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Consolidated Fuel Reprocessing Program

PROCESS DATA IN SAFEGUARDS AT THE OAK RIDGE NATIONAL LABORATORY

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ABSTRACT

The desire to improve timeliness and sensitivity of material control and accounting capabilities is the basis for evaluation and upgrade of regulatory requirements throughout the nuclear industry. Improvements invariably require better measurement capabilities and more frequent measurements. Operating plants typically include a broad range of measurements and equipment devoted to process control. How can these measurements be used to benefit safeguards? A part of the Consolidated Fuel Reprocessing Program at the Oak Ridge National Laboratory has focused on the use of process data for safeguards. This report discusses recent safeguards demonstrations and current activities in a test facility at Oak Ridge.

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SUMMARY

Development and demonstration of advanced reprocessing technology has been the focus of the Consolidated Fuel Reprocessing Program at the Oak Ridge National Laboratory (ORNL). Safeguards development has always been a part of the program. The central theme has been process monitoring. A firm definition of safeguards process monitoring is elusive. Basically, it involves very detailed analysis of a broad range of process information to detect anomalies that "may" be indicative of loss or removal. The point to be made is that process data are used.

The availability of the Integrated Equipment Test (IET) facility at ORNL has been a benefit to safeguards development. This is a full-scale (0.5 MTU-day) reprocessing plant demonstration facility. Prototypic advanced reprocessing equipment is integrated into a complete system that includes shear, dissolution, accountability, feed adjustment, a single cycle of solvent extraction, and product concentration. The system operates using depleted uranium solutions and incorporates chemical recovery systems and waste handling that is typical of an operating plant. It is typically operated for test periods of about a week at a time that feature continuous operation.

The control system of the IET facility is an important feature relating to safeguards demonstrations. This is a commercially available computerized system. Virtually all process instruments are interfaced and process control data are available for safeguards evaluations. Over the past several years, a computerized system for safeguards data collection and evaluation has been implemented. For test purposes, the safeguards system considers the depleted uranium in process solutions as if they contained plutonium in concentrations typical of an operating plant. While focusing on process monitoring, the safeguards system includes elements of near-real-time accounting and conventional accounting. It has been a secondary objective throughout development and testing to investigate the role of process data and process monitoring in relationship to other safeguards techniques.

Testing of the IET safeguards system has continued for several years. These tests have involved actual removals of process solution from operating equipment. The installed safeguards system was used to detect, quantify, and isolate each removal. The safeguards system was demonstrated for a number of persons from operating and research facilities in April 1986. This demonstration included several removals arranged by participants. The IET facility safeguards staff used the installed system to find these removals. In December 1987, another demonstration was conducted for International Atomic Energy Agency staff as part of International Safeguards Project Office Task C.59. During this demonstration, participants actually used the computer system and process data to isolate a number of removals.

The prospects for additional testing and demonstrations in the IET facility are uncertain. There are two major focuses for current activities in the Fuel Recycle Division. The first is a collaborative effort with the Power Reactor and Nuclear Fuel Development Corporation of Japan for design and construction of a breeder fuel reprocessing facility to be added to the existing facility at Tokai, Japan. This effort includes evaluation of safeguards requirements for this facility, both to meet existing requirements and to demonstrate safeguards applications for future large-scale breeder and light water reactor reprocessing plants. The second activity involves demonstration of the product conversion step for the Atomic Vapor Laser Isotope Separation process. Both could result in installation of new test equipment in the IET facility. Equipment and measurements will be interfaced to the existing or an upgraded process control system. Both will include some test runs in which safeguards demonstrations will continue. It is hoped that these tests will focus on how to use process data to enhance all aspects of safeguards.

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INMM WORKSHOP ON INTEGRATED SAFEGUARDS
OCTOBER 17-20, 1988
ALBUQUERQUE, NEW MEXICO

WHO AM I?

