

AMTEX Second Quarter FY96 Report

The AMTEX Partnership™



March 1996

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor Battelle Memorial Institute, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or Battelle Memorial Institute. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

PACIFIC NORTHWEST NATIONAL LABORATORY

operated by

BATTELLE

for the

UNITED STATES DEPARTMENT OF ENERGY

under Contract DE-AC06-76RLO 1830



This document was printed on recycled paper.

The AMTEX Partnership™

Second Quarter Report Fiscal Year 1996

March 1996

Issued by
The AMTEX Program Office

Douglas K. Lemon, Manager
AMTEX Laboratory Program

and

Richard K. Quisenberry, Executive Director
AMTEX Industry Program

CONTENTS

Executive Summary	1
Operations and Program Management	7
Program Office Operations and Management	7
Operating Committee Activities and Actions for the Quarter	8
Project Accomplishments	8
Computer-Aided Fabric Evaluation.....	9
Cotton Biotechnology.....	21
Demand Activated Manufacturing Architecture	24
On-Line Process Control in Flexible Fiber Manufacturing.....	30
Rapid Cutting	33
Sensors for Agile Manufacturing.....	34
Textile Resource Conservation.....	35
Financial Summary.....	38
Appendix A - AMTEX Financial Summary	<i>removed</i>



EXECUTIVE SUMMARY

The AMTEX Partnership™ is a collaborative research and development program among the U.S. Integrated Textile Industry, the Department of Energy (DOE), the national laboratories, other federal agencies and laboratories, and universities. The goal of AMTEX is to strengthen the competitiveness of this vital industry, thereby preserving and creating U.S. jobs.

Operations and Program Management

The operations and program management of the AMTEX Partnership™ is provided by the Program Office. The Program Office produces this report quarterly to provide information on the progress, operations, and project management of the partnership.

Program Office Operations and Management

The Industry Technical Advisory Committee (ITAC) met in January to review project progress and develop a preliminary budget recommendation for the FY96 funding. Since the federal funding profile was still uncertain, a budget was developed based on the best available information with contingency plans to accommodate changes. Although many tasks will have to be shut down or deferred until FY97, the ITAC chose a path that kept all the major projects funded at some level through FY96.

The Industry Operating Board (IOB) met in March at the offices of Textile/Clothing Technology Corporation [TC]² to review projects, approve the ITAC budget recommendation, and discuss the future of AMTEX. The Board expressed strong support for continuing the AMTEX Partnership™.

The laboratory and government members of the Operating Committee met in February to discuss the changing nature of the programs that have funded AMTEX in the past and the status/prospects of future AMTEX funding. A few minor points of policy were also discussed and resolved.

Projects

Computer-Aided Fabric Evaluation

During this reporting period, the Computer-Aided Fabric Evaluation (CAFE) project made extensive progress toward all milestones and deliverables associated with the On-line Greige, Color Printed Pattern

Goods (CPPG), Knit Inspection Systems, and the Economic Model. These activities were modified, however, as a result of a redistribution of funds to support the On-Line Process Control (OPCon) and Cotton Biotechnology projects. Specifically, Argonne National Laboratory's (ANL) efforts on both the On-loom Greige and Knit tasks were suspended until FY97. In addition, task leadership for design and development of the Knit Inspection System was given to Sandia National Laboratories (SNL). The implications associated with the new budget and its impact were discussed with the CAFE Industry Partners during a series of meetings at the Institute of Textile Technology (ITT) in Spartanburg, South Carolina. Strategic plans for each task were proposed and accepted.

For the On-line Greige Inspection System, the team continued efforts to deploy the Beta test system. General team activities included meetings to discuss Beta site preparation, test procedures, and remote operations of the Beta system. Specific activities at individual laboratories include accelerated development and building of respective sensor systems for early test deployment, development of the Beta integrated hardware suite, formulation and development of graphical user interfaces, and development of a communication scheme and protocol to support the Beta deployment. These efforts help establish the informational systems requirements and impacts on plants and were coordinated with Alexco, who has the responsibility of fabricating and building the mounting hardware and replicating sensor systems.

The CPPG focus during this quarter was on preparing software and hardware for the real-time system tests at the Spartan Cherokee Finishing Plant. Routines for data capture, real-time detection, and results logging were developed, as well as several new diagnostic programs to help diagnose system anomalies. These programs were used during the on-site field tests to set up and calibrate the camera on the actual print range. Debugging and development of the real-time hardware and software proceeded on the Color Print Inspection System. Two tests were conducted during this reporting period: a camera system data experiment, conducted at SNL on March 12, and a pre-Alpha test conducted on March 28 at the Spartan Cherokee Finishing Plant. The vendor affiliate activities associated with these efforts were coordinated with Assurance Technology, Inc.

Activities on the Knit Inspection task focused on the continued development of sensors for fabric inspection and the needle diagnostic sensor for Alpha testing. These efforts included hardware design and fabrication, as well as continued development of inspection algorithms and utility programs for setup and image display. The team also held several meetings to develop a plan for deploying the Knit Inspection System.

Work on the Economic Model focused primarily on completing the Break-Even Model, which is to be delivered to ITT in May. There was no work on the Material Marking task.

Cotton Biotechnology

Actions taken by Cotton Incorporated and the Program Office have resolved a funding crisis that would have terminated the project. Subsequently, work has been scheduled through FY96, by which time a molecular map of the cotton genome will be constructed, and a number of factors affecting fiber development will be understood.

The number of cells in a developing ovule have been counted so that the size of the bud at different developmental stages can be defined. Developing ovules have a two-phase growth curve. Cotton buds harvested before flowering have been successfully placed in culture and have flowered. Tissue culture provides a method for controlled testing of different treatments on fiber initiation and differentiation.

The Molecular Markers task has finished the discovery phase for simple sequence repeats; and primer pairs, based on the sequences in hand, are being ordered and tested prior to mapping the polymorphic markers.

Demand Activated Manufacturing Architecture

Following are highlights during the past quarter from each of the technical task areas.

Enterprise Modeling and Simulation (EM&S) - Development of the Integrated Textile Complex (ITC) business structure simulation software continued. Demonstrations of an on-shore/off-shore sourcing scenario were provided at the IQ-1996 Conference and to the Operating Boards of [TC]², AMTEX, Mercantile, and Milliken & Company. These interactions provided valuable feedback to the development team.

The product line investigation for a women's fashion item got under way with several meetings at Anne Klein in New York City.

Jane Macfarlane, the EM&S task leader, resigned from Lawrence Berkeley National Laboratory (LBNL) at the end of March. Jon Stanley is the acting EM&S task leader.

Connectivity and Infrastructure (C&I) - Most efforts this quarter were in support of the TEXNET pilot in collaboration with the Cooperative Business Management task.

The pilot effort of the Electronic Data Interchange (EDI) over the Internet began this quarter. The pilot teams are Burlington and Wellman, Ciba and Fieldcrest Cannon, and Milliken and Wellman. Each company is configuring systems and interfaces to its EDI processors so that messages can be exchanged over the Internet.

Cooperative Business Management (CBM) - Considerable effort was spent this quarter trying to line up pilot teams for the TEXNET pilot. The only team formed to date is Spartan Mills and Fieldcrest Cannon.

Requirements documents for the Supply Chain Inventory Prototype and the Data Analysis and Modeling effort were completed, and planning was concluded for a technical review of each activity in April.

The design team received the first version of the new stand-alone National Sourcing Database (NSDB) with the Auburn Database. A data-entry program prototype for the Electronic Catalogue (EC) '96 listing of companies was completed and demonstrated at Associate Member Congress EC '96.

Education, Outreach, and Commercialization (EOC) - DAMA provided exhibits at the IQ-1996 event in Chicago, Illinois. On-shore/off-shore manufacturing analysis, TEXNET, and the NSDB were demonstrated and papers were presented on activities in the EM&S and CBM tasks.

Electronic Embedded Fingerprints

This project successfully completed the proof of feasibility phase by developing and demonstrating a multiple-tag system. The design information will be available to the Industry Partners to pursue further development and commercialization. No further work in the laboratories is planned beyond this quarter.

On-Line Process Control for Flexible Fiber Manufacturing

The OPCon project is addressing four areas of on-line process control for fiber manufacturing. The Finish Oil and Moisture task group met during the quarter to review progress and decided to pursue two promising technologies—one suitable for real-time, on-line application and one suitable for near-real-time, at-line applications.

The Fiber Morphology task at Princeton Plasma Physics Laboratory (PPPL) has made good progress in showing correlation between predicted (modeled) light scattering and actual observations. The light scattering techniques appear to offer very rich information about the internal structure of the fiber.

The Cut and Crimp task has made significant advancement through merging 2-D images with surface topography maps. The industry steering committee decided to put this task on hold until FY97 because of a shortage of overall project funds.

The Polymer Rheology task was discontinued this quarter because of evidence that the approach being taken would not give the desired information.

Rapid Cutting

At the last ITAC meeting in December 1995, the Rapid Cutting project was terminated. FY95 carryover funds remaining at any participating laboratory were either used for task close-out or transferred within that laboratory to other AMTEX projects. No FY96 funds are available for this project. A draft of the year-end technical report summarizing the work of the project is archived with the lab project engineer. Staff are seeking methods to complete and distribute this report.

Sensors for Agile Manufacturing

The objective of this project is to develop sensors and feedback control methods that will improve the quality and productivity of the textile industry in the cutting and sewing processes associated with garment assembly. The first tasks in this project are to develop sensors for fabric edge detection and felled seam sensing.

