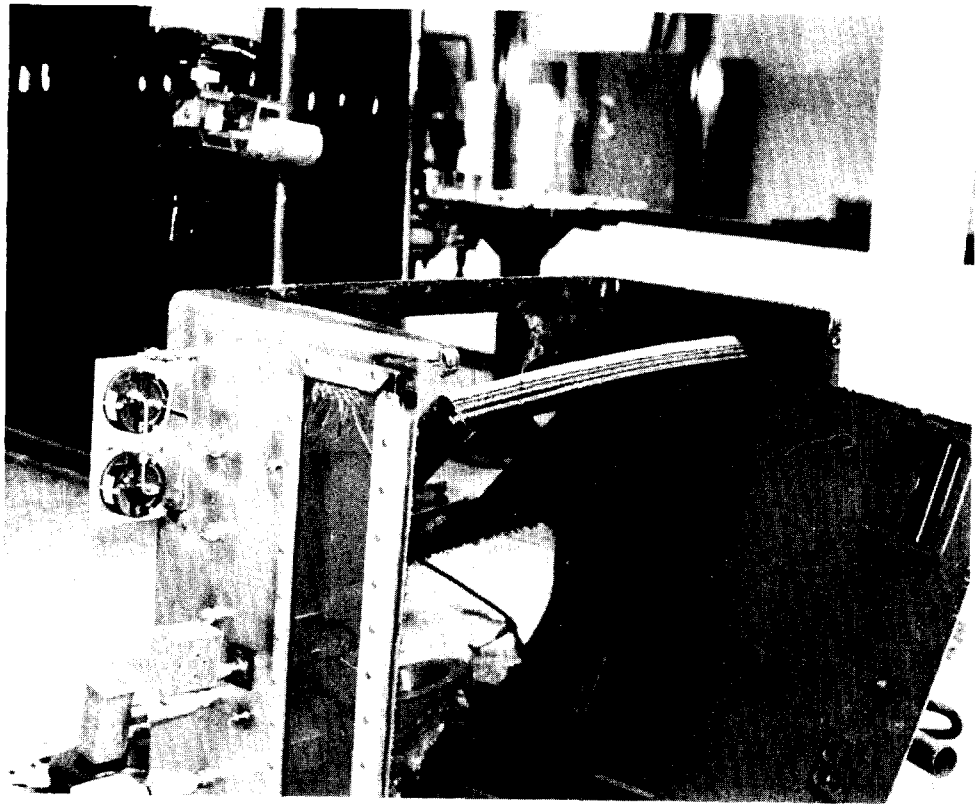

Fig. 6. Glovebox Cut Using Plasma-Arc Torch

Interchanging tools is done automatically using a remote tool change system (Fig. 7). Tools are selected from a menu-driven program using control buttons located on the console. A tool stand near the work area holds each tool until needed. The tool changer is a modified Erickson tool change system that makes the electrical and mechanical connections simultaneously. Electrical slip rings with brushes allow continuous wrist rotation. Average time to change the manipulator tool is less than 3 minutes.

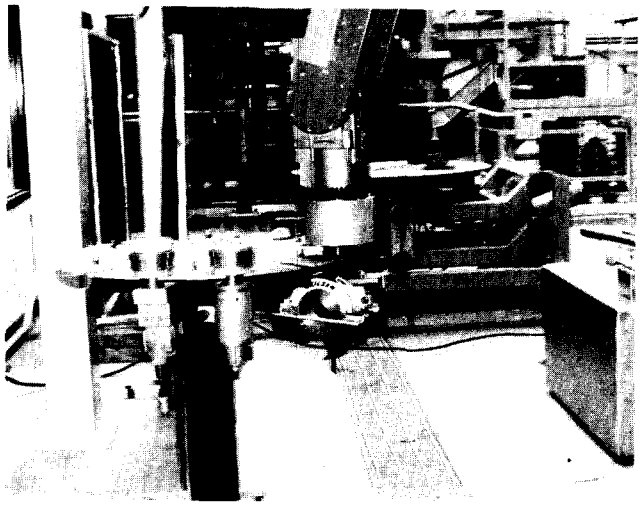

Fig. 7. Automatic Tool Changer and Tool Table

Shredder - Feed material for shredding tests included glovebox sections, cabinet sections, electrical equipment, wooden scrap from cut up boxes, and 55-gallon drums. Items are placed in the shredder hopper using the Telerobot and overhead bridge crane. A drum lifter and pallet lifter plus the manipulator gripper are used to lift material. The shredder hopper is totally enclosed and has two video cameras for remote viewing.

Waste piece size (i.e., volume reduction) is controlled by forward/reverse cycle time and material redistribution during reverse blade rotation. Forward blade rotation is controlled by a 0- to 60-second timer. When forward rotation stops, the blades reverse and redistribute the material in the hopper. This eliminates long continuous cuts and gives shorter cuts at varying angles, reducing overall piece size. Redistribution is important during blade reversal to change the angle of the cut. Without it, long strips are cut in discrete steps, and piece size is not reduced. Reverse rotation time is fixed at 12 seconds, and the degree of redistribution is dependent on the shape of the items and the amount of material in the hopper.

Initial shredder tests were aimed at finding the volume reduction, and shredding time, for typical waste items. The test results are shown in Table I.