- 1968-1976 NUCLEAR FUEL SERVICES REPROCESSING PLANT, WEST VALLEY, NEW YORK
  - OPERATIONS MANAGER ALWAYS KNEW WHAT WAS HAPPENING
  - WHY CAN'T SAFEGUARDS KNOW AS WELL

- 1976-1983 ALLIED GENERAL NUCLEAR SERVICES, BARNWELL, SOUTH CAROLINA
  - COMPUTERIZED DATA COLLECTION SYSTEM BACKFIT
  - A CHANCE TO UNDERSTAND THE OPERATOR'S LOGIC AND TRANSLATE IT TO COMPUTER SOFTWARE
  - SAFEGUARDS TURNED OUT TO BE A SYSTEM THAT KEPT OPERATIONS INFORMED
  - FIRST COOPERATIVE DEMONSTRATIONS OF SAFEGUARDS (LANL, ORNL, ETC.)

- 1983 - FUEL RECYCLE DIVISION OAK RIDGE NATIONAL LABORATORY
  - A CHANCE TO CONTINUE REAL DEMONSTRATIONS IN A TEST FACILITY

WHERE AM I FROM?

- FUEL RECYCLE DIVISION
  OAK RIDGE NATIONAL LABORATORY
  MARTIN MARIETTA ENERGY SYSTEMS

- NOT FROM Y-12

- NOT FROM K-25

- CONSOLIDATED FUEL REPROCESSING PROGRAM (CFRP)
  - FUNDED FROM DOE/NE BUDGET

WHAT IS CFRP?

- DEVELOPMENT AND DEMONSTRATION OF ADVANCED REPROCESSING TECHNOLOGY - PRINCIPALLY BREEDER FUEL PROCESSING.
  - E.G., ROTARY DISSOLVER
  - CENTRIFUGAL CONTACTORS FOR SOLVENT EXTRACTION
  - REMOTE HANDLING/MAINTENANCE
  - ADVANCED CONTROL SYSTEMS

- SEVERAL DESIGNS/STUDIES
  - HOT EXPERIMENTAL FACILITY (HEF)
  - BARNWELL HEAD END ADDITION
  - BREEDER REPROCESSING EXPERIMENTAL FACILITY (BRET)
  - RECYCLE EQUIPMENT TEST FACILITY (RETF) AT TOKAI, JAPAN

- TESTING OF PROTOTYPE EQUIPMENT IN A DEMONSTRATION FACILITY
  - INTEGRATED EQUIPMENT TEST (IET) FACILITY

WHAT IS THE IET FACILITY?

- REPROCESSING PLANT TEST FACILITY
  - 0.5 MTU/DAY THROUGHPUT
  - SHEAR
  - ROTARY DISSOLVER
  - ACCOUNTABILITY/FEED ADJUSTMENT
  - SINGLE CYCLE OF SOLVENT EXTRACTION, CENTRIFUGAL CONTACTORS AND A PULSED COLUMN
  - PRODUCT CONCENTRATION
  - WASTE PROCESSING AND CHEMICAL RECOVERY
- COMPUTERIZED PROCESS CONTROL SYSTEM
  - ALL INSTRUMENTS INTERFACED
  - CONTROL SIGNALS AVAILABLE
- OPERABLE USING DEPLETED URANIUM
  - NO REGULATORY OR PRODUCTION CONSTRAINTS
  - DEPLETED URANIUM FUNCTIONS AS REPROCESSING PLANT FEED
  - ACCESS TO MATERIAL AND EQUIPMENT
  - UPSET CONDITIONS CAN BE INDUCED
- ACTUAL MATERIAL REMOVAL TESTS CAN BE CONDUCTED OVER A BROAD RANGE OF OPERATING SCENARIOS
  - PROCESS SOLUTIONS ARE TREATED AS IF PLUTONIUM IS PRESENT IN SAFEGUARDS TEST DESIGNS

PAST ACTIVITIES

- IET FACILITY BECAME AVAILABLE FOR TESTING IN 1984

- A SAFEGUARDS SYSTEM WAS IMPLEMENTED

  - PRIMARILY BASED ON PROCESS MONITORING
  - SOME ELEMENTS OF NRTA INCLUDED, MAINLY TO INVESTIGATE DATA COLLECTION AND THE USE OF PROCESS DATA IN THE IN-PROCESS INVENTORY MEASUREMENT
  - CONVENTIONAL ACCOUNTING IS NOT EMPHASIZED
  - FOCUSED ON DETECTION OF 2 KG PU EQUIVALENT LOSS

- SAFEGUARDS TESTS ARE COUPLED TO PROCESS AND EQUIPMENT DEMONSTRATIONS

  - APRIL 1986 AND DECEMBER 1987 WERE SPECIAL TESTS.