Because of budget uncertainties, work on the second task to develop advanced sewing sensors has been postponed indefinitely.

Textile Resource Conservation

During this quarter, progress toward milestones has been somewhat satisfactory in the Textile Resource Conservation (TRC) project. Many tasks, especially the field test of an air-emissions sensor at a dyeing and finishing plant, are either short or out of funding. As a result, research for the textile industry has shut down in several areas, including both task efforts at LBNL in recovery of colorants, all efforts in recovery of fibrous solid waste, air-emissions sensor work at ANL,

and all of the alternative cleaning technologies task efforts. Colorants recovery work, directed at the near-term field testing, has continued, including a field test planning meeting at a partner's site. The industry has placed notices in the *Commerce Business Daily* to identify equipment and system vendors who would be interested in becoming vendor partners. It is expected that a vendor will be selected within the next quarter.

Financial Summary (DOE/EPA \$ in thousands)

	(A) Total FY96 Budget*	(B) Quarter Cost	(C) FY96 Cost to Date	(D) Remaining Balance (A - C)	(E) % Spent of Budget (C / A)
(\$K)					
Program Office	764	131	371	393	49%
DAMA	8,693	2,099	3,889	4,804	45%
CAFE	3,720	1,066	2,192	1,528	59%
TReC	2,261	717	1,439	822	64%
EEF	96	11	83	13	86%
Cutting	375	111	402	(27)	107%
Sensors	328	66	139	189	42%
Cotton Biotech	760	200	450	310	59%
OPCon	542	126	310	232	57%
TA Leaders	0	0	0	0	0%
Uncommitted	0	0	0	0	0%
Total	17,539	\$4,527	\$9,275	\$8,264	53%

* Total FY96 Budget includes carryover from FY95. (See Project Summary Reports in the back of this Quarterly Report for details.)

OPERATIONS AND PROGRAM MANAGEMENT

Program Office Operations and Management

The Program Office provides management oversight of the daily operations and project activities of the AMTEX Partnership™ and is composed of an industry and a laboratory component. The following activities were conducted this quarter.

Multi-Laboratory CRADA and Revised Option Agreement

Progress continued on reaching a final version of both the Multi-Laboratory Cooperative Research and Development Agreement (CRADA) and a revised Option Agreement. A cross-laboratory working group has nearly completed development of a standard multi-laboratory CRADA that will be adapted slightly for use in AMTEX. The AMTEX Option Agreement on intellectual property was completed. Both documents should be completed and approved in the coming quarter.

Industry Technical Advisory Committee

The ITAC met on January 11, 1996, in Charlotte, North Carolina. The industry project directors presented their respective FY96 project plans, budget requests, and summary of progress to date. The committee expressed strong support for the AMTEX program, even in the face of decreased federal funding this year. The group discussed strategies for gaining increased support for AMTEX from the industry and government. The committee developed a prioritized funding recommendation to accommodate the changing profile of government funding.

Key decisions made at the meeting were to discontinue work on laser cutting because it appears the technique will not become cost-effective in the next few years. Also, the development of the advanced sewing machine was put on hold. Since the Electronic Embedded Fingerprint project has completed the proof-of-feasibility stage, the project will be turned over to Industry Partners for the commercialization phase. The ITAC also expressed support for continued funding of the OPCon and Cotton Biotechnology projects and advised the Program Office to work out a budget plan that could keep all the AMTEX projects, except as noted above, operating at a reduced level through FY96.

Operating Committee Activities and Actions for the Quarter

Laboratory and Government Members of the Operating Committee

The laboratory and government members of the Operating Committee met on February 14 and 15, 1996, in Charlotte, North Carolina. The purpose was to discuss the status of funding for AMTEX and the position of the laboratories relative to future strategies.

Industry Operating Board

The IOB met on March 21, 1996, in Cary, North Carolina, at the offices of [TCJ]². Brief summaries of the projects were presented by the industry project directors. The industry members then discussed what they could do to ensure a strong future for AMTEX. One of the key messages being shared with others is that successful public-private partnerships should have at least three key features:

- 1) Involve a total industry (raw materials through retail).
- 2) Be guided by an industry-developed R&D Road Map.
- 3) Focus on generic processes, not products.

In formal action, the IOB approved the general direction and funding profile that was developed by the ITAC the previous month.

AMTEX Operating Committee Meeting Schedule

Future meetings of the AMTEX Operating Committee are scheduled for August 15, 1996, at the Los Alamos National Laboratory (LANL) and November 14, 1996, at a site to be determined.

PROJECT ACCOMPLISHMENTS

During the last quarter, accomplishments within the AMTEX Partnership™ have been numerous. Accomplishments for each AMTEX project are reviewed in the following sections.

Computer-Aided Fabric Evaluation

The CAFE project is developing inspection systems that will provide U.S. textile manufacturers with a major leap forward in the assurance of high quality, consistent textiles.

Project Manager: Glenn Allgood, ORNL / 615-574-5673
Project Director: Mark Kametches, ITT / 864-595-0035

Performance Related to Milestones

On-loom Greige Inspection System

1. Met to discuss Beta site preparation, test procedures, and remote operations of the Beta inspection system.
2. Completed design and fabrication of the first of three prototype sensors. Design includes electronic circuits (controller/optical front end) and housing. Drawings for the system, including electronic schematics and hardware design, were given to Alexco for the fabrication of the two additional sensors.
3. Developed conceptual approach for communication and plant operation of the sensor system.
4. Completed preliminary data dictionary, process flow diagrams, and Business Event Models for the On-line Greige Inspection System. These documents were presented to the CAFE Industry Partners and submitted for review and comment.
5. Continued development of the machine diagnostic sensor system with procurement of certain components.
6. Redesigned a second sensor, reducing the number of channels while increasing rastering speed.
7. Concluded preliminary wear tests at Glen Raven with no observed wear. New 6-month wear test being initiated.
8. Installed CAFE rack mounted system at Milliken's Cedar Hill Plant. This hardware/software configuration will support the deployment of the Beta On-loom Greige Inspection and Machine Diagnostics System.

CPPG Inspection System

1. Selected Alpha test site and Alpha test chairman in preparation for Alpha test completed January 18.
2. Completed Alpha test plan outlining the conditions and parameters of the Color Printed Pattern Defect Alpha test on February 21.
3. Completed Pre-Alpha test 1 in March. The test demonstrated key aspects of the proposed Alpha test including the ability to produce the defects outlined in the Alpha test plan under realistic conditions. The test also provided valuable data for system improvements and extensions required to meet Alpha test requirements.

Knitting Inspection

1. Completed design and partial fabrication of the knit sensor. This work includes fabrication of transducers and testing of the inspection/detection algorithm. These efforts have been suspended for FY96.
2. Fabricated, tested, and checked two sensor boards. Included in these efforts were significant advancements in the Digital Signal Processing (DSP) inspection and operational software for the sensor system.
3. Continued the design of the needle diagnostic sensor. This work was suspended during this period due to funding limitations.

Economic Model

Met to discuss the requirements for the Break-Even Model. These were identified and are currently being implemented in the final model.

Material Marking

Activities suspended during this quarter.

Activities and Technical Accomplishments for the Quarter

On-loom Greige Inspection System (ORNL, ANL, SNL)

Mark Kametches attended the January ITAC meeting, representing the CAFE project. Mark presented an update and overview of the current status of the project.

An SNL Sensor Design meeting was held January 16 at Alexco. The SNL team met with representatives of Alexco to develop plans for

designing and fabricating the on-loom sensor mount. Alexco was tasked with developing a design concept.

A Weave task group meeting was held January 17 at Alexco. CAFE's project management met with the industry Weave task team to discuss and review the status of the Weave Inspection task. Specifics included review of the new FY96 budget, discussion of FY96 plans, analysis of current cost reduction alternatives, presentation of the Economic Model, and discussion of market potentials. The Industry Partners concurred with the proposed plan. This meeting served as the CAFE quarterly review meeting for the Weave task group.

An On-loom (Oak Ridge) task meeting was held January 31 at Alexco. The On-loom Greige/Sensor task team met with the On-loom Greige Industry Partners for a review of the Oak Ridge National Laboratory (ORNL) sensor. Presentations included those on functional and operational characteristics of the sensor, fabric and machine process parameters, communication requirements and a proposal for implementation, user interface requirements, impact on manufacturing infrastructure, and preliminary test plan discussions.

A Central Inspection Computer (CIC)/Business Event Model meeting was held February 13 at ITT in Spartanburg. The CIC team met with Mark Kametches (ITT) and Joe Gucwa (Milliken) for a preliminary review of the CAFE Business Event Model, its concept, and approach. The discussion centered around the definition of the Business Event Model and its applicability to the delivery and commercialization of the On-loom Greige Inspection System.

An on-loom test plan meeting was held February 14 at ITT in Spartanburg. The industry Weave task team members met to develop a strategic approach and plan for testing the ORNL sensor during the Beta tests.

An internal SNL intellectual property meeting was held February 27 at SNL. The SNL CAFE designers met with SNL patents and licensing staff to discuss plans for documenting the SNL intellectual property. Plans currently call for the submittal of two additional patent disclosures and two software copyrights.

An On-loom (ORNL) Communication Prototype/Echelon meeting was held March 4 at Echelon to discuss technical requirements for the deployment of the Echelon system with the ORNL sensor. Discussions centered around communication protocols, data structures, and bandwidth, and an implementation strategy.