TABLE I

SHREDDER SIZE REDUCTION TESTS

Test No.	Material	Initial Volume, ft^3	Shredded Volume, ft^3	Volume Reduction	Shred Time, min.
1	Electrical transformers, 1/4 in. steel box, pipe, scrap plate, electrical cabinets.	55.5*	30.6	1.8:1	40
2	Two 55-gallon drums, pipe, miscellaneous scrap.	15.7	5.2	3:1	23
3	3/16-in. glovebox (48 x 43 x 24 in.).	28.7	7.2	4:1	48
4	1/4-in. plate, pipe, 1/16-in. ventilation ducts, cabinets, pipe.	121.0*	31.2	3.9:1	116
5	3/16-in. HEPA filter housing, glovebox windows, and glove rings.	38.7*	20.6	1.9:1	39
Total		259.6	94.8	2.7:1	266

* Volume of box(es) containing material.

In all tests the forward cycle time was set at 5 seconds. The volume reduction in Test 1 was low because shredding the thin metal sheets of the electrical transformer cores increased volume relative to the original enclosed volume. The glovebox in Test 3 was cut into four sections with the plasma-arc torch before shredding. Shredded piece size in all tests was about 6 in. x 9 in., but the size distribution included some large pieces (6 in. x 19 in.) and some thin, narrow pieces (e.g., angle or channel supports) up to 30 in. long (Fig. 8). Thin, narrow items pass unshredded through the gap between the outside diameter of a blade and spacer. We plan to test a restrictor assembly located under the shredder blades to eliminate this problem.

Other factors affecting piece size include waste item size and blade width. Items large enough to cycle through several forward/reverse rotations have smaller average piece size than items cycling through only one or two reversals. Some small items pass quickly through the blades without a reversal. Shredder blades are set in a tandem arrangement (two blades, two spacers, two blades, etc.) Blade width is 2.75 in. with a tandem width of 5.5 in. This arrangement increases piece size but also increases the material thickness the shredder can handle by doubling the power available for each cut.

Shredding time is a function of forward/reverse cycle timing, material shape, size and thickness, and number of jam reversals. At the start of shredding, the forward cycle time is set at 60 seconds until the shredder blades grab the material. Cycle time is then reduced as needed to control piece size.

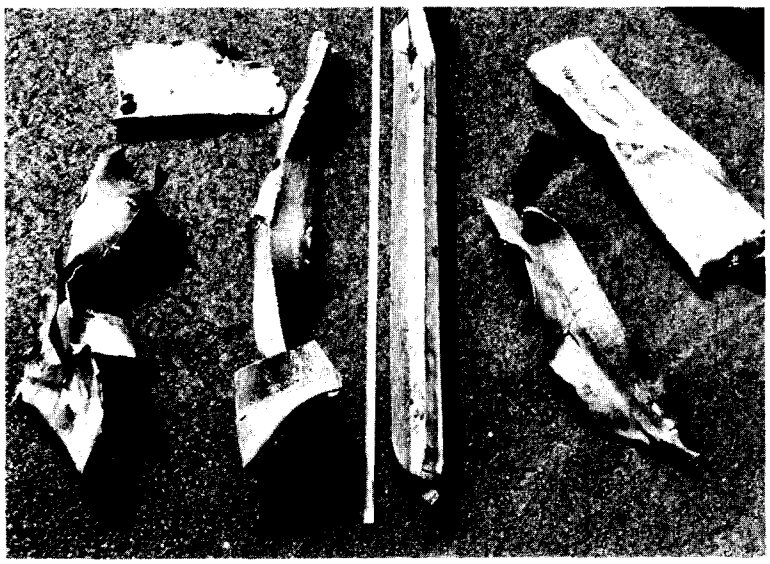

Fig. 8. Shredded Angle and Channel Supports

MATERIAL HANDLING TESTS

Conveyor/Hopper - The conveyor/hopper carries shredded material from the shredder to the bagless transfer machine. Shredded metal pieces 30 in. to 40 in. were successfully conveyed and loaded in bagless transfer drums (Fig. 9). No material jams occurred with the conveyor, but material did fail to completely drop from the hopper occasionally. A vibrator has been added to the hopper to eliminate material bridges.

Fig. 9. Bagless Transfer Drum

Bagless Transfer Machine - The bagless transfer machine successfully transferred over twenty, 55-gallon drums of shredded material. Operability during the transfers was excellent. The cell lid gasket becomes coated with fine debris when material is dumped from the hopper (particularly with shredded wood). A remote cleaning method is needed in contaminated environments to ensure a good seal.

FUTURE TESTING

Telerobot - Test work during FY 1988 will be aimed at performing programmed tasks that are either repetitive or can be done faster in automatic mode. These will include automatic HEPA and prefilter changes, in-cell housekeeping using a vacuum and wipes, radiation measurements, and programmed cutting between two or more points.

Several enhancements planned for the Telerobot include force feedback and obstacle avoidance. Obstacle avoidance will prevent collisions with fixed cell obstacles in either automatic or manual modes. Force feedback will be used to control Telerobot motion using force inputs. This will allow automatic adjustment of cutting speed and angle and maintaining fixed force levels during operation.

Shredder - Shredder testing will continue with a goal of improving volume reduction by decreasing piece size for various waste types. This will include optimizing the shredding parameters and investigating different blade configurations, testing a restrictor device to reduce piece length, and using a smaller shredder for drums and other small items.

Integrated Processing - Integrated size reduction is planned using uncontaminated decommissioned gloveboxes, cabinets, process equipment, and ventilation ducts. This waste will be packaged identical to buried waste and size-reduced in the TWTF. Sample TRU drums will also be prepared to demonstrate drum opening, waste segregation, and drum size reduction. Processing rates and volume reduction for different waste types will be determined.

ACKNOWLEDGMENT

The information contained in this paper was developed during the course of work under Contract No. DE-AC09-76SR00001 with the U.S. Department of Energy.