APRIL 1986 TEST

- 26 PERSONS, FROM DOE, CONTRACTORS, NRC AND INDUSTRY ATTENDED
- 3 ACTED AS AN ADVERSARY TEAM TO PLAN REMOVALS WITH IET OPERATING STAFF
- SAFEGUARDS STAFF HAD TO DETECT REMOVALS
  - 5 REMOVALS WERE MADE AND ALL WERE DETECTED
- RESULTS REPORTED AT THE INTERNATIONAL SYMPOSIUM ON NUCLEAR MATERIAL SAFEGUARDS HELD IN VIENNA, NOV 10-14, 1986. (EHINGER, WACHTER, "DEMONSTRATION OF SAFEGUARDS PROCESS MONITORING")

ISPO TEST

- THE OBJECTIVE OF THE ISPO TASK C.59 WAS TO INVESTIGATE THE POSSIBLE ROLE OF PROCESS MONITORING FOR INTERNATIONAL SAFEGUARDS.

- FINAL PHASE OF THIS TASK INCLUDED A DEMONSTRATION FOR AGENCY STAFF

- IET FACILITY WAS OPERATED DECEMBER 14-18, 1987

- 5 AGENCY STAFF AND AN ISPO REPRESENTATIVE ATTENDED

- PARTICIPANTS WERE GIVEN INSTRUCTION ON USE OF THE IET SAFEGUARDS COMPUTER SYSTEM

- PARTICIPANTS IDENTIFIED SEVERAL REMOVALS. THEY OBTAINED FIRST HAND EXPERIENCE WITH THE SYSTEM, AND DEALT WITH FALSE ALARMS AND OTHER PROBLEMS INHERENT IN THE USE OF PROCESS DATA FOR SAFEGUARDS.

FUTURE CFRP ACTIVITIES

- JOINT USDOE/PNC, JAPAN COLLABORATION ON FBR REPROCESSING
  - DESIGN OF THE RECYCLE EQUIPMENT TEST FACILITY (RETF) TO BE BUILT AS AN ADD-ON TO THE TOKAI REPROCESSING PLANT
  - A CHEMICAL SYSTEMS TEST PROGRAM MAY HAVE A SOLVENT EXTRACTION TEST SYSTEM INSTALLED FOR TESTING IN THE IET FACILITY
  - MAY INCLUDE SLAB TANK TESTING (MIXING, SAMPLING, MEASUREMENTS)
  - ANY TESTING WILL INCLUDE SOME SAFEGUARDS.

FUTURE CFRP ACTIVITIES (CONT)

- AVLIS PRODUCT CONVERSION DEMONSTRATION
  - A PROTOTYPE FACILITY FOR CONVERSION OF AVLIS PRODUCT IS PLANNED IN THE IET FACILITY
  - INCLUDES DISSOLUTION, SOLVENT EXTRACTION, AND OXIDE CONVERSION
  - WILL ALLOW ADDITIONAL SAFEGUARDS DEMONSTRATIONS

FUTURE CFRP ACTIVITIES (CONT)

- CONCENTRATE ON PROCESS MONITORING TYPE APPLICATIONS IN A ROLE TO SUPPORT NRTA AND CONVENTIONAL ACCOUNTING
  - ON-LINE MEASUREMENT CONTROL
  - LIMIT SAMPLING REQUIREMENTS
  - POSSIBILITY OF VERIFICATION
  - AI APPLICATIONS
- PRESENT STATUS OF THE IET FACILITY
  - OPERATORS HAVE BEEN TEMPORARILY REASSIGNED
  - NO NEAR TERM PLANS
- LONG-TERM PLANS FOR IET ARE TENTATIVE
  - CURRENT NEGOTIATIONS WITH PNC ABOUT SCOPE AND FUNDING OF TESTS
  - AVLIS COST AND SCOPE IS ALSO TENTATIVE AND CLASSIFICATION CONCERNS MAY LIMIT ACCESS TO DATA
- PERHAPS OTHER INTERESTS AND FUNDING CAN BE FOUND TO PRESERVE THE IET FACILITY FOR SAFEGUARDS RESEARCH PURPOSES