A CAFE Economic Model meeting was held March 5. The CAFE project manager and project director met with the LBNL team

responsible for the development and integration of the Economic Model modules being developed at LBNL and ORNL. A status report was given on the current state of the model. An action item was established for LBNL to complete and deliver the final Break-Even Analysis Model by May 1996.

An Industry Operating Board meeting was held March 21 at [TC]². Mark Kametches attended the IOB meeting there where a CAFE project overview and budget were presented to the Board. The outcome of this meeting was the redistribution of funds to support the OpCon and Cotton Biotechnology projects.

An Industry Partner CIC meeting was held March 26 at ITT/Spartanburg. ORNL held the meeting with the CAFE Industry Partners to provide a status report and review of the CIC work. At the meeting, the team provided a preliminary CAFE Inspection System data dictionary, process flow diagrams, and Business Event Model documents. The Business Event Model is an approach adopted by the CAFE team for cause/effect analysis on the impact that the inspection system will have on the weaving plant process.

A Greige Inspection System Beta meeting was held March 27 at Milliken's Cedar Hill Plant to discuss the status of the project and staging of equipment. The meeting was attended by Glenn Allgood (ORNL), Mark Kametches (ITT), Gerry Sleaf (SNL), and Joe Gucwa (Milliken). Plans were made to support early deployment of the Beta systems for pre-testing.

CIC – On-loom Greige Inspection System (ORNL)

ORNL completed the preliminary data dictionary, process flow diagrams, and Business Event Models for the Greige Inspection System in preparation for the upcoming Beta tests. These documents will provide the basis for the Beta system's user manuals and trouble shooting guides and overviews of the functional and operational characteristics of each subsystem. The Business Event Model will be adopted to provide a tool for analyzing the impact that each subsystem will have on the weaving plant's infrastructure and identify new methodologies for incorporating the individual elements into the weaving process. Impacts are in communication requirements, data structures, information flow, and process dynamics, and the minimal functional requirements of each subsystem. The CAFE Industry Partners are currently reviewing these documents which will become an integral part of the tech-transfer package.

Sensor (ORNL, Y-12)

The team focused on three major activities for this quarter. The first was the development of the process flow diagrams, Business Event Model, and elements of the data dictionary specific to the sensor. These activities will not only support the early Beta testing of the units but also the final delivered package the Greige vendor affiliate uses to commercialize the subsystem.

The second development activity was building the sensor interface. This application provides the communication link to the sensor through its serial port and an ability to change and initiate setup parameters for test/checkout and diagnostics. The Beta version is based on an Echelon subsystem and will serve as the precursor for the commercial system.

The third activity centered around building and deploying the Beta version. Schematics and timing diagrams of the Beta version were sent to Alexco for fabrication of the second and third systems. Plans for next quarter are to test the first Beta unit at Alexco and then deploy three units into selected plants.

General team activities included meetings to discuss Beta site preparation, testing procedures, remote operation of systems, and coordination of efforts for Beta sensor system deployment.

Machine Diagnostics (ORNL, Y-12)

ORNL was involved in two major activities associated with the machine diagnostic system. The first was the development of the software drivers and operating system for the DSP board. Included in this was the design of the graphical interface for test, checkout, and diagnostics and an application that will allow the operating parameters associated with the system to be initiated and changed.

The second task was the development of the interrogation and diagnostic algorithms, based on the tests conducted in the plants and the results of the Alpha test. Work to develop these algorithms continues. Additional efforts included enhancements to the characterization and classification algorithms and fault detection.

Vision Inspection System (ORNL)

All efforts on the On-loom Greige Vision Inspection System were terminated because of budget reductions. Documentation is complete.

ANL Sensor #1

All efforts on the On-loom Greige Sensor #1 were terminated because of budget reductions.

ANL Sensor #2

The real-time DSP implementation will be completed after the fabrication of electronics, sensors, and translation system is completed. One Beta system was partially fabricated by the electronics department. The designs of the power amplifier and power supply were completed and the components assembled. The prototypes were tested, with very encouraging results.

Alexco, with the help of ANL, will be in charge of the design and fabrication of two translation systems to be used for the Beta test. A visit was made to Alexco to help design a translation system. Alexco has addressed some problems associated with completing a feasible design. ANL is now working with Alexco to design a belt-translated system for a Picanol loom.

SNL Inspection Subsystem

Five sensor boards were completed. One of the boards was completely filled with components and then tested. All of the analog channels worked properly as did the digital channel multiplexing. The cables connecting the sensor to the interface/support electronics box and those connecting the box to the DSP were assembled. The interface box was completed, tested, and debugged. The entire system was connected to the DSP, and analog data were successfully multiplexed, digitized, filtered, and stored on the DSP.

SNL developed a DSP and PC Windows code that will read and write raw A/D data to a binary file and display it in a 256-shade greyscale image. In addition, the software algorithms for the new boards were defined and a new DSP code written that will read 16 channels of data with real-time low-pass and high-pass filtering. In the coming quarter, work will continue to decrease so that a full suite of detection algorithms can be run.

The CAFE Rack System was installed at the Milliken Cedar Hill Facility. The rack-mounted computer and instrument rack were installed and tested along with the cabling required to establish communications from the rack to the Milliken CAFE Office. The system is now fully operational and appears to be suitable for long-term on-loom testing.

Sensor wear tests were completed at Glen Raven Mills. No wear was observed during several weeks of continuous on-loom operation.

Based on these results, SNL began an extended wear test at Burlington/Klopman Fabrics for at least six months.

CPPG Inspection System (SNL, LLNL, ORNL)

The CPPG partners met at ITT Spartanburg on January 18 to discuss the impact of the CAFE budget reductions on the CPPG tasks. The impact of the budget cuts on the Color Print Defect Detection System is to reduce the scope of the proposed Alpha test. Classification by defect name was omitted and there will only be a minimal user interface demonstrated. The Alpha test will still demonstrate the ability to detect the six primary defects previously selected by the partners and indicate the print roller (or rollers) most likely to have caused the defect. Cherokee Finishing Company was announced as the Alpha test site, and Benji Mills was named the acting Alpha test chairman. Meetings leading up to the Alpha test are tentatively scheduled for the week of July 8. Two in-plant, pre-Alpha system development tests were also scheduled for the last week in March and mid-May.

A Colorimetry task meeting was held February 20. The Colorimetry subgroup met with representatives from HunterLab/SheLyn to discuss concepts and designs now being developed at ORNL. The HunterLab/SheLyn team presented an overview of complementary technology currently under development at their firms. In the discussion that followed, the areas of overlap and mutual interests were highlighted, and alternative paths forward were proposed in light of the reduced funding available in FY96. Although there was quite a bit of overlap between CAFE and the HunterLab/SheLyn development approaches, there were some design and algorithm concepts that HunterLab would like to explore.

An Alpha test planning meeting was held February 21. The CPPG partners met at the (Spartan Mills) Cherokee Finishing Plant in Gaffney, South Carolina. The major goal of the meeting was to finalize the Alpha test design and develop plans for two pre-Alpha system development tests at Cherokee Finishing Plant. The test design identified the pattern types, number of screens, dye type, substrate to be used, length of cloth required for the test, format of information to be reported, and post-test inspection requirements for test validation. The lab partners toured the plant and familiarized themselves with the print machine to be used and met key operations personnel in preparation for the first pre-Alpha test scheduled for the week of March 25.

The emphasis this quarter was on preparing software and hardware for the real-time systems tests at the Cherokee Finishing Plant. In preparation for the test, Lawrence Livermore National Laboratory (LLNL) and SNL developed routines for data capture, real-time

detection, and results logging. At SNL, porting of the color print real-time programs to the parallel-processing DSP board was completed. The code was then tested and verified. Camera interface routines and a rudimentary display capability were added to the host system to support camera integration and the first pre-Alpha test in March. The system was then integrated with the camera and its support electronics, and the entire software and hardware suite was tested on SNL's color print inspection frame. Development of the splitter/driver electronics as reported earlier was also completed and tested during this time frame. Several new diagnostic programs were written to help diagnose camera and cabling problems. These programs will also be used during the on-site field tests to set up and calibrate the camera on the actual print range. Debugging and development of the real-time hardware and software proceeded on the color print inspection frame until the equipment was shipped to Spartan Mills in anticipation of the test. The test itself represented the first opportunity to process real-time data gathered on an actual print range and at typical data collection rates. The SNL subsystem successfully collected large amounts of real-time data, which will be useful in developing and testing classification and screen diagnostic algorithms for the upcoming Alpha test.

At LLNL, final hardware and software modifications were made to their real-time system. This activity included cabling and software needed to interface LLNL's image processing system to the camera through the splitter/driver box system. During February, LLNL continued developing and improving the defect classification algorithm and screen diagnostics algorithm. The first version of the defect classification and screen diagnostics algorithm was completed in March. This initial version will be tested off-line at the field test. Special software was developed to make use of a real-time image recorder for storing data during the field test at Spartan Mills. During the last week of March, the LLNL subsystem was tested at Spartan Mills in collaboration with SNL. The defect detection algorithm worked as expected. One of the hardware components of the image recorder failed, however, and the team was not able to store real-time data as originally planned. Unfortunately, these data were needed for testing the new classification and screen diagnostics algorithm. The team hopes to be able to do some testing during April with some of the data collected by the SNL inspection system. By the next field test, the defect classification and screen diagnostics algorithm are expected to be fully functional, and demonstrated on-line in real-time.

Tests/Experiments

Camera System Data Experiment - While reduced funding has precluded the complete integration of the LLNL and SNL real-time subsystems prior to the Alpha test, it is imperative that both subsystems receive data simultaneously from the same camera. An electronic

splitter/driver box was designed and fabricated at SNL to accomplish this. The LLNL team brought their data acquisition unit to SNL, where it was connected to the camera system in parallel with SNL's system. Moving cloth mounted on SNL's test frame was then successfully imaged simultaneously by both subsystems.

Pre-Alpha Test 1 - The first Pre-Alpha test took place at Spartan Cherokee Finishing from March 25 - 28. There were three goals for the first pre-alpha test: 1) to demonstrate the ability to create the six defects that will be used in the alpha test; 2) to demonstrate real-time operation including defect detection capabilities at realistic operating speeds; and 3) to test whether printed cloth containing defects can be remounted on the print range and rerun to provide a source of defect data for real-time system test and evaluation.

Good cloth was observed for a day during normal print operations, then a dedicated test run was performed. During this test, defects were created on demand and observed by the system. The pattern used for the test was a five screen non-tonal print. Most of the test was performed at 20 yd/min to conserve cloth. A short run at 50 yd/min was also made to evaluate the ability of the real-time systems to acquire and process data at this rate. In some cases, the defect areas were separated by areas of good cloth; in other areas, they were contiguous. In general, both the LLNL and SNL subsystems showed good detection capability. System performance will be further assessed from the data logged at the test. Modifications and adjustments will be made as needed to improve performance prior to the next pre-Alpha test in May. A test log was created during the actual test so that the time and yardage of each defect type is known and can be compared with the results of the system.

Finally, the cloth produced was remounted on the print machine and run at 40 yd/min. Both subsystems were able to gather data and indicate defects. Initially, there were some problems tracking the input data because of fabric shrinkage, which changed the repeat length. Once the appropriate repeat length was found, system lock was established. The consensus was that preprinted fabric containing defects was certainly a viable approach to system evaluation and test.

Overall, the test was considered a success and offered the opportunity for both the Cherokee Finishing personnel and the lab partners to identify operational issues for the conduct of the actual Alpha test. These issues will be addressed during April in preparation for the next pre-Alpha test to be conducted in May.

Knit Inspection System (SNL, ANL, ORNL)

A Knit task group meeting was held January 16 at ITT Spartanburg - CAFE's project management met with the Industry Knit task team to discuss and review the status of the Knit Inspection task. Specifics included review of the new FY96 budget, changes in task objectives, impacts on deliverable/milestones, and a new task plan. The group agreed to leverage off of technical progress in the On-line Greige task. Milestones established for FY96 included an on-line demonstration of a capacitance knit sensor (June 1996) and some limited development of machine/needle diagnostic sensors. Also discussed was the reassignment of task leadership. The Industry Partners concurred with the proposed plan. This meeting served as the CAFE quarterly review meeting for the Knit task group.

ANL Sensor

The design of the Alpha system for the knitting task was completed and partially fabricated. A four-channel electronic system has been designed and successfully tested. A DSP board was purchased and successfully tested using detection algorithms. The fabrication of more sensors and the design of the sensor holder were canceled because the project was suspended. On-line detection algorithm and programming were also suspended.

SNL Sensor

All cabling and interconnections for the SNL knit alpha sensor-to-DSP interface were assembled. Test and checkout of the board connections were delayed by a faulty DSP board. Drawings of the mechanical mounting blocks were completed, along with two sensor mounting blocks, one made of aluminum and one made of Nylotron. The drawings and mounting blocks will be sent to Alexco for mounting on the knitting machine.

Two of the knit sensor boards were populated with components by the SNL hybrid assembly group. They are using silkscreen solder-paste application, hand component placement, and convection reflow processes. This method allows one 16-channel board to be assembled in about 4 hours and is the most efficient method for small quantity assembly.

In software, SNL continued to develop the Innovative Integration Dynamic Linked Library to Delphi interface, optimize the Interrupt Service Routine (ISR) routines for the greige and knit DSP programs, and develop a new knit ISR that will help accommodate the high-speed requirements of the knit sensing.

Economic Model (LBNL, ORNL)

A Break-Even Model final requirements meeting was held January 18. The LBNL Economic Model team met with the CAFE project management team to discuss the status and current configuration of the CAFE Economic Model. Defect Analysis and Performance Modules (ORNL) efforts were suspended until FY97.

LBNL continues to refine the Break-Even Model based on requirements established at the January 18 meeting. Final delivery of the model will be in May.

Issues, Major Problems, and Resolutions

The redistribution of funds to support the OPCon and Biotechnology projects had a major impact on the project, particularly, suspension of activities at ANL and the need to reassign the Knit task responsibility. The CAFE project team, from industry and laboratories, met and discussed these impacts. The project management team submitted a plan to compensate for these losses, while still maintaining milestones and deliverables.

Explanation of Variances

On-loom Greige Beta Test

The On-loom Greige Inspection Beta test was modified. Under the current plan, one sensor will be eliminated from the upcoming test, with all efforts suspended until the next fiscal year. The On-loom Greige Team (industry/laboratories) is currently considering which options to pursue in the next fiscal year for deployment of this fabric inspection sensor system.

Color Printed Pattern Alpha Test

Based on reduced CPPG funding for FY96, the project plan for Colorimetry and Alpha testing was modified at the January 18 partners' meeting. The modified project plan is on schedule, and the new project milestones are being met successfully.

Knit Inspection

Based on the reduced funds available for the task, two actions were taken. The first was the suspension of all efforts for FY96 on one sensor type. The second was the transfer of leadership responsibilities from LLNL to SNL.

Plans for Next Quarter

On-loom Greige Inspection System

1. Complete fabrication and building of fabric inspection sensor systems, machine diagnostics system, and Central Inspection Computer for Beta deployment.
2. Complete pre-Beta testing of inspection and machine diagnostic systems.
3. Deploy on-loom systems, complete with communication and graphical user interface, into selected sites for Beta testing.
4. Visit Beta sites for final preparation and configuration.
5. Hand off CIC responsibilities to Alexco.

CPPG Inspection System

1. Continue analysis of lessons learned and test results from pre-Alpha test 1.
2. Plan and execute pre-Alpha test 2 in May.
3. Continue to refine and improve the defect detection system algorithms and real-time implementation in preparation for the Alpha test.
4. Meet with ITT/Industry Partners/Lab task team to finalize operational plans for the Color Print Defect Detection Alpha test.

Knit Inspection System

Complete the fabrication and build of the knit sensor system, and assess progress of needle diagnostic sensor for Alpha test.

Economic Model

Deliver final Break-Even Model.

Material Marking System

Develop strategy and plan for integrating and deploying material marking system into On-loom Greige Beta test.

Invention Disclosures

None.

Publications/Presentations

Data dictionary, process flow diagrams, and Business Event Models for the Greige Inspection System are being prepared for the upcoming Beta tests.

Cotton Biotechnology

This visionary project in cotton biotechnology promises to provide revolutionary advancement in the qualities and performance of cotton fiber. By increasing tenfold the rate of progress in gene description, this project will enable scientists to improve the strength, length, and uniformity of cotton. The improvements will add an array of new product features for consumers and a competitive edge for U.S. companies in the world market.

Project Manager: Ben Burr, BNL / 516-344-3396
Project Director: Gay Jividen, Cotton, Inc. / 919-510-6122

Performance Related to Milestones

No milestones were scheduled for this period.

Activities and Technical Accomplishments for the Quarter

Molecular Markers

The goal of this task is to provide easy-to-use genetic markers that detect a high degree of polymorphism in cotton. Simple sequence repeats (SSRs) are being used as the basis for these markers. The major work in this task to date has involved discovery of these sequences; that is, DNA sequencing after obtaining populations of cotton genomic DNA clones that are enriched for the repeats. This phase of the task is now complete. Approximately 670 unique sequences with simple sequences of sufficient length have been accumulated. Oligonucleotide primers that are complimentary to sequences flanking the simple sequence repeats are now being ordered and tested on a panel of upland cotton cultivars. Plans are to assess variability in the widest possible germplasm. Dr. Daryl Bowman and colleagues prepared a table of coefficient of parentage for most cultivars. This table allowed a group of 16 varieties to be selected, including the parents of three mapping populations and one pima cotton on which primer pairs are being tested for their ability to prime show polymorphism.

Fiber Development

Previous work in this area is listed below:

1. Identified the time during unfertilized seed development at which fiber cell initiation is determined.
2. Developed a method for counting the number of fiber cells on the developing seed.
3. Learned that it is possible to estimate the biological potential for maximum fiber production for any given cultivar.

In an initial attempt to learn about the genetic control of these traits, the fiber number was measured under normal and enhanced conditions in two cultivars and their F1 hybrid. High fiber number could be traced to one parent, and the ability to enhance fiber number under optimal conditions could be traced to the other parent. Varying environmental conditions to achieve maximum fiber potential have been verified by a commercial collaborator.

Although information has been published to the contrary, Jack van't Hof has learned that the total cell number in developing ovules shows a two-phase growth curve. Initially, there is a linear relationship between the log of the cell number and the log of the bud length. However, at 2 cm the buds achieve their maximal number, which remains constant through flowering. This information is important for developing a method for precisely defining the size of a bud at different developmental stages; for instance, for estimating the size of the bud at the time of fiber determination. In addition, cell number appears to be critical for deciding which buds can be placed in culture.

To understand which plant hormones, nutrients, or environmental stimuli influence fiber initiation and fiber properties, a system was developed that would allow for expression during in-vitro culture. Although fiber cells are determined many days before the cotton flower opens, fibers are not actually expressed until two days before or after flowering, depending on the cultivar. Jack has successfully placed buds smaller than 2 cm in culture and routinely observed them to flower.

Database

The database has been invaluable in deciding which clones to resequence, which sequences to edit, and which sequences are ready for primer selection. The Brookhaven National Laboratory (BNL) team used this quarter to thoroughly check and edit the information stored in the database.

At LBNL, Donn Davy added enhancements to the database model to accommodate more types of data. Data entry support tools were adapted to these model changes.

Issues, Major Problems, and Resolutions

This January, Cotton Incorporated and the Program Office were able to defuse a funding crisis that would have essentially terminated the project by the end of the quarter. With the return of borrowed FY95 carryover funds, Cotton Incorporated purchased oligonucleotides, and the Industrial Partners paid technicians' salaries. As a result, the project will be able to continue until the end of FY96. By this time, the molecular map should be completed to help understand the factors affecting fiber expression.

Explanation of Variances

None.

Plans for Next Quarter

Molecular Markers

All primer pairs will be tested in the third quarter. Based on the level of polymorphism observed in the parents, a mapping population will be chosen and mapping will begin. Mapping with SSR markers may be supplemented with the use of a modified amplification fragment length polymorphism (AFLP) technique that has already been tested in order to supply more framework markers.

Fiber Development

Previous work at BNL showed that fibers were determined about 18 days before flowering. However, there is a difference between determination and expression, as the fibers do not appear until one or two days before or after flowering. To learn which factors are responsible for fiber expression, components will be added to immature ovules in culture to determine which components are required for fiber induction. It is already clear that high sucrose is required. In addition to varying media components, mechanical fertilization, and plant hormones, environmental factors will be tested.

F₂ populations descended from parents that differ in fiber number per seed will be assayed to learn the type of inheritance that controls this character. Do few or many genes affect the trait?

Database

In the remaining time left for this task, codes for loading data will be documented and remaining bugs will be corrected.

Invention Disclosures

None.

Publications/Presentations

Two posters were presented in January at the 1996 Beltwide Cotton Conferences in Nashville, Tennessee:

- Jack van't Hof and Sukumar Saha. "Multicellular Fibers in Cotton."
- Sukumar Saha and Jack van't Hof. "Diffuse Linear Growth of Multicellular Fibers in Cotton."

Demand Activated Manufacturing Architecture

The objective of the DAMA project is to define, develop, integrate, and deliver an electronic marketplace system/structure that can be used by all elements of the U.S. textile industry. DAMA will enable companies to reduce process requests for apparel on demand and establish new strategic alliances to create business opportunities. These steps will enhance industry productivity and competitiveness in the world marketplace.

Project Manager: Leon Chapman, SNL / 505-845-8668

Project Director: Jim Lovejoy, [TC]² / 919-380-2184

Performance Related to Milestones

Enterprise Modeling and Simulation

Milestone: *Complete fashion item product line, complex analyses, and simulation development.*

The Women's Jacket Product Line team held two meetings at Anne Klein in New York City. They investigated new product development and product introduction processes by focusing on the business steps

and business decisions through the supply chain that support the creation of a woman's jacket.

Development of the On-shore/off-shore analysis simulation continued; the simulation was demonstrated to several industry audiences during the quarter.

Connectivity and Infrastructure

Milestone: *Develop four National Information Infrastructure (NII) courses and an Electronic Data Interchange (EDI) pilot.*

The first NII course, "Textile Oriented Information Discovery on the Internet," is in Beta evaluation and should be available for first offering at the end of April.

The EDI Over the Internet pilot effort began with face-to-face meetings among the three company pairs who committed to participate: Burlington and Wellman, Ciba and Fieldcrest Cannon, and Milliken and Wellman. Each of these companies is configuring systems and interfaces to company EDI processors so that EDI messages can be exchanged over the Internet.

Cooperative Business Management Tools

Milestone: *Initiate TEXNET pilot and complete National Sourcing Database (NSDB) pilot.*

Technical progress on the TEXNET pilot has been good, but there has been difficulty in forming pilot teams within industry. Only one team had formed by the end of the quarter: Spartan Mills and Fieldcrest Cannon. One additional team is trying to form, but progress is very slow. The pilot is still expected to begin in June, but may only be with one team.

The design team reviewed the first version of the new stand-alone NSDB with the Auburn database. A data entry program prototype for the EC '96 that lists companies was completed and demonstrated at an Associate Member Congress EC '96 meeting on March 26.

Milestone: *Define requirements and prototype a supply-chain production and inventory tool.*

The preliminary design packages and requirements documents for the Supply Chain Integration Prototype (SCIP) were completed. This March 1996 milestone for preliminary design package was accomplished in March.

Education, Outreach, & Commercialization

Milestone: *Plan and commercialize the National Sourcing Database.*

Preparation of the general commercialization plan has been delayed until June. Education, Outreach, and Commercialization (EO&C) has been without a permanent task leader for most of the quarter. In addition, emphasis has been placed on specific commercialization plans for the NSDB, which has a commitment from DAMA to the American Apparel Manufacturers Association Associate Member Congress.

The recently produced DAMA video was honored to receive a national Telly award as the most outstanding entry in the commercial category.

Project Administration and Dual Use

Milestone: *Demonstrate DAMA dual use.*

Two dual benefit activities have been identified: 1) life cycle approach to DOE Defense Programs product realization and 2) TEXNET model for distributed SNL procurement databases. Development has begun, and demonstration in FY96 is anticipated.

Activities and Technical Accomplishments for the Quarter

The following accomplishments are in addition to those previously reported and are provided by DAMA task area.

Enterprise Modeling and Simulation

Work continued this quarter on developing the ITC Business Structure simulation software. Progress was made both in additional functionality and improved user interface features. Demonstrations of EMSim (the software) and discussions were held with several groups, including IQ-1996, the Operating Boards of [TC]², AMTEX, Mercantile, and Milliken & Company.

Task leader, Jane Macfarlane, resigned from LBNL effective March 29. Jon Stanley is the acting EM&S Task Manager.

Connectivity and Infrastructure

Wellman is the first company to actively pursue C&I's Intranets Pilot. The goal of this pilot is to demonstrate the benefits of using World Wide Web technology within an enterprise to share internal information.

In cooperation with [TC]², C&I technical staff gave a hands-on Internet Tools Workshop at Milliken, January 26 and January 29. [TC]² gave the class March 29 and will continue to offer future fee-based courses.

C&I technical staff's main efforts continued to be supporting the TEXNET pilot effort in collaboration with CBM.

Cooperative Business Management

The Data Analysis and Modeling Effort (DAME) requirements document was reviewed and completed this quarter. The team will begin modeling the decision processes and data flows and prototyping a user interface in April.

DAME also began an analysis of the EM&S product flow charts and order process. Industry participants will validate entity relationship and data flow diagrams.

The NSDB Design Review was held February 29 at ORNL.

The TEXNET design was studied to determine if NSDB can fit into, and benefit from, the TEXNET architecture. TEXNET's security requirements preclude significant integration of NSDB into TEXNET.

Education, Outreach and Commercialization

Ivan Markowitz was hired as the new EO&C task leader. He was previously Vice President and General Manager of the cutting business at Gerber Garment Technology, Incorporated.

DAMA exhibited at IQ-1996, March 18-20, in Chicago. Three demonstrations were offered: on-shore/off-shore sourcing analysis, TEXNET, and the National Sourcing Database. Twenty leads were generated, including Levi, Manugestics, JBA, and Karman Inc.

Product Administration and Dual Use

DAMA continued to react to FY96 budget reductions throughout the quarter. DAMA funding was at \$11,290,000 in January, and is currently at \$8,750,000, with 5 alterations experienced during this period.

A DAMA Advisory Committee meeting was held February 13 at [TC]², Cary, North Carolina; and a Steering Committee meeting was held March 20 in Chicago after IQ-1996.

An update to the DAMA Management Plan (Version 1.2) was printed and distributed. The FY96 DAMA Project Plan Version 1.0 (DAMA-I-12-95) was printed and distributed.

Issues, Major Problems, and Resolutions

Enterprise Modeling and Simulation

The recent \$415,000 funding reductions to EM&S have resulted in cutbacks in efforts associated with Process Step Map synthesis/consolidation, modeling/simulation support from Pacific Northwest National Laboratory (PNNL), mass customization analysis, and wrap-up of the "Best Practices" report. Staff losses to EM&S have occurred at both PNNL and LBNL.

Cooperative Business Management

Recent CBM budget reductions at LANL (from \$500,000 to \$260,000) have resulted in insufficient funds to conduct useful work in forecasting and still provide the required LANL support in the SCIP and DAME areas. The forecasting effort will be curtailed until FY97.

Funding reduction at ORNL (from \$750,000 to \$650,000) will impact the NSDB deliverables to the American Apparel Manufacturers Association. Alternatives are being reviewed.

Explanation of Variances

There are no additional variances beyond those covered above in "Performance Related to Milestones."

Plans for Next Quarter

Enterprise Modeling and Simulation

Development of the ITC business structure simulation software will continue as the primary effort. The product line investigation team for the Women's Fashion Item will complete the process step mapping. The current focus of EM&S will be reviewed, and direction for FY96 and FY97 will be formulated. The search for a new task leader will be initiated.

Connectivity and Infrastructure

Three NII courses will be developed and made available to DAMA partners. The EDI over the Internet Pilot will start the actual piloting process.

Cooperative Business Management

The TEXNET piloting will begin in June, with one or two teams participating. The SCIP and DAME tasks will conduct technical design reviews. Detailed design and development of the SCIP and DAME will begin. The NSDB will begin wrapping up the pilot effort.

Education, Outreach, and Commercialization

Work on marketing DAMA will continue. Additional outreach materials will be developed and distributed. Efforts to commercialize the NSDB will also continue.

Product Administration and Dual Use

The dual benefit activities will continue to be developed, and design requirements will be refined. The 1995 annual report will be completed and distributed. Project plan preparation for FY97 will begin.

Invention Disclosures

None.

Publications/Presentations

Publications:

None.

Key Presentations:

- Jane Macfarlane gave a presentation at the January National Textile Center (NTC) Forum on the EM&S task findings to date.
- Jim Lovejoy gave the DAMA overview presentation at the Pentagon and a DAMA and NSDB overview to the AAMA Associate Member Congress in New York.

- Jim Lovejoy gave the Internet tutorial and a demonstration to the American Apparel Manufacturers Association (AAMA) Quick Response Leadership Conference in Miami, Florida.
- Jane Macfarlane gave a simulation software demonstration to NTC Researchers at Milliken on February 19.
- Ken Washington and Jane Macfarlane presented papers on EM&S and CBM activities at the IQ-1996 conference in Chicago on March 19.

On-Line Process Control in Flexible Fiber Manufacturing

The OPCon project's goal is to strengthen the worldwide competitive position of U.S. fiber manufacturers by identifying and developing technology that provides the means for 1) faster transition between products, 2) efficient production of small lots, and 3) improved economics by eliminating off-quality production and off-line testing.

Project Manager: Marc Simpson, ORNL / 423-574-4171
Project Director: Jack Scruggs, TRI / 864-627-8040

Performance Related to Milestones

Polymer Rheology milestones were canceled with the closure of work at LANL, and the FY96 milestones for the Crimp project at PNNL are postponed until FY97.

The Alpha test of the on-line near infrared sensor has changed to an industry-site test of the static finish measurement system for the Finish task. The Alpha test of the near infrared and the Beta test of the on-line finish-on-yarn measurements have been moved to FY97.

The preliminary dynamic tests (Alpha test with a draw unit at DuPont) will take place as scheduled in the Morphology task.

Activities and Technical Accomplishments this Quarter

The AMTEX IOB met on Thursday, March 21, to discuss shortfalls in the present DOE-Energy Research AMTEX FY96 funding. Lacking the additional funding expected from DOE, the IOB decided that it was important to keep the momentum in all present AMTEX projects and to redirect funds from other AMTEX projects to cover activities in OPCon and Cotton Biotechnology. These redirected funds for OPCon will be \$190,000, which is not enough to fully support all projects.

The redirected funds should begin arriving at the Labs in April so that principal investigators can resume activities.

On March 17, in preparation for the IOB meeting, the OPCon Industry Board discussed, via a conference call, how to handle limited resources within the OPCon project. Following are the recommendations that came from the conference call:

1. Discontinue the work on Polymer Rheology because the technical approach appears unlikely to lead to the results industry wants.
2. Postpone the Crimp task until new monies arrive in FY97. The Industry Board felt that the Crimp task was making good progress and had a very innovative approach, but that the time and effort required to achieve the results industry wanted would be greater than in the Finish and Morphology tasks.
3. Concentrate all efforts for the balance of FY96 on the Finish and Morphology tasks, which have shown an indication of introducing some exciting new technology to the fiber industry. Concentrating on these two tasks should enable OPCon to maintain momentum and maximize the chances of achieving early deliverables.

Following are highlights of the technical activities within each of the four OPCon tasks.

Fiber Cut and Crimp

By combining 2D images with surface topology maps, PNNL has demonstrated the first measurement of 3D fiber shape on a tow bundle. This result from the Crimp task represents a major accomplishment because the tow itself is measured without the need to extract single fibers. PNNL is now investigating ways to benchmark and validate the 3D crimp shape measurements. Task participants are receiving white papers describing literature in the area of crimp characterization and providing details on the 3D fiber shape technology.

Finish Oil and Moisture

The Finish task meeting, hosted by Amoco in Atlanta, was held on January 16, 1996. Participants received an overview of the research ORNL is conducting in finish measurements, as well as a demonstration of a benchtop instrument in measuring finish level on spools of filament with potential for at-line use. Questionnaires were distributed to attendees and mailed to OPCon Industry Partners not attending the meeting to solicit input on the usefulness of the different technologies being investigated in the Finish task, as well as input concerning future FY96 efforts. Results of the industry poll indicate

that the development of an instrument for at-line finish measurements and one for on-line measurements should be emphasized.

Fiber Morphology

Models developed at PPPL under the Fiber Morphology task have shown good correlation between observed features in scattered patterns and measured fiber diameters (within 3%). In addition, the models are providing insight for determining which regions within a fiber are contributing to the scattering. These calculations point to the viability of making birefringence measurements as a function of depth within a fiber.

Polymer Rheology

Measurements were made with acoustic sensors in direct contact with the polymer at elevated sensors. Several other techniques were also investigated to extend the rheology measurements to a broader range of textile materials. It appears at this point that these measurements will not match the present needs of the participating fiber manufacturers.

Issues, Major Problems, and Resolutions

Currently, the FY95 carryover funds for OPCon have been expended or committed. FY96 funding for OPCon principal investigators should arrive in April.

Explanation of Variances

None.

Plans for the Next Quarter

A combined industry/laboratory OPCon meeting will be held on April 18, 1996, at the Hoechst Celanese Research Center in Charlotte, North Carolina. The meeting will again provide a forum for information exchange between industry and laboratory partners. Break-out sessions at the meeting will be chaired by the individual task principal investigators to review progress on the tasks and refine FY96 goals and activities in lieu of the present AMTEX budget constraints. Finish, Crimp, Morphology, and Rheology task meetings are also planned before the April meeting.

Scheduled technical activities next quarter include further work on static finish on product measurements for the Finish task and lab scattering measurements on more samples for the Morphology task.

Projected FY96 deliverables for OPCon include alpha test of the Morphology task scattering instrument at DuPont and an in-plant demonstration of the static finish on product instrument in the Finish task.

Invention Disclosures

None.

Publications

None.

Rapid Cutting

The Rapid Cutting (RCUT) project is developing a new generation of cutting systems and technological advancements in current systems that will improve cutting quality and efficiency. Such systems will enable true demand-activated manufacturing of apparel. The RCUT project consists of six national laboratories, each with laser and optical technologies appropriate for the mechanical cutting of textiles using new materials and photonics.

All teams were actively involved with their tasks during this quarter.

Project Manager: Craig Fong, LBNL / 510-486-5298

Project Director: Jim Caldwell, [TC]² / 919-380-2156

Performance Related to Milestones

No milestones were established for the balance of FY96.

Activities and Technical Accomplishments for the Quarter

Industry and laboratory project leaders are reviewing the year-end technical report. It has not been released to the general RCUT partnership.

Issues, Major Problems, and Resolutions

None.

Explanation of Variances

None.

Plans for Next Quarter

Complete and release the final version of the RCUT year-end report.

Invention Disclosures

None.

Publications/Presentations

None.

Sensors for Agile Manufacturing

The Sensors for Agile Manufacturing (SFAM) project team is developing sensors that will allow the automation of sewing processes to improve product quality and process productivity in the apparel manufacturing sector of the U.S. textile industry.

Project Manager: Kevin Widener, PNNL / 509-375-2487
Project Director: Jim Caldwell, [TC]² / 919-380-2156

Performance Related to Milestones

None.

Activities and Technical Accomplishments for the Quarter

Mechanical shops at SNL have designed a new metal folder that can readily accept the felled seam sensor. The printed circuit board shop will install these sensors during the third quarter of this year. Once this is complete, the folder with sensors will be reassembled on a sewing machine and tested in an industrial facility.

The edge sensor design has been transferred to [TC]² and they have provided the information to Industrial Partners. Russell Corporation is currently working on a sensor and testing it on their fabric, with SNL providing technical support. SNL is also working on a test sensor for Levi Strauss & Company, who has sent some samples of pocket

material for their application. Tests on this material have been successful, and Tom Weber will be traveling to their Technical Center in April to try the sensor out on their machine. This builds on the work last summer to control the serging sewing machine, using the edge sensor at SNL in the sewing lab. If these tests are successful, Levi Strauss will be putting these sensors on its machines.

Because of FY96 funding reductions, the Advanced Sewing Sensors task was postponed indefinitely.

Issues, Major Problems, and Resolutions

None.

Explanation of Variances

None.

Plans for Next Quarter

Continue the development of the fabric edge and second generation felled seam sensors at SNL. Document and file the work on the advanced sewing sensors so that it can be restarted at a future date if funding is restored.

Invention Disclosures

No invention disclosures were filed this quarter. An invention disclosure on felled seam sensing is currently pending at SNL.

Publications/Presentations

None.

Textile Resource Conservation

The objective of the TReC project is to define, develop, integrate, and deliver processes, devices, and techniques to be used by all elements of the U.S. textile and soft goods product chain to enhance environmental quality and minimize the production of wastes.

Project Manager: Paul Farber, ANL / 708-252-6522
Project Director: Don Alexander, ITT / 864-595-0035

Performance Related to Milestones

Performance related to milestones has been, for the most part, satisfactory during the present quarter, with future progress dependent upon the availability of funding. The development of metals speciation analytical methods is proceeding according to schedule. The testing of the metals speciation techniques at ANL in concurrence with the American Textile Manufacturers Institute (ATMI)/EPA metals testing program, however, is strongly dependent upon the industry's supplying chemists for assistance in analyzing samples and a professor from a textile university to assist in technology transfer activities. The Alternative Cleaning task has basically stopped because of a lack of funding, as has the Fibrous Solid Waste task and a part of the Recovery of Colorants and Air Emissions Monitoring and Reduction tasks.

Activities and Technical Accomplishments for the Quarter

Work in the TReC project has continued, although many task efforts have temporarily ceased because of funding shortages.

Under the Recovery of Colorants task, salt recovery results have been consistently good as the experiments continue to determine the parameters necessary for the in-plant trial. A meeting was held with one of the partners, at their corporate headquarters, to quantify the scope of the field test to be held at that site. Enhanced-membrane flow tests continued with the proof of concept for recovery of valuable enzymes (used in the garment manufacturing sector of the industry) having been proven out. The field tests for this technology may be at three separate facilities: one for dye recovery, one for polyvinyl alcohol recovery, and one for the enzyme recovery process. Investigators have been pursuing ways of reducing operating costs of a process for extracting dye from spent dye-bath solutions. Because of the great affinity of dyes for the extractant-rich phase, a single extraction stage seems to be capable of producing a colorless-salt stream. With the proper modification to the flowsheet, a single settling tank can be used in place of the Karr column used in past laboratory studies.

The Fibrous Solid Waste Recovery task did not proceed during this quarter because of lack of funding.

Metal speciation work at Argonne has been on hold, pending the availability of chemists from the industry to assist in analyzing samples from the ATMI/EPA Metals Program and to conserve funding. Metals speciation work at SNL has proceeded, and the textile industry is making arrangements to have a professor from one of the textile universities visit SNL to help transfer the metals speciation technology to the industry.

Air emissions monitoring progress is delayed because of funding shortages. LANL is proceeding with work on the Zeeman Refractive Index monitor but is critically low on available funding. Work at Argonne on the CERMET sensor, as well as the quantification of results from the field test, is being delayed until FY97 when new funding will be available.

Low waste chemical applications work is proceeding, and ORNL has made good progress with an efficient technique for yarn coating. Chemicals needed for yarn coating are expected to be received from the textile partners and will help continue this research. The low water washing system under development at the LLNL has advanced far enough to begin constructing an 18"-wide unit for more laboratory and then in-plant testing.

Alternative Cleaning Technologies has put all activities on hold because funding from the efforts at the Idaho National Engineering Laboratory has been withdrawn, and small amounts of funding available at the PNNL and the ANL have been depleted.

Samples of existing software for Environmental Decision Tools have been accumulated by the PNNL task coordinator. Selected pieces of this software have been forwarded to one of the partners for evaluation during a major plant reconstruction.

The Slashing Initiative is proceeding with device set-up and testing scheduled to start-up in April. However, some pressure transducers and the wind-up device needed to set up the experiments have not arrived. To stay on schedule, the textile partners will need to receive this equipment by mid-April.

Issues, Major Problems, and Resolutions

Issues this quarter primarily center around the concerns for FY96 funding for continuation of tasks of interest and need by the industry. An additional issue again this quarter, which has been presented to the Industry Partners for resolution, is the need to ascertain sites for upcoming in-plant tests of colorants recovery and the arrangements for ensuring that needed in-plant test equipment will be available.

Explanation of Variances

Variances in milestones and deliverables from the project plan are major. The variances are due to the great reduction in anticipated FY96 funding. The result of the delayed funding information has been that effort during the first half of the fiscal year has almost exhausted

funding at many laboratories, resulting in a shutdown of many task efforts.

Plans for Next Quarter

Next quarter, tasks that still have funds will continue their programs with directions from the Industry Partners. Work in recovery of colorants will be placed on hold to conserve funds for the expected field tests in the final quarter of the fiscal year.

Invention Disclosures


None.

Publications and Presentations

None.

FINANCIAL SUMMARY

Appendix A contains program financial summary information.

Budget removed 

No. of
Copies

230

Offsite

180 Fletcher Adamson, Vice President
R&D, Russell Corporation
P.O. Box 272
Alexander City, AL 35010-0272

Don Alexander, Director
Institute of Textile Technology
775 Spartanburg Blvd Suite 104
Spartanburg, SC 29301

John Alexander
Idaho National Engineering Laboratory
P.O. Box 1625
Idaho Falls, ID 83425-2214

Glenn Allgood, CAFE Project Mgr. (2)
Oak Ridge National Laboratory
P.O. Box 2008 Bldg 3500 MS: 6007
Oak Ridge, TN 37831

James Anderson
U.S. Department of Energy
Albuquerque Operations Office
P.O. Box 5400
Albuquerque, NM 87185-5400

Robert A. Barnhardt, Dean
College of Textiles
North Carolina State University
P.O. Box 8301
Raleigh, NC 27693-8301

Prakash Bhatt, Vice President
Business System
VF Corporation
P.O. Box 1022
Reading, PA 19603-1022

Diane Bird
U.S. Department of Energy, DP-14
1000 Independence Avenue
Washington, DC 20585

E.P. Blanchard, Jr.
P.O.Box C
Maple Springs, NY 14756

Paul Braxton, Vice President
Textile Products Group
Cone Mills
3101 N. Elm Street
Greensboro, NC 27408

Hal E. Brockmann
Special Projects
Cotton Incorporated
4505 Creedmoor Road
Raleigh, NC 27612

Edward Burgess, Director Engineering
Lawrence Berkeley National Laboratory
One Cyclotron Road/MS:90-1106
Berkeley, CA 94720

Ben Burr, Cotton Bio Project Mgr. (2)
Brookhaven National Laboratory
53 Bell Avenue
Upton, NY 11973

Peter N. Butenhoff, President (20)
Textile/Clothing Tech Corporation [TC]²
211 Gregson Drive
Cary, NC 27511-7909

Jim Caldwell, Industry Project Manager
Textile/Clothing Tech Corporation [TC]²
211 Gregson Drive
Cary, NC 27511-7909

Randy Chang
U.S. Department of Energy
Oakland Operations Office
1301 Clay Street 7th Floor
Oakland, CA 94612-5208

Leon Chapman
DAMA Technical Project Manager
Sandia National Laboratory
P.O. Box 5800 / MS: 0722
Albuquerque, NM 87185

Helena Chum, Director
Renewable Chemical Tech/Materials Lab
National Renewable Engineering Lab
1617 Cole Boulevard
Golden, CO 80401-3393

Alan Claflin, Director
Laboratory Management Division
U.S. Department of Energy/ER-32
19901 Germantown Road
Germantown, MD 20874

Deborah Clayton
Technology Transfer
Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439

Jerry Cogan Jr., President
Milliken Research Corp.
P.O. Box 1927
Spartanburg, SC 29304-1927

Harry Collins
Vice President of Research
Delta & Pine Land Company
P.O. Box 157
Scott, MS 38772

Fred L. Cook, Director
School of Textile &
Fiber Engineering
Georgia Institute of Technology
725 Atlantic Drive
Atlanta, GA 30332-0295

Joe D. Cunning, Director
National Textile Center
3640A Concord Pike Rm 201
Wilmington, DE 19803

George C. Dacey
1123 Bernalillo Place
Albuquerque, NM 87123

Pat Danahy, President & CEO
Cone Mills
1201 Maple Street
Greensboro, NC 27405

Joe DaSilva
U. S. Department of Energy
Brookhaven Area Office
53 Bell Avenue
Upton, NY 11973

James Davenport, Chair
Applied Science Department
Brookhaven National Laboratory
2 Center Street/Bldg 179 A
Upton, NY 11973-5000

Thomas M. Duff, President
Fibers Division
Wellman, Inc.
1040 Broad Street, Suite 302
Shrewsbury, NJ 07702

Gail Eaton, Executive Director
Textile Research Institute
P.O. Box 625
Princeton, NJ 08542

Paul Farber, TRcC Project Manager (2)
Argonne National Laboratory
9700 South Cass Ave/ES-362/C205
Argonne, IL 60439

Douglas Faulkner (3)
DOE-EE/FORSTL 5F-035
1000 Independence Avenue SW
Washington, DC 20585

Ritchie Fishburne, Director
Corporate Information Systems
Burlington Industries
P.O. Box 21207
Greensboro, NC 27410

James M. Fitzgibbons, Chairman & CEO
Fieldcrest Cannon, Inc.
One Lake Drive
Kannapolis, NC 28081

Ronald Foltz, VP Technology
Hoechst Celanese Corporation
P.O. Box 32414
Charlotte, NC 28232-9973

Craig Fong, Rapid Cutting Proj. Mgr. (2)
Lawrence Berkeley National Laboratory
1 Cyclotron Road, MS: 90-2148
Berkeley, CA 94720

Jean Ford, Program Manager
CAIS / PDES Testbed
Nat'l Institute of Standards Technology
U.S. Department of Commerce
Metrology 220/A127
Gaithersburg, MD 20899

Donald Foster, Technology Leader
Lawrence Berkeley National Laboratory
1 Cyclotron Road: 90-2148
Berkeley, CA 94720

Cheryl Fragiadakis
Lawrence Berkeley Laboratory
One Cyclotron Road / MS: 90-1070
Berkeley, CA 94720

Jim Frede
Mercantile Stores Company, Inc.
9450 Seward Road
Fairfield, OH 45014-2230

Steve Freudenthal, Project Manager (5)
Milliken & Company
P.O. Box 1926, M-149
Spartanburg, SC 29304

Mike Furey
Brookhaven National Laboratory
53 Bell Avenue
Upton, NY 11973

Allen Gant, Jr, President
Glen Raven Mills, Inc.
1831 North Park Ave.
Glen Raven, NC 27217

Roger Gilbertson
Program Manager for Basic Research
U.S. Department of Commerce
Mail Code Otxa-H3100
Washington, DC 20230

Rudy Goetzman
Economic Development Division
Westinghouse Savannah River Company
PO Box 616
Aiken, SC 29808

J. Nicholas Hahn, President & CEO
Cotton Incorporated
1370 Avenue of the Americas
New York, NY 10019

William Hamlett
Fieldcrest Cannon
One Lake Drive
Kannapolis, NC 28081

June M. Henton, Dean
School of Human Sciences
Auburn University
210 Spidle Hall
Auburn, AL 36849

Gay Jividen, Cotton Bio Project Manager
Cotton Incorporated
4505 Creedmoor Road
Raleigh, NC 27612

Mark Kametches, CAFE Project Mgr.
ITT Technology Transfer Center
Point West Office Bldg./ Suite 203
775 Spartan Blvd.
Spartanburg, SC 29301

David Koegel
U.S. Department of Energy / ER-32
19901 Germantown Road
Germantown, MD 20874

Martha Krebs, Director
Office of Energy Research
U.S. DOE, ER-1/7B-058
1000 Independence Avenue
Washington, DC 20585

Glenn W. Larsen, Executive VP
Mfg. & Operations
Biltwell Company, Inc.
2005 Walton Road
St Louis, MO 63114

H. Vernon Lemaster, President
Textile Products Group
Ciba-Geigy Corporation
P.O. Box 18300
Greensboro, NC 27419-8300

Darryl Lindsey
Plains Cotton Cooperative Association
P.O. Box 2827
Lubbock, TX 79408-2827

Stuart Loken
Lawrence Berkeley National Laboratory
1 Cyclotron Road, MS 50B-4230
Berkeley, CA 94720

Jim Lovejoy, DAMA Project Director
Textile/Clothing Tech Corporation [TC]²
211 Gregson Drive
Cary, NC 27511-7909

Pete Lyons
Los Alamos National Laboratory
P.O. Box 1663 / SM-30 Warehouse
Bikini Atoll Road / MS: J564
Los Alamos, NM 87545

Roger Malkin, Chairman
Delta and Pine Land Company
One Cotton Row
P.O. Box 157
Scott, MS 38772

Thomas Malone, President & COO
Milliken & Company, Inc.
P.O. Box 1926, MS-149
Spartanburg, SC 29304

George Manthey
U.S. Department of Energy
Oak Ridge Operations Office
P.O. Box 2001
Oak Ridge, TN 37831

Kathleen McCaughey, Director
SNL AMTEX Programs/Dept. 2700
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185-0507

Linda McCoy
U.S. Department of Energy
Idaho Operations Office
785 DOE Place
Idaho Falls, ID 83402

Dan McCreight, Vice President
Institute of Textile Technology
2551 Ivy Road
Charlottesville, VA 22903-4614

Daniel McDonald, Director
Instrumentation & Control Division
Oak Ridge National Laboratory
P.O. Box 2008, Bldg. 350
Oak Ridge, TN 37831-6005

Charles McKeller, Vice President
Glen Raven Mills
1831 North Park Ave.
Glen Raven, NC 27217

Lewis Meixler, Head
PPPL Office of Technology Transfer
P.O. Box 451
Forrestal Campus, Route 1
Princeton, NJ 98543

Mark Miller (5)
U.S. Department of Energy/DP 14
Lockheed Martin Energy Systems
P.O. Box 2009
Knoxville, TN 37831

Roger Milliken, Chairman & CEO
Milliken & Company
234 S Fairview Ave.
Spartanburg, SC 29302

David Nelson
Office of Energy Research
U.S. Department of Energy/ER-30
19901 Germantown Road
Germantown, MD 20874

David L. Nichols, Chairman & CEO
Mercantile Stores Company, Inc.
9450 Seward Road
Fairfield, OH 45014-2230

Joseph W. A. Off
Managing Director
Textile/Clothing Tech Corporation [TC]²
211 Gregson Drive
Cary, NC 27511-7909

Angela Padilla
U.S. Department of Energy
Albuquerque Operations Office
P.O. Box 5400
Albuquerque, NM 87185-5400

Patty Padilla
U.S. Department of Energy
Albuquerque Operations Office
P.O. Box 5400
Albuquerque, NM 87185-5400

Susan Palk
DOE GC-62 (FORSTL) MS 6F-067
1000 Independence Avenue
Washington, D.C. 20585

Lucien Papouchado
Savannah River Technology Center
P.O. Box 616
Aiken, SC 29802

Homi B. Patel, President
Hartmarx Corporation
101 N Wacker Drive 23rd Floor
Chicago, IL 60606

Pete Pesenti, Sr. Research Engineer (10)
U.S. Department of Energy/ER-32
19901 Germantown Road
Germantown, MD 20874

Norman D. Peterson, Special Assistant
Strategic Planning Group
Argonne National Laboratory
9700 South Cass Ave./OTD
Argonne, IL 60439

Charles Pietri
U.S. Department of Energy
Chicago Area Office
9800 South Cass Avenue
Argonne, IL 60439

Martin Piltch
Materials Science & Technology
Los Alamos National Laboratory
P.O. Box 1663/SM-30 Warehouse
Bikini Atoll Road MS G548
Los Alamos, NM 87545

Richard Quisenberry (20)
Executive Director
AMTEX Industry Program Office
P.O. Box 4670
Wilmington, DE 19807

David Rae, Vice President
Nylon Technology.
E.I. du Pont de Nemours & Co.
P. O. Box 88025
Wilmington, DE 19807

John Renfro, Jr, Vice President
Inman Mills
P.O. Box 207
Inman, SC 29349

Victor Reis, Assistant Secretary
for Defense Programs
U.S. Department of Energy/DP-1/4A019
1000 Independence Avenue
Washington, DC 20585

Mike Riley, EEF Project Manager (2)
Lawrence Livermore National Laboratory
7000 East Ave. L-39
Livermore, CA 94583

Douglas V. Rippy, Director
School of Textiles/Clemson University
Clemson, SC 29631

Art Roth, President
Cookson Fibers, Inc.
P.O. Box 8930
Bristol, VA 24203

Burton B. Ruby
Chairman
Trans-Apparel Group
5000 S Ohio Street
Michigan City, IN 46360

Virgil Sanders
Los Alamos National Laboratory
CST-2, MS J567
P.O. Box 1663
Los Alamos, NM 87545

Preston E. Sasser, Sr. Vice President
and Managing Director of Research
Cotton Incorporated
4505 Creedmoor Rd.
Raleigh, NC 27612

Norm Sather, Director
Energy Systems Division
Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439

Nancy Saxer
Office of Technology Transfer
Lawrence Berkeley Laboratory
One Cyclotron Road / MS: 90-1070
Berkeley, CA 94720

Jack Scruggs, OPCon Project Mgr. (2)
Textile Research Institute (TRI)
614 Devenger Rd.
Greer, SC 29650

Marc Simpson, OPCon Project Mgr. (2)
Oak Ridge National Laboratory
P.O. Box 2008 / MS: 6004
Oak Ridge, TN 37831-6004

Irving Stowers
Science & Technology Advisor
Lawrence Livermore National Laboratory
7000 East Ave., MS L-644
P.O. Box 808
Livermore, CA 94551

John Sullivan, Vice President
Business Development
Hoechst Celanese Corp.
P.O. Box 32414
Charlotte, NC 28232

William Toth (7)
Idaho National Engineering Laboratory
P.O. Box 1625
Idaho Falls, ID 83415-2214

Joseph C. Tucker, Vice President
Manufacturing and Technical
Wellman, Inc.
P.O. Box 31331
Charlotte, NC 28231

James Van Fleet, Director
Off. of Econ. Competitiveness/DP 4.1
U.S. Department of Energy
Defense Programs
1000 Independence Avenue
Washington, DC 20585

Brian Volintine / EE-223
U.S. Department of Energy
1000 Independence Ave
Washington, DC 20585

George Waldrep, Exec. Vice President
Corporate Group
Burlington Industries
P.O. Box 691 / 906 Anthony St.
Burlington, NC 27216-0691

William K. Walsh, Head
Textile Engineering Department
101 Textile Building, Auburn University
Auburn, AL 36830

Ted Waroblak, President (5)
Institute of Textile Technology
2551 Ivy Road
Charlottesville, VA 22903-4614

Frank X. Werber, Nat'l Program Leader
U.S. Department of Agriculture
Bldg. 005/ Rm 221 Barc-W
Beltsville, MD 20705

Pete Woody, Director R&D
Wellman, Inc.
P.O. Box 31331
Charlotte, NC 28231

No. of
Copies Onsite

50 Pacific Northwest National Laboratory

E. G. Baker	P8-38
C.R. Batishko	K5-25
D.M. Boyd	K5-02
M.L. Brown	K8-28
M.D. Erickson	K7-02
B.A. Garrett	K8-09
R.W. Gilbert	K5-17
J.M. Hamm	K1-39
B.J. Harrer	K9-21
P.S. Kaae	K8-23
D.K. Lemon (25)	K8-21
J.R. Lewis	K7-10
W.J. Madia	K1-46
G.B. Morgan	K5-02
R.E. Rhoads	K5-02
J.T.A. Roberts	K9-78
K.B. Widener	K5-17
W.R. Wiley	K9-95
G.L. Work	K1-40
Information Release (7)	K8-55